SUPPLY RESPONSE FOR RICE
IN INDONESIA

By

M. MUHARMINTO

Economist
Gajah Mada University
Yogyakarta, Indonesia
1967

Master of Agricultural
Development Economics
Australian National University
Canberra, Australia
1981

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
July, 1990

SUPPLY RESPONSE FOR RICE

IN INDONESIA

Thesis Approved:

Daniel D. Badger
Thesis Adviser

Dean F. Schreiner

[illegible]

David M. Henneberry

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

I am deeply indebted especially to Dr. Daniel D. Badger, my major adviser, for his guidance and encouragement throughout this study, and for his kindness and understanding during my doctoral program. I would like to express my sincere appreciation to the other members of my graduate committee, Dr. Dean F. Schreiner, Dr. David M. Henneberry, Dr. David L. Weeks, and Dr. William D. Warde for their helpful assistance and comments. A word of thanks is also due to Mrs. Janet Barnett for her excellent typing of the preliminary drafts and the final copy of this dissertation.

Special appreciation is extended to the Indonesian Government for awarding me financial support and to Winrock International for its administrative support during my Doctorate degree program at Oklahoma State University.

Finally, I am especially grateful to my wife Renny, and to my son Rudy, to whom this dissertation is dedicated, for their encouragement and sacrifices; without them, completion of this dissertation would have been impossible.

TABLE OF CONTENTS

LIST OF TABLES

Table		Page

Table | Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Agriculture plays a very important role in Indonesia's economic development. It also has become a key factor increasing the income of the people, and it employs more than half the workers in the economy. At constant 1983 market prices, agriculture's contribution to Gross Domestic Product (GDP) increased from 14,381.2 billion rupiah in 1978 to 19,687.0 billion rupiah in 1986; however agriculture's share of GDP decreased from 24.7 percent to 23.9 percent (Table I). Food crops account for about 61 percent of the contribution of the agricultural sector GDP in 1986. During the 1978-1986 period, agricultural sector GDP grew at the rate of 4.1 percent per year, while the food sector GDP grew at a 4.9 percent rate per year. During this period the entire economy achieved a growth rate of 4.6 percent in GDP per year.

The largest contributor to the growth in the food crop and agricultural sectors has been rice. Rice production increased by 121 percent from 1968 to 25,825 million tons in 1984, when Indonesia became self-sufficient in the crop for the first time. This remarkable feat has been achieved in significant part due to government policies in support of rice production. Investment in expansion and improvement of irrigation systems, and in research capacity, rice intensification programs, rice price supports, fertilizers subsidies, and investment in the rural infrastructure have been the main government policies for expanding rice production in Indonesia.

TABLE I

SECTORAL COMPOSITION OF GROSS DOMESTIC PRODUCT (GDP)
AT CONSTANT 1983 MARKET PRICES FOR SELECTED
YEARS, INDONESIA (BILLION RUPIAH)

Sector	1978	1983	1984	1985	1986
1 Agriculture	14,381.2	17,696.1	18,431.1	19,209.0	19,687.0
2 Mining & Quarrying	16,363.8	13,967.9	14,788.7	13,980.5	14,572.0
3 Industry	5,107.5	8,211.3	9,770.3	10,579.1	11,161.5
4 Electricity, Gas, Water	243.7	524.3	550.3	594.9	633.7
5 Construction	2,904.1	4,597.2	4,393.8	4,508.0	4,197.6
6 Trade	8,231.6	12,009.4	12,159.7	12,363.0	12,730.3
7 Transport & Communications	2,505.8	3,978.0	4,442.4	4,481.8	4,541.6
8 Others	8,452.2	12,713.3	13,608.1	14,194.5	14,650.8
Gross Domestic Product	58,189.9	73,697.6	78,144.4	79,910.8	82,474.5

Source: Central Bureau of Statistics, Statistical Year Book of Indonesia, 1987.

A separation between Java and Off-Java, the islands outside Java (Figure 1), in analyzing plans and results of development efforts in Indonesia is very important and beneficial. Java is one of the most densely populated areas in the world. While occupying only 7 percent of the land area of Indonesia, Java has about 64 percent of the population. The majority of the farmers in Java are small farmers, operating half a hectare of land or less. About 40 percent of all the agricultural land is in Java, because the majority of the soils in Java are volcanic in origin and are lowland alluvial soils, which are relatively fertile compared with Off-Java. By contrast, Off-Java islands are relatively under populated with large areas of forest and savannah lands. The majority of the soils are organosol and podsolic soils, which are less fertile.

Due to the dense population and the relatively fertile soils in Java, most of the food crops in the country have been produced on this island. Java dominates rice production and throughout the period 1969-1986, it has accounted for over 50 percent of area harvested and about 60 percent of production. Due to the growth of population and the growth of industries, land for food crop production in Java cannot be expected to increase in the future.

In "Survey of Recent Developments", Evans reported that the food crop sector, dominated by rice, is unlikely to provide much growth in the near future, and could exacerbate the balance of payments problems. Recent 'Surveys' reported on the poor 1987 rice harvest and the fact that domestic prices have risen considerably despite extensive market operations by BULOG, the Government's Agency of Logistics (Booth). Jayasuriya and Manning felt that the projected 1988 harvest of between 28.1 and 28.9 million tons would be sufficient to allow BULOG to replenish its stocks and use them to prevent unacceptable price rises later in the year. BULOG forecast 1988 production of

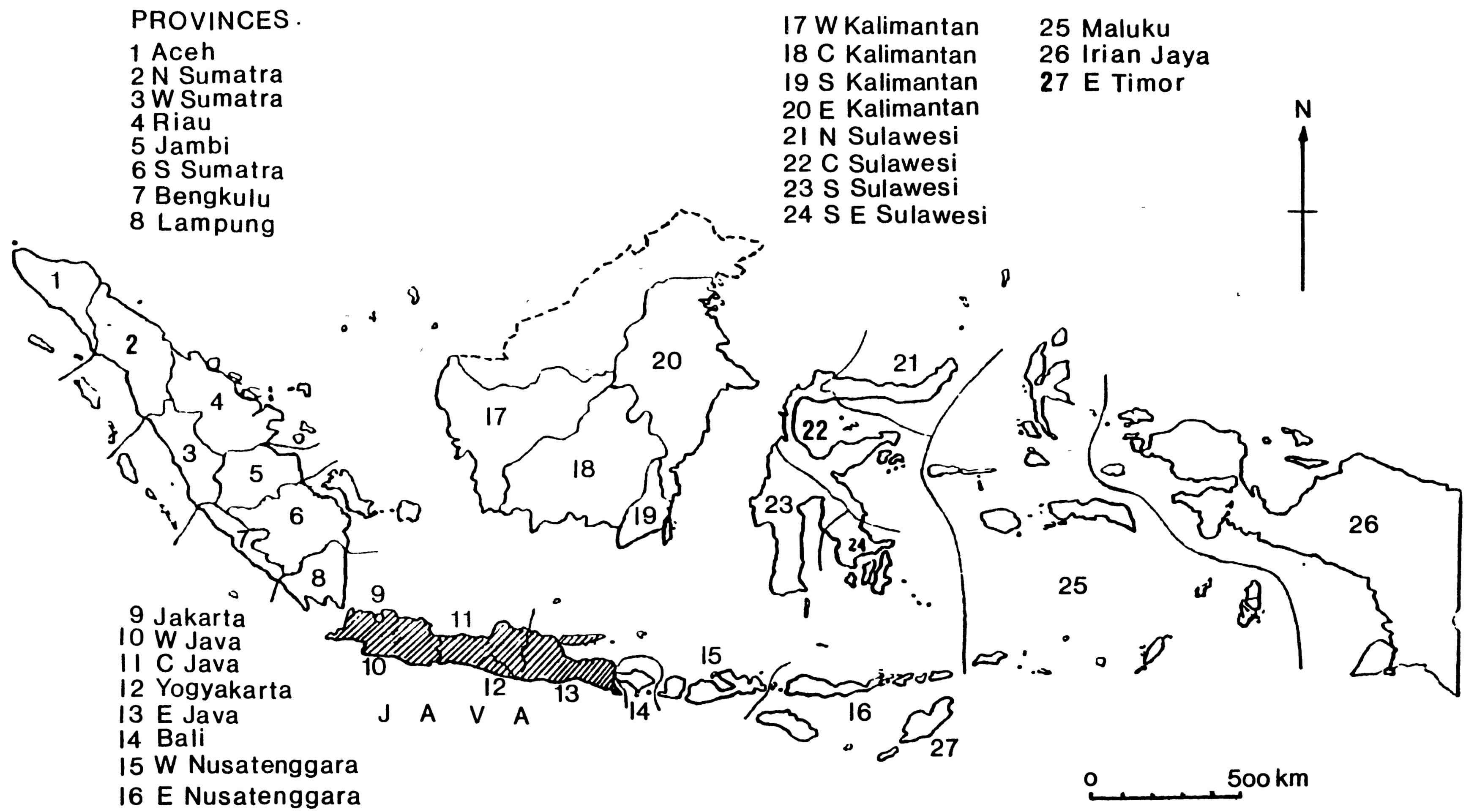

Figure 1. Map of Indonesia, Showing Rice Study Areas

around 27.3 million tons, which would be insufficient to meet domestic demand for the third successive year.

These problems are not simply a result of the recent drought. Since self-sufficiency was achieved in 1984, rice production has increased by only 2 percent per year, compared with over 5 percent per year in the period from 1971 to 1983 (Hill and Weidemann). The major cause for the recent slowdown in production has been the failure of padi sawah (wet land rice) to maintain the rates of growth experienced in the early 1980's. The area planted to padi sawah increased by only 0.6 percent per year in the four years after 1984, compared with 2.2 percent per year in the four years immediately before self-sufficiency was achieved. Padi sawah yields (output per hectare) also have failed to maintain the improvements shown in the early 1980's. They increased at an annual rate of 1.7 percent in the four year period 1985-88, compared with 3.8 percent annual increase in 1980-1984.

There will be increased difficulty in maintaining rice production growth in the future, because of the already high attainment levels in use of high yielding varieties, fertilizer, pesticides, irrigation, as well as the high costs associated with replicating these achievements in more marginal areas.

The technology recommended for rice is highly dependent on chemicals. In addition to the situation of lower real domestic prices for rice, increases in the prices of labor and land have contributed to production cost increases. This has caused a deterioration in the terms of trade, since most of the raw materials required in the manufacture of fertilizer and pesticides are imported. Therefore, rice producers have been facing a decrease in their net income. Reduction of the instability in the price of rice and in farm income is expected to have a positive impact in promoting investment, expanding production, and stabilizing prices significantly.

Some Aspects of Rice Production in Indonesia

One of the most critical problems in the agricultural development of Indonesia has been the government's inability to stimulate a sufficiently rapid increase in output of principal food crops to achieve self-sufficiency. Problems of poverty and declining welfare in the rural sector, particularly in Java, were magnified in the early 1960s by the inability of the agricultural economy to grow at a rate equal to the needs of feeding a growing population. Until the early 1980's, rice imports were used to fill the gap generated by shortfalls in domestic rice production and growing food demand.

In handling the problem of rural poverty and growing food imports, the government of Indonesia is aware that the food problem is one of the most important national problems in stimulating national development and in maintaining national resiliency. Therefore, increasing food production and improving income of the small farmers always have been the primary goals of agricultural development in Indonesia.

The efficient provision of a new technology package implemented in conjunction with a price support program is the major instrument to reach such an objective. The package of new technology is formulated in the country's rice intensification scheme called Bimas Program (Mass Guidance), whereas the price support program is implemented through rice stock management by timely grain purchases, and by selling operations at floor and ceiling prices at appropriate times and locations.

The scheme consists of three major activities that differ in the manner in which they are carried out: (1) agricultural extension activities to encourage farmers to adopt high yielding varieties (HYVs), application of fertilizer, plant protection measures, and better agricultural practices, including water management; (2) actions to distribute inputs properly to ensure physical availability of the requisite production items; and, (3) provision of credit to enable farmers to secure farm supplies and repay credit in kind after harvest. Components of price support programs are: (1) fertilizer price subsidies to encourage greater use of fertilizer by farmers; and (2) rice price stabilization to encourage farmers to adopt more improved technology and to increase production at the same time that consumers benefit by reasonable prices.

To stimulate increased food production, the Indonesian government has introduced a rice extension program. The extension program was designed to increase rice production through the expansion of agricultural lands, such as removing lands from natural forests, conversion of tidal swamp lands to rice production, and expansion of irrigation projects.

The first program of intensification was called Padi Sentra (Paddy Center Program). It was initiated in 1959, in an attempt to attain self-sufficiency in a period of three years. The rice farmers were supplied with farm inputs consisting of seed and fertilizer, plus a small amount of cash to meet at least part of the operating costs. The farmers had to repay this credit in kind after harvest. Ten rice centers were initially set up in Central and East Java in 1958/1959. The target was 250 centers to cover 1.5 million hectares of rice fields by 1961/1962.

The programs were not successful. Credit was poorly administered, with limited participation from the banking systems and very low repayments rates. Problems of logistics also arose and there was lack of adequately trained and experienced personnel to handle the complex activities of this new institution, a particularly large problem, because farmers were for the first time being exposed to new rice technology.

A second program of intensification implemented in 1964 was the mass demonstration program, called Demas. It was based on an experiment as a pilot project conducted by Bogor Agricultural University in the wet season of 1963 in three villages in West Java. It carried out five principles to increase rice production: (1) use of high yielding varieties; (2) use of appropriate fertilizers and pesticides; (3) improved cultivation practices; (4) good water management; and, (5) better soil preparation. The experiment was successful, since the yields obtained by the farmers joining the pilot project were 50 percent or more higher than on neighboring farms. The success of the project may be attributed to the fact that the students lived in the village and had direct contact with the farmers, working with only a limited number of them.

In 1965, this pilot project was expanded into a nationwide intensification program called the mass guidance and abbreviated as Bimas. The program areas were selected on the basis of the availability of irrigation and rural infrastructure. These areas were heavily concentrated in Java. Rice farmers who participate in the Bimas program are supplied farm inputs consisting of seeds, fertilizers, insecticides, and a small amount of credit to meet part of the remaining operation costs. The Bank Rakyat Indonesia (State's People Bank) and the PN Pertani (State Agricultural Enterprise) were utilized to administer credit and distribute new inputs, respectively. In addition, farmers were encouraged to form 'farm coops' to serve as village level marketing institutions. The predominant feature of the program was its group credit approach. The farmers obtained credit through their village cooperatives. Credit was easy to obtain as long as farmers were located in a Bimas area.

Since many of the rice farmers were being exposed to the beneficial use of new technology, a mass intensification program (Inmas) was started in 1967. It was assumed that farmers assisted under the Bimas program would have increased their production and income substantially. Hence, they would no longer need credit and would be provided only with technical advice. It assumed that farmers could actually stand on their own after a few years of Bimas support. Therefore, any farmer who financed his own farm supplies and used improved varieties was considered as an Inmas farmer. The minimum requirements in the beginning of the program were planting of an improved variety and fertilizer use.

The years 1965 to 1967 were plagued by unfavorable weather. The Bimas Gotong Royong program, planned in 1967, resulted partly from a decision to undertake a large-scale operation designed to create a dramatic impact on production. It was constrained by the fact that the country was running out of foreign exchange for the import of needed production inputs. To carry out the plan, the government entered into contracts with seven foreign companies, mostly manufacturers of fertilizer, pesticides and some equipment, on a one-year deferred payment basis. These foreign companies were to be paid a fixed price for every hectare they supplied with production inputs. The BULOG, the government Agency of Logistics, opened letters of credit in favor of these companies which were paid by the Bank of Indonesia on maturity. Repayments collected from farmers were to accrue to the BULOG. Coordination of the entire program was undertaken by the same bodies charged with coordinating the Bimas program.

The Bimas Gotong Royong was criticized for its disruptive effect, but it did provide the government with a procedure for channelling modern inputs through private traders until they reached the farmers. It should have been realized that technical change on the part of the farmers cannot be made mandatory. As a credit operation, the program was a failure. The repayment rate was very low. However, the Bimas Gotong Royong program made definite contributions to Indonesia's agriculture. Farm supplies were, in fact widely available in the rural areas. While some of them may have been used on non-rice crops, a large proportion was used for rice. The program definitely contributed to an improvement in technology. It would perhaps have taken a longer time to attain the current level of technological development in Indonesia had the program not been carried out (Birowo).

In an attempt to find solutions to the problem of credit repayment, the Improved Bimas program was developed in 1970. The program was started as a pilot project in Yogyakarta, in 1969/1970. Because of the success of this initial experience, it is now being carried out on a nationwide scale. This program is discernible from its predecessors by its method of providing services to the farmers, through a cluster of three or more villages, called 'village unit areas'.

In each village unit area, four delivery institutions were created: (1) the agricultural extension managed by a field extension worker; (2) the private kios (a small store) for channelling farm inputs (fertilizers, seeds, pesticides, etc.); (3) the village unit bank to make credit arrangement to the farmers; and, (4) the village unit cooperative, called KUD, assigned to be the purchaser of farm outputs from the farmers. The four delivery institutions were basically new creations, or at least a big improvement over existing ones. The village unit bank and the private kios were purely new creations, while the field extension worker and the village unit cooperative were drastic improvements of earlier efforts (Teken and Soewardi).

The day to day operations of the Improved Bimas program were guided by institutions established at all levels of administration. At the national level, the guiding institution is called Satuan Pengendali Bimas, which is 'Bimas Steering Unit', at the provincial level Satuan Pembina Bimas or 'Bimas developing unit', and at the district, sub-district and village levels Satuan Pelaksana Bimas or 'Bimas implementation Units'. The guiding institutions are coordinating bodies of various government and semi-government offices in charge of the Bimas operations (Suprapto).

The delivery and the guiding institutions are the vital constituents of the Improved Bimas program. These institutions are a decisive factor in the success or failure of the program. As a whole, these institutions have to function well to obtain full and sincere participation of the farmers in the program. In the previous phases of development, the farmers were acquainted with the new technology and adopted it. In the Improved Bimas program, their willingness to practice improved technologies is important in increasing rice production.

Efforts to increase rice production in Indonesia during 17 years of the Bimas program, 1969 to 1986, were remarkably successful, in comparison with both Indonesia's previous history and rice intensification programs in other countries. Rice production grew at a rate of only about 0.3 percent per year from 1960 to 1968. Between 1968 and 1986, rice production grew by 5 percent per year, from 18,013 million tons in 1969 to 39,727 million tons in 1986. The growth record between 1960 and 1986 is illustrated in Figure 2. The picture is one of relatively sustained growth after 1968 and a noticeable acceleration after 1976.

The area, average yield, and production of rice for Java, Off-Java, and for the country of Indonesia from 1969 to 1986, are presented in Table II. Rice production in Indonesia increased at the rate of 5 percent per year during the period 1969-1986. Production growth was even more impressive, 6.8 percent annually, after 1976.

Regions Off-Java, also had strong production growth. This production growth has been primarily as a result of yield improvement. Growth Off-Java

Figure 2. Indonesian Milled Rice Production, 1960-1986 (Million Metric Tons)

TABLE II

AREA, AVERAGE YIELD, AND PRODUCTION OF RICE
ON JAVA, OFF-JAVA, AND INDONESIA,
1969-1986

Year	Area			Yield			Production		
	Java	Off-Java	Indonesia	Java	Off-Java	Indonesia	Java	Off-Java	Indonesia
	'000 ha			mt/ha			'000 mt		
1969	4278	3735	8014	2.57	1.88	2.25	11003	7010	18013
1970	4288	3847	8135	2.70	2.01	2.38	11580	7744	19324
1971	4402	3922	8324	2.81	1.99	2.42	12389	7793	20182
1972	4318	3580	7898	2.76	2.09	2.45	11896	7490	19386
1973	4557	3847	8404	2.86	2.20	2.56	13016	8465	21481
1974	4719	3790	8509	2.94	2.27	2.64	13853	8611	22464
1975	4644	3851	8495	2.95	2.24	2.63	13701	8630	22331
1976	4452	3916	8369	3.15	2.37	2.78	14031	9270	23301
1977	4360	4000	8360	3.00	2.57	2.79	13080	10267	23347
1978	4731	4198	8929	3.29	2.43	2.89	15551	10221	25772
1979	4610	4194	8804	3.40	2.53	2.99	15655	10627	26283
1980	4756	4249	9005	3.86	2.66	3.29	18358	11294	29652
1981	5029	4352	9382	4.07	2.83	3.49	20478	12296	32774
1982	4735	4253	8988	4.39	3.00	3.74	20806	12778	33584
1983	4770	4393	9162	4.53	3.12	3.85	21595	13707	35303
1984	5202	4562	9764	4.55	3.17	3.91	23666	14471	38136
1985	5301	4601	9902	4.57	3.22	3.94	24225	14808	39033
1986	5331	4658	9988	4.59	3.27	3.97	24469	15258	39727

Source: Central Bureau of Statistics.

has been from a much lower base level. Yield growth was 3.8 percent per year during the period, 1969 to 1986, and 5 percent since 1974. Regions on Java recorded the most impressive yield growth, particularly since 1977. On the other hand, expansion of the area planted was relatively slow, reflecting increasing competition for the limited land base from both other agricultural and non-agricultural uses on Java, and the high costs of opening of new land Off-Java. The overall growth rate in area harvested was about 1.2 percent.

East Java is known for its more diversified food crop production, and is the largest producer for palawija (secondary) crops such as corn, soybeans, and cassava. However, with more favorable government interventions for rice compared to palawija crops, rice harvested area and production have increased rapidly, at annual rates of 1.8 percent and 5.9 percent, respectively. This expansion in rice area has been at the expense of corn, soybeans, and cassava areas in the region. Harvested areas for these crops has declined over the last 15 years (Rosegrant et. al.).

As shown in Table II, Java still dominates rice production in Indonesia. Throughout the period 1969-1986, Java has accounted for over 50 percent of area harvested and around 60 percent of production. Yields on Java are 30-50 percent higher than in other regions.

Rice Price Policy in Indonesia

The price support program is a necessary complement to the Rice Intensification Scheme, which sought to stimulate increased adoption to new technology on the part of the farmers and to provide a stable economic environment for agricultural development.

The main components of the program are price subsidies for fertilizers and pesticides and determination of a floor price for farmers and a ceiling price to protect low-income consumers.

The prices of fertilizers and pesticides purchased by the farmers are subsided by the government by roughly 25 and 75 percent, respectively. The price subsidies are paid to the producers or importers of fertilizers and pesticides when the goods are delivered to the farmers. The subsidy covers the difference between the import price (for imported goods) or producer price (for domestically produced commodities such as urea) and the farm gate price. Farmers everywhere in the country can buy urea and TSP (Triple Super Phosphate) fertilizers and various kinds of pesticides at a relatively low fixed price to induce them to use sufficient amounts of those inputs in their food crops production.

Rice is the first food crop commodity where the government intervened in the market. Beginning in 1970, a policy was issued to prevent the price of rice from falling below a certain level during harvest seasons by implementing a floor price of rice. The floor price was determined on the basis of an incremental benefit-cost ratio. The benefit was calculated from the value of additional output of rice obtained by intensifying the crop. The cost was determined from additional inputs used in the effort. The floor price was set up by the government so that the magnitude of the benefit-cost ratio is sufficient to induce farmers to join the intensification program and increase their rice production. The floor price was adjusted every year, taking into account the changes in input prices, the rate of inflation, and the general economic situation of the country.

The village unit cooperatives, KUD, and the Agency of Logistics, BULOG are charged with the implementation of the policy. The floor and ceiling prices are maintained through buffer stock management. If the local free market price of rice falls below the specified floor price, the KUD should buy the rice sold by the farmers at the floor price less a quality discount, if quality is below the standard specified in the policy. Since the KUDs have to buy any quality of rice sold by the farmers, they have to process the rice before they sell it to BULOG.

For the purpose of implementing the policy, the cooperatives were extended credit by the government, the amount of which was determined according to the financial stability of the individual cooperatives. During months when prices are high, the BULOG releases its stock to keep the prices below the ceiling price. This is a benefit to the majority of low income consumers who generally are landless farm laborers and small farmers in rural areas not able to maintain sufficient rice stock for their own consumption needs. Annual rice purchases by the BULOG ranges from 1 to 5 percent of the total annual rice production. The Government has encouraged fertilizer use by maintaining a highly favorable rice price to fertilizer price ratio.

One way to assess the farm economic impact of the price support program is to look at the output/fertilizer price ratio. The floor price of paddy, price of urea, and the paddy/urea price ratio, for 1974-1986 are show in Table III. The floor price of paddy increased from Rp 41.80/kg in 1974 to Rp 175/kg in 1986. In the first six years of this period the paddy/urea price ratio averaged 1.04 and then increased to an average of 1.72 in 1980-1984. The increasing paddy/urea price ratio indicates a favorable price support program for the farmers. It has provided a strong incentive for fertilizer use in Indonesia.

Since 1984, the paddy/urea price ratio has declined as a result of the government's policy to reduce incentives somewhat in the face of surplus rice stocks. Without such a favorable price environment, the Rice Intensification Scheme would not have been successful in increasing food production as cited

TABLE III

FLOOR PRICE OF PADDY, PRICE OF UREA, AND PADDY/UREA PRICE RATIO 1974-1986

Years	Price of Paddy[a] (Rp/kg)	Price of Urea (Rp/kg)	Paddy/Urea Price Ratio	Exchange Rate Rp/US$
1974	41.80	40.00	1.05	420
1975	58.50	60.00	0.98	420
1976	68.50	80.00	0.86	420
1977	71.00	70.00	1.01	420
1978	75.00	70.00	1.07	632
1979	85.00	70.00	1.21	630
1980	105.00	70.00	1.50	632
1981	120.00	70.00	1.71	655
1982	135.00	70.00	1.93	697
1983	145.00	90.00	1.61	998
1984	165.00	90.00	1.83	1075
1985	175.00	100.00	1.75	1126
1986	175.00	125.00	1.40	1644

[a] Price of paddy at KUD (cooperative) level.

Source: Rosegrant et. al.

earlier. By continuously improving the implementation of the policy, it is generally accepted that this policy is one main factor that positively affects rice production.

The key developments of government agricultural policy concerns include: (1) the successes of the rice production program; (2) the likely increase in difficulty in maintaining rice production growth in the future; (3) the tightening of resources available for agriculture due to declining oil prices, government revenue, and budgetary expenditures; and, (4) the increase in competition for land among agricultural commodities and between agricultural and non-agricultural uses.

In line with this broadened perspective on agricultural policy, this study examines the price policy for rice. Estimates of supply response for rice and the effects of price policy are important to be obtained not only for the development of fertilizer and rice price policy alternatives, but also for welfare analysis. The study includes the analysis of the effects of government intervention and the distribution of gains and losses among different sectors in the economy.

Objectives of the Study

The main objectives of the study are:

(1) to estimate the supply function for rice in Java, Off-Java, and Indonesia;

(2) to apply classical welfare analysis to the rice support policy, to estimate the distribution of gains and losses among rice consumers, rice producers, government, and society as a whole;

(3) to estimate the price elasticity supply response for rice;

(4) to examine the impacts of a phase out of fertilizer subsidies on rice production; and,

(5) to analyze whether the price support policy can be an effective tool for increasing rice production (acreage and yields).

Organization of the Study

This study is organized in five chapters. Chapter II covers the review of literature for supply response. Chapter III describes the methodology, estimation and data sources. Chapter IV presents and discusses the results. Chapter V presents the main conclusions and recommendations.

CHAPTER II

REVIEW OF LITERATURE

Even though industrialization remains the prime goal of political and economic planners throughout the developing world, the last decade has seen a strong resurgence of interest in and concern for agriculture. The area where such efforts have been clearly evident has been the estimation of farmer supply response to prices and to other incentives.

Supply response analysis aims at quantifying the change in output caused by a change in price and other economic factors. Government policy considerations are usually based on supply predictions in estimating both commodity and intercommodity effects of changing programs and in anticipating their consequent social benefits and costs. The government and agribusiness firms, and individual farmers need accurate estimates of elasticities of supply and associated price predictions in making investments and production decision.

Fewer studies have been made on the response of supply to price in comparison with the number of studies on demand. What little work that has been done is mainly for agricultural products. The more important of these studies are those of Bradforth Smith, Louis Bean, Robert Walsh, and R. L. Kohls and Don Paarlberg.

Research also has been done in agricultural supply response. Several studies have done a complete review of methods, estimates and comparisons of supply estimates among regions or countries, as well as pointing out areas in which further investigation is needed (Tweeten and Quance, 1969; Askari and Cummings, 1977; Colman; Henneberry; and Shumway, 1986). Although many studies have been done on this topic, Shumway (1986) concluded there remains much room for innovative and substantive research on this important area.

There are some methods for estimating the own price supply elasticity; they can be classified as direct and indirect methods of estimation of the supply function. Direct methods include partial adjustment, adaptive expectation, Nerlove's aggregation of area and yield elasticities, multi-commodity and simulation. The duality model is an indirect method of estimation.

Dynamic Formulations in Econometric Models of Supply

The earliest and simplest explanation of agricultural price expectation was the development of the Cobweb model in 1930's. In 1954, based on a geometric lag model, Koyck developed a more sophisticated approach, which assumes that the coefficient of the lagged terms decline geometrically as one goes into the distant past. With this assumption, a model involving an undefined number of lags can be reduced to a model that contains only the current values of the nonstochastic variable(s) and a simple lagged value of the dependent variable as its explanatory variables. The Koyck model creates some serious statistical problems in that it includes a stochastic explanatory variable which may very well be correlated with the stochastic disturbance term. In this situation economic theory shows that the Ordinary Least Squares (OLS) estimators are not only biased but inconsistent as well.

Modifications of Koyck's model include the adaptive expectation and partial adjustment models. The Koyck model, although popular in empirical econometrics, does not have a solid theoretical underpinning. This void is bridged by the adaptive expectation model popularized by Cagan and others, and the partial adjustment model developed by Nerlove (1958). This model takes into account how the economic agents form expectations about uncertain economic events and how they make adjustments when their expectations do not match reality. The adaptive expectation model faces the same estimation problem as does the Koyck model. The partial adjustment model, however, can be estimated by the usual OLS method.

Despite the estimation problems, the distributed lag and autoregressive models have proved extremely useful in empirical economics because they make the otherwise static economic theory a dynamic one by taking into account explicitly the role of time. Such models help us to distinguish between the short and long-run response of the dependent variable to a unit change in the value of independent variable(s). The adaptive expectation, the partial adjustment, and Nerlove's model have been used extensively in the studies of dynamic supply analysis (Henneberry).

The partial adjustment model has been used by Gichuhi and Dunn to analyze the acreage response of several crops in Kenya. They used the asymmetric supply response hypothesis established in the fixed asset theory, which suggests that it is easier for farmers to increase production than to decrease it. The acreage elasticities suggest that commercial wheat farmers in Kenya responded rationally and substantially to economic incentives. They did not find statistical support in the results for the asymmetric hypothesis.

Since the late 1950's statistical analysis of supply response has been largely influenced by Nerlove's work (1958). Askari and Cummings (1976,

1977) cited 190 studies that were in part influenced by the Nerlove's work. They had applied econometric models to time series data to estimate agricultural supply relationships. Most of these studies used post-World War II data, and the models were simple form. Only a few models included alternative product prices, variable input prices or input quantities. Extreme variability was formed in signs and magnitudes of the elasticities due at least in part to differences in estimation methods, geographical areas, and data periods.

The major criticism to the Nerlove's Model is that farmers' expectations of prices do not necessarily change with observed price changes if the farmers view these changes to be temporary. Therefore, the formation of price expectations may overestimate real expected price changes and a result which underestimate the true aggregate supply elasticity (Henneberry).

Askari and Cummings (1977) observed that one particular notable deficiency in most of the studies they analyzed was that no attempt has been made to evaluate farmer reaction to risk. In this regard they suggested that the effects of such factors as crop diversification need to be clearly examined, as well as changes in indicators of risk, such as standard deviation of price data series. The degree of risk involved in crops grown for different purposes, such as subsistence or market, domestic or export sale, also seems relevant, as does the question as to whether any form of government control over prices is exerted.

In relation to the problems of estimation in Nerlove's model, in general, if OLS techniques are utilized, it can be evaluated as follows; (1) the estimation will be inefficient to the extent the residuals in the estimating equation are serially correlated; and, (2) Nerlovian output adjustment models include lagged values of the dependent variable on the right-hand side of the estimating equation, leading to inconsistent parameter estimates due to the existence of serial correlation.

One way to approach the problem of efficiency and inconsistency in the parameter estimates is to employ non-linear maximum likelihood estimating techniques. Problems arising from serial correlation and lagged dependent variables can be solved by using auto-correlation estimation methods such as the Cochrane-Orcutt model (Ray, 1989).

Aggregation of Area and Yield Elasticity Model

Supply elasticities indicate the speed and magnitude of output adjustments in response to changes in product price. The elasticity parameter for aggregate farm output is especially important for public policy because it measures the ability of the farming sector to adjust production to changing economic conditions continually confronting it in a dynamic economy.

Supply response can be disaggregated into area and yield components (Tweeten and Quance, 1969; Mubyarto, 1965; Evans and Bell, 1978). Output for most commodities is divided into area (A) and yield (Y) components. Given that output O = Y A, the total elasticity of output with respect to price can be expressed as:

$$E_O = E_Y + E_A (1 + E_{YA}) \tag{2.1}$$

where,

E_O = the total elasticity of output with respect to price;

E_Y = the elasticity of yield with respect to price;

E_A = the elasticity of area with respect to price; and,

E_{YA} = the elasticity of yield with respect to area (Tweeten and Quance). If E_{YA} is zero, the total supply elasticity E_O is the simple sum of the yield E_Y and area E_A components. If expansion of area is on marginal land, E_{YA} will be negative. In the empirical analysis, E_{YA} mostly was found to be near zero, hence A was omitted from most yield equations. However, in a few cases E_{YA} was significant and positive. This result may be explained by the fact that expansion of commodity area in response to a higher price or other factors was on above average land, sometimes on newly irrigated land.

Mubyarto and Fletcher also used the indirect approach to estimate aggregate supply elasticity. Given the elasticity of area A with respect to price P = E_{ap} and the elasticity of yield Y with respect to price P = E_{yp}, the elasticity of crop production C with respect to farm price P, E_{cp} can be calculated as follows:

$$E_{cp} = E_{ap} + E_{yp} \tag{2.2}$$

Mellor speculates that aggregate supply elasticity in traditional agriculture is lower than what is observed for developed countries, because of smaller use of purchased inputs and very low marginal productivity of labor, which he believes is the main source of increasing production in traditional agriculture. He hypothesizes that, in relative modern agriculture, the aggregate supply elasticity should be higher because: (1) the share of purchased inputs is more; (2) marginal value product of labor is increased; and, (3) there is greater familiarity with and availability of wide range of consumer goods.

Bogahawatte did an analysis of government policies on rice in Sri Lanka. He estimated the elasticity of production of rice with respect to price as the sum of the elasticity of area planted and the elasticity of yield with respect to price. The parameters of the structural models of the supply and demand models were estimated using two methods, namely Generalized Least Squares (GLS) and Two Stages Least Squares (TSLS). For the supply system: area under irrigation, rainfall, area under crop insurance, guaranteed price of paddy rice, lagged guaranteed price of paddy and lagged area were considered as independent variables in the area and yield models. He found an inelastic price supply response for rice in Sri Lanka. The yield and area elasticities were low.

Risk in Supply Response Models

There has been increasing interest in recent years in the inclusion of variables representing risk in econometric studies of supply of agricultural commodities. Authors such as Behrman, Just, Lin, Ryan, Traill, and Brennan have included variables representing risk in their econometric models. There is no consensus as to how variables representing riskiness in production or prices should be formulated in econometric studies. The methods used have varied from simple measures of instability to complex variables requiring complicated estimation procedures.

Just (1974) did an empirical investigation of the importance of risk in decisions. A measure of risk within positivistic supply response models has been shown to be a significant explanatory variable for specific commodities. A quantitative knowledge of farmers' reactions to changing risk is of considerable importance in evaluating alternative government programs and policies directed towards stabilization of prices and incomes. From a policy standpoint, failure to account for risk-response in a positivistic model ignores the effects of government policies on relative risk structures. Newbery and Stigletz argued that especially in developing countries, producers' attitudes to risk are important in their decision making, where income is lower and risk spreading options fewer.

The relevant issue in attempting to include risk in a positivistic model is identifying the appropriate risk measure. This matter has been widely discussed, with several alternative risk variables found within the literature. The variables used in the studies listed above have represented risk in prices, production or incomes. Price risk is the variability associated with an estimate of the expected price. Such unobservable variability has to be represented by some approximation. An observation on risk in a particular period has been approximated in various ways in econometric models. The expected or anticipated risk can be formed by a weighted sum of past observation of risk, estimated in a distributed lag formation. The means by which an observation on price risk has been represented can be categorized broadly into: (1) the recorded variability or instability over recent periods; and, (2) the extent to which this variability was not expected.

The first category is based on the assertion that risk is directly related to the recorded instability or variability of prices in recent periods. This involves the implicit assumptions that perceived risk is equated with or directly related to variability, and that present riskiness is related to riskiness in the recent past. The use of moving variance, a moving standard deviation or a moving weighted standard deviation are all means of trying to capture aspects of this recent variability in a 'more appropriate' manner.

The second category of measures of risk is based on the assertion that risk is some function of the difference between the expected price and the actual price. Thus, variability which is expected does not induce any reaction through risk.

There are three major drawbacks with the approach which defines risk in terms of the difference between the expected and the actual price (Brennan). First, the results depend critically on the formulation of the expected price. This involves the question of whether price expectations are formed from past prices and, if so, what length and shape of lag is appropriate. Second, the approach requires a more complex estimation procedure where the expected price is formed from a distributed lag on past prices. Third, problems can arise when price variables enter the model as a ratio.

Traill compared a number of different variables representing price risk, including some which defined risk as the difference between the expected price and the actual price, and some which were based simply on recent variability of prices. Although the former group of variables had greater theoretical appeal, neither found any superiority in terms of explanatory power for the more complex variables. Perhaps, based on these findings, little if anything would be lost in terms of accuracy by using the simpler approach, but much can be gained through the simplicity and ease of the approach.

Brennan mentioned that the manner in which risk is included in relation to the risk of competing products also has differed among the various studies. The competition between products is often incorporated into models by the use of relative prices. However, it is inappropriate to use measures of the variability of the relative price as measures of the relative risk. The variability in the relative price may result equally from fluctuations in either price, and would not reflect the relative variability of the price of one product in relation to the price of the other. Measures which have been used to represent the relative variability are some of the above variables in a ratio; for example, the standard deviation of one product's prices divided by the standard deviation of the prices of the competing product, as in Behrman and the ratio of covariance to variance as in Ryan.

For purpose of clarification and illustration, a sample measure of risk (the moving range) can be used by those constructing econometric models to represent risk. Brennan demonstrated some measures of risk have been calculated for the annual price of wheat for the period 1948/49 through 1977/78.

The measures calculated were as follows: (a) moving range (3 periods); (b) moving standard deviation (3 periods); (c) moving range (4 periods); (d) moving standard deviation (4 periods); (e) magnitude of difference between expected and actual prices (naive expectations); (f) magnitude of difference between expected and actual prices (adaptive expectations); and, (g) magnitude of difference between expected and actual prices (Almon lags).

The results showed that the various measures of risk are highly correlated. The correlation coefficient between moving range and the moving standard deviation is 0.999 calculated over 3 years and 0.993 calculated over 4 years. Thus, they are almost perfectly correlated when both are calculated over the same short period. The correlation coefficient between the moving range calculated over 3 years and over 4 years is 0.858, while that of the standard deviation over the two time periods is 0.880. The general similarity between the measures based on the difference between the expected and the actual prices and those based on recorded variability is also apparent.

Brennan concluded that researchers who have compared different variables to represent risk in prices in econometric models of supply have found no superiority for the more complex variables over the simpler variables. In view of these findings, Brennan concluded that it is apparent there is little to be lost by those interested in testing for the presence of risk if the simple measures are used. An appropriate measure for researchers to use to test for the presence of risk would be the moving range over three or four periods. It is easy to calculate and easy to manipulate in the context of model experimentation. Where a measure of relative risk is required, the relative range would be an appropriate measure. Where it is desirable to test whether farmers react more to risk at lower prices than at higher prices, the range divided by the price can be used.

Policy Variables and Expected Price Formulations in Supply Response Models

Most of the studies in supply response that take into account variables other than price have included use of observed farmer response to policy programs as exogenous variables (Ray, 1978). Some researchers have considered the use of dummy variables to represent the occurrence of particular program provisions, and the use of weighted support prices and diversion payments (Langley).

In a study of desegregated analysis of corn acreage response in Kentucky, Reed and Higgins postulated the following supply equation:

$$AC_{it} = f\,(PC_{it-1}, PS_{it-1}, AC_{it-1}, GP_t) \tag{2.3}$$

where,

AC_{it} = acres of corn planted in area i in year t,

PC_{it-1} = the relative price of corn in area i in year t-1,

PS_{it-1} = was the relative price of soybeans in area i in year t-1,

AC_{it-1} = acres of corn planted in area i in year t-1, and

GP_t = variable to measure government program in year t.

Relative prices were output prices divided by fertilizer prices. Fertilizer prices were used as measure of input prices because they were readily available and account for a large proportion of production costs. The price support, the set-aside payment, and the target rate were used to measure the government program.

In the analysis of supply response in Pakistan, Tweeten (1985), specified implicitly the supply function as follows:

$$O_i = f\,(P_i/PP, P_j/PP, I, T, G, W) \tag{2.4}$$

where,

O_i = output of commodity i,

P_i = price of i,

P_j = the price of related commodities,

PP = price paid by farmers for variable inputs,

I = infrastructure and relatively fixed farm inputs,

T = technology,

G = government policy (not working through other variables in the equation), and

W = weather.

Tweeten estimated short and long-run elasticities of area, yield, and production for wheat, cotton, rice, and sugarcane in Pakistan. Only the area equation is a Nerlove-type formulation. OLS estimation techniques were applied. He found that the agricultural production by commodity in Pakistan were responsive to price.

The most important policy variable which can be included in the formulation of the expected prices are likely to be the past prices. The role of price expectations is a important aspect to consider. The difficulties associated with incorporating price expectations into models of agricultural supply response have been the center of analysis (Taylor and Shonkwiler).

The various lagged prices structures (Nerlove, 1956; Ray, 1971; Penn and Irwin), the weighted support price technique (Houck and Ryan) or the future market prices (Gardner) have been used to measure the expected commodity prices.

A methodological question which has arisen in recent studies is whether acreage response should be specified on the basis of net returns of price (Brancoft). Collins argued that with limited acreage, producers wishing to optimize farm income must allocate acreage to alternative crops on the basis of per acre returns and not price alone. Langley mentioned that a measure of returns per acre also allows the inclusion of expected crop yields or program yields into the decision process.

In their studies of the "U.S. Supply of Soybeans: Regional Acreage Functions", Houck and Subotnik (1969) used the following model for acreage supply response:

$$A_t = b_0 + b_1 A_{t-1} + b_2 P^*_{1t} + b_3 P^*_{2t} + u_t \qquad (2.5)$$

where,

A = acreage harvested,

P^*_{1t} = the expected price for the crop in question,

P^*_{2t} = the expected price for a competing commodity,

u_t = a random, mean-zero disturbance with finite variance.

Although the expected price for only one competing commodity was included in the model, the method can easily be extended to incorporate numerous others. Notice that the model was of the lagged adjustment type developed by Nerlove. They mentioned that the farm price of soybeans had been supported, but no acreage restrictions had been attached to these support prices. In most years, average market prices had been above support price levels. However, crops which compete for soybean acreage had been influenced not only by support prices but also by acreage restrictions of one sort or another.

Under these conditions, it was hypothesized that the expected prices of various crops which effect the soybean acreage supply in year t were:

$$P^*_{1t} = W_{i1} P_{it-1} + W_{i2} P^f_{it} \qquad (2.6)$$

where,

P^*_{1t} = expected price in year t for crop i,

P_{it-1} = actual farm price in year (t-1) for crop i, and

Pf_{it} = the effective support price in year t for crop i.

The effective support rate was equal to the announced support rate when no acreage compliance was required to obtain the announced rate. This formulation of price expectations also was assumed to be appropriate for both mandatory and voluntary acreage control programs.

Gallagher presented a method of measuring price expectations for analyzing supply response when the influence of price support and market phenomena varied with market conditions. He investigated the role of government support prices and market phenomena in the formation of the producer's price expectations. The expectations formation relationship was a rather complicated function of current-year support price (PS_t) and previous crop year market price (PM_{t-1}):

$$PE_t = PS_t + \tau[(D_t+1) \ln (D_t + 1) - D_t] \quad \tau > 0 \qquad (2.7)$$

where,

$$D_t = PM_{t-1} - PS_t \qquad (2.8)$$

The advantage of this expected price formulation was that the response of expected price to changes in market or support price was expressed as a simple function of the difference (D_t) between market and support price.

Baily and Womack in their study of wheat acreage response, developed an econometric model of planted wheat acreage for five distinct production regions in the United States. The expected prices used in their model were calculated as follows:

$$EP_{ij} = (PRI_{ij} \times PF_{ij}) + (PRO_{ij} \times PM_{ij}) \qquad (2.9)$$

where,

PRI_{ij} = percent of acreage complying with the farm program for commodity i in region j,

PRO_{ij} = percent of acreage not complying with the farm program for commodity i in region j,

PF_{ij} = effective support price for commodity i in region j,

PM_{ij} = lagged season average price received by farmers for commodity i in region j, and

i = 1, 2; j = 1, 2,.....5.

It was assumed that if a farmer participated in the farm program, PF, reflecting government support variables, would be the relevant acreage inducing price. On the other hand, if a farmer decided not to join the farm program, PM, an expected market price, would be the relevant acreage inducing price. Hence, the variable EP had the advantage of representing both farmers in and outside the farm programs.

Estimates of Rice Supply Elasticities in Indonesia and Various Countries

There are few estimates of rice supply elasticities in Indonesia. Timmer (1976) reported the value of elasticities found by Mubyarto and Fletcher (1966). He mentioned that within the constraints of farm size, input availability, and capital resources, the Indonesia peasant was a remarkably able agriculturalist. The available econometric evidence, while not strong, indicated a market awareness, sense of economic calculation, and willingness to innovate.

The only aggregate production response study was that done by Mubyarto, and reported in Mubyarto and Fletcher. The elasticity of planted rice acreage with respect to relative rice price was small but significantly positive, approximately 0.3. Output elasticity was estimated at 0.4, implying a yield elasticity of approximately 0.1. The yield response could be due to a fertilizer response or more intensive cultivation techniques, although the scope for the latter was quite small at the time.

Timmer (1986), in his study of the "Role of Price Policy in Rice Production in Indonesia, 1968-1982", tried to sort out the contributions of the two factors and, where possible, to identify the sources of increased productivity, whether as part of the shift in the supply function or the greater intensity of input use. Those two factors were: (1) an outward shift in the rice supply function as a result of new technology, increased area harvested, expanded irrigation, and more knowledgeable farmers; and (2) a move upward along the supply function because of improved financial incentives to farmers to use inputs more intensively. The role of increased use of fertilizer received special attention, and much of the focus was on the impact of the substantial budget subsidy required to keep fertilizer prices to farmers well below world prices.

Most of Timmer's analysis was devoted to the econometric methodology used to specify and estimate the key parameters needed to evaluate the social profitability of the fertilizer subsidy. The empirical part of his paper merged the estimated parameters from the data analysis in the first part with the social profitability analysis of the second part.

There were two basic approaches to determine the relative contributions of the factors that had increased rice production. The first was to estimate a set of structural equations, each of which explained the level of used of a critical input into the physical rice production function, and then to estimate the function itself from predicted levels of inputs.

The structural models were:

$$\text{AREA} = f\,(\text{MCP RNXIR RP TIME}) \qquad (2.10)$$

$$\text{TF} = f\,(\text{MCP RNXIR HYV RP TIME}) \qquad (2.11)$$

$$\text{TFXXX} = \text{TF} + \text{XXX} \qquad (2.12)$$

GABAH = f (AREA TFXXX RP TIME) (2.13)

where,

AREA = harvested rice area in million hectares,

GABAH = calendar year gabah (rough rice) production, in million metric tons (mmt),

TF = total fertilizer nutrient applications by farmers (probably on all food crops), in thousands of metric tons.

TFXXX = TF plus a constant soil fertility factor, where XXX is the amount in thousands of metric tons.

PRICE = gabah floor price, in Rp per kg,

PUREA = urea price to farmers, in Rp per kg,

RP = PRICE/PUREA,

RNXIR = water control variable reflecting rainfall and irrigation potential = IRQ + (RAIN/115.2),

IRQ = percent harvested area irrigated times percent rehabilitated,

RAIN = average rainfall over 1600 mm in selected Indonesian location,

MCP = multiple cropping potential = (365-MATUR)/MATUR

MATUR = average days to maturity of harvested rice varieties,

HYV = percent of harvested acreage in high-yielding varieties,

TIME = 10 in 1968, 11 in 1969,...., 24 in 1982.

The structural approach specifically separated the behavioral decisions in the system from the physical, or agronomic, relationships. The structural model estimated here included behavioral equations for area harvested and total nutrient use, as well as an aggregate production function for gabah (the Indonesian term for paddy or rough rice) that contained these two inputs and other exogenous variables, such as time or the relative price of rice to fertilizer.

The second basic approach was to estimate a 'reduced form' equation for gabah directly and regard all independent variables as exogenous to the system. The reduced form was as follows:

GABAH = f (MCP RNXIR RP TIME) (2.14)

This attempt was technically the equivalent of estimating the structural system with Two-Stage Least Squares (TSLS) regression, and the coefficients could be solved for their structural values and compared with those obtained by direct estimation.

From reduced form equations Timmer reported that depending on time horizon of adjustment and one's adherence to 'price fundamentalism', the supply elasticity of gabah production was anywhere between 0.1 and 0.6. The supply elasticity of 0.1 thus represented the very short-run response of farmers before any factors other than fertilizer use change. In the intermediate run, perhaps three to five years, the supply elasticity seemed to be about 0.3. This intermediate-run supply elasticity of 0.3 was quite robust and arises from a wide variety of specification. The supply response was about 0.6 when farmers researchers, governments, and institutions have had adequate time to adjust to a new price environment.

Rosegrant et. al. in the study of "Price and Investment Policies in the Indonesian Food Crop Sector", for the period 1969-1985, reported that the short and long-run rice price supply elasticities were 0.20 and 0.53.

The elasticities of rice supply that were estimated for several less developed countries are summarized in Table IV. It can be concluded that the geographical difference allows juxtaposition of the indicated responsiveness of farmers of the same commodities in rural economies as diverse as those at subsistence levels.

TABLE IV

RICE OWN PRICE SUPPLY ELASTICITIES FOR SELECTED LESS DEVELOPED COUNTRIES

Country/Region	Period	Author	Elasticity	
			Short-run	Long-run
Bangladesh	1950-68	Askari & Cummings	+0.23	+1.28
India:				
Haryana	1950-70	Singh, Singh & Rai	+0.83	-
Andra Pradesh	1950-67	Cummings	+0.48	+0.62
Indonesia:				
Java & Madura	1951-62	Mubyarto	+0.30	-
Indonesia	1969-85	Rosegrant et. al.	+0.20	+0.53
Malaysia (West)	1951-65	Aromdee	+0.23	+1.35
Pakistan	1963-83	Tweeten	+0.20	+0.60
Philippines	1953-64	Mangahas, Recto & Ruttan	negative to +0.55	negative to +2.15
Thailand	1937-63	Behrman	+0.17	+0.43

Source: Adopted from Askari and Cummings (1977), Tweeten (1985), and Rosegrant et. al.

Peterson, and Henneberry mentioned the most important reasons for the differences of the estimates of the studies of supply response, were the estimation method, type of data used, non price variables, and government interventions. Nerlove models are likely to underestimate the own-price short-run and long-run supply elasticities. Misspecification errors and failure to include all relevant past prices in the price expectation variable are some of the reasons for this downward bias.

If there are differences in technological and economic development stages across regions, estimates based on cross-sectional data will overestimate the true supply elasticities. It is also expected that individual crops have a higher-own-price supply response than aggregate farm output; that commercial crops have larger own-price supply elasticities estimates for larger commercial farmers will be higher than the estimates for relative small farms.

Application of Classical Welfare Analysis to Policy Analysis

Classical welfare analysis is another important role for supply and demand elasticities, since the magnitude of the gain or loss in the surplus of each group depends on demand and supply elasticities. It helps to use a supply and demand relationship to determine the level and distribution of gains and losses among consumers, producers, government, and society, from changes in economic policy. The technique is useful to estimate who gains and who losses from market failure and from government distortions of markets.

To understand the concepts of classical welfare analysis first it is necessary to understand the concepts of consumer's and producer's surplus. In 1844, Dupuit defined the consumer's surplus as 'the difference between the sacrifice which the purchaser will be willing to make to get it and the purchase price he has to pay in exchange'. He proposed that consumer's surplus can be measured by the triangle area below the demand curve and above the price line.

In 1943, Hicks introduced several methods of measuring consumer's surplus. Among them, compensating variation and equivalent variation have been intensively used in welfare economics. For a normal good, the Hicksian demand curve must be steeper than Marshallian ('ordinary') demand curve. However, Willig had argued that, provided that the income effect was relatively small, the Hicksian and Marshallian surpluses were approximately equal. Hence, this argument can be used to justify the use of Marshallian or 'ordinary' demand curves in welfare analysis of consumers.

Marshall introduced the concept of producer's surplus to formalize the notion that a seller as well as buyer may receive some sort of surplus from a transaction. The supply curve shows the minimum price at which producers are willing to supply the various quantities of commodity. If incremental variable costs are covered, they will tend to supply additional output. The opportunity cost of an incremental unit of output to a competitive supply is measured by the supply price. If the minimum price were paid for each possible quantity, it follows that the total variable cost of producing any given quantity is the area beneath the supply curve. Consumer's and producer's surplus under free market and a partial equilibrium framework are illustrated in Figure 3.

There is no estimate of the welfare measurement approach to the rice policy analysis in Indonesia. Tweeten (1989) illustrated an application of classical welfare analysis, where public interventions in markets reduce economic efficiency and national income (Figure 4).

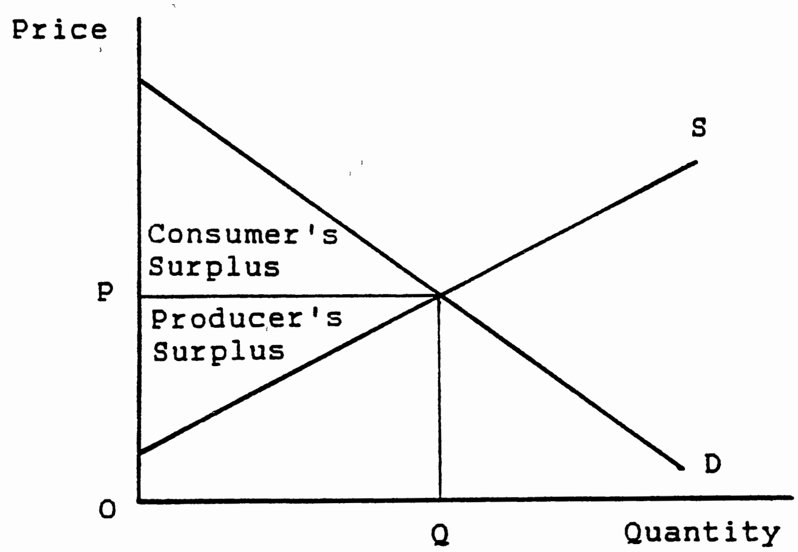

Figure 3. Consumer's And Producer's Surplus

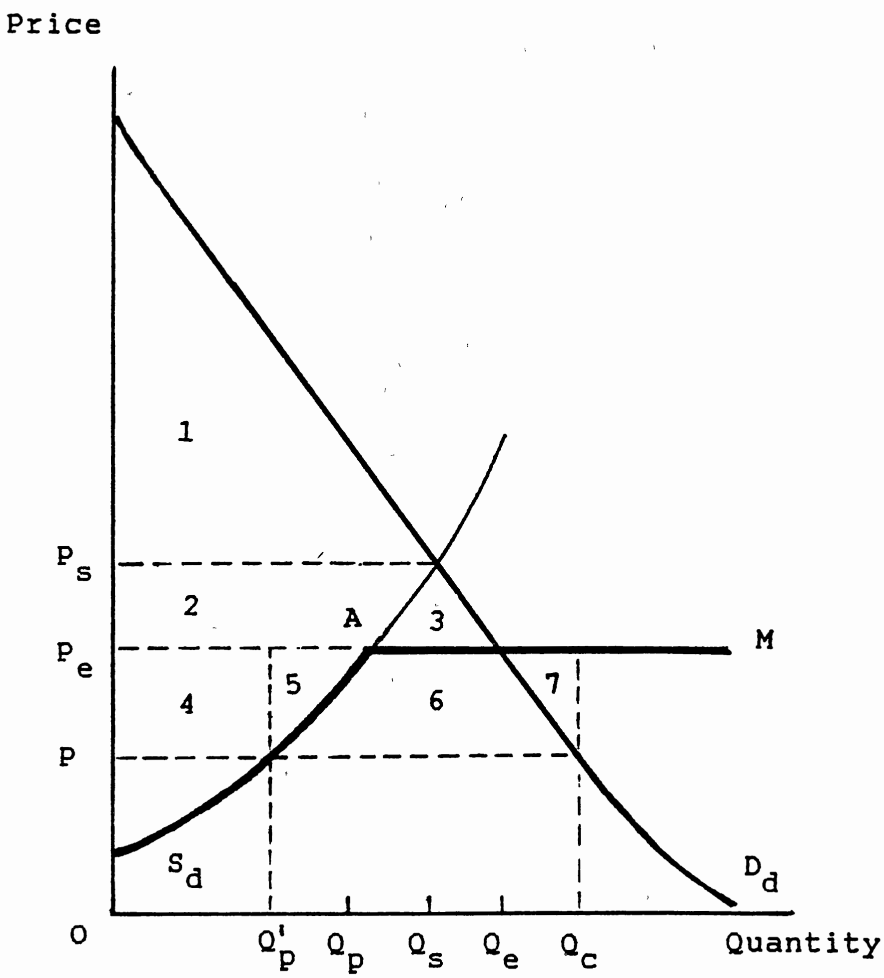

Figure 4. Commodity Program Interventions For A Small Country

Redistributions and social costs from government interventions in market to provide self sufficiency, and to reduce food costs through a ceiling on food price, are illustrated in Figure 4. D_d is domestic demand, and S_d is domestic supply. The horizontal, perfectly elastic import supply curve M is for a small country which can import all it wants without changing world price from P_e. Total supply is the curve of lowest cost of sources of Q, or S_dAM. Open market equilibrium quantity is Q_e which is equal to consumption. Supply quantity is Q_p from the domestic market and Q_e-Q_p from imports.

Raising price to P_s attains self-sufficiency by increasing domestic quantity supplied by Q_s-Q_p and decreasing quantity demand by Q_e-Q_s. The welfare impact is as follows:

Area	
Loss to consumers	2+3
Gain to producers	2
---------------------------	------
Loss to society	3

It is apparent that the loss to consumers offsets the gain to producers; hence, society is worse off from self-sufficiency.

Food prices may be held down by a price ceiling at P in Figure 4. This reduces domestic production to Q'_p and increased consumption to Q_c. An import subsidy of 5+6+7 is required to avoid a massive food shortage. Welfare impacts are summarized as follows:

Area	
Gain to consumers	4+5+6
Loss to producers	4+5
Loss to taxpayers	5+6+7
------------------------	---------
Loss to society	5+7

Transfer inefficiency (5+7)/(4+5+6) per dollar of gain to consumers tends to be low if the P_e-P is small and domestic supply and demand are highly inelastic.

An application of classical welfare analysis for a developing country has been done by Tweeten and Rogers. They estimated the contribution of rice policies to the level and distribution of income among producers, consumers, and the public sector. Their results concluded that rice market policies transferred income from consumers to producers and to the public sector. Losses to consumers more than offset gains to producers and the public sector, however. Thus, rice market interventions reduced total income in Liberia.

CHAPTER III

MODEL CONSTRUCTION AND ESTIMATION METHODS

Partial Adjustment Model

In regression analysis involving time series data, if the regression model includes not only the current but the lagged (past) values of the explanatory variables (the X's), it is called a distributed lag model. If the model includes one or more lagged values of the dependent variable among its explanatory variable, it is called an autoregressive model. Autoregressive and distributed lag models are used extensively in econometric analysis.

In economics, the dependence of the explained variable (Y) on the explanatory variables (X) is rarely instantaneous. Very often Y responds to X with a lapse of time. Such a lapse of time is called a lag. There are three general reasons for the existence of distributed lags: (1) psychological or subjective reasons; (2) technological reasons; and, (3) institutional reasons.

The partial adjustment model gives an alternative rationalization of the geometric lag model. Partial adjustment occurs when various factors prevent a complete response to change in conditions. Mathematically the model can be illustrated as follows:

$$Q^*_t = \beta_0 + \beta_1 P_{t-1} + U_t \qquad (3.1)$$

where:

Q^*_t = the desired output in time t,

β_0 = constant or intercept term,

β_1 = slope term,

P_{t-1} = the price of the crop in time t-1, and

U_t = unobserved factors affecting output in time t.

Since the desired level of output in equation (3.1) is not directly observable, Nerlove postulates the following hypothesis:

$$Q_t - Q_{t-1} = \delta (Q^*_t - Q_{t-1}),\ 0 < \delta < 0 \qquad (3.2)$$

where,

δ = the coefficient of adjustment,

$Q_t - Q_{t-1}$ = actual change,

$Q^*_t - Q_{t-1}$ = desired change.

Sometimes the model is also written as:

$$Q_t - Q_{t-1} = \delta (Q^*_{t-1} - Q_{t-1}) \qquad (3.3)$$

Equation (3.2) postulates that the actual output in any given time period t is some fraction δ of the desired change for that period. If $\delta = 1$, it means that the actual output is equal to the desired output, that is actual output adjusts to the desired output instantaneously (in the same time period). However, if $\delta = 0$, it means that nothing changes since actual output at time t is the same as that observed in the previous time period. Typically, δ is expected to lie between these extremes since adjustment to the desired output is likely to be incomplete because of rigidity, inertia, contractual obligations, etc. Hence the name partial adjustment model. The adjustment mechanism (3.2) alternatively can be written as:

$$Q_t = \delta Q^*_t + (1 - \delta)\ Q_{t-1} \qquad (3.4)$$

showing that the observed output at time t is a weighted average of the desired output at that time and the output existing in the previous time period. δ and $(1 - \delta)$ being the weights. Now substitution of (3.1) into (3.4) gives:

$$Q_t = \delta(\beta_0 + \beta_1 P_{t-1} + U_t) + (1 - \delta) Q_{t-1}$$

$$= \delta\beta_0 + \delta\beta_1 P_{t-1} + (1 - \delta) Q_{t-1} + \delta U_t \quad (3.5)$$

This model is called the partial adjustment model.

Estimation of the equation (3.5) yields:

$$Q_t = \hat{\beta}_0 + \hat{\beta}_1 P_{t-1} + \hat{\beta}_2 Q_{t-1} + V_t \quad (3.6)$$

where,

$$\hat{\beta}_0 = \delta\beta_0 \quad (3.7)$$

$$\hat{\beta}_1 = \delta\beta_1 \quad (3.8)$$

$$\hat{\beta}_2 = (1 - \delta), \text{ and} \quad (3.9)$$

$$V_t = \delta U_t. \quad (3.10)$$

From equation (3.7) to (3.9) we can obtain:

$$\delta = 1-\hat{\beta}_2 \quad (3.11)$$

$$\beta_0 = \hat{\beta}_0/\delta \quad (3.12)$$

$$\beta_1 = \hat{\beta}_1/\delta \quad (3.13)$$

The short-run elasticity E_{sr} is computed as $E_{sr} = \beta_1$ P/Q. The long-run elasticity is calculated as $E_{lr} = E_{sr}/\delta$.

Additional variables such as risk, price of competing crops, policy variables, weather etc., can be considered in equation (3.6). Ordinary Least Squares (OLS) estimation of the partial adjustment model will yield consistent estimates although the estimates tend to be biased (in finite or small samples).

Adaptive Expectation Model

In this adaptive expectation model, the farmer makes decisions on the basis of expected price, and the farmer's expected price changes according to the accuracy of last year's forecast. Suppose we postulate the following model:

$$Q_t = \beta_0 + \beta_1 P^*_t + U_t \quad (3.14)$$

where,

Q_t = actual output in time t,

P^*_t = the expected price in time t,

β_0 = constant or intercept term,

β_1 = slope term,

U_t = error term or unobserved factor effecting output in time t.

Equation (3.14) postulates that output is a function of expected (in the sense of anticipated) price.

Since the expectational variable P^*_t is not directly observable, let us propose the following hypothesis about how expectations are formed:

$$P^*_t - P^*_{t-1} = \gamma (P_t - P^*_{t-1}) \qquad (3.15)$$

Sometimes the model is also expressed as:

$$P^*_t - P^*_{t-1} = \gamma (P_{t-1} - P^*_{t-1}) \qquad (3.16)$$

where γ, such that $0 < \gamma \leq 1$, is known as the coefficient expectation. Hypothesis (3.16) is known as the adaptive expectation, progressive expectation, or error learning hypothesis, popularized by Cagan and Friedman.

What equation (3.16) states is that expectations are revised each period by a fraction γ of the gap between the current value of the variable and its previous expected value, i.e., that this year's forecast is different from last's forecast by a fraction γ of the error in last year's forecast.

In t-1, (3.14) becomes:

$$Q_{t-1} = \beta_0 + \beta_1 P^*_{t-1} + U_{t-1} \qquad (3.17)$$

Multiplying (3.17) by (1 - γ) and substracting from (3.14) provides:

$$Q_t - (1 - \gamma)\, Q_{t-1} = \beta_0 - [1 - (1 - \gamma)] + \beta_1 [P^*_t - (1 - \gamma) - P^*_{t-1}) + U_t - (1 - \gamma)\, U_{t-1} \qquad (3.18)$$

Equation (3.16) may be rearranged to obtain:

$$P^*_t - (1 - \gamma)\, P^*_{t-1} = \gamma P_{t-1} \qquad (3.19)$$

Substituting (3.19) into (3.18), and rearranging terms provides,

$$Q_t = \gamma\beta_0 + \gamma\beta_1 P_{t-1} + (1 - \gamma)\, Q_{t-1} + U_t - (1 - \gamma)\, U_{t-1}$$

$$= \gamma\beta_0 + \gamma\beta_1 P_{t-1} + (1 - \gamma)\, Q_{t-1} + V_t \quad (3.20)$$

where $V_t = U_t - (1 - \gamma)\, U_{t-1}$.

Estimation of equation (3.20) gives,

$$\hat{\beta}_0 = \gamma\beta_0 \quad (3.21)$$

$$\hat{\beta}_1 = \gamma\beta_1 \quad (3.22)$$

$$\hat{\beta}_2 = 1 - \gamma. \quad (3.23)$$

From equation (3.21) to (3.23) the following parameters can be derived:

$$\gamma = 1 - \hat{\beta}_2 \quad (3.24)$$

$$\beta_0 = \hat{\beta}_0/\gamma \quad (3.25)$$

$$\beta_1 = \hat{\beta}_1/\gamma \quad (3.26)$$

The short-run elasticity can be computed as $E_{sr} = \beta_1\ P/Q$. The long-run elasticity $E_{lr} = E_{sr}/\gamma$. The implication of the finding that in the adaptive expectation model the stochastic explanatory variable Q_{t-1} is correlated with the error term V_t.

The estimator obtained from the adaptive expectation model using OLS techniques are not only biased but also not even consistent. Even if the sample size is increased indefinitely, the estimators do not approximate their true population values (Johnston).

The partial adjustment model resembles both Koyck and adaptive expectation models in that it is autoregressive. But it has a much simpler disturbance term: the original disturbance term U_t multiplied by a constant δ. But bear in mind that although similar in appearance, the adaptive expectation and partial adjustment models are conceptually very much different. The former is based on uncertainty (about the future course of prices, interest rates, etc.), whereas the latter is due to technical or institutional rigidities, inertia, cost of change, etc. However, both of these models are theoretically much sounder than the Koyck model (Gujarati).

Nerlove's Model

Following Henneberry, by combining the partial adjustment and adaptive expectation models, we obtain a compound geometric lag model:

$$Q^*_t = \beta_0 + \beta_1 P^*_t + U_t \tag{3.27}$$

where Q^*_t is the optimal level of output in period t, and P^*_t is the expected price in time t. Nerlove's model is a compound geometric lag model.

Nerlove's model is based on the concept that the expected "normal" price for producers P_t is equal to last periods expected "normal" price plus or minus some degree of adjustment depending on last actual price.

Nerlove postulates that this adjustment can be expressed as a fraction of the difference between last periods actual and expected "normal" price:

$$P^*_t - P^*_{t-1} = \gamma (P_{t-1} - P^*_{t-1}),\ 0 < \gamma < 1 \tag{3.28}$$

or equation (3.28) can be written as:

$$P^*_t = P^*_{t-1} + \gamma (P_{t-1} - P^*_{t-1}) \tag{3.29}$$

where γ, the coefficient of expectation, is constant. If γ is zero, actual prices are totally divorced from expectation while a unitary value of γ, implies a naive cobweb-type model where expected prices are identical with last years realized price.

Equation (3.29) represents a moving average of past prices with the weights declining farther back in time. This can be written as:

$$P^*_t = \gamma P_{t-1} + (1 - \gamma) P^*_{t-1} \tag{3.30}$$

which is a first-order difference equation that can be solved for P^*_t as a function of t, P_t and the coefficient γ.

Lagging (3.30) in a year,

$$P^*_{t-1} = \gamma P_{t-2} + (1 - \gamma) P^*_{t-2} \quad (3.31)$$

Substituting (3.31) into (3.30) becomes,

$$P^*_t = \gamma P_{t-1} + (1 - \gamma) \gamma P_{t-2} + (1 - \gamma)^2 P^*_{t-2} \quad (3.32)$$

but,

$$P^*_{t-2} = \gamma P_{t-3} + (1 - \gamma) P^*_{t-3} \quad (3.33)$$

So,

$$P^*_t = \gamma P_{t-1} + (1 - \gamma) \gamma P_{t-2} + (1 - \gamma)^2 \gamma P_{t-3} + (1 - \gamma)^3 P^*_{t-3} + \quad (3.34)$$

thus expressing people's conception of "normal" price expectations as a weighted average of past prices. The weights assigned to each past price will decline as we go back in time if $0 < \gamma < 1$. From equation (3.34), if $\gamma = 1$ then $P^*_t = P_{t-1}$; if $\gamma = 0$, then $P^*_t = P^*_{t-1}$.

In Nerlove's model, it is possible to obtain estimates for the expectation and adjustment coefficients that can be distinguished one from another if there is some relevant and observable variable Z_t, like price of related commodities, policy variable, risk, a trend term, weather, etc., in the output equation in addition to the "normal" price:

$$Q^*_t = \beta_0 + \beta_1 P^*_t + \beta_2 Z_t + U_t \quad (3.35)$$

This equation, together with equation (3.2) of the partial adjustment model:

$$Q_t - Q_{t-1} = \delta (Q^*_t - Q_{t-1}), \; 0 < \delta < 1 \quad (3.36)$$

and equation (3.16) of the adaptive expectation model:

$$P^*_t - P^*_{t-1} = \gamma (P_{t-1} - P^*_{t-1}), \; 0 < \gamma < 1 \quad (3.37)$$

This yields an equation that describes dynamically a supply response model for which distinct estimates of all the parameters can be obtained using either maximum likelihood procedures or least squares technique:

$$Q_t = \beta_0\delta + \beta_1\delta \sum_{i=1}^{n} \gamma (1 - \gamma)^{i-1} P_{t-i} + \beta_2\delta Z_t + (1 - \delta) Q_{t-1} + V_t \quad (3.38)$$

Equation (3.38) is derived by first substituting equation (3.34) in equation (3.35) for P^*. Equation (3.35) is then substituted in equation (3.36) and the resulting terms rearranged to derived in equation (3.38).

If $\delta = 1$, Nerlove's model reduces to a pure adaptive expectation model. If $\gamma = 1$, Nerlove's model reduces to a pure partial adjustment model; and, to a simple regression model if $\delta = 1$ and $\gamma = 1$.

If i = 1, estimation of the Nerlove's model will give:

$$\hat{\beta}_0 = \beta_0\delta \tag{3.39}$$

$$\hat{\beta}_1 = \beta_1\delta \text{ and } \hat{\beta}_2 = \beta_2\delta \tag{3.40}$$

$$\hat{\beta}_3 = 1 - \delta \tag{3.41}$$

The short-run elasticity Esr = $\hat{\beta}_1$ P/Q, and the long-run elasticity $E_{lr} = E_{sr}/\delta$.

Once the coefficient of expectation is known, it is possible using the equation (3.34) to compute the weights that the farmers give to expected prices for each year. The sum of these weights add up to 100 percent, allowing us to determine the period of adjustment or number of periods to reach a new equilibrium output, given a change in the expected price. The larger the coefficient of the lagged dependent variable $\hat{\beta}_3$, the lower the adjustment coefficient δ will be, which means it takes a longer time for the output to adjust to its long-run value after a price change. In other words, the long-run own price elasticity will be much greater than the short-run elasticity. The lower the coefficient of the lagged dependent variable, the quicker output reaches its long-run equilibrium value, and therefore short-run elasticity will be closer to its long run value.

Major Relationships in the Rice Economy

The structure of production, consumption and pricing of rice is complex due to the fact that the domestic prices are determined simultaneously by the supply of rice as well as by some of the key economic factors outside the rice industry. Theoretically five major economic variables that are relevant to rice in Indonesia are: (1) production; (2) domestic price of rice; (3) domestic utilization; (4) quantity imported and exported; and, (5) world price of rice.

The simplified structure of the major economic relationships in the rice industry is presented in Figure 5. The variables that affect domestic production and total supply of rice are shown in this figure. The main policy instruments and target variables in the model are shown in Table V. Rice production is a function of two major factors, namely yield and acreage. Yield is affected by variables such as new varieties, irrigation, fertilizer use, prices, weather, and risk. The acreage is affected by similar variables and also by the prices of the competing food crops relative to rice prices. The deficiency of domestic production is met by imports to meet the food requirements of the country.

Economic Model

A supply-demand model for the Indonesia rice economy is presented in Figure 6. It is assumed that none of the producers and consumers are large enough to influence market prices. Let SS represent the domestic supply curve and DD the demand curve for the rice industry. OP_e represents the domestic equilibrium (open market) price. Assume that the government maintains a rice support price OP_d equal to the world market price OP_w, below OP_e. Under such a stipulation, the government will need to maintain a quantity of rice OQ_w to satisfy consumer requirements. There are three possible policy alternatives that

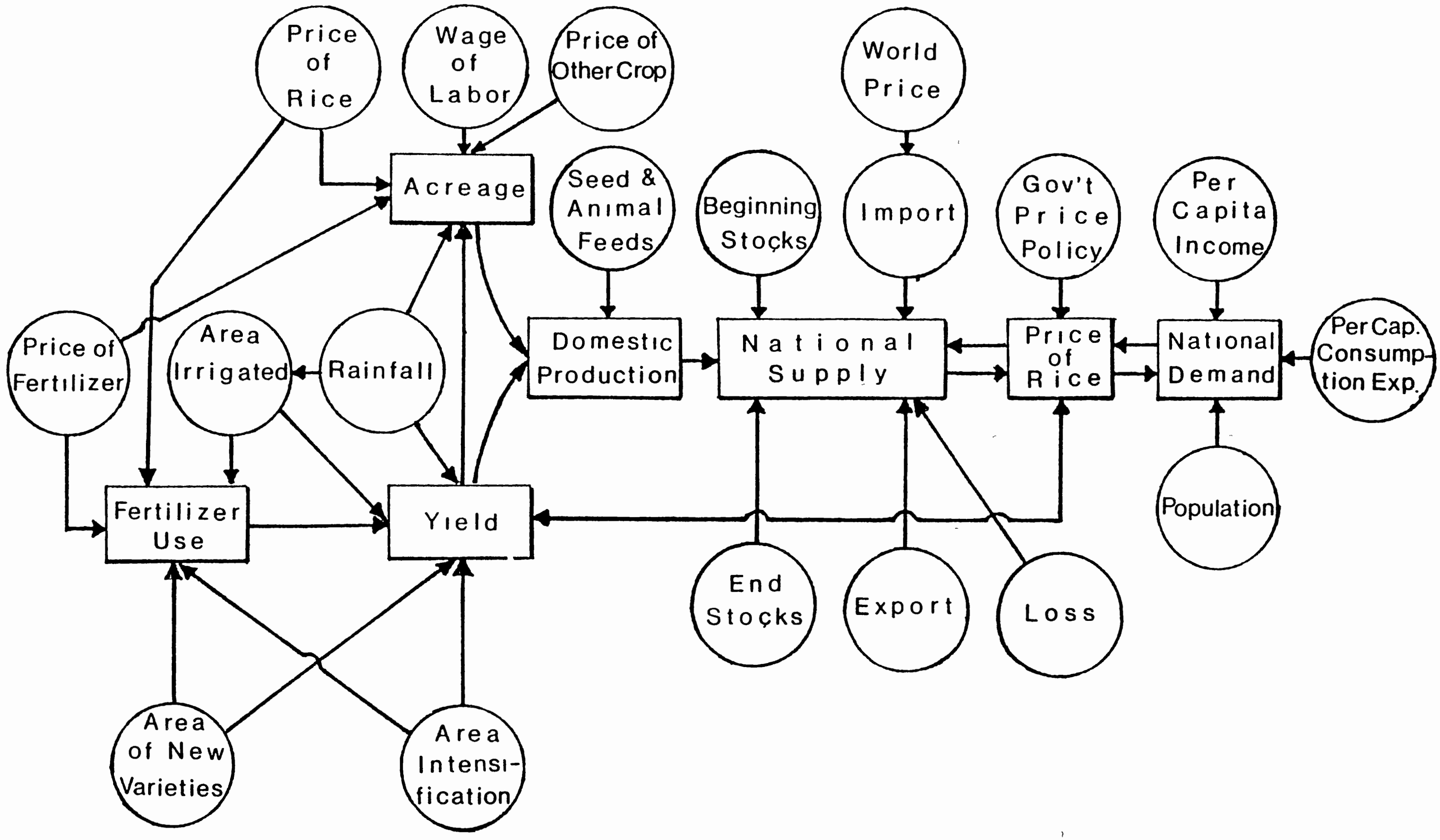

Figure 5. Simplified Structure of the Rice Supply-Demand Model

TABLE V

TARGET VARIABLES AND POLICY INSTRUMENTS IN THE RICE ECONOMY MODEL

Policy Instrument	Target Variables			
	Crop Price	Crop Consumption	Crop Production	Government Budget Cost
Government Crop Purchases	•			•
Government Crop Sales	•	•		•
Imports and Exports	•	•		•
Fertilizer Price			•	•
Intensification Programs			•	•
Irrigation Investment			•	•
Research			•	•

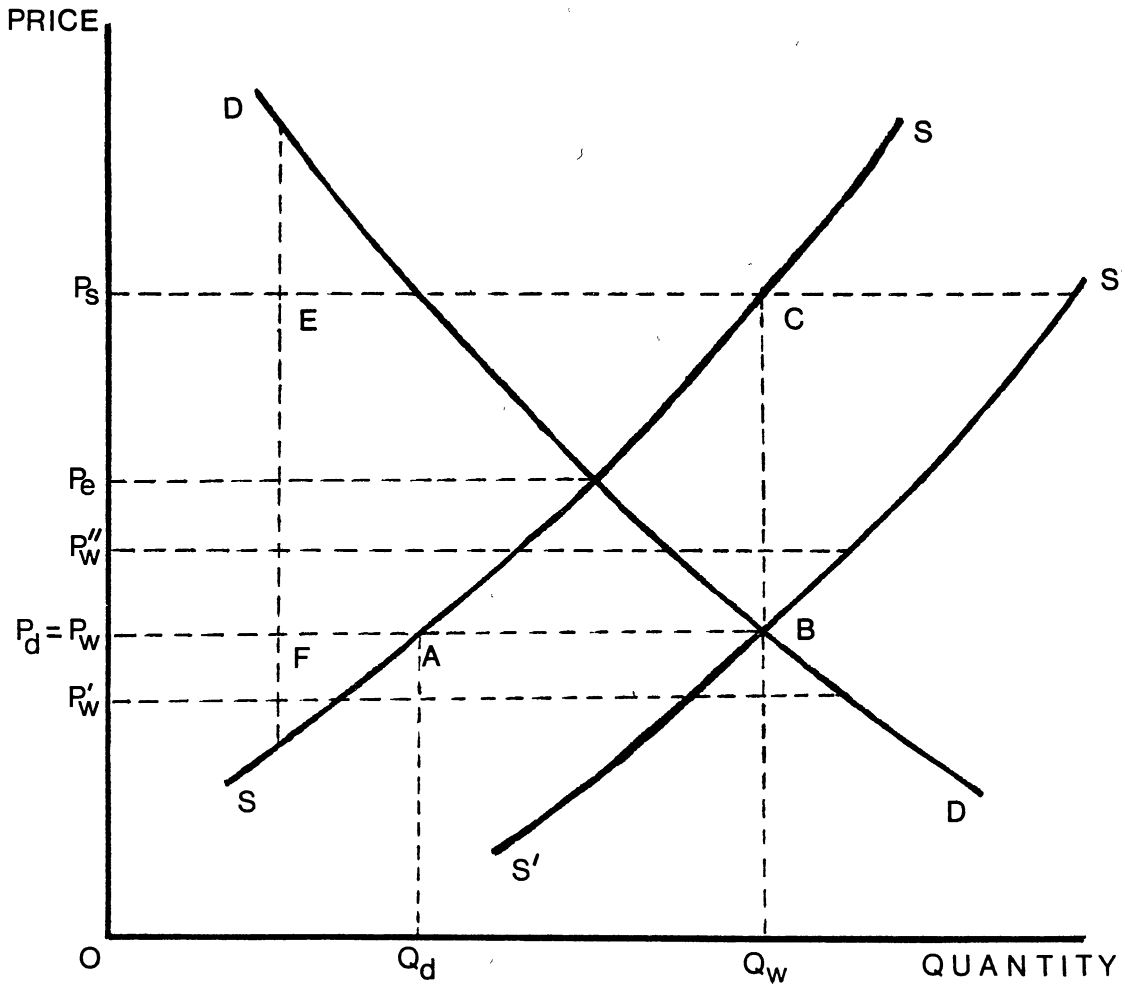

Figure 6. Supply-Demand Model For The Rice Economy In Indonesia

the government follows: (1) import rice quantity AB = Q_w - Q_d; (2) increase the price support received by rice producers to OP_s; or (3) subsidize farm inputs, such as fertilizer to shift the supply curve to S'S'.

However, if OP_w is less than the OP_d ($OP_w' < OP_d$) and if the government maintains its imports at AB, it will incur a profit by restricting imports and selling at OP_d. This policy will protect the domestic producers and earn revenue for the government at a cost to the consumers. Theoretically possible, such a situation has never risen in the Indonesia economy.

If the world price is above the support price OP_d ($OP_w'' > OP_d$), the imports required by the government will be higher and selling below the purchase price benefits the consumers at a cost to the government and the producers. Under such a condition, the rice policy of the government is said to be consumer oriented.

Assuming SS to be fixed and maintaining the price support of rice at OP_d a guaranteed price support of OP_s would cost government a quantity represented by area BCEF. The producer sale of rice increased by an area BCEF, but the cost of the rice to the producers would also increase by an area ABC. The balance of area ACEF represents an increase in the income of the rice producers at a cost to the government. ABC is the net loss of economic welfare to the society. The government programs of subsidizing the farm inputs contributes to the shifting of SS to S'S'.

Rice Supply Model

The law of supply is the relevant economic theory used in the formulation of the economic models in this section. The quantity supplied of a particular commodity by an individual firm is a function of the expected own commodity price, the expected prices of related commodities, the expected price of the inputs used in the production of the product, and other relevant variables.

If there is not an exact "real world" counterpart to a variable suggested by the theory, a proxy variable is used. Expected price and risk are subjective measurements, with no exact real world counterparts; therefore, a proxy variable must be used. In this study policy variables are defined as variables in which the government controls the production or area planted of a commodity by using either incentives or disincentives.

Policy Variables and Formulation of Expected Price Alternatives

Given the structure of rice production in Indonesia, one might presume that rice growers simultaneously make resource allocation decisions among other crops such as corn, soybeans, and cassava, crops which are competing for the same land and other production resources.

The simplest formulation of expected price considered in this study does not include any policy variable directly. In this case, the expected price of crop i in year t (EPi_t) is formulated as the producer's price received of crop i in year t-1 (EPi_{t-1}):

$$EPi_t = Pi_{t-1} \tag{3.42}$$

The price of corn, soybeans, and cassava are considered the related crops of rice in this study. Therefore, the price of corn, soybeans, and cassava will affect rice growers' decisions. One way of introducing these effects in the model is through the formulation of the expected prices of corn, soybeans, and cassava.

Risk Aversion Variables

In general, farmers are risk-averters. Price, yield, and income fluctuations and climatological variability have substantial implications on responsiveness of farmers and may directly or indirectly affect price expectations, output and planning decisions. In this study, the assertion is made that risk is directly related to the recorded instability or variability of prices in recent periods. This involves the implicit assumption that perceived risk is equated to variability, and that present riskiness is related to riskiness in the recent past. Since it was not possible to get information about monthly data of the price of rice, the risk variables will not be included in this study.

Econometric Models of Rice Supply

Model I. Total production of rice is determined by fertilizer demand functions, yield response functions, and acreage response functions estimated for Java, Off-Java, or Indonesia. Fertilizer demand for rice is estimated as a function of expected price of rice, fertilizer price, weather (rainfall), risk, technological shift variables such as percentage use of modern (high yield) varieties, percentage of area irrigated, and trend variable, which represents the effect of unmeasurable technological shift variables. Rice yield is estimated as a function of fertilizer use, weather, risk, lagged yield, and technological shift variables. Area harvested is estimated as a function of expected price of rice, expected price of competing crops, risk and lagged area.

Fertilizer demand, yield and area response functions were estimated using the general form:

$$F_t = f\,(R^*_t/O_t, Z_{it}, T) \qquad (3.43)$$

$$Y_t = f\,(F_t, Z_{it}, T, Y_{t-1}) \qquad (3.44)$$

$A_t = f(R_t, C^*_t, A_{t-1})$ (3.45)

$Q_t = A_t \cdot Y_t$ (3.46)

where,

F_t = fertilizer use, in time t;

R^*_t = expected price of rice, in time t;

O_t = price of fertilizer, in time t;

Z_{it} = a series of shifting variables, in time t, such as percent of area under high yielding varieties, percent area irrigated.

T = time trend;

C^*_t = expected price of competing crops, in time t;

Y_t = yield of rice per hectare, in time t;

A_t = area of rice, in time t; and

Q_t = production of rice, in time t.

Supply of rice consists of current production plus the carry over stock and the quantity imported in a particular year. Equation (3.46) is the current production which can be computed by multiplying Yield (Y) and Acreage (A). Hence the production of rice can be explored through yield and acreage response. The elasticity of production with respect to prices is the sum of the elasticity of area planted and the elasticity of yield with respect to price:

$Q = Y A$ (3.47)

Differentiate (3.47) with respect to price:

$dQ/dP = A\ \delta Y/\delta P + Y\ \delta A/\delta P$ (3.48)

Multiplying through by P/Q:

$$\delta Q/\delta P \cdot P/Q = \delta Y/\delta P\ A\ \ P/Q + \delta A/\delta P\ Y \cdot P/Q$$

$$\delta Y/\delta P\ A \cdot P/YA + \delta A/\delta P\ Y\ P/YA$$

$$\delta Y/\delta P\ \ P/Y + \delta A/\delta P \cdot P/A \qquad (3.49)$$

$$\varepsilon_{QP} = \varepsilon_{YP} + \varepsilon_{AP} \qquad (3.50)$$

The elasticity of output $\varepsilon_{Q.P}$ can therefore be estimated directly through the output function or indirectly through acreage and yield functions.

Models for estimating rice supply for Indonesia, Java, and Indonesia with the expected signs are expressed as:

$$AREA_t = \beta_0 + \beta_1 EPRICE_t - \beta_2 EPUREA_t - \beta_3 PCORN_t - \beta_4 PCASA_t - \beta_5 PSOYB_t + \beta_6 AREA_{t-1} + \beta_7 RAIN_t + U_t \quad (3.51)$$

where,

$AREA_t$ = hectares harvested of rice, in year t (thousand hectares),

$EPRICE_t$ = expected price of rice, in year t (Rp/kg),

$EPUREA_t$ = expected price of fertilizer, in year t (Rp/kg),

$PCORN_t$ = price of corn, in year t (Rp/kg),

$PCASA_t$ = price of cassava, in year t (Rp/kg),

$PSOYB_t$ = price of soybean, in year t (Rp/kg),

$RAIN_t$ = average rainfall in selected Indonesian locations, in year t (mm),

U_t = error term,

t = 1969-1986.

The expected prices are deflated by the index of prices of the non-agricultural sector (1 April 1977 - 31 March 1978 = 100).

Rice yields are affected by weather, economic, cultural, technological and environmental factors. Weather is an important factor which significantly influences rice yields; they are susceptible to an excessive rainy season, or to a long period of dry weather. Insect damage and weather are also related; for example wet weather increases the likelihood of insect damage. Non-availability of data made it impossible to include such as variables in this equation.

The rice yield statistical equations with the expected signs is postulated as:

$$\begin{aligned} YIELD_t = {} & \alpha_0 + \alpha_1 EPRICE_t - \alpha_2 EPUREA_t + \alpha_3 FERHA_t \\ & + \alpha_4 YIELD_{t-1} + \alpha_5 HYV_t + \alpha_6 RAIN_t \\ & + \alpha_7 IRRIG_t + \alpha_8 T_t + Ut_t \end{aligned} \quad (3.52)$$

and,

$$\begin{aligned} YIELD_t = {} & \alpha_0 + \alpha_1 ERURE_t + \alpha_2 FERHA_t + \alpha_3 YIELD_{t-1} \\ & + \alpha_4 HYV_t + \alpha_5 RAIN_t + \alpha_6 IRRIG_t \\ & + \alpha_7 T_t + U_t \end{aligned} \quad (3.53)$$

where, $EPRICE_t$, $EPUREA_t$, $RAIN_t$, t, and U_t were defined before, and

$YIELD_t$ = yield of gabah, in year t (tons/ha),

$ERURE_t$ = EPRICE/EPUREA

$FERHA_t$ = fertilizer use per hectare, in year t (tons),

HYV_t = percentage of new varieties, in year t,

$IRRIG_t$ = irrigated area, in time t (thousand hectares),

T = 10 in 1969, 11 in 1970, ..., 27 in 1986, etc.

The expected prices are deflated with the index of prices of the non-agricultural sector (1 April 1977 - 31 March 1978 = 100).

Fertilizer demand functions with expected signs is postulated as follows:

$$\begin{aligned} TFERT_t = {} & \gamma_0 + \gamma_1 ERURE_t + \gamma_2 HYV_t + \gamma_3 RAIN_t \\ & + \gamma_4 IRRIG_t + \gamma_5 T_t + U_t \end{aligned} \quad (3.54)$$

and,

$$\begin{aligned} TFERTt = {} & \gamma_0 + \gamma_1 EPRICE_t - \gamma_2 EPUREA_t + \gamma_3 HYV_t \\ & + \gamma_4 RAIN_t + \gamma_5 IRRIG_t + \gamma_6 T_t + U_t \end{aligned} \quad (3.55)$$

where, $ERURE_t$, $EPRICE_t$, $EPUREA_t$, $RAIN_t$, $IRRIG_t$, HYV_t, T_t, and U_t were defined before, and:

$TFERT_t$ = total fertilizer applications by farmers, in time t, in thousands of metric tons.

The expected prices are deflated with the index of prices of the non-agricultural sector (1 April 1977 - 31 March 1978 = 100).

Model II. To explain the supply function of rice, a single equation model for rice is postulated.

The estimated production function with expected signs is expressed as follows:

$$GABAH_t = \delta_0 + \delta_1 EPRICE_t + \delta_2 AREA_t + \delta_3 TFERT_t + \delta_4 GABAH_{t-1} - \delta_5 EPSOYB_t - \delta_6 EPCORN_t - \delta_7 EPCAS_t + U_t \quad (3.56)$$

and,

$$GABAH_t = \delta_0 + \delta_1 RURE_t + \delta_2 AREA_t + \delta_3 TFERT_t + \delta_4 GABAH_{t-1} - \delta_5 EPSOYB_t - \delta_6 EPCORN_t - \delta_7 EPCAS_t + U_t \quad (3.57)$$

where all the independent variables have been defined, and

$GABAH_t$ = calendar year gabah (rough rice) production, in time t, in thousands metric tons.

The expected prices are deflated by the index or prices of the non-agricultural sector (1 April 1977 - 31 March 1978 = 100).

Econometric Model of Rice Demand

Empirical demand estimation is necessary for public analysis in two important ways. First, estimates of price and income elasticities are useful for determining the magnitude and direction of changes in the price and quantity of commodity that might occur when a particular government policy affects any of the determinants of the demand for that commodity. Second, estimates of the demand parameters can be employed to obtain measures of the gain or loss in consumer welfare as a result of some public policy, as is the purpose of this study.

The domestic utilization consists of quantity of rice required for human consumption, animal feed and industrial usage. In the absence of data on use in animal feed and industrial usage, only the amount used for human consumption was considered.

Per capita demand for rice per year is estimated as a function of per capita consumption expenditures on food, the own price of rice, the prices of complementary and substitute of rice consumption, and population. The statistical model with the expected signs is expressed as follows:

$$RCONS_t = \beta_0 - \beta_1 PRICE_t + \beta_2 EXOFO_t + \beta_3 PSOYB_t - \beta_4 PCORN_t - \beta_5 PCAS_t + \beta_6 POPUL_t + U_t \quad (3.58)$$

where,

$RCONS_t$ = consumption of rice per capita per year, in time t (kg),

$EPRICE_t$ = price of rice, in time t (Rp/kg),

$EXOFO_t$ = consumption expenditures on foods, per capita per year, in time t (Rp/kg),

$PSOYB_t$ = price of soybean, in time t (Rp/kg),

$PCORN_t$ = price of corn, in time t (Rp/kg),

$PCAS_t$ = price of cassava, in time t (Rp/kg),

$POPUL_t$ = population, in time t (thousand of people).

All prices and consumption expenditures are deflated by the index of prices of the non-agricultural sector (1 April 1977 - 31 March 1978 = 100).

Soybeans were expected to be a complementary crop to rice since they are used to substitute for meat in daily diets. Corn and cassava, which are rich in carbohydrate, also are substitutes for rice.

Analytical Framework for the Analysis of the Current Rice Policy in Indonesia

Under partial equilibrium assumptions, classical welfare analysis will be applied to provide some insight into the merits of the current inputs subsidy, and the price control policy (import subsidy) for rice. It will identify the impact of those policies on producers, consumers, government revenues and net social welfare within the society.

In the analysis of international trade policy impacts, it is crucial to differentiate between a "small" and "large" country. Small and large refer to the relative size of the country in the market for the commodity analyzed. A small country's policies cannot affect the world price of the commodity through the independent policies it adopts. A large country's policies do have an impact on the world price.

A two-stage process will be employed to derive the net social welfare impact on society: (1) the impact on consumers and producers will be identified as changes in consumer and producers surplus, and also government revenues and expenditures will be identified; and, (2) the gains and losses accruing to these groups will be balanced against one another to deduce the net impact on societal welfare. The implicit assumption is that the marginal utility of money is held constant across all groups.

It is always assumed that initially world prices are directly translated into domestic prices. Only after the adoption of a policy does a difference between world and domestic prices emerge. It is also assumed that domestic prices apply equally to consumers and producers.

The rice situation for the 1980 crop year is illustrated in Figure 7. Indonesia is an importing country, and to keep the domestic price of rice lower, the government imposed import price and inputs subsidy.

To make a simple illustration of classical welfare analysis of the rice situation for the 1980, Indonesia is considered as a large country case and imposed an import price subsidy only.

Country supply is represented by the line SS, and domestic demand is represented by DD. Pd is domestic price equal with Pw, world price before the subsidy. P_w' is world price resulting from an increase in demand which occurs as a result of the import subsidy. P_w' - s is price faced by domestic producers and consumers with the subsidy. Q_1' - Q_1 is imports before subsidy and Q_2' - Q_2 is imports with the subsidy.

An import subsidy on the rice will result in an increase in imports. Since Indonesia is a large country, the increase in imports causes world demand to increase. This results in a world price increase from P_w to P_w'. The final price faced by domestic producers and consumers equals the new world price P_w' - s.

The effects of the current import subsidy and price control policy are given by the following changes in areas with respect to a situation of no government intervention:

Consumer's surplus gain	=	+ 1 + 2 + 3 + 4 + 5
Producer's surplus loss	=	- 1 - 2
Government revenue loss	=	- 2 - 3 - 4 - 5 - 6 - 8 - 9 - 10

Net social welfare loss	=	- 2 - 6 - 8 - 9 - 10

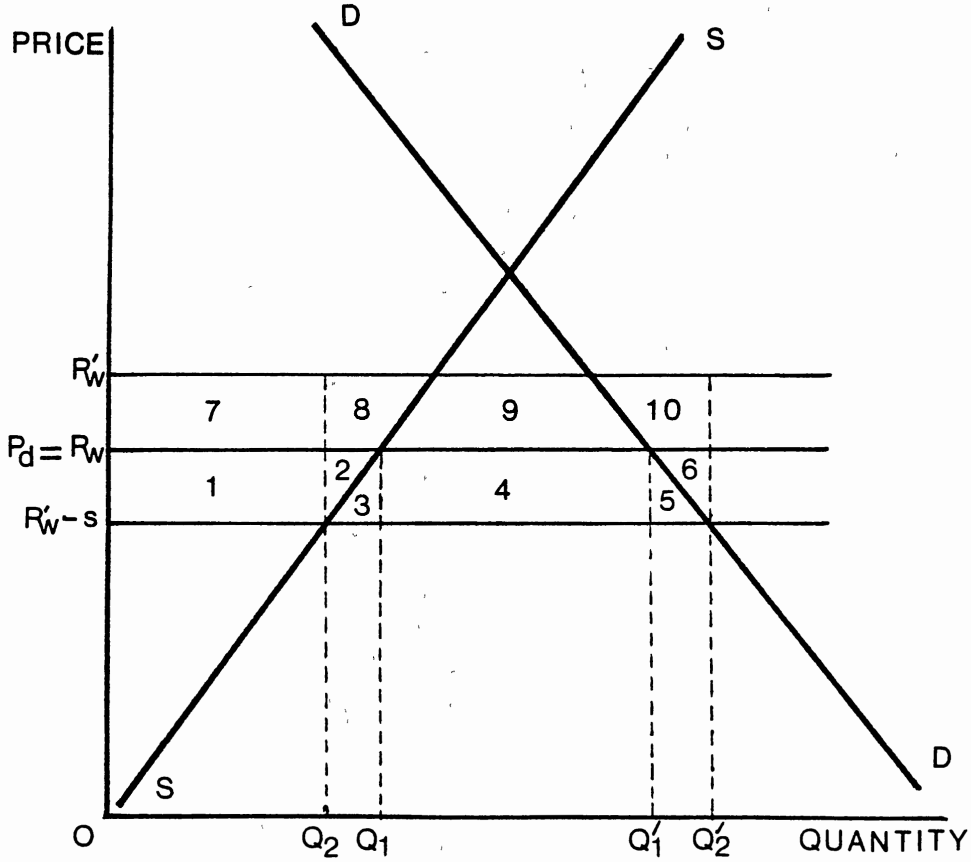

Figure 7. Price Control and Import Subsidy Policy for Rice in Indonesia, 1980

An import subsidy is a policy designed to increase consumer welfare. The result of an import subsidy is reduced prices and increased imports. However there is a net social welfare loss as a result of this policy.

Estimation of areas 2, 6, 8, 9, and 10 can be computed using the following equation:

$$\text{Areas } 2 + 6 = \int_{P_w' - s}^{P_w} D(p)\,dp + \int_{P_w' - s}^{P_w} S(p)\,dp \tag{3.59}$$

where D(p) and S(p) are the demand and supply functions.

$$\text{Areas } 8 + 9 + 10 = s\,(Q_2' - Q_2) \tag{3.60}$$

where, s is subsidy per unit sold, and $Q_2' - Q_2$ is quantity of rice imported.

Forecasting of Supply and Demand Under Fertilizer Subsidy Phase-Out

The government of Indonesia has employed the fertilizer subsidy as a key instrument to stimulate crop production, particularly rice. The rapid growth in fertilizer use, induced in part by the subsidy, together with adoption of modern varieties and massive investments in irrigation, has sharply increased the budgetary burden of the subsidy.

Given the heavy burden of the fertilizer subsidies, and large cutbacks in the government budget, there is considerable discussion in the government regarding possible reduction or complete elimination of the fertilizer subsidy. Elimination of the fertilizer subsidy would achieve significant financial gains for the government.

It is assumed that the reduction or elimination of the subsidy, in other words increasing the price of fertilizer, would reduce the production of rice. Since rice is needed to feed the population which continues to increase, a decline in production will affect the rice self-sufficiency and even the rice exporter position. So the fertilizer subsidy phase-out should be examined carefully and should be linked to the Indonesian national policy as a whole.

The size of Indonesia's imports or exports is an important factor in determining world rice prices. Policies that would lead to an increase in Indonesian rice imports will also boost the world price of rice. A precise estimate of the flexibility of the world rice price with respect to Indonesian imports is not available. However, Timmer (1985) estimated that each incremental million metric tons of Indonesian imports will raise world prices by $50.00 per metric ton.

The core of the supply sector of rice is the production function described above. Using the equation (3.56) the production was estimated for four stages, i.e. 1990, 1995, 2000, and 2005, using a base year of 1985.

The increase of explanatory variables are estimated from annual growth rate. The percentage of high yielding varieties is assumed constant since year of 1986. Weather, which is measured by rainfall, fluctuates year by year and it cannot be predicted. This study assumed rainfall to be the same as the average for the last 18 years. It is also assumed that price is not influenced by world market price though it actually is. Since Indonesia exports or imports of rice will influence the world price of rice. Estimated demand for rice was based on equation (3.58) described above.

Estimation Methods and Data Sources

The error term of the fertilizer demand equation and demand for rice equation meets all the assumptions of the classical normal linear regression model: (1) the expected value of the population disturbance term U_i is zero; (2)

the conditional variance of U_i is constant; (3) there is no autocorrelation in the disturbances; (4) the explanatory variables are either nonstochastic, or if stochastic, distributed independently of the disturbances U_i; (5) there is no multicollinearity among the explanatory variables; (6) the number of observations is greater than the number of parameters to be estimated; and, (7) the U's are normally distributed with mean and variance given by assumptions 1 and 2 above.

With the preceding assumptions, application of the OLS estimation technique to the regression coefficients of equation (3.54), (3.55), and equation (3.58) will give the best linear unbiased estimator (BLUE), and with the normality assumption, the coefficients will be distributed normally.

The supply equations (3.51), (3.52), (3.53), (3.56), and (3.57) do not meet the assumption of serially independent errors. Specifically, equations which include the lagged dependent variables as an explanatory variable have serially correlated disturbances and further, the presence of lagged dependent variable biases Durbin-Watson test for serial correlation in OLS estimation. When successive disturbances are correlated, the parameter estimators are not minimum variance estimators. These results are inefficient estimators, biased "t" values, inaccurate "F" values, and underestimate the significance of the explanatory variables.

There are several different techniques to correct for autocorrelation. A technique followed for these equations is to assume serial correlation and automatically adjust for its presence through the use of an appropriate estimation procedure, called the Cochrane-Orcutt technique. This consists of regressing the OLS residuals on themselves lagged one period to provide an estimate of the first order autocorrelation parameter (p). Using this estimate, the dependent and independent variables are transformed, and OLS regression on these transformed variables gives the generalized-least-squares estimators (β^{GLS}). New estimates of the disturbances are made, by substituting β^{GLS} into the original (untransformed) relationship, which should be "better" than the OLS estimates. Regressing these new residuals on themselves lagged one period provides a new (and presumably "better") estimate of p. To estimate the parameters through this procedure are biased, consistent and asymptotically efficient, that is if the sample size is increased indefinitely, the estimator will converse to their true population values.

The period under consideration of this study is 1969-1986. Since it was not possible to find information or data for all the variables, and some values were preliminary, the most recent years (1987-89) are not included. Most of the information or data utilized in this study came from the Central Bureau of Statistics, the study realized by Rosegrant, et. al., Directorate of Foodcrop Economics and Postharvest Processing, Ministry of Agriculture, and national and international publications from Indonesia, the USA, and other sources.

CHAPTER IV

RESULTS OF THE SUPPLY AND DEMAND MODELS AND MEASURES OF WELFARE ANALYSIS OF RICE POLICY IN INDONESIA

The estimates of the parameters of the structural equations of the supply and demand models are presented in this Chapter. Also, implications of the results obtained are discussed. Measures of welare analysis of rice policy and results of simulations of policy alternative are presented.

Supply Models

Variables in logarithmic and linear terms of several equations were considered and presented as the results for every model. Only the "best" result equation, since it presented acceptable results in R^2, F and t statistics, signs and magnitude of the coefficients, was selected for discussion. The structural estimates are accompanied by their t values, Durbin-Watson statistic, the coefficient of determination (R^2), R-adjusted square, and F-statistic.

The levels of significance accepted in the statistical results were 5 percent, 15 percent, and 30 percent. Several reasons were considered for the selection of those levels of significance. All the variables included in the models were at the aggregate level; therefore, data manipulation could distort the "true" relation among the variables. For several variables, various "official" sources of data reported different numbers. Consistency with economic theory also was considered to be an important reason for leaving a variable in the model.

Model I

The production model consisted of the area and yield response.

Area Response Function. Hectares harvested under paddy cultivation in thousand of hectares was fitted as a function of price of rice (PRICE), price of fertilizer (PUREA), the price of corn (PCORN), price of cassava (PCASA), price of soybean (PSOYB), lagged of area, AREA(-1) and rainfall (RAIN) variables.

OLS and the Cochrane-Orcutt procedure with first order autocorrelation specification was applied to estimate the parameters.

The statistical results for the various area response equations for Java are presented in Tables VI and IX, for Off-Java in Talbes VII and X, and in Tables VIII and XI for Indonesia. The estimated coefficients in Tables VI, VII, and VIII are those without policy variables in the expected price formulation. All the variables in those area functions were of the expected signs.

For the equations in logarithmic terms, the low values of the area price elasticities suggest that the price increases provide only a small incentive for paddy cultivation. This variable was significant at the 5 percent level in both logarithmic and linear terms for all the regions. Rainfall has a positive effect in the area function for all the regions. Its coefficient was significant at the 5 percent level in both the logarithmic and linear models; except, it was significant at the 30 percent level in logarithmic terms for Java. The coefficient of lagged

TABLE VI

ESTIMATED COEFFICIENTS FOR AREA FUNCTION OF RICE, JAVA, 1969-1986, WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Area of Rice)[4]					
	LAREA	LAREA	LAREA	AREA	AREA	AREA
Intercept	0.91 (0.35)[2]	2.99 (1.38)	5.19 (2.24)	-685.95 (0.51)	4104.61 (30.47)	3166.93 (2.85)
LPRICE	0.18*** (2.21)	0.08* (1.42)	0.04 (0.49)			
LPUREA	-0.04 (0.75)	-0.08** (1.74)	-0.09** (1.80)			
LAREA(-1)[3]	0.87*** (2.74)	0.61*** (2.33)	0.34* (1.23)			
LRAIN	0.02* (1.44)	0.03** (1.52)	0.02* (1.24)			
LPCORN	-0.14* (1.40)					
LPCASA		0.01 (0.19)				
LPSOYB			0.15** (1.60)			
PRICE				0.07*** (3.95)	0.02*** (30.47)	0.01 (0.87)
PUREA				-0.02* (1.31)	-0.01 (1.01)	-0.02 (0.92)
AREA(-1)				1.14*** (3.67)	0.01 (0.48)	0.25 (1.02)
RAIN				0.29*** (2.70)	0.45*** (3.80)	0.30*** (2.06)
PCORN				-0.11*** (3.45)		
PCASA					-0.06*** (3.02)	
PSOYB						0.01 (1.05)
R^2	0.84	0.82	0.85	0.94	0.92	0.87
$\bar{R}^2$	0.75	0.72	0.77	0.91	0.88	0.82
Durbin-Watson	2.16	2.10	2.21	2.11	2.10	2.43
F-statistic	9.93***	8.40***	10.76***	28.65***	11.25***	11.29***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE VII

ESTIMATED COEFFICIENTS FOR AREA FUNCTION OF RICE, OFF-JAVA, 1969-1986, WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Area of Rice)[4]					
	LAREA	LAREA	LAREA	AREA	AREA	AREA
Intercept	2.27	1.59	0.27	1241.70	2224.78	1325.90
	(1.50)[2]	(0.75)	(0.16)	(1.13)	(1.25)	(1.10)
LPRICE	0.13***	0.03	0.12			
	(3.23)	(0.82)	(2.51)			
LAREA(-1)[3]	0.68***	0.76***	0.93***			
	(3.66)	(2.95)	(4.53)			
LRAIN	0.03***	0.03**	0.04***			
	(2.50)	(1.98)	3.27)			
LPCORN	-0.11***					
	(2.83)					
LPCASA		-0.01				
		(0.32)				
LPSOYB			-0.10***			
			(2.16)			
PRICE				0.02***	0.01*	0.01*
				(2.26)	(1.23)	(1.81)
AREA(-1)				0.64***	0.39	0.61
				(2.32)	(0.86)	(2.02)***
RAIN				0.24***	0.20*	0.27
				(2.06)	(1.33)	(2.01)***
PCORN				-0.03**		
				(1.72)		
PCASA					-0.01	
					(0.56)	
PSOYB						-0.01
						(0.79)
R^2	0.95	0.92	0.94	0.94	0.92	0.93
$\bar{R}^2$	0.93	0.89	0.92	0.91	0.89	0.90
Durbin-Watson	2.16	2.21	2.44	1.94	1.67	1.93
F-statistic	48.80***	44.21***	42.20***	36.15***	29.28***	30.36***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE VIII

ESTIMATED COEFFICIENTS FOR AREA FUNCTION OF RICE, INDONESIA, 1969-1986, WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Area of Rice)[4]					
	LAREA	LAREA	LAREA	AREA	AREA	AREA
Intercept	1.04	2.59	2.72	930.92	9203.16	5710.65
	(0.52)[2]	(1.15)	(1.02)	(0.44)	(4.19)	(2.47)
LPRICE	0.15***	0.07***	0.06			
	(3.30)	(1.57)	(0.80)			
LPUREA	-0.01	-0.05*	-0.05*			
	(0.26)	(1.29)	(1.31)			
LAREA(-1)[3]	0.85***	0.68***	0.66***			
	(3.80)	(2.68)	(2.22)			
LRAIN	0.03***	0.03**	0.03**			
	(2.26)	(1.94)	(1.89)			
LPCORN	-0.13***					
	(2.14)					
LPCASA		-0.00				
		(0.09)				
LPSOYB			0.01			
			(0.12)			
PRICE				0.07***	0.04***	0.01**
				(4.24)	(3.93)	(1.61)
PUREA				-0.01	-0.00	-0.00
				(0.49)	(0.06)	(0.05)
AREA(-1)				0.86***	0.15	0.27
				(3.43)	(0.56)	(0.99)
RAIN				0.57***	0.36**	0.48***
				(3.48)	(1.99)	(2.03)
PCORN				-0.12***		
				(3.50)		
PCASA					-0.10	
					(2.85)	
PSOYB						0.00
						(0.09)
R^2	0.94	0.90	0.91	0.97	0.96	0.93
$\bar{R}^2$	0.90	0.85	0.85	0.95	0.94	0.89
Durbin-Watson	2.12	2.19	2.20	2.10	2.42	2.14
F-statistic	27.04***	17.65***	17.69***	55.24***	45.06***	25.00***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

harvested area of gabah was positive and significant at the 5 percent level for all the regions in both logarithmic and linear models. Thus, area under paddy in the previous year, leads to an increase in the present area harvested in all regions.

Corn, acted as a competitive crop with rice in all the regions, and its coefficient was highly significant in both logarithmic and linear terms. The estimated coefficients of fertilizer price were negative and it was not significant in the Java and Indonesia equations. This variable was dropped from the equation for Off-Java, because its coefficient had a positive sign, contrary to what was the expected, and it was not significant.

The R-squares for all equations were between 84 percent and 97 percent. the F-statistics were significant, and the Durbin-Watson statistics were close to 2, indicating no autocorrelation for the corrected models.

The estimated coefficients of area function considering policy variables in the expected price formulation are presented in Tables IX, X, and XI for Java, Off-Java, and Indonesia, respectively. Based on the sign of the coefficients from the equations in logarithmic terms, corn competes with rice. The lagged dependent variable was positive and significant. The low value of the area price elasticities suggest the price control schemes provide only a small incentive for paddy cultivation. This variable was significant at the 5 percent level for all the regions. The price of fertilizer follows a similar pattern in its response in the area function. The estimated coefficients were negative and significant at 5 percent level for both Java and Indonesia.

The R-squares and the F-statistics were higher for the logarithmic equations. The Durbin-Watson statistics were close to 2.

TABLE IX

ESTIMATED COEFFICIENTS FOR AREA FUNCTION OF RICE, JAVA, 1969-1986, WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Area of Rice)[4]					
	LAREA	LAREA	LAREA	AREA	AREA	AREA
Intercept	4.80	5.67	5.68	3232.23	3847.26	3526.20
	(2.27)[2]	(2.76)	(2.60)	(2.85)	(3.13)	(3.11)
LEPRICE	0.16***	0.16***	0.11*			
	(2.83)	(2.56)	(1.47)			
LEPUREA	-0.10***	-0.12***	-0.10**			
	(2.16)	(2.29)	(1.98)			
LAREA(-1)[3]	0.40**	0.30*	0.30*			
	(1.58)	(1.19)	(1.12)			
LRAIN	0.03**	0.02*	0.02*			
	(1.77)	(1.51)	(1.24)			
LPCORN	-0.05*					
	(1.26)					
LPCASA		-0.03*				
		(1.10)				
LPSOYB			0.00			
			(0.01)			
EPRICE				0.02*	0.01	0.01
				(1.34)	(1.58)	(0.74)
EPUREA				-0.00	-0.00	-0.00
				(0.16)	(0.09)	(0.17)
AREA(-1)				0.24	0.10	0.16
				(0.91)	(0.36)	(0.65)
RAIN				0.25**	0.26**	0.28**
				(1.74)	(1.91)	(1.90)
PCORN				-0.01		
				(0.74)		
PCASA					-0.02	
					(0.96)	
PSOYB						0.00
						(0.02)
R^2	0.89	0.86	0.85	0.88	0.89	0.88
$\bar{R}^2$	0.79	0.78	0.77	0.82	0.83	0.81
Durbin-Watson	2.23	1.98	2.03	2.05	2.15	2.23
F-statistic	11.99***	11.29***	10.37***	14.09***	14.66***	13.32***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE X

ESTIMATED COEFFICIENTS FOR AREA FUNCTION OF RICE, OFF-JAVA, 1969-1986, WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Area of Rice)[4]					
	LAREA	LAREA	LAREA	AREA	AREA	AREA
Intercept	5.68	3.18	3.59	1126.63	577.70	989.18
	(2.35)[2]	(1.05)	(1.62)	(0.85)	(0.42)	(0.74)
LEPRICE	0.11***	0.04*	0.09***			
	(2.77)	(1.04)	(2.08)			
LAREA(-1)[3]	0.26	0.56**	0.52**			
	(0.86)	(1.52)	(1.90)			
LRAIN	0.02**	0.03**	0.03***			
	(1.98)	(1.70)	(2.59)			
LPCORN	-0.08***					
	(2.28)					
LPCASA		-0.01				
		(0.49)				
LPSOYB			0.06*			
			(1.09)			
EPRICE				0.00	0.00	0.00
				(0.12)	(0.20)	(0.66)
AREA(-1)				0.67***	0.81***	0.71***
				(2.01)	(2.35)	(2.13)
RAIN				0.25**	0.28**	0.25**
				(1.79)	(1.93)	(1.72)
PCORN				0.01		
				(0.50)		
PCASA					0.01	
					(0.86)	
PSOYB						-0.00
						(0.14)
R^2	0.95	0.93	0.94	0.91	0.91	0.91
$\bar{R}^2$	0.93	0.90	0.91	0.87	0.88	0.87
Durbin-Watson	2.27	2.22	2.42	1.95	1.99	1.92
F-statistic	43.91***	30.31***	36.77***	24.69***	25.91***	24.10***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XI

ESTIMATED COEFFICIENTS FOR AREA FUNCTION OF RICE, INDONESIA, 1969-1986, WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Area of Rice)[4]					
	LAREA	LAREA	LAREA	AREA	AREA	AREA
Intercept	5.67	6.92	5.55	6689.73	6893.40	6699.26
	(2.69)[2]	(2.77)	(2.31)	(2.62)	(2.57)	(2.79)
LEPRICE	0.15***	0.15***	0.13***			
	(3.56)	(2.76)	(2.23)			
LEPUREA	-0.07***	-0.09***	0.08**			
	(2.22)	(2.24)	(1.99)			
LAREA(-1)[3]	0.34*	0.19	0.35*			
	(1.43)	(0.69)	(1.30)			
LRAIN	0.03***	0.02**	0.03			
	(2.52)	(1.75)	(0.15)			
LEPCORN	-0.06***					
	(2.21)					
LEPCASA		-0.04				
		(1.61)				
LEPSOYB			-0.04			
			(0.96)			
EPRICE				0.01	0.01	0.01
				(0.60)	(0.65)	(0.40)
EPUREA				-0.05*	-0.05*	-0.05*
				(1.19)	(1.30)	(1.24)
AREA(-1)				0.13	0.15	0.15
				(0.41)	(0.52)	(0.50)
RAIN				0.38**	0.41**	0.39**
				(1.72)	(1.82)	(1.78)
EPCORN				-0.01		
				(0.22)		
EPCASA					-0.00	
					(0.32)	
EPSOYB						-0.00
						(0.04)
R^2	0.94	0.93	0.92	0.93	0.93	0.93
$\bar{R}^2$	0.91	0.89	0.88	0.90	0.90	0.89
Durbin-Watson	2.34	1.80	2.04	2.03	2.08	2.05
F-statistic	28.78***	23.36***	21.56***	25.40***	25.53***	25.27***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

Yield Response Model. Yield in tons per hectare per calendar year was fitted as a function of price of rice (PRICE), price of fertilizer (PUREA), fertilizer use per hectare (FERHA), lagged dependent variable YIELD(-1), high yielding varieites (HYV) and rainfall (RAIN). Ratio of price of rice to fertilizer price (RURE) was also included in the models.

The estimated coefficients of yield functions are presented in Tables XII through XVII. Tables XII, XIII, and XIV are those results without policy variables in the expected price formulation. For the equations in logarithmic term, it can be observed directly that the low price elasticity of the yield response is a significant feature in the results. Such results have been shown in yield response models fitted in Thailand, India, Phillippines, Egypt, Iraq, West Malaysia and Java-Madura (Askari and Cummings, 1977).

The coefficients of price of rice, both with and without policy variables in the expected price formulation, had positive signs and were significant for all the regions. The contribution of price to yield response is higher in the model with policy variables in the expected price formulation. This variable has higher impact to yield in Java than the other regions.

The coefficient of lagged yield of gabah was positive and highly significant for all the regions in the model with policy variables in the expected price formulation. The coefficients of price of fertilizer were negative and significant for all the regions. The coefficients of high yielding varieties were positive, but most of them were not significant. The positive impact of fertilizer use per hectare was more significant in Off-Java region than the other two areas.

The R-squares were between 98 percent and 99 percent, the F-statistics were significant, and the Durbin-Watson statistics were close to 2.

TABLE XII

ESTIMATED COEFFICIENTS FOR YIELD FUNCTION OF RICE, JAVA, 1969-1986, WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Yield of Rice)[4]					
	LYIELD	LYIELD	LYIELD	YIELD	YIELD	YIELD
Intercept	0.61	0.55	0.75	2.32	1.89	1.58
	(1.00)[2]	(0.87)	(2.02)	(2.91)	(2.33)	(3.69)
LPRICE	0.13***	0.11*				
	(1.88)	(1.32)				
LPUREA	-0.09**	-0.09*				
	(1.52)	(1.44)				
LRURE			0.09*			
			(1.45)			
LFERHA	0.09	0.07	0.10**			
	(0.79)	(0.61)	(1.74)			
LYIELD(-1)[3]	0.43***	0.52***	0.51***			
	(2.19)	(2.78)	(2.85)			
LHYV	0.06*					
	(1.06)					
LRAIN		-0.01	-0.01			
		(0.53)	(0.47)			
PRICE				0.00**	0.00	
				(1.58)	(0.87)	
PUREA				-0.00***	-0.00***	
				(2.11)	(1.52)	
RURE						0.14***
						(2.24)
FERHA				2.66***	3.02***	2.32***
				(3.11)	(3.93)	(3.13)
YIELD(-1)				0.03	0.23	0.27**
				(0.11)	(0.74)	(1.61)
HYV				0.00		
				(1.02)		
RAIN					-0.00	-0.00
					(0.56)	(0.60)
R^2	0.98	0.98	0.98	0.99	0.99	0.99
$\bar{R}^2$	0.97	0.97	0.97	0.98	0.98	0.98
Durbin-Watson	2.32	2.51	2.52	2.39	2.39	2.70
F-statistic	104.09***	90.58***	116.57***	153.03***	141.38***	209.08***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XIII

ESTIMATED COEFFICIENTS FOR YIELD FUNCTION OF RICE, OFF-JAVA, 1969-1986, WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Yield of Rice)[4]					
	LYIELD	LYIELD	LYIELD	YIELD	YIELD	YIELD
Intercept	0.39	0.66	0.72	1.39	0.82	0.79
	(1.34)[2]	(2.69)	(4.09)	(3.64)	(2.22)	(3.86)
LPRICE	0.05*	0.02				
	(1.13)	(0.38)				
LPUREA	-0.03	-0.01				
	(0.74)	(0.23)				
LRURE			0.01			
			(0.30)			
LFERHA	0.05**	0.06***	0.07**			
	(1.83)	(2.55)	(3.49)			
LYIELD(-1)[3]	0.53***	0.54***	0.57***			
	(2.83)	(3.63)	(5.52)			
LHYV	0.01					
	(0.34)					
LRAIN		-0.02**	-0.02**			
		(1.91)	(1.96)			
PRICE				0.00	0.00	
				(0.21)	(0.20)	
PUREA				-0.00	-0.00	
				(0.17)	(0.14)	
RURE						0.03
						(0.88)
FERHA				1.33***	2.00***	1.89***
				(2.15)	(3.20)	(3.12)
YIELD(-1)				0.31**	0.63***	0.62***
				(1.61)	(3.34)	(5.84)
HYV				0.01***		
				(2.17)		
RAIN					-0.00	-0.00
					(0.88)	(0.81)
R^2	0.98	0.99	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.97	0.98	0.98	0.98	0.98	0.98
Durbin-Watson	1.95	1.92	2.02	2.29	2.20	2.30
F-statistic	104.08***	149.10***	192.06***	202.62***	140.67***	190.77***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XIV

ESTIMATED COEFFICIENTS FOR YIELD FUNCTION OF RICE, INDONESIA, 1969-1986, WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Yield of Rice)[4]					
	LYIELD	LYIELD	LYIELD	YIELD	YIELD	YIELD
Intercept	0.34	0.11	0.58	2.18	1.39	1.23
	(1.61)[2]	(0.23)	(1.82)	(3.68)	(2.34)	(2.00)
LPRICE	0.10**	0.10***				
	(1.93)	(2.02)				
LPUREA	-0.06*	-0.08**				
	(1.28)	(1.85)				
LRURE			0.06*			
			(1.46)			
LFERHA	0.04	0.00	0.07*			
	(0.50)	(0.07)	(1.41)			
LYIELD(-1)[3]	0.56***	0.66***	0.63***			
	(2.74)	(4.43)	(4.17)			
LHYV	0.03					
	(0.82)					
LRAIN		-0.01	-0.00			
		(0.89)	(0.43)			
PRICE				0.00	0.00**	
				(0.56)	(1.78)	
PUREA				-0.00	-0.00	
				(0.42)	(0.96)	
RURE						0.07*
						(1.41)
FERHA				7.05***	9.23***	4.95**
				(3.02)	(3.84)	(1.58)
YIELD(-1)				0.03	0.33*	0.40*
				(0.10)	(1.21)	(1.48)
HYV				0.01***		
				(2.01)		
RAIN					-0.00	-0.00
					(0.57)	(0.16)
R^2	0.99	0.99	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.98	0.98	0.98	0.99	0.99	0.99
Durbin-Watson	2.47	2.46	2.50	2.64	2.53	2.00
F-statistic	265.14***	234.07***	263.16***	432.02***	297.78**	348.77***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XV

ESTIMATED COEFFICIENTS FOR YIELD FUNCTION OF RICE, JAVA, 1969-1986, WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Yield of Rice)[4]					
	LYIELD	LYIELD	LYIELD	YIELD	YIELD	YIELD
Intercept	0.73	0.56	0.95	1.40	1.44	1.95
	(1.70)[2]	(1.14)	(2.77)	(2.06)	(2.17)	(4.95)
LEPRICE	0.26***	0.21***				
	(3.25)	(2.07)				
LEPUREA	-0.19***	-0.17***				
	(3.12)	(2.09)				
LERURE			0.12**			
			(1.66)			
LFERHA	0.07	0.03	0.12***			
	(0.89)	(0.32)	(2.15)			
LYIELD(-1)[3]	0.14	0.27*	0.38**			
	(0.77)	(1.32)	(1.93)			
LHYV	0.07**					
	(1.92)					
LRAIN		-0.02*	-0.02			
		(1.18)	(0.95)			
EPRICE				0.00	0.00	
				(0.16)	(0.01)	
EPUREA				-0.00	-0.00	
				(0.68)	(0.78)	
ERURE						0.25***
						(2.61)
FERHA				3.11***	3.18***	2.31**
				(3.22)	(3.81)	(3.41)
YIELD(-1)				0.38*	0.39**	0.10
				(1.36)	(1.53)	(0.60)
HYV				0.00		
				(0.19)		
RAIN					-0.00	-0.00
					(0.74)	(1.39)
R^2	0.99	0.98	0.98	0.98	0.99	0.99
$\bar{R}^2$	0.98	0.97	0.97	0.97	0.98	0.98
Durbin-Watson	2.51	2.43	2.44	2.60	2.74	2.34
F-statistic	170.68***	103.48***	120.50**	121.79***	130.00***	235.06***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XVI

ESTIMATED COEFFICIENTS FOR YIELD FUNCTION OF RICE, OFF-JAVA, 1969-1986, WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Yield of Rice)[4]					
	LYIELD	LYIELD	LYIELD	YIELD	YIELD	YIELD
Intercept	0.56	0.89	0.78	1.33	0.65	0.91
	(2.18)[2]	(3.40)	(4.88)	(3.27)	(2.05)	(4.26)
LEPRICE	0.09**	0.05*				
	(1.62)	(1.09)				
LEPUREA	-0.07**	-0.06*				
	(1.52)	(1.44)				
LERURE			0.04*			
			(1.08)			
LFERHA	0.07***	0.08***	0.07***			
	(2.39)	(3.25)	(4.17)			
LYIELD(-1)[3]	0.39**	0.47***	0.48***			
	(1.78)	(2.50)	(3.73)			
LHYV	0.01					
	(0.50)					
LRAIN		-0.02**	-0.02***			
		(1.97)	(2.11)			
EPRICE				0.00	0.00	
				(0.32)	(0.22)	
EPUREA				-0.00	-0.00	
				(0.21)	(0.61)	
ERURE						0.05*
						(1.24)
FERHA				1.37**	2.18***	2.00***
				(1.97)	(3.34)	(3.54)
YIELD(-1)				0.35**	0.72***	0.54***
				(1.68)	(4.47)	(4.34)
HYV				0.01***		
				(2.17)		
RAIN					-0.00*	-0.00
					(1.17)	(0.86)
R^2	0.98	0.99	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.97	0.98	0.98	0.98	0.98	0.98
Durbin-Watson	2.26	2.09	2.12	2.39	2.42	2.29
F-statistic	112.53***	157.61***	207.93***	195.28***	142.79***	206.64***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XVII

ESTIMATED COEFFICIENTS FOR YIELD FUNCTION OF RICE, INDONESIA, 1969-1986, WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Yield of Rice)[4]					
	LYIELD	LYIELD	LYIELD	YIELD	YIELD	YIELD
Intercept	0.68	0.47	0.80	2.14	1.50	1.54
	(1.67)[2]	(1.19)	(2.71)	(3.72)	(2.67)	(2.88)
LEPRICE	0.12**	0.10*				
	(1.92)	(1.43)				
LEPUREA	-0.08**	-0.07*				
	(1.63)	(1.30)				
LERURE			0.04			
			(0.75)			
LFERHA	0.09*	0.04	0.10***			
	(1.35)	(0.67)	(2.20)			
LYIELD(-1)[3]	0.33**	0.46**	0.54***			
	(1.79)	(2.66)	(3.39)			
LHYV	0.04					
	(1.30)					
LRAIN		-0.01*	-0.01			
		(1.01)	(0.69)			
EPRICE				0.00	0.00*	
				(0.11)	(1.18)	
EPUREA				-0.00	-0.00*	
				(0.04)	(1.44)	
ERURE						0.03
						(0.39)
FERHA				8.05***	8.19***	6.54***
				(4.10)	(3.82)	(2.13)
YIELD(-1)				-0.02	0.29*	0.29*
				(0.06)	(1.08)	(1.18)
HYV				0.00*		
				(1.44)		
RAIN					-0.00	-0.00
					(0.40)	(0.36)
R^2	0.99	0.99	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.98	0.98	0.98	0.99	0.99	0.98
Durbin-Watson	2.39	2.38	2.32	2.36	2.26	1.74
F-statistic	249.80***	197.86***	229.28***	420.89***	331.51***	307.78***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

Model II

The Output Function. The price elasticity of output can be estimated directly through the output function. A single equation model representing the rice supply has been used in this study. Total output in calendar year of GABAH (rough rice) was fitted as a function of price of rice (PRICE), area (AREA), total fertilizer use per year (TFERT), lagged dependent variable GABAH(-1), and price of competing crops, corn (PCORN), cassava (PCASA), and soybeans (PSOYB). The ratio of price of rice to fertilizer (RURE) was also included in the model.

OLS and the Cochrane-Orcutt procedure first order autocorrelation specifications were applied to estimate the parameters. Th results obtained are presented in Tables XVIII through XXIII. Tables XVIII, XIX, and XX are those results without policy variables in the expected price formulation for Java, Off-Java, and Indonesia, respectively. The results show that for the equations with variables in logarithmic and linear terms, all the variables were of the expected signs. The coefficient of the price of rice was highly significant at the 5 percent level for Java in both the logarithmic and linear model. It indicated that for each rupiah increase in the price of rice, the quantity of gabah produced will increase by 25 thousand tons per year. For Off-Java, it was significant only for the equation in linear terms, and for Indonesia it was significant only for the equations in the logarithmic terms.

The estimated coefficients of area, total fertilizer use, and lagged dependent variables were all positive and highly significant for all the regions in both logarithmic and linear terms. The coefficients of the lagged dependent variables were less than one for all the regions. This tends to support the year to year adjustment hypothesis. Soybeans acted as a competitive crop,

TABLE XVIII

ESTIMATED COEFFICIENTS FOR PRODUCTION FUNCTION OF RICE, JAVA, 1969-1986 WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Production of Rice)[4]			
	LGABAH	LGABAH	GABAH	GABAH
Intercept	-5.95 (2.72)[2]	-3.09 (1.31)	-3036.74 (1.18)	-654.40 (0.21)
LPRICE	0.25*** (3.08)			
LRURE		0.12** (1.60)		
LAREA	1.30*** (4.75)	1.00*** (3.28)		
LTFERT	0.21*** (2.48)	0.14* (1.11)		
LGABAH(-1)[3]	0.38*** (3.30)	0.35*** (2.51)		
LPSOYB	-0.29*** (3.51)	-0.02 (0.46)		
PRICE			0.09*** (4.38)	
RURE				967.31*** (3.31)
AREA			2.85*** (4.65)	2.05*** (2.83)
TFERT			2.89*** (6.62)	2.12*** (2.92)
GABAH(-1)			0.10** (1.82)	0.10* (1.46)
PSOYB			-0.05*** (4.21)	-0.02** (1.67)
R^2	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.98	0.98	0.99	0.99
Durbin-Watson	2.26	2.30	2.22	2.13
F-statistic	208.45***	138.35***	434.30***	321.13***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XIX

ESTIMATED COEFFICIENTS FOR PRODUCTION FUNCTION OF RICE, OFF-JAVA, 1969-1986 WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Production of Rice)[4]			
	LGABAH	LGABAH	GABAH	GABAH
Intercept	-1.20	-1.40	-1276.03	-2157.62
	(0.59)[2]	(0.71)	(0.52)	(0.81)
LPRICE	0.04			
	(0.61)			
LRURE		0.02		
		(0.49)		
LAREA	0.71***	0.78***		
	(2.24)	(2.59)		
LTFERT	0.06**	0.06**		
	(1.95)	(1.97)		
LGABAH(-1)[3]	0.43***	0.40***		
	(2.92)	(2.62)		
LPSOYB	-0.02	0.02		
	(0.33)	(0.71)		
PRICE			0.03**	
			(1.75)	
RURE				167.67
				(0.95)
AREA			1.51***	1.59***
			(2.08)	(1.96)
TFERT			2.05***	1.92***
			(2.73)	(2.28)
GABAH(-1)			0.44***	0.48***
			(2.86)	(2.81)
PSOYB			-0.01*	0.00
			(1.35)	(0.54)
R^2	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.98	0.98	0.98	0.98
Durbin-Watson	1.80	1.88	1.89	1.90
F-statistic	203.73***	201.84***	252.67***	214.51***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XX

ESTIMATED COEFFICIENTS FOR PRODUCTION FUNCTION OF RICE, INDONESIA, 1969-1986 WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Production of Rice)[4]			
	LGABAH	LGABAH	GABAH	GABAH
Intercept	-4.36	-3.68	-10535.69	11040.67
	(2.65)[2]	(1.86)	(2.37)	(2.46)
LPRICE	0.12***			
	(2.59)			
LRURE		0.05		
		(0.98)		
LAREA	1.10***	1.04***		
	(5.42)	(4.26)		
LTFERT	0.15***	0.12*		
	(5.07)	(1.41)		
LGABAH(-1)[3]	0.37***	0.36***		
	(3.72)	(2.84)		
LPSOYB	-0.13***	-0.01		
	(2.87)	(0.28)		
PRICE			0.02	
			(0.65)	
RURE				71.10
				(0.16)
AREA			2.95***	3.00***
			(5.52)	(5.51)
TFERT			9.02***	7.89***
			(5.53)	(3.89)
GABAH(-1)			0.22***	0.23***
			(2.49)	(2.46)
PSOYB			-0.01	-0.02*
			(0.86)	(1.43)
R^2	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.99	0.99	0.99	0.99
Durbin-Watson	2.31	2.33	2.28	2.24
F-statistic	493.59***	332.76***	877.78***	846.37***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XXI

ESTIMATED COEFFICIENTS FOR PRODUCTION FUNCTION OF RICE, JAVA, 1969-1986 WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Production of Rice)[4]			
	LGABAH	LGABAH	GABAH	GABAH
Intercept	-3.04	-1.24	-2484.30	-523.04
	(1.38)[2]	(0.44)	(0.54)	(0.10)
LEPRICE	0.13***			
	(2.25)			
LERURE		0.11**		
		(1.11)		
LAREA	1.10***	0.83***		
	(3.80)	(2.54)		
LTFERT	0.28***	0.20**		
	(3.05)	(1.54)		
LGABAH(-1)[3]	0.20*	0.28**		
	(2.44)	(1.84)		
LPSOYB	-0.16***	-0.03		
	(2.70)	(0.64)		
EPRICE			0.03	
			(0.77)	
ERURE				1347.74***
				(2.58)
AREA			2.44***	2.29***
			(2.39)	(2.45)
TFERT			3.72***	2.73***
			(4.70)	(3.06)
GABAH(-1)			0.18*	0.06
			(1.24)	(0.32)
PSOYB			-0.03	0.01
			(1.01)	(0.56)
R^2	0.99	0.98	0.99	0.99
$\bar{R}^2$	0.98	0.97	0.98	0.98
Durbin-Watson	2.40	2.21	2.02	2.15
F-statistic	160.40***	125.62**	177.03***	263.21***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XXII

ESTIMATED COEFFICIENTS FOR PRODUCTION FUNCTION OF RICE, OFF-JAVA, 1969-1986 WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Production of Rice)[4]			
	LGABAH	LGABAH	GABAH	GABAH
Intercept	-2.41 (1.01)[2]	-1.10 (0.57)	-2741.17 (1.01)	3061.60 (1.21)
LEPRICE	0.03 (0.56)			
LERURE		0.05 (1.00)		
LAREA	0.83*** (2.66)	0.80*** (2.74)		
LTFERT	0.06*** (2.23)	0.07*** (2.40)		
LGABAH(-1)[3]	0.46*** (2.77)	0.35*** (2.20)		
LPSOYB	0.04 (0.85)	0.01 (0.44)		
EPRICE			0.00 (0.15)	
ERURE				359.83** (1.68)
AREA			1.70*** (2.04)	2.03*** (2.66)
TFERT			2.15*** (2.57)	2.07*** (2.84)
GABAH(-1)			0.54*** (2.95)	0.35** (1.85)
PSOYB			0.00 (0.19)	0.00 (0.38)
R^2	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.98	0.98	0.98	0.98
Durbin-Watson	1.86	1.90	1.93	1.92
F-statistic	203.31***	215.27***	198.27***	239.09***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XXIII

ESTIMATED COEFFICIENTS FOR PRODUCTION FUNCTION OF RICE, INDONESIA, 1969-1986 WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Production of Rice)[4]			
	LGABAH	LGABAH	GABAH	GABAH
Intercept	-2.86 (1.46)[2]	-3.38 (1.56)	-11031.51 (2.40)	-10879.42 (2.09)
LEPRICE	0.05* (1.42)			
LERURE		0.01 (0.23)		
LAREA	1.04*** (4.42)	1.04*** (4.00)		
LTFERT	0.19*** (3.50)	0.17*** (2.29)		
LGABAH(-1)[3]	0.24** (1.97)	0.31*** (2.50)		
LPSOYB	-0.07** (1.77)	-0.02 (0.72)		
EPRICE			0.04* (1.15)	
ERURE				132.82 (0.24)
AREA			2.96*** (5.67)	3.00*** (5.26)
TFERT			8.32*** (7.43)	8.21*** (4.82)
GABAH(-1)			0.24*** (2.43)	0.23** (1.97)
PSOYB			-0.00 (0.06)	-0.02** (1.89)
R^2	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.99	0.99	0.99	0.99
Durbin-Watson	2.36	2.20	2.61	2.62
F-statistic	359.83***	305.39***	925.59***	772.16***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] The (-1) indicates lagged one period
4 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

especially in the Java region. The soybean coefficients were highly significant in both logarithmic and linear terms.

The explanatory variables considered in the model in both logarithmic and linear terms explained 99 percent of the changes in the production of gabah. The F-tests were significant and the Durbin-Watson statistics were close to 2, indicating no presence of autocorrelation for the corrected models.

The results of the estimated parameters with policy variables in the expected price formulation are presented in Tables XXI, XXII, and XXIII. The results were almost similar to those estimated for the estimated parameters obtained without policy variables in the expected price formulation. The coefficients of price of rice were positive, but were not significant for Off-Java, in either logarithmic or linear terms. The coefficients of the price of soybean changes sign from negative to positive, but it was not significant for Off-Java, in both the logarithmic and linear models.

It is interesting to note, that the price elasticity in all those regions is lower compared with the price elasticity obtained without policy variables, in the expected price formulation. This indicates that price control schemes provides little or no incentive for paddy production in the country.

R-squares and adjusted R-squares were high, the F-statistics were significant, and the Durbin-Watson statistic indicated no autocorrelation among the errors for the corrected models.

In summary, the low price elasticity in the yield and area response function indicates a positive but relatively small impact of the price control schemes on paddy cultivation in the country. Rainfall contributes a positive impact to area responses. Corn acted as a competitive crop with rice, especially in Off-Java region.

The estimated elasticities of acreage and yield with respect to price is different than their corresponding elasticities for output. Theoretically, the sum of the elasticities of acreage and the elasticity of yield make up the elasticity of output.

The statistical results for the supply functions obtained by the model with and without policy variables in the expected price formulation are similar. The single equation model can explain with acceptable accuracy the supply function of rice.

Fertilizer Demand Function

The total application of fertilizer by farmers per year was fitted as a function of price of rice (PRICE), or ratio of price of rice to price of fertilizer (RURE), high yielding varieties (HYV), rainfall (RAIN), irrigation (IRRIG), and time (TIME).

OLS was applied to obtain the estimation of the fertilizer demand equation. Several specifications of the fertilizer demand function in both logarithmic and linear terms and the statistical results are presented in Tables XXIV through XXIX. The results without the policy variables in the expected price formulation are shown in Tables XXIV through XXVI. Almost all the variables were of the expected signs. The coefficients of price of rice were positive and highly significant in logarithmic terms in all the regions.

The coefficients of price of fertilizer were negative and significant for Java and Indonesia, in both logarithmic and linear models, but it was not significant for Off-Java. The coefficient of high yielding varieties were positive and significant in the linear model for all the regions. Irrigation was a key variable in total fertilizer use in Java, and significant at the 5 percent level in both

TABLE XXIV

ESTIMATED COEFFICIENTS FOR FERTILIZER DEMAND FUNCTION, JAVA, 1969-1986, WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Total Fertilizer Use)[3]					
	LTFERT	LTFERT	LTFERT	TFERT	TFERT	TFERT
Intercept	-131.94	-66.47	-58.80	-30430.33	21086.86	-28694.94
	(6.99)[2]	(2.47)	(2.97)	(10.48)	(2.11)	(6.48)
LRURE	0.31**		0.29***			
	(1.69)		(2.04)			
LPRICE		0.50***				
		(3.14)				
LPUREA		-0.25**				
		(1.69)				
LHYV	0.31***	0.07				
	(4.60)	(0.73)				
LIRRIG	17.50***	8.89***	7.78***			
	(7.23)	(2.58)	(3.01)			
LTIME			1.53**			
			(6.32)			
RURE				130.65**		132.35**
				(1.58)		(1.63)
PRICE					0.01**	
					(1.89)	
PUREA					-0.02*	
					(1.08)	
HYV				1.72	4.48**	
				(0.71)	(1.92)	
IRRIG				12.20***	8.54***	11.44***
				(10.19)	(2.13)	(6.06)
TIME						18.80
						(0.74)
R^2	0.97	0.98	0.98	0.98	0.98	0.98
$\bar{R}^2$	0.96	0.98	0.98	0.97	0.97	0.97
Durbin-Watson	1.78	1.87	1.74	1.47	1.46	1.41
F-statistic	180.59***	212.19***	279.29***	231.49***	176.36***	232.11***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XXV

ESTIMATED COEFFICIENTS FOR FERTILIZER DEMAND FUNCTION, OFF-JAVA, 1969-1986, WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Total Fertilizer Use)[3]					
	LTFERT	LTFERT	LTFERT	TFERT	TFERT	TFERT
Intercept	4.12	-1.84	-0.80	78.25	14.76	-346.69
	(3.63)[2]	(1.16)	(0.32)	(0.65)	(0.21)	(1.58)
LRURE	1.04**					
	(1.98)					
LPRICE		0.99***	0.92**			
		(2.81)	(1.80)			
LPUREA		-0.27	-0.25			
		(0.68)	(0.63)			
LHYV	0.41***	0.09				
	(3.30)	(0.64)				
LRAIN	-0.07	0.09	0.06			
	(0.41)	(0.81)	(0.58)			
LTIME			-0.19			
			(0.09)			
RURE				48.57		
				(0.75)		
PRICE					0.00	0.01*
					(0.45)	(1.47)
PUREA					-0.00	-0.00
					(0.31)	(0.23)
HYV				19.27***	12.60***	
				(6.46)	(2.92)	
RAIN				-0.01	-0.00	-0.03
				(0.15)	(0.06)	(0.26)
TIME						32.30***
						(2.12)
R^2	0.87	0.95	0.94	0.93	0.94	0.92
$\bar{R}^2$	0.84	0.93	0.93	0.92	0.92	0.90
Durbin-Watson	1.87	2.52	0.93	2.29	2.49	2.37
F-statistic	31.86***	57.84***	56.02***	66.39***	49.36***	39.54***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XXVI

ESTIMATED COEFFICIENTS FOR FERTILIZER DEMAND FUNCTION, INDONESIA, 1969-1986, WITHOUT POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Total Fertilizer Use)[3]					
	LTFERT	LTFERT	LTFERT	TFERT	TFERT	TFERT
Intercept	5.04 (8.54)[2]	2.58 (5.10)	0.75 (1.07)	-211.74 (0.88)	158.34 (4.11)	-222.51 (2.54)
LRURE	0.97*** (3.29)					
LPRICE		0.87*** (5.57)	0.55*** (3.00)			
LPUREA		-0.46*** (2.59)	-0.47*** (3.13)			
LHYV	0.47*** (3.69)	0.01 (0.14)				
LRAIN	-0.19** (1.84)	-0.06* (1.08)	-0.07** (1.66)			
LTIME			1.68*** (2.86)			
RURE				198.79** (1.51)		
PRICE					0.02* (10.58)	0.02*** (9.82)
PUREA					-0.02*** (3.20)	-0.02*** (3.67)
HYV				14.98*** (3.21)	5.77*** (5.36)	
RAIN				-0.30* (1.48)	-0.02 (0.33)	0.01 (0.07)
TIME						35.71*** (5.56)
R^2	0.92	0.98	0.99	0.89	0.99	0.99
$\bar{R}^2$	0.91	0.97	0.98	0.87	0.99	0.99
Durbin-Watson	1.86	1.48	1.91	1.65	1.87	1.75
F-statistic	57.47***	166.09***	267.06***	38.07***	605.01***	573.56***

1 The L before the name of the variable indicates logarithm
2 t-statistics
3 Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XXVII

ESTIMATED COEFFICIENTS FOR FERTILIZER DEMAND FUNCTION, JAVA, 1969-1986, WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Total Fertilizer Use)[3]					
	LTFERT	LTFERT	LTFERT	TFERT	TFERT	TFERT
Intercept	-98.78	-44.92	-30.83	-24495.22	-28104.49	-23202.91
	(6.35)[2]	(1.50)	(1.76)	(7.91)	(3.94)	(5.39)
LERURE	0.51***		0.49***			
	(3.72)		(3.91)			
LEPRICE		0.70***				
		(4.11)				
LEPUREA		-0.49***				
		(3.44)				
LHYV	0.38***	0.13				
	(7.75)	(0.95)				
LIRRIG	13.22***	6.25**	4.17**			
	(6.62)	(1.62)	(1.83)			
LTIME			1.58***			
			(7.84)			
ERURE				302.58***		303.53***
				(3.60)		(3.60)
EPRICE					0.02***	
					(2.94)	
EPUREA					-0.09***	
					(2.87)	
HYV				1.56	8.33***	
				(0.72)	(3.13)	
IRRIG				9.74***	11.31***	9.17***
				(7.60)	(3.11)	(5.00)
TIME						14.87
						(0.67)
R^2	0.99	0.99	0.99	0.99	0.99	0.99
$\bar{R}^2$	0.98	0.98	0.98	0.98	0.98	0.98
Durbin-Watson	1.87	1.93	1.94	2.03	1.92	1.99
F-statistic	269.84***	277.76***	323.86***	276.06***	172.58***	273.97***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XXVIII

ESTIMATED COEFFICIENTS FOR FERTILIZER DEMAND FUNCTION, OFF-JAVA, 1969-1986, WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Total Fertilizer Use)[3]					
	LTFERT	LTFERT	LTFERT	TFERT	TFERT	TFERT
Intercept	3.94	-1.73	-2.36	88.65	26.69	-321.38
	(2.89)[2]	(1.11)	(0.72)	(0.64)	(0.46)	(1.48)
LERURE	0.99***					
	(2.04)					
LEPRICE		0.51*	0.44			
		(1.44)	(0.78)			
LEPUREA		0.21	0.23			
		(0.51)	(0.54)			
LHYV	0.43***	0.02				
	(3.69)	(0.11)				
LRAIN	-0.04	0.12	0.12			
	(0.20)	(0.97)	(1.00)			
LTIME			0.40			
			(0.17)			
ERURE				84.50		
				(0.97)		
EPRICE					0.00	0.00
					(0.16)	(0.63)
EPUREA					0.02	0.01
					(0.99)	(0.39)
HYV				21.50***	10.51***	
				(4.99)	(3.39)	
RAIN				0.01	-0.02	-0.07
				(0.13)	(0.21)	(0.67)
TIME						31.21**
						(1.93)
R^2	0.87	0.95	0.95	0.94	0.95	0.93
$\bar{R}^2$	0.82	0.93	0.93	0.92	0.93	0.93
Durbin-Watson	2.45	2.30	2.30	2.00	2.24	2.12
F-statistic	21.10***	46.73***	46.82***	48.50***	48.54***	33.25***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

TABLE XXIX

ESTIMATED COEFFICIENTS FOR FERTILIZER DEMAND FUNCTION, INDONESIA, 1969-1986, WITH POLICY VARIABLES IN THE EXPECTED PRICE FORMULATION (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Total Fertilizer Use)[3]					
	LTFERT	LTFERT	LTFERT	TFERT	TFERT	TFERT
Intercept	5.29 (10.98)[2]	3.09 (7.60)	1.71 (1.62)	-387.44 (2.75)	155.27 (2.93)	-732.24 (4.21)
LERURE	1.12*** (4.56)					
LEPRICE		0.96*** (7.75)	0.79*** (4.21)			
LEPUREA		-0.64*** (4.51)	-0.62*** (4.60)			
LHYV	0.35*** (2.93)	0.03 (0.34)				
LRAIN	-0.17** (1.96)	-0.04 (0.91)	-0.04* (1.10)			
LTIME			1.07* (1.41)			
ERURE				439.81*** (4.88)		
EPRICE					0.02*** (7.01)	0.02*** (6.99)
EPUREA					-0.05*** (3.31)	-0.07*** (4.03)
HYV				5.95** (1.72)	11.48*** (7.31)	
RAIN				-0.20** (1.59)	-0.11** (1.81)	-0 08** (1.17)
TIME						80.80*** (6.72)
R^2	0.95	0.99	0.99	0.95	0.99	0.99
$\bar{R}^2$	0.93	0.98	0.98	0.94	0.98	0.98
Durbin-Watson	1.10	2.09	2.24	0.97	1.82	1.87
F-statistic	82.23***	263.52***	255.00***	94.64**	318.27***	220.43***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

logarithmic and linear terms. However, rainfall were not significant for Off-Java and Indonesia, in either the logarithmic or linear model.

The R-squares were between 94 percent and 99 percent, and the F-statistics also were highly significant.

The statistical results in Tables XXVII, XXVIII, and XXIX were from the model with policy variables in the expected price formulation in both logarithmic and linear form. The results were similar to the results obtained without the policy variables in the expected price formulation.

Demand Model

The demand for rice was not a principal topic of this study. However, estimates of the demand parameters can be employed to obtain measures of the gain or loss in consumer welfare analysis. Rice consumption per capita was fitted as a function of price of rice (PRICE), expenditure consumption on food per capita (EXOFO), and population (POPUL). OLS was applied to estimate the parameters of demand function. The statistical results obtained for the rice demand model are presented in Table XXX.

A negative relationship was found between the price of rice and the quantity demanded of rice, but it was not significant in both the logarithmic and linear model. The coefficient of expenditure on food was positive and significant in both logarithmic and linear model. The coefficient of number of population was also positive and significant in both linear and logarithmic models, indicating that when number of population increases, the quantity demand domestically for rice was increased also.

The R-square was high (92%) and the F-test also was highly significant.

TABLE XXX

ESTIMATED COEFFICIENTS FOR DEMAND FUNCTION OF RICE, INDONESIA, 1969-1986 (LOGARITHM AND LINEAR)

Independent Variables[1]	Dependent Variables (Consumption of Rice)[3] LRCONS	RCONS
Intercept	-5.40	10.60
	(0.76)[2]	(0.49)
LPRICE	-0.01	
	(0.29)	
LEXOFO	0.26**	
	(1.94)	
LPOPUL	0.74*	
	(1.14)	
PRICE		-0.00
		(0.91)
EXOFO		0.18***
		(2.92)
POPUL		0.00***
		(2.26)
R^2	0.92	0.94
$\bar{R}^2$	0.91	0.93
Durbin-Watson	1.68	1.72
F-statistic	60.21***	82.54***

[1] The L before the name of the variable indicates logarithm
[2] t-statistics
[3] Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

Elasticities and Adjustment Periods

The own-price (short-run), long-run, coefficient of expectations, adjustment periods for rice, and the level of significance of the coefficients from which the elasticity was computed are presented in Table XXXI.

The elasticities indicate that area and production of rice are low-responsive to rice. It is interesting to note that elasticities obtained from the model with the policy variables in the expected price formulation tend to be lower than the results obtained from the model without the policy variables in the expected price formulation. This indicates that price control schemes provides little or no incentive for paddy cultivation in the country.

For hectares harvested of rice, the range of own-price elasticity was between 0.13 and 0.46 in Java, between 0.01 and 0.15 in Off-Java, and between 0.03 and 0.25 in Indonesia; and the range of the long-run elasticity was between 0.17 and 1.38 in Java, between 0.02 and 0.42, and between 0.03 and 1.78 for Off-Java and Indonesia, respectively.

For the production of rice, the range of the own-price elasticity was between 0.04 and 0.25 in Java, between 0.01 and 0.09 in Off-Java, and for Indonesia between 0.05 and 0.12; the range of the long-run elasticity was between 0.05 and 0.40 in Java, between 0.02 and 0.16 in Off-Java, and for Indonesia between 0.03 and 0.19.

The elasticity values obtained in this study indicated that hectares harvested and production of rice is not very responsive to price. Such results have been reported in past studies.

TABLE XXXI

PRICE ELASTICITIES AND ADJUSTMENT PERIODS FOR RICE IN INDONESIA, 1969-1986

Model	Region	Variables[1]	Short-Run SR	Long-Run LR	Coefficient of Expectation(γ)	Adjustment Periods
I(AREA):						
	JAVA	LPRICE	0.18***	1.38***	0.13	20 years
		PRICE	0.46***	0.46***	1.00	1 years
		LEPRICE	0.16***	0.26**	0.60	6 years
		EPRICE	0.13*	0.17	0.76	4 years
	OFF-JAVA	LPRICE	0.13***	0.41***	0.32	10 years
		PRICE	0.15***	0.42***	0.36	9 years
		LEPRICE	0.11***	0.15	0.74	4 years
		EPRICE	0.01	0.02***	0.33	10 years
	INDONESIA	LPRICE	0.15***	1.00***	0.15	18 years
		PRICE	0.25***	1.78***	0.14	20 years
		LEPRICE	0.15***	0.23*	0.66	6 years
		EPRICE	0.03	0.03	0.85	3 years
(YIELD):						
	JAVA	LPRICE	0.13***	0.23***	0.57	6 years
		PRICE	0.12**	0.12	0.97	2 years
		LEPRICE	0.26***	0.30	0.86	3 years
		EPRICE	0.01	0.02*	0.69	5 years
	OFF-JAVA	LPRICE	0.05*	0.11***	0.47	7 years
		PRICE	0.01	0.02**	0.69	5 years
		LEPRICE	0.09	0.15	0.61	5 years
		PRICE	0.01	0.02	0.65	6 years
	INDONESIA	LPRICE	0.10**	0.23***	0.44	7 years
		PRICE	0.07	0.10	0.67	6 years
		LEPRICE	0.12**	0.18**	0.67	6 years
		EPRICE	0.06	0.08	0.71	5 years
II(PRODUCTION):						
	JAVA	LPRICE	0.25***	0.40***	0.62	5 years
		PRICE	0.11***	0.12**	0.90	3 years
		LEPRICE	0.13***	0.16*	0.80	3 years
		EPRICE	0.04	0.05*	0.82	3 years
	OFF-JAVA	LPRICE	0.04	0.07***	0.57	6 years
		PRICE	0.09**	0.16***	0.56	6 years
		LEPRICE	0.03	0.05***	0.54	6 years
		EPRICE	0.01	0.02***	0.46	7 years

TABLE XXXI (Continued)

Model	Region	Variables[1]	Short-Run SR	Long-Run LR	Coefficient of Expectation(γ)	Adjustment Periods
II(PRODUCTION):						
	INDONESIA	LPRICE	0.12***	0.19***	0.63	5 years
		PRICE	0.02	0.03***	0.78	4 years
		LEPRICE	0.05*	0.06**	0.76	4 years
		EPRICE	0.05*	0.07***	0.76	4 years
DEMAND:						
	INDONESIA	LPRICE	-0.01			
		PRICE	-0.02			

[1] The L before the name of the variable indicates logarithms
Variable definitions are in the Appendix
* Thirty percent (30%) level of significance
** Fifteen percent (15%) level of significance
*** Five percent (5%) level of significance

For Java, other things equal, an increase of 10% in the expected price of rice is expected to increase the number of hectares harvested of rice by 1.6% in the short run and by 2.6% in the long run. For Indonesia, other things equal, an increase of 10% in the expected price of rice is expected to increase the number of hectares harvested of rice by 1.5% in the short run and by 2.3% in the long-run.

For the production of rice for Java, other things equal, an increase of 10% in the open market price of rice will increase rice production by 2.5% in the short run and 4.0% in the long-run. Also for Indonesia, if the expected price of rice increases by 10%, production will increase by 1.2% in the short-run and 1.9% in the long-run.

Rewriting the equation (3.34)

$$P_t \quad = \quad \gamma P_{t-1} + (1 - \gamma)\,\gamma P_{t-2} + (1 - \gamma)^2 \gamma P_{t-3} + (1 - \gamma)^3 P^*_{t-3} + \ldots\ldots \qquad (4.1)$$

By using equation (4.1) and the coefficient of expectations (γ), the adjustment period for rice in each model and every region was computed. For example, in Model II (production) of Indonesia, rice producers with or without policy variables in the expected price formulation, for period t give a weight of 76%, (γ), to the price of the period t-1; rice producers give a weight of 18.24%, $[(1 - \gamma)\,\gamma]$, to the price of the period t-2; a weight of 4.37%, $[(1 - \gamma)^2\gamma]$, to the price of the period t-3; a weight of 1.05%, $[(1 - \gamma)^3\gamma]$, to the price of period t-4; and a weight of 0.002%, $[(1 - \gamma)^4\gamma]$, to the price of period t-5; from the sixth year and beyond, the weights that rice producers give to the past prices are very low. The sum of these weights until the fourth year indicates that the prices of the four last years explain 99.66% of the price of the current year. Therefore, the adjustment period to arrive to the new equilibrium production, other things be equal, is 4 years. The shortest period of adjustment were found in the Model I and II in Java when policy variables are not considering in the expected price formulation.

The demand for rice is inelastic. An increase of 10% in the price of rice, if other things are equal, will reduce the quantity demanded of rice by 0.1% in the short-run.

For rice, the cross-price, area, total fertilizer use, rainfall, high yielding varieties elasticities values for the different models and regions, and the level of significance of the coefficients from which the elasticities were derived are presented in Table XXXII.

Corn and soybean showed competitiveness with rice for area and production in all the regions. According to the results obtained, other things being equal, an increase of 10% in the open market price of corn will decrease the hectares harvested of rice by 1.4%, 1.1%, and 0.6% in Java, Off-Java, and in Indonesia, respectively. An increase of 10% in open market price of soybean will decrease the production of rice by 2.9%, 0.2%, and 1.3% in Java, Off-Java, and in Indonesia, respectively.

Availability of land (area) and fertilizer showed a positive and a significant efffect on production of rice. An increase of 10% in area will increase by 13%, 7.1%, and 11% the production of rice in Java, Off-Java, and in Indonesia, respectively.

An increase in 10% in total fertilizer use per year for paddy cultivation, will increase the production of rice by 2.1%, 0.6%, and 1.5% per year for Java, Off-Java, and Indonesia, respectively.

The magnitude of the rainfall was low, but showed a positive and a significant effect on area. An increase of 10% in the rainfall will increase by 0.3%, 0.3%, and 0.4% the number of hectares harvest of rice for Java, Off-Java, and Indonesia, respectively. The price of fertilizer showed a negative effect and

TABLE XXXII

CROSS-PRICE, AREA, TOTAL FERTILIZER USE, RAINFALL, HIGH YIELDING VARIEITIES FOR THE RICE SUPPLY FUNCTION IN INDONESIA, 1969-1986

Models	Independent Variables[1]	Regions		
		Java	Off-Java	Indonesia
I(YIELD):				
	LPUREA	-0.09**	-0.03	-0.06
	PUREA	-0.09***	-0.01	-0.02
	LEPUREA	-0.19***	-0.07**	-0.08**
	EPUREA	-0.06	-0.01	-0.01
	LFERHA	0.09	0.05**	0.04
	FERHA	0.21***	0.05**	0.21***
	LHYV	0.06*	0.01	0.03
	HYV	0.06	0.09	0.08
(AREA):				
	LPUREA	-0.04	-	-0.01
	PUREA	-0.04	-	-0.01
	LEPUREA	-0.10***	-	-0.07***
	EPUREA	-0.01	-	-0.01*
	LPCORN	-0.14*	-0.11***	-0.06***
	PCORN	-0.36***	-0.11**	-0.21***
	LEPCORN	-0.05*	-0.08***	-0.06***
	EPCORN	-0.03	-0.02	-0.01
	LRAIN	0.02*	0.03***	0.03***
	RAIN	0.03***	0.03***	0.04**
II(PRODUCTION):				
	LPSOYB	-0.29***	-0.02	-0.13***
	PSOYB	-0.13***	-0.04**	-0.02
	LEPSOYB	-0.16***	-	-0.07***
	EPSOYB	-0.05	-	-0.01
	LAREA	1.30***	0.71***	1.10***
	AREA	0.80***	0.58***	0.95***
	LTFERT	0.28***	0.06**	0.15***
	TFERT	0.24***	0.06***	0.28***

[1] Variable definitions are in the Appendix
* Computed from coefficient with 30 percent level of significance
** Computed from coefficient with 15 percent level of significance
*** Computed from coefficient with 5 percent level of significance

significant effect on area. An increase of 10% in the expected price of fertilizer will decrease the number of hectares harvested of paddy by 1% and 0.7% in Java, and Indonesia, respectively.

Measures of Welfare Analysis of the Rice Policy

Estimation of the areas shown in Figure 7 are presented in Table XXXIII. Estimated supply and demand equation for rice of Indonesia in 1980 was obtained from the estimated production and demand functions for rice in logarithmic term (Table XX and Table XXX).

The supply equation is as follows:

$$S = \text{Ln } -4.36 \text{ PRICE}^{0.12} \text{ AREA}^{1.1} \text{ TFERT}^{0.15} \text{ GABAH}(-1)^{0.37} \text{ PSOYB}^{-0.13} \quad (4.2)$$

Except for the price of rice, other variables are assumed to be constant; therefore supply as a function of the price of rice is:

$$S = 8567.9079 \text{ PRICE}^{0.12} \quad (4.3)$$

The demand equation is:

$$D = \text{Ln } -5.3961 \text{ PRICE}^{-0.01456} \text{ EXOFO}^{0.264744} \text{ POPUL}^{0\ 747959} \quad (4.4)$$

Other variables are assumed to be constant; therefore demand for rice as a function of the price of rice is:

$$D = 143.7996 \text{ PRICE}^{-0.01456} \quad (4.5)$$

Based on the domestic and world market price of rice in 1980, and given the import subsidy, total consumers gained 162,324 millions of rupiah, producers lost 133,788 millions of rupiah, and the government lost 32,800 millions of rupiah. Society as a whole or net social welfare loss was 4,324 millions of rupiah.

TABLE XXXIII

WELFARE ANALYSIS EFFECTS OF PRICE POLICY FOR RICE IN INDONESIA, 1980

	Factor	Figure 7 Area	Figure 7 Price-Quantity	Units	1980
			Consumers		
(1)	Domestic market price		$P_d = P_w$	Rp/kg	228.99
(2)	Domestic market price with import subsidy		P_w'-s	Rp/kg	221.82
(3)	World market price		P_w'	Rp/kg	250.52
(4)	Consumer surplus gain	1	$[P_d-(P_w'-s)] \cdot Q_2$[1]	Million of rupiah	133,531.20
(5)	Consumer surplus gain	2+3	$[P_d-(P_w'-s)](Q_1-Q_2)$[2]	Million of rupiah	521.50
(6)	Consumer surplus gain	4	$[P_d-(P_w'-s)](Q_1'-Q_1)$[3]	Million of rupiah	28,159.61
(7)	Consumer surplus gain	5	$0.5[P_d-(P_w'-s)](Q_2'-Q_1')$[4]	Million of rupiah	60.15
(8)	Consumer surplus gain	6	$0.5[P_d-(P_w'-s)](Q_2'-Q_1')$	Million of rupiah	60.15
(9)	Total gain to consumers under import subsidy (4), (5), (6), (7), and (8)	1+2+3 +4+5+6		Million of rupiah	162,323.61
			Producers		
(10)	Producer surplus loss	1	$[P_d-(P_w'-s)] \cdot Q_2$	Million of rupiah	133,531.20
(11)	Producer surplus loss	2	$0.5[P_d-(P_w'-s)](Q_1-Q_2)$	Million of rupiah	256.25
(12)	Total loss to producers (10) and (11)	1+2		Million of rupiah	133,787.45
			Government		
(13)	Government revenue loss	2+3+4 +5+6		Million of rupiah	28,792.41
(14)	Government revenue loss	8+9+10		Million of rupiah	4,007.28
(15)	Total loss to government (13) and (14)	2+3+4+5 +6+8+9+10		Million of rupiah	32,799.69
			Society		
(16)	Net social welfare loss	2+6+8 +9+10		Million of rupiah	4,323.68

[1] Q_2 is the quantity produced for rice, introducing P_w'-s into the estimated supply equation

[2] Q_1 is the quantity produced for rice, introducing P_d into the estimated supply equation

[3] Q_1' is the quantity consumed for rice (+ rice product), introducing P_d into the estimated demand equations

[4] Q_2' is the quantity consumed for rice (+ rice product), introducing P_w'-s into the estimated demand equation

Actually the producers' loss was not as much as mentioned above, because factor inputs subsidy were not included in this study. A further study and more detailed analysis are needed to resolve that issue.

Predictions of Supply and Demand of Rice Under Fertilizer Subsidy Phase-Out

For prediction purposes, the estimated production function (4.2) and demand function (4.4) for rice were applied since they presented acceptable results in R^2, F and t statistics, signs and magnitude of the coefficients. To estimate the total demand of fertilizer, the fertilizer demand model with variables in logarithmic terms (Table XXVI) was applied:

$$F_d = \text{Ln } 2.58 \text{ PRICE}^{0.87} \text{ PUREA}^{-0.46} \text{ HYV}^{0.01} \text{ RAIN}^{-0.06} \qquad (4.6)$$

To supply the values of the independent variable, a rate of growth of the variable was estimated (Table XXXIV). Weather, measured by rainfall, fluctuates year by year, and it cannot be predicted. This study assumed that rainfall to be the same of the average for 18 years (475 mm). The percentage of high yielding varieties also was assumed to be the same since 1986 (77.06%). It also is assumed that the domestic price of rice is not influenced by world market price, though it actually is.

Finally, values forecast for the independent variables were used to obtain the predictions of suppy and demand of rice, and also for total demand of fertilizer from 1990 to 2005.

Based on the adjusted CIF price of fertilizer (Table XXXV), scenarios for several fertilizer subsidy alternatives were postulated. Effects of these subsidy alternatives on estimated rice production for years of 1990, 1995, 2000, and 2005 are presented in Table XXXVI.

TABLE XXXIV

GROWTH RATE AND MEAN OF THE VARIABLES INCLUDED IN THE ANALYSIS OF SUPPLY AND DEMAND OF RICE, AND DEMAND OF FERTILIZER FOR ALL THE REGIONS, 1969-1986

Variables[1]	Indonesia		Java		Off-Java	
	Growth rate	Mean	Growth rate	Mean	Growth rate	Mean
GABAH[2]	0.045	27227	0.046	16633	0.044	10598
AREA	0.012	8802	0.012	4693	0.012	4108
TFERT	0.134	834	0.127	1409	0.177	429
PRICE	0.134	175	0.134	175	0.134	175
PUREA	0.080	64	0.080	64	0.080	64
PSOYB	0.145	251	0.145	251	0.145	251
CPI	0.122	127	0.122	127	0.122	127
CIF[3]	0.098	132661	0.098	132661	0.098	132661
HYV	0.182	47	0.159	66	0.347	25
RAIN	0.046	475	0.046	475	0.046	475
RCONS	0.019	118				
EXOFO	0.041	234				
POPUL	0.021	139313				

1 Variable definitions are in the Appendix
2 Rice production in term of dry unhusked rice
3 Adjusted CIF (price of fertilizer, see Table XXXV)

TABLE XXXV

AVERAGE SUBSIDY FOR FERTILIZER (UREA), INDONESIA, 1970-1986

Year	CIF[1]	Marketing Cost	Adjusted CIF	Farmer Prices	Implicit Tariff	Exchange Rate
	$/mt	----------- Rp/tons	-----------	-----------	---%---	Rp/US$
1970	69.40	8733	37823	26600	-28.7	420
1971	68.39	8885	37541	26660	-28.1	420
1972	80.44	9609	43340	26600	-37.9	420
1973	121.57	13293	64300	40000	-37.3	420
1974	328.61	16376	154391	40000	-74.0	420
1975	261.08	19010	128663	60000	-53.2	420
1976	141.18	22260	81556	80000	-0.9	420
1977	157.32	24308	90380	70000	-21.9	420
1978	172.36	25889	133615	70000	-47.3	632
1979	215.04	34428	168829	70000	-58.3	630
1980	256.09	38783	200635	90000	-54.9	632
1981	255.88	43577	211177	90000	-57.1	655
1982	223.91	31605	187670	90000	-52.0	697
1983	133.24	35511	168484	100000	-40.6	998
1984	142.16	33705	186527	100000	-46.3	1075
1985	116.86	43107	174691	100000	-42.8	1126
1986	86.70	43083	185617	125000	-32.7	1644

[1] CIF urea derived from FOB Western Europe + insurance cost for 1970-81, for 1982-86, FOB Indonesia was used

Source: Adopted from Rosegrant et. al.

TABLE XXXVI

PROJECTED SUPPLY AND DEMAND OF RICE, INDONESIA, 1985-2005

Year	Production of rice[1]	Change in stock	Net imports	Supply for Consumption	Waste, Seeds, Feed, others[2]	Food
	---------- thousands of metric tons ----------					
Subsidy 0%[3]						
1985, base	26473		34	22521	3719	22555
1990	30012	0	1841	26411	3601	28252
1995	37223	0	2441	32756	4467	35197
2000	46168	0	3152	40628	5540	43780
2005	57262	0	4184	50391	6871	54575
Subsidy 25%						
1985, base	26473		34	22521	3719	22555
1990	30614	0	1312	26940	3674	28252
1995	37970	0	1783	33414	4556	35197
2000	47094	0	2337	41443	5651	43780
2005	58410	0	3174	51401	7009	54575
Subsidy 50%						
1985, base	26473		34	22521	3719	22555
1990	31482	0	548	27704	3778	28252
1995	39047	0	836	34361	4686	35197
2000	48429	0	1162	42618	5811	43780
2005	60067	0	1716	52859	7208	54575
Subsidy 75%						
1985, base	26473		34	22521	3719	22555
1990	33024	0	-809	29061	3963	28252
1995	40960	0	-848	36045	4915	35197
2000	50803	0	-927	44707	6096	43780
2005	63010	0	-874	55449	7561	54575

[1] Conversion factor from gabah to rice = 65%
[2] Waste + Seeds + Feed + others = 12% of rice production
[3] Subsidy was calculated from Adjusted CIF (price of urea, Table XXXV)

The price of fertilizer would increase by 74 percent by eliminating fertilizer subsidies. By maintaining fertilizer subsidies, estimated production of rice would continue to increase. On the other hand, by eliminating fertilizer subsidies, production of rice would decrease. Therefore, to meet the increase in the domestic demand of rice, an estimated 1,841, 2,441, 3,152, and 4,184 thousands of metric tons should be imported in years of 1990, 1995, 2000, and 2005, respectively.

Given a subsidy of 75 percent of the price of fertilizer, the estimated domestic production of rice in years of 1990, 1995, 2000, and 2005 would provide a surplus of 809, 848, 927, and 874 thousands of metric tons respectively above domestic consumption requirements.

By maintaining the fertilizer subsidies, net imports would be negative; in other words, there would be exports; by eliminating fertilizer subsidies, imports would be needed to feed the people. Both of these scenarios actually would be influenced by the world market price of rice, and also would affect the world market price.

According to the results above, full elimination of fertilizer subsidy would cause large amount imports of rice. This policy should be considered and examined carefully before being applied. This finding is consistent with the previous studies by Suprapto and Rosegrant et. al.

Better and more complete data are needed to improve this study. Since the size of Indonesia's import or export of rice will affect world market price of rice, the impact in domestic market to make prediction of domestic supply and demand of rice in the future should be considered. To differentiate producers and consumers of rice by rural, urban, provinces, and income classes also would provide better estimates.

CHAPTER V

SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FUTURE RESEARCH

Summary

Rice is the staple food of the Indonesian people, and it remains dominant in the Indonesian agriculture. The largest contributor to the growth in the food crops and agricultural sectors has been rice. Rice production increased by 121 percent from 1968 to 1984, when Indonesia became self-sufficient in the crop for the first time. This remarkable feat has been achieved in significant part due to government policies in support of rice production. Investment in expansion and improvement of irrigation systems, and in research capacity, the rice intensification program, fertilizer subsidies, and investment in the rural infrastructure have been the main government policies for expanding rice production in Indonesia. Food security is an issue of national importance, and maintaining rice self-sufficiency in Indonesia is one of the prime objectives of the government.

Price policy in the rice sector has been characterized by active intervention of the government. The government's most important objectives for the rice sector have been to increase production, have domestic consumer price stability, and to improve rice farmers' income. Policies implemented by the government to achieve these policies have been based on domestic market intervention, input subsidies, and import subsidies.

Models that allow researchers to analyze the effects of rice production caused by changes in domestic policy variables need to be developed. Results from studies that considered estimates of supply response with the introduction of policy variables into expectation of price formulations, and the distribution of gains and losses of government among producers, consumers, and society as a whole will help the decision makers of rice policy.

This study had three main objectives: (1) estimate the supply function for rice considering policy variables in the formulation of expected prices; (2) apply welfare analysis to estimate the distribution of gains and losses among consumers, producers, government and society of the import subsidy policy for rice in Indonesia; and, (3) simulate the effects of a fertilizer subsidy phase-out on rice production.

Two alternative models with a Nerlove type formulation were postulated. Model I was formed by a system of two behavioral equation (area and yield). Model II is a single equation model, represented by the supply rice function (production). The demand model for rice and fertilizer is a single equation. Variables in logarithmic and linear terms were considered.

Ordinary-least-squares (OLS) was applied to estimate the demand functions for rice and fertilizer. To correct for autocorrelation, the Cochrane-Orcutt technique was applied. The time period considered was 1969-1986. Most of the data utilized in this study came from the Indonesian Central Bureau of Statistics, a study done by Rosegrant et. al., Directorate of Foodcrops Economics and Postharvest Processing, Directorate General of Foodcrops, Ministry of Agriculture, national and international publications from Indonesia, the USA, and other sources.

The statistical results for the supply functions obtained by the model with and without policy variables in the expected price formulation are indifferent.

The low price elasticity in the yield and area response function indicates a positive but relatively small impact of the price control schemes on paddy cultivation in the country. Rainfall contributes a positive impact to area supply responses. Corn acts as a competitive crop with rice, especially in Off-Java. The estimated elasticities of area and yield with respect to price are different than corresponding elasticities for output. Theoretically, the sum of the elasticities of area and the elasticity of yield make up the elasticity of output. The single equation model (Model II) can explain with acceptable accuracy the supply function of rice.

Short-run and long-run direct price elasticity, cross-price elasticities, and elasticity with respect to other shifters of the supply function, as well as the adjustment period for each model, were computed. Elasticities indicated that area and production of rice are low responsive to price. Such results have been shown in the past studies.

For area of rice, the range of own-price elasticity was between 0.13 and 0.46 in Java, between 0.01 and 0.15 in Off-Java, and between 0.03 and 0.25 in Indonesia; and the range of long-run elasticity was between 0.17 and 1.38 in Java, between 0.02 and 0.42 in Off-Java, and between 0.03 and 1.78 for Indonesia.

For production of rice, the range of the own-price elasticity was between 0.04 and 0.25 in Java, between 0.01 and 0.09 in Off-Java, and for Indonesia between 0.05 and 0.12; and the range of the long-run elasticity was between 0.05 and 0.40 in Java, between 0.02 and 0.16 in Off-Java, and for Indonesia between 0.03 and 0.19. The elasticity values obtained in this study indicated that area and production of rice is low responsive to price.

For area, the range for adjustment periods was between 1 and 20 years in Java, between 4 and 10 years in Off-Java, and between 3 and 20 years in

Indonesia. For yield, the range for adjustment periods was between 2 and 6 years in Java, between 5 and 7 years in Off-Java, and for Indonesia between 5 and 7 years.

For production, the range of adjustment periods was between 3 and 5 years period in Java, between 6 and 7 years in Off-Java, and between 4 and 5 years for Indonesia.

The statistical results of the rice and fertilizer demand were good, in the sense of the level of significance, R-squares were high, and the F-test also was highly significant.

Under partial equilibrium assumptions, classical welfare analysis was applied to provide some insight into the merits of the actual import subsidy and the price control policy for rice. The effects of these policies were measured by their impacts on producers, consumers, government, and society. Based on the price control policy, and using the import subsidy for rice for the year 1980, consumers gained 162,324 millions of rupiah, producers lost 133,788 millions of rupiah, and the government lost 32,800 millions of rupiah. Society as a whole, or net social welfare loss, was 4,324 millions of rupiah.

For forecasting purposes, Model II (production) and the demand model for rice were applied. The growth rate of the variables was calculated. The forecasted values of the variables were estimated and used to obtain the predictions for rice from 1990 to 2005.

Alternative scenarios of fertilizer subsidies phase-out were postulated. The simulation results showed that given 75 percent subsidy of price of fertilizer, the rice production would be surplus in years of 1990, 1995, 2000, and 2005. On the other hand, by eliminating the fertilizer subsidy, an estimated 1,841, 2,441, 3,152, and 4,184 thousands of metric tons would be imported in 1990, 1995, 2000, and 2005, respectively.

Conclusions

Area and production of rice are low responsive to price. Such results have been reported in past studies. Although not always the expected signs, magnitude and significance of fertilizer price, high yielding varieties, rainfall, irrigation, and total fertilizer use were maintained in the model of all the regions. Inclusion of these variables are promising, but refinements are required.

Interdependence of the rice sectors with the corn and soybeans sector was found; therefore, formulation of policies of related crops and their effects should be considered in the analysis of rice strategy.

Government intervention in the rice sector based on the price control schemes and the import subsidy for rice represents an economic loss to the country.

Alternative scenarios of fertilizer subsidies phase-out showed that full removal of fertilizer subsidy would cause large amount imports of rice. These results argue against full elimination of fertilizer subsidies, because this would require government - subsidized rice imports, the cost of which could more than offset the savings from elimination of the fertilizer subsidy.

Limitations of the Study

The major limitation of this study is related to the availability of data in Indonesia. Most of the data required for this study were obtained from the Central Bureau of Statistics and other reports. Variation in data for the same variable was found among different sources. Data limitations were greater at the regional than the national level.

The results presented in this study are for the entire country or aggregate level. Differences in rice farmers' performance among regions is expected since the conditions are not the same. Estimation of parameters by using econometric models under this condition could be underestimated or overestimated.

Given the time constraint, it was impossible to obtain a constructive criticism of this study by rice farmers and policy makers of the Indonesian rice sector. The results presented in this study still have validity for public policy analysis purposes.

This study is based on partial equilibrium. In the study, analysis of the input side problems of the rice sector was weak. The welfare effects of the current rice policy on the output side presented in this study has to be balanced against welfare effects of rice policy in the input side. Effects of the rice product market on the production of rice were not considered in this study. Estimation of elasticity values may or may not change significantly, if additional equations to capture those effects were included in the model.

Policy Recommendations and Suggestions for Future Research

The fertilizer subsidy phase-out would cause large imports of rice. This policy should be examined before being applied. Better and more complete data are needed to improve this study. Since Indonesia is a major actor in the world rice market, the impacts of world market on the domestic market should be included to make more reliable predictions of supply of rice in the future.

This study was done at the national level. Rice is produced in several zones of the country by both traditional and commercial farmers. Differences in the response of supply by zones, type of farm, and income classes should be estimated. Rice policy effects are expected to be different among these subclasses.

Incomplete time series data have a strong limitation in carrying out studies in the Indonesian agricultural sector. Elaboration and updating of data by institutions is recommended. Current and accurate availability is an important tool for researchers and policy makers.

One of the direct methods of estimation of the supply function was used in this study. Prediction and stimulation of policy analysis were based on econometric models. Given the limitation of time series data, the linear programming method is a good alternative that should be considered.

Application of classical welfare analysis to the input side and other interventions in the rice sector would be important. The rice product market has to be considered in the analysis of the rice policy. Estimation of elasticities and policy conclusions can change if additional equations representing the rice product market are incorporated in the model presented in the study.

An increase in yield is a very important alternative if the country is to expand the production of rice. Finally, agricultural economics research is suggested in the rice sector, applied and basic, not only from the product but also from the input side.

BIBLIOGRAPHY

Adams, Richard M., D. J. Menkhaus and K.A. Keith. An Investigation of Alternative Risk Supply Response Models for Selected U.S. Crops. Wyoming Agricultural Experiment Station RJ-161, 1981.

Affif, S. and C. P. Timmer. "Rice Policy in Indonesia." Food Research Institute Studies. 10(1971).

Affif, S., W. Falcon and C. P. Timmer. "Elements of a Food and Nutrition Policy in Indonesia." The Indonesian Economy. Edited by G.F. Papanek. New York: Praeger Publishers, 1980.

Almon, S. "The Distributed Lag Between Capital Appropriations and Expenditures." Econometrica, 33(1965):178-196.

Alvarez, Ramon A. R. "Supply Response and Welfare Analysis of Price Policy for Cotton in Colombia." Unpublished Ph.D. Dissertation, Oklahoma State University, 1987.

Amang, Beddu. "The Price of Rice and Inflation in Indonesia 1967-1981." Unpublished Ph.D. Dissertation, University of California, Davis, 1985.

Anon. "Development in Indonesian Agriculture." Supporting Paper to the Presidential speech delivered at the World Food Conference, FAO, Rome 14 November 1985. Indonesian Agricultural Research & Development Journal. Vol. 8 No. 1(1986):26-31.

Askari, Hossein and John Thomas Cummings. Agricultural-Supply Response. A Survey of the Econometric Evidence. New York: Praeger Publishers, 1976.

Askari, Hossein and John Thomas Cummings. "Estimating Agricultural Supply Response with the Nerlove Model: A Survey." International Economic Review. 18(1977):257-292.

Baily, Kenneth W. and Abner W. Womack. "Wheat Acreage Response: A Regional Econometric Investigation." Southern Journal of Agricultural Economics. 67(1985):171-180.

Bean, L. H. "The Farmers' Response to Price." Journal of Farm Economics. 11(1929):368-385.

Beattie, Bruce R. and C. Robert Taylor. The Economics of Production. Baltimore: John Wiley and Sons, 1985.

Behrman, Jere R. Supply Response in Undeveloped Agriculture: A Case Study of Four Major Annual Crops in Thailand. 1937-1963. Amsterdam: North-Holland Publishing Co., 1968.

Birowo, A. T. "The Economics of New Technology: A Case of Indonesia." Village-Level Storage for Cereal in Selected Asian Countries. Asian Productivity Organization, Tokyo, 1981.

Bogahawatte, Cyrill. "Government Agricultural Policies and Their Impact on Supply and Demand for Rice in Sri Lanka." Unpublished Ph.D. Dissertation, Texas A&M University, 1982.

Booth, A. "Survey of Recent Developments." Bulletin of Indonesian Economic Studies. Vol. 24 No. 1 (1988):1-35.

Booth, A. and R. M. Sundrum. "Income Distribution." In A. Booth and P. McCawley (eds). The Indonesian Economy During the Suharto Era. Kuala Lumpur: Oxford University Press, 1981.

Brancoft, Robert L. "An Econometric Analysis of Aggregate Acreage Response, Program Participation and Land Retirement." Unpublished Ph.D. Dissertation, Purdue University, 1981.

Brennan, John P. "The Representation of Risk in Econometric Models of Supply: Some Observations." Australian Journal of Agricultural Economics. 26(1982):151-156.

Cagan, Phillip. "The Monetary Dynamics of Hyper Inflations," in M. Friedman (eds.), Studies in the Quantity Theory of Money, Chicago: University of Chicago Press, 1956.

Central Bureau of Statistics. Statistical Year Book of Indonesia. Jakarta, (1981-88).

Chernicchovsky, D. and O. A. Meesook. Patterns of Food Consumption and Nutrition in Indonesia. An Analysis of the National Socioeconomic Survey, 1978. World Bank Staff Working Papers Number 670. Washington, D.C.: The World Bank, 1984.

Chipman, John S. and James C. Moore. "Compensating Variation Consumer Surplus and Welfare." American Economic Review. 70(1980):933-944.

Colman, David. "A Review of the Arts of Supply Response Analysis." Review of Marketing and Agricultural Economics. 51(1982):201-230.

Collins, Glenn S. "An Economic Situation Model for Evaluating Aggregate Economic Impacts of Technological Change on Major U.S. Field Corps." Unpublished Ph.D. Dissertation, Texas A&M University, 1980.

Currie, J. M., J. A. Murphy, and A. Schmitz. "The Concept of Economic Surplus and Its Use in Economic Analysis." Economic Journal. 81(1971):741-799.

Dean, Gerald and Earl O. Heady. "Changes in Supply Response and Elasticity for Hogs." Journal of Farm Economics. 40(1958):835-844.

Denney, E. Wayne. "Summary of Supply and Demand for Agricultural Products in Indonesia, 1975-85." USDA, Economic Research Service. Foreign Agricultural Economic Report No. 126 (1976).

Durbin, J. "Testing for Serial Correlation in Least-Squares Regression when some of the Regressors are Lagged Dependent Variables." Econometrica. 38(1970):410-421.

Evans, David. "Survey of Recent Developments." Bulletin of Indonesian Economic Studies. Vol. 24 No. 3(1988):3-30.

Evans, Sam and Thomas M. Bell. "How Cotton Acreage, Yield, and Production Response to Price Changes." Agricultural Economics Research. 30(1978):255-280.

Ezequiel, Moscardi. "The Cobweb Theorem." Quarterly Journal of Economics. 53(1938):255-280.

Friedman, M. A Theory of the Consumption Function. National Bureau of Economic Research. Princeton: Princeton University Press, NJ, 1957.

Gallagher, Paul. "The Effectiveness of Price Support Policy Some Evidence for U.S. Acreage Response." Agricultural Economic Research. 30(1978): 8-14.

Gardner, Bruce L. "Future Prices in Supply Analysis." American Journal of Agricultural Economics. 58-(1976):81-84.

Gichuhi, George and James Dunn. Kenya Maize and Wheat Acreage Response: An Econometric Study of the Large Farm Sector. Technical Bulletin 855, Pennsylvania State University, 1984.

Griliches, Zvi. "The Demands for Inputs in Agriculture and A Derived Supply-Function." Journal of Farm Economics. 41(1959):309-322.

Griliches, Zvi. "Estimates of the Aggregate U.S. Farm Supply Function." Journal of Farm Economics. 42(1960):282-293.

Gujarati, Damodar. Basic Econometrics. New York: McGraw-Hill Book Company, 1978.

Harberger, Arnold C. "Three Basic Postulates for Applied Welfare Economics: An Interpretative Essay." Journal of Economics Literature. 9(1971): 785-797.

Hazell, Peter B. and Roger D. Norton. Mathematical Programming for Economic Analysis in Agriculture. New York: Macmillan Publishing Company, 1986.

Henderson, J. M. and R. E. Quandt. Microeconomic Theory: A Mathematical Approach. 3rd ed. New York: McGraw-Hill, 1980.

Henneberry, Shida R. "A Review of Agricultural Supply Responses for International Policy Model." Department of Agricultural Economics, Oklahoma State University, 1986.

Hicks, J. R. A Revision of Demand Theory. Oxford Press, 1956.

Hill, H. and A. Weidemann. "Regional Development in Indonesia: Patterns and Issues," in H. Hill (eds.), Unity in Diversity: Regional Economic Development in Indonesia Since 1970. Singapore: Oxford University Press, 1989.

Houck, James P. "The Link Between Supply Response and Production Elasticities." North Central Journal of Agricultural Economics. 7(1985): 11-17.

Houck, James P. and Abraham Subotnik. "The U.S. Supply of Soybeans: Regional Acreage Functions." Agricultural Economics Research. 21(1969):99-108.

Houck, James P. and Mary E. Ryan. "Supply Analysis for Corn in the United States: the Impact of Changing Government Programs." American Journal of Agricultural Economics. 54(1972):184-191.

Indonesia. Ministry of Agriculture, Directorate of Food Crop Economics and Postharvest Processing. "Supply and Demand for Food Crops in Indonesia." Jakarta, 1988.

Jayasuriya, Sisira and Chris Manning. "Survey of Recent Developments." Bulletin of Indonesian Economic Studies. Vol. 24 No. 2(1988):3-41.

Johnston, J. Econometric Methods 3rd ed. New York: McGraw-Hill Book Company, 1984.

Just, Richard E. "An Investigation of the Importance of Risk in Farmer's Decisions." American Journal of Agricultural Economics. 56(1974):14-25.

Just, Richard E. "Risk Response Models and Their Use in Agriculture Policy Evaluation." American Journal of Agricultural Economics. 57(1975): 835-843.

Just, R. E., D. L. Hueth, and A. Schmitz. Applied Welfare Analysis and Public Policy. Englewood Cliffs, N.J.: Prentice Hall, 1982.

Kaldor, N. "Welfare Propositions of Economics and Interpersonal Comparisons of Utility." Economic Journal. 49(1947):549-552.

Kennedy, Peter. A Guide to Econometrics. 2nd ed. Cambridge, Massachusetts: The MIT Press, 1985.

Kohls, R. L. and Don Paarlberg. Short-Time Response of Agricultural Production to Price and Other Factors. Purdue University Agricultural Experiment Station Bulletin 555, 1950.

Koutsoyiannis, A. Theory of Econometrics. 2nd ed. London and Basingstoke: The Macmillan Press Ltd, 1977.

Koyck, L. M. Distributed Lags and Investment Analysis. Amsterdam: North-Holland Publishing Company, 1954.

Langley, James A. "Regional Differences in Acreage Response for Major U.S. Field Crops." USDA, ERS, June 1985.

Lin, William, "Measuring Aggregate Supply Response Under Instability." American Journal of Agricultural Economics. 59(1977):903-907.

Lopez, Ramon E. "Applications of Duality Theory to Agriculture." Western Journal of Agricultural Economics. 7(1982):353-365.

Lopez, Ramon E. "Estimating Substitution and Expansion Effects Using a Profit Function Framework." American Journal of Agricultural Economics. 66(1984):358-367.

Mann, Jitendar S. "Techniques to Measure Social Benefits and Costs in Agriculture: A Survey." Agricultural Economics Research. 29(1977): 115-126.

McCalla, Alex F. and Timothy E. Josling. Agricultural Policies and World Market. New York: Macmillan Publishing Company, 1985.

Mears, L. A. "Rice and Food Self-Sufficiency in Indonesia." Bulletin of Indonesian Economic Studies, Vol. 20, No. 2. (1984).

Mears, L. A. and Saleh Affif. "An Operational Rice Price Policy for Indonesia." Ekonomi dan Keuangan. Vol. XVII, (1969):3-13.

Mellor, John W. "Increasing Agricultural Production in Early Stages of Economic Development: Relation, Problems and Prospects, in Haroldren," Edwin, O. (eds.), Food: One Tool in International Economic Development. Ames, Iowa: Iowa State University Press, 1962.

Mishan, E. J. "What is Producer Surplus." American Economic Review. 58(1968):1269-1282.

Mlay, Gilead I. "Economic Analysis of Acreage Supply Response Under Risk: The Case of Selected Crops in Oklahoma." Unpublished Ph.D. Dissertation, Oklahoma State University, 1981.

Mubyarto. "The Elasticity of the Marketable Surplus of Rice in Indonesia: A Study in Java-Madura." Unpublished Ph.D. Dissertation, Iowa State University, Ames, 1965.

Mubyarto and L. B. Fletcher. "The Marketable Surplus of Rice in Indonesia: A Study in Java-Madura." International Studies in Economics, Monograph No. 4, Department of Economics, Iowa State University, Ames, 1966.

Nerlove, Marc. "Estimates of Elasticities of Supply of Selected Agricultural Commodities." Journal of Farm Economics. 38(1956):496-509.

Nerlove, Marc. "Distributed Lags and Estimation of Long-Run Supply and Demand Elasticities: Theoretical Considerations." Journal of Farm Economics. 40(1958):301-313.

Nerlove, Marc. "The Dynamics of Supply: Retrospect and Prospect." American Journal of Agricultural Economics. 61(1979):874-888.

Newberry, D. M. and J. E. Stigletz. The Theory of Commodity Price Stabilization. Oxford: Clarendon Press, 1981.

O'Mara, G. and Vinh Le-Si. The Supply and Welfare Effects of Rice-Pricing Policy in Thailand. World Bank Staff Working Papers Number 714. Washington, D.C.: The World Bank, 1985.

Pandey, S. R. Piggot and T. G. MacAulay. " The Elasticity of Aggregate Australian Agricultural Supply: Estimates and Policy Applications." Australian Journal of Agricultural Economics. 26(1982):202-219.

Parikh, A. "Farm Supply Response: A Distributed Lag Analysis." Oxford University Institute of Economic and Statistic Bulletin. 33(1971):57-72.

Penn, J. B. and G. D. Irwin. "A Simultaneous Equation Approach to Production Response: Delta Region." Southern Journal of Agricultural Economics. 31(1971):115-121.

Peterson, Willis. "International Prices and the Social Cost of Cheap Food Policies." American Journal of Agricultural Economics. 61(1979):12-21.

Pindock, Roberts and Daniel L. Rubinfield. Econometric Models and Economic Forecasts. 2nd ed. McGraw-Hill Book Company, 1981.

Pinstrup-Andersen, Per., Nohra R. de Londono and Edward Hoover. "The Impact of Increasing Food Supply on Human Nutrition: Implications for Commodities Priorities in Agricultural Research and Policy." American Journal of Agricultural Economics. 19(1976):131-142.

Pomareda, Carlos and Otto Samoya. "Area and Yield Response to Price Policy: A Case Study of Guatemala, C.A." American Journal of Agricultural Economics. 61(1979):683-686.

Quantitative Micro Software. "Micro TSP User's Manual." Version 4.1c. Program by David M. Lilien. User's Manual by Robert E. Hall. New York: McGraw-Hill Book Company, 1986.

Rasahan, Chairil A. "Commodity Market Model for the Indonesian Rice Ekonomy." Ekonomi dan Keuangan Indonesia. Vol. XXXI No. 3(1983):277-291.

Ray, Daryll E. "Regression and Statistical Methods." Agricultural Policy Analysis Tools for Economic Development. Edited by Luther Tweeten. Boulder Co.: Westview Press, 1989.

Ray, Daryll E. "An Econometric Simulation Model of the United States Agriculture with Commodity Submodels, Vols. 1 and 2." Unpublished Ph.D. Dissertation, Iowa State University, 1971.

Ray, Daryll E. and James W. Richardson. Detailed Description of Polysim. Oklahoma State University, Agricultural Experiment Station, Technical Bulletin T-151, 1978.

Reed, Michael R. and Steven K. Higgins. "A Disaggregate Analysis of Corn Acreage Response in Kentucky." American Journal of Agricultural Economics. 63(1981):708-711.

Rosegrant, M. W. et. al. "Price and Investment Policies in the Indonesian Food Crop Sector." Final Report submitted to the Asian Development Bank, Phase II, 1987.

Ryan, Timothy J. "Supply Response to Risk: The Case of U.S. Pinto Beans." Western Journal of Agricultural Economics. 2(1977):35-43.

Sastrohoetomo, M. A. "Dampak Kebijaksanaan Harga Pupuk dan Beras Terhadap Pendapatan Masyarakat." Ph.D. Thesis, Fakultas Pasca Sarjana, Institut Pertanian Bogor, 1984.

Shumway, G. Richard. "Supply Relationship in the South-What Have We Learned?" Southern Journal of Agricultural Economics. 18(1986):11-19.

Shumway, G. R. and R. C. Green. Joint Estimation of U.S. Field Crop Supply Functions. Texas Agricultural Experiment Station, Department of Agricultural Economics. DTR 82-1. August, 1982.

Siamwalla, Ammar and Stephen Haykin. The World Rice Market: Structure, Conduct and Performance. Washington, D.C.: International Food Policy Research Institute, Research Report 39(1983).

Simandjuntak, Djisman S. "Survey of Recent Development." Bulletin of Indonesian Economic Studies. Vol. 25 No. 1. (1989):3-30.

Smith, Bradforth B. Factors Affecting the Price of Cotton. Washington: Technical Bulletin 50, 1928.

Soekartawi. "Supply-Response Analysis of Agricultural Production." Ekonomi dan Keuangan Indonesia. Vol. XXXI No. 4. (1983):407-417.

Suprapto, Ato. "Applications of a General Equilibrium Model for Agricultural Policy Analysis: A Case Study of Fertilizer Input Subsidy in Rice Production for Indonesia." Unpublished Ph.D. Dissertation, Oklahoma State University, 1988.

Taylor, Timothy G. and J. Scott Shonkwiller. "Interdependent Supply Functions and Revisional Price Expectations." Canadian Journal of Agricultural Economics. 33(1985):285-298.

Teken, I. B. and Herman Soewardi. "Food Supply and Demand and Food Policy." Growth and Equity in Indonesian Agricultural Development. Edited by Mubyarto. The Ministry of Agriculture, Republic of Indonesia and the Indonesian Society of Agricultural Economics, Yayasan Agro-Ekonmika, 1982.

Timmer, C. P. "The Role of Price Policy in Rice Production in Indonesia, 1968-1982." Research in Domestic and International Agribusiness Management. Vol. 6 (1986):55-106.

Timmer, C. P. "Rice Price Policy in Indonesia: Keeping Prices Right." Graduate School of Business Administration, Harvard University, Boston-Massachusetts, 1985.

Timmer, C. P. "The Political Economy of Rice in Asia: A Methodological Introduction." Reprinted from Food Research Institute Studies, Vol. XIV No. 3, 1975(1976).

Timmer, C. P. "A Model of Rice Marketing Margins in Indonesia." Reprinted from Food Research Institute Studies, Vol. XIII No. 2, 1974(1975).

Timmer, C. P. and H. Alderman. "Estimating Consumption Parameters for Food Policy Analysis." American Journal of Agricultural Economics. 61(1979):982-987.

Tolley, G. S., Vinod Thomas and C. Ming Won. Agricultural Price Policies and the Developing Countries. Baltimore: John Hopkins University Press, 1982.

Tomek, G. William and Kenneth L. Robinson. Agricultural Product Prices. 2nd ed. Ithaca: Cornell University Press, 1981.

Traill, Bruce. "Risk Variables in Econometric Supply Response Models." Journal of Agricultural Economics. 29(1978):53-61.

Trapp, James N. "An Econometric Simulation Model of the United States Agricultural Sector." Ph.D. Dissertation, Michigan State University, 1976.

Tweeten, Luther. "Classical Welfare Analysis." Agricultural Policy Analysis Tools for Economic Development. Edited by Luther Tweeten. Boulder, Co.: Westview Press, 1989.

Tweeten, Luther. Introduction to Agricultural Policy Analysis: The Analytical Program and Tools. Department of Agricultural Economics, Oklahoma State University, 1986.

Tweeten, Luther. Supply Response in Pakistan. Report of the FAO Consultancy to the Agricultural Prices Commission, Department of Agricultural Economics, Oklahoma State University, 1985.

Tweeten, Luther. Introduction to Agricultural Policy Analysis: The Distribution of Economics Costs and Benefits from Market Intervention. Report B-5. Department of Agricultural Economics, Oklahoma State University, 1985.

Tweeten, Luther. Foundation of Farm Policy. 2nd ed. University of Nebraska Press, 1979.

Tweeten, L. G. and Leroy C. Quance. "Positive Measures of Aggregate Supply Elasticities: Some New Approaches." American Journal of Agricultural Economics. 51(1969):342-353.

Tweeten, L. and Boima Rogers. Costs, Benefits and Income Distribution from Liberian Rice Policies. Association of Agricultural Development Planners in Africa. Arusha, Tanzania, 1987.

Tweeten, L., S. Henneberry and K. Nainggolan. An Analysis U.S. Aggregate Output Response by Farm Size. Unpublished Paper, Department of Agricultural Economics, Oklahoma State University, 1987.

Unnevehr, L. J. et. al. "Consumer Demand for Rice Grain quality in Thailand, Indonesia, and the Philippines." IRRI Research Paper Series. Number 116, November 1985.

Variant, Hal R. Microeconomic Analysis. 2nd ed. New York: Norton Inc., 1978.

Vartia, Yrjo O. "Efficient Methods of Measuring Welfare Change and Compensated Income in Terms of Ordinary Demand Functions." Econometrica. 51(1983):79-98.

Walsh, Robert M. "Response to Price in the Production of Cotton and Cottonseed." Journal of Farm Economics. 26(1944):359-372.

Wardhani, Mohammad Anwar. "Response Analysis in a Multi-Crop Environment: The Case of Food Crop Production in Java, Indonesia." Unpublished Ph.D. Dissertation, Iowa State University, Ames, 1988.

Willig, R. D. "Consumer Surplus Without Apology." American Economic Review. 66(1976):587-597.

Wilson, W. R., L. M. Arthur, and J. K. Whittaker. "An Attempt to Account for Risk in Aggregate Wheat Acreage Response Model." Canadian Journal of Agricultural Economics. 28(1980):63-71.

APPENDIX

BASIC DATA USED IN THE ESTIMATION AND ANALYSIS

List of Variables and Definitions[1]

GABAH	=	Calendar year gabah (rough rice) production, (thousands of metric tons)
AREA	=	Hectares harvest of rice (thousands of hectares)
YIELD	=	Yield of rice (tons/hectare)
TFERT	=	Total fertilizer nutrient applications by farmers (probably on all food crops), (thousands of metric tons)
FERHA	=	Fertilizer use per hectare (tons)
HYV	=	High yielding varieties or new varieties (percentage)
IRRIG	=	Irrigated area (thousands of hectares)
PGABAH	=	Gabah floor price (Rupiah/kilogram)
PRICE	=	Price of rice, Jakarta wholesale price, (Rupiah/kilogram)
PUREA	=	Price of urea to farmers (Rupiah/kilogram)
PCORN	=	Price of corn, Jakarta wholesale price, (Rupiah/kilogram)
PSOYB	=	Price of soybean, Jakarta wholesale price, (Rupiah/kilogram)
PCASA	=	Price of cassava, Jakarta wholesale price (Rupiah/kilogram)
GABUR	=	PGABAH/PUREA

[1] Variables with "L" as prefix are in natural logarithms; and variables with (-1) are lagged one period.

RURE	=	PRICE/PUREA
CPI	=	Index prices of non-agricultural sector (1 April 1977 - 31 March 1978 = 100)
RAIN	=	Average rainfall in selected Indonesian locations (millimeter)
MATUR	=	Average days to maturity of harvested rice varieties (days)
MCP	=	Multiple croping potential = (365-MATUR)/MATUR)
RCONS	=	Consumption of rice per capita per year (kilogram)
EXOFO	=	Expenditure on foods per capita (Rupiah/year)
POPUL	=	Population (thousands of people)
EXRATE	=	Exchange rate (Rupiah/US dollar)

APPENDIX TABLE I

BASIC DATA USED IN THE ESTIMATION AND ANALYSIS FOR INDONESIAN RICE STUDY

YEAR	GABAH	AREA	YIELD	TFERT	FERHA	HYV
1969	18,013	8,014	2.25	192.40	0.024	3.82
1970	19,324	8,135	2.38	197.10	0.024	9.49
1971	20,182	8,324	2.42	244.40	0.029	12.88
1972	19,386	7,898	2.45	308.10	0.039	18.14
1973	21,481	8,404	2.56	379.20	0.045	27.63
1974	22,464	8,509	2.64	393.30	0.046	38.02
1975	22,331	8,495	2.63	422.60	0.051	39.07
1976	23,301	8,369	2.78	415.60	0.051	41.13
1977	23,347	8,360	2.79	556.80	0.067	49.05
1978	25,772	8,929	2.89	617.60	0.069	48.85
1979	26,283	8,804	2.99	698.70	0.079	53.19
1980	29,652	9,005	3.29	1,012.20	0.112	61.58
1981	32,774	9,382	3.49	1,240.60	0.132	64.59
1982	33,584	8,988	3.74	1,364.70	0.152	73.16
1983	35,303	9,162	3.85	1,622.10	0.177	74.68
1984	38,136	9,764	3.91	1,761.50	0.180	72.88
1985	39,033	9,902	3.94	1,814.60	0.183	74.74
1986	39,727	9,988	3.98	1,852.80	0.186	77.06

APPENDIX TABLE I (Continued)

YEAR	IRRIG	RCONS	CONEX	EXOFO	POPUL	EXRATE
1969	3,388	98.81	20,616	5,136	114,448	381
1970	3,436	103.83	23,040	6,420	116,851	381
1971	3,488	102.22	24,936	6,252	119,208	420
1972	3,517	101.29	27,132	7,548	121,974	420
1973	3,546	110.41	38,496	12,492	124,804	420
1974	3,657	106.84	57,516	12,864	127,699	423
1975	3,757	104.32	66,828	15,792	130,662	421
1976	3,844	111.90	79,080	19,776	133,693	421
1977	3,942	114.41	91,236	21,456	136,795	421
1978	4,018	115.28	108,480	25,440	139,968	634
1979	4,063	123.48	136,260	34,320	143,216	632
1980	4,107	122.09	187,692	39,936	146,538	634
1981	4,152	127.58	237,216	46,872	149,909	643
1982	4,195	128.91	271,728	51,864	153,357	692
1983	4,241	145.08	313,800	69,432	156,884	994
1984	4,322	131.81	352,416	68,148	160,492	1,076
1985	4,345	137.17	371,364	77,004	164,183	1,110
1986	4,390	138.48	408,504	84,708	166,949	1,285

APPENDIX TABLE II

BASIC DATA USED IN THE ESTIMATION AND ANALYSIS FOR JAVA RICE

YEAR	GABAH	AREA	YIELD	TFERT	FERHA	HYV	IRRIG
1969	11,003	4,278	2.57	376.30	0.088	6.91	2,506
1970	11,580	4,288	2.70	370.64	0.086	17.21	2,513
1971	12,389	4,402	2.81	442.27	0.100	22.81	2,506
1972	11,896	4,318	2.76	496.08	0.115	30.39	2,513
1973	13,016	4,557	2.86	709.18	0.156	46.01	2,518
1974	13,853	4,719	2.94	715.81	0.152	60.19	2,518
1975	13,701	4,644	2.95	779.74	0.168	60.75	2,522
1976	14,031	4,452	3.15	773.39	0.174	63.93	2,521
1977	13,080	4,360	3.00	980.63	0.225	75.82	2,555
1978	15,551	4,731	3.29	1,038.06	0.219	72.65	2,557
1979	15,655	4,610	3.40	1,187.69	0.258	78.19	2,581
1980	18,358	4,756	3.86	1,796.90	0.378	86.07	2,592
1981	20,478	5,029	4.07	2,135.76	0.425	87.30	2,608
1982	20,806	4,749	4.39	2,423.24	0.510	95.39	2,623
1983	21,595	4,779	4.53	2,357.97	0.493	96.81	2,637
1984	23,666	5,211	4.55	2,631.72	0.505	93.22	2,656
1985	24,225	5,301	4.57	2,925.38	0.552	96.22	2,686
1986	24,518	5,330	4.60	3,217.92	0.604	97.68	2,705

APPENDIX TABLE III

BASIC DATA USED IN THE ESTIMATION AND ANALYSIS FOR OFF-JAVA RICE

YEAR	GABAH	AREA	YIELD	TFERT	FERHA	HYV	IRRIG
1969	7,010	3,735	1.88	57.31	0.015	0.26	882
1970	7,744	3,847	2.01	68.79	0.018	0.87	923
1971	7,793	3,922	1.99	65.08	0.016	1.74	582
1972	7,490	3,580	2.09	62.17	0.017	3.38	1,004
1973	8,465	3,847	2.21	122.91	0.032	5.85	1,028
1974	8,611	3,790	2.27	159.61	0.042	10.41	1,135
1975	8,630	3,851	2.24	140.81	0.036	12.93	1,236
1976	9,270	3,916	2.37	140.71	0.036	15.21	1,289
1977	10,267	4,000	2.57	561.08	0.141	19.89	1,385
1978	10,221	4,198	2.43	302.63	0.072	22.03	1,437
1979	10,627	4,194	2.53	354.02	0.084	25.71	1,470
1980	11,294	4,249	2.66	487.66	0.115	34.15	1,500
1981	12,296	4,352	2.83	676.13	0.155	38.38	1,529
1982	12,778	4,253	3.01	893.26	0.211	48.11	1,558
1983	13,707	4,393	3.12	712.58	0.162	50.44	1,586
1984	14,471	4,562	3.17	877.24	0.192	49.51	1,636
1985	14,808	4,601	3.22	975.13	0.212	52.16	1,647
1986	15,278	4,658	3.28	1,072.64	0.231	55.62	1,657

APPENDIX TABLE IV

BASIC DATA USED IN THE ESTIMATION AND ANALYSIS FOR ALL REGIONS IN INDONESIAN RICE STUDY

YEAR	PGABAH	PRICE	PUREA	PCORN	PSOYB	PCASA
1969	20.90	37	31.50	25	56	5
1970	18.00	45	26.60	26	50	7
1971	20.90	42	26.60	26	60	8
1972	20.90	49	26.40	33	73	12
1973	30.40	77	40.00	46	109	18
1974	41.80	78	40.00	60	131	16
1975	58.50	97	60.00	75	157	20
1976	68.50	119	80.00	90	162	25
1977	71.00	127	70.00	77	180	25
1978	75.00	157	70.00	76	190	18
1979	85.00	196	70.00	126	272	23
1980	105.00	222	70.00	117	309	36
1981	120.00	243	70.00	132	347	37
1982	135.00	274	70.00	177	356	48
1983	145.00	328	90.00	183	415	83
1984	165.00	347	90.00	192	508	70
1985	175.00	359	100.00	208	508	60
1986	175.00	356	125.00	207	642	64

APPENDIX TABLE IV (Continued)

YEAR	GABUR	RURE	CPI	RAIN	MATUR	MCP
1969	0.66	1.17	33.19	150	153	1.38
1970	0.68	1.69	36.84	600	151	1.42
1971	0.78	1.58	37.17	600	149	1.45
1972	0.79	1.86	40.82	110	148	1.46
1973	0.76	1.92	53.34	1,152	149	1.44
1974	1.04	1.95	71.25	850	144	1.54
1975	0.97	1.62	81.75	966	143	1.56
1976	0.86	1.49	91.66	297	143	1.56
1977	1.01	1.81	104.04	669	140	1.61
1978	1.07	2.24	117.74	787	135	1.69
1979	1.21	2.81	132.35	388	131	1.78
1980	1.50	3.17	156.32	415	124	1.95
1981	1.71	3.47	175.46	274	122	1.99
1982	1.93	3.91	192.09	200	120	2.04
1983	1.61	3.64	214.74	254	118	2.09
1984	1.83	3.85	237.19	260	115	2.17
1985	1.75	3.59	248.40	235	112	2.26
1986	1.40	2.85	262.88	335	110	2.32

VITA

M. Muharminto

Candidate for the Degree of

Doctor of Philosophy

Thesis: SUPPLY RESPONSE FOR RICE IN INDONESIA

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Pekalongan, Central Java, Indonesia, August 20, 1940, the son of M. Kabul Joyodiwiryo and Sri Murdiati. Married to Renny Pudiastuti. One child: Rudyanto Setiawan.

Education: Graduated from Public High School, Pekalongan, in 1960; received an economic degree from the Department of Economics, Gajah Mada University, Yogyakarta, Indonesia, on April 1, 1967; received the Master of Science degree in Agricultural Development Economics from the Australian National University, Canberra, Australia, on April 22, 1981; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in July, 1990.

Professional Experience: Employed as a research worker in the Project of Survey Agro-Economics, Department of Economics, Gajah Mada University, Yogyakarta, 1966-1969. Employed as a socio-economics researcher in the Research Institute for Estate Crops Bogor, Ministry of Agriculture, from January 1970 to October 1982. Employed as a research coordinator in the Research Institute for Estate Crops Sembawa, Palembang, Ministry of Agriculture, from November 1982 to present.

Professional Membership: Member of the American Agricultural Economics Association, North Central Agricultural Economics Association, Southern Agricultural Economics Association, Oklahoma Agricultural Economics Association, and Northeastern Agricultural Economics Association.