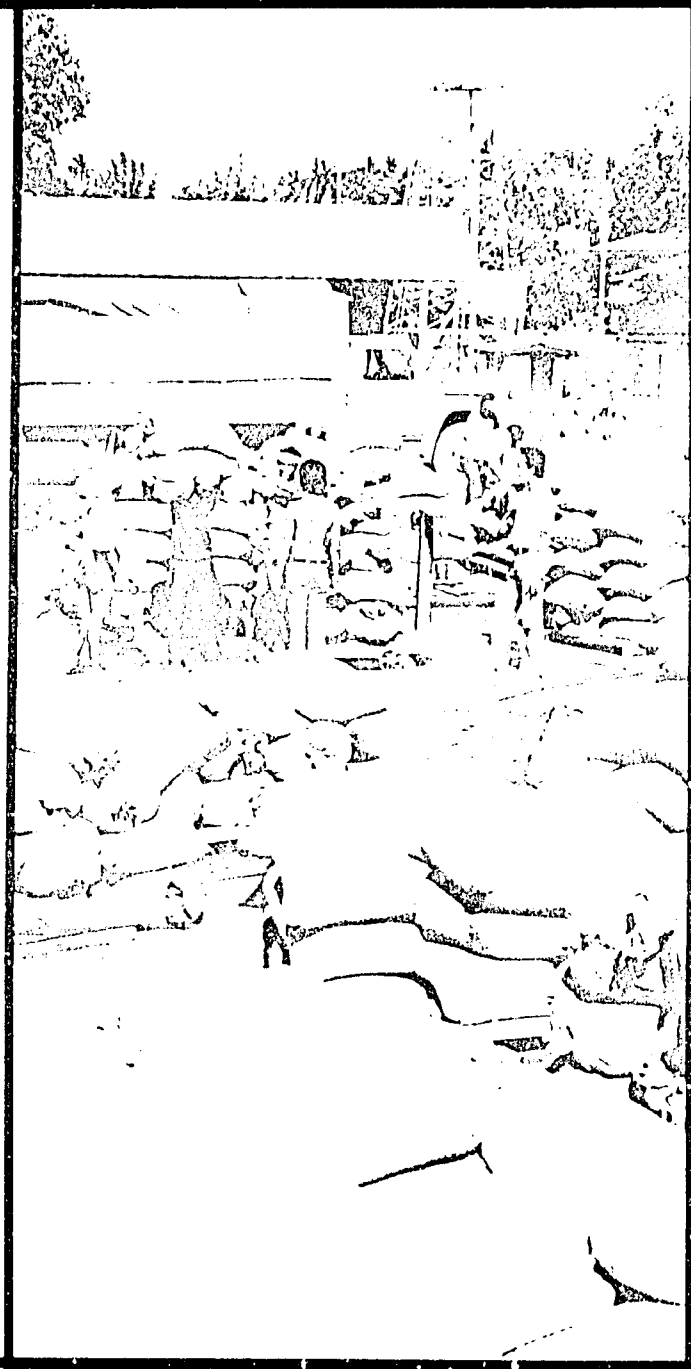
Working Paper No. 7



An Economic Analysis of a Reserve Stock Program for Rice in the Philippines

Amanda Te

Rice Policies in Southeast Asia Project

International Food Policy Research Institute
International Fertilizer Development Center
and the International Rice Research Institute

AN ECONOMIC ANALYSIS OF A RESERVE STOCK PROGRAM FOR RICE IN THE PHILIPPINES

by

Amanda Te

CONTENTS

Foreword..... iii

1. Introduction..... 1
   The Problem..... 1
   Purpose of the Study..... 4

2. Theoretical Framework..... 6
   The General Model..... 6
   Cost of Reserve Stock Program..... 9
   Benefits from Reserve Stock Program..... 9

3. Rice in the Philippines -- Past and Future..... 11
   Past Trends in Production and Consumption..... 11
   Estimation of Supply and Demand Functions
   for Rice in the Philippines..... 16
   Exogenous Variables used for Projections..... 19
   Results of Projections..... 21

4. Reserve Stock Management Simulation Model..... 23
   Production Function and Price Equation..... 23
   Simulation Results..... 25

Bibliography..... 31

TABLES

1. Annual domestic palay procurement as percent of production, 1955/56-1976/77 2
2. Actual prices received by farmers compared to the government palay support price, 1955/56-1976/77 3
3. Per capita supply of calories per day, 1953-75 11
4. Per capita gross national product and per capita personal disposable income, 1953-76 12
5. Rice importation as percent of production, 1954/55-1976/77 13
6. Annual compound growth rates of production, area, and yield of palay and their components, 1954/55-1974/75 14
7. Production, area, and yield of palay, 1954/55, 1964/65, and 1974/75 15
8. Estimates of the production function, 1954/55-1975/76 16
9. Estimates of the rice demand function, 1957-76 18
10. Data used in the projections for rice, 1978-92 20
11. Projections of rice price and output using alternative projections of exogenous variables, 1978-92 21
12. Frequency distribution of projected rice prices, 1978-92 22
13. Frequency distribution of projected rice prices, 1978-92 26
14. Expected rice prices, 1978-92 27
15. Summary of benefits and losses of the reserve stocks without trade model 28
16. Summary of benefits and losses of the free market with trade model 29
17. Summary of benefits and losses of the reserve stocks with trade model 30

FIGURES

1. Model of reserve stock operations 7
2. Storage rules 8
3. Flow chart of the rice reserve stock management simulation model 24

FOREWORD

The Rice Policies in Southeast Asia Project is a collaborative effort involving the International Food Policy Research Institute, the International Rice Research Institute, the International Fertilizer Development Center, and researchers and institutions in Indonesia, Malaysia, the Philippines, and Thailand.

As part of the project, working papers were commissioned to estimate the benefits and costs of trade and reserve stock policies to stabilize rice prices in Indonesia and the Philippines. The papers review and summarize available information on the production, consumption, trade, stocks, and prices of rice in the countries, and formulate simple buffer stock models incorporating rice supply and demand relationships to assess the effects of alternative import and reserve stock policies on rice prices.

The working papers are intended to provide a preliminary assessment of the potential that reserve stock management in the two countries has for rice price stabilization and to identify key issues for further study. Rigorous analyses of some of the important issues, including efforts to derive optimal storage rules and assess the impact of reserve stock policy on seasonal prices, are now being made by researchers at IFPRI and in the collaborating countries.

Mark W. Rosegrant
Coordinator, Rice Policies
in Southeast Asia Project
July 1982

1. INTRODUCTION

Governments in Asia are deeply involved in the production, consumption, and trade of rice. Rice is the most important source of income for farmers. At the same time, it is the major staple food. A decrease in rice prices can cause a farmer's income to decline sharply, often below subsistence level. An increase in rice prices increases expenditures on the rice needed by the urban population and curtails their standard of living. This paradox has been an overriding constraint on rice policy in Asian countries, making it difficult to maintain a sufficient supply of rice for urban consumers at stable prices while covering the cost of production and maintaining the income of producers.

Many rice importing countries, including the Philippines, have adopted rice self-sufficiency as a national goal, partly to save foreign exchange and partly to minimize the leverage that might be exercised by foreign powers through the supply of food. Both internationally and nationally, much effort and many resources have been and still are being invested in infrastructure and irrigation development, input subsidies, price supports, credits, and research and extension designed to stimulate increases in production. However, self-sufficiency cannot make prices stable in the short run, because year-to-year fluctuations in rice production cannot be avoided, especially as self-sufficiency in a year with normal weather means a shortage in a bad weather year and a surplus in a good one.

THE PROBLEM

Rice is the staple food of more than three out of four Filipinos. Traditionally, the Philippines has satisfied its demand requirements and maintained a degree of price stability by importing rice when the harvest is bad and purchasing rice domestically when it is good. Imports have been used to defend a ceiling price for consumers; domestic purchases have been used to defend a floor price for producers. But, in the past, the government was more concerned with defending the ceiling price. Defending the floor price was not much of a problem. The yearly domestic procurement of palay (rough rice) has been minimal. It averaged only 2.18 percent of production from crop year 1955/56 to 1974/75 (Table 1). The actual price received by farmers for palay for the same period, however, was well within the range of the government's support price and was even higher in some years, as Table 2 shows. But, as can be noted in the same table, the actual price received by farmers fell significantly below the government support price in the last two crop years. This may signify that it is time for the government to increase its domestic palay procurement.

Table 1--Annual domestic palay procurement as percent of production, 1955/56-1976/77

Crop Year	Palay Production	Palay Procurement (metric tons)	Procurement as Percent of Production
1955/56	3,273,370	59,149	1.81
1956/57	3,345,990	126,830	3.79
1957/58	3,203,520	141,403	4.41
1958/59	3,684,550	120,142	3.26
1959/60	3,739,550	502	0.01
1960/61	3,704,800	n.a.	n.a.
1961/62	3,910,100	93,906	2.40
1962/63	3,967,030	209,565	5.28
1963/64	3,842,910	110,165	2.87
1964/65	3,992,510	5,324	0.13
1965/66	4,072,680	33,667	0.83
1966/67	4,094,070	80,049	1.96
1967/68	4,560,750	244,154	5.35
1968/69	4,444,710	74,690	1.68
1969/70	5,233,470	237,811	4.54
1970/71	5,342,920	911	0.02
1971/72	5,100,084	3,115	0.06
1972/73	4,414,652	6,695	0.15
1973/74	5,594,116	49,488	0.88
1974/75	5,660,028	112,310	1.98
1975/76	6,159,472	259,317	4.21
1976/77	6,456,076	335,254	5.19
Average			2.42

Sources: Production: The figures for 1955/56-1958/59 are from Philippines, Department of Agriculture and Natural Resources (DANR), Crop and Livestock Statistics, various years. The 1959/60 figures are from Philippines, Bureau of Census and Statistics, Summary, Census of Agriculture, 1960, and Summary, Census of Agriculture, 1961. The figures for 1963/64-1976/77 are from Philippines, DANR, Bureau of Agricultural Economics, "Rice Production, Area, and Yield in the Philippines." (Mimeographed.)

Procurement: The figures for 1955/56-1973/74 are from A. Apiraksirikul, "Rice Trade Policy as It Relates to National Objectives in the Philippines" (M.A. thesis, University of the Philippines, 1976), Table 2.5. The figures for 1974/75-1976/77 are unpublished data from the Philippines' National Grains Authority.

Note: n.a. means not available.

Table 2--Actual prices received by farmers compared to the government palay support price, 1955/56-1976/77

Crop Year	Government Palay Price Support Range	Price Received by Farmers for Palay Ordinario
	(₱/kilogram)	
1955/56	0.16 - 0.19	n.a.
1956/57	0.16 - 0.19	n.a.
1957/58	0.23 - 0.25	0.23
1958/59	0.20 - 0.23	0.20
1959/60	0.19 - 0.22	0.18
1960/61	0.16 - 0.23	0.23
1961/62	0.16 - 0.27	0.22
1962/63	0.26 - 0.28	0.24
1963/64	0.26 - 0.28	0.30
1964/65	0.26 - 0.28	0.30
1965/66	0.27 - 0.39	0.32
1966/67	0.35 - 0.39	0.34
1967/68	0.35 - 0.39	0.35
1968/69	0.35 - 0.39	0.34
1969/70	0.35 - 0.39	0.34
1970/71	0.35 - 0.43	0.44
1971/72	0.40 - 0.54	0.61
1972/73	0.54 - 0.60	0.57
1973/74	0.60 - 0.80	0.84
1974/75	0.80 - 1.00	0.91
1975/76	1.10	0.93
1976/77	1.10	1.02

Sources: The support prices for 1955/56-1974/75 are from A. Apiraksirikul, "Rice Trade Policy as It Relates to National Objectives in the Philippines" (M.A. thesis, University of the Philippines, 1976), Table 2.6. The prices for 1975/76 and 1976/77 are unpublished data from the Philippines' National Grain Authority.

The prices received by the farmers are unpublished data from the Bureau of Agricultural Economics of the Philippines' Department of Agriculture and Natural Resources.

Note: Where n.a. appears, the figure was not available.

This suggests that a reserve stock might be established. Reserve stocks can be used to keep prices stable in the short run. They can be built from local production or imports. However, stocks are not easy to institute or operate. A number of questions must be answered: What is the size of the stock needed to maintain an acceptable range of fluctuation between floor and ceiling prices? How much does it cost to operate a stock program? Is it cheaper to rely on imports in years of low production, as in the past, than to establish a reserve stock? What are the effects of reserve stock operations on rice producers and consumers?

The food crisis in the early seventies generated a great deal of interest in reserve stocks not only to stabilize prices but also to attain food security. Many studies and proposals on the establishment of reserve stocks for foodgrains have been made.1/ These studies, however, deal mostly with the international market or are from the point of view of the United States. Although they provide some insight into the consequences of alternative reserve stock management strategies, they provide little help in deciding whether or not the Philippines should establish its own reserve stocks for rice.

PURPOSE OF THE STUDY

The general aim of this study is to evaluate the socioeconomic costs and benefits associated with operating reserve stocks of rice in the Philippines. Reserve stocks refer to the stocks over and above the "working stock" used for normal business operations. Though important, the operational problem a buffer stocking agency faces in transferring stocks to even out surpluses and shortages on a monthly or quarterly basis is beyond the scope of this study. Formally, a reserve stock is defined as the quantity of grain accumulated, when supplies are plentiful and prices are low, to make up a reserve that can be returned to the market when supplies are short and prices are high.

1/For instance, see W. W. Cochrane, "Reserve Stock Grain Models, the World and the United States, 1975-85," Technical Bulletin No. 305, Agricultural Experiment Station, University of Minnesota, 1976; A. Nand and J. P. Houck, "Buffer Stocks of Foodgrains in India: The Economics of Their Operation and Potential Size," Economic Study Report S71-2, Department of Agricultural and Applied Economics, Institute of Agriculture, University of Minnesota, 1971; F. O'Carroll and H. D. Traylor, "An Economic Analysis of a Reserve Stock Program for Rice in the United States: A Technical Publication," D.A.E. Research Report No. 517, Department of Agricultural Economics and Agribusiness, Louisiana State University and Agricultural and Mechanical College Agricultural Experiment Station, 1977; and Shlomo Reutlinger, Simulation of World-Wide Buffer Stocks of Wheat, World Bank Staff Working Paper No. 219 (Washington, D.C.: International Bank for Reconstruction and Development, 1975).

The general purpose of this study includes the following specific objectives:

1. To look at past trends in rice production and consumption in the Philippines;
2. To develop a simple econometric model of the Philippine rice market using national aggregate data;
3. To determine the likelihood that the price of rice would fall outside the price range which the government would like to maintain; and
4. To use the estimated econometric model in a simulation model to compare and evaluate alternative strategies for reserve stock management. This will involve the development of alternative sets of rules for the acquisition and release of rice stocks. The reserve stock schemes will be evaluated by taking into account the costs, benefits, and stabilization effects on rice price, and the gains and losses to consumers and producers.

2. THEORETICAL FRAMEWORK

THE GENERAL MODEL

For a given year, the price of rice is the intersection of its market supply and demand curves. Price instability is caused by changes of supply and demand relative to each other. Demand changes occur in response to changes in the prices of substitute commodities, population growth, alterations in people's taste and preferences, and changes in the distribution of income. But, rice being a staple food, the demand for it usually changes gradually and is not the prime cause of price instability. Sharp changes in supply can arise in the short run from the vagaries of weather and infestations of pests and diseases. Reserve stock operations can stabilize prices by regulating market supply relative to demand. Figure 1 presents a schematic model of reserve stock operations.

The amount of storage activity in a given year is determined by storage rules and production and is constrained by the storage capacity and the amount of rice already stored. Storage rules relate the accumulation and release of stocks to the supply available in the market. They express the desired extent of stabilization. They are stated as follows: If the price is too high, rice is withdrawn from storage to augment supply in order to bring the price down to the specified amount; and if the price is too low, then rice is placed in storage to bring the price up to the specified amount. In Figure 2, let DD be the demand curve for rice. Assume P_1^* to P_2^* to be the acceptable price range or the degree of price stability the stocking agency wants to maintain, with P_1^* as the buying price and P_2^* as the selling price.

Suppose the prevailing price is P_1 under open market conditions. The stocking agency will buy rice to bring the price to P_1^*. The purchase volume would be $Q_1^*Q_2$. But if the prevailing price is P_2 under open market conditions, the stocking agency will sell rice to bring the price down to P_2^*. Sales volume would be $Q_2Q_2^*$. If the prevailing price is between P_1^* and P_2^*, then the stocking agency will do nothing. Thus, theoretically, with reserve stocks, there can be narrower price fluctuations between P_1^* and P_2^*. However, actual fluctuations would not really be confined within P_1^* and P_2^*. This is because the actual amount of rice put into storage in a given year can never exceed the available storage capacity, and the amount of rice taken out of storage cannot exceed the amount of rice available in storage. The storage space available and the amount of rice in storage depend on the maximum available storage capacity and the amount of storage activity in previous years. Hence, reserve stock operations can minimize price fluctuation outside the target range, but they may not be able to eliminate it completely.

Figure 1--Model of reserve stock operations

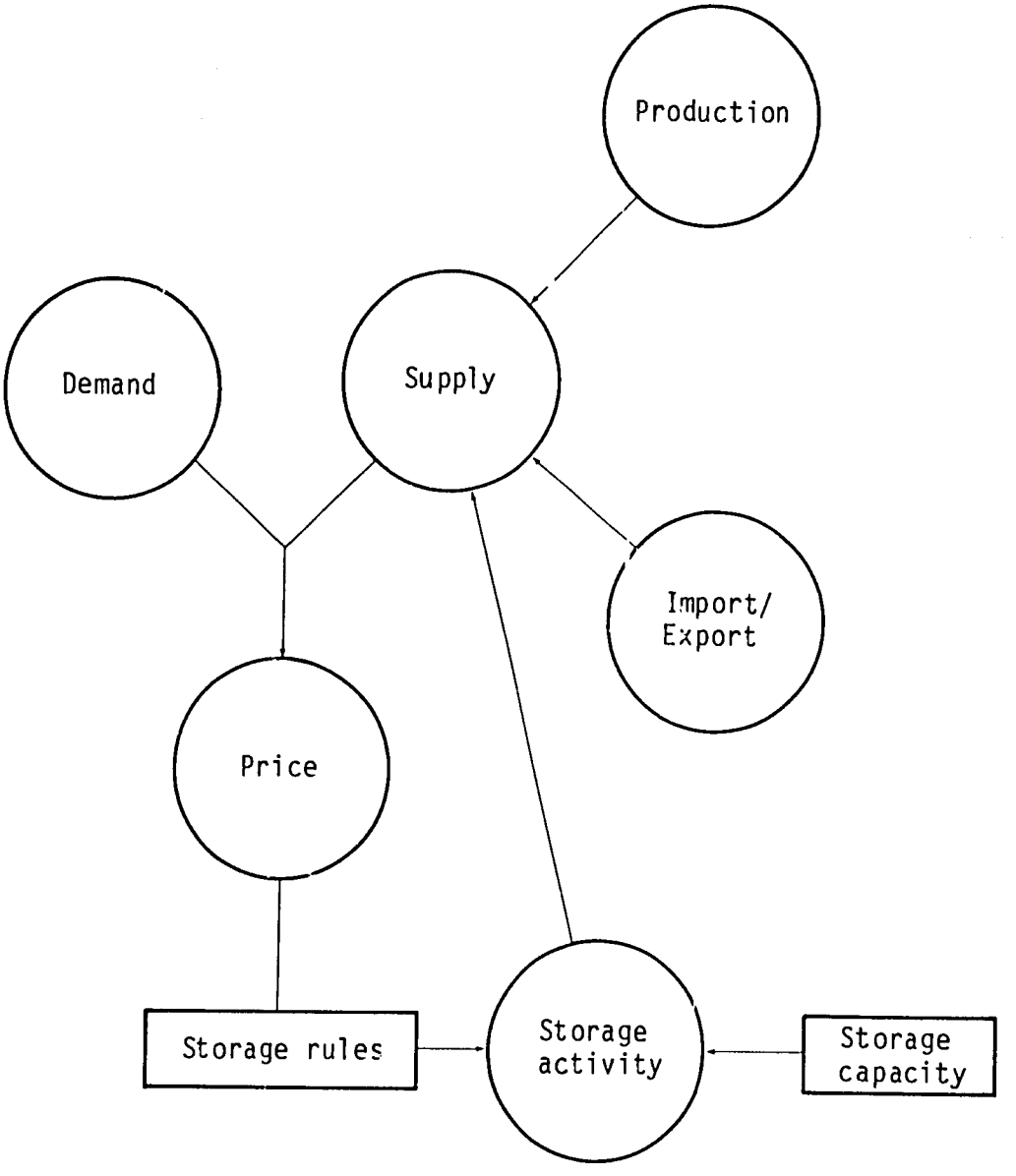
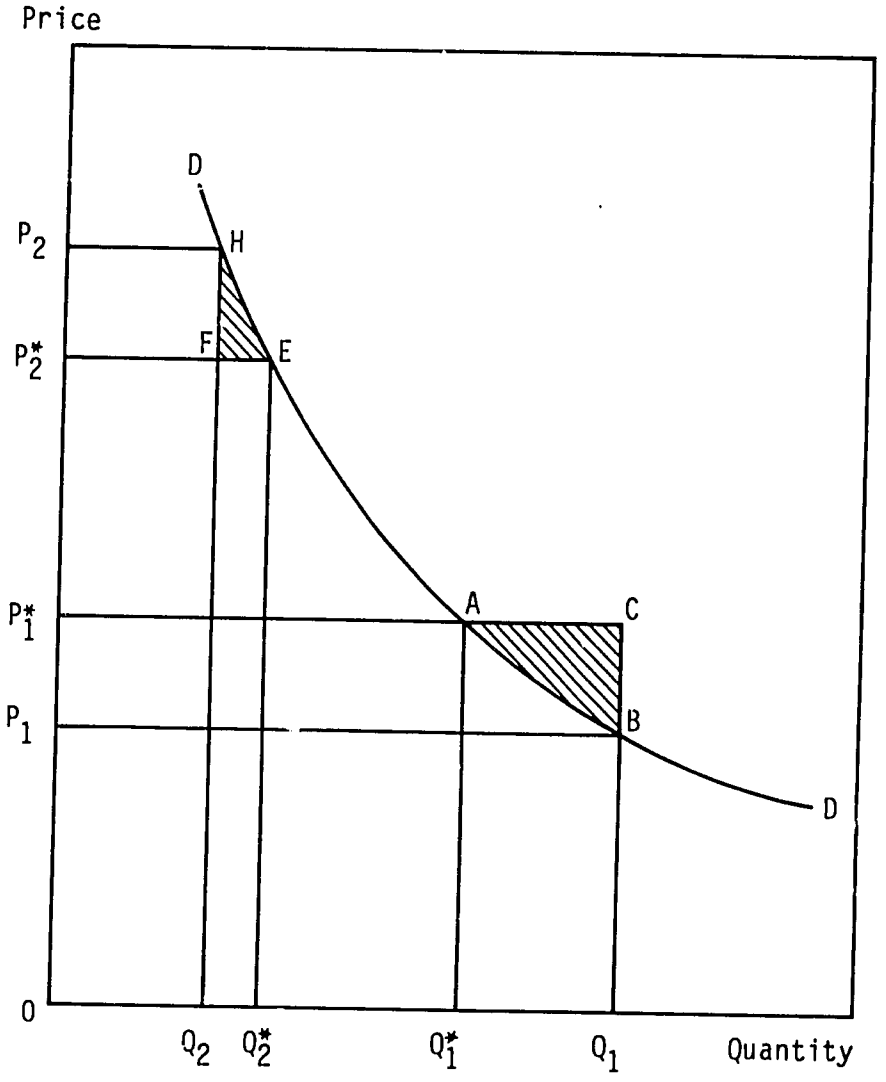


Figure 2--Storage rules



COST OF RESERVE STOCK PROGRAM

The costs of reserve stock operations have two components: fixed costs and operational costs. The fixed costs are the capital costs of storage facilities construction and are a function of the type and capacity of storage facilities. The operational costs can be subdivided into two categories: one-time costs, such as the cost of loading and unloading, which are proportional to the size of the stock; and costs that are proportional to both the size of stock and the length of time stocks are stored, such as interest on money invested in stocks or the decline in the quantity and quality of grain. It is therefore apparent that the dominant factor determining storage cost is the size of the stock. The larger the stock, the greater the storage cost, though the increase need not be proportional since there may be economies of scale.

BENEFITS FROM RESERVE STOCK PROGRAM

The benefits from reserve stock operations will be analyzed using the concept of consumer and producer surpluses. Referring back to Figure 2, assume that the desired price range is P_1^* to P_2^*. During a good year, when stocks are accumulated, consumers lose while producers gain. This is because if there is no storage when supply is plentiful, say at Q_1, then the price would be low, say, P_1. However, if the quantity $Q_1^*Q_1$ is placed in storage, then the price will go up to P_1^*. Consequently, consumers will not only have to pay a higher price but will also be consuming less. The loss in consumer surplus is area $P_1^*P_1BA$. On the other hand, producers will be enjoying a higher price for their produce, so their incomes will increase. The gain in producer surplus is area $P_1^*P_1BC$. The gain in producer surplus is greater than the loss in consumer surplus by area ABC, the gross benefit to society. This is termed "gross" benefit because the cost of storage has not been taken into account.

On the other hand, during a bad year, when stocks are released, consumers gain while producers lose. This is because when supply is short, say at Q_2, then the price will be high, say P_2. But if stocks are released, then supply will increase, say to Q_2^*, and the price will go down. Therefore consumers will not only pay a lower price but will also consume more, while producers' incomes will be smaller. The gain in consumer surplus is area $P_2P_2^*EH$, while the loss in producer surplus is area $P_2P_2^*FH$. The gross benefit to society is area HFE.

The gross benefit concept, however, says nothing about the effect buffer stock operations have on individual producers and consumers. As mentioned earlier, the primary purpose of reserve stock operations considered in this study is to carry rice over from good years to bad as a way of stabilizing prices. If prices are low when stabilized, the producer is harmed and the consumer benefits. If they are high when stabilized, the producer benefits and the consumer is harmed. As pointed out by Waugh, price stability in itself appears to be neither harmful nor beneficial. Its value depends upon the level at which the price is stabilized and whether the policy is designed to benefit the

consumer or the producer. To assess who gains from reserve stock operations, it is necessary to evaluate the sequence of accumulation and release years and the level at which the price is set.

3. RICE IN THE PHILIPPINES -- PAST AND FUTURE

PAST TRENDS IN PRODUCTION AND CONSUMPTION

Data from food balance sheets suggest that per capita availability of rice in the Philippines (including imports) remained constant at about 89 kilograms per year from 1953 to 1975. The absolute amount of rice in the Philippine diet remained constant, although total calorie consumption increased by roughly 1.4 percent per year (Table 3).

Table 3--Per capita supply of calories per day, 1953-75

Year	All Food	Milled Rice
	(calories/day)	
1953	1,691	893
1954	1,725	892
1955	1,766	907
1956	1,709	873
1957	1,756	849
1958	1,814	923
1959	1,735	877
1960	1,782	850
1961	1,862	910
1962	1,815	844
1963	2,035	919
1964	2,010	905
1965	2,103	982
1966	1,992	828
1967	2,094	901
1968	2,006	830
1969	2,084	887
1970	2,097	948
1971	2,123	996
1972	2,047	899
1973	2,108	923
1974	2,274	896
1975	2,290	872
Average	1,953	896

Source: Philippines, National Economic Development Authority, Statistical Coordination Office, Food Balance Sheet (Manila: NEDA, 1953-76).

Per capita disposable income increased 2.0 percent per year from 1953 to 1976 (Table 4). This fact, together with the indication that per capita availability of rice remained constant, suggests that the conventional belief that the income elasticity of demand for rice is low may be right. Hence, the bulk of the increase in rice consumption can be assumed to be caused largely by the population growth of the past two decades, which was close to 3 percent per year.

Table 4--Per capita gross national product and per capita personal disposable income, 1953-76

Year	Per Capita Gross National Product	Per Capita Personal Disposable Income
	(constant 1972 pesos)	
1953	932	796
1954	974	835
1955	1,006	853
1956	1,053	887
1957	1,076	908
1958	1,085	925
1959	1,119	941
1960	1,101	918
1961	1,143	948
1962	1,170	951
1963	1,215	979
1964	1,220	979
1965	1,244	1,014
1966	1,260	1,014
1967	1,282	1,018
1968	1,311	1,033
1969	1,341	1,060
1970	1,358	1,048
1971	1,398	1,085
1972	1,428	1,105
1973	1,524	1,128
1974	1,576	1,174
1975	1,623	1,202
1976	1,690	1,263
Annual compound growth rate (percent)	2.62	2.03

Source: Philippines, National Economic Development Authority, "National Income Accounts Link-Series."

Note: Per capita personal disposable income was computed as the sum of the compensation of employees and the property and entrepreneurial income of persons less personal direct taxes.

Admittedly, there are political factors involved in the decision to import rice, as Apiraksirikul's study confirms.2/ However, production is still the major factor in the decision to import. The Philippines traditionally imports about 5 percent of total production (Table 5). This suggests that, on average, Philippine production is about 5 percent below consumption.

Table 5--Rice importation as percent of production, 1954/55-1976/77

Crop Year	Production: Palay	Production: Milled Rice a/ (metric tons)	Imports b/	Imports as Percent of Production
1954/55	3,202,940	2,079,028	63,518	3.05
1955/56	3,273,370	2,124,744	42,401	2.00
1956/57	3,345,990	2,171,882	77,904	3.59
1957/58	3,203,520	2,079,405	230,669	11.09
1958/59	3,684,550	2,391,641	6,502	0.27
1959/60	3,739,550	2,427,342	0	0
1960/61	3,704,800	2,404,786	186,380	7.75
1961/62	3,910,100	2,538,046	0	0
1962/63	3,967,030	2,574,999	256,303	9.95
1963/64	3,842,910	2,494,433	300,002	12.03
1964/65	3,992,510	2,591,538	569,275	21.97
1965/66	4,072,680	2,643,577	108,184	4.09
1966/67	4,094,070	2,657,461	291,467	10.97
1967/68	4,560,750	3,018,304	8	---
1968/69	4,444,710	2,941,509	9	---
1969/70	5,233,470	3,529,976	0	0
1970/71	5,342,920	3,608,800	367,765	10.20
1971/72	5,100,084	3,440,007	444,965	12.94
1972/73	4,414,652	2,977,683	311,421	10.46
1973/74	5,594,116	3,773,231	167,872	4.45
1974/75	5,660,028	3,817,689	145,337	3.31
1975/76	6,159,472	4,154,564	55,191	1.39
1976/77	6,456,076	4,354,623	30,499	0.70
Average				5.68

Sources: The production figures are from Table 1. The import figures are unpublished data from the Philippines' National Grains Authority.

a/Converted from palay production using the following conversion rates:

64.91 percent milled rice by weight for 1954/55 to 1966/67,
66.18 percent milled rice by weight for 1967/68 to 1968/69, and
67.45 percent milled rice by weight for 1969/70 and after.

b/Figures on imports are for the calendar year.

2/A. Apiraksirikul, "Rice Trade Policy as It Relates to National Objectives in the Philippines" (M.A. thesis, University of the Philippines, 1976).

In the past two decades, 1954/55-1974/75, rice output grew 2.84 percent per year, area expanded at the rate of 1.24 percent per year, and yield increased about 1.57 percent per year (Table 6). A more detailed breakdown reveals that output during the 10-year period from 1964/65-1974/75 grew slightly more than during the 10-year period 1954/55-1964/65. For the period 1954/55-1964/65, area expansion accounted for 71 percent of the growth in output, while yield increases accounted for only 29 percent. In the period 1964/65-1974/75, however, yield increases accounted for 73 percent of the growth in output, while the expansion of area accounted for only 27 percent.

Table 6--Annual compound growth rates of production, area, and yield of palay and their components, 1954/55-1974/75

Factor	1954/55-1964/65	1964/65-1974/75	1954/55-1974/75
		(percent)	
Production	2.15	3.54	2.84
Area	1.52	0.95	1.24
Yield	0.62	2.52	1.57
Percent attributed to:			
Area			
Irrigated	1.59	1.17	1.39
Nonirrigated	-0.07	-0.22	-0.15
Yield			
Type of rice land	0.28	0.47	0.50
Fertilizer	0.32	1.33	0.82
Residual	0.02	0.72	0.25

Sources: The data for production, area, and yield are from Table 7. The fertilizer data are unpublished data from the Fertilizer and Pesticide Authority (formerly the Fertilizer Industry Authority).

Growth rates of area and yield can be broken down further to understand the sources of output growth more clearly. Area expansion can be separated into the growth of irrigated and nonirrigated areas. Yield increases can be separated into the contributions of irrigation and fertilizer. In calculating the contribution of fertilizer, it is assumed that 1 kilogram of fertilizer nutrients produced 10 kilograms of paddy. The contribution of new varieties is assumed to be embodied in the added fertilizer made profitable by their adoption.

Irrigated area increased by roughly 500,000 hectares every 10 years, while nonirrigated area remained constant with a slightly decreasing trend (Table 7). The irrigated area increased because more area was brought under irrigation and cropping intensity increased. Existing data, however, do not permit a rigorous analysis of this.

Referring back to Table 6, it can be noted that fertilizer was responsible for about 50 percent of the yield increases for the 1954/55-1964/65 period and for the 1964/65-1974/75 period. Since yield contributed little to output growth in the first 10-year period and much more to the second period, it appears that the importance of modern inputs, especially fertilizers, as sources of growth of rice production is increasing. Irrigation was a major source of output growth during the past two decades and is likely to continue to be one in the future.

Table 7--Production, area, and yield of palay, 1954/55, 1964/65, and 1974/75

Year	Production	Area			Yield
		Irrigated	Not Irrigated	Total	
	(1,000 metric tons)	(1,000 hectares)			(kilograms/ hectare)
1954/55	3,230	585[a/]	2,108[a/]	2,693	1,199
1964/65	3,994	1,043	2,088	3,131	1,276
1974/75	5,657	1,426	2,017	3,443	1,637

Source: The figures are unpublished data from the Bureau of Agricultural Economics of the Philippine Department of Agriculture and Natural Resources.

Note: The figures are five-year averages centered at the year shown.

a/Before crop year 1958/59, a breakdown for irrigated and nonirrigated area is available only for crop years 1947/48 and 1955/56. These figures were obtained by multiplying the proportion of area irrigated or not irrigated for crop year 1955/56 with the total average area for the period 1952/53-1956/57.

ESTIMATION OF SUPPLY AND DEMAND FUNCTIONS FOR RICE IN THE PHILIPPINES

In the classical supply model, output is a function of price and a number of variables. Estimating efforts using this model produced empirical results that were less than satisfactory. An alternative approach that defines output as the product of area and yield and estimates the area and yield response functions separately was also tried. The results of this approach, however, were also unsatisfactory. Therefore, the attempt to use a supply function for projections was abandoned. A production function was used instead.

Table 8 shows the estimated production function based on time-series data for the period 1954/55-1975/76. The principal variables in the function are irrigated area and fertilizer use. Both of these have increased steadily. Dummy variables for weather, which account for major short-run deviations in production caused by weather, and a technology dummy that accounts for the change in the input mix after modern varieties were introduced in 1966. Production is national

Table 8--Estimates of the production function, 1954/55-1975/76

	1	2	3
$\bar{R}^2$	0.91	0.91	0.92
DW	2.20	1.64	2.18
Constant	6.1014	5.9105	6.0722
ln irrigated rice area	0.3026 (2.908)	0.3422 (4.302)	0.3182 (4.148)
Technology dummy x ln irrigated rice area	0.5498 (1.622)	---	0.5272 (1.677)
ln fertilizer	0.0143 (0.232)	---	---
Technology dummy x ln fertilizer	0.2545 (2.422)	0.2665 (2.919)	0.2673 (3.090)
Good weather dummy	0.0359 (0.910)	0.0542 (1.437)	0.0380 (1.027)
Bad weather dummy	-0.0974 (2.517)	-0.1024 (2.607)	-0.0982 (2.632)
Technology dummy	-5.4276 (2.224)	-1.5340 (2.669)	-5.3391 (2.288)

Notes: The figures in parentheses are t-values. The dependent variable is the logarithm of production.

palay production in thousand metric tons. Data are from the Philippine Bureau of Agricultural Economics (BAEcon). Irrigated area is the effective irrigated crop area of rice in thousand hectares; data are from BAEcon.

In the absence of actual fertilizer consumption data, it is assumed that the stock adjustment from year to year is constant. The figures for total supply of inorganic fertilizer in thousand metric tons were used for the years 1955-72. However, imports of fertilizer were unusually high in 1974, which nullifies the assumption made. Actual consumption data became available by 1973, so to complete the series to 1976, these data were used. Data from 1955 to 1972 are taken from Anden and Palacpac, "Data Series on Rice Statistics -- Philippines," International Rice Research Institute, Los Banos, revised December 1976. Data for 1973-76 are from the Philippine Fertilizer and Pesticide Authority (FPA), formerly the Fertilizer Industry Authority (FIA).

The good weather dummy equals 1 for crop years 1961/62, 1969/70, 1973/74, and 1975/76 and equals 0 for other years. During the specified four years, no major calamities affected Philippine rice production.

The bad weather dummy equals 1 for crop years 1957/58, 1968/69, and 1972/73 and equals 0 for other years. These three years had severe weather,which greatly affected rice production.

The technology dummy equals 1 for years after 1965/66 and equals 0 for 1965/66 and earlier. With a disturbance term (e) added, equation (3) in Table 8 for the period after 1965/66 is therefore:

$$\begin{aligned} \ln \text{production} = {} & 0.7331 + 0.8455 \ln \text{irrigated rice area} \\ & + 0.2673 \ln \text{fertilizer} - 0.0982 \text{ bad weather dummy} \\ & + 0.0380 \text{ good weather dummy} + e, \end{aligned} \tag{1}$$

where e is assumed to be normally distributed with mean 0 and standard deviation 0.05686.

Using national aggregate data from 1956-67, Nasol estimated the demand function for rice in the Philippines.3/ He found that the price elasticity of demand for rice ranges from -0.23 to -0.47, while cross-price elasticity and income elasticity are not significant. The demand function for rice in the Philippines was reestimated using a longer series of national aggregate data.

3/R. L. Nasol, "Demand Analysis for Rice in the Philippines," Journal of Agricultural Economics and Development 1 (No. 1, 1971): 1-13.

The price of rice, prices of consumption substitutes, disposable incomes of consumers, population, and consumer tastes determine the demand for rice. For simplicity, tastes are assumed to be constant except for changes associated with income growth.

A straightforward estimation using ordinary least squares was run for the years 1955 to 1977. Ideally, the dependent variable used would have been total consumption. However, because of the unreliability of stocks data, it was deemed better to use rice availability (production plus imports) instead. The results of the estimation are presented in Table 9. The specific definitions of the variables used are rice availability, rice price, corn price, wheat price, income, and population.

Rice availability is national production for crop year t plus imports in calendar year t in thousand metric tons of milled rice. Production data are from BAEcon. Import data were compiled from the following sources: for 1957-63, the data are those adopted by an interagency committee on March 1965; for 1964-70, the data are from the Philippine Rice and Corn Administration (RCA) and the Philippine Bureau of Census and Statistics (BCS); for 1971-76, the data are from the Philippines' National Grains Authority (NGA).

Table 9--Estimates of the rice demand function, 1957-76

	1	2	3	4	5
$\bar{R}^2$	0.92	0.93	0.92	0.93	0.89
DW	2.42	2.42	2.46	2.45	1.97
Constant	-3.618	-3.189	-2.537	-3.248	-1.824
ln rice price	-0.412 (2.254)	-0.410 (2.329)	-0.448 (2.510)	-0.455 (2.671)	-0.139 (0.753)
ln corn price	0.574 (2.761)	0.568 (2.887)	0.567 (2.735)	0.576 (2.926)	---
ln wheat price	0.084 (0.963)	0.080 (1.016)	---	---	0.076 (0.720)
ln income	-0.079 (0.130)	---	0.130 (0.235)	---	0.249 (0.354)
ln population	1.048 (1.180)	0.933 (6.262)	0.820 (0.960	1.017 (8.217)	0.738 (0.698)

Notes: The dependent variable is the logarithm of rice availability. The figures in parentheses are t-values.

The rice price is the deflated retail price of Macan class rice in Manila, averaged for calendar year t in pesos per metric ton. The original price data are from the Central Bank of the Philippines. The deflator used is the consumer price index for Manila (1972=100), which is also from the Central Bank.

The corn price is the deflated retail price of milled corn in Manila, averaged for calendar year t in pesos per metric ton. The source of the data and deflator are the same as for the rice price.

The wheat price is the deflated wholesale price of wheat flour in Manila, averaged for year t in pesos per metric ton. The source of the data and deflator are also the same as for the rice price.

Income is personal disposable income at constant 1972 prices in million pesos. This is compensation of employees plus entrepreneurial and property income, less personal direct taxes. Basic data are from the national income accounts of the Philippine link-series compiled by the Philippine National Economic and Development Authority (NEDA).

Population is given in thousands. These data are also from NEDA.

The price elasticity of demand for rice is approximately -0.4 in most of the estimates. This is as expected.4/ There is a significant positive cross elasticity of demand for corn close to 0.6. Given the high correlation between population and income in the time-series data, it is not surprising to find that the income elasticity of demand is not significant. Previous estimates of the income elasticity of demand from cross-section household surveys suggest that the elasticity is low, 0.1 or less.

Equation (4) in Table 9 will be transformed into a price equation and used in the projection. The corn price will be assumed to remain constant at its 1973-77 average. The resulting price equation is:

$$\ln \text{rice price} = 1.48763 + 2.23632 \ln \text{population} - 2.19842 \ln \text{rice availability}. \quad (2)$$

EXOGENOUS VARIABLES USED FOR PROJECTIONS

Projections of rice output and the corresponding rice price are made for 15 years, 1978-92. The exogenous variables needed to project production are irrigated area, fertilizer, and weather. Two sets of assumptions on irrigated area will be used. One set, the plan projections, is based on the Five-Year Philippine Development Plan 1978-82. The Plan projects rice irrigated area to the year 1987; the data after 1987 are projected based on the trend of the Plan projections. The second set, the trend projections, uses the trend projections for irrigated area. It is based on the following equation:

$$\text{Irrigated area} = -1{,}239.22 + 36.14t; \quad R^2 = 0.73. \quad (3)$$

4/Ibid.

This equation resulted from a linear regression of the time-series data from 1960 to 1977.

The Philippine Development Plan does not have projections of fertilizer supply. For both the Plan and the trend projections, fertilizer supply is assumed to grow at its trend rate of 8 percent per year.

It is assumed that there is a 0.1364 probability that the weather will be bad and a 0.1818 probability that it will be good. These probabilities are based on the assumption that out of the 22 years, 1954/55-1975/76, used in the regression estimation of the production function, three years had bad weather while four years had good weather. Three hundred repetitions of 15 years were made using the above-stated probabilities for bad and good weather to get the sequence of years with bad, good, and normal weather.

Once production has been projected, the only variable needed to project the rice price is population. Since the Plan population projection, 2.9 percent, is close to the trend projection, 3.0 percent, both the Plan projections and the trend projections use the population figures projected by the Plan.

Except for the weather variable, the exogenous data used for projections are shown in Table 10.

Table 10--Data used in the projections for rice, 1978-92

Year	Irrigated Area: Plan[a/]	Irrigated Area: Trend[b/]	Fertilizer Product[c/]	Population[a/]
	(1,000 hectares)		(1,000 metric tons)	(1,000)
1978	1,694	1,579	752	46,350
1979	1,782	1,616	813	47,719
1980	1,883	1,652	878	49,137
1981	1,979	1,688	948	50,557
1982	2,077	1,724	1,024	52,026
1983	2,170	1,760	1,105	53,535
1984	2,265	1,796	1,194	55,087
1985	2,360	1,832	1,289	56,685
1986	2,456	1,869	1,393	58,329
1987	2,541	1,905	1,504	59,903
1988	2,646	1,941	1,624	61,640
1989	2,744	1,977	1,754	63,428
1990	2,847	2,013	1,894	65,267
1991	2,956	2,050	2,046	67,160
1992	3,069	2,086	2,210	69,107

a/Taken from Philippines, National Economic Development Authority, Five-Year Philippine Development Plan, 1978-1982 (Manila: NEDA, 1977). The Plan had projections only up to 1987. The projections for 1988-93 were based on the trends of the Plan projections.

b/Projection based on time-series analysis of 1960-77 linear regression: irrigated area = -1,239.22 + 36.14t; R^2 = 0.73.

c/Projected at an 8 percent per year trend rate.

RESULTS OF PROJECTIONS

Table 11 summarizes the expected palay output and the rice price for the next 15 years, based on the trend projections and the Plan projections. Both sets of projections show a decreasing trend for the rice price. However, the higher output growth in the Plan projections causes the rate of decline of prices to be faster in the Plan projections than in the trend projections.

Presently, the Philippine government is trying to maintain a ceiling price of ₱2.10 per kilogram of milled rice and a floor price of ₱1.10 per kilogram of palay. Assuming a milling cost of ₱100.00 per metric ton, a milling recovery rate of 67.45 percent, and deflating to constant 1972 prices, the floor price (the buying price) of ₱1.10 per kilogram of palay at current prices is equivalent to ₱943.00 per metric ton of milled rice at 1972 prices. The ceiling price (the selling price) of ₱2.10 per kilogram is equivalent to ₱1,113.00 per metric ton at 1972 prices.

Table 11--Projections of rice price and output using alternative projections of exogenous variables, 1978-92

Year	Trend		Plan	
	Output[a/] (1,000 metric tons)	Price[b/] (pesos/ metric ton)	Output[a/] (1,000 metric tons)	Price[b/] (pesos/ metric ton)
1978	6,183	1,347	6,561	1,182
1979	6,451	1,307	7,007	1,090
1980	6,686	1,290	7,468	1,011
1981	6,932	1,275	7,930	949
1982	7,212	1,244	8,442	880
1983	7,462	1,227	8,907	831
1984	7,754	1,206	9,434	784
1985	8,072	1,178	9,999	736
1986	8,395	1,149	10,575	692
1987	8,700	1,128	11,099	660
1988	8,998	1,118	11,692	629
1989	9,392	1,083	12,392	589
1990	9,648	1,086	12,933	570
1991	10,009	1,070	13,639	542
1992	10,391	1,054	14,402	514
Annual compound growth rate (percent)	3.78		5.78	

a/Output is in palay form.
b/This is the price of milled rice at constant 1972 prices.

Assuming that the government will maintain this range of price fluctuation, let us assess the likelihood of prices falling out of this price range in the future. Table 12 presents the frequency distribution of projected rice prices from 1978 to 1992. The probability that the rice price will exceed the ceiling price shows a declining trend, while the probability that the price will fall below the floor price shows an increasing trend. It is interesting to note that should the Plan projections be realized, then by 1990 the probability of the rice price falling below the floor price would be 100 percent. The Plan projections may be too optimistic. The actual price would probably be somewhere between the trend projections and the Plan projections.

The projections' results suggest that the Philippines can remain self-sufficient if investments for shifting the supply function, such as irrigation development, are made continuously. However, as was already mentioned, self-sufficiency does not make prices stable in the short run because of unpredictable year-to-year fluctuations in production. This raises the issue of how stocks should be managed to minimize price fluctuations.

Table 12--Frequency distribution of projected rice prices, 1978-92

	Trend Price Per Metric Ton			Plan Price Per Metric Ton		
Year	<₱943	₱943-₱1,113	>₱1,113	<₱943	₱943-₱1,113	>₱1,113
	(percent)					
1978	1.00	11.33	87.67	6.00	35.00	59.00
1979	0.33	13.33	86.33	17.00	45.33	37.67
1980	2.00	13.67	84.33	35.33	42.34	22.33
1981	1.33	23.67	75.00	53.33	34.34	12.33
1982	2.33	24.67	73.00	71.33	23.34	5.33
1983	3.00	23.00	74.00	83.00	14.33	2.67
1984	5.33	30.00	64.67	88.00	10.67	1.33
1985	8.33	34.67	57.00	92.33	7.00	0.67
1986	7.67	39.67	52.67	97.00	3.00	0.00
1987	12.00	39.00	49.00	99.33	0.67	0.00
1988	13.00	40.33	46.67	98.67	1.33	0.00
1989	17.33	43.33	39.33	99.67	0.33	0.00
1990	19.33	42.67	38.00	100.00	0.00	0.00
1991	23.00	41.33	35.67	100.00	0.00	0.00
1992	26.67	41.33	32.00	100.00	0.00	0.00

4. RESERVE STOCK MANAGEMENT SIMULATION MODEL

Figure 3 presents the flow chart of the rice reserve stock management simulation model. The model is designed to use stocks of rice to reduce variations in prices. It uses the market price to activate adjustments of stocks (as far as possible) until the desired price has been reached. The basic operational model contains the production function and the price equation that were used for projections in the previous section. The model will do 300 iterations of a 15-year sequence.

Results from four simulation runs are presented. The first simulation run assumed no reserve stock storage and no foreign trade. This is actually the trend projection presented above and is the free market without trade model. It serves as the basis for comparison with the other programs. The second simulation run assumes that the storage capacity is 300,000 metric tons, but that there is no foreign trade. This is the reserve stock without trade model. The third simulation run assumes that there is no reserve stock, but that foreign trade opportunities are open. This is the free market with trade model. The fourth simulation run assumes that the storage capacity available is 300,000 metric tons and that foreign trade opportunities are open. It is the reserve stock with trade model. Before presenting the results, the parameters used in the simulation will be discussed briefly.

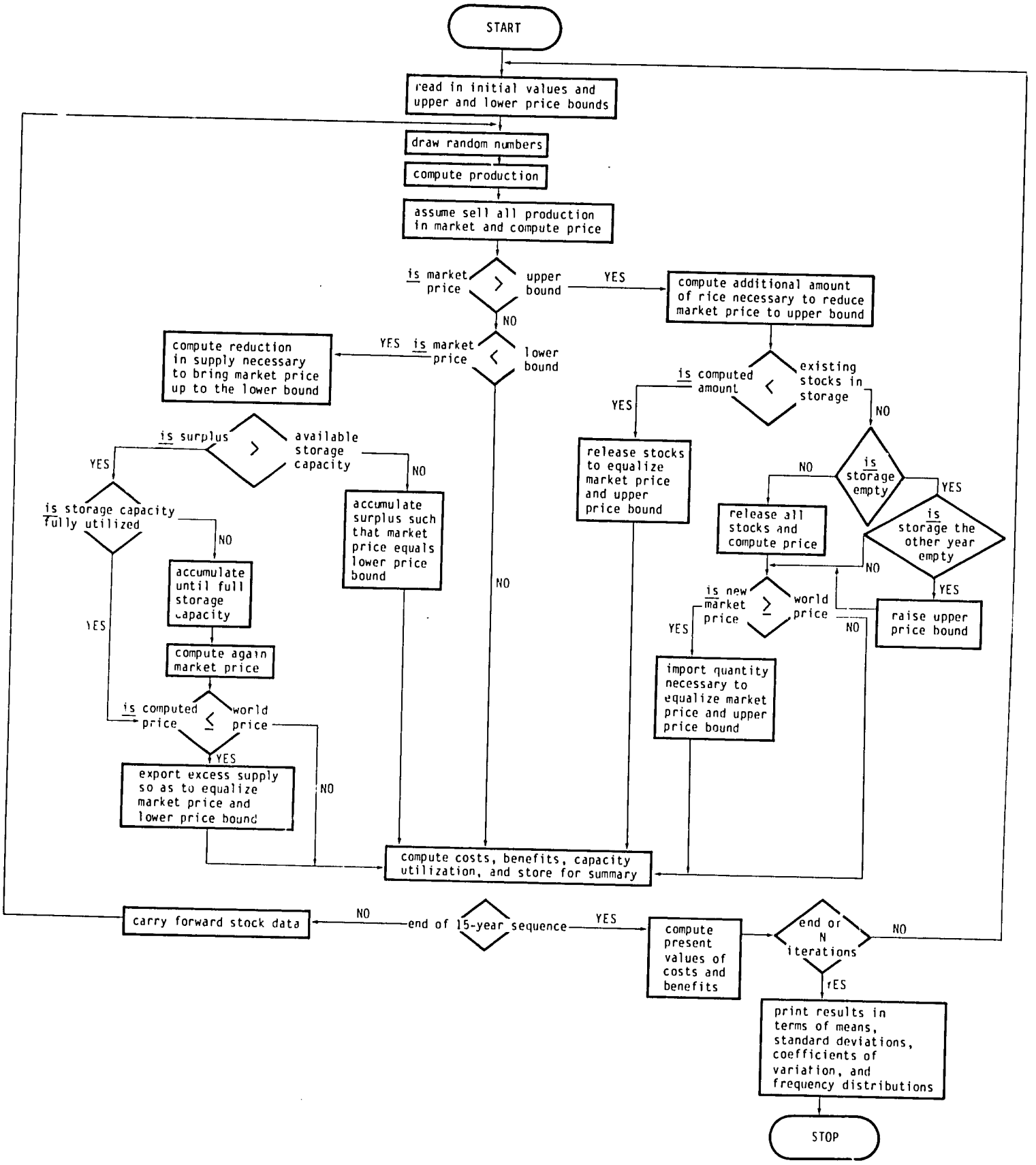
PRODUCTION FUNCTION AND PRICE EQUATION

The production function and the price equation used are the same as those that were used to project output and price. The assumptions about the exogenous variables are those of the trend projections.

The storage rules involve the setting of target prices, that is, the buying price and the selling price. As mentioned above, the Philippine government is trying to maintain a ceiling price of ₱1,113 and a floor price of ₱943 per metric ton of milled rice at constant 1972 prices. This price range will be used as the desirable range of price fluctuation in the simulations.

Just like all prices, all costs are expressed in constant 1972 prices. The handling cost from farm to warehouse is taken to be ₱6.20 per metric ton, assuming four movements. The releasing cost from warehouse to dealer is also taken to be ₱6.20 per metric ton. The maintenance cost of stocks in storage, including the costs of insect and pest control, is taken to be ₱10.40 per metric ton per year. The quantity loss of stock is assumed to be 2 percent per year. The interest rate on money tied up in stocks is taken to be 12 percent per year. The fixed cost of constructing warehouses is taken to be ₱334.00 per metric ton.

Figure 3--Flow chart of a rice reserve stock management simulation model



SIMULATION RESULTS

Table 13 compares the percentage frequency distribution of price for the four models considered. As this table shows, if there is no reserve stock and no foreign trade, the probability of the rice price overshooting the ceiling price of ₱1,113 per metric ton within the next 10 years is more than 50 percent, while the probability of the rice price falling below the floor price is low. However, as the probability of the rice price overshooting the ceiling price shows a declining trend, from 88 percent in 1978 down to 32 percent in 1992, the probability of the rice price falling below the floor price shows an increasing trend, from 1 percent in 1978 to 27 percent in 1992. A reserve-stock storage capacity of 300,000 metric tons, assuming no carry-in at first, reduces the probability of the rice price falling below the floor price but does not significantly affect the probability of prices overshooting the ceiling price.

The availability of foreign trade opportunities greatly alters this frequency distribution. Though the probability of the price falling below the floor price within the next few years did not change significantly, the probability of the price overshooting the ceiling price did significantly decrease, from over 50 percent to less than 40 percent. After 1982, however, the probability of the price falling below the floor price declined significantly with foreign trade compared to the probability without it. The decline was such that after 1990, the probability fell from more than 20 percent to less than 10 percent.

The existence of a reserve-stock storage capacity of 300,000 metric tons did not significantly alter the frequency distribution of the free market with trade model. The reserve stock with trade model does, however, further decrease the probability of the price falling below the floor price.

Looking at the expected prices for the different models, the two models without trade showed higher prices than the two models with trade (Table 14). The expected prices from the two models with reserve stocks are not significantly different from the models without reserve stocks.

Tables 15, 16, and 17 present the summaries of the yearly benefits and losses to consumers, producers, and the stocking agency of the reserve stock without trade model, the free market with trade model, and the reserve stock with trade model. The present values discounted at four alternative discount rates are shown as well.

Without foreign trade, it appears that producers benefit more from reserve stocks than consumers. However, because the probability of prices overshooting the ceiling price is higher, consumers gain at the expense of producers with foreign trade. The losses incurred by producers are slightly less in the reserve stock with trade model compared to the free market with trade model. Benefits to the stocking agency appear to be highest in the free market with trade model.

In the future, the results of simulations assuming different storage capacities and different initial carry-in amounts will be compared. An attempt will be made to further refine the storage rules by allowing adjustments in target prices.

Table 13--Frequency distribution of projected rice prices, 1978-92

Year	Free Market without Trade Model			Reserve Stock without Trade Model[a/]			Free Market with Trade Model			Reserve Stock with Trade Model[a/]		
	<₱943	₱943-₱1,113	>₱1,113	<₱943	₱943-₱1,113	>₱1,113	<₱943	₱943-₱1,113	>₱1,113	<₱943	₱943-₱1,113	>₱1,113
	(percent)											
1978	1.00	11.33	87.67	0.33	12.00	87.67	0.67	69.33	30.00	0.00	67.33	32.67
1979	0.33	13.33	86.33	0.00	13.67	86.33	0.00	63.33	36.67	0.00	63.67	36.33
1980	2.00	13.67	84.33	0.33	15.00	84.67	0.67	64.00	35.33	0.33	65.34	34.33
1981	1.33	23.67	75.00	0.33	25.00	75.67	0.67	68.33	31.00	0.00	71.67	28.33
1982	2.33	24.67	73.00	0.33	26.67	73.00	1.67	68.00	30.33	0.33	66.00	33.67
1983	3.00	23.00	74.00	1.00	24.67	74.33	0.67	64.66	34.67	0.00	68.33	31.67
1984	5.33	30.00	64.67	1.33	34.67	64.00	2.00	66.67	31.33	0.00	71.67	28.33
1985	8.33	34.67	57.00	2.33	40.67	57.00	2.00	72.33	25.67	0.00	73.33	26.67
1986	7.67	39.67	52.67	2.00	46.67	51.33	2.00	72.00	26.00	0.33	78.34	21.33
1987	12.00	39.00	49.00	5.00	47.67	47.33	4.00	71.33	24.67	0.67	75.66	23.67
1988	13.00	40.33	46.67	6.33	49.34	44.33	3.00	76.00	21.00	1.33	76.34	22.33
1989	17.33	43.33	39.33	10.67	53.00	36.33	3.00	79.00	18.00	2.67	78.33	19.00
1990	19.33	42.67	38.00	9.33	56.34	34.33	3.67	77.00	19.33	1.67	81.00	17.33
1991	23.00	41.33	35.67	14.33	53.00	32.67	7.67	77.33	15.00	3.00	78.67	18.33
1992	26.67	41.33	32.00	18.67	52.66	28.67	6.00	81.00	13.00	4.33	82.34	13.33
Average	9.51	30.80	59.69	4.82	36.74	58.44	2.51	71.36	26.13	0.98	73.20	25.83

Note: The prices are constant 1972 pesos per metric ton.

a/This assumes an available total reserve stock storage capacity of 300,000 metric tons and zero initial carry-in.

Table 14--Expected rice prices, 1978-92

Year	Free Market without Trade Model			Reserve Stock without Trade Model[a]			Free Market with Trade Model			Reserve Stock with Trade Model[a]		
	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
	(pesos/metric ton)											
1978	1,347	205	0.15	1,348	204	0.15	1,164	126	0.11	1,178	138	0.12
1979	1,307	192	0.15	1,307	192	0.15	1,171	128	0.11	1,170	128	0.11
1980	1,290	186	0.14	1,290	185	0.14	1,163	122	0.10	1,162	127	0.11
1981	1,275	214	0.17	1,275	214	0.17	1,152	133	0.12	1,147	124	0.11
1982	1,244	202	0.16	1,245	200	0.16	1,139	109	0.10	1,148	135	0.12
1983	1,227	177	0.14	1,227	175	0.14	1,144	124	0.11	1,140	119	0.10
1984	1,206	193	0.16	1,206	190	0.16	1,129	128	0.11	1,127	129	0.11
1985	1,178	194	0.16	1,179	187	0.16	1,111	129	0.12	1,167	137	0.12
1986	1,149	178	0.16	1,149	172	0.15	1,101	125	0.11	1,094	114	0.10
1987	1,128	170	0.15	1,130	160	0.14	1,093	126	0.12	1,093	116	0.11
1988	1,118	182	0.16	1,116	168	0.15	1,077	115	0.11	1,079	111	0.10
1989	1,083	165	0.15	1,085	149	0.14	1,060	106	0.10	1,063	109	0.10
1990	1,086	151	0.14	1,084	138	0.13	1,067	109	0.10	1,065	104	0.10
1991	1,070	162	0.15	1,071	145	0.14	1,051	109	0.10	1,055	105	1.10
1992	1,054	176	0.17	1,056	159	0.15	1,041	106	0.10	1,043	113	0.11
Average	1,184	205	0.17	1,184	199	0.17	1,111	127	0.11	1,112	128	0.12

Notes: All prices are in constant 1972 pesos. SD stands for standard variation; CV stands for coefficient of variation.

a/This assumes an available total reserve stock storage capacity of 300,000 metric tons and zero initial carry-in.

Table 15--Summary of benefits and losses of the reserve stocks without trade model

Year/ Discount Rates	Consumers' Benefits			Producers' Benefits			Stocking Agency Benefits[a/]		
	Mean	Probability		Mean	Probability		Mean	Probability	
		Negative	Positive		Negative	Positive		Negative	Positive
	(million pesos)	(percent)		(million pesos)	(percent)		(million pesos)	(percent)	
1978	-3	1.00	0.00	3	0.00	1.00	-2	1.00	0.00
1979	2	0.33	0.67	-2	0.67	0.33	1	0.67	0.67
1980	-1	2.00	0.33	1	0.33	2.00	-1	2.33	0.33
1981	1	1.33	2.00	--	2.00	1.33	--	1.67	2.00
1982	-4	2.33	0.67	4	0.67	2.33	-2	3.33	0.67
1983	--	3.00	1.67	1	1.67	3.00	-1	4.00	1.67
1984	-3	5.33	2.67	4	2.67	5.33	-3	6.00	2.67
1985	-3	8.33	4.00	9	4.00	8.33	-8	10.33	4.00
1986	-4	7.67	5.67	6	5.67	7.67	-7	12.00	5.33
1987	-16	12.00	5.67	18	5.67	12.00	-15	18.00	5.67
1988	5	13.33	11.00	-1	11.00	13.33	-8	20.00	10.67
1989	-14	17.67	10.33	18	10.33	17.67	-19	26.00	10.33
1990	9	17.33	12.67	-6	12.67	17.33	-8	29.67	12.00
1991	-13	24.00	12.00	17	12.00	24.00	-21	37.33	11.67
1992	-20	27.00	11.67	24	11.67	27.00	-28	45.67	11.00
Average	-5	9.51	5.40	6	5.40	9.51	-8	14.53	5.24
3 percent	-31	47.33	31.33	40	27.33	51.33	-50	78.67	0.00
12 percent	-21	52.33	26.33	28	22.00	56.67	-34	78.67	0.00
15 percent	-16	54.67	24.00	21	21.00	57.67	-26	78.67	0.00
20 percent	-11	57.00	21.67	14	16.67	62.00	-17	78.67	0.00

Notes: All means are in constant 1972 pesos. The model assumes an available total reserve stock capacity of 300,000 metric tons and zero initial storage.

a/These do not include the fixed cost of constructing storage facilities.

Table 16--Summary of benefits and losses of the free market with trade model

Year/ Discount Rates	Consumers' Benefits			Producers' Benefits			Stocking Agency Benefits[a/]		
	Mean	Probability		Mean	Probability		Mean	Probability	
		Negative	Positive		Negative	Positive		Negative	Positive
	(million pesos)	(percent)		(million pesos)	(percent)		(million pesos)	(percent)	
1978	773	0.33	58.33	-718	58.33	0.33	42	18.00	40.67
1979	593	0.33	49.67	-553	49.67	0.33	29	16.33	33.67
1980	570	1.33	50.00	-534	50.00	1.33	31	15.67	35.67
1981	569	0.67	44.67	-529	44.67	0.67	14	15.33	30.00
1982	500	0.67	44.33	-464	44.33	0.67	19	15.33	29.67
1983	409	2.33	40.33	-385	40.33	2.33	26	9.00	33.67
1984	389	3.33	35.33	-365	35.33	3.33	12	10.67	28.00
1985	347	6.33	33.33	-325	33.33	6.33	28	8.67	31.00
1986	259	5.67	28.67	-244	28.67	5.67	18	7.33	27.00
1987	190	8.00	28.33	-179	28.33	8.00	19	6.33	30.00
1988	230	10.33	29.00	-214	29.00	10.33	39	6.33	33.00
1989	129	14.67	24.33	-117	24.33	14.67	37	7.33	31.67
1990	111	13.67	22.67	-102	22.67	13.67	24	5.67	30.67
1991	111	16.33	28.67	-101	28.67	16.33	39	5.67	39.33
1992	65	21.00	25.00	-50	25.00	21.00	38	7.67	38.33
Average	350	7.00	36.18	-325	36.18	7.00	28	10.36	32.82
8 percent	3,574	0.33	99.67	-3,329	99.33	0.67	235	20.33	79.67
12 percent	3,051	0.33	99.67	-2,843	99.67	0.33	187	20.33	79.67
15 percent	2,741	0.33	99.67	-2,555	99.67	0.33	161	21.33	78.67
20 percent	2,337	0.33	99.67	-2,178	99.67	0.33	131	21.67	78.33

Note: All means are in constant 1972 pesos.

a/These do not include the fixed cost of constructing storage facilities.

Table 17--Summary of benefits and losses of the reserve stocks with trade model

Year/ Discount Rates	Consumer's Benefits			Producer's Benefits			Stocking Agency Benefits[a/]		
	Mean	Probability		Mean	Probability		Mean	Probability	
		Negative	Positive		Negative	Positive		Negative	Positive
	(million pesos)	(percent)		(million pesos)	(percent)		(million pesos)	(percent)	
1978	712	1.00	55.00	-660	55.00	1.00	27	22.00	34.00
1979	597	0.33	50.33	-557	50.33	0.33	29	16.67	34.33
1980	576	2.00	50.33	-540	50.33	2.00	37	14.67	38.00
1981	592	1.33	47.67	-550	47.67	1.33	27	16.33	33.00
1982	455	2.33	39.67	-425	39.67	2.33	33	12.33	30.67
1983	431	3.00	43.33	-406	43.33	3.00	28	15.33	32.00
1984	399	5.33	37.67	-375	37.67	5.33	25	14.00	29.67
1985	319	8.33	32.33	-300	32.33	8.33	15	19.67	23.00
1986	297	7.67	33.00	-280	33.00	7.67	18	20.00	24.67
1987	188	12.00	28.00	-175	28.00	12.00	6	22.00	24.00
1988	217	13.33	29.67	-200	29.67	13.33	13	22.33	27.00
1989	108	17.67	24.33	-96	24.33	17.67	-4	29.00	21.33
1990	122	17.33	25.00	-113	25.00	17.33	9	30.67	23.33
1991	81	24.00	23.33	-70	23.33	24.00	5	36.67	23.67
1992	43	27.00	23.67	-29	23.67	27.00	--	43.33	25.33
Average	342	9.51	36.22	-318	36.22	9.51	18	22.33	28.27
8 percent	3,508	0.00	100.00	-3,268	100.00	0.00	183	24.00	76.00
12 percent	2,994	0.00	100.00	-2,790	100.00	0.00	156	24.00	76.00
15 percent	2,689	0.00	100.00	-2,507	100.00	0.00	139	24.33	75.67
20 percent	2,289	0.00	100.00	-2,134	100.00	0.00	117	24.00	76.00

Notes: All means are in constant 1972 pesos. The model assumes an available total reserve stock capacity of 300,000 metric tons and zero initial storage.

a/These do not include the fixed cost of constructing storage facilities.

BIBLIOGRAPHY

Anden and Palacpac. "Data Series on Rice Statistics -- Philippines." International Rice Research Institute, Los Baños, revised 1976.

Apiraksirikul, A. "Rice Trade Policy as It Relates to National Objectives in the Philippines." M.A. thesis, University of the Philippines, 1976.

Cochrane, W. W. "Reserve Stock Grain Models, the World and the United States, 1975-85." Technical Bulletin No. 305, Agricultural Experiment Station, University of Minnesota, 1976.

Drilon, J. D., Jr. "Rice Price Stabilization and the Rice and Corn Administration." Philippine Journal of Public Administration 11 (No. 3, 1967).

Doyle, C. J. "A Comment." Food Policy. May 1976: 390-391.

Gustafson, R. L. Carryover Levels for Grains -- A Method for Determining Amounts That Are Optimal under Specified Conditions. Technical Bulletin No. 1178. Washington, D.C.: U.S. Department of Agriculture, 1958.

Khusro, A. M. Buffer Stock and Storage of Foodgrains in India. New Delhi: Tata McGraw-Hill Publishing Co., Ltd., 1973.

Nand, A. and Houck, J. P. "Buffer Stocks of Foodgrains in India: The Economics of Their Operation and Potential Size." Economic Study Report S71-2, Department of Agricultural and Applied Economics, Institute of Agriculture, University of Minnesota, 1971.

Nasol, R. L. "Demand Analysis for Rice in the Philippines." Journal of Agricultural Economics and Development 1 (No. 1, 1971): 1-13.

Nguyen, E. L. "The Influence of Weather on Rice Production." M.A. thesis, University of the Philippines, 1978.

O'Carroll, F. and Traylor, H. D. "An Economic Analysis of a Reserve Stock Program for Rice in the United States: A Technical Publication." D.A.E. Research Report No. 517, Department of Agricultural Economics and Agri-business, Louisiana State University and Agricultural and Mechanical College Agricultural Experiment Station, 1977.

Philippines, Bureau of Census and Statistics. Summary, Census of Agriculture 1960.

_____. Summary, Census of Agriculture 1961.

Philippines, Department of Agriculture and Natural Resources, Agricultural Economics Division. Crop and Livestock Statistics. Various years.

Philippines, Department of Agriculture and Natu l Resources, Bureau of Agricultural Economics. "Rice Production, Area, and Yield in the Philippines." (Mimeographed.)

_____. Unpublished data.

Philippines, Fertilizer and Pesticide Authority. Unpublished data.

Philippines, National Economic Development Authority. Five-Year Philippine Development Plan, 1978-1982. Manila: NEDA, 1977.

_____. "National Income Accounts Link-Series."

Philippines, National Economic Development Authority, Statistical Coordination Office. Food Balance Sheet. Manila: NEDA, 1953-76.

Philippines, National Grains Authority. "Three-year Warehousing Program. FY 1975/76-FY 1977/78." Prepared by the Corporate Planning Group in coordination with the Warehousing Development Committee, Quezon City, 1975. (Mimeographed.)

_____. Unpublished data.

Ray, S. K. "Stabilizing Foodgrains Availability and Prices through Buffer Stocks Operation: An Econometric Approach." Ph.D. thesis, University of Delhi, 1973.

Reutlinger, Shlomo. Simulation of World-Wide Buffer Stocks of Wheat, World Bank Staff Working Paper 219. Washington, D.C.: International Bank for Reconstruction and Development, 1975.

Reutlinger, Shlomo; Eaton, D.; and Bigman, D. Should Developing Nations Carry Grain Reserves? World Bank Staff Working Paper 244. Washington, D.C.: International Bank for Reconstruction and Development, 1976.

Te, Amanda. "An Economic Ana ·is of Reserve Stock Program for Rice in the Philippines." Ph. . dissertation, University of the Philippines, 1978.

Torres, R. D.; Prantilla, E. B.; and Darrah, L. B. "A Buffer Stock Scheme for Rice and Corn in the Philippines." (Mimeographed.)

Turnovsky, S. J. "The Distribution of Welfare Gains from Price Stabilization: A Survey of Some Theoretical Issues." Ford Foundation Conference on Stabilizing World Commodity Markets held at Airlie, Virginia, 1977. Revised version. (Mimeographed.)

U.S. Department of Agriculture. Analysis of Grain Reserves: A Proceedings. Washington, D.C.: USDA, 1976.

Walker, R. L. and Sharples, J. A. "Stabilizing the International Wheat Market with a U.S. Buffer Stock." Food Policy 10 (No. 5, 1976): 382-389.

Waugh, F. V. "Consumer Aspects of Price Instability." Econometrica 34 (No. 2, 1966): 504-508.