GRAIN RESERVES: A REVIEW OF SELECTED LITERATURE

by

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CHAPTER I

INTRODUCTION

Until the early 1970's the world food situation was gradually improving. World production of grains rose almost every year from 1960 through 1972, interrupted only by poor crops in the USSR in 1961 and 1963 and the great Indian drought of 1965-1966.[1] Over the period 1950 to 1970, world food output increased by 0.75 percent per capita per year and in the developed countries by about 1.5 percent.[2] In general, world production growth kept pace with world consumption increases until 1970.[3]

The first threat of this period started with the corn blight in the United States in 1970 which caused a brief increase in grain and meat prices and a sharp reduction in feed grain stocks.[4] Another unexpected development was the decline in food and grain production in many areas during the period 1972-1973, attributable to adverse weather over large areas of the world, especially the United States,

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[1]Dale E. Hathaway, "The World Food Crisis-Periodic or Perpetual?", Increasing Understanding of Public Problems and Policies-1975, (Oak Brook, Ill.: Farm Foundation 1975), p. 67.

[2]Ibid., p. 69.

[3]G. Edward Schuh, "US Food Policies: The Perspective of Developed Countries", Increasing Understanding of Public Problems and Policies-1977, (Oak Brook, Ill.: Farm Foundation 1977), p. 50.

[4]Committee For Economic Development, A New U.S. Farm Policy For Changing World Needs, (n.p.: Georgian Press, Inc., October 1974), p. 49.

the Soviet Union, China, the Middle East, Australia, and Africa.[1] Because of the poor wheat crop, the Soviet Union purchased a significant amount of U.S. grain -- more than they had previously imported.[2] This was followed by increased grain importation by the People's Republic of China and the developing countries in 1973-74 (Table 1). The poor anchovy catch off the coast of Peru, contributed to a fish meal shortage which increased the demand for U.S. soybeans and soybean meal and thus further intensified the impact of the reduction of U.S. feed grain stocks. The decline in Peruvian production of fish meal from 1972 to 1973 was equivalent to 750,000 tons of soybean meal.[3]

Other developments of a more permanent nature which depleted world grain reserves in 1972-1974 were noted by Lutgen and Peterson:[4] 1) the lost momentum in the Green Revolution which resulted in leveling-off production in Southeast Asia; 2) the re-entry of the People's Republic of China in the international market; 3) the United States devaluation of the dollar, which greatly increased the purchasing power of other countries and expanded exports of U.S. agricultural products; 4) the shift from holding goods as a hedge against rapid

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[1]Tim Josling, "The World Food Problem: National and International Aspects", in The World Food Problem and U.S. Politics and Policies: 1972-1976, ed. Ross B. Talbot (Ames, Iowa: Iowa State University Press, 1977), p. 6.

[2]Schuh, p. 51.

[3]D. Gale Johnson, World Food Problems and Prospects, (Washington, D.C.: American Enterprise Institute for Public Policy Research, June 1975), Foreign Affairs Study 20, p. 646.

[4]Lynn H. Lutgen and Everett E. Peterson, "Food Reserves Policy Choices", Food and Farm Policy: A Fresh Outlook, (Manhattan, Kansas.: Kansas State University, October 1974), p. 15.

Table 1

World Net Grain Exports and Imports

Country	1969/70 to 1971/72 (average)	1971/72	1972/73	1973/74
	(million metric tons)			
Developed Countries	31.9	41.9	62.4	58.4
United States	39.8	42.8	73.1	72.5
Canada	14.8	18.3	18.8	13.1
Australia and New Zealand	10.6	10.8	5.8	9.9
South Africa	2.5	3.7	0.4	4.0
EC-9	-16.6	-14.0	-13.4	-13.0
Other West Europe	-4.8	-4.3	-5.3	-8.9
Japan	-14.4	-15.4	-17.0	-19.2
Centrally Planned Countries	-6.8	-13.0	-32.2	-15.9
East Europe	-7.6	-9.2	-8.0	-4.8
USSR	-3.9	-1.3	-19.6	-4.4
People's Rep. of China	-3.1	-2.5	-4.6	-6.7
Developing Countries	19.1	-26.9	-23.2	-30.3
North Africa and Middle East	-9.2	-11.9	-8.1	-14.9
South Asia	-5.7	-5.4	-4.5	-7.0
Southeast Asia	3.2	3.3	1.2	2.5
East Asia	-8.4	-9.2	-10.4	-10.2
Latin America	3.2	-2.0	--	0.7
Central America	-1.9	-2.0	-2.0	-2.1
East Africa	-0.3	0.3	0.6	0.7
Others	-0.2	-0.2	-0.3	-0.3
World Total Exports	107.6	111.2	141.8	151.0

Source: Foreign Agricultural Service and Economic Research Service, USDA Grain Data Base, November 1974.

inflation; 5) the general increase in the demand for food due to a growing world population; and 6) the rising affluence during the 1960's which significantly increased the demand for livestock products and consequently for feed grains and oilseeds. Programs undertaken by the United States, Canada, and Australia to reduce grain production were another factor.[1]

World grain stocks decreased from 188 million metric tons in 1969-1970 to about 102 million metric tons in 1975-1976. The United States holdings also declined from 67.8 million metric tons of grains to 23.2 million metric tons within the same span of time(Table 2).

According to D.Gale Johnson,[2] shortfalls in production had relatively small impact in reducing grain prices. In his analysis, sharp price increases were results of "still other factors" such as: 1) the simultaneous economic boom in the industrial economies; 2) the continued increase in cattle herds throughout the world; and 3) internal government price policies in some countries which prevented the price system from rationing available supplies and enhancing domestic outputs. Thus, the price increasing factors were concentrated in the international grain markets which had to absorb most of the production shortfalls and the expanding world demand.[3]

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[1]Committee for Economic Development, p. 50.

[2]Johnson, p. 653.

Table 2

Stocks of Grain on Hand at the Beginning of the Year, 1960-61 to 1976-77.[1]

Year	World Total Grain	United States Total Grain	United States Wheat	United States Coarse Grains	Percent of Total Stocks Held by the U.S.
	million metric tons				
1960/61	164.0				
1961/62	176.7	115.4	38.4	77.0	65.3
1962/63	150.0	101.5	36.0	65.5	67.7
1963/64	153.2	91.0	32.5	58.5	59.4
1964/65	148.0	87.4	24.5	62.9	59.1
1965/66	151.3	71.9	22.2	49.7	47.5
1966/67	115.6	71.9	22.2	49.7	47.5
1967/68	144.6	45.3	11.6	33.7	31.3
1968/69	159.4	58.7	14.7	44.0	36.8
1969/70	188.1	67.8	22.2	45.6	36.0
1970/71	168.2	68.1	24.1	44.0	40.5
1971/72	130.5	50.7	19.9	30.8	38.9
1972/73	147.7	68.6	23.5	45.1	46.4
1973/74	108.1	42.0	11.9	30.1	38.9
1974/75	110.6	27.0	6.7	20.3	24.4
1975/76[2]	101.9	23.2	8.7	14.5	22.8
1976/77[2]	99.4	32.2	10.8	21.4	32.4

[1] Total grains include wheat, rye, barley, oats, corn, sorghum. Coarse grains include grains listed except wheat.

[2] Estimated.

Source: U.S. Department of Agriculture, Foreign Agricultural Service, World Grain Situation, FG8-75, July 15, 1975 and FG16-75, December 22, 1975.

All these circumstances, temporary or permanent in nature threatened world food supplies and brought unusual instability to farm and food prices during the early 1970's. Hence, the interest in establishing reserves for emergencies and to reduce price instability.

The purpose of this report is to deal with price instability and food security issues. Included are: 1) a review of events that led to grain shortages and increased price variability (these events were discussed earlier in the introduction); 2) a historical review of food reserve efforts; 3) a discussion of objectives of grain reserve programs; 4) a survey of various proposals for grain reserves; 5) costs of building grain reserves; 6) a discussion of management and financing alternatives for grain reserves; and 7) a presentation of benefits obtained from grain reserve programs.

CHAPTER II

WORLD FOOD PRICE VARIABILITY AND FOOD SECURITY

Recent international concern about high variability in prices of food and feed grains emerged in 1972. A comparison of the percentage change in monthly prices of corn, soybeans, and wheat in the United States between the periods 1968-1971 and 1972-1974 concretely describes the condition during those years (Table 3). The average percent price change from low to high for wheat during the first period was 13.0 percent. From 1972-74, the average variation was 90.0 percent. Monthly prices for soybeans exhibited the largest variation (111.0 percent) in 1972-1974, while corn showed 70.0 percent variability. Daily price fluctuations for all three commodities were reported to be even greater in this latter period.

Prices for hogs and cattle were also reported to be more variable in the period 1972-1975 than in previous years. Monthly average prices for hogs fluctuated within one year by 55.0 percent during 1972- 1975 compared to 42.0 percent for 1968-1971. Average prices for cattle varied by 31.0 percent in 1972-1975 compared to 17.0 percent during the earlier period. The variability of prices for soybeans, corn, and other grains contributed much to the fluctuations in livestock prices because these commodities are used as animal feeds.[1]

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[1]Hathaway, p. 67.

Table 3

Percentage Change in National Monthly Average Prices Received by U.S. Farmers for Corn, Soybeans, Wheat, Hogs, and Beef Cattle, 1968-1974.

Item	Price Change, Low to High Month	
	1968-1971 Average Percent	1972-74[1] Average Percent
Corn, per bushel Year Beginning, October 1	27	70
Soybeans, per bushel Year beginning, September 1	18	111
Wheat, per bushel Year beginning, July 1	13	90
Hogs, hundred weight[2]	42	55
Beef Cattle, hundred weight[3]	17	31

[1]For grains, 1972-74 are included. For livestock, average is for 1972-1975.

[2]Barrows and gilts, markets.

[3]Choice steers, Omaha.

Note: Change is measured from low price month to high price month within a given year, then averaged over the years included.

Source: B.F. Jones, Grain Reserves in Agricultural and Food Policy, (West Lafayette, Ind.: Purdue University Agricultural Experiment Station), no. 124 (May 1976), p.2.

Consumer food prices increased considerably from January 1972 to December 1975. Higher farm commodity prices contributed to this increase.[1] The average growth of consumer prices in OECD[2] countries was 3.7 percent annually during 1961-1971. However, prices increased by 4.7 percent in 1972 and increased as much as 12.5 percent between March 1973 and March 1974. In developing countries, the effect of increased food prices was more severe because consumer expenditures on food as a percentage of income is much higher.[3]

The tremendous reduction in world grain reserves was a big contributing factor in the price variability of grain and livestock. When grain reserve levels are low, "grain prices fluctuate widely in response to changes in output."[4] This causes the price of other food commodities to vary eventually. High prices brought windfall gains to grain producers during the early years of crisis.[5] On the other hand, high prices caused hardships, especially to the world's poorest consumers. Price variability benefited grain and livestock producers who were good at speculation. However, variability made it

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[1]B. F. Jones, Grain Reserves in Agricultural and Food Policy, (West Lafayette, Indiana: Purdue University Agricultural Experiment Station), No. 124 (May 1976), p. 1.

[2]Countries that are members of the Organization for Economic Cooperation and Development are: Canada, United States, Japan, Australia, France, Germany, Italy, United KIngdom, Belguim, Denmark, Ireland, Netherlands, Austria, Finland, Norway, Portugal, Spain, Sweden, and Switzerland.

[3]USDA, The World Food Situation and Prospects to 1985, (Washington, D.C.: U.S. Government Printing Office for the USDA Economic Research Service, March 1975), No. 98, p. 7.

[4]Jones, p. 1.

[5]USDA, The World Food Situation and Prospects to 1985, p. 40.

more difficult for producers to plan their production for efficient use of resources. Furthermore, poor information about future prices increased the risk for producers. Some actually went bankrupt.[1]

These conditions forced a renewed interest in rebuilding grain reserves for the purpose of "providing for the world food security and for grain price and supply stability."[2] Various proposals to attain stability in grain price and supply were forwarded.[3] Since production has always been uncertain due to yield variability, most of the proposals focused on rebuilding food and feed grain reserves. However, proposals also varied in terms of their treatment of management and financial factors. Different views existed as to who should hold stocks, where stocks should be held, how large stocks should be, and who should pay for them.[4]

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[1]USDA, The World Food Situation and Prospects to 1985, p. 4.

[2]Ibid., p. 40.

[3]Lutgen and Peterson, p. 15.

[4]Ibid.

CHAPTER III

HISTORY OF FOOD RESERVE EFFORTS

Present concern for stabilizing prices or the supply of food is not of recent origin. The Bible records that Joseph, as Governor of the Land, stored one fifth of the crop in the years of abundance for release in the lean years.[1] However, there is evidence that Egypt was a granary for hundreds of years before Joseph was born.[2]

The name "ever-normal granary" appeared in Chinese records of about 1100 B.C. The Chinese recognized the importance of storing grain which benefited not only the people but also earned money for the state. Li K'o, minister of Wei in the 12th century B.C., pointed out that high grain prices in years of poor crops hurt consumers and that low grain prices in years of successful crops hurt farmers.[3] The Athenians and Romans also attempted to control both quantities and prices of grain.[4]

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[1]Genesis 41-47

[2]Jerry A. Sharples and Rudie W. Slaughter, "Alternative Agricultural and Food Policy Directions for the United States with Emphasis on Stability of Prices and Producer Income", Agricultural and Food Price and Income Policy: Alternative Directions for the United States, ed. Robert G. F. Spitz, Report of a Policy Research Workshop, Washington, D.C., January 15-16,1976, (Champaign, Ill.: University of Illinois at Urbana-Champaign Agricultural Experiment Station), Special Publication No. 43 (August 1976), p. 75.

[3]Huan-Chang Chen, "The Economic Principles of Confucious and His School", cited by David J. Eaton, A Systems Analysis of Grain Reserves, (Washington, D.C.: n.p. for the USDA Economics, Statistics, and Cooperative Service, January 1980), No. 1611, pp. 3-4.

[4]Mary G. Lacy, "Flood Control During Forty-Six Centuries", Vol. 16, No. 6, (June 1923), cited by Sharples and Slaughter, p. 75.

During the 17th and 18th centuries, efforts were made by India and England to stabilize grain prices. Similar attempts were made by the Spanish Viceroy in Mexico City by maintaining a controlled market.[1]

Food reserves to protect farm prices continued to be a major concern through the years. In the United States, the Commodity Credit Corporation initiated by Henry Wallace,[2] was created in 1933 to stabilize, support, and protect U.S. farm prices and to help maintain adequate supplies of agricultural commodities. The result of Wallace's works was embedded in Title III of the Agricultural Adjustment Act of 1938. In that title, "provision was made for the systematic storage of surpluses to meet any shortage that develops either on the farm, in the country, or in the case of natural need."[3]

Food problems which arose during and after World War II resulted in the United States and Great Britain joining forces in 1942 to establish the Combined Food Board. The Board was designed to formulate plans for a number of purposes, among them the "supply, production, transportation, disposal, or distribution in or to any part of the world of foods" and "to work in collaboration with other member-countries of the United Nations toward the utilization of their food resources."[4]

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[1]Sharples and Slaughter, p. 75.

[2]U.S. Secretary of Agriculture, in the Roosevelt Administration.

[3]U.S. Congress, House Committee on Foreign Affairs, International Food Reserves: Background and Current Proposals, 93rd Congress, 2nd Session, 1974 October, p. 3.

[4]Eric Roll, "The Combined Food Board", (Stanford, Calif.: Stanford University Press, 1956), cited by U.S., Congress, International Food Reserves, p. 4.

While the Board did not become directly involved in food production and allocation, its proposal "tempered the broad pattern of food policy for the United States and Great Britain during its lifetime."[1] After four years, the International Emergency Food Council, supported by nineteen member-nations, took over functions of the Board.[2]

The Food and Agricultural Organization of the United Nations also made a number of proposals to solve the widespread food problem. An executive board, the World Food Council was established to continue a steady review of the world's food situation. One of the achievements of the Council was the creation of the World Food Program. The United States participated in the program through its Public Law 480. PL 480 was a mechanism for distributing U.S. agricultural surplus to developing food deficit nations of the world. It was designed to prevent hunger and malnutrition and to stimulate economic growth.[3] Other countries participated through contributions of commodities, cash, and services.[4] The program proved to be successful to developing nations, not only during emergency situations but also in carrying out their economic and social development projects.

The Food Aid Convention was set up under the International Grains Agreement of 1967 and the 1971 International Wheat Agreement. Its objective was to carry out a food aid program with the help of contributions for the benefit of developing countries. A Food Aid Committee

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[1]Eric Roll, p. 4.

[2]U.S. Congress, International Food Reserves, p. 4.

[3]USDA-Foreign 202, "Twelve Years of Achievement Under Public 480", November 1967, cited by U.S. Congress, International Food Reserves, p. 6.

[4]U.S. Congress, International Food Reserves, p. 6.

established by the convention reviews the amount and terms of contribution made and exchanges information on the operation of the convention.[1]

Besides the FAO and the Food Aid Committee, several other official and semi-official international organizations have considered the importance of world food reserves. The proposal of the Secretary General of the Organization of Economic Cooperation and Development (OECD), Thorkil Kristensen in 1967, is a case in point. He suggested that the bad weather in India for two consecutive years indicated the need for a world food reserve. His proposition stated that wheat and possibly rice should be kept at a certain level, "and that in the event such reserves fell below that level in a bad year, they should be restored the following year."[2] He suggested that such responsibility entailed world cooperation and should not be shouldered solely by a single country. However, his proposal was never given serious consideration.

The history of grain reserve efforts indicate that countries such as the United States realized the importance of stability in food prices and supplies. However, it is evident that the goal of stability was secondary to raising farm income. Lutgen and Peterson[3] reported that "federal farm programs over the past 45 years were designed primarily to increase net farm income and that large carryovers were a byproduct of this effort." Basically, supplies reaching the market were

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[1] U.S. Congress, International Food Reserve, p. 7.

[2] Ibid.

[3] Lutgen and Peterson, p. 13.

restricted to boost farm product prices. Stocks accumulated "accidentally" due to overproduction. Holding these surpluses was costly, so the government had to find means of disposing them. The increased foreign demand due to war and crop failure transformed these surpluses into "strategic reserves" or as gifts and concessional sales to needy countries.

The "surplus psychology" was held by developed and developing nations alike until 1972.[1] A combination of circumstances in 1972 and 1973 changed this outlook. Suddenly food reserves (especially grains) in the United States and world-wide were depleted, causing concern over "possibly chronic food shortages." Since then, a serious interest in food security emerged and led to the 1974 Rome World Food Conference sponsored by the United Nations. At the conference relevant steps concerning food production, nutrition, food security, and food trade, food aid, and related matters were agreed upon. The World Food Council, different from the Executive Board created by FAO in 1945, was established to coordinate the implimentation of these resolutions.[2]

Other international forums followed subsequently. Economic research increased and provided suggestions and measures for attaining food security.[3] Much of this research focused on food and feed grain reserves. This is to be expected, because the variations in prices and supplies of commodities have been correlated to the availability and prices of food and feed grains in the world market.

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[1]Hathaway, p. 67.

[2]USDA, The World Food Situation and Prospects to 1985, p. 86.

[3]See James P. Houck and Mary E. Ryan, Economic Research on International Reserves: The State of Knowledge, (University of Minnesota Agricultural Experiment Station, 1979), No. 532.

CHAPTER IV

WHAT IS A GRAIN RESERVE?

With the development of various proposals regarding grain reserves, numerous perspectives about the type, objectives, size, composition, and management responsibility were forwarded. This chapter reports a range of options and their implications. There is no general agreement concerning definitions of categories of reserves.

Types of a Grain Reserve

David J. Eaton[1] distinguished four varieties of grain reserves, i.e., working stocks, bufferstocks, food aid, and emergency food reserves. Working stocks are marketing reserves in which "grain is stored for gradual use over the remainder of the growing cycle." Buffer stocks store grains from a year of high production for use in another period of low harvest. A food aid reserve is grain set aside "at any time (even during a year of production shortfall) for distribution to domestic or foreign persons defined as the needy." In times of natural disaster or civil order, emergency food reserves are dispatched to help meet food needs of people. Conceptually, these four reserve categories can be distinguished by certainty of demand, the rate of stock turnover, and their function (Table 4).

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[1]David J. Eaton, A System Analysis of Grain Reserves, (Washington, D.C.: n.p. for the USDA Economics, Statisitics, and Cooperative Service, January, 1980) No. 1611, p. 5.

Table 4

Four Types of Grain Reserves

Reserve Type	Demand Certainty	Rate of Reserve Turnover	Social Function
Working Stock	Relatively Certain	Disposed of within one year of growing cycle	Intra-year stabilization
Buffer Stock	Uncertain	Build-up and release rules set time in storage	Inter-year stabilization
Food Aid Reserve	Relatively Certain	Determined by need of target group	Political leverage and/or humanitarian use
Emergency Reserve	Uncertain	Depends upon what is defined as an emergency	Humanitarian use and/or political leverage

Source: David J. Eaton, A Systems Analysis of Grain Reserves,(Washington, D.C.: n.p. for the USDA Economics, Statistics, and Cooperative Service, January, 1980), no. 1611, p.6.

Unlike Eaton, Harry Walters[1] categorized grain reserves into three different levels (Table 5) i.e., 1) an insurance reserve of around 20 to 30 million metric tons; 2) a stabilization reserve of about 60 million metric tons; and 3) a combined food aid- emergency relief-contingency reserve ranging between 30 to 60 million metric tons. Quantities and costs involved in an insurance reserve are moderate and considerable room is allowed for market forces to reflect demand and supply within price bands. Such reserves would not become available until prices or production or consumption shortfalls reached predetermined levels. Stabilization reserves are needed to offset deviations in production or consumption trends. The third kind of reserve would provide some measure of food security to poor developing countries and international stability within a wide price band.

James P. Houck and Mary E. Ryan[2] reported two types of grain stocks. The first type (market stocks) includes: 1) minimum working stocks (also called pipeline supplies); 2) additional working stocks held by consumers or merchandisers to meet future needs; and 3) speculative stocks held in anticipation of future profit. The second type, (the non-market stocks) are stocks segregated from normal market channels to meet special needs such as price stability, food aid commitments, and unanticipated emergency food needs in times of disaster.

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[1]Harry Walters, Food Reserves Policy and International Trade Policy, n.p., p. 2.

[2]James P. Houck and Mary E. Ryan, p. 26.

Table 5

Types of Reserves According to Size and Function

Type	Size (million metric tons)	Function
Insurance Reserve	20 to 30	Halt extreme effects of price or supply stability
Stabilization Reserve	60	Provide a high degree of stability to grain prices and offset a large fraction of grain shortfalls (85 to 95 percent)
Combined Food Aid-Emergency Relief-Contingency Reserve	30 to 60	Provide food security to developing countries and grain stability within wide price bands (50 to 100 percent) worldwide

Source: Harry Walters, Food Reserves Policy and International Trade Policy, n.p., p.2.

There are three types of internationally supervised agricultural stocks according to a tripartite report by fourteen experts from North America, the European Community and Japan.[1] They are stocks for commercial emergencies, buffer stocks, and strategic food reserves (Table 6).

Stocks for commercial emergencies would be held by individual governments. The cost of acquiring and holding them would be allocated among participating governments on the basis of volume of production and consumption or some combination of the two. Stocks would be released from the market when the world price reaches or exceeds a predetermined level. In a situation of surplus, these stocks would be accumulated when prices fall below a predetermined floor.

To minimize year to year fluctuations in the volume and value of international trade in grains, buffer stocks are accumulated. Such stocks are acquired by requiring participating nations to add to stocks when output exceeds the level of a moving average of output over the previous four or five years. Stocks are released when output falls below the average. As an alternative, acquisitions and releases are based on an agreed international market price.

Strategic food reserves are established to alleviate the threat of sudden crop failures in developing countries. Some analysts suggest such stocks be placed in developing countries themselves as far as is economically feasible to assure that supplies will not depend on the availability of international shipping facilities.

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[1]The Brookings Institution, Toward the Integration of World Agriculture: A Tripartite Report by Fourteen Experts from North America, the European Community and Japan , (Washington, D.C.: The Brookings Institution, 1973), p. 24.

Table 6

Types and Functions of a Grain Reserve

Type	Function
Commercial Emergency Reserve	Provide price stability when world price reaches or exceeds predetermined level
Buffer Stocks	Minimize year to year fluctuations in prices of major grains
Strategic Food Reserve	Insurance against threat of crop failures in developing countries

Source: The Brookings Institution, Toward the Integration of World Agriculture: A Tripartite Report By Fourteen Experts From North America, the European Community and Japan, (Washington, D.C.: The Brookings Institution, 1973), p. 24.

Phillips and Kelley[1] classified grain reserves as: national security reserves, buffer stocks, and food security reserves. National security reserves satisfy two functions: 1) to supply direct government demand by the armed forces or other government institutions; and 2) to protect against the uncertainty of war or major disaster. Buffer stocks are stored to support seasonal price stabilization. Food security reserves are kept to stabilize year to year variations in quantities and prices. They are built up when supplies are in excess of those needed for domestic consumption and are drawn upon in years of shortfall below domestic consumption needs. Acquisition for each type of reserve are through domestic procurement programs and from grain imports.

In general, grain reserves could be grouped into two categories, market stocks and non-market stocks (Table 7). Non- market stocks are stocks segregated from normal market channels to meet special needs such as food aid program commitments, and unanticipated emergency food needs. On the other hand, market stocks include working stocks, buffer stocks, food security reserves.

These categories of grain reserves differ with respect to possibility of obtaining measures of their cost and benefits. Costs and benefits of market stocks generally could be estimated given good estimates of market supply and demand functions, etc. However, measurement of benefits is generally not possible for non-market stocks. Costs generally could be approximated for these latter stocks.

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[1] Richard Phillips and Paul Kelley, publication in process.

Table 7

Measurability of Cost and Benefits
by Type of Grain Reserves

Type of Stocks	Cost	Benefits
MARKET STOCKS:		
Working Stocks	yes	yes
Buffer Stocks	yes	yes
Food Security Reserves	yes	yes
Stabilization Reserves	yes	yes
NON-MARKET STOCKS:		
Food Aid	yes	no
Emergency Relief - Contingency Reserves	yes	no
Strategic Food Reserves	yes	no

yes = generally measurable
no = not measurable

Multiple Goals of a Grain Reserve

Grain reserves are established to satisfy certain goals. These goals vary depending on the diversified interests of the countries, regions, or international bodies utilizing stocks. However, the most commonly cited objectives are: 1) price stabilization; 2) income stabilization; and 3) food security or supply stabilization.

Price Stabilization

Food prices vary greatly with respect to changes in supply because the demand for food is highly inelastic. To put it another way "small changes in availability of food supply will cause large changes in prices."[1] Relatively inelastic demand for food arises because food and fiber are the basic needs of life and have very few substitutes in the short run. Likewise, few alternatives available for food production resources, such as land, labor, limited storage facilities, etc. make supply relatively inelastic in the short run.[2] Changes in the movement of the demand and supply curves also cause price instability. Changes in demand occur in response to population growth, alterations in people's tastes and preferences, fluctuations in the level of economic activity, and changes in the distribution of income. Sharp changes in supply can arise in the short run due to vagaries of weather, infestation of pest and diseases, political and social instability.

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[1]Hathaway, p. 68.

[2]Sada Nand and James P. Houck, Buffer Stocks of Food Grain in India: The Economics of Their Operation and Potential Size, (St. Paul, Minnesota.: University of Minnesota, May 1971), Economic Study Report S71-2, p. 4.

Price stabilization schemes for agricultural products were of particular interest to John Maynard Keynes.[1] He advocated buffer stocks for control of price fluctuations. In his view, "stability of prices does not mean fixed prices, but prices which follow reasonably closely the long period trend of demand and supply conditions."

Like Keynes, Willard Cochrane[2] envisioned that the price stabilization objective of a reserve stock program cannot be the holding of grain prices on a flat, fixed support level. He believed that "a reasonable price level is one that moves or fluctuates within a range in the domestic market, acceptable to consumers and farmers, and to the extent possible, stabilizes the world price level."

Philip Trezise[3] specified some effects of sharp changes in cereal prices.

> (First). . . in the affluent industrial countries sharp upward changes in cereal prices often have a pervasive influence on all food prices and via the wage mechanism, on the over-all price level. The complications for national economic policy, or for demand management, that follow from these inflationary developments can restrict total output below potential, at large economic costs.
>
> (Second). . . for the non-industrial countries and especially the poorest among them, higher prices for cereals can work a variety of hardships: 1) directly on development programs and prospects, by forcing reductions in the volume of non- food imports; 2) on economic stability by way of heightened inflationary pressures; and 3) on levels of food consumption through

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[1]John Maynard Keynes, "The Objective of International Price Stability", Economic Journal, June- September 1943, cited by Sada Nand and James P. Houck, p. 5.

[2]Willard Cochrane, Feast or Famine: The Uncertain World of Food and Agriculture and Its Policy Implications for the U.S., National Planning Association, Washington, D.C., no. 136, February 1974, cited by U.S. Congress, International Food Reserves, p. 118.

[3]Philip Trezise, Rebuilding Grain Reserves: Toward an International System, (Washington, D.C.: Brookings Institution, 1976), p. 56.

> cutbacks in cereal imports -- in effect, a spreading and worsening of pre-existing malnutrition among the poorest member of these societies.

Sharples and Slaughter[1] have developed several arguments for price stabilization as a food reserve goal:

> . . . governments will attempt price stabilization from self-preserving motivation... Rapidly rising prices, especially food prices, create consumer unrest and increase the chances of political turnover of any government-- republican, democratic, parliamentary, or dictatorship.

> . . . stable prices help the producer forecast prices more accurately. This enables him to allocate resources correctly, produce the right combination of products, and get more income. Similarly, consumers can allocate purchases over time.

Comparing the welfare effects of a buffer stock between producers and consumers, Benton Massel[2] concluded that a buffer stock will favor grain producers more than consumers when supply shifts and where annual supplies are probably quite price inelastic. In his analysis, Massel made a number of assumptions. He assumed a market consisting of atomistic consumers and producers in which price fluctuations can arise from parallel shifts in either a linear supply curve, a linear demand curve, or both. He further assumed that storage is costless. Massel's analysis, however, was oversimplified. For instance, the effect of price stabilization on real income of producers and consumers was assumed away. Fluctuations in food grain supplies have not only a destabilizing effect on prices, but also on real incomes of producers and consumers.

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[1]Sharples and Slaughter, pp. 76-77.

[2]Benton Massel, Price Stabilization and Welfare, cited by Sada Nand and James P. Houck, p. 6.

Brandow[1] also supported price stability when he wrote that :

> . . . dependable supplies and stable prices in the United States will encourage the long range development of commercial grain exports, which both the nation and the producers want...
>
> . . . another possible benefit of grain reserve is more stable output and prices in the livestock industries. Instability of livestock production induced by variable supplies and prices of feed grains surely causes inefficient use of fixed resources, income variability for livestock farmers and processing firms, and unemployment of labor.

Furthermore, Hathaway[2] states that:

> . . . stability in grain prices greatly reduces the risk of grain production, speeding the adoption of new technologies, and encouraging new investments.
>
> . . . stability discourages hoarding and smoothes out the supply of grain, especially in developing countries where both private and public action tend to distort price movements in periods of both shortage and surplus.

On the contrary, studies have been written which criticize deliberate efforts by policymakers to stabilize price. Waugh and Oi[3] have demonstated that price stability does not favor either consumers or producers. Employing the concept of consumers surplus, Waugh showed

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[1]G.E. Brandow, "Grain Reserves and the U.S. Economy: A Policy Perspective", Analysis of Grain Reserve: A Proceedings, (Washington, D.C. U.S. Government Printing Office for the USDA Economic Research Service in cooperation with STIA and Rann Directorates, August 1976), **compiled by David J. Eaton and Scott Steele, p. 92.**

[2]Hathaway, p. 3.

[3]F. V. Waugh, "Does the Consumer Benefit from Price Stability?", cited by Paul A. Samuelson, "The Consumre Does Benefit from Feasible Price Stability", Quarterly Journal of Economics, August 1972, p. 476.

that consumer welfare increases when the price of the commodity fluctuates as compared with stabilizing the price of the commodity at its arithmetic mean. Oi, using the concept of producer surplus, concluded that producers, too, would experience economic gains from price instability.

However, numerous perceptive questions were raised with regard to the applicability of this theoretical literature to the resolution of urgent policy problems. The welfare analyses cited are of limited use in solving policy problems since they employ partial equilibrium analysis and assume perfectly competitive markets, perfect information, and a constant marginal utility of money. Finally, and most important for policy decision making, most welfare literature on price stability assumed costless stabilization. Therefore, the relevance of this literature to the policy question of grain reserves is open to serious questions because the holding of reserves is not costless.[1]

Income Stabilization

Income stabilization is also an objective of many agricultural programs, including the grain reserve programs of the United States and other countries.

Sharples and Slaughter[2] pointed out that

> . . . the focus on an income stability policy should be on the stability of returns to resources invested in

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[1]Willard W. Cochrane, Marshall A. Martin, and R.G.F. Spitze, "Grain Reserve Policies In An Uncertain World", Analysis of Food and Agricultural Policies for the Eightees, North Central Regional Research Publication, no. 271, Illinois Bulletin 764, p. 89.

[2]Sharples and Slaughter, p. 87.

> farming and not on the stability of personal incomes of farmers.
>
> . . . the objective of a policy to stabilize resource returns is to reduce the year to year variation around long term trend without directly affecting the trend.
>
> . . . the relevant level of concern for the variance of resource returns is at the firm rather than at the national level. Investment decisions are made at the firm level. Firms take the risk, reap the benefits, or suffer the consequences.
>
> . . . the rational for reducing the variance of resource returns closely parallels that for reducing price variance, to reduce uncertainty, to increase efficiency of resources use and ultimately to achieve a higher social utility function.

Food Security and Supply Stability

World food security was defined by the Food and Agriculture Organization(FAO) as the "availability at all times of adequate cereal supplies in the world to avoid acute food shortages."[1] Food shortage, on the other hand, is the condition that exists when "people wish to consume more food than is available.[2] This takes into consideration both supply and price effects on desired consumption and availability.

Dale Hathaway presented a long and short term meaning of food security.[3] In the long term, food security is the "assurance that per

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[1]Food and Agriculture Organization, World Food Security: Proposal of the Director-General, (August 1973), cited by Johnson, p. 673.

[2]John Picard Stein and Rodney Topper Smith, The Economics of United States Grain Stockpiling, (Sta. Monica, Ca. : Rand Corporation), R-1861-CIEP, March 1977, A Report prepared for Council on International Economic Policy, p. 2.

[3]Dale Hathaway, "The Relationship Between Trade and World Food Security", International Food Policy Issues: A Proceedings, (Washington, D.C.: n.p. for the USDA Economics, Statistics, and Cooperative Service, January 1978), Foreign Agricultural Economic Report no. 143, p. 55.

capita food consumption can at least be maintained at current levels and preferably increased over time, particularly in poor countries." In the short term, food security is the "capability to prevent sharp declines in supplies and resultant sharp increases in prices to levels which many low income consumers at home and abroad cannot afford."

Shlomo Reutlinger[1] defined food security in developing countries as "a condition whereby food grain consumption equals or exceeds a desired level(C*). This level could be the market demand, at an acceptable price. Alternatively, C* could be the market demand plus an additional amount of food distributed under special arrangements to uphold minimal levels of consumption to every living person to achieve adequate nutrition."

To Harry Walters[2] a true world food security is an improved balance between food production and demand among countries. " The imbalance which has long been recognized and has been worsening since 1950 - increasing food deficits in developing countries and persistent food surpluses in many developed countries - is producing a progressively greater degree of food insecurity because of the dependence of one part of the world on the surplus food production of another." Once food supply becomes unavailable to the developing countries, as happened in 1972-74, their food security immediately decreases.

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[1]Sholomo Reutlinger, "Food Insecurity: Magnitude and Remedies", World Development, (Great Britain : Pergamon Press Ltd., 1978) Vol. 6, p. 799.

[2]Harry Walters, "International Food Security: The Issues and the Alternatives", International Food Policy Issues: A Proceedings, USDA, p. 91.

Other Objectives

Aside from price and income stability and food security, food reserves were cited to accomplish other goals. Enumerated below are some of these objectives:

1) Reserves can serve as emergency relief in times of droughts and natural disasters where they occur.[1]

2) In addition to the humanitarian objective, grain reserve stocks serve as support to development programs of Less Developed Countries(LDC). Stability in prices and supply provided by grain reserve programs is believed to encourage the adoption of modern technology and the development of food grain industries and other agriculturally related endeavors.[2]

3) Reserves can be established as part of a bargaining process for the reduction of barriers to trade in farm products.

> ". . . It is going to be difficult to induce the major importers of Western Europe and Japan to reduce their barriers to trade and increase their dependence upon other areas of the world for an increasing fraction of their food supply. To have any significant chance of achieving such reductions, the major exporters must be able to convince the major importers that the former will be reliable suppliers at reasonable and relatively stable prices."[3]

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[1]Alexander H. Sarris, Philip C. Abbot, and Lance Taylor, "Grain Reserves, Emergency Relief, and Food Aid", Policy Alternatives for a New International Economic Order, ed. William R. Cline, (New York: Preager Publishers for the Overseas Development Council, 1979), P. 190.

[2]Richard Phillips and L. Orlo Sorenson, Food Grain Reserves in Developing Countries, (Manhattan, Kansas: Food and Feed Grain Institute, Kansas State University, March 1978), Special Report no. 6, pp. 3-8.

[3]Johnson, p. 678.

Also, Task Force of the Council for Agricultural Science and Technology, "The Impact of an International Food Bank", Mimeo, December 1973.

Size of a Grain Reserve

The question regarding the overall size of a reserve has always been a crucial issue. It is for this reason that numerous studies on grain reserves have dealt with this topic rather extensively. However, from the vast literature written about the topic, there has been no sole conclusion reached as to how large a reserve should be. This is true because many factors are considered in sizing a reserve.

The size of a reserve depends on how much insurance is desired against risk according to Trezise.[1] Reserves are not costless and so policymakers will need to decide what voters are prepared to spend or invest collectively. Competing political interests[2] also affect determination of the size of a reserve.

Objectives specified for a global stock are also considered in determining size, according to Whitacre and Schmidt.[3] Reserves may be held to stabilize production, utilization, prices, and trade. With respect to stabilization of production, size would be dependent on projected probabilities of crop failures and production variability and the degree of protection sought against them.

The size of a buffer stock, a type of reserve, is a function of four variables:[4] 1) frequency and size of fluctuation in production;

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[1]Trezise, p. 3.

[2]David J. Eaton, W. Scott Steele, Jared L. Cohon, and Charles S. Revelle, "A Method to Size World Grain Reserve: Initial Results", Analysis of Grain Reserve: A Proceeding, comp. Eaton and Steele, p. 43.

[3]R. C. Whitacre and S.C. Schmidt, Analysis of a World Grain Reserve Plan Proposed Under A New International Wheat Agreement, (Urbana, Ill.: University of Illinois at Urbana -Champaign, May 1980), Series E, Agricultural Economics, 80E-109, p. 7.

[4]Nand and Houck, pp. 14-15.

2) the limits set by finance; 3) the ability to procure and store food grains; and 4) the extent of open market price fluctuations to be permitted before buffer stock scheme is activated. It is important that the buffer agency take into consideration the trend of consumption based on population growth and rising incomes consequent to economic growth. It should also be borne in mind that a buffer stock program involves physical stocks and money under the control of a competent independent authority.

A number of studies have calculated quantities of grain necessary to cover deviations from trend levels of production, consumption, and yields, to arrive at the approximation of the stock levels that might be held to cover these contingencies. Others estimated the amount of reserves required for emergency needs and food aid. The following discussion focuses on the various findings of thse studies. However, the models used or the analysis performed to arrive at a given approximation are not discussed in this report.

Studies with the objective of determining the size of a world reserve needed to offset deviations in trend production or consumption, with the underlying objective of providing a high degree of stability in grain prices and supplies and offsetting a larger fraction of grain shortfalls(85 to 95 percent), arrived at quantities in the neighborhood of 60 milliom metric tons of grain. Cochrane and Danin, for example, arrived at ranges of 32 to 62 million metric tons depending on the price stability to be achieved.[1] The Food and Agriculture Organization

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[1]Willard Cochrane and Vigil Danin, Reserve Stock Grain Models: The World and the United States, 1975-1985, University of Minnesota Technical Bulletin 305, cited by Harry Walters, p. 3.

arrived at an estimated one year contingency reserve requirements of wheat, coarse grains, and rice totalling 66 to 71 million metric tons on the basis of 1973-1974 levels of grain consumption.[1] The United States Department of Agriculture estimated that 56 to 80 million metric tons of grain stocks, over and above working stock levels, would be needed to cover world production shortfalls from trend for any single year, based on the 1960 to 1973 period.[2]

The United Nations Conference on Trade and Development(UNCTAD), originally proposed reserve stocks at around 60 million metric tons. A similar reserve target level was mentioned by Kissinger in his address at the World Food Conference in Rome, Italy on November 5-16,1974.

Some authors proposed different levels of reserve sizes. Trezise, for instance, estimated grain reserve requirements over the period 1976-80 (Table 8). In 1976, a total of 50 million metric tons (wheat

Table 8

Estimated Grain Requirements, 1976-80

(million metric tons)

YEAR	WHEAT	COARSE GRAINS	TOTAL
1976	22.0	28.4	50.4
1977	24.2	29.9	54.1
1978	26.1	30.9	57.0
1979	28.2	32.3	60.5
1980	30.5	33.6	64.1

Source: Philip H. Trezise, Rebuilding Grain Reserves: Toward an International System, (Washington, D.C.: The Brookings Institution, 1976)

[1]FAO, World Food Security, pp. 18-29, cited by Trezise, p. 18.

[2]USDA, The World Food Situation and Prospects to 1985, p. 42.

and coarse grains) was needed to offset cereal shortfalls from trends in importing countries. This increased to 64 million metric tons by 1980. From the figures, we can observe that there is a rising level of reserve requirements both for wheat and coarse grains.

Jones[1] reported that if all shortfalls in each particular grain had been made up with similar grains during the 1960-73 period, a stock of 21 million metric tons of wheat, 41 million metric tons of coarse grains, and 23 million metric tons of rice would have been required. However, in another study he recommended that a maximum stock of 30 million metric tons of grain would have been sufficient to compensate for all shortfalls which occurred over the 1960-73 period when all the major grains are considered as an aggregate.[2]

Other authors also made efforts to determine the size of reserves necessary to meet other objectives such as food aid, emergency relief, and contingency reserve. Walters observed that proposals of this type have suggested that there should be 10 million metric tons for minimum levels of food aid, an emergency relief of 500,000 metric tons, and some minimum contingency reserve of 15 to 20 million metric tons.[3] Trezise, in a similar study, proposed that 18 to 20 million metric tons of all grains should be a reasonable contingency reserve target.[4]

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[1]Jones, Grain Reserves in Agricultural and Food Policy, p. 16.

[2]B.F. Jones, A Grain Reserve Program, (West Lafayette, Indiana: Purdue University Agricultural Experiment Station), no. 137, (August 1976), p. 7.

[3]Walters, p. 3.

[4]Trezise, p. 18.

The various findings bring to light two important points. First, a reserve is needed and, second, depending on what the reserve is expected to accomplish, the level would need to be somewhere between 30 to 60 million metric tons.[1]

There are advantages and disadvantages involved in choosing the size of a grain reserve. The larger the reserve the more difficult it is to manage. Storage cost is also greater. The bright side is, with a larger reserve, price fluctuations can be reduced greatly. On the other hand, the smaller the reserve, the easier it is to manage but the greater is the degree of price instability, given swings in production.

Composition of a Grain Reserve

The basic grain cereals -- wheat, rice, corn, oats, barley, and grain sorghum -- are considered the commodities appropriate for storage.[2] However, wheat and coarse grains are the major commodities used to build a reserve. Of the two, wheat shows greater substitutability for food or feed usage. It can be utilized as a substitute for rice as a food grain. Likewise, it can be used as a substitute for coarse grains to feed poultry and livestock. For this reason, there have been arguments for building a reserve made up entirely of wheat.

Whitacre and Schmidt[3] did not perceive an all-wheat reserve to be advantageous in the long run. Initially, a wheat reserve would be able to constrain a sharp rise in prices following widespread crop failure.

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[1] Walters, p. 4.

[2] Stein and Smith, p. 1.

[3] Whitacre and Schmidt, p. 8.

However, since there would be a change in the wheat and coarse grains price relationship, it could result in increased wheat feeding to livestock. This would trigger an increase in demand for wheat and would contribute to an increase in wheat prices.

Rice, which is the principal food of most developing countries, seldom plays an important part in the systematic build-up of a reserve. There are reasons for this. Though rice has accounted for about a quarter of the volume of exports of cereals throughout the world, there are very few developing countries which generate exportable surplus. Also, rice has been declining sharply as a component of world trade in cereals. Furthermore, rice has a shorter storage life than other cereals and the cost of holding stocks in excess of working inventories would be substantial.[1] But we must not rule out the possibility of stockpiling rice in the future.

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[1]Trezise, p. 6.

CHAPTER V

COST OF HOLDING A GRAIN RESERVE

Maintaining grain stocks entails money. In general, the cost of holding stocks will depend on the quantities of stocks and the length of time they are held.[1] The major costs incurred are storage, handling, and interest reflecting the return on the investment in inventory.

David J. Eaton[2] regarded reserve costs as the commitment of real resources in producing and storing grain. Costs include the expenses of growing grain, capital costs of a grain reserve, operation and maintenance costs of the stocks facility, and charges for loading or unloading grain reserves.

Jones estimated that a stock of 42 million metric tons of wheat, 41 million metric tons of coarse grains, and 1 million metric ton of rice covering shortfalls during the 1960-73 period would have an annual cost of $1.41 billion. On the other hand, stocks sufficient to meet anticipated world deviations from trend, with 95 percent probability that stocks would be adequate, would cost $1,510 million. His cost estimates are based on $2.35/bushel of corn, $3.50 for wheat, and $8.00 per hundred weight of rice. Annual storage and interest costs were assumed to be 15 percent of acquisition.[3]

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[1]USDA, The World Food Situation and Prospects to 1985, p. 45.

[2]David J. Eaton, p. 62.

[3]Jones, Grain Reserves in Agricultural and Food Policy, p. 14.

A target of 30 million metric tons each of wheat and coarse grains would cost the United States government $640 million dollars. This was based on buying prices averaging $110.0 per ton for wheat and $100 for coarse grains. Interest charges were assumed to be 3 percent, while storage (including recycling) was computed at $7.50 per ton.[1]

A USDA study arrived at an estimated $500 to $800 million worth of reserves to cover the world's shortfalls in grain production.[2] Interest and storage charges were assumed to be $10.00 per ton.

A 22 million metic ton wheat reserve would cost about $300 million annually; 30 to 40 million metric tons of coarse grains and wheat, $400 to $600 million annually.[3]

Scott Steele estimated that a reserve of 60 million metric tons would have a total storage cost which could range from about $600 million to $1,200 million a year. These costs are exclusive of the cost of acquiring the grain which could be recovered when the grain is released from stocks.[4]

These figures are only estimates of how much it would cost to hold a given level of reserve. No amount could be singled out from the studies cited because each one had their respective assumptions.

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[1]Trezise, p.38.

[2]USDA, The World Food Situation and Prospects to 1985, p.45.

[3]Terry Sharples and Rodney Walker, "Grain Reserves: Price Instability and the Food Supply", Agricultural-Food Policy Review, (January 1977), cited by Walters, p. 5.

[4]Scott Steele, Toward a World Grain Reserve Policy, pp. 12-13.

But one thing is certain from the above discussion-- reserves are not costless. In fact, they cost millions of dollars.

In the past, the cost of stockpiling was allocated to consumers through the tax system.[1] However, since countries are benefited by stable prices several studies have suggested that they share the cost.[2]

The estimation of costs can be specified to a world reserve, regional reserve , or in-country reserve. Phillips and Jeon arrived at annual costs that could be incurred by ASEAN nations if they were to maintain in-country and regional reserves of rice or all food grains.[3] A more detailed discussion of the study is found in Chapter IX of this report.

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[1]U.S. C ngress, 1975 US Agricultural Outlook, p. 44.

[2]Trezise, pp. 38-41. Also, Morrow and Steele, p. 5.

[3]Richard Phillips and Doyle Jeon, "Simulating the Impact of Alternative Food Reserve Programs: The ASEAN Case", Journal of Rural Development, Vol.3, (April 1980), pp. 98-100

CHAPTER VI

WHO SHOULD HOLD AND CONTROL THE RESERVE?

The major exporting countries, particularly the United States and Canada, have been the world's major grain stockholders.[1] In 1961, 109 million metric tons of wheat and coarse grains, which constituted over 60 percent of total world carryover grain stocks, were held under U.S. government loan and storage programs. This large holding of stocks in North America meant that other grain producing and importing countries were not required to keep stocks much above working levels.

As a result of the food crisis of the early 1970's, U.S. government stocks were depleted. Beginning U.S. grain stocks for 1974-1975 were estimated to be about 27 million metric tons, down from 41 million metric tons a year earlier.[2]

With the efforts toward rebuilding grain stocks various alternatives regarding management and control of reserves were suggested.

This chapter presents the major alternatives and their corresponding implications as proposed by economists and policymakers.

Reserve Stocks Managed by the Private Sector of the Economy

Under this alternative, producers and processors would have

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[1]Scott Steele, Toward A World Grain Policy, Unpublished, p. 1.

[2]USDA, The World Food Situation and Prospects to 1985, p. 45.

ownership and control of reserves. They would make the managerial decisions on how much to store and when to sell or buy. This would essentially be a free market system with little government intervention.[1]

Some objections to this type of reserve have been forwarded. It has been argued that the private sector will adjust their stockholding positions to their expectations of the financial advantages of holding stocks.[2] Producers will only hold grain if they expect its price to rise more than enough to cover storage costs. It is quite unrealistic to believe that when producers think the price will rise that they will sell grain to stabilize prices. In the same manner, if processors believe prices will rise they will build-up reserves but only to protect themselves. If they believe prices will fall, it is difficult to believe that they will buy more grain than needed for operation just to stabilize prices. It is for these reasons that government incentives to the private sector to hold reserves may be necessary. These incentives could be in the form of subsidized interest rates for construction of storage facilities and for covering costs of carrying grain.[4]

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[1]Lutgen and Peterson, p 15.

[2]Daniel T. Morrow and Scott Steele, "Toward A Food Reserve System," given at the International Studies Association Meeting, Washington, D.C., February 24, 1978, p. 15.

[3]Lutgen and Peterson, p.15.

[4]Jones, Grain Reserves in Agriculural and Food Policy, p. 20.

A government subsidy or loan arrangements could also be used to obtain the desired participation from the private sector.[1]

Another objection that arises concerning this type of reserve is that it may not possess the size, the capacity, or the design to deal with major grain gluts or shortages.[2] It is also argued that there is a great possibility that producers and processors will under or over hold reserves because of inadequate market information and lack of organization.[3] Furthermore, the stocks agency would not have sufficient control over stocks and could not call on them in time of need. This could be overcome somewhat by making loans available only to those who would agree to deliver grain when it is needed.[4]

Costs involved in administering, storing, and maintaining a privately held grain reserve is lesser compared to the other alternatives such as reserves held by importing and exporting countries, reserves controlled by an international organization, etc,. These costs will either be passed back to producers in the form of lower prices or forwarded to consumers in the form of higher prices. In other words, costs of storage will be shared by producers and consumers.[5]

Reserve Program Administered by the U.S. Government

This particular type of food reserve program would be established and administered by the federal government and paid for by the taxpayer.

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[1] Scott Steele, "Grain Reserves as a Solution to Unstable Markets", presented at the Session of the Society of Government Economists, Southern Economic Association Annual Conference, Atlanta, Georgia, Nov. 1976, p. 10.

[2] Cochrane, Martin, and Spitze, p. 97.

[3] Lutgen and Peterson, p. 15.

[4] Jones, Grain Reserve in Agricultural and Food Policy, p. 20.

The program would operate in such a way that reserve stocks are placed on domestic markets when a shortage is causing prices to rise above the acceptable range. During periods of overproduction and falling prices, stocks would be removed from the market and reserves are rebuilt.[1]

It is suggested that a reserve program of this kind be controlled by a Federal Board appointed by the President subject to approval of Congress. Congress should establish rules on how the Board would operate for acquiring and releasing grain.[2]

Lutgen and Peterson reported four consequences of reserves managed by the Federal Government:[3]

1) American consumers are assured of a more stable supply of food;

2) if managed properly, such reserves could reduce price instability and protect consumers from rapid food price inflation ;

3) the United States could again end up as a food warehouse for the world with storage costs paid by American taxpayers; and

4) large reserves will have a price depressing effect on the market.

Reserves Held by Importing and Exporting Nations

Walters asserts that there is a general agreement among economists that all countries (at least the major exporters and importers) should participate in a reserve.[4]

The United States could take the lead role in encouraging other

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[1]Lutgen and Peterson, p. 16.

[2]Jones, A Grain Reserve Program, p. 16.

[3]Lutgen and Peterson, p. 16.

[4]Harry Walters, p. 4.

countries to establish their own reserves. Cochrane, Martin, and Spitze[1] proposed an arrangement wherein the "US would operate unilaterally a grain reserve program with, say, half the capacity to stabilize world grain prices that is, a grain reserve that averaged 40 million metric tons in size. To this proposed reserve program would be attached a network of long-term bilateral agreements:

> . . . Under the provisions of such an agreement the United States would guarantee to supply the customer nation at all times its historic import quantity of grain, plus some agreed upon growth factor, at a price no higher than the upper limit of the price stabilization band in effect in the domestic U.S. economy.
>
> . . . In turn the customer nation would agree to build a grain reserve consistent in size with the grain utilization in its economy and operate that reserve program in accordance with the rules of U.S. reserve program.
>
> . . . Countries that did not enter into long-term grain agreement with the U.S. would not be permitted to purchase grain when the market price reached the upper limit of price stabilization band. As long as market prices in the U.S. fluctuated within the defined price stabilization band, all countries would be free to purchase grain from the United States.

The advantages of the program according to its proponents are several in number:

1) First, the U.S. could launch this world wide program unilaterally. It need not wait for approval in an international negotiating conference.

2) As the number of this particular kind of bilateral grain agreements

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[1] Cochrane, Martin, and Spitze, pp 101-102.

increased, so would the probability of achieving increased stability in the world market.

3) Importing nations would share in the cost of building and operating a grain reserve program with the capacity to stabilize the world grain market.

4) Such development would recognize U.S. grain exports and contribute to rational planning of annual grain production.

Lutgen and Peterson pointed out that a reserve held by importing and exporting nations would do the following:[1]

> . . . Reserves would be less subject to domestic political pressure and, therefore, have less potential for depressing product prices...
>
> . . . Food reserves would be closer to points of consumption if shortages occur...
>
> . . . Each country would manage and control its own reserves in deciding the amount and when reserves should be released.

There are, however, opposing opinions regarding this type of a reserve.[2] First, the development of a network of bilateral grains agreements would further increase the amount and degree of governmental intervention in the domestic and international economies. Second, the purpose of the agreement procedure is to discriminate among foreign buyers.

Reserves Controlled by an International Organization

The acquisition and distribution of food reserves could be

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[1]Lutgen and Peterson, p. 16.

[2]Cochrane, Martin, and Spitze, pp.102-103.

handled by an international organization.[1] The organization could be made up of major exporting countries as well as the largest importing countries who share common interest in the stability of world grain prices.[2]

Under this alternative, the responsibility of holding reserves and bearing the costs would be shared among participants.[3] The program could be financed by contributions in kind from food exporting countries. Size of reserves, amount of contribution, and recipient's eligibility requirement would be established by agreement within the framework of the international organization.[4]

A good example is the United States proposal for an international grain system which embodies all the important details in establishing an internationally held grain reserve.

One advantage of this type of reserve over the other alternatives is its ability to respond quickly to alleviate human hardships caused by unpredictable calamities. However, common to all international organizations are complex administrative, political, and diplomatic problems which cannot be avoided.

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[1]Lutgen and Peterson, p. 17.

[2]Lewis Gulick, "The U.S. Proposal for an International Grain Reserve System", in the World Food Problem and U.S. Food Politics and Policies: 1972-1976, ed. Ross B. Talbot, (Ames, Iowa: Iowa State University Press, 1977), p. 230.

[3]W. Scott Steele, "Alternative Approaches to Stabilizing International Markets", Southern Journal of Economics, July 1978, Vol. 8, pp. 60.

[4]Lutgen and Peterson, p. 17.

Food Reserves Managed by a Combination of Methods

Reserves, on the other hand, could be held or controlled using a combination of the four approaches. As Lutgen and Peterson proposed, the private sector could control the immediate or shortrun reserves that would be stored on farms and by processors. These groups would make the managerial decisions as to storage and marketing. However, during periods when rising or falling prices are beyond an acceptable range, the government could then step in to buy or sell commodities, depending on the given situation. The Food and Agricultural Organization could also initiate establishment of a contingency reserve which would be released only to meet temporary food needs after natural or man-made disaster while governments of other countries would establish and maintain their own reserves.[1]

[1] Lutgen and Peterson. p. 17.

CHAPTER VII

WHERE SHOULD STOCKS BE HELD?

Traditionally, grain stocks have been held mainly in exporting countries. These countries have developed grain storage capacity and the marketing, administrative, and organizational mechanisms to handle the storage and shipment of large quantities of grain.[1] Trezise[2] stressed that the location of stabilization stocks - in a wholly rational scheme with all contingencies foreseeable, would be decided on the basis of the costs of storage. Considering the availability of storage facilities and climatic conditions, he further stated that "most stocks probably should be physically situated in the exporting countries." These stocks would belong to the countries financing their acquisition and storage, just as though they had literal possession of them. The storage cost advantage would be the determinant.

However, a variety of reasons might lead some countries to take physical control of stocks allocated to and financed by them,[3] e.g., concern about future transport costs, political attitudes at home, even uncertainties about the reliability of guarantees that stocks held abroad could be recaptured in an emergency.

On the contrary, Scott Steele feels that "while it may be desirable

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[1] Daniel T. Morrow and W. Scott Steele, p. 13.

[2] Trezise, p. 47.

[3] USDA, The World Food Situation and Prospects to 1985, p. 45.

for larger stocks to be held in countries such as the USSR and those countries on the Asian subcontinent, where shortfalls in grain production are likely to occur, physically locating grain stocks in a large number of places would greatly complicate the problem of mobilizing reserve supplies if a serious need arose."[1]

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[1] Scott Steele, Toward a World Food Grain Reserve Policy, p. 13.

CHAPTER VIII

BENEFITS FROM A GRAIN RESERVE

Is the cost of holding a reserve justified by its benefits? Some studies say it is. For example, Trezise considered the expenses incurred in acquiring stocks as a profitable investment, not as a cost. Maintaining consumption at higher levels than would otherwise be possible is a direct compensation. Even more important are returns in the form of more efficient agriculture and higher levels of economic activity for the world as a whole as a result of more stable prices.[1]

What is more interesting to note is the debate over who gains and who losses when grain is withdrawn from or released into the market to stabilize prices. Basically, grain reserves are established in the interest of producers and consumers, including exporting and importing nations, processors, and livestock growers. However, the benefits obtained are not proportionally distributed among each sector. In some instances, producers benefit more than consumers and vice-versa, or it may be the case that exporters lose while importers gain.

Jones reported that while stocks are being acquired, grain producers would benefit through higher prices while consumers lose paying higher prices. With price stability, consumers gain but would pay the cost of holding buffer stocks through tax payments. Farmers that can survive price fluctuations tend to gain less from stable prices relative to highly variable prices. On the other hand, there are offsetting gains

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[1]Trezise, p. 37.

to farmers provided by expansion in foreign demand. Exporters too, would lose from stability provided by a reserve while importers gain.[1]

Roger Gray believed that a reserve program is more likely to be in the consumer's interest than in the producer's. Similarly, importers gain and exporters lose and therefore suggested that importers should pay for the reserves to which they have access contrary to the arrangement ending in 1972 under which the **United States** was the residual supplier to the world, out of reserves maintained at U.S. expense.[2]

Reutlinger, Eaton, and Bigman,[3] using a stochastic simulation[4] model, estimated the gains and losses from a reserve. The results showed that farmers gain when grain is put into storage. The gain was measured by multiplying domestic production by the difference between the price without and with storage. The country's farmers lose when grain is taken out of storage. The loss is measured by multiplying domestic production by the difference between the price without and with storage. Consumers also gain when the quantity of domestic grain production is supplemented with grain out of storage. The gain is measured by multiplying average

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[1]Jones, Grain Reserves in Agricultural and Food Policy, p. 21.

[2]Roger Gray, "Grain Reserve Issues", 1975 U.S. Agricultural Outlook, (Washington, D.C.: U.S. Government Printing Office for the Committee on Agriculture and Forestry, U.S. Senate,1974), p. 44.

[3]Reutlinger, Eaton, and Bigman, "Should Developing Nations Carry Grain Reserves?", Analysis of Grain Reserves: A Proceeding, com., Eaton and Steele, pp. 17-18.

[4]Stochastic Simulation Model is a method of transforming a probability distribution of one or several variables into the probability distribution of one or several variables into the probability distribution of one or many other variables. This model transforms world and LDC grain production distributions of the multiple criteria for evaluating trade or storage policies.

consumption (without and with storage) by the difference in price. They lose when grain is withdrawn from the market for storage. The loss is measured by multiplying the average consumption by the price change.

A similar result was obtained by G. Meir [1] using simple economic theory. In this approach, benefits (losses) to producers are increased by the additional (lessened) revenue they receive; and the benefits (losses) to consumers are measured by the additional (lessened) consumer surplus [2] they receive.

However, without empirical knowledge concerning long-run movements, the shape of supply and demand curves, risk aversion, the elasticities, and the causes of shifts, the impact of price stabilization on producer's revenue and consumer's welfare cannot be determined. There are a variety of demand and supply curve specifications. Likewise, their elasticities can vary from perfectly elastic to perfectly inelastic. In this particular example, the supply curve is assumed to be linear, is equally likely to be at Q_1 or Q_2 (Fig. 1). Assume, further a fixed demand curve and the only source of instability is the shifting supply curve. P_0 is the average price and the one at which the buffer stock stabilizes the price when it is in operation. When supply increases to Q_1, buffer stock purchases Q_1-Q_0 units. The change in consumer surplus due to paying P_0 instead of P_1 that would have prevailed without a buffer stock is negative, -A -B -C. The producer's revenue gain due to higher prices

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[1] G. Meir, International Trade and Development, n.p., pp. 37-38.

[2] Consumer surplus is measured by the sum for all units of a commodity of the difference between what consumers would be willing to pay for each unit and what they have to pay.

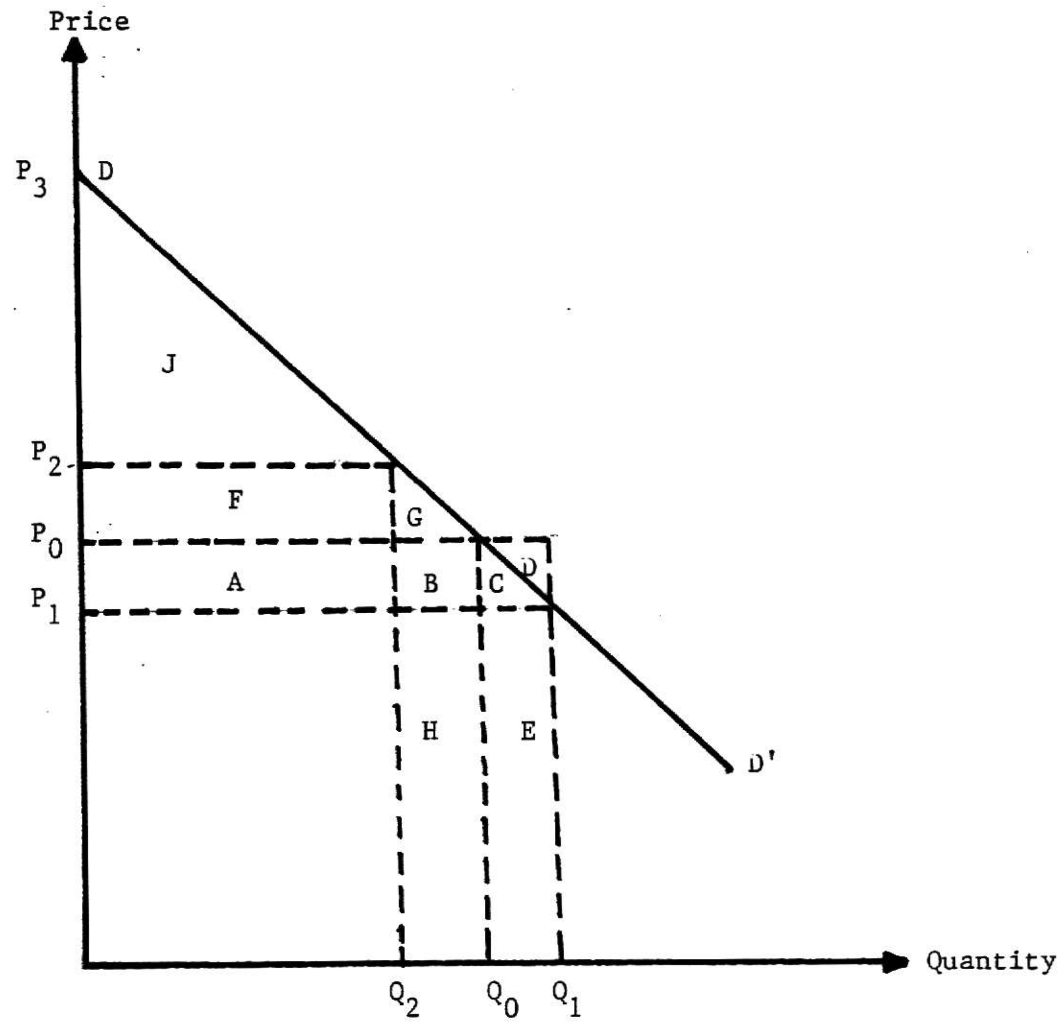

Figure 1: Gains and Losses from Storage Operation

is positive A +B +C +D. The cost to the buffer stock by buying Q_1-Q_0 units is -C -D -E. The total benefit is -C -E.

A shift of the supply curve to Q_2, would require the buffer stock to sell Q_0-Q_2 units at price P_0. This prevents the price from rising to P_2. The benefit to the consumers is F+G due to the lower price and the larger quantity while the benefit to producers is -F since they receive a lower price for their Q_2 units than they would without the buffer stock. By selling Q_0-Q_2 units the buffer stock receives the amount B + H. The total benefit is B + G + H.

According to Bigman and Reutlinger,[1] the gains and losses from buffer stocks to society and their distribution among consumers, producers, and the government depend largely on the difference between the price of grain with and without stock operation. The results of their combined study are summarized in Table 9. It is important to refer to 2 and 3 for the designated areas.

[1]David Bigman and Sholomo Reutlinger, Food Price and Supply Stabilization: National Buffer Stocks and Trade Policies, (paper is part of an extensive study undertaken by the World Bank(RPO 671-24), pp. 661-662.

Table 9

Gains and Losses When Grain is Stored and When Grain is Withdrawn From Storage

Types of Gains and Losses	Designated Area of Gain or Loss
Grain into storage (Figure 2)	
Consumers	- A - B
Producers	A + B + C
Government (financial)	- B - C - D
Overall (economic)	- B - D
Grain withdrawn from storage (Figure 3)	
Consumers	F + G
Producers	- F
Government (financial)	H
Overall (economic)	G + H

Source: David Bigman and Shlomo Reutlinger, "Food Price and Supply Stabilization: National Buffer Stocks and Trade Policies", American Journal Of Agricultural Economics, (November, 1979).

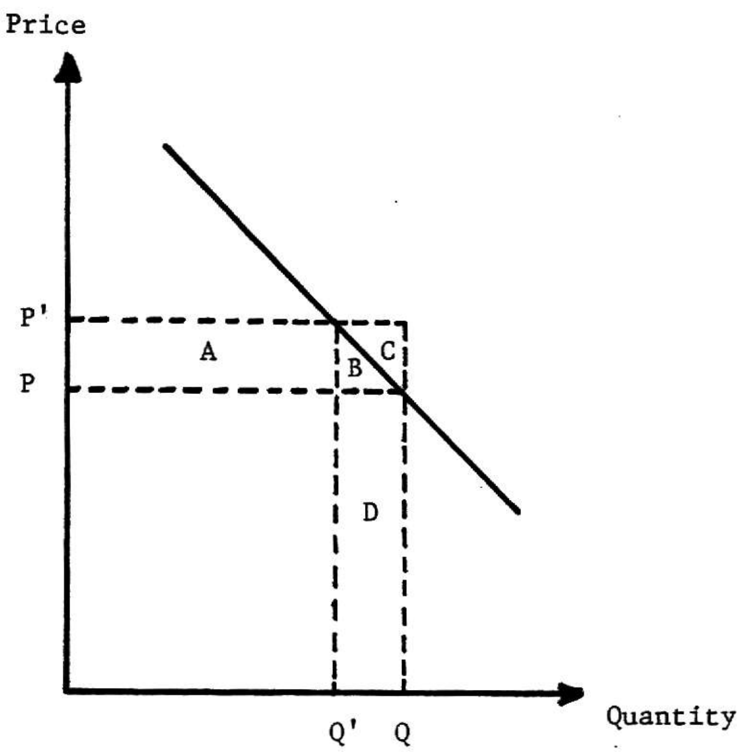

Figure 2. Gains and losses from storage operation: grain into storage.

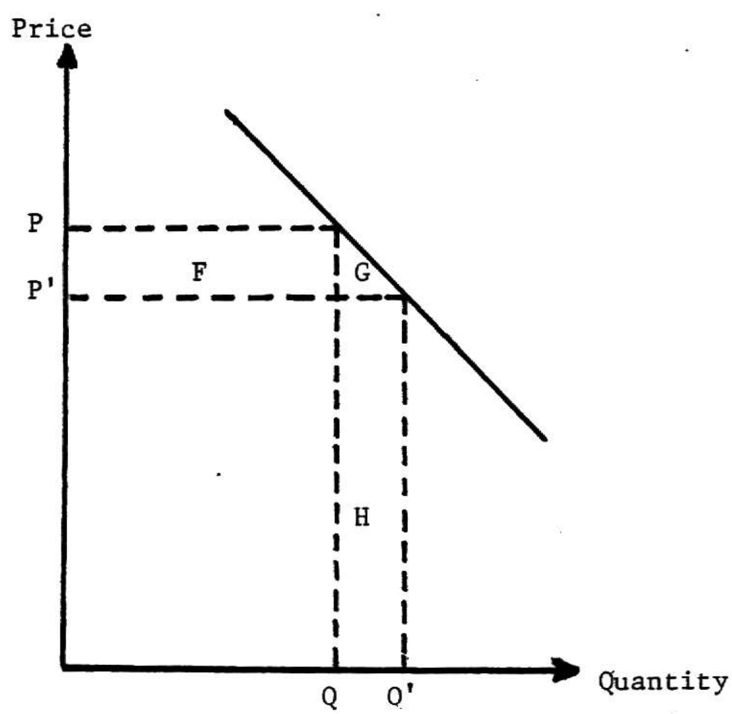

Figure 3. Gains and losses from storage operation: grain out of storage.

CHAPTER IX

APPLICATION OF GRAIN RESERVES TO A DEVELOPING COUNTRY

Price instability and chronic shortages in food and feed grains have been a world concern since the early years of the 1970's. The numerous literature written concerning these world problems have focused mainly on the building of a world grain reserve as a solution. Few studies were written on individual country reserves as well as regional reserves. While there are agreements on the advantages of establishing a world grain reserve, the importance of a national or regional reserve cannot be ruled out. In fact, these kinds of reserves, especially regional and in-country reserves of developing countries, can be used to complement world reserves.

There are several types of grain reserves, depending on the purposes for which they are established. In many cases, terminologies for a specific type differ from one author to another causing confusion among readers. This report identifies five types of grain reserves of developing countries according to their functions:

a) National Security Reserves can either be stocks held to supply direct government demand by the armed forces and other government institutions or stocks held to protect against the uncertainty of war or major disaster.

b) Buffer Stocks are stored grains to support seasonal price stabilization (price support to producers and price control for consumers).

c) Food Security Reserves are reserves to stabilize year-to-year variations in quantities and prices for consumers and producers.

For developing countries, availability of food at all times to avoid the danger of mass starvation is a major objective. Effectively meeting the daily food grain requirements of their people is a large and priority task for most of these countries. This task, however, has never been easy given the unpredictable variation in food grain supplies from year to year.

An effective food security program can help the developing countries attain this goal. To operate successfully, the appropriate size, type, and location of storage facilities must be determined. Also, the costs and benefits from establishing such a food reserve must be available.

Measuring Needs For Security Reserves

Phillips and Jeon[1] have developed a methodology to determine the size and costs from food reserve stabilization activities. This is based upon the historical patterns of food grain production, international trade, and utilization as they have existed within a nation. The methodology is outlined as follows:

Step 1A. Develop supply-utilization balance sheets by crop year for major grain in each country such that the total supply quantity, Q equals the total quantity utilized, U:

(1) $Q_{ijk} = U_{ijk}$,

for crop year (i), specific grain (j), and country (k).

For each ijk, total supply quantity, Q, is the sum of the quantities available from each source:

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[1]Richard Phillips and Doyle Jeon, pp. 86-97.

(1B) $Q = Q_1 + Q_2 + Q_3$, where

Q_1 = beginning inventory at the start of the crop year

Q_2 = domestic production during the crop year

Q_3 = net imports during the crop year (if exports of the grain of concern exceeds imports, Q_3 is negative).

Likewise, for each ijk, total quantity utilized, U, is the sum of the quantities absorbed by each use:

(1C) $U = U_1 + U_2 + U_3 + Q_4$, where

U_1 = on-farm disappearance (seed loss, animal feed)

U_2 = total consumption for food

U_3 = total industrial utilization

Q_4 = ending inventory at the close of the crop year

The quantities available from each specific source and those utilized in each specific use from Equations 1B and 1C are substituted into Equation 1A to form the basic supply-utilization equation. Thus, for each ijk:

(1) $Q_1 + Q_2 + Q_3 = U_1 + U_2 + U_3 + U_4$

Step 1B Convert the balance sheets from Step 1A to a common denominator, g, (for example, milled rice equivalent), by applying appropriate conversion factors for each ijk. Thus, Equation 1A becomes $Q_{igk} = U_{igk}$, and comparable summation is made for Equation 1.

Step 1C For cases where the concern is for reserves of total food grains, sum across the g's for each ik combination from Step 1B to obtain the equivalent quantities of total food grains, f, in terms of the common denominator, such as milled rice. Thus, Equation 1A becomes $Q_{ifk} = U_{ifk}$, and comparable summation is made from Equation 1. For cases where other types of grain reserves may be of interest, (total feed grain reserves, etc.), corresponding summations are made for such uses other than solely for human food.

Step 2 For the specific type of utilization of concern reorder Equation 1 to focus on the historical quantities available. For example, where the concern is food supply quantities Equation 1 is reordered for each ijk, or ifk as follows.

(2) $U_2 = Q_1 + Q_2 + Q_3 - U_1 - U_3 - U_4$

Step 3. Convert the total quantities for U_2(or other utilization of concern)to the equivalent quantities available per capita over historical period in each country. The corresponding per capita quantities in Equations 1 and 2 can be designated by the lower case q and u, respectively, and obtained by dividing these total equations through by the appropriate total human population figures, H_{ik}. Thus, for each ijk, igk, and ifk, the corresponding per capita quantities are defined by:

(3) $q_1 + q_2 + q_3 = u_1 + u_2 + u_3 + u_4$, and

(4) $u_2 = q_1 + q_2 + q_3 - u_1 - u_2 - u_3 - u_4$.

Note: Accurate annual mid-year population figures are required for the conversion; source population data should be checked carefully.

Step 4. Fit statistical time trends to the historical per capita quantities of the u_{ijk} (or q_{igk}) of concern, using suitable regression equations. Thus, over the relevant historical period, a set of trend estimates, q and u, is developed for each quantity in Equations 3 and 4 which is of interest. Linear trend estimates often are suitable for the per capita quantities, but in individual cases logarithmic or exponential equations may be needed. The trend estimates are fitted by the method of least squares to the historical quantities, estimating the per capita quantity as a function of time, i. The linear estimating equation is simply:

(5) $q_i = a + b_i$

Other common time trend equations include the natural logarithmic functions.

(6A) $\log_e q_i = \log_e a + \log_e b_i$,

and exponential functions,

(6B) $q_i = a + b(i)^x$, where x is some power greater or less than 1.0.

In lieu of time trends, more complex multi-variable estimating equations may be used to reflect such factors as anticipated changes in relative real prices of alternative food grain, and changes in the anticipated rate of growth in real per capita incomes. Even though the concern in this analysis is not with estimates, per se, but rather in the pattern of deviations from the estimates, still the more complex estimators may yield more accurate results in some cases. If more complex estimators have been developed for other kinds of economic planning, then their use also for this purpose is recommended.

Step 5. Determine for each crop year the deviations from trends in available per capita quantities. Thus,

(7) $\dot{q}_{ijk} = \hat{q}_{ijk} - q_{ijk}$, and $\dot{u}_{ijk} = \hat{u}_{ijk} - u_{ijk}$, where

q and u = observed quantities

$\hat{q}$ and $\hat{u}$ = estimated quantities

$\dot{q}$ and $\dot{u}$ = deviations from trend, plus or minus; ijk subscript identifies the crop year, the grain, and the country, as before.

Step 6. Convert the per capita deviations from the above step to the corresponding total tonnages for each country by applying the appropriate total population figures. Thus,

(8) $\dot{Q}_{ijk} = \dot{q}_{ijk} * H_{ik}$, and $\dot{U}_{ijk} = \dot{u}_{ijk} * H_{ik}$

Step 7. Compute the corresponding deviations which are in excess of that acceptable were a security reserve program is in operation. Thus,

(9) $\ddot{Q}_{ijk} = \dot{Q}_{ijk} - Q'_{ijk}$, and $\ddot{U}_{ijk} = \dot{U}_{ijk} - U'_{ijk}$, where

$\ddot{Q}$ and $\ddot{U}$ = excess deviations = needed annual transactions with reserves

$\dot{Q}$ and $\dot{U}$ = observed deviations (from Step 6)

Q' and U' = acceptable deviation levels, as determined exogeneously.

Note: Given the trend and deviation patterns, the wider the range of acceptable deviation from trend, the lower the security reserve requirement, and vice-versa.

Step 8. Define the need for annual transactions with security reserves as the tonnages, $\ddot{Q}$ and $\ddot{U}$, for each basic grain in each country each year. If such potential transactions are designated as RT, then Equation 2(above) can be stated as:

(10) $U_2 = Q_1 + Q_2 + Q_3 - U_1 - U_3 - RT$, where

$RT = \ddot{Q}$, or $RT = \ddot{U}$

In years when additional supplies are needed for consumption, withdrawals are made from the reserves (RT is negative), so that the sign for the last term in Equation 10 becomes +; in years when current supplies are greater than needed for consumption, additions are made to the reserves(RT is positive; in years when total supply quantities are in balance with total utilization requirements no transactions are made with the reserve(RT is zero).

Step 9. Determine reserve stock levels and net reserve transactions for economic and acceptable levels of security reserves for food grains within each country over the historical test-period. For each ijk, establish realistic bounds on in-country reserve levels, and compute the possible reserve transactions subject to these bounds, as follows:

(11) RT1 = RT, provided $L1 \leq RB1 \geq M1$, where

RT_{ijk} = total reserve transactions, as above
$RT1_{ijk}$ = transactions with in-country reserves
$RB1_{ijk}$ = balance in in-country reserves
$L1_{ijk}$ = lower limit for in-country reserve levels
$M1_{ijk}$ = maximum limit for in-country reserve levels

Furthermore,

(12) $RB1_i = RB1_{i-1} + RT1_i$

This is a simultaneous computation, with RB1 as a function of RT1, subject to constraints on RB1.

Step 10. Determine the indicated residual transactions with regional reserves by each country in order to meet the targeted stability level in that country. Following Equation 11, this is done for each ijk subject to bounds on the regional reserves as follows:

(13) RT2 = RT - RT1, provided $\sum_k L2 \leq RB2 \geq \sum_k M2$, where

RT and RT1 are identified as above
$RT2_{ijk}$ = transactions with regional reserves
$RB2_{ijk}$ = balance in regional reserves
L2 and M2 = represent the limit on stock levels in regional reserves.,

Likewise, following Equation 12

(14) $RB2_t = RB2_{t-1} + RT2_i$

Step 11. If residual needs for further reserve transactions to meet targeted levels stability still remain from the above step, the analysis can be extended to a still higher level of world-wide reserves, RT3 and RB3, following the procedures outlined above. Thus, corresponding to Equations 13 and 14

(13') RT - (RT1 + RT2), provided $\sum_k$ L3 $\leq$ RB3 $\geq$ $\sum_k$ M3, and

(14') $RB3_i = RB3_{i-1} + RT3_i$.

These steps can be repeated for as many alternative configurations, targeted stability levels and constraint levels for reserve stocks as may be needed to support planning decisions by officials in each country and region.

Step 12. Determine the potential-adjustments in international trade to stabilize supply quantities in each country, using the relevant historical data from the above steps as base. This requires realistic determination of (1) the date within the crop year by which accurate estimates of domestic production, $Q1_i$, can be known, and (2) the time lag required for completing delivery of adjusted transactions in international trade. These two factors determine the fraction of the indicated adjustments which can be achieved during the same crop year, F1 and the fraction that will not be effective until the following crop year, F2.

Given this information, the potential adjustments in international trade are computed from the excess deviations in the historical quantities of grains in each country, Q_{ijk} from Equation 10. For each ijk, the net quantity adjustments in international trade, A, has two components, (1) effective adjustments for the current crop year, $A1_i = F1{*}Q_t$ plus the carryover adjustment for the previous crop year, $A2_i = F2{*}Q_t{-}1$. This time lag gives rise to the possibility of additional trade adjustments to offset lastyear's adjustment equation:

(15A) $A_i = F1{*}Q_i + F2{*}Q_i{-}1$, becomes
(15B) $A_i = F1{*}(Q_i + A2_i{-}1) + F2{*}(Q_i{-}1 + A2_i{-}2)$, or
(15C) $A_i = F1{*}Q_i + (Q_t{-}1{*}F2) + F2\ Q_i{-}1 + (Q_i{-}1{*}F2)$.

It will be noted that as F1 approaches 1.0 (F2 $\rightarrow$ 0.0), trade adjustments approach excess deviations, except with opposite sign. As F2 approaches 0.0 (F1 $\rightarrow$ 1.0), trade adjustments may exhibit far greater frequency and amplitude than the excess deviations they are designed to overcome.

Step 13. Define the need for transactions with security reserves after adjustments in international trade by each country. Thus, Equation 10 from Step 8 becomes:

(16) U2 = Q1 + Q2 + Q3 +A - U1 - U3 - U4 - AT,
AT = Q - A, where
A = net adjustment in international trade as specified be Equation 15
AT = annual transactions with security reserves after trade adjustments.

Note that if $AT \rightarrow 0$ through time, then there is no need for food security reserves if full advantage is taken of potential adjustments in international trade by each country.

Step 14. Determine the required stock levels and net reserve transactions for each country after trade adjustments. This step parallels Step 9 so that for each ijk Equations 11 and 12 become:

(17) $AT1 = AT$, provided $L1 \leq AB1 \geq M1$, given

(18) $AB1_i = AB1_{i-1} + AT1_i$, and where

AT = as identified in Step 13

AT1 = transactions with in-country reserves after trade adjustments

AB1 = balance in-country reserves after trade adjustments

L1 and M1 = limits on stock levels for in-country reserves, as in Step 9.

Step 15. Determine the indicated residual transactions with regional reserves after trade adjustments by each country in order to meet the targetted stability levels in that country. Following Equation 13 this is done for each ijk subject to bounds on the regional reserves as follows:

(19) $AT2 = AT - AT1$, provided $\sum_k L2 \leq AB2 \geq \sum_k M2$, given

(20) $AB2_i = AB2_{i-1} + AT2_i$, and where

AT and AT1 are identified as in Step 14

$AT2_{ijk}$ = transactions with regional reserves after trade adjustments

$AB2_{ijk}$ = balance in regional reserves after trade adjustments

L2 and M2 = represent t - e limits on stock levels in regional reserves, as in Step 10.

Step 16. As in the case of Step 11, if residual needs for further reserve transactions to meet targeted levels of stability still remain from Step 15, comparable analysis can be extended to a still higher level of world-wide reserves (after international trade adjustments), AT3 and AB3, following the procedures outlined in Step 15. Corresponding to Equations 19 and 20 are:

(19') $AT3 = AT - (AT1 + AT2)$, provided $\sum_k L3 \leq AB3 \geq \sum_k M3$, and given

(20') $AB3_i = AB3_{i-1} + AT3_i$.

III. Measuring Cost - Effectiveness of Alternative Schemes

Step 17. Compute the annual fixed costs for maintaining the required grain storage capacity for in-country security reserves. If this capacity is assumed to be committed for security reserves and not available for alternative use, the annual fixed cost is defined for each ijk as,

(21) $FC1 = RC1 * K1 * fc1$, where

FC1 is the total annual fixed cost of in-country storage facilities for security reserves.

K1 is the appropriate constant for converting from milled rice equivalent to the form in which the grain would be stored in the reserve.

fc1 is the annual fixed cost per metric ton for the in-country storage facilities.

The required storage capacity is determined directly from the in-country reserve balances given from Equation 12 by the following:

(12) $RC1_i = RB1_i$ or RB_{i-1}, whichever is greater.

The per unit annual fixed costs for maintaining in-country reserve storage are given by the following;

(21') $fc1 = fca + fcd + fcc + fcm + fco$, where

fca is the annual per ton costs for administering the program, taken at \$3.00 for ASEAN.

fcd is the annual per ton facility depreciation expense, taken at \$5.00 (\$2.50 Bldgs. + \$2.50 Equip.) for ASEAN

fcc is the annual per ton charge for capital invested in the storage facilities, taken at \$7.50 (\$125/2 x 12) for ASEAN.

fcm is the annual per ton repair and maintenance cost for the storage facilities, taken at \$2.50 (\$150 x .02)/2 for ASEAN.

fco is the annual fixed cost per ton for other expenses of the storage facilities, taken at \$3.80 for ASEAN.

Step 18. Compute the annual variable cost for maintaining the required grain inventory for in-country security reserves. If such inventory is held at strategic locations so that no extra handling nor transportation is required, the annual variable cost for each ijk is defined as,

(22) $VC1 = RB1 \times K1 \times vc1$, where

vcc is the annual per ton carrying charge for grain in security reserves, taken at \$15.30 (\$150 x 10.2%) for ASEAN

vcm is the annual per ton cost for quality maintenance, taken at \$4.00 for ASEAN.

vco is the annual per ton cost for operating expense, taken at \$3.00 for ASEAN.

vcs is the annual per ton cost for grain shrinkage, taken at \$1.00 for Asean.

Step 19. Sum the annual fixed cost and the annual variable cost for the estimated annual total cost of in-country reserves. This is done by straight summation for each ijk as indicated by Equation 23.

(23) TC1 = FC1 + VC1

Step 20. Repeat Steps 17 through 19 for regional reserves. Annual fixed costs for regional storage facilities are given by Equation 24.

(24) FC2 = RC1 x K1 x fc2, where

fc2 is defined in the same manner as fc1 in Equation 21'

K1 is defined as in Equation 21

RC1, the required regional storage capacity, is determined directly from the regional reserves balances given by Equation 14 as follows:

(14') $RC2_i = RB2_i$ or RB_{i-1}, whichever is greater.

Annual variable costs for regional inventories are defined for each ijk by Equation 25.

(25) VC2 = RB2 x K1 x vc2, where

vc2 is defined in the same manner as vc1 by Equation 22'.

K1 is defined as in Equation 21.

RB2 is defined by Equation 14 and shown in Table 14. Negative balances by individual participating nations are charged at the same rate as corresponding positive balances in the regional reserves.

Annual total costs for regional reserves are obtained by summation as indicated by Equation 26.

(26) TC2 = FC2 + VC2

Step 21. Determine the combined total costs for the regional reserve program. This is done by summing the total costs for in-country reserves and the total costs for regional reserves for each ijk.

(27) CTC= TC1 + TC2

Step 22. Compare the relative total costs of alternative security reserve programs to measure the cost-effectiveness of the alternatives. The comparison varies depending upon the kinds of alternatives under analysis. Following are common examples.

The additional cost of more complete programs is obtained by subtracting the combined total costs of the two cases. Thus, for each ijk,

(28) $ATC = CTC_c - CTC_s$, where

ATC is the additional cost.

CTC_c is the combined total cost from Equation 27 for the more complete case.

CTC_s is the combined total cost from Equation 27 for the more simple case.

The magnitude of cost savings between two alternatives capable of producing the same level of benefits is obtained by subtracting the combined total costs for the two alternatives. Thus, for each ijk,

(29) $STC = CTC_2 - CTC_1$, where

STC is the saving in total cost.

CTC2 is the combined total cost for the second best alternative.

CTC1 is the combined total cost for the best alternative.

Step 23. Compute the costs of using adjustments in imports and/or exports to help stabilize food grain supplies in each country. This is done by applying the average total per ton extra cost for the adjustmnents in international trade to the calculated volumes of trade adjustments. Thus, for each ijk,

(30) CAT = AT x cat, where

CAT is the total addition cost for net adjustments in international trade.

AT is the net plus or minus adjustment in tonnage of grain imported (see Equation 15)

cat is the average total additional cost per metric ton for making the adjustments in international trade transactions. For the ASEAN case, cat is taken at $57. 69 ($25.00 x 1.5)/.65), assuming extra cost for trade adjustments of $25/ M/T, total adjustment of 1.5 M/T net adjustment, and average rice milling rate of 65 percent.

Step 24. Repeat Steps 17 through 19 for the costs of in-country reserves after net imports adjustments. Following Equation 21, annual fixed costs for in-country reserve storage facilities are given by Equation 31.

(31) FCA1 = RCA1 x K1 X fc1, where

FCA1 is the total annual fixed cost for the needed in-country reserve storage facilities after import adjustments.

K1 and fc1 are the same as defined in Equation 21.

RCA1 is the required storage capacity for in-country reserves, and is computed directly from the in-country reserve balances given in Equation 18 as follows:

(18') $RCA1_i = AB1_i$ or $AB1_{i-1}$, whichever is greater.

Following Equation 22, the annual variable costs for in-country reserves after import adjustments are given by the following:

(32) VCA1 = AB1 x K1 x vc1, where

AB1 is as defined in Equation 18 and K1 and vc1 are as defined for Equation 22.

Annual total costs for in-country reserves with import adjustments are computed by straight summation. For each ijk,

(33) TCA1 = FCA1 + VCA1

Step 25. Repeat Steps 17 through 19 for the costs of regional reserves after net import adjustments. Following Equation 21, annual fixed costs for regional storage facilities after import adjustments are given by Equation 34.

(34) FCA2 = RCA2 x K1 x fc2, where

K1 and fc2 are comparable to the corresponding variables in Equation 21.

RCA2 is the required regional storage capacity with import adjustments, as given by the Equation,

(20) $RCA2_i = AB2_i$ or $AB2_{i-1}$, whichever is greater.

Following Equation 22, annual variable costs for needed regional reserve stocks after import adjustments are computed as follows:

(35) VCA2 = AB2 x K1 x vc2, where

AB2 is as defined in Equation 20 and

K1 and vc2 are as defined in Equation 22.

Following Equation 23, annual total costs for regional reserves after net import adjustments are computed by summation. For each ijk,

(37) CTCA = CAT + TCA1 + TCA2

Step 26. Determine the combined costs for the regional reserve program with net import adjustments to help stabilize supplies in each member country. This is done by summing the total costs for adjustments in international trade, total costs for in-country reserves, and the total costs for regional reserves with trade adjustments. Thus, for each ijk,

(37) CTCA = CAT + TCA1 + TCA2

Step 27. Compare the costs of alternative regional reserve programs after net import adjustments to measure relative cost-effectiveness. Following the equations in Step 22, alternative comparisons can be made. For example, to compare the after-trade-adjustments cost of a more complete program with one which is less complete, the following equation is used:

(38) $ATCA = CTCA_c - CTCA_s$, where

ATCA is the additional total cost.

$CTCA_c$ is the combined total cost from Equation 37 for the more complete program.

$CTCA_s$ is the combined total cost from Equation 37 for the more simple case.

Findings of the ASEAN Case:

The procedure previously outlined was applied by Phillips and Jeon[1] using data from the ASEAN countries over the period 1960 through 1977. This included annual food grain supply and utilization information and aggregate human population data. The purpose of the analysis was to test the performance and estimated costs of alternative ASEAN food reserve programs had they operated during the above mentioned period. The Kansas State University's "Master Projection" computer program (MPJ) was used in this analysis. The alternatives tested were a 2x2 matrix which included 1) rice only and 2) all food grains by a) without and b) with import (export) adjustments.

The results of the study revealed that, to achieve the targeted stability of $\pm$ 3 percent of total food requirements, the needed grain storage capacity without import adjustments would have been 4,301,000 metric tons for rice and 5,129,000 metric tons for all food grains. With import adjustments, the capacities would have been reduced to 2,496,000 metric tons and 3,039,000 metric tons respectively with the major reductions coming from the regional reserves (Table 10).

Average annual utilization would have varied as summarized in Table 11. Note that the utilization of storage capacity for the regional reserves under the adjustments trade alternatives would have been nearly twice the rate of that for the historical trade alternatives.

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[1]Phillips and Jeon, pp. 97-101.

Table 10

Computed Reserve Storage Capacity

Location	Alternative			
	1. Rice only		2. All Food Grains	
	A. Historical Trade	B. Adjusted Trade	A. Historical Trade	B. Adjusted Trade
	(1,000 M/T milled rice equivalent)			
In-Country:	1,434	1,393	1,718	1,671
Indonesia	603	603	690	690
Malaysia	68	68	84	73
Philippines	143	139	173	137
Singapore	43	43	61	61
Thailand	557	540	710	710
Regional	2,867	1,103	3,411	1,368
Combined	4,301	2,496	5,129	3,039

Source: Richard Phillips and Doyle Jeon, "Simulating the Impact of Alternative Food Reserve Programs: The ASEAN Case", Journal of Rural Development, 3 (April 1980), p. 83.

Table 11

Average Utilization of Reserve Capacity

Location	Alternative			
	1. Rice only		2. All Food Grains	
	A. Historical Trade	B. Adjusted Trade	A. Historical Trade	B. Adjusted Trade
		(Percent)		
In-Country:	45.4	48.2	45.5	52.2
Indonesia	26.3	26.5	28.7	40.7
Malaysia	54.8	59.8	69.6	67.4
Philippines	79.1	88.8	64.8	75.3
Singapore	46.9	51.6	55.2	55.2
Thailand	63.1	69.8	60.0	63.1
Regional:	34.1	65.0	35.5	59.6

Source: Phillips and Jeon, "Simulating the Impact of Alternative Food Reserve Programs: The ASEAN Case, Journal of Rural Development, 3 (April 1980), p. 98.

A somewhat higher rate of utilization is observable for all food grain reserves than for rice reserves alone. A comparision of the utilization rates by country showed that the Philippines would have had higher rates than the other countries under all alternatives considered.

Storage capacity and inventory levels for alternative 2B were simulated for the five countries (Fig. 4). The charts depict regional storage immediately above the in-country storage. The total storage capacity for each country is shown by the height of the total bar for a specific year.

The average annual total costs for the alternative food security programs over the 18 - year period are shown in Table 12. The results were based on uniform unit costs for the adjustments under the adjusted import alternatives. The annual costs for the combined in-country and regional reserves would have been higher for all food grains than for rice only under all alternatives. However, annual costs with import adjustments would have been much lower without adjustments. The all food grain reserves are somewhat more costly than the reserves of rice only in all countries except the Philippines. (However, all food grains provide more stability to the greater food consumption base.)

Several studies have measured the gains that can be obtained by developing countries in establishing a grain reserve system. For example, Byung Seo Ryu[1] estimated the benefits South Korea would achieve from food security reserves. Conceptually, the benefits from this type of reserves come only in those surplus or deficit years when transactions

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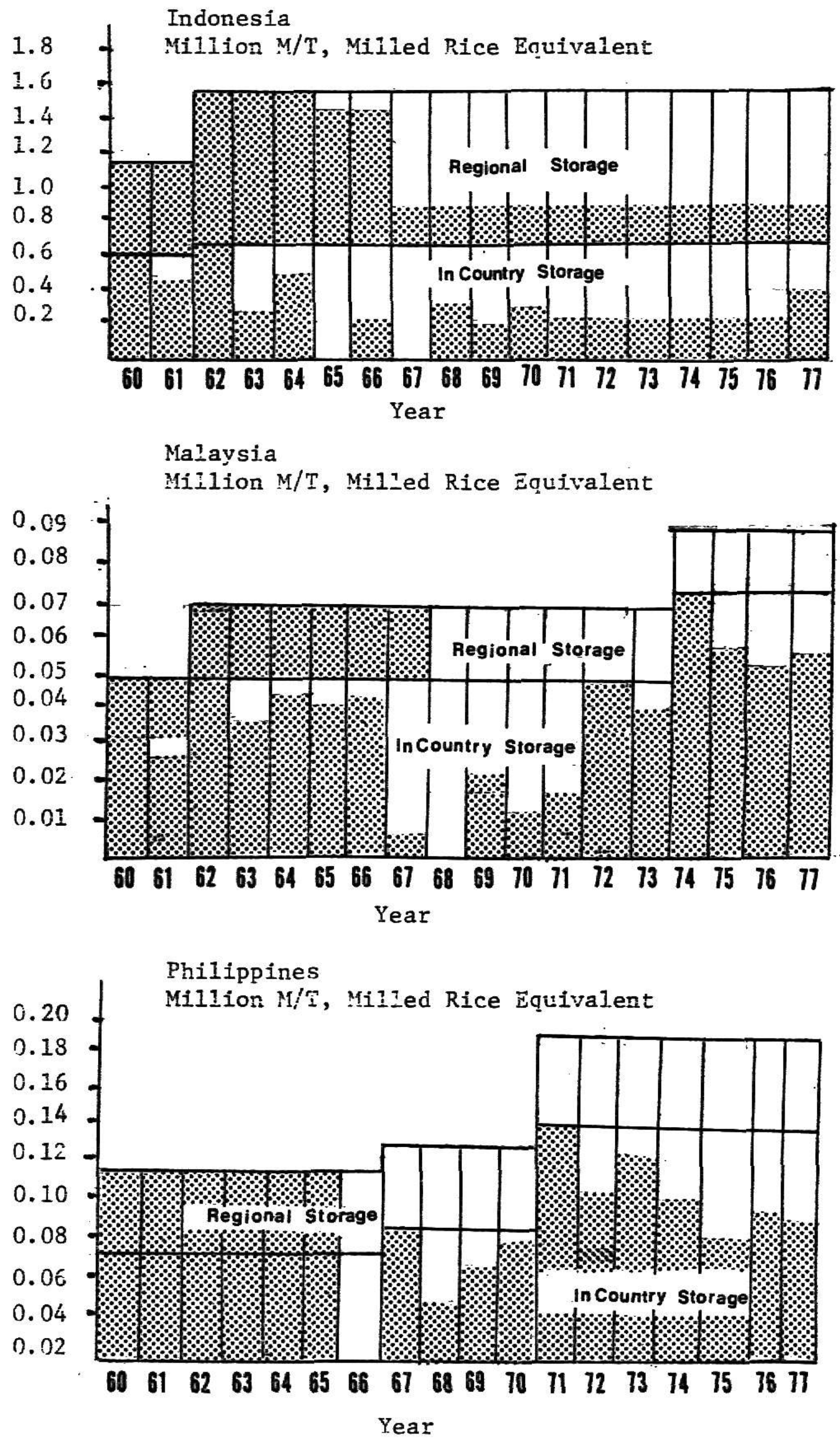
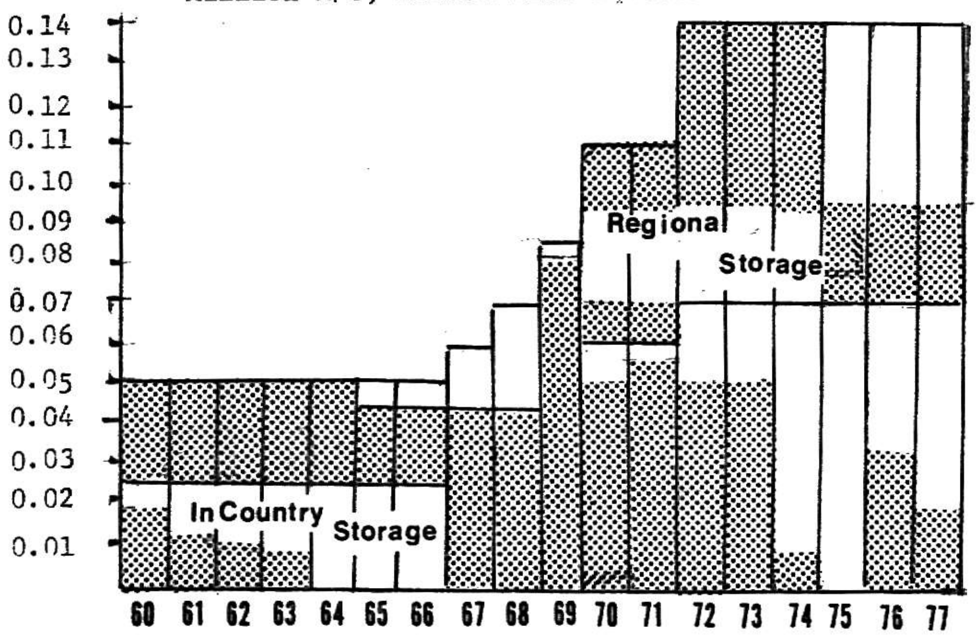
[1]Byung Seo Ryu, "Feasibility of Food Security Reserves for Korea", (Ph. D. dissertation, Kansas State University, 1981), p. 140.

Figure 4. Computed Storage Capacity and Inventory for ASEAN Security Reserves (All Grains with Stabilizing Trade)

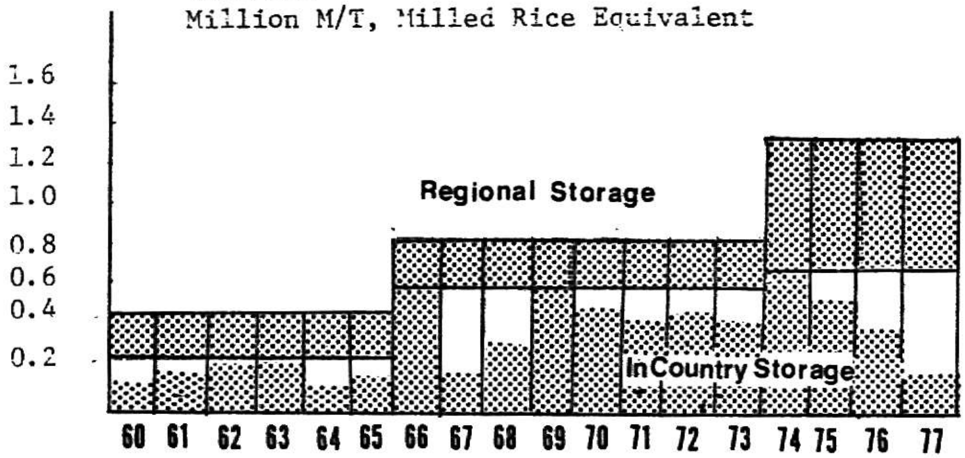


Singapore
Million M/T, Milled Rice Equivalent



Year

Thailand
Million M/T, Milled Rice Equivalent



Year

Table 12

Computed Average Annual Total For Reserves

Location	Alternative: 1. Rice Only — A. Historical Trade	Alternative: 1. Rice Only — B. Adjusted Trade*	Alternative: 2. All Food Grains — A. Historical Trade	Alternative: 2. All Food Grains — B. Adjusted Trade*
	($ million)			
In-Country:	79.2	100.6	92.2	117.7
Indonesia	33.5	43.9	39.1	54.8
Malaysia	3.4	3.9	5.0	5.0
Philippines	7.0	9.1	7.6	8.8
Singapore	2.1	3.2	3.2	4.4
Thailand	33.2	40.5	37.3	44.7
Regional:	166.5	78.7	170.6	83.2
Combined:	245.7	179.3	262.8	200.9

* In-Country costs include those for import (exports) adjustments.

Source: Phillips and Jeon, "Simulating the Impact of Alternative Food Reserve Programs: The ASEAN Case", Journal of Rural Development, 3 (April 1980), p. 98.

with the reserves are made. Producers benefit in surplus years through the price support effects of acquisition transactions with the reserves. Consumers on the other hand, gain substantial benefits during deficit years through the quantity supplementation and price control effects of releases from the reserves.

In Korea, measurable benefits from year to year grain stabilization accrue to urban consumers and farm producers from three sources. These benefits are summarized below:

A. Urban Consumer Benefits (in years of release from food security reserves)

a. Reduced Consumer Expenditure, measured as the net saving in total food expenditure resulting from the release of reserve stocks, and accruing to all urban consumers regardless of expenditure level.

b. Protection of Calorie Intake (Quantity Effect), measured as the added calorie intake, up to the minimum level for health and productive activity, resulting from the disposable income effect. This benefit arises only in those urban households at or below the margin in calorie intake.

c. Prevention of Household Budget Deficit, measured as the household income-expenditure deficit avoided through the disposable income effect. This benefit arises only in those urban households at or below the margin of public welfare support.

B. Farm Producer Benefits (in years of acquisition for food security reserves)

a. Added Farm Income, measured as a net addition to farm revenue from off-farm grainsales of marketable surplus resulting from the acquisitions for food security reserves, and accruing to all grain producers, regardless of farm size and income level.

b. Prevention of Cash Deficit, measured as the deficit between cash grain production expense and cash revenue from marketable surplus grain sales which is prevented by a positive farm income effect. This benefit arises for the small farms at the margin in subsistence production for the farm family.

c. Prevention of Production Deficit, measured as the deficit between the market value of total net crop production and total farm production cost prevented by the farm income effect. This benefit arises only for the smaller farms at the margin in crop enterprise profitability.

CHAPTER X

SUMMARY

A physical grain reserve is the amount of cereals carried over in storage for a specified time period. It is established for a number of reasons subject to the political interests of the party utilizing the reserve. In general, the objectives of a grain reserve include price and income stabilization, food security, and food aid. Basically, the grain cereals, wheat, rice, corn, oats, barley, and grain sorghum are the commodities appropriate for storage. Among these cereals, wheat, and the coarse grains are the two commodities commonly used to build up a reserve. Previous studies demonstrate that the size of an international grain stock could vary between 30 to 60 million metric tons depending on what the reserve is expected to accomplish. However, the larger the reserve, the more difficult it is to manage and the storage cost is also greater. On the other hand, the smaller the reserve, the easier it is to manage but the greater is the degree of price instability which has to be borne given swings of production.

In the past, the major grain exporters such as the United States, and Canada have been the world's principal grain stockholders. The cost of maintaining grain reserves were shouldered primarily by these countries. When grain reserves were depleted due to the food crisis of the early 70's, efforts were made to rebuild them. This time, proposals regarding financing, management, and control of reserves were suggested to be shared by importers as well since, they too, benefit from grain reserves.

In general, the cost of holding stocks will depend on how long the stocks are held and the size of quantities held. The major costs that could be incurred are storage, handling costs and an interest reflecting the return in the investment in inventory.

A grain reserve once established costs millions of dollars. Nevertheless, the benefits obtained may outweigh its cost. The distribution of benefits among producers and consumers has been a much debated issue. There are claims that producers gain when grain is withdrawn from the market into storage because of the increased price. When grain is released from storage to augment current supply, consumers benefit through price reduction.

Size and costs can be specified for a world reserve, regional reserve, or in-country reserve. The methodology developed by Phillips and Jeon to determine the size and costs from a food reserve stabilization activities of ASEAN countries is cited as an example. Research is needed to demonstrate benefits from reserve programs. The research of Ryu, Phillips and Kelley suggests that under certain conditions benefits may be estimated without utilizing producer-consumer surplus methodology.

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GRAIN RESERVES: A REVIEW OF SELECTED LITERATURE

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ABSTRACT

The wide array of literature written about grain reserves is evidence of the growing interest in this subject. Discussions presented in most studies have generally focused on the issues of objectives, size, costs, benefits, financial management, and control responsibilities of a grain reserve.

This paper reports the range of grain reserve options discussed in selected studies and their implications. Discussed are: 1) the objectives of grain reserve programs; 2) costs of stockpiling grains; 3) analyses of producer and consumer benefits from reserve programs; 4) management and financing alternatives; and 5) a methodology proposed to measure the cost and size of a regional and in-country reserves among ASEAN nations. Several studies have measured the gains that can be obtained by developing countries in establishing a grain reserve system. However, the results of these studies are not discussed in this report.