ECONOMIC STUDY REPORT S71-2 MAY 1971

BUFFER STOCKS OF FOODGRAINS IN INDIA

by Sada Nand and James P. Houck

the economics of their operation and potential size

DEPARTMENT OF AGRICULTURAL AND APPLIED ECONOMICS

INSTITUTE OF AGRICULTURE

UNIVERSITY OF MINNESOTA

ST. PAUL, MINNESOTA 55101

BUFFER STOCKS OF FOODGRAINS IN INDIA:

THE ECONOMICS OF THEIR OPERATION AND POTENTIAL SIZE

by

Sada Nand and James P. Houck*

---

* The authors are Senior Research Officer, Planning Commission, Government of India and Professor, Agricultural and Applied Economics Department, University of Minnesota respectively. The analysis on which this report is based was done in 1969-70 while Mr. Nand was visiting the University of Minnesota under a Ford Foundation Fellowship for research and study. The views expressed are those of the authors.

INTRODUCTION

The world food problem as it exists today can be viewed in three parts:

(1) Some two billion people in the world live in countries and regions with inadequate food supplies. Many of the inhabitants in these areas suffer from under-nourishment and malnutrition. These regions are found largely in the tropics. In terms of sheer numbers of people, this problem is growing.

(2) The total demand for food in the world and particularly in the less-developed world has been increasing more rapidly than food supplies. This is not only due both to population growth and growth in money incomes, the latter leading to an increase in the per capita demand for food. The growth in food demand relative to supply results in economic problems such as rising food prices, periodic shortages, and the need for food aid provided by richer nations.

(3) The thin margin between total food demand and aggregate food supplies can foster periodic instabilities in the economies of developing nations. These instabilities can occur as periodic shortages or surpluses of physical stocks, widely fluctuating food and farm prices, unstable real incomes, and social or political unrest.

It is no exaggeration to say that India's food problems are largely similar to those of the world. In response to these problems the government of India is taking steps to assure that agricultural development receives high priority in India's successive Five Year Plans. For example, a program to speed the introduction of high-yielding varieties of foodgrains is receiving

special attention. Similarly, programs to encourage multiple cropping, extension of irrigation, etc., are underway. The goal is to increase India's degree of self-sufficiency in the production of foodgrains. In the meantime, imports of foodgrains under various programs, notably the United States' Public Law 480, have been used to meet the foodgrain requirements of the people. The Fourth Five Year Plan (1969 to 1974) has placed special emphasis on the objective of "growth with stability." Together with programs of increased agricultural production, the Plan envisions the building up of sizeable national buffer stocks to even out the supplies of foodgrains and to stabilize their prices. This objective is the subject of the research discussed in this report.

The need for maintaining reserve buffer stocks of foodgrains has been emphasized since the 1940's by various committees of the government of India. But a buffer stock policy has never become operational because of persistent foodgrain shortages. It was, in fact, the record output of foodgrains in 1967-68 and the promise of sustained increases in domestic production which prompted the government to take the decision in 1968-69 to build a buffer stock of foodgrains. A foodgrain buffer stock is now officially recognized as an important ingredient of India's food policy.

A buffer stock program operates by purchasing the commodity when its price is relatively low and selling it when its price is relatively high. A well-managed buffer stock can play an effective role in tackling the food problem of a country like India. It can help to maintain a steady flow of foodgrain supplies to stabilize prices over seasons and over years, and <u>indirectly</u> provide a stimulus to increased production through the reduction of uncertainty. However, a buffer stock cannot itself overcome the basic problems of chronic foodgrain shortage because, even a well-managed buffer-

ing program cannot directly change long run or secular trends in demand and supply.

This report contains two major sections. The first is a discussion of the buffer stock as a policy tool in the foodgrain sector of the Indian economy. The second section presents the empirical results of applying several hypothetical buffer stock programs to the aggregate foodgrain sector. The major thrust of the research involves estimating the size of needed buffer stocks in an annual or crop year context over the entire foodgrain economy of India.

Two major problems which must be faced by a buffer stocking agency are largely outside the scope of this particular discussion. The first is the intra-year operation of the buffer stock to even out surpluses and shortages on a monthly or quarterly basis. The second is the problem of adopting the buffer stocking agency and its operation to the existing zonal policy for food distribution currently in force in India. These are crucial topics and certainly require additional analyses.

I. Buffer Stock as a Policy Tool

Objectives

Buffer stocks are often advocated for a variety of purposes. F. V. Waugh of the U. S. Department of Agriculture has suggested the following objectives of a buffer stock [7., p. 15-16]:

(1) To provide adequate "working stocks" (for processors and distributors from one harvest to the next and allow for an orderly adjustment from the old crop to the new);

(2) To reduce the danger of food shortages at home and abroad. (this means guarding against the possibility of future low yield by storing adequate reserves in periods of high yield);

(3) To help maintain commercial exports;

(4) To help stabilize farmers' incomes and the general economy;

(5) To increase the average level of farm prices or farmers' incomes;

(6) To assist growth in under-developed areas of the world (substantial reserves are essential as short-run insurance against wide-spread famine conditions arising due to droughts and wars).

These objectives, broadly speaking, can be applied to buffer stock proposals in both developed and less-developed countries. However, the problem of adjusting supply to demand to achieve price stabilization is particularly difficult in less-developed countries where the marketing, transportation, and storage of agricultural products is not well-adapted to respond to purchases and sales by a buffer stock agency. Further, the seasonal nature of agricultural production and uncontrollable year-to-year fluctuations in output make less-developed nations peculiarly susceptible to price instability. Some of these problems are especially evident in India.

Basically, the role of prices is to show the way to efficient allocation of productive resources on the one side and consumption expenditures on the other. Prices in a market economy have also another important function apart from that of allocation. They act as the primary determinants of the distribution of income. It is often argued that agricultural prices exhibit more instability and fluctuation from period to period than is necessary for efficient resource and consumption allocation. Furthermore, this instability is disruptive to the economy's income distribution patterns from a longer-run point of view. It is for these reasons, among others, that the Fourth Five Year Plan attaches great importance to maintenance of price stability during the period of growth. For achieving this, reliance is placed on a number of

measures including a sizeable buffer stock of foodgrains. This is because foodgrains occupy a critical place in the economy of the country.

Price instability is caused in short run by (1) inelastic demand and supply curves; and (2) movements of these curves relative to one another. The inelastic demand arises because food and fiber are the basic needs of life, because most primary products represent a small portion of the total value of final goods, and because most primary products have few substitutes in the short run. The inelastic supply arises because resources like farm land and labor have few alternatives, because the biological processes of production limits short-term adjustment, and because storage facilities are often limited. Changes demand occur in response to population growth, alterations in peoples' tastes and preferences, fluctuations in the level of economic activity, and changes in the distribution of income. Generally, demand changes occur rather gradually and are not the prime cause of instability. However, sharp changes in supply can arise in the short run due to vagaries of weather, infestations of pests and diseases, and political and social instability. These relationships are quite evident in India--a continually growing but fluctuating supply of foodgrains against a steadily-rising demand. This leads to fluctuations in price and food availability from year to year.

Interest by economists in buffer stocks and price stabilization schemes for agricultural products goes back at least as far as the 1930's. John Maynard Keynes, on the basis of a study of the inter-war commodity control schemes, indicated that some form of control was needed to achieve greater stability of prices of primary products [3.]. He argued that this was an essential requisite for a generally stable and expanding world economy. In this context he advocated buffer stocks for the control of price fluctuations. In his view, "stability of prices does not of course mean fixed prices,

but prices which follow reasonably closely the long-period trend of demand and supply conditions. In this way prices can be expected to give greater security to producer incomes both in the short and the long periods." This stresses the distinction between price support and price stabilization, the latter being the appropriate goal of a buffer stock policy.

The goals of price and income stability can be justified in the context of welfare economics. Benton F. Massell has assessed this problem from a theoretical point of view in a recent article [4.]. He first assumes a market consisting of atomistic consumers and producers in which price fluctuation can arise from parallel shifts in either a linear supply curve, a linear demand curve, or both. Storage is assumed to be costless. In this setting, using the expected value of the change in producer and consumer surplus as a measure of gain, he shows that price stabilization, brought about by a buffer stock, can generally provide a net gain to producers and consumers taken together. In regard to the distribution of gains between producers and consumers, he shows that the magnitude of the gain to producers is (1) a <u>decreasing</u> function of the demand shifts, and (2) an <u>increasing</u> function of the supply shifts and of the steepness of the supply curve. On the other hand, consumers are more likely to gain, the larger the demand shifts relative to the supply shifts, and the steeper the demand curve relative to the supply curve. This analysis suggests that a buffer stock can be a desirable policy measure and will favor producers more than consumers in the context of the foodgrain sector where supply shifts are large relative to demand shifts and where annual supplies are probably quite price inelastic.

However, one should bear in mind the simplifications underlying this analysis. For instance, the effect of price stabilization on real incomes

of producers and consumers has been assumed away. In a less-developed nation like India, fluctuations in foodgrain supplies have not only a destabilizing effect on prices, but also on real incomes of producers and consumers. In addition, it is not easy in practice to separate the impact of the buffer stock scheme on producers as opposed to consumers. In India, producers and consumers of foodgrains are often the same people, peasants and subsistance farmers.

Mechanics

In general, under a buffer stock scheme, the official stock-piling agency or marketing board pursues a policy of purchases and sales so as to prevent prices and availability from fluctuating too widely. This institution also acts as a storage agent. It is usually assumed to make no profit, to accumulate stocks during periods of falling prices and to dispose of them in the market during periods of rising prices. It sets an approximately equal price range for both users and suppliers, and maintains it from period to period. The stabilization price or price range may be changed from time to time in line with an assessment of longer-run demand and supply conditions.

The buffer stock differs importantly from the buffer fund as a stabilization mechanism. A buffer fund agency imposes special taxes or levies when prices are high and makes "deficiency payments" when prices are low. The purpose of this type of scheme is to stabilize the net price received by producers, while the market mechanism is allowed to determine the actual market price level and the quantities traded according to changing demand and supply relationships. The buffer fund, therefore stabilizes producer prices, but does not directly influence

market prices or availabilities except through subsequent production decisions based on stabilized producer prices.

The buffer stock agency operates to directly influence the market. It may start with only a stock of the commodity--in which case it can initially only hold the price down to some maximum. Or it may begin only with a stock of money--in which case it can initially only hold the price up to a minimum. If the agency begins operations with both commodity and cash, it can stabilize in both directions. Given sufficient resources a buffer stock is probably the most effective method of moderating commodity price fluctuations in the context of foodgrains where producers and consumers are considered jointly, and where a major policy goal is to assure even supplies of foodgrains from period to period.

Now consider the simple analytics of buffer stock operations. In figure 1, DD is the stable foodgrain demand curve, and S_1 and S_2 are upper and lower bounds of fluctuating short run supply curves. Open market price fluctuation (P_1 to P_2) is assumed to be too wide. The range P** to P* is acceptable. Suppose P_1 prevails under open market conditions. The stabilization or buffer agency will sell the commodity to bring the price down to P**. Sales volume is indicated by AB. Now suppose the price is P_2 as a result of a rightward shift in the supply curve to S_2. The stabilization agency will buy the commodity to bring its price up to P*. Here the purchase volume is indicated by CD. Thus with a buffer stock, there will be narrower price fluctuations, between P** and P*.

If sales are larger than purchases over time because of, say, a policy of food aid imports, the buffer stock will be a price-depressing policy. On the other hand, if purchases are larger than sales, and stocks are built up, then it will be a price-support mechanism.

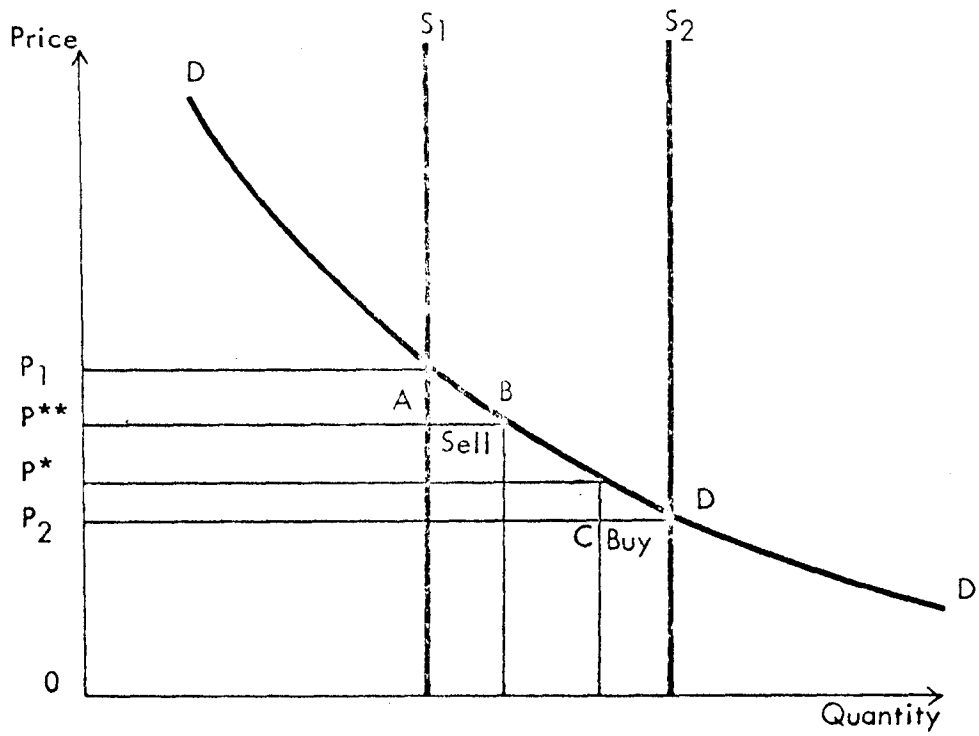


Figure 1.

To be effective, the stabilization agency must have access to both cash and physical stocks of the commodity concerned. The wider the price stabilization zone (P** to P*) the less resources the agency needs to meet its commitments. If the buffer stock's resources are inadequate--as they may be if runs of high or low production levels are persistent or as they will be if the long-run equilibrium price moves outside the selected range of stabilization prices--then the buffer stock will exhaust either its cash reserves or its physical stocks and lose its power to stabilize.

If the selected price range for stabilization is too low compared with long run trends, the agency will run out of stocks and find itself unable to control rising prices. The buffer stock will end its operations with a profit and large cash balances. If on the other hand, the selected price range for stabilization is too high, the agency will run out of cash and find itself with large inventories of commodities which it must hold at positive storage costs. It is apparent that if the scheme is to make a significant contribution towards reduction in price instability, the price range P** to P* must be periodically evaluated to determine whether or not it encompasses the longer run equilibrium price.

Institutions

An institution for handling a buffer stock scheme can be a public agency or private firms acting as agents for a public institution. In India the Food Corporation of India [F.C.I.] is at present generally responsible for activities of this type. The FCI is a public agency within the Food Secretariat of the Ministry of Food and Agriculture. It may appoint co-operative societies and sometimes even private traders as agents for making purchases or sales in its behalf. At the moment, however,

decisions concerning releases from national stocks are generally made at the highest government level.

When the operation of a buffer stock scheme becomes an ongoing, regular, and permanent part of the economy, its success will depend upon the wisdom of those who design the rules for operating the scheme and its day-to-day management. The agency for buffer stock operation should have administrative flexibility as well as adequate resources. Above all, it should also command the full confidence of the government and be apart from political activities as far as possible.

In India, it is equally important that such an agency should have access to good storage facilities. In addition, the buffer stock operation should have administrative and operational ties with sources of back-up or emergency stocks of grain. This suggests a close relationship between the buffer stock management and the administration of grain imports.

II. An Application to India

Need and Objectives

The need for a buffer stock of foodgrains in India hinges largely on the following assumptions and assertions:

(1) Sharp fluctuations in prices are harmful to producers, to consumers, and to the wider interests of economic development of India. Instability in prices erodes the producer's incentive to invest in agriculture. It therefore affects his real income. The real income of consumers is also subject to fluctuation as foodgrain prices change.

(2) Agricultural output in India is characterized by low yields and wide yield fluctuations from year to year. The new strategy of

agricultural development already under way will accelerate production growth rate of foodgrains. But it is yet to be known whether it will greatly reduce the annual variability of output. Nevertheless, it is evident from the past experience that crops in large parts of the country, especially the unirrigated areas, will continue to remain vulnerable to unpredictable weather changes over a period of time. In consequence, large variations in agricultural output may continue to bedevil the economy.

(3) The marketed surplus may be even more erratic than agricultural output itself since much of the total output is retained by farmers for their own consumption. When prices are expected to rise, the cultivator may hold back stocks even though he has produced more than he usually consumes. On the other hand, when prices are expected to fall, he may market exceptionally large quantities. The speculative activities of many traders occasionally adds even greater destabilizing potential to the market. Sharp fluctuations in prices, unwarranted by changes in either total output or market supply may occur.

(4) For foodgrains in India, stabilization of supplies will generally lead to stabilization of prices. However, the buffer stock should not aim at a complete stabilization of prices but a moderation of excessive fluctuations. A buffer stock which attempts to stabilize prices at a single point may not be in the overall interest of the general economy nor is it likely to be successful.

Before developing empirical estimates of a buffer stock scheme, it may be useful to consider some internal aspects of India's current national food policy as it may impinge upon the operation of such a scheme.

Public Distribution System

An important ingredient of national food policy is the public distribution system which largely focuses on the requirements of the more vulnerable sections of the community. Its objective is to insure the poorest segments of the population a minimum supply of foodgrains at reasonable cost. The annual volume of foodgrain supplies handled through this system over the 5 year period, 1965-1969 varied between 9 and 14 million tonnes.[1/] The agency procures supplies both domestically and from imports largely concessional purchases from the United States under Public Law 480. It distributes supplies to the population through the system of "fair price" shops or ration shops located mainly in the large urban concentrations.

The buffer stock program discussed in this paper is assumed to be apart from and in addition to the public distribution system. Although the operations of both programs will have to be consistent with one another, the general objectives of the two programs differ. The public distribution system is essentially a social welfare program. On the other hand, the buffer stock program as envisioned here would directly benefit the total economy, consumers and producers alike.

1/ In this report, "tonnes" will indicate metric tons (2,204.6 pounds).

Zonal Restrictions

Another important measure included in the national food policy involves zonal restrictions on the movement of foodgrains within India. It is beyond the scope of this report to describe or analyze this complex and controversial portion of the nation's food policy. Briefly, the country is divided into zones; surplus zones where foodgrains are produced in excess of normal consumption and deficit zones where foodgrains are consumed in excess of production. Purchases, sales, and transportation of grains across zonal boundaries by private traders are controlled by government. The stated major purposes of the zones are (1) to prevent the wealthier consumers in urban areas from draining grain supplies out of the rural areas and (2) to facilitate government procurement of grain for various purposes including public food distribution.

For the purposes of this report it is assumed that the zonal restrictions are modified or operated so as to permit a buffer stock to function over the nation as a whole. The empirical results presented later pertain to the nation as a whole if zonal restrictions are administered so as not to run directly counter to the objectives of the buffer stock agency.

Size of Buffer Stock

The size of a buffer stock is, generally speaking, a function of four variables: (1) frequency and size of fluctuation in production; (2) the limits set by finance; (3) the ability to procure and store foodgrains; and (4) the extent of open market price fluctuations to be permitted before the 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 be borne in mind that a buffer stock program involves both physical stocks and money under the control of a competent independent authority.

For the purposes of this paper a simple analytical model of a buffer stock was developed and tested. The major aim of the model was:

(1) To determine an appropriate size of the buffer stock to meet, with given levels of assurance, shortfalls in production of foodgrains;

(2) To determine an appropriate size of storage to stabilize heavy production with given levels of assurance; and

(3) To assess the price stabilization aspects of buffer stock schemes.

This analysis assumes that foodgrains can be considered as a single commodity in India. Another assumption is that the year-to-year fluctuations in production around the trend are principally due to weather and natural causes beyond immediate control of the economic policy and that they are approximately normally distributed.

The analysis then proceeds on the following lines:

(1) The trend of foodgrain production is estimated using actual data for the sample period 1949/50 to 1968/69.

(2) The standard deviation of foodgrain production around this trend is estimated.

(3) This estimated deviation is used as an indicator of the likely fluctuation, around the trend, of future production of foodgrains.

(4) Alternative buffer stock schemes based on this estimate are evaluated, including:

(a) two levels of protection against probable future fluctuations; the first provides for 95% assurance of the buffer stock being able to cope with annual fluctuations; the second provides for 67%

assurance. The former level is designed to deal with fluctuations 1.96 standard deviations above and below the trend line, and the latter designed to handle fluctuations 1.00 standard deviations around the trend.

(b) four levels of permitted year-to-year open market price fluctuation in the aggregate foodgrains market, namely, 0, $\pm$ 5%, $\pm$ 10% and $\pm$ 15%.

The semi-logarithmic trend of production of foodgrains for the period 1949/50 to 1968/69 and actual production levels around this trend are given in table 1 and plotted on a semi-logarithmic graph figure 2. The calculated trend line is in terms of common logarithms (base 10). The estimated annual growth in foodgrain output for the 20-year period is approximately 2.3 percent.

Since a semi-log trend is used, the estimated standard deviation is in terms of <u>percentage changes</u> in production rather than actual quantities. The statistic used as the standard deviation estimate is the standard error of regression based on the fitted trend. Its calculation is;

$$\hat{s} = [\sum e^2 / n-2]^{\frac{1}{2}}$$

where $\sum e^2$ is the sums of squares of the residuals between actual and predicted logarithms of foodgrain production. The computed value of $\hat{s}$ is .036. The anti-log of this figure indicates that the standard deviation of production around the trend is approximately 8.6 percent. In the buffer stock calculations which follow, deviation and stock estimates are converted to actual units, namely million tonnes.

Five projected years (1969-74) were used to obtain estimates of variation in the potential production of foodgrains. Since the projected semi-log trend is used, these estimates are larger than averages of the sample period (1949-68). Even as the overall trend of foodgrain production in India increases because of

Table 1. -- Production of food grains all-India, 1949/50 to 1968/69.

Year (1)	Actual production (2)	Semi-log trend of production*/ (3)	Deviation from trend [Col. (2)-(3)] (4)
	million tonnes		
1949/50	60.65	59.30	1.35
1950/51	54.92	60.70	- 5.78
1951/52	55.51	62.10	- 6.59
1952/53	61.67	63.50	- 1.83
1953/54	72.19	64.90	7.29
1954/55	70.61	66.40	4.21
1955/56	69.22	67.90	1.32
1956/57	72.34	69.50	2.84
1957/58	66.50	71.10	- 4.60
1958/59	78.69	72.70	5.99
1959/60	76.70	74.40	2.30
1960/61	82.02	76.10	5.92
1961/62	82.71	77.80	4.91
1962/63	80.15	79.60	0.55
1963/64	80.64	81.40	- 0.76
1964/65	89.36	83.20	6.16
1965/66	72.03	85.10	-13.07
1966/67	74.23	87.10	-12.87
1967/68	95.05	89.20	5.85
1968/69	94.01	91.10	2.91

*/ Calculated from the following equation which was fitted by least squares method for the years 1949/50 to 1968/69:

$$\log Q = a + bT = 1.7640 + 0.0098\ T$$

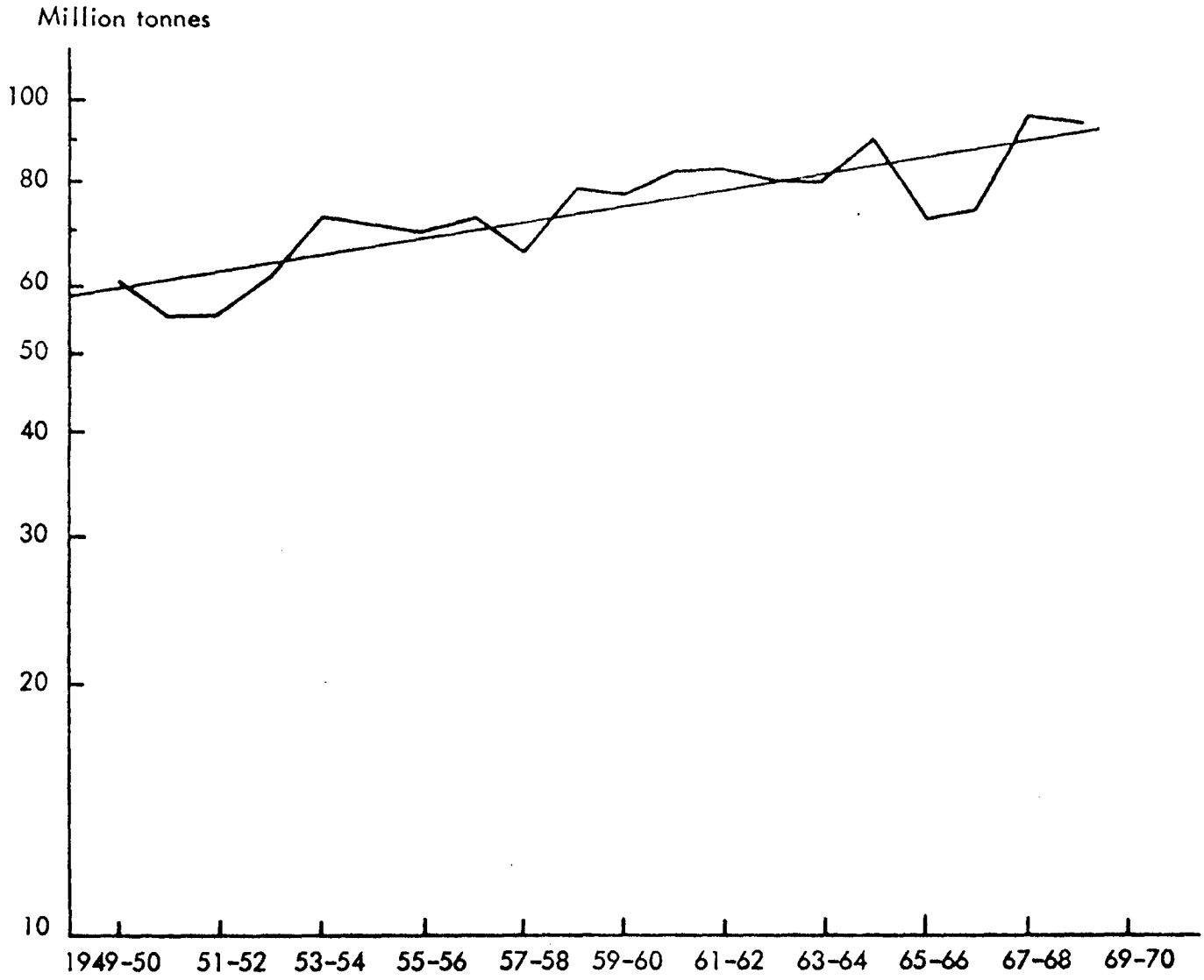
where

Q = production

T = time (1949/50 = 1, 1950/51 = 2, etc.)

Source of Data: Ministry of Food and Agriculture, Government of India

Figure 2. All-Indian Food Production and Fitted Trend Line (Logarithmic Scale)



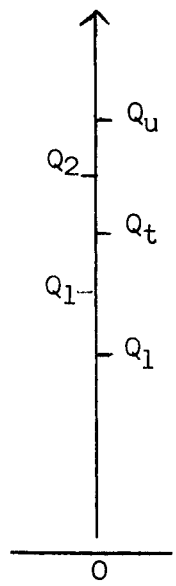
development programs already under way, it is assumed here that the variance around the new trend is proportionate to that experienced in the sample period. It is the variation of production, not the trend, that is important for analysis of buffer stocks. However, accurate trend estimates must be made continually in order to assess variation correctly.

It is useful to consider a broader range of buffer stock programs than those which are operated so as to remove all non-trend fluctuations in foodgrain availabilities and prices. In this analysis, buffer stocks with four levels of permitted annual price fluctuation (0, ± 5%, ± 10% and ± 15%) were investigated. That is, the permitted amount of price fluctuation could occur before the buffer agency stepped in with purchases or sales. This permitted level of price fluctuation is equivalent to P** — P* in figure 1.

When investigating the impact of fluctuating foodgrains availability on prices, the size of the price elasticity of demand becomes important. Three levels of price elasticity of demand have been investigated; -0.5, -0.75 and -1.0. This range was adopted for the following reasons. First, it has been estimated that the income elasticity of demand for foodgrains in India is approximately +0.5 [1, p. 70]. Therefore, under the standard assumption of zero-degree homogenity in the demand relationship, the sum of all the direct and cross price elasticities foodgrains must be -0.5 [8, p. 111]. Assuming that substitute relations generally prevail between foodgrains and other commodities in India, the direct price elasticity for foodgrains must be -0.5 or larger (absolutely). Hence, price elasticities of -0.5, -0.75 and -1.0 were adopted for investigation. The first, -0.5, suggests that no substitution exists between foodgrains and other commodities in India, the third, -1.0, suggests that substitution in the aggregate is half as important as the direct effect of price change, and the second is an intermediate value.

Armed with estimates of the standard deviation in production and the price elasticity of demand, plus assumptions about permitted price fluctuations and the level of protection to be assured by the scheme, calculations concerning the size of the buffer stock and its needed resources can be made. Using the following simple diagram, the analysis proceeds as follows.

Quantity of foodgrains



The vertical line represents foodgrain quantities for any given crop year. (1) Along this line, Q_t is the quantity of foodgrains on the semi-logarithmic trend line, (2) Q_u and Q_1 are the upper and lower extremes of output fluctuation which the buffer scheme is designed to handle (i.e. either 1.00 or 1.96 standard deviations around the trend), and (3) Q_2 and Q_1 are upper and lower levels of output fluctuation consistent with the permitted open market price fluctuations and the price elasticity of demand.2/

2/ The policy variable here could also be expressed in terms of foodgrain availabilities. Then the range $Q_2 - Q_1$ would be set as the permitted supply fluctuation and market prices allowed to fluctuate in response.

If actual output in a given crop year falls in the area bounded by Q_2 and Q_1, the agency will neither dispose of or acquire stocks. Prices will remain inside the permitted zone of fluctuation; if actual output is above Q_t, prices will fall and if output is below Q_t, prices will rise. The size of $Q_2 - Q_1$ for a given demand elasticity is larger the larger the permitted open market price fluctuation. For a given level of permitted price fluctuation, $Q_2 - Q_1$ is larger the larger the demand elasticity used in the computations.

If actual output falls in the area between Q_2 and Q_u, the agency will acquire stocks in sufficient quantity to bring market prices up to the lower bound of the permitted range. Similarly, if the actual output is between Q_1 and Q_1, the agency will pour stocks onto the market in order to bring prices down to the upper bound of the permitted range and to increase per capita foodgrain availabilities.

If Q_u and Q_1 are 1.00 standard deviations above and below Q_t, the agency will be able to deal with output fluctuations about 2 years out of 3 with cash and stock resources equal to $Q_u - Q_2$ and $Q_1 - Q_1$ respectively. This is the 67 percent level of assurance. If Q_u and Q_1 are 1.96 standard deviations above and below Q_t, the agency will be able to deal with output fluctuations 19 years out of 20 with cash and stock resources of $Q_u - Q_2$ and $Q_1 - Q_1$ respectively. This is the 95% level of assurance.[3/] When output is either above Q_u or below Q_1 then the agency cannot cope and open market prices will escape the prescribed range. The estimates which follow are calculations of $Q_u - Q_2$ and $Q_1 - Q_1$ for various assumed demand elasticities and permitted price fluctuations. Furthermore, the analyses are based on average trend and deviation values for the projected 1969-74 period.

3/ This analysis takes no explicit account of the possibility that a run of either good or bad years would seriously tax the ability of a given buffer stock to cope with instability. A more sophisticated study would have to introduce this dimension of the problem.

Table 2 summarizes the estimates based on an assumed price elasticity of -0.5. Since this is the smallest (absolute) level of demand elasticity assumed, the range $Q_2 - Q_1$ is the narrowest, hence, the buffer stock size and storage requirements are the largest among all the alternatives. The complete set of estimates is presented in detail in table 3. Under Alternative I (95% assurance) the size of estimated buffer stock varies between 7 and 15 million tonnes depending upon permitted open market price fluctuations. On the other hand, Alternative II (67% assurance) provides for relatively smaller sizes of buffer stocks but at a cost of less assurance. At present, the Government of India is proceeding on the basis of a target of 5 million tonnes of foodgrains for a buffer stock.

This size of buffer stock is consistent with the estimate of 5.4 million tonnes under Alternative II with assumed -0.5 price elasticity of demand and permitted annual open market price fluctuation of 5%. Under the higher protection of Alternative I, the 5 million ton buffer stock would be approximately consistent with a 15% annual level of permitted price fluctuation and an assumed demand elasticity of -.75 to -1.00.

Stock Accumulation

For this section, assume that a 7 million tonne foodgrain stock is to be built up as the basis for buffering operations. A proposed breakdown of this stock as well as its accumulation is suggested in table 4.

The accumulation of this stock can be achieved in two ways--through domestic procurement and/or imports. To the extent that domestic production exceeds Q_t or some other minimum consumption goal in the next few years, the stockpile could be augmented by domestic procurement, with the balance of the yearly accumulation goal supplied by concessional imports mainly from the United States. In any case, the program of stock accumulation might proceed as indicated in table 4 even if

Table 2. -- Buffer stock and storage requirements with price elasticity of demand set at -0.5.

Permitted price fluctuation	Needed stocks ($Q_1 - Q_1$)	Needed storage ($Q_u - Q_2$)
	-- million tonnes --	
	Alternative I -- 95% level of assurance	
0	14.7	17.3
± 5%	12.3	14.9
±10%	9.8	12.4
±15%	7.4	10.0
	Alternative II -- 67% level of assurance	
0	7.8	8.5
± 5%	5.4	6.1
±10%	2.9	3.6
±15%	.5	1.2

Table 3. -- Estimates of size of buffer stock and storage requirements for foodgrains.

Assumed price elasticity of demand	Assumed level of permitted price fluctuation	Q_t	Q_u	Q_1	Q_1	Q_2	Needed stocks ($Q_1 - Q_1$)	Needed Storage ($Q_u - Q_2$)
			-- million tonnes --					
			Alternative I -- 95% level of assurance					
	0	97.6	114.9	82.9			14.7	17.3
-0.5	5%	97.6	114.9	82.9	95.2	100.0	12.3	14.9
	10%	97.6	114.9	82.9	92.7	102.5	9.8	12.4
	15%	97.6	114.9	82.9	90.3	104.9	7.4	10.0
-0.75	5%	97.6	114.9	82.9	93.9	101.2	11.0	13.7
	10%	97.6	114.9	82.9	90.3	104.9	7.4	10.0
	15%	97.6	114.9	82.9	86.6	108.6	3.7	6.3
-1.00	5%	97.6	114.9	82.9	92.7	102.5	9.8	12.4
	10%	97.6	114.9	82.9	87.8	107.3	4.9	7.6
	15%	97.6	114.9	82.9	82.9	112.2	0	2.7
			Alternative II -- 67% level of assurance					
	0	97.6	106.1	89.8	--	--	7.3	8.5
-0.5	5%	97.6	106.1	89.8	95.2	100.0	5.4	6.1
	10%	97.6	106.1	89.8	92.7	102.5	2.9	3.6
	15%	97.6	106.1	89.8	90.3	104.9	0.5	1.2
-0.75	5%	97.6	106.1	89.8	93.9	101.2	4.1	4.9
	10%	97.6	106.1	89.8	90.3	104.9	0.5	1.2
	15%	97.6	106.1	89.8	86.6	108.6	(-)3.2*	(-)2.5*
-1.00	5%	97.6	106.1	89.8	92.7	102.5	2.9	4.1
	10%	97.6	106.1	89.8	87.8	107.3	(-)2.0*	(-)1.2*
	15%	97.6	106.1	89.8	82.9	112.2	(-)6.9*	(-)6.1*

* No buffer stock or storage needed.

Table 4. -- Proposed composition and accumulation of foodgrain buffer stock.

Year	Wheat	Rice	Coarse Grains	Total
	-- million tonnes --			
1969 (on hand, Oct. 1)	2.0	1.5	0.5	4.0
1970 (additional)	.5	.5	--	1.0
1971 (additional)	.5	.5	--	1.0
1972 (additional)	.5	.5	--	1.0
Total	3.5	3.0	0.5	7.0

domestic production falters by relying fully on imports to do the job. Of course the stockpile's composition need not be rigid and could be adapted, within limits, to accommodate the actual production and marketing patterns which develop.

This suggested program is broadly consistent with the announced intention of stopping regular concessional imports of foodgrains after 1971. Even if regular concessional imports are stopped after 1971 or 1972, irregular imports of this type might be used from time to time to rebuild or supplement buffer stocks.

Storage

The problems of storage involve not only having adequate capacity given the goals of the scheme, but also having suitable capacity in the right place and at the right time. Further, the problem of turn-over of stocks is largely determined by the quality of storage facilities and the commodities held. For instance, wheat when stored in bags usually can be kept for only one year. When stored in bulk, however, it can be preserved for about five years in silos and three years

in a scientific flat storage. It is beyond the scope of this report to examine the detailed problems of storage for the buffering schemes suggested. However, some of the overall issues are discussed in this section.

At the outset, it might be useful to mention a method of reducing the size of storage capacity needed to conduct a rather sizeable buffering operation. If, due to a good crop in any given year, it becomes necessary for the agency to procure large quantities of foodgrains, the agency could be permitted to export the volume over and above the domestic storage capacity and thereby hold the buffer in foreign currency. In years of low production, foreign exchange reserve created out of the sales of foodgrains could be utilized for making commercial imports. This would help to reduce the losses on account of long storage and reduce the needed domestic storage capacity for a given size of buffer stock.

In terms of location, adequate storage accommodation is required in surplus production areas and ports to avoid transport bottlenecks and waste during the procurement period. At the same time, storage depots are also necessary at distribution points such as chronically deficit areas, areas often affected by floods and droughts, and large cities and industrial centers. Since the construction of storage facilities is quite costly, it would likely be feasible to rent, where possible, existing good storage capacity through the private sector rather than build completely new facilities. Estimates of storage requirements are indicated in the analysis of the size of buffer stocks, tables 2 and 3.

There are, however, some other factors which also should be considered in determining storage requirements. Assuming the target of 5 million tonnes of buffer stock already laid down in the fourth Five Year Plan and adding to that

an additional 2 million tonnes suggested by this analyses, the total buffer stock at the end of a season (i.e. in October) would be 7 million tonnes. If the stock were to be built up entirely through imports, the storage requirement would be 7 million tonnes plus 10 to 15 percent to allow for vacant space for operational reasons (i.e., in the short supply period of October the stocks would be mainly in deficit areas while much storage capacity in surplus areas might be empty). Thus total storage requirement would be about 8 million tonnes. Further, if the buffer stock is to be built up partly through internal procurement there would be times in May and June when large supplies will have to be provided for distribution throughout the year. This would require at least another 1.5 million tonnes of storage. In the peak marketing period when procurement would be taking place, grain would be moving from surplus to deficit areas. A part of the storage in deficit areas may be under-utilized for some time until replenished by stocks carried from surplus areas. Thus the total storage requirement might be on the order of 9.5 million tonnes for the buffer stock program.

Financial Requirements

The amount of storage needed for successful implementation of a buffer stock scheme have been suggested. Some rough estimates of financial requirements should be provided. Financial requirements include acquisition costs, operating costs, and capital costs.

It is assumed that if wheat is purchased at Rs 76 per quintal, its economic cost after adding commission, transport expenses, bag cost, taxes, interest charges (calculated roughly 4 months in a year), is Rs 95 per quintal.[4/] This

---

4/ One rupee (Rs 1) is equivalent to about 13 cents. A quintal is one tenth of a metric ton or 220.46 pounds.

would be the per unit cost for the operational stock which is used within the year. There are also carrying expenses from one year to another. These include interest charges for one year, storage costs for one year, and losses in storage. The cost for of all these items is taken as Rs 10 per quintal. Thus wheat, which is purchased at Rs 76 per quintal, will cost to the government Rs 95 per quintal in the lean season of the same year and Rs 105 per quintal in the lean season of the next year. In case of rice, the total cost has been assumed to be Rs 115 per quintal. For coarse grains, it has been taken as Rs 70 per quintal. This gives a weighted average cost of Rs 968.5 per tonne for foodgrains as a whole, using the commodity composition of the stock suggested in table 4.

On this basis the total acquisition and operating costs of 7 million tonnes of foodgrains would work out to approximately Rs 6.8 billion or about $900 million.

Capital costs are sustained as new storage facilities are built and old facilities improved. Assuming that there is a storage capacity of about 5.5 million tonnes already available in the country, the additional capacity needed would be about 4.0 million tonnes. For bagged storage, the cost is estimated at Rs 200 per tonne. For grain silos, needed for maintaining quality over seasons, the cost would be higher, say, Rs 250 to Rs 300 per tonne. Taking an average of Rs 250 per tonne, the total capital cost needed for storage of 4.0 million tonnes would be Rs 1.0 billion or about $130 million.

The capital costs could be covered over a long period of time by storage and handling charges, but the large initial investments for grain and new storage facilities would still have to be financed from current government budgets. The storage handling, and distribution costs of the buffer stocks would go on year after year when stocks are held. These costs together with any net losses sustained

in buying and selling in the established price ranges, can be regarded as the costs of increased stability in foodgrain prices and supplies.

Some Hypothetical Results

Suppose that the government of India had operated a buffer stock program throughout the 20-year period, 1949/50 to 1968/69. Table 5 illustrates the acquisitions and disposals of foodgrains that would have been required under the following assumed conditions:

1. That, beginning in 1949/50, the government of India had correctly assessed the growth rate in foodgrain production at approximated 2.3 percent per year, and continued to operate on this basis.
2. That the price elasticity of demand for foodgrains was constant at -0.5.
3. That permitted foodgrain price fluctuations were ± 10 percent per year throughout the period, *ceteris paribus*.

Column (1) of table 5 contains the estimated trend values of foodgrain production (see figure 2 and table 1). Column (2) shows the permitted fluctuation of output under the above assumed conditions. Within this range, the buffer stock agency would neither acquire or dispose of stocks. Column (3) shows the output fluctuations that actually did occur. Columns (4) and (5) display the acquisitions and disposals of foodgrains that would have been required to iron out the actual supply fluctuations to the permitted levels.

A beginning buffer stock of 6.3 million tonnes would have been adequate to meet estimated needs, up to and including the very poor crop year of 1965/66. However, the poor crop of 1966/67 in conjunction with the poor crop in the previous year would have depleted this scheme and virtually any other feasible buffer stock program. Moreover, storage facilities equipped to handle up to 11.4 million tonnes

Table 5. -- Hypothetical acquisitions and disposals of foodgrain buffer stocks 1949/50 - 1968/69; Assuming price elasticity of demand equal to -.05, and permitted price fluctuation equal to ± 10%.

Year	Trend value of production (1)	Permitted fluctuation around trend (2)	Actual fluctuation around trend (3)	Acquisitions (4)	Disposals (5)
		Million Tonnes			
1949/50	59.30	± 2.96	+ 1.35	0	0
1950/51	60.70	± 3.03	- 5.78	0	2.75
1951/52	62.10	± 3.10	- 6.59	0	3.49
1952/53	63.50	± 3.18	- 1.83	0	0
1953/54	64.90	± 3.24	+ 7.29	4.05	0
1954/55	66.40	± 3.32	+ 4.21	.89	0
1955/56	67.90	± 3.39	+ 1.32	0	0
1956/57	69.50	± 3.48	+ 2.84	0	0
1957/58	71.10	± 3.55	- 4.60	0	1.05
1958/59	72.70	± 3.64	+ 5.99	2.35	0
1959/60	74.40	± 3.72	+ 2.30	0	0
1960/61	76.10	± 3.81	+ 5.92	2.11	0
1961/62	77.80	± 3.89	+ 4.91	1.02	0
1962/63	79.60	± 3.98	+ .55	0	0
1963/64	81.40	± 4.07	- .76	0	0
1964/65	83.20	± 4.16	+ 6.16	2.00	0
1965/66	85.10	± 4.26	-13.07	0	8.81
1966/67	87.10	± 4.35	-12.87	0	8.52
1967/68	89.20	± 4.46	+ 5.85	1.39	0
1968/69	91.10	± 4.56	+ 2.91	0	0

would have been required if all buffer stock acquisitions were held internally as grain. A beginning stock of 12.2 million tonnes in 1949/50 and maximum storage capacity of 17.3 million tonnes would have been required to deal with all the fluctuations up to and including both drought years 1966/67 and 1967/68.

If the buffer stock had been established in 1959/60, perhaps with concessional imports of foodgrains, 12.2 million tonnes also would have been needed to meet all fluctuations including the emergencies in 1965/66 and 1966/67. A 3.7 million tonne buffer stock with 8.8 million tonnes of storage beginning in 1959/60 would have been adequate to meet all fluctuations up to and including the poor crop year of 1965/66, but not the short crop of 1966/67.

Although these results, based on historical experience, are only hypothetical, they do suggest that a buffer stock of something like 7.0 million tonnes would be capable of dealing with most year-to-year fluctuations in foodgrain production. However, the results also suggest that there may be recurrent periods of shortage or surplus which no feasible stockpile, financial balance, or set of storage facilities could meet adequately.

Concluding Comments

The building and operating of a buffer stock in foodgrains appears to be a feasible and potentially useful project for the government of India. Although such a buffer stock will not solve the major food problems facing the nation, it could do much to reduce year-to-year fluctuations in prices, foodgrain availability, and therefore real incomes in India. By promoting price stability, it would provide incentive to producers to invest in productive resources for foodgrains. The agency would buy and hold grain in years of abundant supplies thus holding prices above an agreed minimum level. It would sell grain in years of short supplies thus keeping prices from exceeding an agreed maximum

level and assuring a more adequate food supply than otherwise would prevail. Careful planning, competent management, and administrative autonomy should be reflected in the operation of such an agency.

Apart from supplies held for public food distribution and other welfare programs, a buffer stock of 7 million tonnes would provide a reasonable level of protection for India's foodgrain consumers. Assuming that the price elasticity of demand for foodgrains lies between -0.5 and -0.75, a 7 million tonne stock probably could handle production fluctuations better than 9 out of 10 years and hold maximum price changes to approximately 10 to 15 percent annually. A tighter permitted range of price fluctuation, say 5 to 10 percent per year could be handled by this buffer stock about 2 out of 3 years.

Acquisition and storage problems are formidable. However, the potential availability of foodgrain supplies under P.L. 480 from the United States could ease the acquisition problem. In general, the foodgrain buffer stock problem discussion and partially analyzed in this report is consistent with India's planned goal of "growth with stability".

Selected References

1. Cochrane, Willard W., The World Food Problem-A Guardedly Optimistic View, (Crowell Co. Inc.: New York) 1969.

2. F.A.O., "Price Stabilization Projects for Staple Food Crops in Developing Countries"--Note by the Executive Director for Twelfth Session, Rome, October, 1967.

3. Keynes, J. M., "The Objectives of International Price Stability," Economic Journal, June-September, 1943.

4. Massell, Benton, F., "Price Stabilization and Welfare," Quarterly Journal of Economics, May, 1969.

5. McKinnon, Ronald I., "Futures Markets, Buffer Stocks, and Income Stability for Primary Producers," Journal of Political Economy, December, 1967.

6. Powell, Alan A., and Keith O. Campbell, "The Significance of Non-Speculative Returns in the Appraisal of Buffer Stock Schemes," Journal of Farm Economics, August, 1962.

7. Waugh, F. V., "Reserve Stocks of Farm Products-Agricultural Policy: A Review of Programs and Needs," Volume V. Technical Papers National Advisory Commission on Food and Fiber, August, 1967.

8. Wold H., and L. Jureen, Demand Analysis, (Wiley: New York) 1953.