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WHEAT STORAGE POLICY IN PAKISTAN: IMPLICATIONS OF PRICE POLICY AND PRODUCTION INSTABILITY

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EXECUTIVE SUMMARY

The government of Pakistan is concerned about stabilizing prices and supplies of the staple food for its population, wheat. The government has an influence on the wheat market through procurement and releases. These activities are only possible because of public stockholding. This report studies the appropriate capacity of storage facilities for wheat to meet both present and future needs.

The analysis begins with a categorization of the different reasons why stocks may be held, and then proceeds to calculate the size of the three different components of stockholding. In the process, considerable insight is gained into the nature of efficient storage, trade, and price policies; trade-offs are measured between interannual price variability and fiscal cost, and between the seasonal price spread and fiscal cost; and estimates are made of the minimum amount of stock that should trigger imports month by month. The resulting figure for storage capacity is highly sensitive to the size of the gap between the procurement price and the release price. At the 1987/88 gap of 8 paisa per kilogram, required capacity is 5.4 million tons today, rising to 8.2 million tons in the year 2000; with a gap of 30 paisa, required capacity falls to 3.5 million tons today and 5.3 million tons in the year 2000.

The three reasons for government stockholding are as follows:

(1) to move wheat from surplus to deficit years;

(2) to move wheat from surplus to deficit seasons;

(3) to ensure a smooth flow of supplies at all times, especially when imports are on order but not yet available domestically.

These three components of storage policy can be termed interannual supply stabilization stocks, seasonal stocks, and import buffer stocks. They are studied in Chapters 2 through 4, respectively.

INTERANNUAL SUPPLY STABILIZATION STOCKS

The first storage requirement is commonly cited as the primary purpose of government stockholding. Production varies from year to year in ways that cannot be anticipated. Since Pakistan is self-sufficient in wheat at prevailing prices in a normal production year, production variability can lead to exportable surpluses in one year followed by imports in the following year. The government loses money in such circumstances since there are large differences between import and export parity prices. The government has the option, then, of storing some portion of an exportable surplus and releasing these stocks in deficit years.

Variability in production must be translated into either consumption variability, stock variability, or trade variability. Chapter 2 of this report examines when each of these is appropriate given the relative preferences of the government.

The first step in estimating capacity requirements for interannual supply stabilization stocks is identifying the extent of

the variability of wheat production in the country, and seeing if this variability has been changing over time. The coefficient of variation of mean production -- that is, the standard deviation of a detrended production series, divided by the mean -- has increased to about seven percent in recent years, although the increase is not statistically significant. This implies that in two out of three years, production will be within seven percent of its trend. This level of variability is low compared to other countries, primarily because of the relative stability of yields in irrigated cropping systems. The inherent variability of wheat production is actually lower than seven percent, since past changes in government policies have induced some fluctuations in production around trend.

Despite this relatively low level of production instability, price variability would be fairly high in the absence of government intervention in the market. A non-intervention model estimates that harvest-time procurement prices would be higher than Rs 95 one out of six years, and lower than Rs 65 one of out six years. The government, then, has some rationale for intervention to stabilize prices and consumption.

Given this rationale, an optimizing model is built which allows for different relative preferences between the government objectives of lowering fiscal expenditure and lowering price and consumption variability. World prices and production vary exogenously in the model, with domestic price, imports, and stocks under the control of the government.

Stabilizing supplies by holding stocks across years turns out to cost more money than it saves on average. Regardless of the degree

of government preference for price stability, the efficient policies do not hold interannual supply stabilization stocks unless the world price for wheat falls below US$80 per ton. This result assumes that Pakistan has access to some food aid in deficit years. Even under the extreme assumption that Pakistan never receives food aid, only 50 thousand tons of interannual supply stabilization stocks are held when the world price is US$100 per ton, and no such stocks are held at higher world prices.

Thus, interannual supply stabilization stocks are very small on average. Should world wheat prices fall to US$60 per ton, however, efficient stockholding levels increase to 600 thousand tons if no food aid is available. It may seem appropriate to build storage capacity so that stocks of this size could be held if world prices fall. But given the low likelihood of such a dramatic fall in world prices, the expected benefits of the additional capacity do not come close to paying for construction costs. Consequently, no capacity should be added to government storage to accommodate interannual supply stabilization stocks, although in years of abundant supplies and low world prices some stocks of this type could efficiently be held if storage space is available.

Chapter 2 also investigates the benefits of introducing flexibility to official prices in Pakistan so that actual policy becomes more similar to the optimal policy. Fiscal expenditures will fall if the domestic price becomes more responsive to changes in production and world price. Thus, there is a trade-off between the government's objectives of lowering expenditure and stabilizing prices. For example, a policy which holds harvest-time prices

between Rs 73 and 87 per 40 kg is expected to cost about Rs 200 million less annually than a policy which holds those prices between Rs 78.90 and 81.10.

The benefits of allowing the domestic price to reflect changes in the world price are measured as ranging from Rs 7 to 55 million annually, depending on the degree of the government's preference for price stability. The flexibility in price required to produce these savings is not especially large; the Rs 55 million savings come from allowing the domestic price to move 85 paisa per 40 kg when the world price changes by 10 dollars per ton.

The benefits of official price flexibility to variations in domestic production are large, but difficult to measure because they depend on seasonal price policy. Flexibility to both world prices and to production could be achieved by announcing a price at planting time which is calculated by assuming a large crop and a drop in world price, then paying the farmer a "world price bonus payment" and a "crop size bonus payment" over and above the procurement price, with the size of the bonus payments dependent upon changes in the world price and the size of production.

SEASONAL STOCKS

The size of public seasonal storage is dependent on the relative importance of the government and the private sector in moving wheat from harvest time to the months preceding the next harvest. Chapter 3 begins with a study of past relationships between procurement price, wholesale price, production size, and procurement. This question is explored further by developing a model of private storage

behavior and testing the consequences of raising the gap between the procurement and release prices.

The first section of the chapter shows that procurement increases by about 840 thousand tons when production is one million tons above trend. Thus, in order to accommodate high production for 19 out of 20 years, it is necessary to allow for 1.1 million tons of additional storage capacity.

Although past patterns should provide reasonably accurate estimates of the increase in procurement in high production years, average levels of procurement in normal production years could change substantially with changes in government seasonal price policy. The recent change in government policy from a quantity-based system of releasing wheat to releasing all that is demanded at a set price fundamentally alters the relationship between the government and the private market. Government price policy will affect the private storage system primarily through its impact on the seasonal pattern of wholesale prices, and thus on price expectations within a crop year.

In the past, prices have risen about 18 percent from a low in May/June/July to a peak in December/January/February. This translates into a price rise of about Rs 14 per 40kg at current prices. In contrast, the gap between the procurement price and the release price in 1987/88 was only Rs 3.20 per 40kg, even without adjusting for the cost of the bag. If the government were to buy all that was offered at the procurement price and sell all that was demanded at the release price, the seasonal price rise would be limited to little more than that Rs 3.20 gap. This could have

serious implications for private agents who engage in storing, thereby decreasing private storage and leading necessarily to higher levels of procurement procurement -- and larger losses -- by the government.

This concern would not be an issue if private storage were small or insensitive to expected changes in price. However, estimates in this report show that private storage at the end of July has been no less than five million tons for each of the last several years. This includes wheat held by farmers, traders, and millers, with most of the wheat held by farmers.

Moreover, private storage has been quite sensitive to expected changes in price. The larger the expected seasonal price rise, the more private agents in Pakistan have held in the past. Thus, it is reasonable to conclude that any government policy which lowers the expected seasonal price rise will increase government procurement and, in turn, fiscal cost. This clearly has implications for the appropriate size of public storage.

Expected costs of a narrow gap between the procurement and release prices are high. The 1987/88 policy, which had a gap of 8 paisa per kilogram, would be expected to lead to procurement of 4.9 million tons, with average annual costs of Rs 3.5 billion. On the other hand, a policy with a gap of 30 paisa per kg implies procurement of 2.8 million tons, with average annual costs of Rs 1.3 billion. Thus, on average the government saves about Rs 100 million annually and 100 thousand tons of storage capacity for every one paisa per kg increase in the gap between the procurement and release prices.

If the goals of the government are to decrease government expenditure and to increase private sector involvement in wheat storage and marketing, increasing the gap between the procurement and release prices is an attractive option. The extent to which the gap is increased will be tempered by concerns about costs to the consumer, but consumer costs under a policy with a 15 percent price rise should be lower than under the old system since the vast majority of the rationed wheat did not reach consumers at the subsidized price.

Storage capacity required for this component, therefore, is dependent on government pricing policy. With a small gap such as that in effect during 1987/88, capacity requirements are 5.4 million tons. With a 30 paisa gap between the procurement and release prices, capacity requirements fall to 3.5 million tons.

STOCKS FOR ENSURING SMOOTH OPERATIONS

There are two elements of stocks required for smooth operations. First, stocks must be sufficient to allow for some wheat to be in transit and in godowns waiting to be sold without producing any supply disruptions. Given the historical time series of government stocks per capita, allowing one month of expected offtakes for this component is more than adequate.

Second, stocks must be sufficient to provide offtakes for four succeeding months if it is discovered that imports are required. Chapter 4 examines the past patterns of offtakes per capita by month, and the same series adjusted for procurement. The adjusted series is termed net offtakes per capita. The space required for import buffer

stocks is estimated for each month fo the year by taking the highest historical observation of four-month net offtake per capita. In order to meet this requirement in December and January, the government must be holding about 3.5 million tons in early August, and should not export unless stocks are above 650 thousand tons at the end of April.

CONCLUSIONS

Combining these different components of the demand for storage yields the figures for public storage capacity given in the opening paragraph. There are five policy changes recommended in addition to the estimation of storage capacity. In order of importance, these are:

(1) choosing a gap between the procurement and release prices which takes account of the large cost savings;

(2) holding no interannual supply stabilization stocks;

(3) introducing some responsiveness of official prices to production size through the use of "crop size bonus payments";

(4) introducing responsiveness of official prices to world prices through the use of "world price bonus payments"; and

(5) changing the law which allows the government to seize private stocks in an emergency.

Each of these changes would improve the efficiency of the wheat marketing system in Pakistan. The degree to which seasonal and interannual prices are allowed to fluctuate, however, will be based on the relative preferences of the government for reduced fiscal expenditures and price stability.

1. INTRODUCTION

1.1 THE RATIONALE FOR STORAGE

The price and availability of the primary staple food are of critical concern to all governments. Rapid increases in price or periods of unavailability can lead to calorie deprivation, real income declines, and political crises. Thus, most governments, including the government of Pakistan, take measures to moderate price fluctuations and to ensure supplies through some intervention in the market.

If the government is to have an impact on prices or availability, it is necessary to increase supplies reaching the market. This requires moving the commodity from surplus to deficit regions, or from surplus to deficit time periods. The surplus "region" may be the world market, with imports enhancing domestic supply. Often governments or parastatal organizations store, transport, and import or export the staple food for these purposes; alternately, they may conduct policies which encourage the private sector to perform the activities.

Such activities are typically expensive for governments. Storage of foodgrains in particular requires both a high capital cost up front in order to build proper facilities and high costs each year to hold the stock (typically 15 to 25 percent annually of the value of the stock). Thus, there is a trade-off between the government's ability to intervene and cost. The degree of government involvement will stop at the point where the added security is not worth the added cost. Lessening government involvement implies allowing the private sector to conduct more of the storage and transport

operations, with the consequence of a larger degree of price variability but lower cost.[1]

Estimating the economically efficient size of government storage facilities is one important component of limiting government cost. This is a particularly relevant topic for Pakistan because present storage facilities are in need of repair, and new facilities are being considered. In addition, the conversion of the storage system to bulk-handling is being studied.

Calculating such a number requires an analysis of the rationale for holding stocks. There are three reasons for governments to hold stocks of grain:[2]

(1) To move supplies from a surplus year to deficit year;

(2) To move supplies from a surplus season to a deficit season;

(3) To avoid any disruption in supply, particularly while imports are on order but before they arrive in the country.

In short, these three rationales can be termed the interannual, seasonal, and import buffer storage requirements. These three distinct demands on government storage can be confused easily, yet analyzing the requirements for each must remain distinct. General considerations for analyzing them will be considered in turn in the remainder of this introduction, followed by separate chapters on the

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[1] If the government is attempting to defend a price policy which it is fiscally unable to enforce, the result may be higher cost and higher actual price variability than what would result from allowing some official price variability. There is some evidence that this was the case in Kenya in the early eighties. See Pinckney (1988).

[2] For a similar analysis of the reasons for government storage, see Siamwalla (1988).

empirical measurement of each need, and a final chapter on policy options for the government.

1.2 INTERANNUAL SUPPLY STABILIZATION STOCKS

The analysis of storage requirements for moving supplies from a surplus year to a deficit year is best begun by examining a simple identity.[3] For a particular year in any country, total supply must equal total demand. There are three possible sources of supply -- production, opening stocks, and imports -- and three possible sources of demand -- consumption, closing stocks, and exports.[4] In equation form, this can be stated:

(1) $Q_t + S_{t-1} + M_t = C_t + S_t + X_t$

where the subscript refers to the year and Q is production, S is closing stocks, M is imports, C is consumption, and X is exports. Solving for Q yields:

(2) $Q_t = (S_t - S_{t-1}) + (X_t - M_t) + C_t$

That is, production equals the change in stocks plus net exports plus consumption.

Equation 2 implies that when production -- Q_t -- fluctuates from one year to the next, at least one of the three terms on the right-hand side will also have to fluctuate. In other words, production variability <u>must</u> be translated into stock variability, trade variability, or consumption variability.

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[3] See Josling (1981) for a fuller discussion of this and other identities relating to food security.

[4] In this formulation, food aid is included with imports, public and private stocks are aggregated, and production is taken to be net of losses and seed.

A country which is an exporter in a normal production year can buffer production fluctuations by reducing exports, provided the production shortfall is less than its usual exportable surplus. Similarly, a normal-year importing country can increase imports in a bad year. The production shortfall could translate into tightness in the supply of foreign exchange -- and if domestic prices are not at parity with world prices, or if the exchange rate is misaligned, the country may want to adjust domestic prices in order to decrease consumption during the shortfall. In neither the case of the importer nor the exporter, however, is it likely that stock changes will play any role in buffering such production fluctuations. The exporter would have to forego exports in year t-1 if it is to hold stocks for a possible shortfall in supply in year t. Thus, although holding stocks may allow the country to maintain exports in the face of the production shortfall in year t, the net effect is to move exports from year t-1 to year t, while incurring a year's worth of storage charges. Such an operation would lose money unless there is a very large movement in world prices between the years. A similar analysis would hold true for the importing country.[5]

The situation is considerably more complicated when a country is self-sufficient in a normal production year, as Pakistan is with wheat. This results primarily from the costs of engaging in foreign

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[5] This paragraph assumes that the country is always an exporter, even in a bad year. A country such as Zimbabwe which is an exporter of maize in a normal year but occasionally has a disastrous year and is forced to import is more similar in this regard to a normally self-sufficient country.

trade.[6] If Pakistan could buy wheat in a deficit year at the U.S. Gulf Port price, and sell in a surplus year at the same price, the situation would be the same as for the normal year exporter. But in fact, Pakistan's export price is about US$25 less than the U.S. Gulf Port price, and the import price is about US$40 above that price. Thus, if Pakistan has a surplus in one year, and knows that it will be in deficit the next year, it is profitable to store the commodity for one year since storage costs are about US$25 per ton.

The problem is that next year's crop is not known, and if the stock has to be stored for more than a couple of years, the government is losing more money than if they were to depend on imports. Thus, there is no obvious answer to the question of whether or not stocks for interannual supply stabilization should be held by a normally self-sufficient country. The specific answer to Pakistan's question of how much should be stored under what circumstances is studied in Chapter 2.

The simple identity in equation 2, however, does provide at least three clues as to the general type of policy that will be most effective:

First, a "food security reserve" which ends every market year at the same level is totally ineffective in compensating for shortfalls in production. In Equation 2, it is the change in stocks which counteracts the shortfall in production. Thus, if stocks do not change, whether they begin and end the year at 0 or 3 million tons, all of the production decline will be translated into increased

[6] For countries where the staple food is rice or white maize, the thinness of the international market is another consideration. See Siamwalla (1988).

imports or decreased consumption. Such a reserve may act as an import buffer -- the third type of storage requirement, discussed below -- but it does not stabilize consumption across years.

Second, domestic price policy is intimately related to storage questions. In equation 2, if domestic prices are allowed to change in response to fluctuations in production, consumption will change leading to less of a need for stock or trade variability. The extent to which domestic consumption varies with domestic production is thus important in the formulation of a storage strategy.

(3) Finally, trade variability and stock variability can be substitutes for each other. Thus, a country may depend totally on trade, or mostly on stock changes to make up for production surpluses and shortfalls. For a wheat-consuming country, the choice between relying on one or the other should be based purely on cost after accounting for any misalignment of the exchange rate (recall that stocks to cover the delay between ordering and receiving imports are analyzed separately), as consumers have no clear preference for domestic wheat or imported wheat and the international market for wheat is well-functioning. It is likely that the relative costs of relying on trade or stocks will vary with the world price.

Given these clues, then, the question is, how much should domestic prices adjust to a production deviation, thereby allowing consumption to vary with production? Of the remaining production variability, how much should be assigned to stock variability, and how much to trade variability?

The answers to these questions depend on the characteristics of the country in question. One particularly important parameter is the

degree of willingness of the government to spend fiscal resources to stabilize consumption. These issues are discussed in detail in Chapter 2. At this point, the discussion turns to the second rationale for holding stocks: moving stocks from a surplus season to a deficit season.

1.3 SEASONAL STORAGE

Equation 2 above can be generalized to make it appropriate not only to years but also to seasons. Distinguishing between private and public stocks is necessary in this context. If time period t is considered to be, say, quarters of the marketing year with April/May /June being quarter 1 and January/February/March being quarter 4, after isolating consumption on the right hand side the equation becomes:

(3) $Q_t + (SG_{t-1} - SG_t) + (SP_{t-1} - SP_t) + (M_t - X_t) = C_t$

where SG is government stocks, SP is private stocks, and $Q_t = 0$ if t equals 2, 3, or 4.

The equation shows that consumption equals this quarter's production plus the net decline in government stocks plus the net decline in private stocks plus net imports. The same equation holds for the annual case, the main difference being the extreme production instability which is known ahead of time in the quarterly case. In Pakistan, for three quarters all consumption comes from stock drawdowns or imports. As in the annual case, stock variability and trade variability are substitutes. The rationale for holding stocks is much stronger in the seasonal case, however, since it is known that no production will take place for three quarters and since the

lag between ordering and receiving imports will be at least one full quarter. Nevertheless, a country which is a normal year importer can reduce domestic storage costs considerably by timing imports to coincide with the pre-harvest period.

Price policy has a larger impact on seasonal storage than on interannual storage because of the increased importance of private stocks. Private stocks should respond to changes in expected prices; evidence reported in chapter three indicates that private stocks in Pakistan respond readily. A government policy which involves increases in government stocks and decreases in the seasonal price rise may actually lower total stocks if the price effect on private stocks is greater than the additional government stocks. In addition, allowing seasonal prices to increase has the same effect as in the interannual case of decreasing consumption during the scarce months.

The other point to be made from the equation is the trade-off between private and public stocks: if private agents do not store wheat, all seasonal storage will have to be conducted by the government. Since in Pakistan about a million tons of wheat are consumed each month, theoretically the potential demand for storage at the end of May is over 10 million tons. Thus, seasonal storage issues have the potential to be extremely costly in terms of operating costs and storage space requirements.

The final point is an obvious one: seasonal storage demand is seasonal. The peak for this type of storage is immediately after the harvest -- typically the end of June for government storage in Pakistan -- while the minimum is virtually zero immediately prior to

the harvest. To the extent that the other two reasons for holding stocks have seasonal components, total storage capacity required by the government is likely to be less than the sum of the maximum requirements for each reason. Thus, it will be necessary to consider the storage requirements on a monthly or quarterly basis.

1.4 STORAGE FOR AVOIDING DISRUPTIONS IN SUPPLY

This type of storage is composed of amounts that are required at any one time to be in transit or in regional stores, and the amount necessary to allow for the delay in the arrival of imports when they are necessary. Since the latter requirement is likely to be the largest in most months, the term "import buffer stocks" is appropriate and will be used here. In some analyses, this component of storage is termed "working stocks", but that term can be confusing since it is also used for seasonal storage in many papers.

The key questions in this respect are as follows: How long does it take the government to make a decision to import, including the allocation of foreign exchange? Once ordered, how long is the delay before imports arrive, are unloaded, and are available? What is the distribution of net offtake from government stocks for different months?

This last question indicates that this component of storage, like the seasonal stock component, will vary by month. Unlike the other components of storage, however, little can be said about this component prior to examining empirical data. Chapter 4 conducts the empirical analysis.

This study does not examine the appropriate location of government storage. This issue has been considered by Majeed (1985). Nor does this report study storage needs for crops other than wheat. Instead, the focus is on the three reasons for wheat stocks, and the implications of these reasons for policy.

Thus, this introduction has outlined the three reasons that government may desire to hold stocks. Chapter 2 begins with an analysis of the level of variability of wheat production in Pakistan, and then examines efficient policies for stabilizing wheat consumption given that level of production variability. The analysis shows that interannual supply stabilization stocks should be close to zero in Pakistan unless world prices decline to unprecedented levels. Chapter 3 considers the seasonal demand for storage. This amount is seen to depend on government price policy, with the gap between the procurement and release prices changing the storage requirement by millions of tons. Chapter 4 analyzes the final component, the amount necessary to ensure availability of supplies. Chapter 5 draws the different pieces together, showing that the seasonal component dominates the others in terms of total required storage capacity.

2. STORAGE AND PRICE POLICY IMPLICATIONS OF INTERANNUAL SUPPLY STABILIZATION

2.1 INTRODUCTION

The most commonly heard justification for government involvement in storage operations is to stabilize supplies across surplus and deficit years. The chapter examines the rationale for holding such stocks in Pakistan by, first, studying past production instability. Section 2.2 examines these issues in some detail for national cereal production and for regional wheat production. Given the inherent instability of the production system and the government's objectives of stabilizing prices without spending an inordinate amount of money, Section 2.3 uses an optimization model to examine questions concerning the appropriate role of foreign trade and stockholding. That section also considers whether or not it is worthwhile for Pakistan to build additional storage to accommodate the interannual supply stabilization stocks that are efficient to hold. The next section studies policy modifications which would make the system more efficient, such as adjusting the domestic purchasing price to changes in the world price and to changes in domestic production. The value of such policy modifications is measured, and a scenario for how these policies might work in practice is presented. The final section sums up the implications of this analysis for Pakistan.

2.2 INSTABILITY OF PAKISTAN'S CEREAL PRODUCTION

One important parameter necessary for conducting calculations of the costs of stabilizing wheat prices and consumption is the instability of production in the country. Instability is often measured in terms of the coefficient of variation of production -- that is, the standard deviation of production divided by the mean, expressed as a percentage. A higher coefficient of variation implies higher instability relative to the average size of the crop, leading to increased fiscal costs for the same degree of price stability. The absolute level of instability is given by the standard deviation.

Instability of all cereal production is examined here in order to weigh the relative importance of the variability of wheat production vis-a-vis other cereals, and to measure the importance to overall variability of correlations between the production of different cereals.

One simple method for measuring both the level of instability and its trend is to compute the coefficient of variation for detrended production data for successive 10-year periods. This is done in Tables 2.1, 2.2, and 2.3 for wheat, basmati rice, and non-basmati rice on a national level. Tables 2.6 and 2.7 present similar results for wheat production in two of the most important agro-ecological zones -- the Punjab Rice/Wheat zone and the Sind Cotton/Wheat zone.[1]

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[1] Hamid et al (1987) describes these agro-ecological zones in more detail. Appendix A lists the zones used in that report along with the districts assigned to each zone.

Table 2.1: Changes in the Means and Variability of Pakistan Wheat Production

Years	Mean Production (000 Mt)	Mean Area (000 Ha)	Mean Yield (Mt/Ha)	c.v. Production %	c.v. Area %	c.v. Yield %
68-77	7420	6054	1.23	4.8	4.6	3.3
69-78	7616	6092	1.25	5.5	4.3	4.1
70-79	7949	6145	1.29	5.4	3.5	4.1
71-80	8305	6214	1.33	5.7	2.8	4.2
72-81	8805	6315	1.39	6.4	2.9	4.2
73-82	9257	6457	1.43	6.0	3.3	4.0
74-83	9754	6600	1.47	6.4	3.7	4.0
75-84	10080	6723	1.49	7.0	3.7	5.4
76-85	10483	6868	1.52	6.8	2.8	5.5
77-86	11013	6997	1.57	6.9	2.2	6.1
78-87	11310	7114	1.59	7.8	2.1	6.7

Table 2.2. Changes in the Means and Variability of Basmati Production in Pakistan

Years	Mean Production (000 Mt)	Mean Area (000 Ha)	Mean Yield (Mt/Ha)	c.v. Production %	c.v. Area %	c.v. Yield %
70-79	561.7	471.8	1.185	18.0	15.8	8.3
71-80	590.9	501.1	1.176	15.2	14.5	8.4
72-81	647.8	540.0	1.201	16.4	15.6	5.2
73-82	714.9	591.2	1.210	16.4	15.1	5.2
74-83	775.9	641.0	1.213	13.9	13.0	5.1
75-84	823.9	686.1	1.200	12.0	10.3	4.7
76-85	859.5	714.6	1.201	11.6	10.2	4.7
77-86	883.6	736.9	1.198	12.6	11.0	4.8
78-87	896.6	758.8	1.179	15.7	12.1	5.9

Table 2.3: Changes in the Means and Variability of Non-Basmati Rice Production in Pakistan

Years	Mean Production (000 Mt)	Mean Area (000 Ha)	Mean Yield (Mt/Ha)	c.v. Production %	c.v. Area %	c.v. Yield %
70-79	1992.3	1184.3	1.679	7.3	7.2	4.1
71-80	2043.9	1196.3	1.705	7.3	7.2	4.0
72-81	2079.0	1200.4	1.730	7.4	7.3	3.9
73-82	2129.4	1201.1	1.774	7.2	7.6	5.3
74-83	2179.4	1201.1	1.818	7.1	7.9	6.2
75-84	2220.0	1204.7	1.847	7.0	8.0	6.1
76-85	2285.0	1215.6	1.886	5.2	7.7	5.2
77-86	2291.1	1208.6	1.903	8.1	8.5	6.0
78-87	2356.3	1220.0	1.937	8.3	8.7	5.7

The tables are created in the following manner. A linear trend is calculated for area, yield, and production for each of the commodities for the entire time period. The standard deviation of the residuals from these regressions is then computed for each successive 10-year interval and divided by average production for that period to yield the coefficient of variation of the detrended series.

The first table presents results for Pakistan wheat production. Wheat production instability has been increasing over time, as the increase in yield instability has more than offset the decline in area instability. The coefficient of variation of production has increased from 4.8 to 7.8 percent from 1968-77 to 1978-87 even though the c.v. for area has decreased from 4.6 to 2.1 percent. Yield instability more than doubles, from 3.3 to 6.7 percent, although much of the increase occurred in the first year.

The results for rice are less clear, as the trends are not consistent over the entire time period.[2] For both varieties, yield instability is less than area instability, indicating that policy considerations may be more of a factor in rice production instability than any inherent instability because of weather or other exogenous factors.

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[2] The tables for rice begin in 1969/70 because data on rice production by variety are not available prior to that year.

A Decomposition of the Total Variance of Cereal Production in Pakistan

Increases in total variability result from a combination of statistical factors. Hazell (1982, 1984, 1985) has developed a technique for decomposing the variance of crop production into component parts. Hazell (1984) explains the methodology in detail. This technique has been especially useful for identifying whether or not production variance has been changing over time, and, if so, discovering the source of the change. In most of the countries studied to date, the variance of cereal production has been increasing.

In a recent overview paper for a conference on production instability, Hazell (1985) presents basic results for numerous countries, including Pakistan. These results are informative because of the comparison across countries that they allow. Interestingly, the coefficient of variation of production of cereals in Pakistan for 1972 to 1983 is the second smallest of the 34 countries in the study. Although the tables above show some increase in instability since 1983, it is important to note that Pakistan's problems in this regard are far less than those for almost any other country in the world, primarily because of the prevalence of irrigated cereal production.

The results of Hazell's study are expanded here for Pakistan by extending the time period to 1984/85, considering only the post-Green Revolution period, and by using provincial and agro-ecological zone data. In the remainder of this section, results of four different variance decompositions are presented. First, the variance of cereal production for the entire time period is decomposed into that due to

individual crops and to provinces.[3] Second, the variance of wheat production for the entire period is decomposed by production zone. The last two decompositions follow Hazell by dividing the time period in half and decomposing the change in the variance, first for total cereals by province and crop, and second for wheat by zone.

Table 2.4 presents the results of the first decomposition. The total variance of each crop is first broken up into the proportion which is attributable to individual provinces and correlations between production in different provinces (column 1). At the bottom of column 1, the total variance of cereal production is divided into that which comes from individual crops (65 percent) and that which comes from other sources.

Column two presents the weight of the provincial contribution to each crop variance; that is, each province's proportion of the variance due solely to provincial differences. Note that Punjab accounts for a much higher share of the variance of wheat production than its share of production. Although less than 75 percent of Pakistan's wheat is grown in Punjab, over 90 percent of the variance attributable to individual provinces comes from Punjab. Conversely, Sind supplies 16 percent of the country's wheat, but contributes only three to four percent of the variance directly. For rice and maize, variance proportions are close to production proportions.

The two varieties of rice are aggregated for the variance decomposition since the time period of analysis for all crops must be the same. This is unsatisfactory because of the differences in characteristics of the varieties, but necessary because of the short length of the time series.

Table 2.4 Decomposition of the Total Variance of Pakistan Cereal Production, 1967/68 to 1984/85

Crop	Province	% of Variance	% of Variance Directly Attributable to Provinces	% of Provinces
		(1)	(2)	(3)
Wheat				
	Punjab	59.7	91.8	74.2
	Sind	3.6	5.5	16.3
	NWFP	1.3	2.0	7.4
	Baluchistan	0.4	0.6	2.1
		65.0	100.0	100.0
	Inter-Provincial co-variances	35.0		
Rice				
	Punjab	46.5	52.7	47.4
	Sind	36.2	41.0	45.8
	NWFP	0.1	0.1	3.0
	Baluchistan	5.6	0.6	3.8
		88.3	100.0	100.0
	Inter-provincial co-variances	11.7		
Maize				
	Punjab	26.8	43.2	46.7
	Sind	0.1	0.2	1.4
	NWFP	35.1	56.6	51.5
	Baluchistan	0.0	0.0	0.4
		62.0	100.0	100.0
	Inter-provincial co-variances	38.0		
Total Cereal				
	Wheat	54.2	83.0	67.9
	Rice	10.3	15.8	20.6
	Maize	0.4	0.6	6.2
	Millet & Sorghum	0.4	0.6	4.4
	Barley	0.1	0.2	1.0
		65.3	100.0	100.0
Covariance of different crops in same province		7.2		
Covariance of same crop in different provinces		31.0		
Covariance of different crops in different provinces		-3.4		
Total		100.0		

Decomposing the variance of total cereal production shows that wheat is the primary source of variability. Wheat contributes 68 percent of total cereal production but is the source for 83 percent of the variance which can be attributed to individual crop instability. Maize, millet, sorghum, and barley contribute hardly at all to total variance. This justifies further concentration on the breakdown of wheat variance, and shows that the costs of ignoring production instability of other crops in the forthcoming analysis is small.

Table 2.5 presents the results of decomposing the total variance of wheat production by agroclimatic zone. The results are dominated by the correlations of wheat production among zones, as over 76 percent of the variance can be attributed to these correlations. Nevertheless, it is interesting that of the remaining 24 percent of the variance, the Rice/Wheat Punjab zone accounts for a disproportionately high share. This zone produces about 16 percent of the country's wheat, but is responsible for over 25 percent of the variance attributable to individual zones. Cotton/wheat Sind, on the other hand, contributes less to total variance than its proportion of production.

A priori, one might expect the rainfed (barani) areas to be responsible for a large share of the variance, but this view is notsupported by the analysis. The Barani Punjab zone is responsible for only 5.5 percent of the zone-specific variance -- higher than its share of wheat production, but small in total. Even if all the variance of Other Baluchistan and Other NWFP is added to the Barani

Table 2.5 A Decomposition of the Total Variance of Pakistan Wheat Production, 1967/68 to 1984/85

Wheat Production Zone	% of Variance	% of Variance Directly Attributable to Zones	% of Production
Rice/Wheat Punjab	6.0	25.6	16.5
Mixed Crops Punjab	3.9	16.5	20.3
Cotton/Wheat Punjab	6.7	28.5	24.3
Low Intensity Punjab	1.5	6.4	10.2
Barani Punjab	1.3	5.5	4.0
Rice/Other Sind	0.5	2.3	3.0
Cotton/Wheat Sind	2.4	10.1	12.8
Other - NWFP	0.9	4.0	6.3
Other - Baluchistan	0.3	0.1	1.2
	23.5	100.0	100.0
Inter-zone covariances	76.5		
	100.0		

Punjab variance, the total is less than ten percent. The figure of ten percent overstates the rainfed areas contribution to total variance since both NWFP and Baluchistan grow some irrigated wheat.

In order to examine two contrasting zones, changes in the mean and variability of wheat production in the Rice/Wheat Punjab and the Cotton/Wheat Sind zones are presented in Tables 2.6 and 2.7. Rice/Wheat Punjab exhibits a large increase in production variability over time, all of which is attributable to an increase in yield variability. The Cotton/Wheat Sind zone, on the other hand, shows declining variability of both areas and yields. Overall variability is higher in Cotton/Wheat Sind at the beginning of the period, but by the end of period yield variability in this zone is only 40 percent of yield variability in Rice/Wheat Punjab, more than offsetting the continued lower area variability in Rice/Wheat Punjab. A partial explanation for the Rice/Wheat Punjab increase in variability is that this zone was the hardest hit during the 1978 blight attack.

A Decomposition of the Change in Variance of Cereal Production

The variance decomposition approach can also be used to study changes in variability of cereal production more rigorously than the moving-average, coefficient-of-variation approach. For this purpose, the time period is divided into two segments of equal length: 1967/68 to 1975/76 and 1976/77 to 1984/85. The variance of the detrended series for each time period is then computed. Table 2.8 presents a summary of the changes in production, area, yield, variance of production, and coefficient of variation of production for the different cereals.

Table 2.6: Changes in the Mean and Variability of Pakistan Wheat Production -- Rice/Wheat Zone Punjab

Years	Mean Production (000 Mt)	Mean Area (000 Ha)	Mean Yield (Mt/Ha)	c.v. Production %	c.v. Area %	c.v. Yield %
68-77	1233	1073	1.15	6.4	3.0	6.4
69-78	1276	1085	1.18	7.7	2.9	7.2
70-79	1345	1088	1.23	7.9	2.0	7.4
71-80	1422	1100	1.29	9.2	2.0	8.3
72-81	1513	1109	1.36	9.8	1.8	8.7
73-82	1572	1129	1.39	9.5	2.4	9.5
74-83	1653	1146	1.44	9.3	2.8	9.0
75-84	1699	1157	1.46	10.2	2.8	9.9
76-85	1751	1171	1.49	10.3	2.5	10.2

Table 2.7 Changes in the Mean and Variability of Pakistan Wheat Production -- Cotton/Wheat Zone Sind

Years	Mean Production (000 Mt)	Mean Area (000 Ha)	Mean Yield (Mt/Ha)	c.v. Production %	c.v. Area %	c.v. Yield %
68-77	864	593	1.46	8.4	8.0	6.1
69-78	912	601	1.52	8.5	7.4	6.2
70-79	981	616	1.59	7.8	7.5	5.5
71-80	1040	628	1.65	6.8	6.6	5.2
72-81	1110	645	1.70	6.7	6.8	4.4
73-82	1195	668	1.77	7.4	6.9	4.2
74-83	1284	690	1.84	7.2	6.5	4.4
75-84	1352	708	1.89	7.4	6.3	4.3
76-85	1440	730	1.95	6.8	5.2	4.2

Table 2.8: Changes in the Mean and Variability of Pakistan Cereal Production, 1967/68 to 1984/85

	Wheat	Rice	Maize	Millet & Sorghum	Barley	Total Cereals
Mean Production						
First Period	7231	2226	725	634	113	10949
Second Period	10668	3200	911	516	142	15426
% Change	47.5	43.8	25.6	-18.6	26.2	40.9
Mean Area						
First Period	6017	1540	628	-1214	170	9570
Second Period	6952	1955	726	988	201	10822
% Change	15.5	26.9	15.6	-18.6	18.2	13.1
Mean Yield						
First Period	1.20	1.45	1.16	0.52	0.66	1.14
Second Period	1.53	1.64	1.25	0.52	0.71	1.43
% Change	27.5	13.1	8.5	0.2	7.2	24.6
Variance of Production						
First Period	119825	51063	2186	4031	137	292991
Second Period	688660	15814	1205	1770	479	667018
% Change	474.7	-69.0	-44.9	-56.1	249.6	127.7
Coefficient of Variation						
First Period	4.79	10.15	6.45	10.01	10.37	4.94
Second Period	7.78	3.93	3.81	8.15	15.37	5.29
% Change	62.4	-61.3	-40.9	-18.6	48.2	7.1

Note: First period is 1967/68 to 1975/76 and second period is 1976/77 to 1984/85

The variance of total cereal production has more than doubled between the two time periods. Much of this increase in variance, however, can be attributed to the 41 percent increase in average production. The coefficient of variation of the detrended series -- which expresses variability relative to average production -- hardly increases at all for total cereals, rising from 4.94 to 5.29 percent, a statistically insignificant increase. Thus, the variability of total cereal production has increased roughly in proportion to the increase in average production.

The various cereals have behaved quite differently, however. The variance of wheat production has increased more than fivefold, while all other cereals except barley show a declining variance. The coefficient of variation for wheat increases by three percentage points, but this is not statistically significant because of the short length of the series. The coefficients of variation for the other cereals except barley all decline, with that of rice declining dramatically from 10.2 to 3.9 percent.

The increase in wheat variance and the decline in the variance of other major crops suggests that wheat is the source of the increase in the variance of total cereal production. Indeed, Table 2.9 shows that almost 69 percent of the increase in the variance of total cereal production is directly attributable to the increase in variance of wheat production. The other major factor contributing 27 percent of the increased variance in cereal production is an increase

Table 2.9: A Decomposition of the Change in Variance of Total Cereal Production, 1967/68-1975/76 to 1976/77-1984/85

	Source of Change (%)					
	Change in Mean Yields	Change in Mean Areas	Change in Yield Variances and Covariances	Change in Area Variances and Covariances	Area-Yield Covariances, Interaction Terms, and Residual	Row Sums
Crop Variances						
Wheat	6.86	4.53	32.61	-4.72	29.46	68.75
Rice	0.05	1.02	-2.02	-1.08	1.01	-1.02
Maize	-0.00	0.12	-0.43	0.04	0.18	-0.09
Millet & Sorghum	-0.02	-0.02	-0.05	-0.00	-0.14	-0.24
Barley	0.00	0.00	0.00	0.13	-0.05	0.09
Total Crop Variances	6.89	5.65	30.12	-5.64	30.47	67.49
Covariance of different crops in same province	2.67	0.96	-4.22	-3.92	-5.50	-10.02
Covariance of same crop in different provinces	6.06	3.05	9.69	-5.42	13.88	27.26
Covariance of different crops in different provinces	3.96	-1.81	21.59	-5.08	-3.40	15.27
Column Sums	19.58	7.84	57.18	-20.05	35.45	100.00

in the correlations of production of the same crop in different provinces. Wheat again is the major cause of this increase.

Reading across the bottom line of Table 2.9, 57 percent of the increase in variability results directly from an increase in yield variance, while variance in areas actually has a negative contribution (-20 percent). In other words, production variance is 20 percent lower than what it would have been, other things being equal, if area variances and correlations had not declined.

Table 2.10 provides a breakdown of the change in the variance of wheat production by agro-climatic zone. Because of the high correlations between production fluctuations in the different zones, only 17 percent of the change in variance can be attributed directly to the different zones. However, the Rice/Wheat Punjab zone is responsible for 40 percent of this change, even though that zone accounts for only 17 percent of the increase in total production. In contrast, the Cotton/Wheat Sind zone is responsible for only 3 percent of the change in variance, but contributed 19 percent of the increase in mean production.

Thus, in Pakistan the variability of wheat production has been increasing over time, while the variability of most other cereals has been declining.[4] The increase in the coefficient of variation of wheat production, however, is not statistically significant.

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[4] These results are in contrast with Hazell's finding that in most countries, rice and wheat have become more stable and coarse grains have become less stable.

Table 2.10: A Decomposition of the Change in Variance of Wheat Production, 1967/68-1975/76 to 1976/77-1984/85

	Source of Change (%)						
	Change in Mean Yields	Change in Mean Areas	Change in Yield Variances and Covariances	Change in Area Variances and Covariances	Area-Yield Covariances, Interaction Terms, and Residual	Row Sums	Per Cent of Variance Attributable Directly to Zones
Zones							
Rice/Wheat Punjab	0.20	0.26	4.42	-0.02	1.87	6.73	39.76
Mixed Crop Punjab	0.10	0.28	0.66	-0.18	0.64	1.49	8.83
Cotton/Wheat Punjab	0.50	0.41	2.49	-0.72	2.18	4.86	28.73
Low Intensity Punjab	0.02	0.11	0.61	-0.05	1.01	1.70	10.05
Barani Punjab	0.06	-0.00	1.26	-0.00	0.24	1.56	9.21
Rice/Wheat Sind	0.33	0.04	-0.06	-0.20	-0.20	-0.10	-0.58
Cotton/Wheat Sind	0.86	0.32	0.09	-0.65	-0.05	0.57	3.40
Other - NWFP	0.18	0.18	-0.25	0.01	-0.05	0.08	0.45
Other - Baluchistan	0.03	0.02	-0.09	0.00	0.06	0.03	0.15
Total Variance Within Zones	2.29	1.61	9.12	-1.81	5.71	16.91	100.00
Inter-zone Covariances	7.36	2.51	33.40	-3.82	43.62	83.08	
Column Sums	9.65	4.13	42.52	-5.63	49.33	100.00	

Implications for Supply Stabilization Analysis

In the analysis that follows, it is necessary to use a parameter for the inherent instability of wheat production; that is, the degree to which wheat production would fluctuate if government policy were constant. The historical degree of variability should be an overestimate of this number since past changes in government pricing and marketing policies most likely have caused some of the observed production fluctuations. Estimates of yield variability should be closer to the purely random effect than production variability, although government policies could affect yields through their impact on the use of variable inputs (such as fertilizer), and random weather events can affect harvested areas particularly in barani zones by causing a planted field to be abandoned.

Table 2.1 above shows that the coefficients of variation of wheat yield and production are 6.7% and 7.8%, respectively, for the most recent 10-year period. Both of these figures are the highest for their series. Since the proper number to use for the inherent instability of production should be somewhat less than actual past yield instability, a figure of 6.0 percent is used here. Sensitivity analysis is included for a value of 7.0 percent. These assumptions should be on the high side, for as recently as 1974-83 the coefficient of variation was only 4.0 percent for yields. Consequently, the results below should be slightly biased towards high costs and high optimal stock levels. This bias should cover the relatively small degree of instability added by other cereals.

In sum, this section has shown that Pakistan's variability of cereal production is lower than most countries, although it has been

increasing somewhat over time. Increases in wheat production variability are responsible for the increase in total cereal variability, while Punjab -- particularly the Rice/Wheat Punjab zone -- accounts for most of the increase in wheat variability. The next section examines how the government can use price, trade, and storage policy to stabilize consumption and prices in the face of these fluctuations in production.

2.3 EFFICIENT POLICY DESIGN FOR PRICE STABILIZATION

Governments have multiple objectives with respect to supply stabilization policy, of which only two will be considered here: minimizing price and consumption variability, and minimizing fiscal expenditure.[5] The price stability goal as defined here is concerned with the prevailing price paid for the staple food. Price rather than consumption is the stated goal since price is observable while consumption is not. The government is assumed to stand ready to buy or sell sufficient quantities to enforce its price on both official and private markets, importing the quantities if necessary.

Economists have debated whether or not price stability is welfare enhancing. For the purposes at hand, that debate is irrelevant. With varying degrees of success, most governments have attempted to control prices for decades and will continue to do so. There is no question that governments -- including the government of

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[5] In some countries, minimizing imports is a separate objective over and above minimizing cost. This is the case when the international market for the staple food is quite thin and thus supplies may not be available (rice, white maize) and/or when the closest commodity substitute for the domestic staple is considered inferior by the population (yellow maize for white maize). See Pinckney (1988) for a supply stabilization study with three government objectives.

Pakistan -- perceive it to be in the interest of the country to stabilize prices. The question then becomes: what is the trade-off between price stability and fiscal cost, and how can a simple and efficient policy be designed to achieve the best possible combination of outcomes for those two objectives?

For the sake of the analysis, the average level of price is assumed to have been chosen efficiently ahead of time. Much has been written in the literature about "getting prices right"; that is not the topic of discussion here. Rather, assuming that the government is aiming at a reasonably efficient price, the question considered here is how should prices vary from that target from year to year given unanticipated changes in production and world price. This is a separable question from choosing the appropriate target price.

Methodology

This section presents a brief overview of the model and optimization method. For more details see Pinckney (1988).

An optimization method, stochastic dynamic programming, is used here to explore the techniques of efficient policy design.[6] The objective is to minimize the net present value of a cost function consisting of two components: fiscal cost and price variability, with the latter defined as the square root of the average squared deviation from the target price. The last component of the cost function will equal the standard deviation of price if the target price equals the ex-post mean price.

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[6] For a discussion of the relative merits of simulation versus optimization techniques, and for an analysis of different possible optimization techniques, see Pinckney (1986, 1988).

There is no way of knowing ahead of time how much the government is willing to "pay" in terms of fiscal cost for a given degree of price variability. Consequently, different systems of government priorities are modeled by weighting price variability, and varying the weight in order to see how the optimal policy adjusts to different political preferences. The optimization procedure is run for each possible weight. This allows for the measurement of the trade-off between the two government objectives.

Each optimization run finds the values of government procurement, offtake, and foreign trade that minimize the cost function for every modeled combination of domestic production, world price, and opening stocks. The dynamic programming procedure continues until the optimal policy for one year is the same as the optimal policy for the next year. Thus, the outcome of the optimization procedure is a policy which does not vary from year to year. This policy is discrete, however, since the procedure only considers selected possible values for production, world price, and the other variables. Consequently, the discrete policy is interpolated linearly so as to be continuous, and simulated over 300 ten-year cycles of random production and world price. The values of the objectives are calculated in the simulation, and results reported in the tables and the graphs.

The model to be optimized is set up as follows. Production is an exogenous, stochastic, normally-distributed random variable. For simplicity, neither supply nor demand is assumed to shift regularly

over time.[7] The demand curve has constant elasticity. Since there are no private stocks in the model, domestic consumption equals production less government procurement plus government releases. These last two amounts are combined to yield net government procurement since the model is interannual, and not concerned with seasonal storage. Foreign trade is handled exclusively by the government, and therefore does not affect consumption directly in the model. Similarly, the government is assumed to be the recipient of all food aid, which covers a set proportion of the shortfall in domestic supply in bad years. Government's closing stock is equal to its opening stock plus net domestic procurement plus net imports (including food aid).

Fiscal costs are calculated as follows. The government's net procurement is multiplied by the price at which the grain is bought or sold. Thus any costs incurred by the government in both buying and selling in the same market year are not included since this is an interannual model. Net costs of foreign trade -- both exports and imports -- are calculated in a similar manner, adjusting for the difference between import and export parity. Foreign exchange is valued at a set premium for both imports and exports. Storage fees are a constant amount per ton of interannual storage. In addition, at the conclusion of the final year of each 10-year cycle in the

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[7] This assumption only makes sense if the expected growth rates of supply and demand are reasonably close to each other, leading to a normal production year equilibrium price which is almost constant. Such is the case for Pakistan in the short run. Because of this assumption, the cost figures are slightly understated, and the volumes mentioned for imports and stocks will grow over time. The assumption is necessary in order to allow the dynamic programming algorithm to stabilize over time. Adjustment of the stock volumes for expected future production growth is carried out below.

simulation, a cost is incurred for rebuilding the stock to its opening level in year one of the simulation in order to facilitate comparison of different policies.

World price is modeled as a random walk, with movements independent of domestic production. It is particularly important that next year's expected price is close to this year's actual price; otherwise, the optimizing model will engage in speculative behavior.

For the values of specific parameters, see Appendix C.

Optimal Policies Vs Price Band Policies

Most government price stabilization schemes have tried to stabilize prices within a band. That is, a maximum price and minimum price are set, with the government promising to enter the market with sufficient purchases or sales to keep the domestic price from moving outside those limits. Normally, no government intervention is assumed if the price stays between the maximum and minimum. On the foreign trade side, it is frequently proposed that imports should be triggered by a minimum stock size, and exports triggered when some maximum stock size is reached.

In order to gain an understanding of how the optimal policies differ from these simple price band/buffer stock policies, Table 2.11 presents one of the three hundred ten-year cycles of the simulation for both types of policies. Both policies target a price of 85 Rs/40kg, and over all 300 cycles their average levels of price variability are equal. The price band/buffer stock policy has stock triggers for imports and exports at 0 and 200 thousand tons, respectively. The optimal policy costs about Rs 85 million less

Table 2.11: Simulation of Optimal (1) and Price Band (2) Policies: One Cycle

Year	World Price	Production	Net Procurement		Domestic Price		Net Imports (Including Aid)		Closing Stocks		Annual Cost		Present Value of Annual Lose	
			(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	$US/ton	- - - thousand tons - - -			- Rs/40kg -		- - - - - thousand tons - - - - -				- - - - million Rupees - - - -			
0									100	100				
1	102	12869	-117	0	85	88	17	0	0	100	-205	43	-205	43
2	92	11353	-1360	-1349	92	92	1359	1249	0	0	-773	-1027	-927	-917
3	68	13681	230	376	76	79	-117	-176	113	200	380	669	-595	-333
4	68	13891	376	586	75	79	-285	-586	204	200	538	723	-156	258
5	84	13308	-23	3	78	79	-180	-3	0	200	-257	87	-352	324
6	85	11284	-1450	-1418	91	92	1450	1218	0	0	-904	-1396	-997	-671
7	108	12901	-3	0	85	85	3	0	0	0	2	0	-995	-671
8	135	13136	144	0	85	82	-14[illegible]	0	0	0	1	0	-995	-671
9	157	13474	517	169	86	79	-517	0	0	169	-199	404	-1110	-436
10	151	12605	-69	-97	93	92	69	0	0	72	85	-192	-1064	-541
Replace Stock Adjustment											187	52	-962	-512
Average Annual Cost											-128	-68		

Source: Author's calculations.

annually over all 300 cycles than this price band policy. The table helps to explain why.

For this particular cycle, the optimal policy costs about Rs 60 million less annually. Three years out of ten, however, the price band policy is substantially cheaper than the optimal policy. In each of the three years -- years 2, 6, and 10 -- the optimal policy opens a bad production year with no stocks, while the price band policy has substantial stocks. These years cannot be looked at in isolation. The reason that the price band policy is able to outperform the optimal policy in year 10, for example, is only because it failed to earn money from exports in year 9. The problem is dynamic, and the policies can only be judged in a dynamic context. The distribution of prices is dramatically different in the two policies. In seven out of ten years, the price band policy is at either its maximum or minimum price. The optimal policy, on the other hand, has four years when the price is within one rupee of the target price. In three years, the price resulting from the optimal policy is below the minimum price of the price band policy. In each case, supplies are abundant and the world price is low. Similarly, the one year when the optimal policy price is above the price band's maximum is when production is low and the world price is high.

Year 9 is perhaps the best example of why the optimal policy is more efficient than the price band policy. Production is fairly high -- high enough so that the price band minimum is reached and that policy withdraws 169 thousand tons from the market, placing all of it into storage. In contrast, the optimal policy has net procurement of 517 thousand tons, bringing the domestic price very close to the

target price, and exports the entire amount at a profit since the world price is US$157 per ton. The net result is earnings of Rs 200 million for the optimal policy and losses of Rs 400 million for the price band policy, with the price outcome also preferable under the optimal policy.

These examples suggest that the optimal policy is superior because of greater responsiveness to the world price and domestic production. This suggestion is explored in more detail below, after a consideration of average results for all of the cycles.

Optimization Results

Table 2.12 presents results of the optimization model for the base case. The first two columns of the table present the government objectives of price variability and fiscal cost. The third and fourth columns present two other items of concern to the government which are not included in the objective function: the variability of fiscal cost and average total imports during ten years.[8] The fifth column presents average closing stocks.

The last four columns of the table present a breakdown of fiscal costs into four components. The first component, storage costs, consists of the direct cost of storing wheat, including the value of physical losses and the costs of putting the grain into and taking it out of the storage facility. The second component, the domestic costs of foreign trade, include charges for transportation, bagging, and handling of wheat exports, and the excess costs of handling wheat

[8] Column 3 presents the standard deviation of the average price over 10 years, not the standard deviation of the annual cost. The latter figure can be approximated by multiplying the number in column 3 by the square root of ten (about 3.2).

Table 2.12: Optimal Policy Results, Base Case

Price Variability	Average Annual Fiscal Cost	Standard Deviation Of Cost	Average Imports 10-Year Period	Average Closing Stock	Components of Cost: Storage Costs	Domestic Costs of Foreign Trade	Net Other Domestic Costs	Direct Foreign Exchange Losses
(Rs/40kg)	- - - (mil Rs) - - -		(mil tons)	(thousand tons)	- - - - million Rupees - - - -			(mil. US$)
*14.7	-164.5	138	1.76	0	0.0	193	212.5	-30.5
5.9	-44.9	125	1.95	34	7.4	171	-14.5	-11.2
5.4	-26.5	128	2.03	30	6.6	179	-7.7	-10.9
4.8	-4.5	132	2.11	37	7.8	186	-4.3	-10.4
4.2	19.9	137	2.20	40	8.3	194	2.6	-9.9
3.7	43.6	140	2.27	43	8.8	201	12.1	-9.5
3.1	70.9	144	2.39	23	5.1	214	22.5	-9.1
2.6	94.0	148	2.48	24	5.1	220	25.2	-8.4
1.9	123.6	155	2.57	26	5.4	229	35.4	-7.8
1.4	150.1	163	2.66	26	5.5	236	44.4	-7.3
0.9	174.7	167	2.77	12	2.2	246	49.4	-6.6

(*) Free Market Result

imports over and above the costs of handling domestic wheat. The third component, net other domestic costs, is composed primarily by the difference between the value of domestic sales and the value of domestic purchases. The implicit value of the stock change between the first and tenth year is also included in this component. The last column gives the direct foreign exchange losses, expressed in U.S. dollars. A negative value indicates a gain in foreign exchange on average through wheat operations. This component includes the cost of foreign shipping on all imports (including food aid).

The first line of the table presents results of a run which attempts to describe the free market solution. Instead of using the government objective function outlined above, a producer/consumer surplus function is maximized. It has been shown elsewhere that such an objective function will give the result of a market with no government intervention (Gustafson 1958, pp. 48-49). This can be considered a test of the stability of domestic prices under a free international trade regime.

The results indicate that the government has stabilized prices compared to what would have been the case in the absence of intervention. Price variability in the non-intervention case is almost 15 Rs/40kg; this implies that, if the average harvest-time price were 80 Rs/40kg, one year out of six the price would be greater than 95 Rs and one year out of six the price would be less than 65 Rs. Column 2 for this row is not fiscal cost but net cost to the economy of domestic and foreign wheat marketing. A large profit is made, most of it in foreign exchange as shown in the last column. On average, the non-intervention solution raises the average domestic

price above its equilibrium level by buying more than it sells domestically and exporting the difference in years of high world prices.

The substantial change in average price possible in the non-intervention case calls into question the model's assumption about no supply response to price. Adding a supply response would cause profits made under this scenario to increase further, as more would be grown -- and thus exported -- in periods of high world prices. It would also increase average imports, as domestic production would decrease in low world price periods, which are the only times when imports take place in the non-intervention scenario. Price variability should be unaffected by such a change.[9]

The other ten lines in the table present optimal solutions under different possible relative preferences between price stability and low fiscal expenditure. There are several general observations to be made about the results:

First, <u>fiscal costs increase substantially as price variability is limited</u>. This is the trade-off between the two government objectives included in the model. On average for the range considered here, the trade-off is about Rs 45 million annually for each one rupee decrease in price variability. The trade-off increases slightly as price variability declines. Consequently, a policy which would efficiently keep harvest-time prices between 70 and 90 Rs/40kg for nine years out of ten costs about Rs 220 million

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[9] For all optimization runs except the non-intervention case, ignoring supply response is reasonable because of the resulting simplicity of the model and the absence of significant changes in expected price from year to year (Pinckney 1988).

more per year than a policy which keeps those prices between 78.5 and 81.5 Rs/40kg[10].

Second, the variability of cost is quite high. Over a ten-year period, the expected average annual cost of the policy with price variability of 0.9 is about Rs 175 million, but since the standard deviation of this cost is Rs 167 million, there is a one-in-six chance that the cost would average less than Rs 8 million annually, and a one-in-six chance that the cost would average over Rs 332 million annually. In any single year, there is a one-in-six chance that the cost will be greater than about Rs 700 million, and a similar chance that the policy will make a profit of over Rs 350 million.[11] The variability of cost increases somewhat as price variability decreases.

Third, all of the efficient policies have net foreign exchange earnings on the wheat account, but there is a negative relationship between price stability and foreign exchange earnings. The extent to which this result is dependent on the assumptions about food aid is tested below.

Fourth, average closing stocks are exceptionally low, ranging from twelve to 43 thousand tons. As a consequence, storage costs are quite low relative to other costs. Recall that these stocks are only those for interannual supply stabilization; actual stock levels will

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[10] In order to calculate these numbers, the price variability is multiplied by 1.645, since 90 percent of a normal distribution falls within this number of standard deviations of the mean.

[11] The annual cost figures are calculated by taking the standard deviation of the ten-year average cost, Rs 167 million, and multiplying it by the square root of ten to produce the standard deviation of annual cost.

be higher because of the other reasons for storage. Supply stabilization stocks are only held in these policies when the world price of wheat is less than US$80 per ton. In real terms, such a price would be a record low for wheat.

When the world price is $60 per ton, the policies with higher price variability hold as much as 400 thousand tons of stock before exporting the excess. No policies studied here hold more than 600 thousand tons under any circumstances. The reasons for this relatively low level of interannual stockholding are explored in the following section.

Rationale for Interannual Stockholding

The policy decision variables under the government's control can be considered as sequential. The government opens the marketing year with some opening stock, S_{t-1}. Given production, a certain amount is procured and sold, leaving a net level of procurement, PC_t.[12] The sum $S_{t-1} + PC_t$ is termed here "available supply". If available supply is negative, the government must import in order to meet domestic demand. If available supply is positive, the government can decide how much to export and how much to store.

This decision, then, involves comparing the known value of exporting the commodity this year with the expected value of holding the commodity for possible sale next year. The value of one ton of available supply this year is simply the present export parity price, XP_t. The expected value next year is a weighted average of the

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[12] The decision variable is considered in volume terms here for consistency with the trade/stock decision variable. As there is a one-to-one correspondence between price and consumption, however, this decision variable determines price in conjunction with production.

possible uses of the stock next year. These possibilities are as follows:

(1) Export next year. The expected value today for exporting next year is $(E(XP_{t+1}) - STCH)/D$, where E(.) is the expectations operator, XP is export parity as above, STCH is the cost of storing the commodity for one year, and D is the discount rate applied because of the time value of money.[13] Assuming that the government has no inside information about world wheat prices, it is reasonable to assume that the expected price next year equals the present price; that is, $E(XP_{t+1}) = XP_t$. Thus, this component of the value of the stored commodity can be simplified to $(XP_t - STCH)/D$.

(2) Sell domestically next year, displacing imports. In this case, the value of the commodity is import parity next year, as opposed to next year's domestic price. If imports are displaced, the only difference between storing or not storing this year is not having to import next year. Consequently, the value is $(E(MP_{t+1}) - STCH)/D$, which can be simplified as above to $(MP_t - STCH)/D$, with MP being import parity.

(3) Store again next year. This can be calculated by setting up possibilities (1) and (2) for several years into the future until the discount rate minimizes the importance of additional years, and then working backward to calculate the value of storing an additional year. These are the only possible uses for the stock.[14] The value

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[13] Analytically, based on standard economic theory, it is inappropriate to apply both a discount rate and an interest rate in an interannual model in real prices. See Gardner (1979).

[14] The fourth possibility, sell domestically next year not displacing imports, is only possible if the government allows the domestic price to be affected by its opening stock level. Such

of storing, therefore, is the weighted average of these three components, with the probability of each occurring next year used as the weights.[15] The decision will depend on the value of the parameters and the probabilities.

The dynamic programming exercise can be considered a complex method for determining the probabilities of the different reasons for storage. As an example, however, assume that the probability of exporting the stock next year equals the probability of displacing imports next year at 0.45. Thus the probability of storing again next year equals 0.1. Given other parameters as in Appendix C and a world price of US$110 per ton, the values are as follows:

Use of Stock Next Year	Present Value	Probability
Export Next Year:	1130 Rs/ton	.45
Displace Imports Next Year:	2181 Rs/ton	.45
Store Again Next Year:	1101 Rs/ton	.10
Weighted Average:	1600	
Export This Year:	1663 Rs/ton	

As the world price declines, the difference between the value of exporting and the value of storing decreases. For these probabilities, the two are equal when the world price is US$63 per ton. Thus, if these probabilities were correct, no wheat would be stored with world prices above this US$63.

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behavior does occur in the optimal policies to a minor extent; it is left out to simplify the discussion.

[15] In the model formulated above, government storage has a negative impact on the amount of food aid received. The expected negative value of this amount should also be included in the calculation, but is excluded for clarity of exposition.

Each additional ton stored, however, has a different set of probabilities for its disposal in the next year. As more is kept in store, the probability of each additional ton displacing imports next year declines, as a higher percentage of production shortfalls will be met with already existing stocks. Similarly, the probabilities of exporting next year and storing again increase. This decreases the incentive to hold additional stock. Small changes in probabilities have a large impact on the world price at which additional grain will be put in store. For example, suppose that the probabilities for the three outcomes above change from 0.45, 0.45, 0.10 for the first ton stored to 0.46, 0.43, 0.11 for the 100th ton stored. In this case, the world price at which storage takes place declines from $63 to $48, even though the probability change is small.

Note that the decision of whether or not to store the wheat makes no reference to the price paid domestically to purchase the crop. Unfortunately, for accounting reasons grain marketing authorities in some countries have been restricted from exporting because of the accounting loss they would incur if their stock of grain is exported at a price beneath their purchase price. Valuing the stock at its purchase price is an accounting fiction, however. Economically, the value of the stock is its most profitable possible use, and this value has been determined in the calculation above. Thus, it saves money at times to export rather than store even though an accountant may have to enter a loss in the marketing board's books.

Sensitivity of Optimal Stock Size to Assumptions

Assumptions about food aid and the variability of production will affect the average stock size which results from the optimal policies. This section tests to see what affect ignoring food aid and assuming a higher variability of production have on storage and other outcomes.

As shown in the first section of this chapter, assuming a coefficient of variation for production of six percent is reasonable. There is some indication, however, that variability has been increasing over time. For future planning, testing the sensitivity of storage size to production variability of seven percent is desirable.

In terms of the analysis in the previous section, a rise in production variability will increase both the probability of exporting the stock next year and the probability of using the stock to displace imports. Although these two effects are offsetting to some extent, an equal increase in both probabilities raises the world price at which storage is profitable. For example, in the table above if these two probabilities are both raised from 0.45 to 0.48, the world price at which storage becomes profitable increases from $63 to $87.

Table 2.13 presents optimization results with all parameters the same as in Table 2.12, but with production variability increased to 7 percent. Figure 2.1 shows these results graphically, along with the results for no food aid.

Table 2.13: Optimal Policy Results, Production Instability at 7 Percent

Price Variability	Average Annual Fiscal Cost	Standard Deviation Of Cost	Average Imports 10-Year Period	Average Closing Stock	Components of Cost: Storage Costs	Domestic Costs of Foreign Trade	Net Other Domestic Costs	Direct Foreign Exchange Losses
(Rs/40kg)	(mil Rs)		(mil tons)	(thousand tons)	- - - - million Rupees - - - -			(mil. US$)
6.2	-59.0	150	2.36	40	8.7	205	-30.7	-12.9
5.7	-38.2	154	2.44	35	7.5	214	-21.5	-12.7
5.1	-13.3	158	2.53	41	8.6	221	-15.1	-12.2
4.5	14.5	164	2.63	43	9.1	228	-5.2	-11.6
3.8	42.0	169	2.72	46	9.5	239	5.3	-11.3
3.3	71.3	173	2.85	24	5.2	253	19.0	-11.0
2.7	96.9	177	2.95	25	5.3	260	22.5	-10.2
2.0	130.5	185	3.05	27	5.5	269	35.9	-9.6
1.5	159.7	194	3.14	27	5.6	277	46.9	-9.1
1.0	186.2	197	3.26	13	2.3	288	53.5	-8.4

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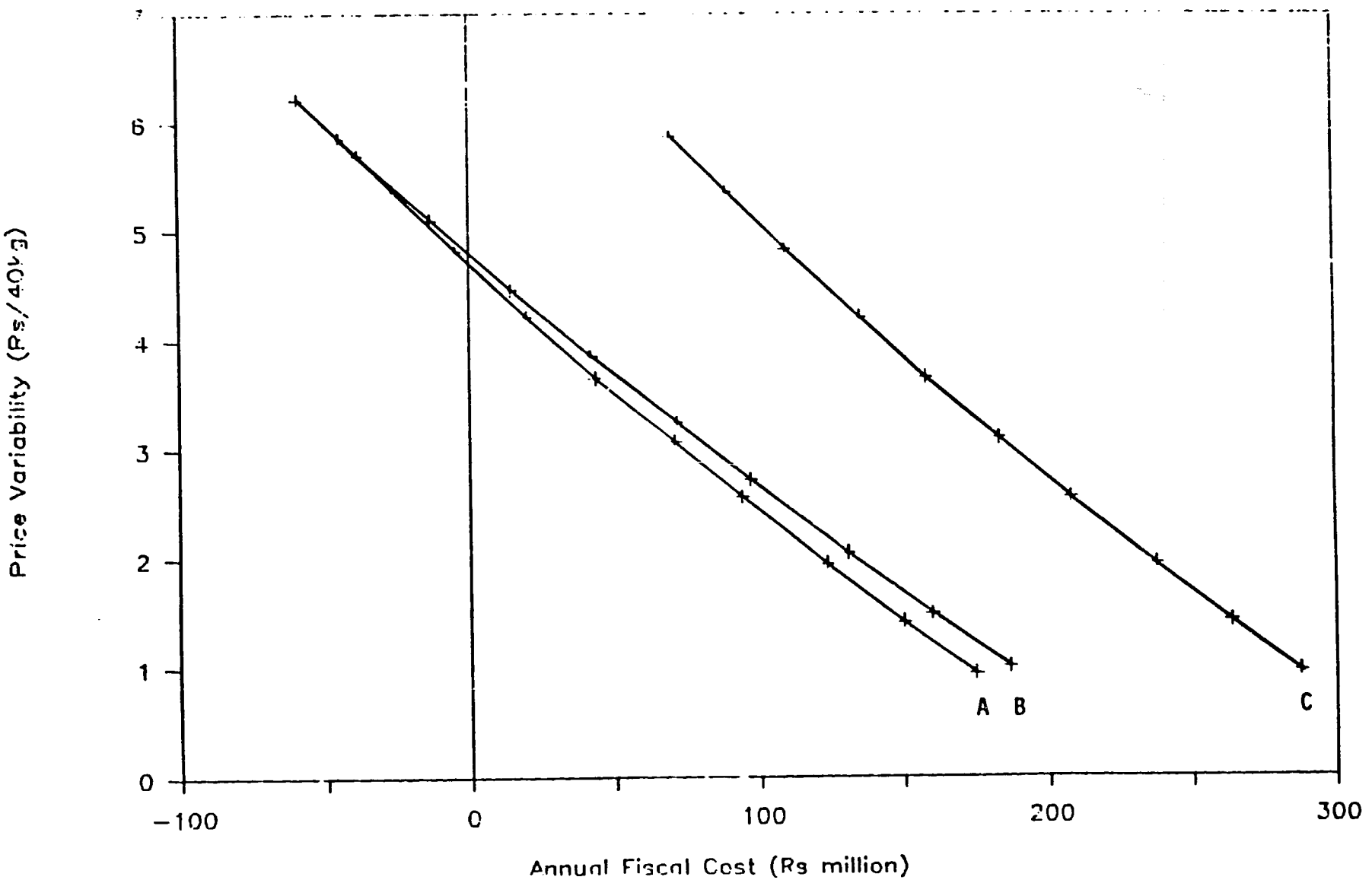
Figure 2.1: Optimal Policy Trade--off Curves



C- No Food Aid

The production variability change increases stockholding only slightly. Costs are almost identical at the higher range of price variability, although cost differences increase to about Rs 15 million annually at lower levels of price variability (this is clearer in the figure than in the table because of differences in price variability). These cost differences are small partly because the higher production variability induces increased food aid. The higher variability raises average imports and exports by almost 20 percent, but this additional foreign trade is conducted with only small losses. Thus, changing the assumption about production variability has little effect on storage or expected fiscal costs.

Assuming no food aid, on the other hand, increases costs substantially and increases average stockholdings to about 80 thousand tons. In the base case, food aid amounts to about 560 thousand tons over a ten-year period, thus constituting about one-fourth of total imports. The removal of this grant adds about Rs 110 million to the average annual cost, as displayed graphically in the figure. As would be expected, Table 2.14 shows that the foreign exchange account suffers most in comparison to the base case.

The table only shows average stockholding. For an analysis of storage capacity, maximum stockholding is an important variable. The largest amount stored increases from the base case amount of 400 to 600 thousand tons when the world price is $60 per ton, and some stocks (50 thousand tons) are held when the world price is as high as $100 per ton. Nevertheless, when the world price is $110 per ton or

Table 2.14: Optimal Policy Results, No Foreign Aid

Price Variability	Average Annual Fiscal Cost	Standard Deviation Of Cost	Average Imports 10-Year Period	Average Closing Stock	Components of Cost: Storage Costs	Domestic Costs of Foreign Trade	Net Other Domestic Costs	Direct Foreign Exchange Losses
(Rs/40kg)	(mil Rs)		(mil tons)	(thousand tons)	- - - - million Rupees - - - -			(mil. US$)
5.9	69.7	118	1.87	57	17.5	161	-23.8	-4.6
5.4	88.9	123	1.94	62	17.9	169	-15.5	-4.4
4.8	109.3	130	2.01	69	19.4	174	-14.3	-3.7
4.2	135.2	137	2.09	76	21.2	182	-4.5	-3.4
3.7	157.9	144	2.16	81	22.2	188	2.7	-3.0
3.1	183.0	151	2.25	84	23.2	196	7.8	-2.3
2.6	207.8	158	2.35	82	21.4	205	14.9	-1.8
1.9	237.3	167	2.44	80	21.4	214	25.9	-1.3
1.4	263.2	178	2.51	85	23.5	220	33.4	-0.7
1.0	287.4	184	2.61	80	22.7	227	37.2	0.0

higher no interannual supply stabilization stocks are held, regardless of whether or not food aid is available.

The assumption of no food aid is extreme. For the foreseeable future, Pakistan will be able to arrange for significant amounts of food aid from the international community in poor crop years. The absence of large supply stabilization stocks even in this extreme case strongly indicates that the requirement for this component of stockholding is quite small.

Computing the Value of Additional Storage Space

Despite low average stockholdings, all three sets of optimization results occasionally hold stocks of 400 to 600 thousand tons. In the model, neither construction nor depreciation costs are included since storage space of that amount is assumed to be available already. But in planning for future storage capacity, the question arises: Should Pakistan build 400 to 600 thousand tons of storage capacity for supply stabilization over and above storage requirements for other uses?

In order to assess the cost advantages of having the additional storage, the optimization model is run with maximum storage capacity constrained. Then the average cost of the constrained policy can be compared to the average cost of the unconstrained policy, keeping price variability the same in the two cases. The value of the additional capacity is assessed by comparing the change in fiscal cost.

When this is done the value of the extra storage space turns out to be small, primarily because of the low percentage of years in which it is used. The average gross benefit ranges from Rs 100 to

500 thousand annually for each additional 100 thousand tons of storage, with the actual number sensitive to the chosen degree of price variability and how much storage has already been built. The Experience Incorporated (1986) study estimates that construction costs are about Rs 70 million per 100 thousand tons capacity, and maintenance costs are between Rs 250 thousand and Rs 1 million annually. Thus, the value to the country of building extra capacity for supply stabilization is barely equal to the maintenance costs of the facility; the benefits do not begin to pay the country back for the capital costs of construction.

Therefore, in terms of planning for future storage requirements, no additional capacity should be built for interannual supply stabilization. If capacity is available, in years of abundant supply and very low world prices it will make sense to store up to a few hundred thousand tons, but the value of always having that capacity available is only equal to average maintenance costs.

2.4 LESSONS FOR AN EFFICIENT SUPPLY STABILIZATION STRATEGY

Characterizing the Efficient Policies

A policy produced by the optimization process meets the government objectives of price stability and low fiscal cost better than any alternative policy, given a set of government preferences. These policies, however, are difficult to understand and describe. Simpler policies are required if the optimization exercise is to have an impact on the policy making process. A detailed examination of what makes the optimal policies efficient can provide clues for the design of simpler, yet efficient, policies.

Recall that government intervention can be considered as two separate steps: first, making a decision about net procurement, and second, allocating available supply between exports and carryover stocks. The efficient rule for the latter decision is already clear. When aid is included in the model, the optimal policies do not hold any stock when world prices are $80 per ton or above. Thus, the decision on how to allocate available supply between stocks and exports is simple for most world prices: hold no stocks.

The prior decision -- determining net procurement and the domestic price -- is more difficult to characterize. The simulation of one 10-year cycle in Section 2.3 above suggests that a key difference between an optimal policy and a price band policy is the degree to which the domestic price responds to the world price and to domestic production. In order to examine this relationship further, Figure 2.2 plots optimal net procurement against production for one of the optimal policies, holding world price within a fairly narrow range.[16] The figure suggests that the relationship between these two variables is close to linear, but that a piecewise linear curve with a flatter section close to mean production may model the optimal relationship more closely. This hypothesis is investigated using regression analysis in Table 2.15.

In this table, five regression equations are reported for each of three levels of price variability. The dependent variable in each case is net procurement in years of the simulation of the interpolated optimal policy. As there are 300 ten-year cycles, there

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[16] Since only nine possible production levels are modeled in the optimization process, these points are all taken from the simulation of the interpolated optimal policy.

Figure 2.2: Net Procurement Function

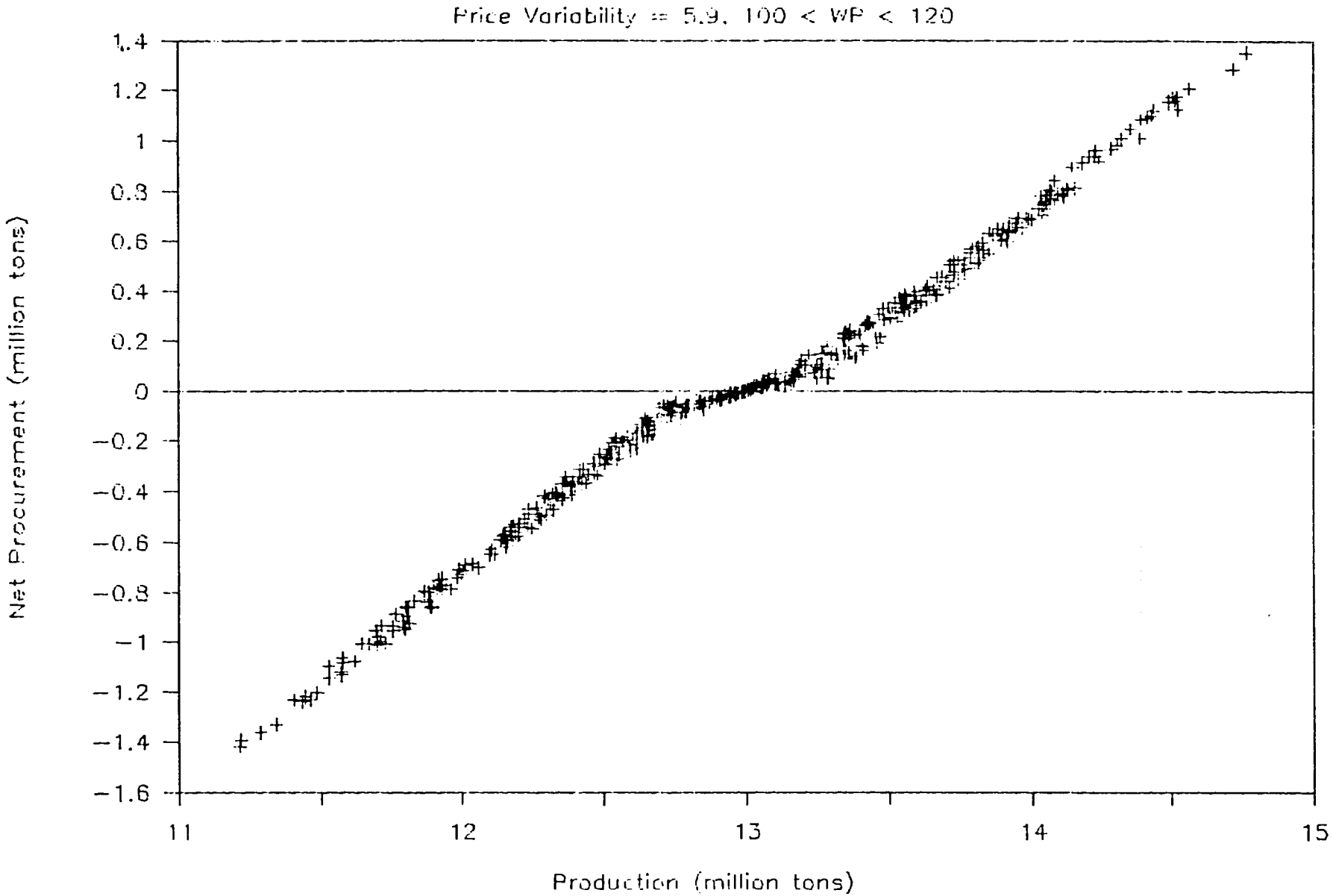

Table 2.15: NET PROCUREMENT FUNCTION

Level of Production (thousand tons)	Constant	World Price (WP)	Production (Qt)	R^2	Standard Error of Regression	N
REGRESSION RESULTS FOR PRICE VARIABILITY AT 0.9:						
(1) All production levels	-46.42	0.60 (.44)	-	0.001	708.7	2287
(2) All production levels	-12496	0.62 (.01)	0.956 (.0003)	1.000	12.3	2287
(3) (a) Qt > 13300	-12813	0.69 (.01)	0.978 (.001)	0.999	9.3	821
(b) 12700 < Qt < 13300	-11969	0.50 (.01)	0.917 (.002)	0.996	10.2	692
(c) Qt < 12700	-12729	0.66 (.01)	0.976 (.001)	0.999	8.5	774
REGRESSION RESULTS FOR PRICE VARIABILITY AT 3.1:						
(1) All production levels	-205.3	2.06 (.40)	-	0.012	632	2287
(2) All production levels	-11300	2.07 (.02)	0.852 (.001)	0.997	34.2	2287
(3) (a) Qt > 13300	-12358	2.59 (.01)	0.925 (.001)	0.999	12.5	821
(b) 12700 < Qt < 13300	-9350	1.54 (.02)	0.707 (.004)	0.979	19.1	692
(c) Qt < 12700	-12274	2.06 (.01)	0.933 (.001)	0.999	9.0	774
REGRESSION RESULTS FOR PRICE VARIABILITY AT 5.9:						
(1) All production levels	-415.5	3.91 (.33)	-	0.057	531.5	2287
(2) All production levels	-9686	3.92 (.04)	0.712 (.002)	0.986	64.2	2287
(3) (a) Qt > 13300	-11433	5.13 (.02)	0.827 (.002)	0.995	23.2	821
(b) 12700 < Qt < 13300	-6419	2.78 (.04)	0.471 (.008)	0.914	37.2	692
(c) Qt < 12700	-11529	3.73 (.02)	0.866 (.002)	0.997	19.3	774

Notes: The figures in parentheses are the standard errors of the estimated coefficients.
Source: Author's calculations

are 3000 possible observations. Opening stocks in year one of each cycle are 100 thousand tons, while average closing stocks are much lower. In order to avoid a bias due to a large number of relatively high stock years, only the last nine years of each simulation are included in the regression, lowering the total possible number of observations to 2700. In addition, years with extreme observations of world price or production are excluded since the interpolated policy may not reflect the optimal relationship for values far from the discrete levels modeled in the optimization process. The optimization process models seven levels of world price between $60 and $180, and nine levels of production between 11.2 and 14.8 million tons. So the regressions are run on all years in which the world price is between $50 and $190 and production is between 11.1 and 14.9 million tons. These restrictions lower the total number of observations to 2287. Regressions are reported for world price alone on the entire sample, for world price and production on the entire sample, and for world price and production on three subsets of the sample: production less than 12.7 million tons, greater than 13.3 million tons, and between those two values. This final partitioning is consistent with the pattern seen in Figure 2.2.[17]

The regressions help to explain how the optimal policies act, and how such policies change as the government preference for price stability changes. Net procurement is more responsive to the world price and less responsive to production when price variability is

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[17] Pinckney (1988) presents results for Kenya which include sensitivity of net procurement to opening stocks. Similar regressions were run for Pakistan, but stock levels are so low that the contribution of the variable negligible.

high. Estimating three regressions -- one each for low, medium, and high production -- improves the fit substantially,[18] and produces coefficients for each production level which are significantly different from corresponding coefficients at different production levels. In each case, the response of net procurement to a change in the world price or production is less in the middle of the production range than it is at either extreme. The change in the coefficients becomes more dramatic as price variability increases.

The primary rationale for the decreased sensitivity to production and world price when production is close to normal is that the government would prefer several small price changes rather than a single, sharp rise in price. A policy which allows a sudden 50 percent change in price once in five years while holding prices constant in the other four is much worse than a policy which allows a 10 percent change in price each of five years. Thus, the government preference for price stability is assumed to penalize deviations from the target price at an increasing rate (proportional to the square of the deviation). Consequently, the optimal policies do not force consumption to change as much when the price is close to the target as when the price is further from the target. An efficient government policy would do the same.

The implied degree of price sensitivity to world price and domestic production can be calculated. As stated in the methodology section above, for any given level of production, consumption is determined by net procurement. Thus, changes in production and world

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[18] The goodness of fit should be judged here by comparing regression standard errors rather than R^2s since the range of the dependent variable changes in the partitioned regression.

price affect consumption by the negative of their coefficients in the net procurement equations. Consequently, a coefficient of world price of 0.62 (Equation 2, top section) requires that consumption decrease by 6.2 thousand tons if the world price increases $10 per ton. Assuming a base of 13 million tons for total consumption, this is a -6/13000 = -0.046 percent change. Dividing this percentage by the price elasticity of -0.3 yields a required price increase of 0.15 percent, or Rs 0.13 assuming a prior price of Rs 85/40kg. A similar calculation shows that the highest sensitivity of domestic price to the world price, which occurs when price variability equals 5.9 and production is greater than 13.3 million tons, implies a price change of Rs 1.12 per 40kg when the world price goes up $10 per ton.

On the production side, a coefficient of production of .978 -- the highest in the table -- implies that 97.8 thousand tons out of a 100 thousand ton increase in production would be procured. Consequently, consumption would rise by only 2.2 thousand tons. Continuing as above, this implies a 0.017 percentage change in consumption and a -0.056 percentage change in price, or about Rs -0.05 per 40kg. Similarly, the lowest coefficient of production in the table -- 0.471 -- implies a change of Rs -1.15 per 40kg for the same 100 thousand ton increase in production.

Thus, the optimal policies can be characterized quite well. The optimal domestic intervention of the government can be approximated quite well by three linear relationships linking net procurement to production and the world price. The available supply which results from adding this net procurement to opening stocks should be exported

unless world prices reach new record lows. The next section discusses how this characterization can aid in policy design.

Designing a Simple and Efficient Policy

It is not reasonable to propose that a government adopt the policies which result from an optimization routine. Such policies are difficult to describe and complicated to implement. The government has an objective of "simplicity of policy" which is difficult if not impossible to build into the objective function of an optimization procedure. Consequently, there is a trade-off between the complexity of a policy and its efficiency. There is a need to examine the elements that make the optimal policies more efficient, and to measure the degree to which each element contributes to decreasing fiscal cost while holding price variability constant. In this way, decision makers can decide whether or not the complexity introduced by an additional element is worth the associated savings in cost.

The regression results and the knowledge about the relative importance of stocks and exports suggest that there are five elements that make the optimal policies more efficient than the simplistic price band/buffer stock policies discussed above. These are as follows:

(1) Stockholdings should be quite low;

(2) The maximum stock level should be sensitive to the world price, and decline to 0 at some world price;

(3) The domestic price should be sensitive to the world price;

(4) The domestic price should be sensitive to domestic production;

(5) The degree of sensitivity to world price and production should depend on whether production is high, average, or low.

These elements are listed in order of increasing difficulty of implementation. The first two do not affect the domestic price, and are thus invisible to most persons in the country.

Table 2.16 presents the results of adding these elements one by one to a simple price band/buffer stock policy. Figure 2.3 presents the same information in graphical form for the three levels of price variability, while Figure 2.4 details the results for the middle case. In the figures, the optimal policies are connected by a line, and the numbers correspond to the policy numbers in the table. Policies 2 and 5 do not appear in the figures because their costs are virtually equal to the costs of policies 3 and 4.

The improvements are much more dramatic for the relatively high price variability case than for the low price variability case. As prices become more stable, the scope for policy modifications becomes less. All policies with price variability of 0 would have a coefficient of 1.0 in the net procurement function; that is, all changes in production would be absorbed by changes in procurement in order to hold the price constant. Thus, a the net procurement function for a simple price band/buffer stock policy begins to approach the same shape as the optimal policy when price variability approaches zero. Consequently, when price variability is 0.9, the gain in moving from a price band policy which never holds stocks (policy 2) to a policy in which net procurement is sensitive to both production and the world price at levels dependent on production (policy 6) is only Rs 13 million annually. In contrast, when price

Table 2.16: Building an Efficient Policy

Policy		Annual Cost	Improvement	Foreign Exchange Earnings
		(mill. Rs)		(mill. US$)
(a) Price Variability 0.9 Rs/40 Kgs.:				
Policy 1(a):	Simple Price Band With 150,000 metric tons Buffer Stock	207	-	4.0
Policy 2(a):	Policy 1 With No Buffer Stock	186	22	5.6
Policy 3(a):	Policy 1 with Variable Buffer Stock, Size Dependent on World Price	185	1	5.6
Policy 4(a):	Policy 3 with Price Band Adjusting to World Price	178	7	8.8
Policy 5(a):	Policy 4 adding Sensitivity to Domestic Production	174	3	6.6
Policy 6(a):	Policy 5 With Degree of Sensitivity to World Price and Production Depending on Production	173	1	6.7
Policy 7(a):	Optimal Policy	175	-2	6.6
(b) Price Variability 3.1 Rs/40 Kgs.:				
Policy 1(b):	Simple Price Band With 150,000 metric tons Buffer Stock	134	-	4.4
Policy 2(b):	Policy 1 With No Buffer Stock	108	26	6.0
Policy 3(b):	Policy 1 with Variable Buffer Stock, Size Dependent on World Price	107	1	3.5
Policy 4(b):	Policy 3 with Price Band Adjusting to World Price	75	32	10.9
Policy 5(b):	Policy 4 adding Sensitivity to Domestic Production	75	-0	9.3
Policy 6(b):	Policy 5 With Degree of Sensitivity to World Price and Production Depending on Production	71	4	9.4
Policy 7(b):	Optimal Policy	71	-0	9.1
(c) Price Variability 5.9 Rs/40 Kgs.:				
Policy 1(c):	Simple Price Band With 150,000 metric tons Buffer Stock	54	-	4.6
Policy 2(c):	Policy 1 With No Buffer Stock	21	32	6.3
Policy 3(c):	Policy 1 with Variable Buffer Stock, Size Dependent on World Price	21	0	6.3
Policy 4(c):	Policy 3 with Price Band Adjusting to World Price	-34	55	11.8
Policy 5(c):	Policy 4 adding Sensitivity to Domestic Production	-32	-2	11.8
Policy 6(c):	Policy 5 With Degree of Sensitivity to World Price and Production Depending on Production	-42	7	11.9
Policy 7(c):	Optimal Policy	-45	3	11.2

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Notes (1) Policies 1(a), 2(a) and 3(a) have a price band of 1.12 percent.
Policies 1(b), 2(b) and 3(b) have a price band of 3.82 percent.
Policies 1(c), 2(c) and 3(c) have a price band of 7.72 percent.

(2) Policies 3 a, b, & c have a buffer stock of zero when the world price is above eighty have.

(3) The maximum buffer stock for policies 3 a, b, & c rises to 150,000 metric tons as the world price drops to US$ 30 /mt.

(4) The price band for policy 4(a) is 0.78 percent. The domestic price is adjusted 13 paisa/40 kgs. for every US $10 change in the world price.
The price band for policy 4(b) is 3.12 percent. The domestic price is adjusted 45 paisa/40 kgs. for every US $10 change in the world price.
The price band for policy 4(c) is 6.82 percent. The domestic price is adjusted 85 paisa/40 kg for every US $10 change in the world price.

(5) In policy 5(a), the domestic price moves 13 paisa/40 kgs. for each US $10 change in the world price, and 9 paisa/40 kgs. for each 100,000 metric ton increase in production. In policy 5(b), the domestic price moves 45 paisa/40 kgs. for each US $10 change in the world price, and 32 paisa/40 kgs. for each 100,000 metric ton increase in production. In policy 5(c), the domestic price moves 85 paisa/40 kgs. for each US $10 change in the world price, and 63 paisa/40 kgs. for each 100,000 metric ton increase in production.

(6) In policy 6(a), 6(b) and 6(c), the domestic price moves with respect to the world price and domestic production in accord with regressions (3)(a), (3)(b) and (3)(c) of Table 2.15.

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Figure 2.3: EFFICIENT POLICY ADJUSTMENTS

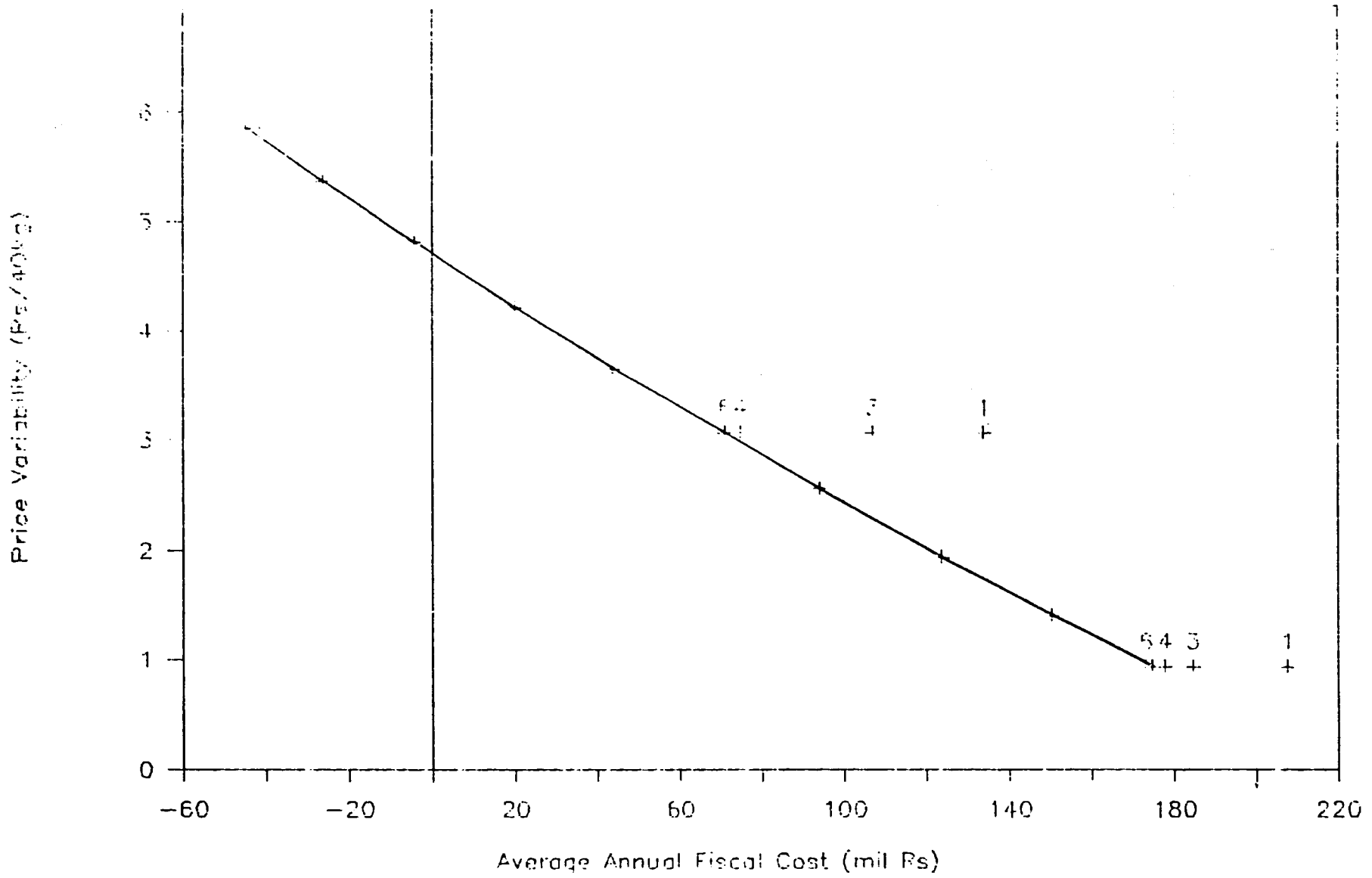
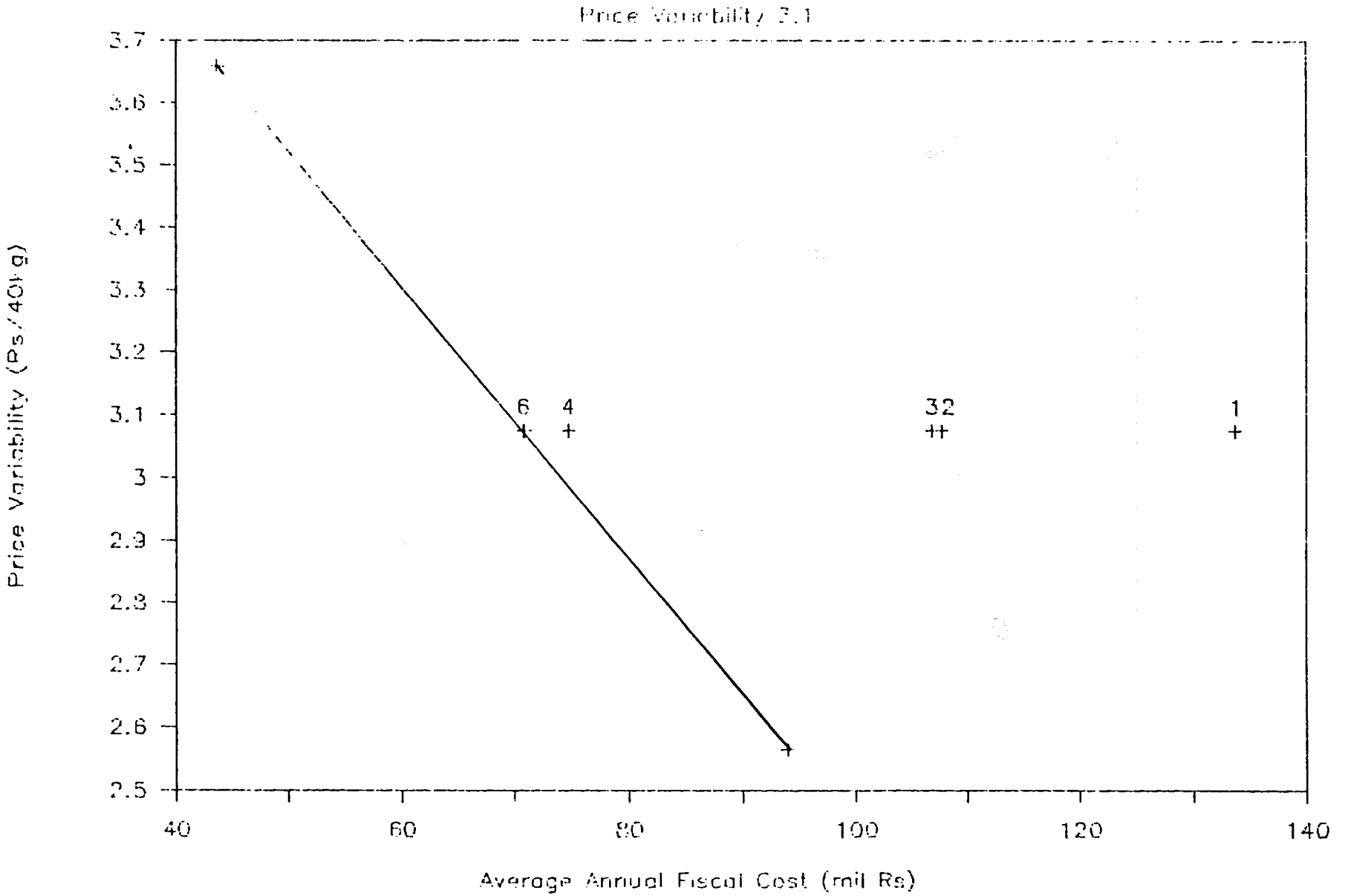


Figure 2.4: EFFICIENT POLICY ADJUSTMENTS



variability is 5.9, the difference between these two types of policy is Rs 63 million.

At all levels of price variability, lowering the maximum stock level in the price band/buffer stock scheme from 150 thousand tons to zero saves large amounts, ranging from Rs 22 to 32 million annually. Changing the policy by allowing some stocks to be held when the world price is low (policy 3) has virtually no impact on the cost since years with world price below US$80 per ton are few.

Allowing the domestic price to respond to the world price (policy 4) has the largest impact of any single policy change for the higher levels of price variability. This policy adjustment also exhibits the largest variation in effect, as shown in the figure. The improvement from policy 3 to policy 4 is only Rs 7 million annually when price variability is 0.9; the improvement is Rs 32 and 55 million annually when price variability is 3.1 and 5.9, respectively. This disparity is explained by the large difference in sensitivity to the world price among the different optimal policies. When price variability is 5.9, domestic consumption responds more than six times as much to a change in the world price as when price variability is only 0.9. The policy change is more dramatic and consequently more effective at higher levels of price variability.

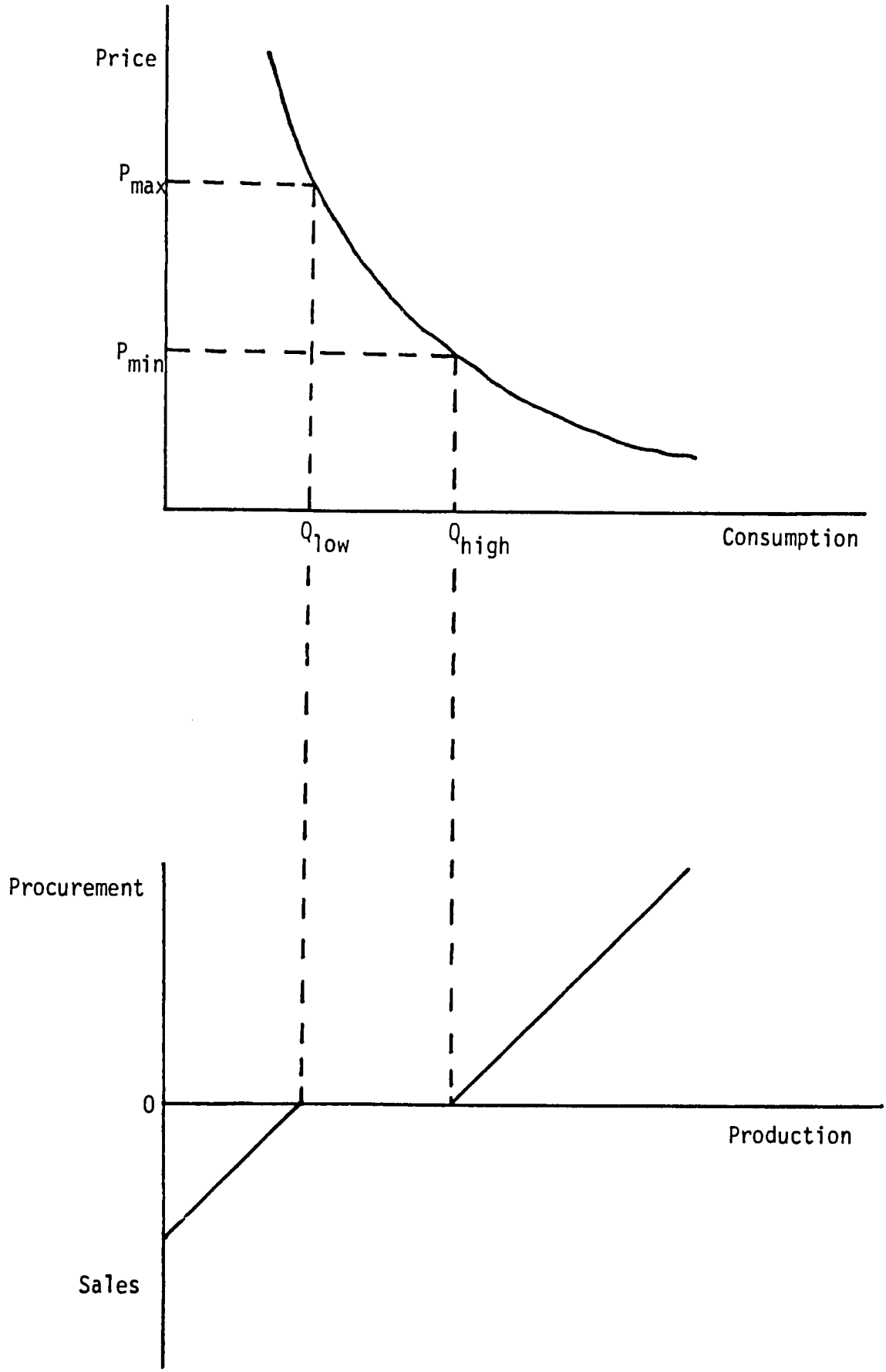
Adding sensitivity to domestic production -- moving from policy 4 to policy 5 -- has only a small effect, and actually produces an inferior policy when price variability is 5.9. In interpreting this result, it is important to understand the differences between policy 4 and policy 5. Policy 4 consists of a domestic price band which moves up and down depending on the world price. Holding world price

constant, the net procurement function looks like the one shown in Figure 2.5. If price is to be held between P_{max} and P_{min}, the net procurement function has a slope of one when production is less than Q_{low}, a slope of zero when production is between Q_{low} and Q_{high}, and a slope of one again when production is above Q_{high}. On the other hand, policy 5 basically implements the net purchases function estimated in Equations 2 of Table 2.15, which is a straight line when world price is constant. Given the pattern for the optimal net purchases function shown in Figure 2.2, it is clear that the function implied by the price band policy is closer to optimal than the straight line of policy 5. As price variability declines, however, the middle section of the net procurement curve becomes less flat, and a straight line eventually becomes a better approximation than the zero-sloped segment of a price band policy.

The policy which is sensitive to the world price alone -- policy 4 -- is thus not an implementation of the net procurement function estimated in Equations 1 of Table 2.15. The sensitivity to world price estimated in the equations is added, and brings about a large increase in efficiency. A degree of sensitivity to production is included in all of policies 1 through 4 -- but not in Equations 1 -- by the existence of a price band. This explains how the fit of Equations 2 can be so much better than Equations 1, yet policy 5 is no improvement over policy 4.

Policy 6 attempts to correct the shape of the net procurement equation of policy 5 by using the regression results from Equations 3a, 3b, and 3c of Table 2.15 to allow for different degrees of sensitivity to production and world price over different ranges of

Figure 2.5- Net Purchases Function Implied by Price Band Policy



production.[19] For all levels of price variability, policy 6 leads to some improvement. The improvement is small, however, ranging from Rs 1 million to 7 million annually.

The resulting policies are very close in efficiency to the optimal policies. It is thus possible to be confident that policy 6 includes all of the important components of the optimal policy. Indeed, with a price variability of 0.9, that policy 6 is actually superior to the "optimal" policy.

Figure 2.6 explains how this anomaly can be possible. Recall that the optimal policies are actually interpolated policies from a discrete optimization process. In the figure, suppose that the truly optimal relationship between production and net procurement is the straight line, but only points on the grid are considered by the discrete optimization procedure. Thus, the points marked with boxes are chosen by the procedure as being superior to all other considered points. These points are the closest points on the grid to the straight line. The interpolated policy will then consist of the grid points and the segments connecting the points. A linear regression estimated from the interpolated policy, therefore, will produce a line which exactly coincides with the truly optimal policy, and a simulation of this policy will produce a superior result to a simulation of the interpolated "optimal" policy.

Although it would be rare for the truly optimal relationship to coincide exactly with the regression results, it is quite possible

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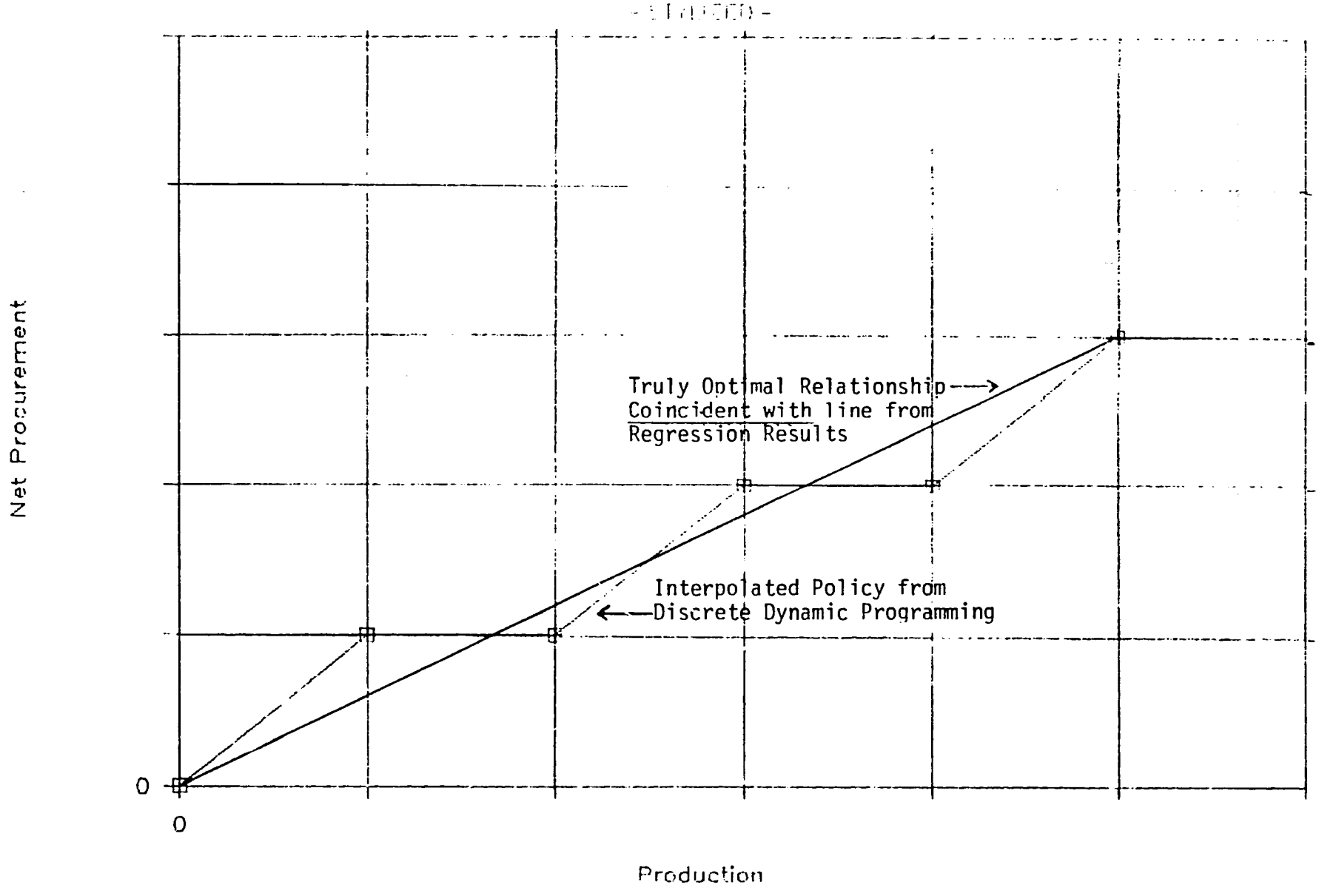
[19] Tests were conducted modifying policy 4 by allowing the sensitivity of net procurement to world price to be responsive to different levels of production. The resulting policies were no improvement over policy 4.

Figure 2.6: OPTIMAL NET PROCUREMENT FUNCTION



for the regression line to be closer to the truly optimal relationship than the interpolated policy. This is more likely to be true when the truly optimal relationship loses its curvature as price variability moves toward zero. This explains the anomalous result from the table.

Thus, it is possible to delineate the differences between simple price band/buffer stock policies and optimal price, storage, and trade policies. The elements of an efficient policy can be introduced one by one into a price band policy, with the added efficiency of each component measured. The implications of the modelling effort for policy in Pakistan are discussed in the next, final section of this chapter.

2.5 POLICY IMPLICATIONS

The most important policy recommendations of this analysis are:

(1) Do not hold interannual supply stabilization stocks at present world prices; and

(2) Do not build extra storage capacity for such stocks.

These have been discussed above. The savings that accrue from following these recommendations far outweigh the savings for Pakistan that result from modifying the domestic price structure so that it approximates an optimal policy.

Nevertheless, there are significant benefits shown in Table 2.15 and Figure 2.6, particularly if the government's relative preferences for low fiscal cost and price stability lead to a choice for price variability in the higher range of the tables. Once stock sizes are reduced, the table and figure show that the largest gain in efficiency comes from allowing the domestic price to respond to the

world price. As pointed out above, the degree of sensitivity is not particularly large, with a US$10 change in the world price leading to a change in the domestic price between Rs 0.13 and Rs 1.12 per 40kg for the levels of price variability considered here.

World prices are taken into account by the Agricultural Prices Commission in making a recommendation to the government each year. This recommendation, however, is made based on September world prices for a crop year that will begin the next April. World prices can swing widely in seven months; indeed, excluding the large 1972/73 price increase, the standard deviation of the percent changes in the world price from September to April is 80 percent as high as the standard deviation of the percent changes in the annual price.[20] From 1970 to 1987, the range of percent changes in the world price from September to April is from -18 to +32 percent; in 15 out of the 18 years, the absolute change has been larger than US$10 per ton (in 1986 dollars).

One way to incorporate such information into the pricing mechanism would be to announce a procurement price at planting time which is calculated assuming a significant fall of 15 percent in the world price. Given the past history of world price changes, it is unlikely that the world price would fall more than this amount between September and April. In mid-April, before procurement begins, the government would announce a "world price bonus payment" to be paid over and above the procurement price for all wheat procured.

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[20] U.S Gulf Port prices for No 2 Hard Winter Wheat are used in these calculations.

The amount of the bonus would be calculated as follows:

$D = (WP_1 - (0.85*WP_0))*S$

where D is the world price bonus payment, WP_0 is the world price is September of the last year, WP_1 is the world price on 15 April, and S is the sensitivity of the domestic price to the world price.

For example, suppose that the world price in September is US$120 per ton. Given this world price, the government's desired procurement price is Rs 85 per 40kg. Suppose also that the government is aiming at a price variability of 5.9, and thus the sensitivity of the domestic price to the world price should be Rs 1.12 per $10 change, or Rs 0.112 per $1 change. Consequently, the procurement price announced at planting time would be:

85 - 0.112*(0.15*120) = 85 - 2.02 = Rs 83

to the nearest five paisa. Suppose then that the actual price on 15 April is $130 per ton. The world price bonus payment to be added to the Rs 83 procurement price would be:

(130 - 102) * 0.112 = Rs 3.15

to the nearest five paisa. The total amount paid to farmers would thus be Rs 86.15 per 40kg.

These price movements are not large, yet they lead to significant savings in fiscal cost. If the desired price variability level is lower than 5.9, the degree of sensitivity to world price will be lower still.

The estimates of the savings from allowing the domestic price to be sensitive to domestic production are small. These estimates, however, may not be accurate given Pakistan's present seasonal price policy. The price band policies used in the simulations of policies

1 to 4 assume that the government selling price covers the procurement price plus all incidentals plus the price band. Under such a policy, the average price for the year can vary significantly from year to year. But for this to occur, the price band for even the lowest price variability level would require a selling price more than 50 paisa per kilogram above the procurement price. For 1987/88, this gap was only 8 paisa per kilogram. With such a small gap, the average annual domestic price will be virtually constant from year to year, regardless of the size of production.

If this gap cannot be raised above government costs, the benefits to allowing official prices to be sensitive to domestic prices will be much larger than measured. Sensitivity to production can be built into the system through a bonus payment system, as in the case of sensitivity to world price. A "production bonus payment" could be added to the world price bonus payment. As in the case of the world price bonus payment, the announced procurement price would have to be the lowest price offered under any circumstances. Thus, it would be calculated based on the two events that would lower the optimal domestic price: a fall in the world price and an abundant crop.

Suppose, for example, that expected production for next year is 13 million tons. World price in September is US$120 per ton as above. Given the variability of production of 0.06 measured in section 2.2 above, the standard deviation of production would be 0.06 * 13 million = 780 thousand tons. As in the case of the world price differential, the government wants to announce the lowest price at which it would buy wheat. It consequently assumes high production

for the present crop year. A production level of 1.28 standard deviations above the mean would occur about one year in ten, while a level 1.64 standard deviations above would occur one year in 20. For illustrative purposes, we will choose the lower level. This works out to:

1.28 * 780 = 1000 thousand tons

to the nearest 5 thousand tons.

As above, suppose that the government's desired procurement price at the world price of US$120 and a production level of 13 million tons is Rs 85 per 40kg. Suppose also that the desired price variability is 5.9 and the government chooses to implement the more complicated, tripartite net purchases function. The regression results from Table 2.15 indicate that consumption would increase by:

(1 - 0.471)*300 + (1 - 0.827)*700 = 280 thousand tons.[21]

This translates into a percentage price change of:

280/13000/0.3 = 7.2 percent

or Rs 6.10 per 40 kg. Given that the world price adjustment equal Rs 2, the announced procurement price would be:

85 - 2 - 6.10 = 76.90 Rs per 40kg.

Now, assume that the early April forecast of production is 12.9 million tons. This forecast is used to compute the production bonus payment. Although the April forecast will deviate from actual production to some extent, it includes much more information than was known at the time of announcing the procurement price. The bonus

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[21] Since the coefficients are for net procurement, the increase in consumption equals 1 - (increase in net procurement). The 1000 thousand ton increase in production is broken down into the first 300 thousand tons and the second 700 thousand tons because of the partitioning of the net procurement function.

payment is then equal to the previously calculated Rs 6.10 (which is what the production bonus payment would equal if production were 13 million tons) plus an adjustment for the shortfall below expected production. The additional change in consumption is:

(1 - 0.471)*(13.0 million - 12.9 million) = 53 thousand tons

This amount implies a price change of:

53/13000/.3 = 1.36 percent

or Rs 1.15 to the nearest 5 paisa.

The total production differential is thus 6.10 + 1.15 = Rs 7.25 per 40kg. The total price paid to farmers is the procurement price plus the production bonus payment plus the world price bonus payment. Assuming the world price bonus payment is Rs 3.15 as above, the total payment is:

76.90 + 3.15 + 7.25 = 87.30

On the other hand, if production had ended up being 14 million tons or above, the production differential would have been zero and the total paid to farmers would have been:

76.90 + 3.15 = 80.05

The important point to note here is not the exact calculations, but the existence of sensitivity to domestic production. If the amount of sensitivity shown in these calculations were deemed too large, a lower level of price variability could be chosen (albeit at higher levels of fiscal expenditure). But if the government selling price is to remain below the government cost, some mechanism such as this needs to be instituted to allow a degree of sensitivity of price to production.

In addition, note that both the producer price and the consumer price must respond to the world price and domestic production in order to reap the benefits measured in this chapter. Thus, if a world price bonus payment is added to the procurement price, the government selling price will have to go up by a corresponding amount. Simulations of these policies holding the consumer price constant while the procurement price changes show that virtually all of the benefits disappear.

2.6 CONCLUSIONS

The coefficient of variation of Pakistan's wheat production is about six percent. Using stocks to stabilize consumption in the presence of this variability is inefficient unless world prices are less than US$80 per ton. Given any reasonable assumption about future world prices, the value of building additional storage capacity for interannual supply stabilization purposes is much less than the cost. Other than minimizing this type of stockholding, the most profitable change in policy would be allowing the domestic price to reflect changes in the world price. This degree of sensitivity is not large, and could be accomplished by paying a "world price bonus payment" over and above the procurement price. If seasonal price policy, as examined in the next chapter, does not allow for a release price above government cost, the benefits of allowing the official price to respond to domestic production increase substantially. In that case, a strong rationale exists for instituting a "production bonus payment" also.

3. WITHIN-YEAR PRICE POLICY AND GOVERNMENT SEASONAL STORAGE

The second rationale for government storage is similar to the first: just as there is an apparent rationale for some agent to transfer grain from surplus to deficit years, there is a rationale for an agent to transfer grain from surplus to deficit seasons. Moreover, the rationale is stronger in the seasonal case for two reasons: the time periods are shorter, thus diminishing the role of foreign trade; and the production variability between seasons is extreme -- no wheat is harvested in Pakistan between August and February.

For the same reasons, however, it is much more likely that private agents will be involved in seasonal storage. Indeed, everyone acknowledges that surplus farmers for the most part store their consumption requirements for the remainder of the year. The question of the appropriate size of government seasonal storage storage revolves around how much private agents will store given different expectations of the seasonal price rise.

This chapter examines the demand for government storage brought about by the government's seasonal price stabilization. The key concept is the trade-off between the required size of seasonal storage -- and thus fiscal cost -- and the allowed seasonal rise in prices. The chapter begins by examining the determinants of procurement under the ration shop system, since the size of procurement has a large impact on required government storage. Section 3.2 studies the past seasonal price patterns, while section

3.3 attempts to estimate the amount of wheat held by private agents month by month. The next two sections estimate the sensitivity of private storage to expected price changes and examine the implications for fiscal cost of widening the difference between the procurement and the release price. The final two sections discuss sensitivity analysis and policy implications.

3.1 DETERMINANTS OF PROCUREMENT SIZE

A Model of Procurement

A simple three-equation model is used here to characterize the determinants of procurement:

(1) MS = f(Q, PP, WP, T)

(2) WP = f(MS, PP, D)

(3) PC = f(MS, PP, WP, T)

where MS is marketed surplus, Q is production, PP is procurement price, WP is the wholesale price at harvest time, PC is procurement, D is demand at the wholesale level, and T is time. The equations will be discussed in turn.

In Equation 1, marketed surplus is expected to be a positive function of all four variables. Even though output has a positive effect on income and thus on consumption of the commodity, it is unlikely that the income effect is large enough to cause marketed surplus to decrease when production increases. Indeed, if the income elasticity is less than one (as it is for wheat in Pakistan), an increase in output ceteris paribus must lead to an increase in marketed surplus.

The relationship between marketed surplus and the price variables is somewhat less clear since these variables also raise income. The income effect would increase consumption for most commodities. For a surplus producer, however, the relevant own-price in a demand equation is the selling price, so a rise in price will tend to decrease consumption through the substitution effect. In testing which effect is strongest, Singh, Squire, and Strauss (1986 p. 171) have found in the context of a household model that a rise in prices generally increases marketed surplus. Their analysis includes the supply response to a price announced prior to planting time and thus is most relevant to the procurement price in this model. Even for an unexpected change in the wholesale price, however, marketed surplus should be positively correlated with the change unless the income effect is much larger than the substitution effect. For wheat in Pakistan, therefore, it is expected that both price variables positively affect marketed surplus.

The time variable is the least clear. In general one would expect that as development proceeds farmers become more market oriented, due to more demand for purchased items and a reduction in transactions costs. Thus marketed surplus would be positively correlated with time. In Pakistan, however, there is some evidence that procurement agents forced farmers to sell to them in the early seventies, which possibly could lead to higher than desired levels of marketed surplus in those years. Therefore, the anticipated effect of the time variable is positive, but the earlier forced procurement makes this expectation tentative.

Equation 2 expresses the wholesale price as a function of the procurement price, marketed surplus, and time. Historically, the wholesale price at harvest time has been quite close to the procurement price, as shown in Figure 3.1 in nominal terms and Figure 3.2 in real terms. Evidently, a relatively small deviation from the procurement price is sufficient to switch enough of the marketed surplus from the procurement agency to the wholesale market to balance supply and demand in the market. Thus, wholesale price should go up with the procurement price. Marketed surplus should decrease the wholesale price as supply in the market increases. The non-farm sector demand is the most important component at the wholesale level. Fluctuations in this component from year to year should be small relative to fluctuations in marketed surplus. Consequently, time will be used as a proxy for demand in this equation. The expected sign, then, would be positive.

Finally, procurement is expected to be a positive function of marketed surplus and the procurement price, and a negative function of the wholesale price. Holding marketed surplus constant, the relationship between the procurement price and the wholesale price determines the proportion of marketed surplus going to the procurement agencies. An increase in marketed surplus raises procurement, while the time trend may be negative because of forced procurement in the early seventies, as mentioned above.

Thus the model described here has three variables considered endogenous -- procurement, marketed surplus, and wholesale price -- and three variables considered exogenous -- production, procurement price, and time (after substituting time for demand in Equation 2).

Figure 3.1: Procurement & Wholesale Prices of Wheat

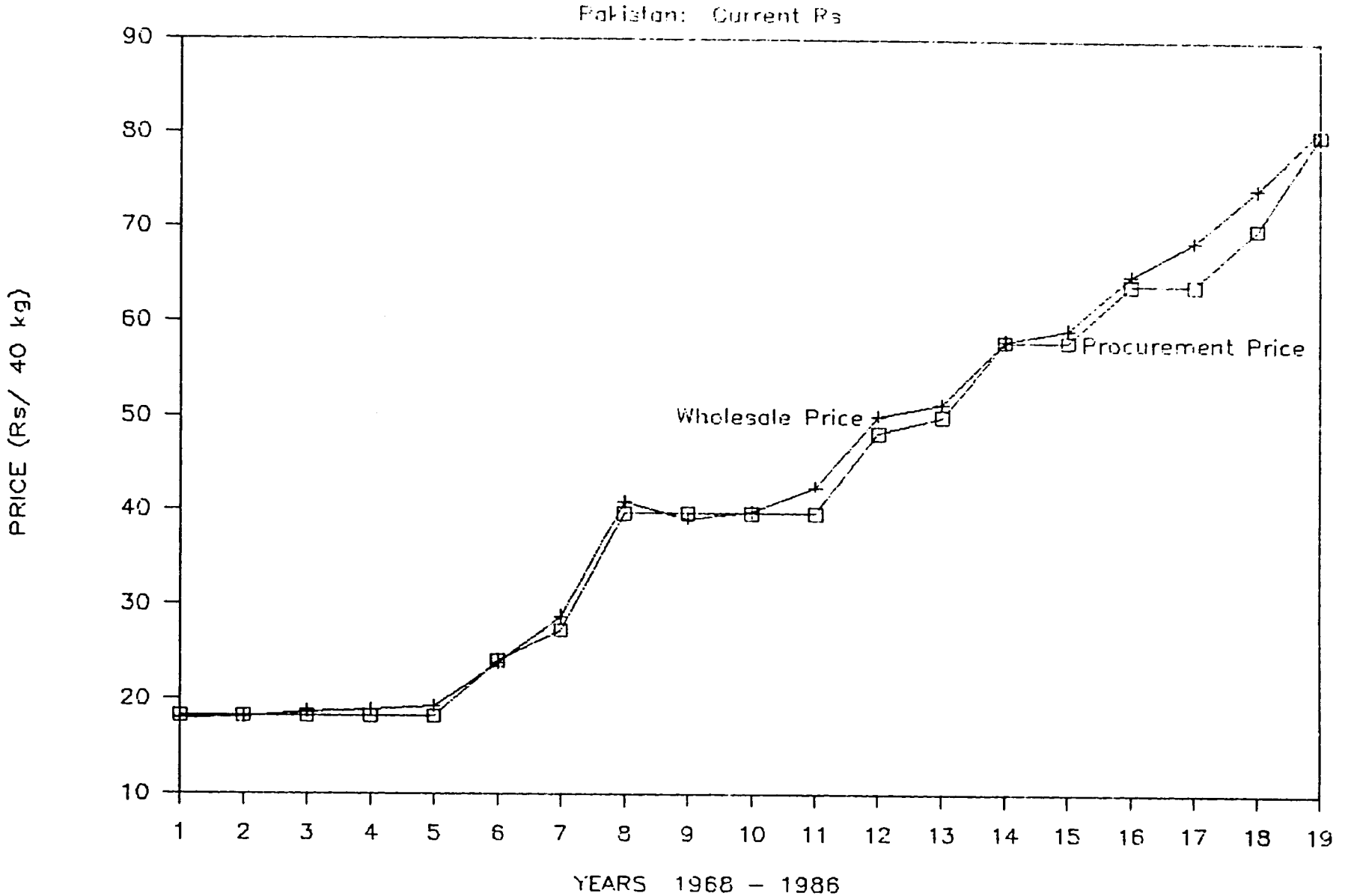

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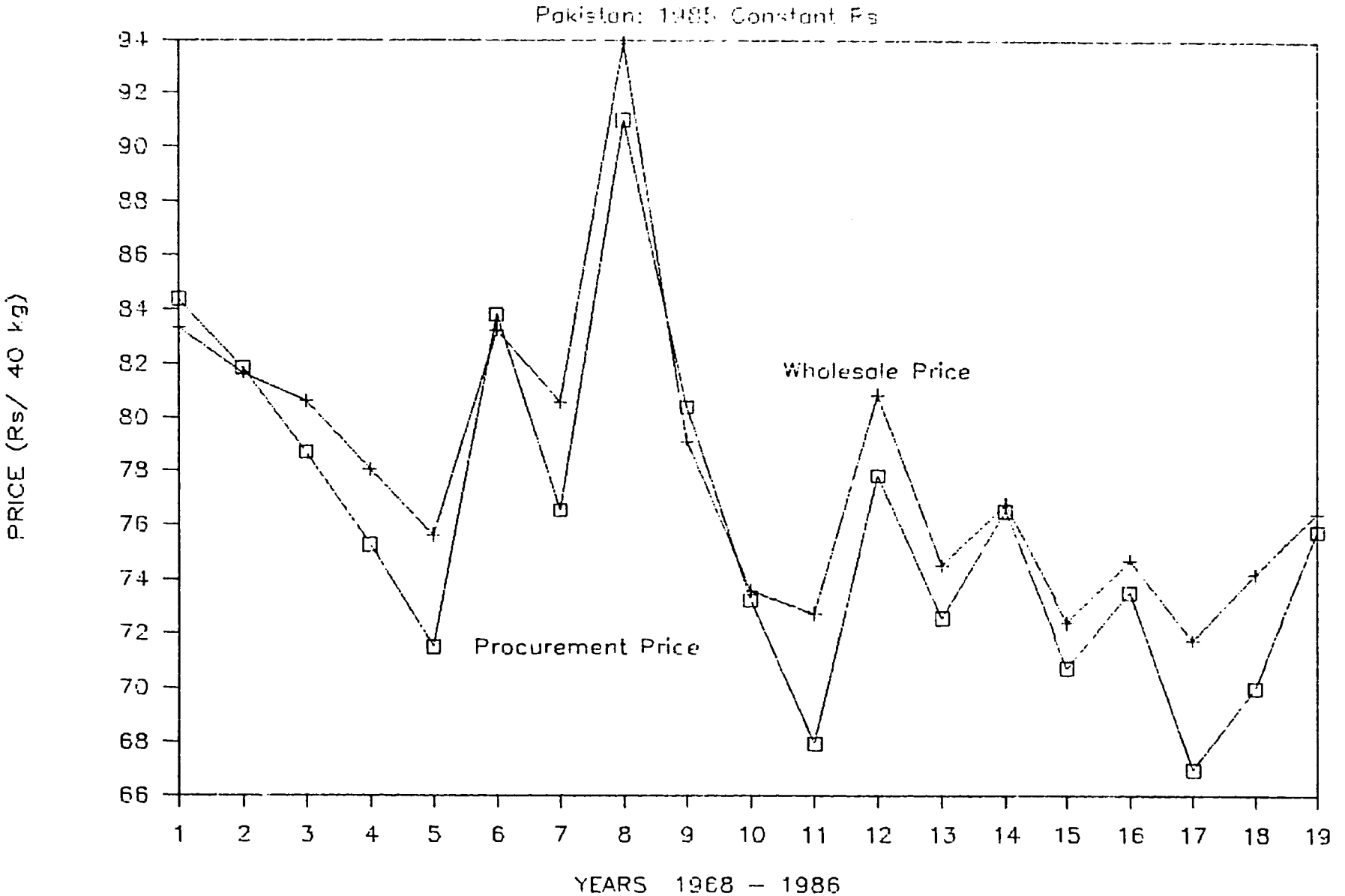
Figure 3.2: Procurement & Wholesale Prices of Wheat



Production could be considered an endogenous variable in a supply equation with the procurement price as one of the explanatory variables, but that is an unnecessary complication for the purposes at hand. The next step is modifying the model for estimation.

Estimation of the Procurement Model

The model outlined above cannot be estimated because the marketed surplus variable is unobserved. For estimation this model is collapsed into a two-equation model with only the wholesale price and procurement as endogenous variables by substituting Equation 1 for marketed surplus into Equations 2 and 3:

(4) WP = f(Q, PP, T)

(5) PC = f(Q, PP, WP, T)

As before, WP is the wholesale price, Q is production, PP is the procurement price, T is time, and PC is procurement. The earlier model remains useful for understanding the estimated coefficients. For example, the coefficient of the wholesale price in Equation 5 has two offsetting components: wholesale price positively affects marketed surplus and via the marketed surplus positively affects procurement; on the other hand, wholesale price has a direct negative effect in Equation 3 on procurement. Thus both effects will be included in the coefficient of the wholesale price in the procurement equation.

One advantage of the two-equation model is the absence of simultaneity in the system. Since Equation 4 has only exogenous variables on the right hand side, the system is recursive and thus both equations can be estimated consistently and without bias by ordinary least squares (Johnston p.468).

The time period for estimation is the post-Green Revolution period of 1968 to 1985. Variables used for estimation are as follows: for procurement, national purchases of wheat by the provincial food departments and PASSCO, measured in thousand metric tons. For the wholesale price, we use a weighted average of wholesale prices during harvest time in 15 surplus zones.[1] The units are constant 1985 rupees per 40kg, deflating by the GDP deflator for the non-agricultural sector. Procurement price is the effective procurement price at harvest time, which for a few years in the seventies is higher than the procurement price announced at planting time. This price also is deflated. Production is total wheat production in Pakistan, in thousand metric tons. The time trend is straightforward.

Procurement Equation Results

Equations 4 and 5 above are estimated and reported in Table 3.1. The wholesale price equation has an R^2 of 0.93 and highly significant coefficients, all with the expected signs. The coefficient of 0.87 on the procurement price indicates that if the procurement price is raised 10 Rs per 40kg, the wholesale price would be expected to increase by 8.7 Rs per 40kg. The production coefficient suggests

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[1] Months used are May and June for Punjab cities, April and May for Sind cities. The weights are derived from the proportion of total wheat procurement that comes from surrounding districts. The cities and their weights are as follows:

Bahawalnager	(.0352)	Bahawalpur	(.0262)
Gujranwala	(.1084)	Faisalabad	(.1224)
Multan	(.2085)	Okara	(.1086)
R.Y. Khan	(.0358)	Sahiwal	(.0758)
Sargodha	(.0535)	Hyderabad	(.0240)
Khairpur	(.0215)	Larkana	(.0179)
Mirpur Khas	(.0314)	Nawabshah	(.1106)
Sukkur	(.0201)		

Table 3.1. WHEAT PROCUREMENT MODELS (OLS) 1968-1986

Equation No.	Dependent Variable	Constant	Wholesale Price	Procurement Price	Price Ratio	Trend	Production	Adj. R2	D.W.
		Independent Variable/Estimated Coefficient							
(4)	WP	20.2	...	0.873*** [0.07]	...	0.653*** [0.21]	-0.0016*** [0.0005]	0.93	2.00
(5)	PC	-5277	-95.6 [50.9]	118.3** [46.3]	...	-48.9 [53.5]	0.680*** [0.13]	0.96	2.38
(5a)	PC	-7209	...	35.2	...	-111.0	0.837	...	...
(6)	PC	-7208	...	34.9** [14.1]	...	-111.3** [45.3]	0.837*** [0.10]	0.95	2.59
(7)	PC	-14009	...	...	10874*** [35]	-39.8 [54.5]	0.635*** [0.13]	0.96	2.16

Note: The standard errors of the estimated coefficients are presented in brackets.

The statistical significance of the estimated coefficients are indicated as follows:

* = 10% significance level
** = 5% significance level
*** = 1% significance level

that a rise in production of 100 thousand tons leads to a decline in the wholesale price of 0.16 Rs per 40kg. Thus, although the relationship between production and wholesale price is statistically significant at the 1 percent level, the effect is relatively small.

The estimation of equation 5 is also statistically strong, with an R^2 of .96 and all coefficients except trend significant at least at the 10 percent level. The sign of trend in this equation was ambiguous a priori. Trend was expected to have a negative direct effect, but also to have a positive impact on marketed surplus. The estimated coefficient picks up both components, and thus is insignificant. The other coefficients are significant despite the presence of high multicollinearity, which does not bias the results but tends to increase estimates of standard errors.

The equation indicates that, holding production and wholesale price constant, procurement increases by 118 thousand metric tons when the procurement price is raised by 1 Rupee per 40kg. This captures both the indirect positive effect of a rise in the procurement price on marketed surplus and the direct positive effect on the percentage of marketed surplus purchased by procurement agents.

As expected, the wholesale price coefficient is negative and somewhat smaller in absolute value than the procurement price coefficient. A rise in the wholesale price, ceteris paribus, has a positive effect on total marketed surplus, but a negative effect on the percentage of marketed surplus procured by the government. The latter effect outweighs the former.

Holding prices constant, the production coefficient indicates that 68 percent of an increase in production is procured. Since this marginal percentage is higher than the average percentage of the crop procured, in good years such as 1973, 1976, and 1981, the percentage increase in procurement can be considerably greater than the percentage increase in production.

Since equation five includes an endogenous variable (wholesale price), the coefficients reflect only the direct effects, and not the indirect effects, of the exogenous changes. For this reason, all results in the previous paragraph are stated with other variables held constant. If production increases, for instance, the wholesale price will go down, thus increasing procurement over and above the direct production effect. In equation 5a of the table, Equations 4 and 5 are combined to give an overall effect of the exogenous variables on procurement. This is accomplished by substituting Equation 4 for the wholesale price into Equation 5 and combining terms. The result can be considered a reduced form equation for procurement since only exogenous variables are on the right hand side.

Equation 5a shows that the direct plus indirect effect of an increase in the procurement price of 1 Rupee per 40kg is only a 35 thousand ton increase in procurement. As in all of the preceding analysis, the effect of an increase in the procurement price on output is ignored. The latter effect can be approximated using results from Hamid et al (1987). That report estimates a supply elasticity of about 0.43 for wheat, which implies that a 1 Rupee per 40kg increase in the procurement price will increase production by

about 70 thousand tons.[2] Equation 5a indicates that this increase in production will translate into an increase in procurement of slightly less than 60 thousand tons (0.84 times 70). The total expected effect on procurement, therefore, of a real 1 Rupee per 40kg increase in the procurement price is an increase of just over 90 thousand tons.[3]

The estimated percentage procured from an increase in the crop is much higher than the average percentage of production procured. It is important to distinguish between the estimated marginal effect and the average effect. Farmers hold a considerable portion of their crop for own consumption, and this amount is relatively inelastic to the size of the crop. Consequently, the marginal procurement ratio will always be higher than the average procurement ratio.

Equation 5a, used in the above calculations of the effect on procurement of an increase in the procurement price, was calculated from two separate regressions. Equation 6 is a direct estimation of the same equation, with similar results. The coefficient of the procurement price incorporates the negative impact on procurement of the resulting rise in the wholesale price. Despite the high collinearity between the two price variables, the results are robust.

An alternative specification of the procurement equation has been used by Krishna and Chhibber (1983). In that study, procurement is modeled as a function of production and the ratio of the

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[2] This is calculated by taking the percentage increase in the procurement price (1/80), multimplying by the supply elasticity (0.43), and multiplying by expected production (13 million tons).

[3] In this context, "real" means deflated by the average increase in prices for non-agricultural goods and services.

procurement price to the wholesale price. Results using this specification are presented in Equation 7.

The advantage of this specification is that it lowers multicollinearity in the equations considerably. There are two disadvantages. First, the ratio variable will vary the same amount when the procurement price goes up by 10 percent as when the wholesale price goes down by 10 percent, implying that the two effects are equal. Second, in this specification it is assumed that procurement will not change if both the procurement price and the wholesale price rise by the same percentage. Neither is true according to our estimates of Equations 4 and 5. In the latter case, procurement could increase either by diverting wheat from the wholesale market -- and thus increasing the percentage of the marketed surplus being procured -- or by increasing the marketed surplus while holding its share of marketed surplus constant. Therefore, it is advisable to keep both prices in the equation as separate variables even though the fit of the ratio equation is just as good as that of the two-price equation.

Implications for Storage

The most important implication of the above analysis for storage is the degree to which procurement increases in high production years. Wheat production in Pakistan is expected to be less than 10 percent above trend 19 out of 20 years.[4] Trend production in 1987/88 is about 13 million tons, and 10 percent of this figure is 1.3

[4] This is calculated by taking the coefficient of variation of 6 percent from Chapter 2 above, and multiplying it by 1.65 standard deviations since.

million tons. Consequently, maximum procurement in 19 out of 20 years should be the marginal share of procurement in production -- 0.84 from equation 5a -- times the production increase. The result is that, ceteris paribus, procurement should be less than 1.1 million tons above its normal year value in 19 out of 20 years. This result assumes that the government does not allow its procurement price to change with the size of the crop. If policies studied in Chapter 2 above were implemented, the maximal increase in procurement would decline.

Projections from Hamid et al (1987) show wheat production increasing at about 3.3 percent per year. Should this trend continue, the required storage space for bumper crop procurement would increase to about 1.6 million tons by the year 2000.

These figures could be lowered if the government required only enough storage space for nine years out of ten rather than nineteen years out of twenty. If nine years out of ten is sufficient, required storage space for bumper crop procurement is approximately 0.9 million tons today and will be about 1.3 million tons by the year 2000.

All of these figures are relative to some normal production year procurement. This amount can vary greatly, however, depending upon the prevailing policy towards seasonal prices. The remaining sections in this chapter examine this important point.

3.2 SEASONAL PRICE POLICY AND IMPLICATIONS FOR PROCUREMENT SIZE[5]

The previous section has examined how the level of the procurement price will affect the amount of wheat procured by the government. This relationship between official prices and procurement size is widely recognized. Less well known, but equally important, is the relationship between the permitted seasonal price rise and procurement size. Holding production and the procurement price constant, the amount of wheat procured by the government will be an inverse function of the allowed seasonal price rise. Showing that this effect is important and measuring its size is the subject of the remainder of this chapter.

The government of Pakistan has only recently begun to cap the seasonal price rise as an alternative to selling wheat through the ration shop system. Early in 1987, the government of Pakistan announced that it was phasing out its ration shop system, which had been in place for over forty years. Instead of providing set quantities at a highly subsidized price to a limited segment of the population, the new policy requires the government to sell all that the market will buy at a set price.[6] This change fundamentally

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[5] The remainder of this chapter is a revised version of a paper circulated earlier under the title "The Effects of Wheat Pricing Policy on Fiscal Cost and Private Seasonal Storage In Pakistan." The author gratefully acknowledges written comments on earlier drafts by John Mellor, Harold Alderman, Tom Olsen, and Pat Peterson, plus the numerous comments by the participants of several workshops and discussions in Islamabad during December 1987 and at IFPRI in October 1987.

[6] Since most of the supplies earmarked for the ration shops did not reach the intended beneficiaries but were diverted into the open market, the change in policy was not as dramatic as it appears. See Alderman, Chaudhry, and Garcia (1988).

alters the relationship of the Pakistan government to the private wheat market.

Historically, the private wheat market has been officially sanctioned and supported by the government, unlike in many less developed countries where private markets have been tolerated but are in fact illegal. The result has been an active private market in wheat trading. In past years, prices in the private market have shown a marked seasonal pattern, with harvest prices close to the government procurement price, afterwards rising an average of 18 percent to a peak in January. Unless the difference between the government buying and selling prices is close to this figure of 18 percent, the expected seasonal price rise would be less. Thus expected returns to storage would be lower than in the past, and private agents consequently would store less. The result would be larger procurement and higher demands on government storage facilities. Thus, this topic is of direct relevance to establishing the appropriate size of government storage facilities.

But how important is the private sector in seasonal storage in Pakistan? Does the change in price policy make any substantial difference? What are the implications of this policy in terms of government cost, government procurement, and the growth of private marketing activity?

This chapter addresses these questions in the following way:

(1) The next section examines the seasonal pattern of prices that has held historically.

(2) Section 3.4 estimates the importance of private sector seasonal storage. This is seen to be significant, with millers,

traders, and farmers holding between five and six million tons at the end of July during 1983 to 1986.

(3) Section 3.5 discusses the sensitivity of private sector storage to the seasonal price change, with an examination of the theory of the supply of storage function and estimation of a storage function for Pakistan. This function is then tested against actual data for 1985/86 and 1986/87 marketing years to verify its validity.

(4) Section 3.6 estimates the fiscal cost of different policies and implications for procurement and private storage using the function from the previous section. The estimated average fiscal cost for the 1987/88 policy is an average of Rs 3.5 billion per year, inclusive of the value of physical storage losses and the costs of transporting wheat to remote areas. With normal production, procurement is estimated to be 4.9 million tons.

(5) The same section considers the implications of widening the band between the procurement price and the release price. Costs decline by Rs 300 million annually if the gap between the procurement and release price is raised by 2 paisa to 10 paisa per kilogram; costs decline by a further Rs 1.9 billion annually -- for a total savings of 2.2 billion -- if the release price is 30 paisa per kilogram higher than the procurement price. Estimated procurement is 2.8 million tons in this case, requiring 2 million tons less storage capacity than the 1987/88 policy. A 30 paisa gap is fifteen percent, and thus still less than the average seasonal price rise historically.

(6) Section 3.7 tests these results for sensitivity to key parameters. Basic results are seen to be robust.

(7) The concluding section considers implications for policy.

3.3 THE HISTORICAL SEASONAL PRICE PATTERN

Figure 3.3 presents the historical seasonal price pattern, which is constructed using a weighted average of separate price series for Multan, Faisalabad, Sargodha, Okara, Lahore, and Hyderabad. Since the scale is the average ratio of each month's price to a twelve-month moving average, the 12 percent price rise presented in the figure can be considered a real price rise.[7] The figure shows slowly rising prices during the procurement season of May, June, and July, followed by rapid increases in October, November, and December, with prices levelling off before declining dramatically in April and May.

In order to consider nominal prices and the dispersion of price rises across markets and years, Table 3.2 presents the percentage price rise for each of these six wholesale markets from 1976/77 to 1986/87.[8] In the ten years prior to 1987, the lowest nominal seasonal price rise in these six markets was 5.3 percent in Hyderabad

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[7] The index was developed by constructing a weighted average time series of wholesale prices for the six markets from 1979 to 1987, with the weights determined by average share in total procurement since this should reflect the extent of wheat available for storage. A seasonal index was then constructed for this weighted average series using the ratio to moving average method. Data from the Federal Bureau of Statistics were used in the analysis.

[8] In order to minimize the effects of any single month's data, the table is presented as the percent rise from the three usually lowest price months (May, June, and July in Punjab, April, May, and June in Sind) to the three usually highest price months (December, January, and February for Punjab, November, December, and January for Sind).

Figure 3.3: SEASONAL PRICE RISE FOR WHEAT

Pakistan, 1979–1987

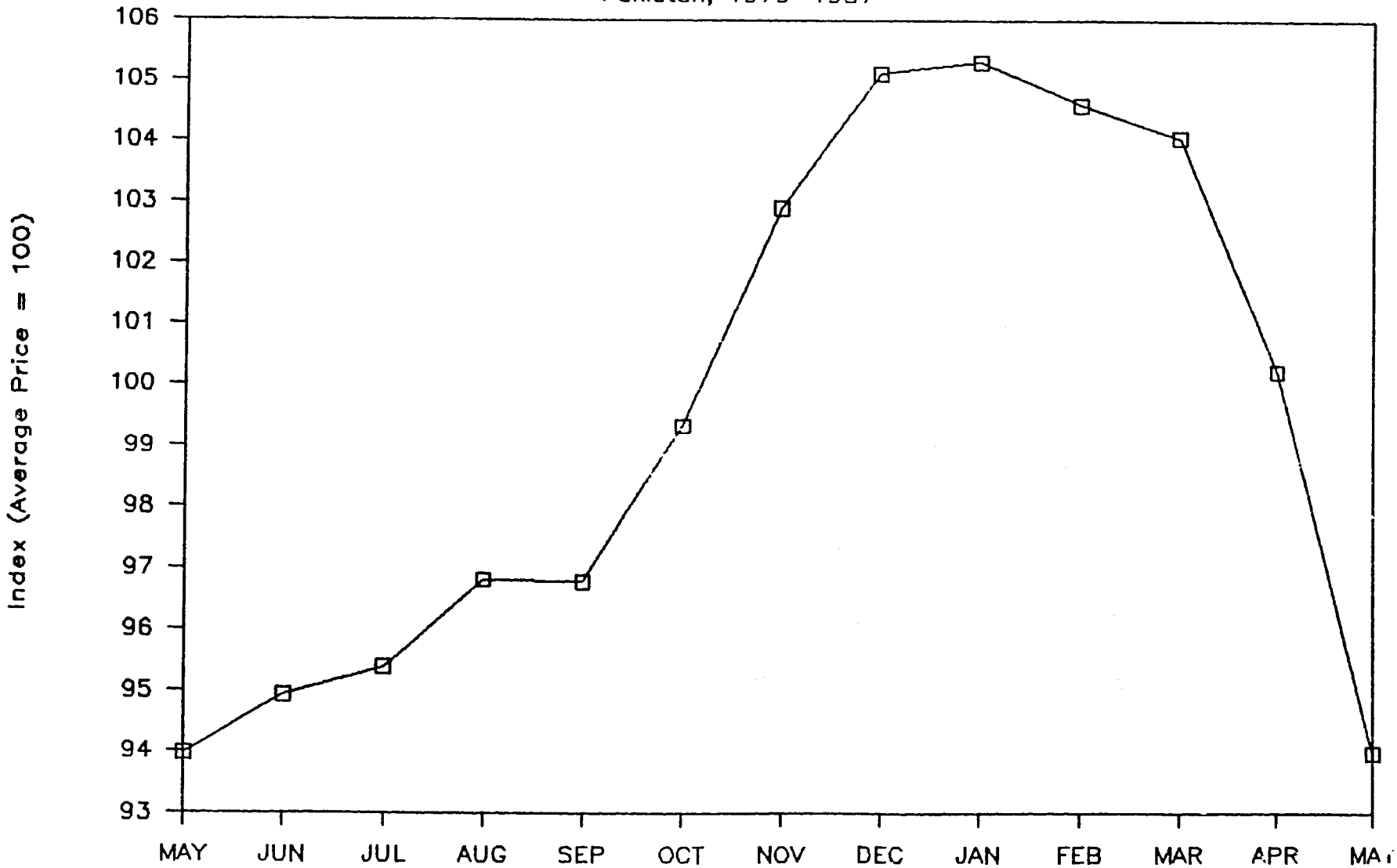

Table 3.2 -- Seasonal Price Rises in Selected Markets, 1976/77 to 1986/87
(Three Highest Months Divided by Three Lowest Months)

	Multan	Faisalabad	Hyderabad	Lahore	Okara	Sargodha	Weighted Average
				(%)			
1976/77	15.6	16.5	11.4	9.5	9.8	17.6	13.1
1977/78	47.5	62.3	NA	44.3	58.7	61.9	NA
1978/79	24.4	13.3	20.5	21.8	29.8	18.3	22.6
1979/80	7.5	12.7	22.6	17.6	17.7	19.6	14.9
1980/81	5.9	10.7	10.2	7.3	8.9	15.3	8.5
1981/82	20.8	22.1	27.3	24.5	22.7	25.7	23.3
1982/83	17.6	14.8	9.4	17.1	18.5	20.3	16.0
1983/84	17.2	18.7	21.1	14.6	16.4	21.8	17.8
1984/85	27.7	18.6	11.1	24.2	27.6	24.2	22.8
1985/86	15.3	18.6	5.3	20.7	15.4	14.5	14.6
1986/87	6.2	6.5	7.1	6.1	2.7	6.1	5.7
average 1977-87	15.8	16.5	NA	14.8	17.6	18.9	NA
average 1979-86	17.1	16.2	15.9	18.5	19.6	20.0	17.6

Data Source: Federal Bureau of Statistics

in 1985/86.[9] The price rise during 1986/87 was considerably smaller, perhaps because the announcement of the policy change was made during the normally high-price months. Market year 1977/78 is the outlier on the high side, as prices rose dramatically in all markets in the months following the declaration of martial law. Aside from that abnormal year, the highest price rise was 29.8 percent in Okara in 1978/79.

Three-fourths of all the price rises across markets and years from 1978/79 to 1985/86 were between 10 and 25 percent, while price rises greater than 10 percent occurred 90 percent of the time. Averages by market during this period range from 15.9 percent for Hyderabad to 20.0 for Sargodha. Weighting the price rise for each market by the share of procurement for that market yields an average price rise of 17.6 percent.

In sum, the previous system gave private agents a return to storage that was reasonably secure. Although there is dispersion across markets and years, there was a price rise of 10 percent or more in almost all cases aside from the year in which the new policy was announced.

3.4 THE SIZE OF PRIVATE STORAGE

The normal seasonal pattern of price rises has given the private sector, particularly surplus farmers, an incentive to store wheat from harvest until the later months in the marketing year. Knowing how much has been stored in different months in different years,

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[9] The data for Hyderabad for 1977/78 show a price decline during a period when the smallest increase in any other market listed here was 44 percent. These data are considered suspect and consequently are not included in the analysis.

however, is difficult, as there have been no national surveys of farmers, traders, and millers that collected such data.

Table 3.3 presents a monthly time series of minimum estimates of private storage which was constructed in the following manner. Market arrival of production is assumed to be distributed across months in the same proportion as procurement for each year. Losses of ten percent are incurred at the time of market arrival. Private stocks at the end of April from the previous year's harvest are assumed to be zero. These last two assumptions are both known to be simplifications; private stocks would never go to zero and losses would be spread out over the course of the year. These assumptions are useful, however, for providing a lower bound for actual private storage.

Per capita consumption is assumed to be constant across months within a marketing year, with total consumption in the marketing year equal to production less 10 percent, plus offtake from government stocks, minus procurement. Population is interpolated for each month from government estimates.

Given these assumptions, private storage at the end of any month is equal to private storage at the end of the previous month plus net production plus offtake minus procurement minus consumption:

$$(8) \quad PS_t = PS_{t-1} + Q_t + O_t - PC_t - C_t$$

where PS_t is private storage at the end of month t, Q_t is production in month t, O_t is offtake from government stocks during the month, PC_t is government procurement, and C_t is consumption during the

Table 3.3 -- Estimated Private Storage of Wheat in Pakistan, 1983 to 1987

Year	Month	Annual Production	Market Arrival of Production	Procurement	Offtake	Estimated Private Storage
		(Thousand tons)				
1983/84	May	12414	4535	1551	235	2570
	Jun		5106	1746	147	5205
	Jul		957	327	146	5106
	Aug		211	72	179	4546
	Sep		70	24	181	3894
	Oct		1	0	217	3231
	Nov				263	2610
	Dec				316	2040
	Jan				385	1537
	Feb				399	1046
	Mar				420	573
	Apr		452	105	363	388
1984/85	May	10882	7523	1747	186	5430
	Jun		1637	380	172	5937
	Jul		142	33	227	5348
	Aug		39	9	243	4693
	Sep				266	4030
	Oct				285	3383
	Nov				306	2754
	Dec				366	2184
	Jan				441	1686
	Feb				397	1141
	Mar		21	5	431	644
	Apr		1376	331	372	1114
1985/86	May	11703	7864	1892	254	6399
	Jun		1023	246	220	6452
	Jul		229	55	233	5913
	Aug		21	5	229	5210
	Sep				241	4500
	Oct				259	3806
	Nov				285	3135
	Dec				317	2494
	Jan				352	1886
	Feb				361	1284
	Mar		17	7	378	707
	Apr		701	282	345	504
1986/87	May	13916	7343	2952	297	4279
	Jun		3473	1396	231	5672
	Jul		853	343	247	5512
	Aug		129	52	244	4913
	Sep		7	3	255	4251
	Oct				265	3591
	Nov				276	2941
	Dec				311	2322
	Jan				351	1742
	Feb				347	1156
	Mar		6	2	432	655
	Apr		921	325	389	702

month. The results in the last column of Table 3.3 show large amounts in private storage, with five to six million tons being held at the end of July of each year.

These private stocks are held for at least four purposes. Some traders are holding for later sale; millers are holding for later processing; farmers are holding for later sale; and farmers as well as consumers are holding for own consumption. It would be useful to know how much of this private storage is held for each of those purposes. Unfortunately, this is not possible both because of a lack of micro-level data and because the farmers themselves may shift their intended use depending on prices. The most that can be said about the breakdown is that farmers hold the vast majority of the stock at the end of July, since the Agroprogress study reports that total storage capacity of traders and millers is only 1.1 million tons (Agroprogress, Vol. 1, p. 43).

3.5 THE RELATIONSHIP BETWEEN PRIVATE STORAGE AND PRICE RISES

The Theory of the Supply of Storage

In order to estimate the effects of a change in the seasonal price pattern on private stocks, it is necessary to have a theory of the relationship between interseasonal prices and stocks. Working's (1949) classic article on the supply of storage provides us with a useful theoretical background. In a free, competitive market, Working shows that the difference between today's spot price and today's expected price at some time in the future cannot be larger than the cost of storage; otherwise, market participants would demand more today to store until the future time period, thus bidding up the

present price and lowering the expected future price. This can be stated as:

(9) $EP_{t+1} - P_t <= SC_{(t,t+1)}$

where EP_{t+1} is the expected price at time t+1 (with expectations taken at time t), P_t is the spot price at time t, and $SC_{(t,t+1)}$ is the cost of storing the commodity from time t to time t+1.[10]

It is clear that if the equality in the equation holds, private storage will be the amount necessary to keep the price differential no larger than the cost of storage. It does not follow, however, that private storage will be zero if the price differential is less than the cost of storage. Stocks are held for reasons other than making a profit from inter-temporal arbitrage. Indeed, Lele (1971) found that most of the Indian traders interviewed for her study held grains for only short periods of time, just until a profit-making opportunity came along, often through market arbitrage. Working, following Kaldor (1939), terms the benefits of holding grain over and above expected profit the "convenience yield". Even if there is a negative expected return to holding stocks over the next month, market actors will hold some grain in order to take advantage of other trading opportunities, and to use the grain as an adjunct to other profitable activities.

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[10] In Working's analysis, the price differential is that between the spot price and the futures price. Thus, the market participant can virtually guarantee returns to storage by hedging in the futures market. In the absence of futures markets, as in Pakistan, there is no way to guarantee a future price. Consequently, the concept of cost of storage used here must include some amount over and above the physical cost. This amount is positively related to the uncertainty of the future price and the degree of risk aversion of the market participants.

Working's key insight, however, was to show that even the amount of stocks held because of the convenience yield is an increasing function of the differential in expected prices. If prices are expected to fall 20 percent over the next month, market actors will hold less in storage than if prices are expected to remain constant. In neither case is the cost of storage expected to be met, but there will be more trading opportunities for profit-making in the latter case than in the former.

Working (1949) and Peck (1977/78) have explored the resulting shape of the supply of storage function, which relates the amount stored to $EP_{t+1} - P_t$, the expected change in price. Figure 3.4 presents a stylized version of that curve. The function is a steeply rising curve until the change in expected price approaches the cost of storage. At that point, the curve becomes close to horizontal. It may not be exactly horizontal because of different costs of storage for different market participants, and because of increasing opportunity costs for storage space as storage facilities fill. The curve in the figure is the natural logarithm function, $y = \ln(x)$. This functional form will be used in the analysis below, which, after making storage the dependent variable and adding the constant, becomes:

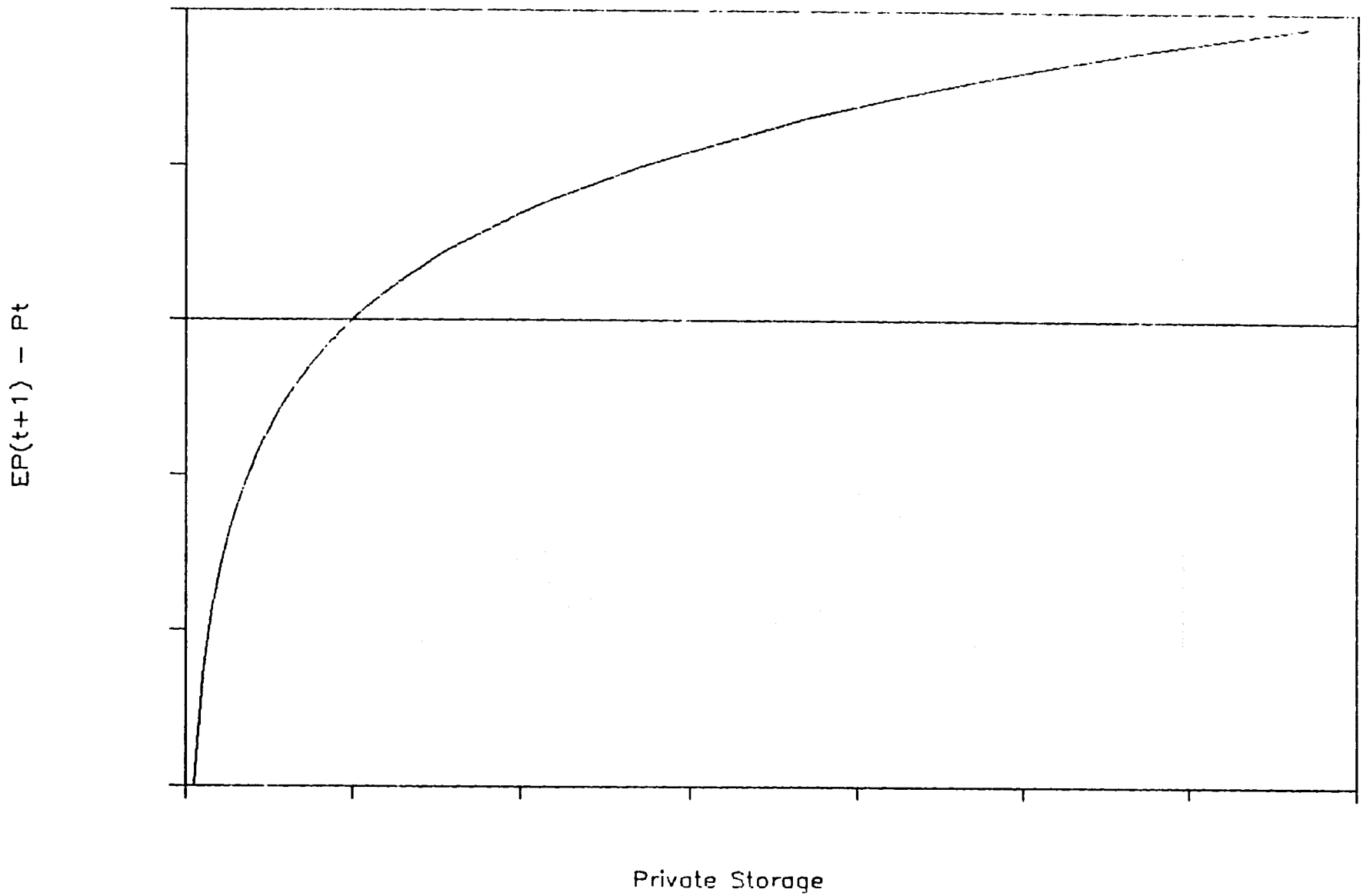
(10) $ST_t = A*\exp(B*(EP_{t+1} - P_t))$

where ST_t is private storage in time t, A and B are parameters to be estimated, and "exp" is the exponential function (taking antilogs).

Estimating a Supply-of-Storage Curve for Pakistan

The goal of the analysis at hand is to use the theory of the supply-of-storage curve to estimate the effects of changing

Figure 3.4: STYLIZED SUPPLY OF STORAGE CURVE



government policy on private storage and government cost. Consequently it is necessary to have a supply-of-storage curve for each time period under consideration.

This analysis will be done on a monthly basis. Unfortunately, as Working indicates, it is unlikely that the supply-of-storage curve is stable across months. In Pakistan, the amount of wheat stored in July if there is no expected price rise in August is almost certainly less than the amount stored in February if there is no price rise expected in March. Thus, equations will have to be estimated for each month.

The estimation of these equations requires the use of expected prices. Expected prices are difficult to know in the absence of futures markets, however. Working's original analysis of the supply-of-storage curve was based on the difference between spot and futures prices. Peck (1977/78) uses this difference also in her analysis of U.S. buffer stocking policies. Unfortunately, this option is unavailable in Pakistan.

Thus, it is necessary to make some assumptions in order to proceed with the analysis. First of all, the logarithm function is used as the functional form, as mentioned above. Second, the amount of storage in any one month is assumed to be a function of the expected price in the next month. Expected prices for months t+k where k is greater than 1 do not enter the storage function explicitly, although they do influence storage in time t through their impact on expected prices in time t+1. Third, the expected price change between any two months is assumed to equal the average percentage price change between those two months between 1979 and

1987, as measured by the weighted average series graphed in Figure 3.3. Fourth, the "B" parameter in Equation 10 is assumed to be constant across months. This implies that, holding P_t constant, a 1 Rupee increase in P_{t+1} leads to the same percentage increase in ST_t, regardless of the value of t.

Consequently, there are 13 parameters to estimate from Equation 3: 12 values of A (one for each month), and 1 value for B. It is not possible to estimate these simultaneously, however, because the changes in expected price for each month are constant across years, leading to a singular matrix of independent variables in the estimating equation if dummy variables are included for the months. Instead, the technique used is to estimate B holding A constant, and then to compute the value of A for each month using residuals and the constant from the regression equation.

The estimating equation for B uses data for the logarithm of private storage from July to March from 1979 to 1987 as the dependent variable. May, June, and April are excluded because private storage for those months is much more highly variable than for the other nine months. This results primarily from differences in harvesting time between years. The independent variable is the expected price rise. This estimating equation produces an R^2 of 0.61 and a value of B of 0.255 with a t-statistic of 10.5.

Because a significant component of private storage is for own consumption, private storage is expected to increase with increases in the rural population, holding month and the expected price change constant. Adding the logarithm of rural population in May of each market year to the estimating equation produces a reasonable

elasticity of 1.1, but an insignificant t-statistic of 1.25. The estimated value of the B-parameter does not change since the two independent variables are uncorrelated.

Table 3.4 presents the monthly values for the A parameter. These are computed by taking the residuals from the original estimating equation, averaging them for each month, then adding the result to the constant from the equation. These numbers can be interpreted as the amount of storage that will take place each month if there is no expected change in price. Such figures are important since some modeled policies hold prices close to constant throughout the year. One would expect the values of A to reach a peak in June or July and fall throughout the year until the next harvest begins in April. That general pattern holds, but as the table shows, the estimates for October and November are smaller than the December figure. Consequently, in the policy exercise the constants are adjusted so that:

$A_{t+1} <= A_t$ for $t<10$

where t=1 in May. Parameter A is allowed to increase in March and April, with the beginning of the harvest. The adjusted estimates are presented in column 2 of Table 3.4. The adjusted estimates are tested against the original estimates below.

In order to test again for the influence of rural population on private storage, a second-stage regression was run after adjusting the data series for the monthly values of the A-parameter. The effect of this adjustment is to remove the variance in the dependent variable that is correlated with month but uncorrelated with the expected price changes. Consequently, this regression by design had

Table 3.4: Parameters for the Monthly Storage Equations

Month	Estimated Series	Revised Series	Revised, Adjusted for Rural Population
May	2570	2570	2905
June	4674	4674	5283
July	3549	3549	4012
August	4566	3549	4012
September	2049	2049	2316
October	1325	2034	2300
November	1540	3034	2300
December	2034	2034	2300
January	1930	1930	2182
February	1252	1252	1415
March	1570	1570	1775
April	1920	1920	2170

to produce the same values for the B-parameter and the coefficient of rural population. The results are encouraging as the t-statistic for the rural population variable increases to a highly significant 7.9. Consequently, the A-parameters used in the model -- column 3 of Table 3.4 -- include an adjustment for the size of the rural population.

This completes the estimation of the private sector storage equation. Total private demand equals demand for private storage plus demand for consumption. Consumption demand is modeled as a constant elasticity curve with own-price demand elasticity of -0.25. This demand elasticity is subject to sensitivity analysis below.

Modeling Government Policy

The government sector can be modeled in a straightforward manner. Government is assumed to purchase all that is demanded at the procurement price and sell all that is demanded at the release price.[11] Actually, the technique used requires that government intervention be a single-valued function of the price, so the following linear equations are used:

(11) If $P_t < PP$ then

$$PC_t = G*(PP - P_t)$$

[11] Some observers contend that the government did not buy all that it was offered during the 1987 buying season because of the large stocks already held. If the government does not defend its floor and ceiling prices, this analysis would have to be adjusted. The 1987 buying season was complicated, however, by the presence of large amounts of wheat with high moisture content which was properly rejected by government buying agents. It is possible that the government did indeed buy all the wheat offered to it which had an allowable moisture content, although this is disputed.

Otherwise,

$$PC_t = 0.$$

If $P_t > PR$ then

$$O_t = G*(P_t - PR) + 160$$

Otherwise

$$O_t = 160.$$

where PP is the procurement price in rupees per 40 kg, PC_t is procurement in the present month, PR is the release price, O_t is releases (offtake) in the present month, and G is a parameter reflecting government response to prices above or below the set limits. The G parameter is taken to be 10 million, implying, for example, that procurement would be 2 million tons in a month when market prices are 20 paisa per 40 kg below the procurement price. The G parameter thus measures the extent to which the government can truly defend its intervention prices. It has only a small impact on the results as long as it is large.

Releases never go to zero in this formulation. Because of the regional diversity of Pakistan and the constant release of stock in some parts of NWFP, Baluchistan, Azad Kashmir, and Northern Areas there will always be positive offtake from government stock, even under the new policy. The lowest figures for offtake per capita during the last fifteen years translate into offtake of 160 thousand tons per month in 1987; this figure is assumed to be the minimum that the government would sell in a month under the present policy. This amount is assumed to be insensitive to price adjustments.

Even if the government does buy all that is offered and sell all that is demanded at the stated prices, wholesale prices will vary

somewhat more than official prices since the government is not intervening in the wholesale markets directly. The numbers which are important for comparison with the former policy are wholesale prices, not official government prices. The relationship between the two is unclear under the new system. Here it is assumed that the 1987/88 policy translates into a four percent seasonal rise in the wholesale price of wheat. This is equivalent to assuming that the resale value of the bag is equal to the 8 paisa gap, and that wholesale prices will be 2 percent above or below official prices for wheat alone during low and high price months, respectively. This is consistent with past deviations of wholesale prices from procurement prices at harvest time. This relationship will become better understood after the first few years of operation under the new system.

Government actions are modeled completely by these equations. Government expenditure is computed as follows. The costs of buying are assumed to be Rs 220 per ton. This includes the cost of bags, delivery charges, fumigation charges, transportation from procurement center to the storage center, handling at the storage center, and part of the godown expenses and departmental charges. The costs of selling are assumed to be Rs 280 per ton, which include handling upon removal from storage and transport to the point of sale. The majority of this amount is the cost of transporting to and marketing within farflung areas. These numbers are based on figures for incidentals reported by PASSCO, the Punjab Food Department, and the Agroprogress study. For a more detailed breakdown of the method used to produce these numbers, see Appendix D.

The government also incurs interest charges on its stock-on-hand of 1.2 percent per month (14.4 percent annually with no compounding). Physical losses to stock occur at the rate of 0.7 percent per month, or 3.5 percent for a five-month period. This figure is on the low side of studies of losses in government storage reported by the Agro-progress report (Vol 1, p. 65).

If different policies lead to differences between closing government stocks from one market year to the next, the cost of the policies must be adjusted to take account of the difference in the value of the stock. Choosing the appropriate price at which to value the stock is not straightforward, however. Since additional wheat cannot be bought or sold domestically without undermining the stated policy, prevailing domestic prices do not accurately reflect the value of the stock. Consequently, small changes in stock -- less than 50 thousand tons in a normal production year -- are valued at the world price of US$110 per ton. Additions to stock greater than 50 thousand tons are valued at the export parity price, taken here to be US$85 per ton. Deletions from stocks of greater than 50 thousand tons are valued at the import parity price of $150 per ton.

The policy model is thus a set of 24 non-linear equations in 24 unknowns: one price equation and one storage equation for each month. Expectations of future prices are taken to be correct in the model since it is set up to handle a normal year and changes in information from one month to the next are not modeled. The model is solved using the non-linear equation-solving algorithm of the GAUSS econometrics package.

Validation of the Model

At this point a complete model of private storage behavior, government market intervention, and government cost structure has been specified. How closely does it model events of the last two years?

Since government policy did not change until March of 1987, present policy is irrelevant to the validation process. However, government offtake and procurement are known for each month during past years, so these figures are input and the model is solved for wholesale prices and private storage. Figures 3.5 to 3.8 compare the modeled results for private storage and prices to the actual numbers, and to the results using the original A-parameters rather than the adjusted A-parameter series from Table 3.4. In each case the adjusted A-parameter series is either equally as good or superior to the original series. In comparison to the actuals, the fit is good for private storage and reasonably good for prices considering that the model assumes that no new information enters the market during the year. The 1986/87 actual prices suggest that significant new information did become available between April/May and September/October. Perhaps the actual size of the crop was larger than had been anticipated at harvest time. In any event, the modeled pattern is not far off given the inherent instability in seasonal prices.

Figure 3.5: Comparing Estimated With Actual Prices

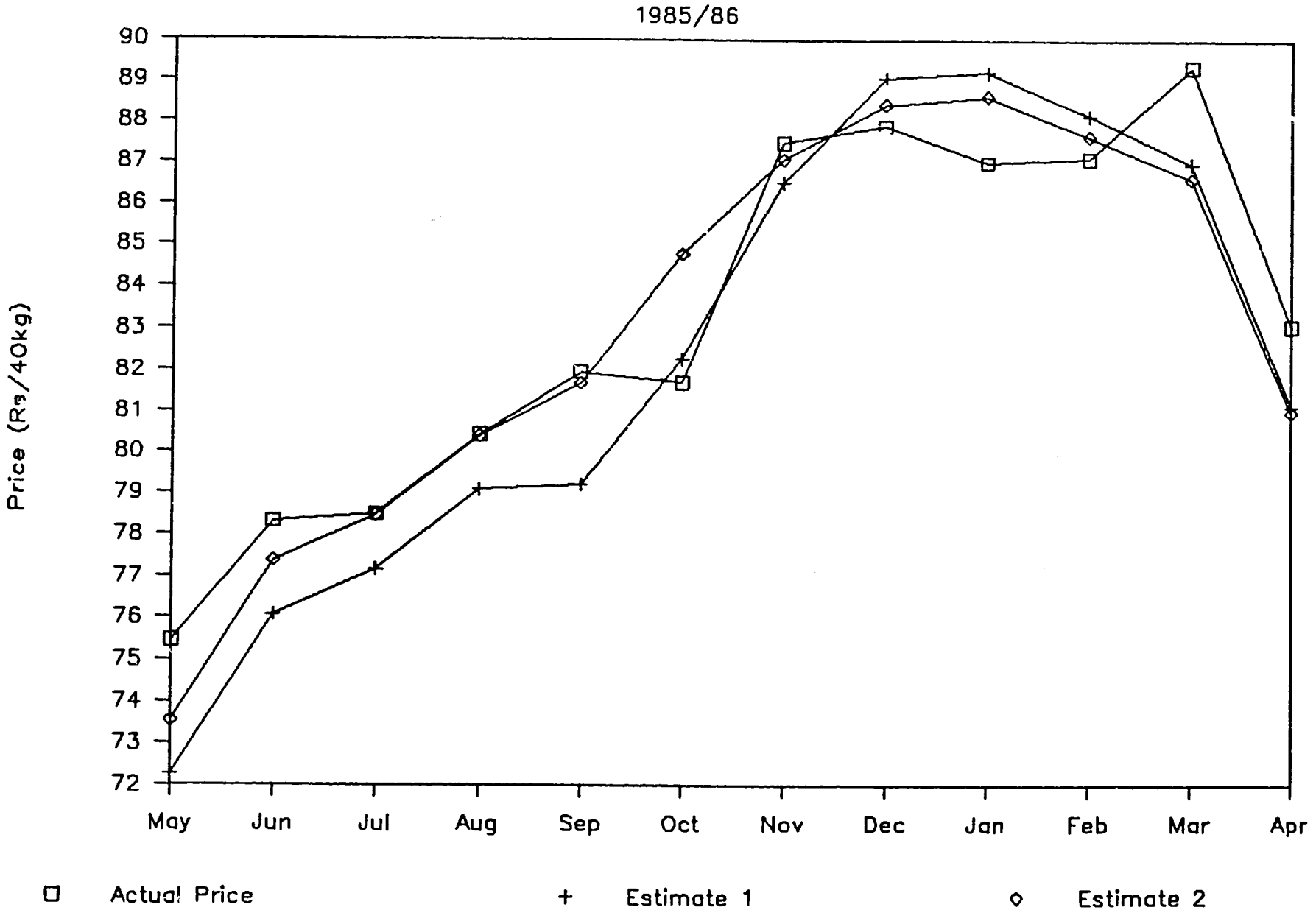


Figure 3.6: Comparing Estimated With Actual Prices

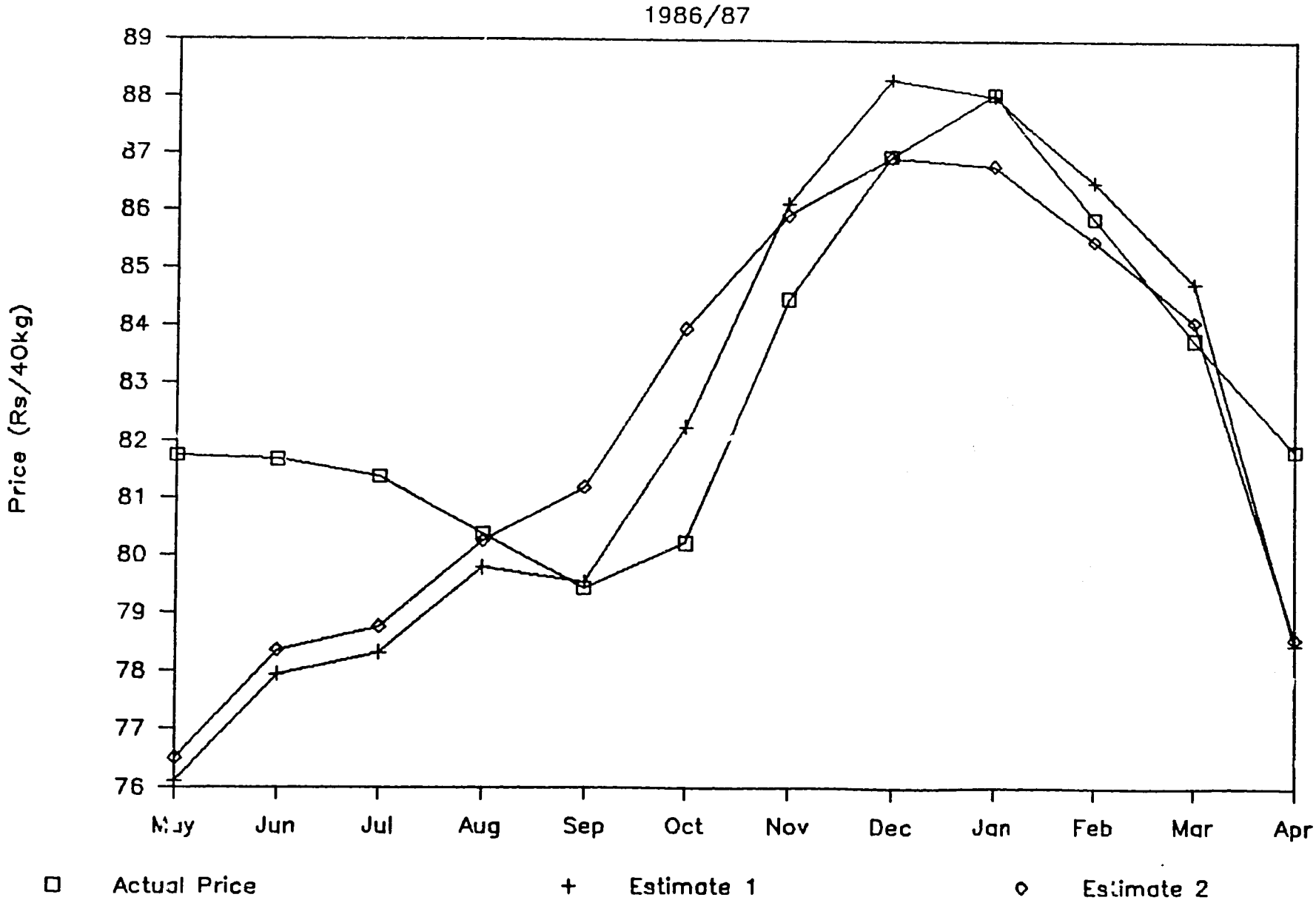


Figure 3.7: Actual and Estimated Private Storage

1985/86

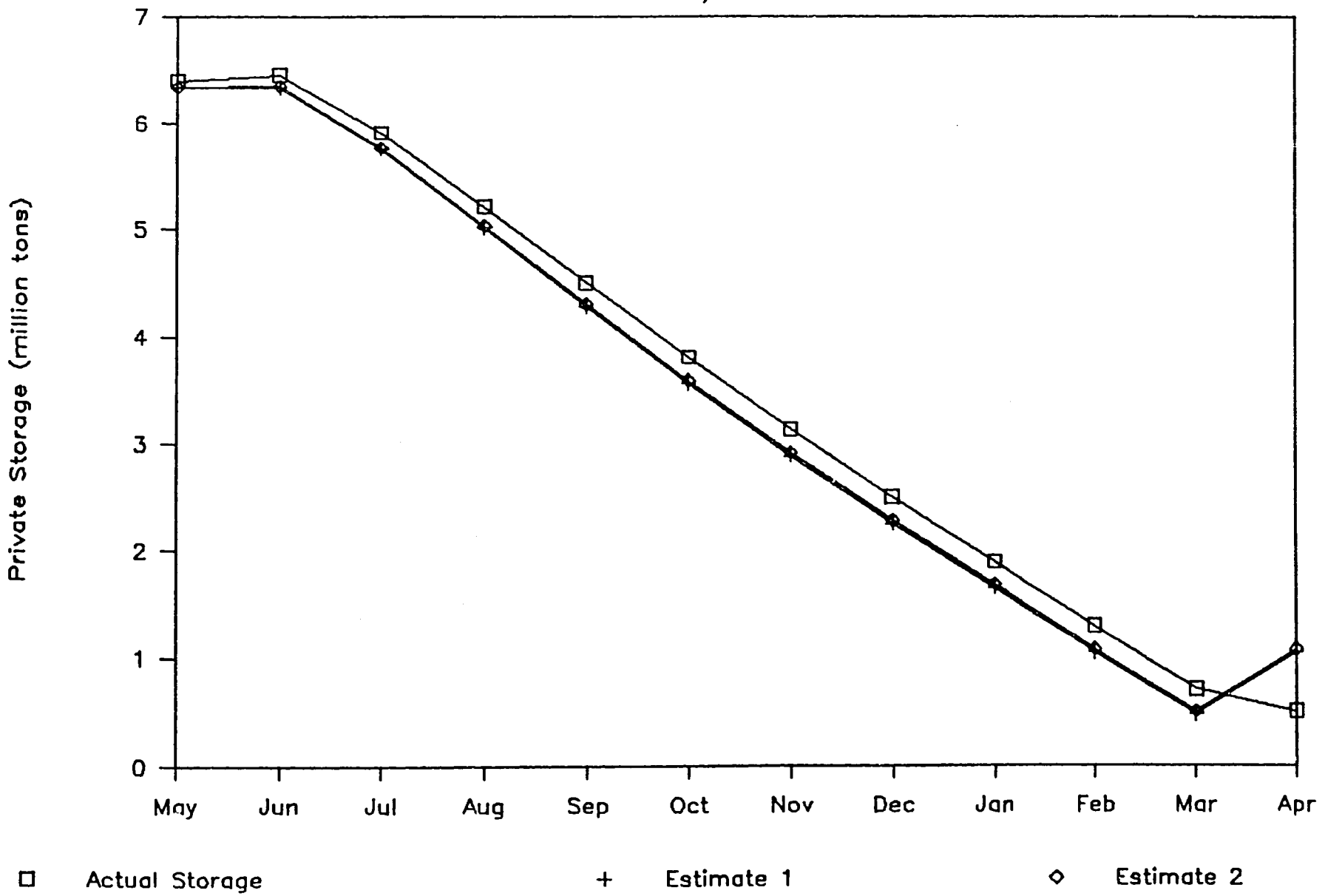
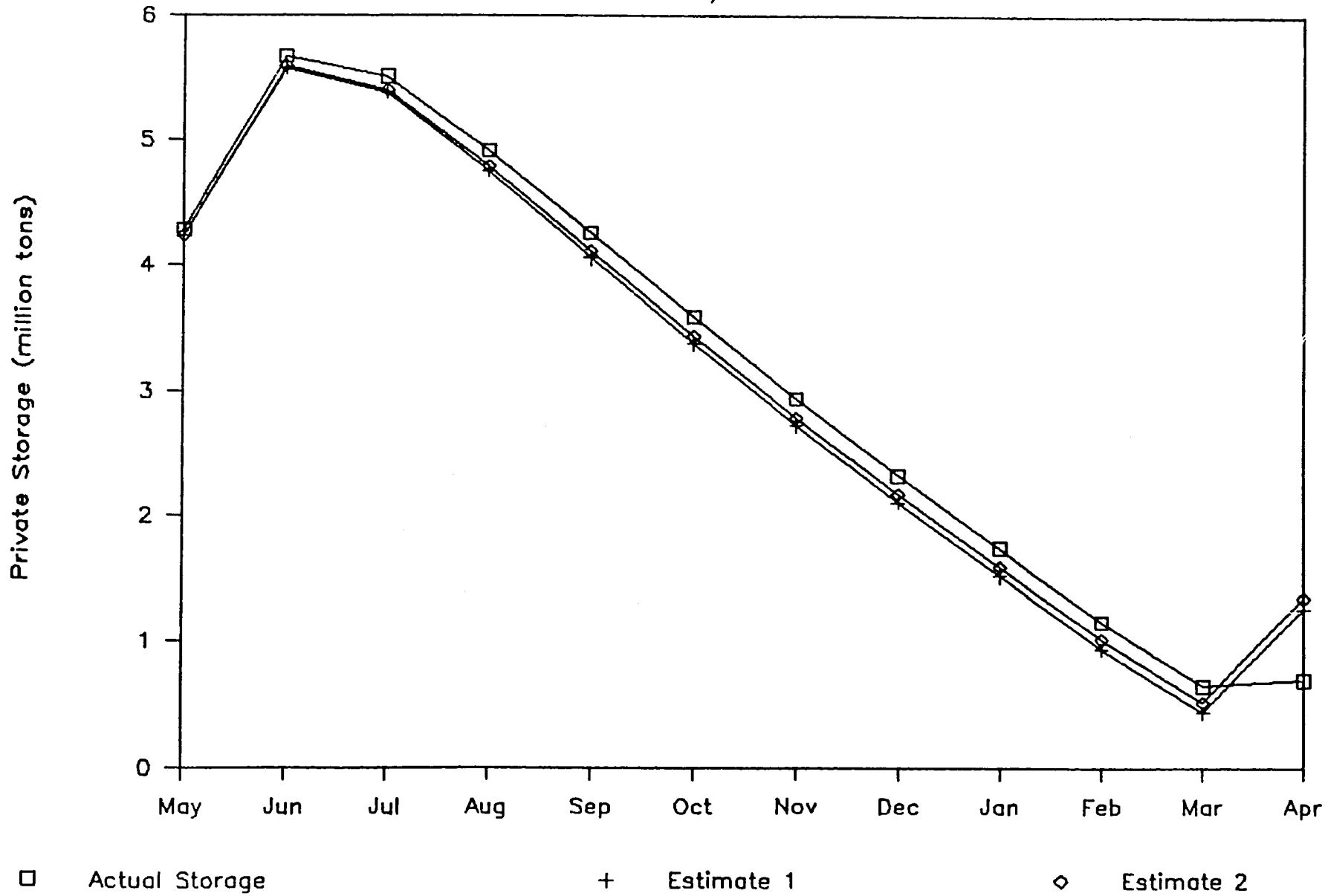


Figure 3.8: Actual and Estimated Private Storage

1986/87



3.6 RESULTS OF THE MODEL

Results for Widening the Gap

The most important results of this model are presented in Table 3.5. These are discussed below.

The first policy tested is the 1987/88 policy. With a crop of 13.4 million tons -- an expected "normal" year for Pakistan -- the policy of buying wheat at Rs 2.00 per kg and selling it at Rs 2.08 per kg is expected to cost Rs 3.5 billion per year. Private storage at the end of July is 5.0 million tons. Total procurement under these circumstances is 4.9 million tons. Prices reach their maximum in November and remain flat until a small decline in April. Thus, there is a marked change in the seasonal price pattern.

The Rs 3.5 billion loss can be broken down into component parts as follows: physical storage losses of 220 thousand tons, worth Rs 0.6 billion (valued at import parity since the policy as a whole sells more than it buys domestically); interest charges of Rs 0.8 billion; costs of purchasing wheat of Rs 1.1 billion; and costs of selling wheat of Rs 1.4 billion. This last figure includes about Rs 1.0 billion for distributing in the farflung areas, which is the cost of holding prices constant all over the country. The 8 paisa per kilogram difference between buying and selling price brings the government Rs 0.4 billion, thus yielding the Rs 3.5 billion cost.

One policy under consideration at the time of derationing was to both buy and sell at Rs 2.00 per kilogram. Had this policy been put into effect the estimated annual cost would have been Rs 5.4 billion

Table 3.5: Implications of Width of Price Band for Fiscal Cost and Private Storage

Procurement Price	Release Price	Percent Different	Fiscal Cost	Procurement	Private Storage July	Private Storage March	Difference
(Rs/kg)			(Bil.Rs)	(Million tons)			
2.00	2.00	0.0	5.4	7.1	4.2	1.7	2.4
2.00	2.05	2.5	3.9	5.3	4.8	1.5	3.3
2.00	2.08	4.0	3.5	4.9	5.0	1.4	3.7
2.00	2.10	5.0	3.2	4.7	5.2	1.3	3.9
2.00	2.15	7.5	2.6	4.1	5.6	1.0	4.5
2.00	2.20	10.0	2.0	3.6	5.9	0.8	5.0
2.00	2.25	12.5	1.6	3.2	6.1	0.7	5.5
2.00	2.30	15.0	1.3	2.8	6.4	0.6	5.8
2.00	2.40	20.0	0.8	2.2	6.8	0.4	6.4

per year, with procurement rising to 7.1 million tons and private storage in July falling to 4.2 million tons.

The cost savings which resulted from increasing the release price from Rs 2.00 to Rs 2.08 are much larger than those calculated from mulitiplying a single offtake figure by the 8 paisa per kilogram gap. With virtually no seasonal price rise, the private sector stores considerably less of the new crop. The column presenting the increase in private storage from March to July is more relevant in this context than the July storage figure alone. Because prices decline less in April and May under a flat price policy, private storage is actually higher in March and April under this policy, but absorbs considerably less of the harvest than under a policy in which prices are allowed to rise. Thus the government is hit with two large cost increases: the losses per kilogram handled increase because of the lower selling price, and the volume handled increases also. Consequently, losses increase dramatically.

Looked at the other way, losses decline dramatically with only small increases in the release price. The table shows that a 2 paisa increase in the release price to 10 paisa per kg is expected to save about Rs 300 million per year. Allowing prices to rise 10 percent during the year -- the result of making the release price 20 paisa above the procurement price -- decreases losses to Rs 2.0 billion per year, a savings of Rs 1.5 billion annually. And allowing prices to rise 15 percent -- a 30 paisa gap -- saves Rs 2.2 billion annually, with expected costs of Rs 1.3 billion per year. As shown in section 3.3 above, this fifteen percent price rise is less than what the country has been experiencing historically.

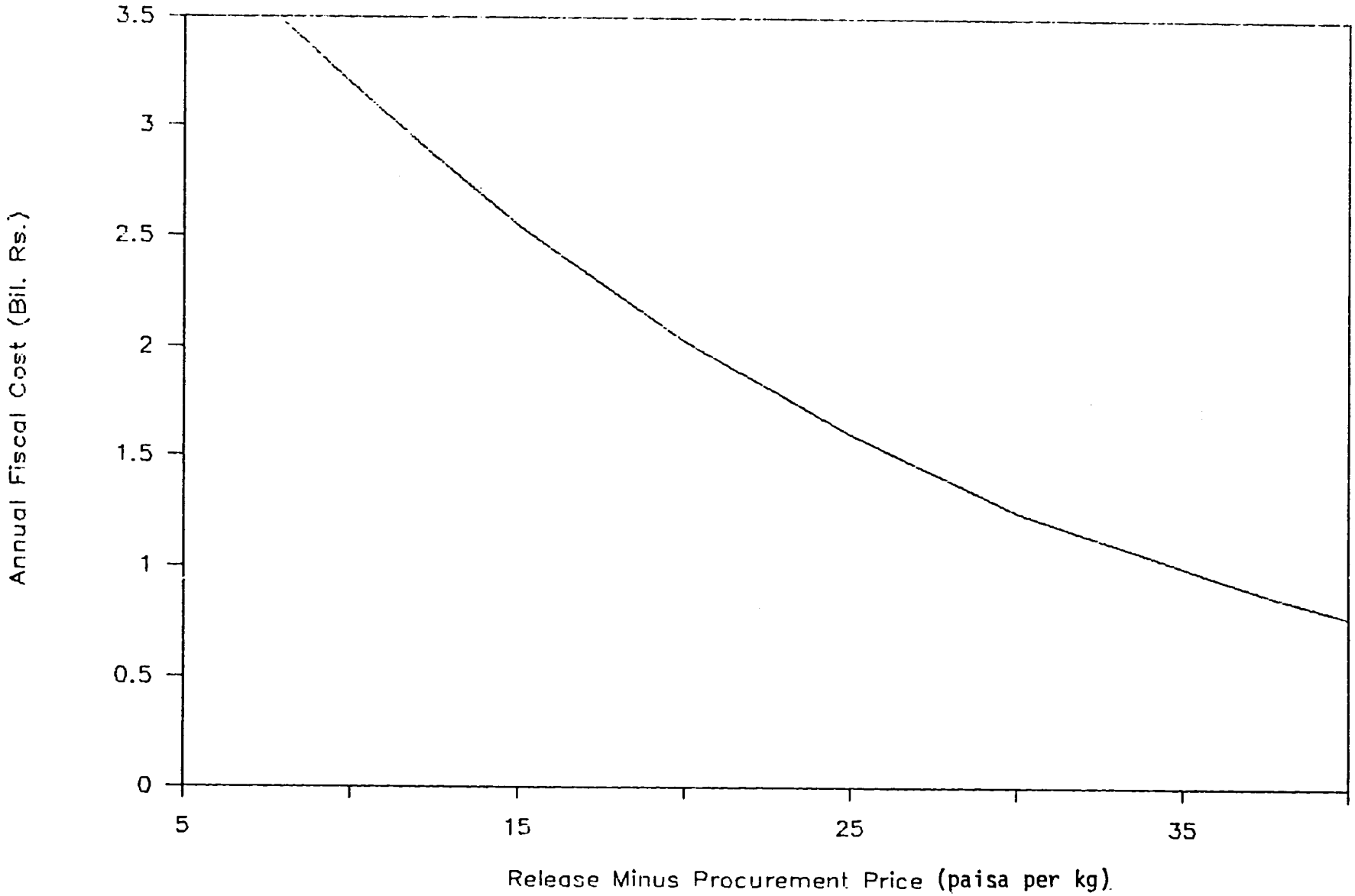
Figure 3.9 presents the trade-off curve between price variability and fiscal cost. The horizontal axis is the percent difference between the procurement and the release price, while the vertical axis is fiscal cost. Clearly there are large savings associated with the first percentage increments of the price differential. The savings which result from raising the gap further grow smaller as the gap grows larger.

The costs considered here are average annual operating costs. Additional savings would result from decreased storage requirements because of lower procurement. Construction costs are about Rs 700 million for a million tons of storage (Experience Incorporated, 1986). Thus, moving from the 1987/88 policy to one with a 30 paisa gap between procurement and release prices would also save about Rs 1.5 billion in construction costs since procurement declines by 2.1 million tons. This cost is a one-time savings, while the other costs mentioned above are annual savings. A loan for Rs 1.5 billion at a 7 percent real interest rate would have an anuual payment of about Rs 120 million. In addition, 2.1 million tons of storage would have annual fixed costs for maintenance and operating expenses of between 5 and 20 million rupees annually. Thus, the total savings of moving from the 1987/88 policy to one with a 30 paisa gap expressed in annual terms would be about 2.4 billion rupees annually.

Results for a Sliding Procurement Price

Another policy option that has been discussed is to raise the procurement price during the course of the year in order to spread procurement over a longer time period, to encourage private storage,

Figure 3.9 FISCAL COST VS SEASONAL PRICE BAND



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and to save on fiscal cost. Four policies of this type are modeled here. In each case the release price is Rs 92 and the procurement price in May is Rs 80 per 40 kilograms. In policy 1 the procurement price is raised to 84 in August and to 88 in November while in policy 2 the price rises in the same months to the higher figures of 85 and 90. Policies 3 and 4 hold the Rs 80 procurement price constant until October, when the price rises to 88 and 89 respectively. Results are presented in Table 3.6.

In general, the promises of the sliding procurement price are not fulfilled. The model shows a larger fiscal loss and less private storage at the end of July under a sliding procurement price as opposed to a constant procurement price. Policy 3 produces the same result as the constant procurement price since the price increase is not large enough to induce any procurement in November. With this exception, the other policies do succeed in reducing stock losses and interest charges, but also induce more procurement and more offtake. Since the government continues to lose money on every ton that it buys and sells, this increase in volume leads to an increase in fiscal cost, even though losses per handled ton decline. For the three policies considered here which affect the market, fiscal cost increases by Rs 50 to 150 million per year.

These policies do increase private storage in July, however, with increases of about 150 thousand tons for policies 1 and 4, and 500 thousand tons for policy 2. Government storage requirements decline by a corresponding amount. Consequently, even though more is procured under these policies, government's peak storage -- and thus its requirements for storage capacity -- decreases. Nevertheless,

Table 3.6: Effects of Sliding Procurement Price

	Fiscal Cost	Procurement	Private Storage July	Private Storage March	Difference
	Bil./Kg.	(Millions Tons)			
Policy 0	1.25	2.80	6.38	0.56	5.82
Policy 1	1.27	2.90	6.54	0.56	5.98
Policy 2	1.40	3.10	6.89	0.57	6.32
Policy 3	1.25	2.80	6.38	0.56	5.82
Policy 4	1.38	3.03	6.53	0.56	5.97

Note: All policies have a release price of Rs 92 per 40 kg and procurement prices of Rs 30 per 40 kg in May.
Policy 0 holds the procurement price constant. The procurement price for Policy 1 rises to Rs 84 in August and Rs 88 in November. The procurement price for Policy 2 rises to Rs 85 in August and Rs 90 in November. The procurement price for Policy 3 rises to Rs 88 in October. The procurement price for Policy 4 rises to Rs 89 in October.

such a policy change is an inefficient way to reduce government's peak storage requirement. Since the cost of building 500 thousand tons of storage capacity is approximately Rs 350 million (Experience Incorporated, 1986), the savings on construction costs would be more than offset by the losses from annual operations within three years. Seasonal adjustments to the procurement price, therefore, do not appear to be useful changes to present policy.

3.7 SENSITIVITY ANALYSIS

Models can be quite sensitive to the choice of parameters, and thus should be tested for sensitivity to assumptions. Sensitivity analysis is conducted here for three parameters. The first two parameters check for sensitivity to the specification of the demand equation. The model assumes that if the wholesale price is Rs 84, one million tons of wheat will be consumed in a month. Values of 82 and 86 are tested here. Second, the own-price demand elasticity is tested. A forthcoming article by Alderman (1988) estimates the own-price elasticity of wheat in Pakistan to be -0.7, based on the 1979 household and income expenditure survey. This is much larger in absolute value than what is normally assumed for a staple food in a poor country. An even larger value of -0.9 is tested below to see if this extreme assumption affects results. Finally, parameter B, the private storage parameter, is tested for values of one standard error above and below its estimated value, taking the standard error from the first-stage estimating equation. Results are presented in Table 3.7.

The major conclusions do not change at all from these results. The chosen model estimates the cost of 1987/88 policy to be Rs 3.47

Table 3.7: Sensitivity Analysis

Procurement Price	Release Price	Fiscal Cost	Procurement	Private Storage July	Private Storage July	Difference
Rs/kg		Bil.Rs	(million tons)			
Equilibrium Price = Rs 82/40kg						
2.00	2.08	3.45	5.0	5.0	1.4	3.7
2.00	2.20	2.01	3.6	5.9	0.8	5.0
2.00	2.30	1.29	2.8	6.4	0.6	5.8
Equilibrium Price = Rs 86/40kg						
2.00	2.08	3.49	4.9	5.1	1.4	3.7
2.00	2.20	2.04	3.6	5.9	0.8	5.0
2.00	2.30	1.24	2.8	6.4	0.6	5.8
Demand Elasticity = -0.9						
2.00	2.08	3.48	4.8	5.1	1.4	3.7
2.00	2.20	1.95	3.5	5.9	0.8	5.0
2.00	2.30	1.38	2.8	6.3	0.6	5.8
B-Parameter 1 standard error higher						
2.00	2.08	3.40	4.8	5.1	1.3	3.8
2.00	2.20	1.92	3.4	6.0	0.8	5.2
2.00	2.30	1.15	2.6	6.5	0.5	6.0
B-Parameter 1 standard error lower						
2.00	2.08	3.54	5.0	5.0	1.4	3.6
2.00	2.20	2.14	3.8	5.8	0.9	4.9
2.00	2.30	1.36	3.0	6.2	0.6	5.6

billion per year, and the cost of a policy including a 15 percent price rise to be Rs 1.25 billion per year. The range reported in the sensitivity analysis table is from Rs 3.40 to Rs 3.55 billion for 1987/88 policy, and Rs 1.15 to Rs 1.38 billion for a 15 percent price rise. The largest difference in estimated savings that result from increasing the width of the price differential to 15 percent is about Rs 0.1 billion.

Consequently, these results are considered to be robust. Actual costs in any particular year, however, could vary significantly from those reported here, especially because of deviations from normal production. In addition, the costs reported here are those associated with the policy after private stocks have adjusted to their new desirable level given the policy change. In the first years after a policy change, stock adjustments could significantly affect cost. Finally, as in any econometric exercise using estimated parameters, the further one moves from the policy under which the estimation took place, the less reliable are the results. Thus, results for price changes on the order of 10 to 20 percent should be considered more reliable than those with virtually no price change.

3.8 DISCUSSION

The benefits of raising the release price are clear. Savings of approximately Rs 2 billion were realized by the government decision to release wheat at Rs 2.08 per kilogram rather than Rs 2 per kilogram. Significant additional reductions in cost will result from the wider band implemented for 1988/89. Little is to be gained by moving to a system of increasing procurement price during the season.

The primary savings come from increasing private sector storage. This paper has only considered the benefits of increasing storage by increasing seasonal price changes, but there may be other ways the government could encourage such activity. Since over 80 percent of private storage in July is on-farm, such storage has to be the primary focus of any such efforts. One obvious change would be to remove the laws from the books that allow the District Food Controller to force the sale of stocks of wheat to a specified agent at a specified price (Agroprogress, Vol 1, p. 14). Even if not this power is not used, the presence of such laws on the books inhibits private storage.

The costs to the consumer of raising the release price are moderate. If the government were to release wheat at 2.30, that price would only be effective during the months of December, January, and February according to the model because private traders would undersell the government prior to December. Thus the average increase in wheat price would be only about 6 percent rather than the 11 percent increase from 2.08 to 2.30.[12] The average consumer spends about eight percent of annual household income on wheat and wheat products. Thus, the real income loss associated with a six percent price rise is less than one half of one percent. The poorest consumers, who spend about 12 percent of income on wheat and wheat

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[12] The 6 percent figure is calculated by taking the average of the percentage increases by month as estimated by the model, weighting each month equally. Since one would expect higher consumption of wheat in low price months, this estimate of the average price increase is on the high side. Graphs of single years of data in the Agroprogress report indicate that the price rise is similar for retail flour and wholesale wheat.

products, would suffer an income loss for the year of less than three-fourths of one percent.

Nevertheless, the income loss is not spread out evenly over the months, and for the three months in which the maximum price is in effect the real income loss for the poorest consumers is (0.11 * 0.12) or 1.3 percent. If the income elasticity for calorie consumption is 0.5, this would imply a reduction in calorie consumption during those months of 0.6 to 0.7 percent, or about 15 calories per day. Although it is undesirable to reduce the income of the poorest group, it seems clear that a program which costs Rs 2.3 billion annually to raise calorie consumption of the poorest groups by only 15 calories per day for only three months of the year is inefficient. The more efficient policy calls for government intervention in extreme circumstances, thus averting disastrous price rises, but allows for private marketing at most other times.

Another way to view the loss to consumers is to compare costs under a 15 percent change in official prices to those under the old system. As shown above, the average price rise under the old system was fifteen to twenty percent, with some years substantially higher. Although the ration shop price was constant throughout the year, very little was actually being sold at the subsidized price (Alderman, Chaudhry, and Garcia, 1988). Consequently, under a policy with a fifteen percent price cap, the consumer would be no worse off than under the old system, and in some years substantially better off.

In sum, if the government's goals are to reduce the fiscal costs of wheat marketing, to encourage private sector marketing and storage behavior, and to protect consumers from excessive price movements, increasing the difference between the procurement and release prices is an attractive option.

4. OTHER STORAGE REQUIREMENTS

4.1 STOCKS FOR SMOOTH FUNCTIONING DURING NORMAL PERIODS

The third and final component of storage after interannual supply stabilization and seasonal stocks consists of amounts required to maintain the normal functioning of the market. This component can be broken down further into two sub-components: the amount necessary during normal periods of operation, and the amount necessary to disburse after imports have been ordered but before they arrive in the country. This section estimates the former amount.

One way to approach this estimation is to examine past stock levels relative to offtakes. If no disruptions in supply occurred when stocks were at low levels, these historical amounts can be considered upper limits for the amount required to ensure normal operations. Because of the seasonal stocks the government has held in the past, the lowest stock levels have occurred at the beginning of April and May, immediately prior to the procurement season.

Stocks on May 1 have been less than offtake during May in six out of the last eighteen years. Indeed, in May of 1970, 1972, 1974, 1975, and 1978 opening stocks were less than one-half of offtake. In several of those years, the stocks held on April 1 were also less than offtake during April. Stocks have always been larger than offtake since 1978; nevertheless, the past history of lower stock levels indicates that if opening stocks are equal to expected offtakes in a given month, it is unlikely that supply disruptions will occur.

In planning for this component of storage, then, it is necessary to have an estimate of expected offtakes by month. The move away from the ration shop system has changed the nature of private sector demand for government offtakes, and thus past patterns may not be accurate indicators of the future. Nevertheless, in the last ten years the ration shop system moved away somewhat from a distribution of set quantities and towards meeting demand, at least partly because of the illegal diversion of supplies from the ration shops. Until more data become available of behavior since the policy change, these past patterns will be the most reliable indicators of the seasonality of demand for government supplies.

Since the pattern of offtakes took on a much more marked seasonal pattern after 1975/76, the time period of 1976/77 through 1986/87 will be considered. Past data are put in per capita terms in order to allow comparisons across years. Table 4.1 presents these offtake data for the individual months and averages over the time period. In addition, the standard deviation, maximum, and minimum are presented for each month. The last column presents aggregate data for the market year.

Over the eleven years in the table, offtakes per capita have averaged slightly over 36 kg per capita per year. There is no apparent trend in the data. The first seven months of the market year -- May through November -- all have averages under three kg, while December through April all have averages above three kg. Indeed, for the last four months of the market year, the minimum observed offtake per capita is greater than three kg. January, February, and March are the highest offtake months. The highest

Table 4.1: Offtake Per Capita, by Month, May 1976 to April 1987
(kilograms)

Scheme Year	May	June	July	August	September	October	November	December	January	February	March	April	Annual Total
1976/77	2.55	2.46	2.25	2.60	2.14	2.27	2.64	3.14	3.87	4.65	4.72	4.00	37.3
1977/78	2.89	2.68	2.63	2.55	2.43	2.80	3.10	3.68	4.01	3.63	3.87	3.51	37.8
1978/79	2.93	2.89	2.94	3.05	2.71	3.03	2.97	3.40	3.58	3.51	3.60	3.33	37.9
1979/80	2.79	2.51	2.59	2.38	2.61	2.65	2.44	2.68	3.11	3.34	3.54	3.27	33.9
1980/81	2.70	2.55	2.47	2.23	2.37	2.34	2.71	2.98	3.28	3.18	3.24	3.14	33.2
1981/82	2.80	2.48	1.67	1.71	1.90	2.40	3.28	3.85	4.29	4.21	4.76	3.98	37.3
1982/83	2.64	1.93	1.63	2.05	2.23	2.72	3.06	3.51	3.91	3.74	3.88	3.80	35.1
1983/84	2.61	1.63	1.61	1.97	1.99	2.38	2.88	3.45	4.19	4.33	4.55	3.92	35.5
1984/85	2.01	1.85	2.44	2.60	2.84	3.03	3.25	3.88	4.66	4.18	4.53	3.90	39.2
1985/86	2.65	2.29	2.42	2.37	2.49	2.67	2.93	3.25	3.60	3.69	3.85	3.51	35.7
1986/87	3.01	2.34	2.49	2.46	2.56	2.65	2.76	3.10	3.49	3.44	4.27	3.64	36.4
Average	2.69	2.33	2.28	2.36	2.39	2.63	2.91	3.36	3.82	3.81	4.07	3.65	36.3
Std. Deviation	0.26	0.36	0.43	0.35	0.28	0.25	0.25	0.35	0.44	0.45	0.50	0.30	1.73
Maximum	3.01	2.89	2.94	3.05	2.84	3.03	3.28	3.88	4.66	4.65	4.76	4.00	39.2
Minimum	2.01	1.63	1.61	1.71	1.90	2.27	2.44	2.68	3.11	3.18	3.24	3.14	33.2

Source: Collected from the Ministry of Food, Agriculture and Cooperatives. Data originates from the provincial food departments.

offtake per capita in any one month occurred in March of 1982, 4.76 kg, while the lowest occurred in July of 1983, 1.61 kg. There is no apparent trend in the data.

Thus, it is clear that large numbers of persons rely on their own stocks or stocks from private traders during the first several months of the year, and then begin to depend on the government later in the year. Since average monthly per capita consumption is about ten kg, the government is supplying about forty percent of total consumption in March, but only about half that percentage in July.

The amount required for normal periods of operation, then, has a marked seasonal component. Multiplying the average per capita offtake figures by present population yields a requirement at the beginning of May of about 280 thousand tons. For March, the figure is about 430 thousand tons.

4.2 IMPORT BUFFER STOCKS

Over and above the stocks required for normal operations, there is a requirement for wheat to sell during the lag between ordering and receipt of imports. Normally it is assumed that imports take three months to arrive. This analysis will assume that four months are required from the time imports are ordered until that wheat is available for general distribution in the country. Past patterns can be useful here also to examine how much government stocks have been depleted in any given four-month period.

The first step in the analysis is to take the data in Table 4.1 and aggregate it over four-month periods. This is done in Table 4.2, which presents four-month aggregates of per capita offtakes. In this case, the June through September period is the lowest offtake period

Table 4.2: Cumulative Per Capita Offtakes, Four Month Aggregates (kilograms)

Scheme Year	May-August	June-September	July-October	August-November	Sept-December	Oct-January	Nov-February	Dec-March	Jan-April	Feb-May	March-June	April-July
1976/77	9.85	9.44	9.25	9.65	10.19	11.92	14.30	16.37	17.24	16.26	14.29	12.20
1977/78	10.75	10.29	10.41	10.88	12.01	13.59	14.42	15.19	15.03	13.95	13.21	12.27
1978/79	11.81	11.59	11.72	11.76	12.11	12.98	13.46	14.08	14.01	13.22	12.22	11.21
1979/80	10.26	10.09	10.23	10.08	10.38	10.88	11.57	12.67	13.26	12.85	12.06	10.99
1980/81	9.95	9.63	9.42	9.66	10.40	11.31	12.14	12.67	12.83	12.35	11.66	10.08
1981/82	8.65	7.76	7.68	9.29	11.43	13.82	15.63	17.11	17.25	15.59	13.32	10.19
1982/83	8.25	7.84	8.63	10.05	11.52	13.20	14.22	15.04	15.33	14.03	11.92	9.65
1983/84	7.83	7.21	7.96	9.22	10.69	12.90	14.85	16.52	16.99	14.81	12.33	10.21
1984/85	8.89	9.73	10.91	11.72	13.00	14.82	15.97	17.25	17.27	15.27	13.38	11.27
1985/86	9.74	9.58	9.96	10.47	11.35	12.46	13.48	14.40	14.65	14.06	12.71	11.35
1986/87	10.30	9.85	10.16	10.43	11.07	12.00	12.78	14.30	15.03	13.99	13.44	11.94
Average	9.66	9.36	9.67	10.29	11.29	12.72	13.89	15.05	15.35	14.21	12.77	11.03
Std. Deviation	1.11	1.22	1.17	0.83	0.82	1.10	1.31	1.54	1.56	1.13	0.77	0.86
Maximum	11.81	11.59	11.72	11.76	13.00	14.82	15.97	17.25	17.27	16.26	14.29	12.27
Minimum	7.83	7.21	7.68	9.22	10.19	10.88	11.57	12.67	12.83	12.35	11.66	9.65

Source: Collected from the Ministry of Food, Agriculture and Cooperatives. Data originates from the provincial food departments.

at 9.36 kg per capita, while the January through April period is the highest at 15.35 kg. The maximum four-month offtake during the last eleven years was January through April of 1985 at 17.27 kg per capita, and the minimum was June through September of 1983 at 7.21 kg.

Offtakes alone, however, overestimate the required import buffer stock. Even in a bad year, significant amounts are procured from surplus areas in April through July. Table 4.3 adds procurement for the same four-month periods to the offtakes, and presents the net offtake in each period.

Since procurement is considerably more variable than offtake, the standard deviations in this table are much larger than those in Table 4.2. The maximum four-month period for net offtakes is December through March, with an average of 15.04 kg per capita, whereas the minimum is April through July at -21.89 kg per capita. April through July of 1986 had the lowest net offtake on the table at -39.01 kg, while December through March of 1985 had the highest at 17.19.

Of special interest is that all of the numbers in Table 4.3 for March through June, April through July, and May through August are negative; moreover, in all the years after the 1978 rust attack, the smallest number (in absolute value) for these three periods is -11.71 kg per capita (for March to June of 1984). This implies that in all of these four-month periods, government stocks ended the period at higher levels than they began (ignoring any imports or exports that may have taken place). There is thus no need to order imports

Table 4.3: Cumulative Per Capita Net Offtakes, Four Month Aggregates (kilograms)

Scheme Year	May-August	June-September	July-October	August-November	Sept-December	Oct-January	Nov-February	Dec-March	Jan-April	Feb-May	March-June	April-July
1976/77	-19.41	-11.32	1.36	7.42	9.02	11.29	14.04	16.35	16.85	8.08	-4.72	-10.51
1977/78	-12.70	-5.86	4.95	9.12	11.37	13.44	14.42	15.19	14.55	5.61	-0.20	-1.58
1978/79	-1.68	5.93	11.11	11.59	12.06	12.95	13.46	14.08	13.46	0.16	-12.69	-17.13
1979/80	-18.20	-6.53	5.41	8.69	9.67	10.83	11.57	12.67	12.40	-6.38	-21.01	-24.16
1980/81	-24.80	-7.00	6.59	8.91	10.13	11.28	12.14	12.67	10.94	-13.30	-31.50	-35.93
1981/82	-36.18	-13.57	3.84	8.30	11.14	13.78	15.60	17.09	16.12	4.29	-16.64	-24.87
1982/83	-26.31	-16.63	2.81	9.34	11.44	13.20	14.22	15.04	14.22	-4.31	-25.77	-31.65
1983/84	-33.15	-16.81	3.28	8.16	10.43	12.89	14.85	16.52	15.86	-5.15	-11.71	-14.18
1984/85	-14.46	5.19	10.46	11.63	13.00	14.82	15.97	17.19	13.75	-8.02	-12.48	-15.10
1985/86	-13.21	6.40	9.34	10.42	11.35	12.46	13.48	14.32	11.71	-18.80	-34.26	-39.01
1986/87	-37.71	-8.28	6.15	9.88	11.04	12.00	12.78	14.28	11.81	-10.00	-23.53	-26.68
Average	-21.62	-6.23	5.94	9.40	10.97	12.63	13.87	15.04	13.79	-4.35	-17.68	-21.89
Std. Deviation	10.67	8.22	3.06	1.30	1.06	1.15	1.30	1.54	1.86	7.91	10.18	10.84
Maximum	-1.68	6.40	11.11	11.63	13.00	14.82	15.97	17.19	16.85	8.08	-0.20	-1.58
Minimum	-37.71	-16.81	1.36	7.42	9.02	10.83	11.57	12.67	10.94	-18.80	-34.26	-39.01

Source: Collected from the Ministry of Food, Agriculture and Cooperatives. Data originates from the provincial food departments.

between March and June; by the time the imports arrived, government stocks would be higher than when they were ordered.

The import buffer component of government stocks for February, March, and April, therefore, simply needs to be enough to bridge the gap until procurement comes on line at the end of the market year. From June to January, however, there is a need for stocks in case imports are required. These needs should be based on the highest observed offtake per capita over each four-month period since offtakes are likely to be on the higher end of the scale in deficit years.

Therefore, month-by-month storage requirements for these two components are as reported in Table 4.4. The absolute amounts are computed by multiplying the per capita figures by 105 million persons. The monthly required stock -- column 5 of the table -- is the larger of either the import buffer or the amount required for normal operations since the import buffer stocks can also fulfill the normal operations role. The import buffer is the larger of the two in all months except May.

This column, then, is the minimum amount of wheat with which the government should begin any month. If opening stocks for any month are below the amount shown in this column, imports should be ordered if there is enough time for them to arrive before procurement begins. During March and April and to some extent February, it is unlikely that imports could be ordered, received, and distributed before the country is again in surplus. Consequently, for these months the numbers are reference points that can be used as targets in earlier months rather than import triggers.

Table 4.4 - Storage Requirements for Normal Operations and Import Buffer

Month	Import Buffer		Normal Operations		Monthly Required Stock	Minimum Amount to Trigger Exports
	per capita	Absolute	per capita	Absolute		
	(kg)	('000 tons)	(kg)	('000 tons)		
May	0.0	0	2.69	282	282	650
June	6.4	672	2.33	245	672	2040
July	11.1	1167	2.28	239	1167	3047
August	11.6	1221	2.36	248	1221	3108
September	13.0	1365	2.39	251	1365	2920
October	14.8	1556	2.63	276	1556	2694
November	16.0	1677	2.91	306	1677	2424
December	17.2	1805	3.36	353	1805	2121
January	16.9	1769	3.82	401	1769	1769
February	13.4	1404	3.81	400	1404	1404
March	8.7	918	4.07	427	918	918
April	4.0	420	3.65	383	420	420

The required stocks peak in December and drop off only slightly in January. It is clear that if the January requirement is going to be met without imports, then all previous targets will be met also. The subsequent targets will be met too unless offtakes per capita increase to levels above the historical maximum. Based on this observation, the last column shows the amount of stock required at the beginning of each month to ensure that the January target is met if net offtakes per capita follow the average historical pattern. For January and subsequent months, the column is equal to the required stock column. The export trigger column peaks in August at 3.1 million tons. If early August stocks are above this amount and world prices are such that interannual supply stabilization stocks are uncalled for, the amount in excess of 3.1 million could be exported without fear that imports would be required during the present market year. These numbers, then, are the minimum figures that the government would want to use as export triggers.

This last column also provides the maximum storage space requirement for these components. If the government had only enough space for the monthly required stock, it could not store sufficient quantities from the previous harvest to meet the required stock amounts for January. Thus, storage requirements to ensure normal operations must be 3.1 million tons, with the amount peaking in early August.

In sum, the demand for stocks to maintain the normal functioning of the market is highly seasonal. Amounts required to buffer import arrival are the most seasonal, but requirements for normal operations also have a significant seasonal component. Total storage

requirements can only be estimated on a monthly basis because of this highly seasonal nature. The maximum required storage capacity in any one month for the components measured in this chapter is 3.1 million tons.

5. CONCLUSIONS AND POLICY OPTIONS

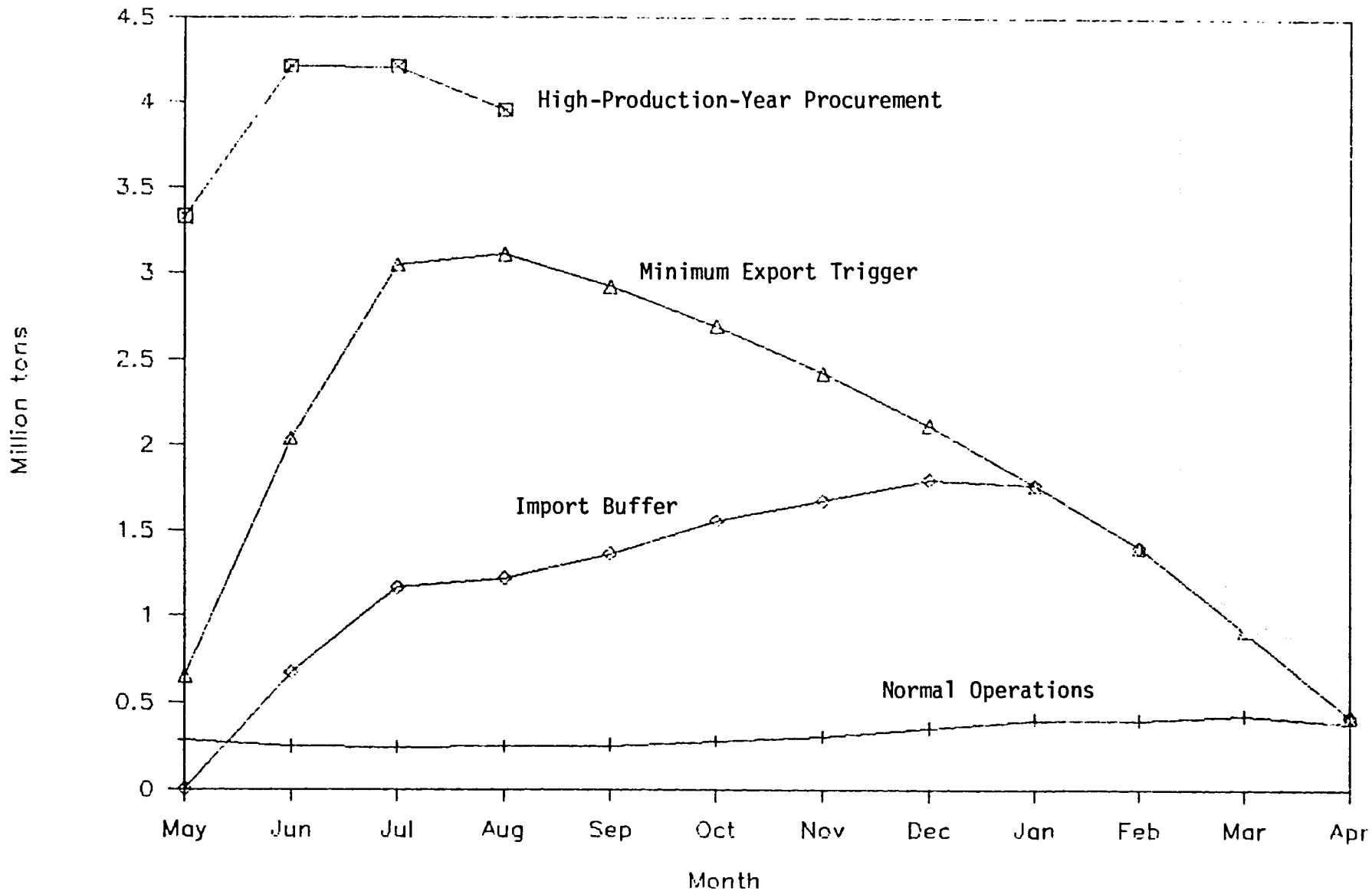
5.1 TOTAL REQUIREMENT FOR GOVERNMENT STORAGE FACILITIES

Previous chapters have measured the requirements for government storage from the three different sources: interannual supply stabilization stocks, seasonal storage, and stocks to ensure a continuous supply of wheat under all circumstances. Figure 5.1 summarizes results on a month by month basis. Interannual supply stabilization stocks do not appear on the graph since Chapter 2 shows that it is unprofitable to build additional capacity for such stocks.

Stocks for normal operations, import buffer, and the minimum export trigger are graphed directly from Table 4.4 above. These amounts are compared with the requirements for procurement in a good year. In order to translate the procurement figures from Chapter 3 into monthly storage requirements, two steps are necessary: choosing a gap between the procurement and release prices, and apportioning procurement among the different months.

A gap between procurement and release price of 20 paisa per kilogram is shown in the figure. The total procurement level in a normal production year associated with this gap is 3.6 million tons, which is close to the average offtake from which the import buffer and export trigger are calculated. Excess procurement during an exceptionally good year of 1.1 million tons is added to this amount, as discussed in section 3.1 above, for a total of 4.7 million tons.

Figure 5.1: Total Storage Requirements



142.

Calculations are made below both for a gap of 8 paisa -- the 1986/87gap -- and for a gap of 30 paisa or 15 percent, the approximate historical seasonal price rise.

In order to apportion procurement among the months, the percentage of total procurement that took place in each month is calculated for buying years 1984 through 1987. The chosen starting year is 1984 because the procurement season seems to have shifted to somewhat earlier dates beginning with that year. For these years, approximately 8%, 63%, 24%, and 5% of procurement has taken place in April, May, June, and July respectively.

Expected procurement in April is less than expected offtake. Therefore, the opening stocks in May assumed in the calculation of the procurement storage requirement is the minimum export trigger for May from Table 4.4, 650 thousand tons. If opening stocks are larger than this amount and the crop is abundant, exports can be arranged immediately. Total requirements for May are therefore 650 thousand tons plus 63 percent of procurement less expected offtake in May. The June requirement replaces the 650 thousand ton opening stock with the calculated figure for May. These numbers are graphed in Figure 5.1.

Although total procurement is 4.7 million tons, total storage requirements are less because of offtakes during the buying season. The curve for the storage of high-production year procurement peaks in June and July at 4.2 million tons. As this amount is above the 3.1 million ton peak of the minimum export trigger line, 4.2 million tons would be the required storage capacity of the government for

wheat if the gap between the procurement and release prices is 20 paisa.

As pointed out in Chapter 3, however, the appropriate storage capacity of the government is a function of price policy. If the government were to institute a gap of 30 paisa per kilogram between the procurement and release prices, expected procurement in an excellent production year would be 3.9 million tons. Under this scenario, requirements peak in June at 3.5 million tons, or 700 thousand tons below requirements when the price gap is 20 paisa per kilogram. Similarly, if the policy for 1987/88 had been continued so that there was only an 8 paisa gap, expected procurement after a bumper crop would be 6.0 million tons, with peak requirements of 5.4 million tons in July.

Thus, government storage requirements for wheat at present are 3.5 to 5.4 million tons, assuming that the gap between procurement and release prices is between 8 and 30 paisa per kilogram. Projections in Hamid et al (1987) suggest that wheat production will increase at a rate of approximately 3.3 percent annually. This implies that required storage capacity of the government will have to rise to between 5.3 and 8.2 million tons by the year 2000, with the exact point determined by price policy.

5.2 POLICY IMPLICATIONS

Policy changes implied by this analysis have been discussed throughout the report. These include:

(1) choosing a gap between procurement and release price which takes account of the large cost savings both from lower annual subsidies and reduced future storage requirements;

(2) allowing the official domestic price to respond to changes in production by introducing a production bonus system after choosing an appropriate level of variability of interannual domestic prices;

(3) holding no interannual supply stabilization stocks; and

(4) allowing the domestic price to reflect changes in the world price. The most important of these policy adjustments is the gap between the procurement and release prices. Chapter 3 shows that a 2 paisa increase in this gap from its 1987/88 level saves Rs 300 million annually (about US$ 17 million), with cost savings for reduced storage requirements over and above this amount. Over a wider range, this tool has the potential to save the government billions of rupees annually. The government has tremendous leverage with this tool, and policy choices for this gap should take into account all of the ramifications of a change.

If that gap remains smaller than government marketing costs, the second intervention to consider is to introduce the production bonus payment system as outlined in Chapter 2. The key to having an efficient interannual supply stabilization policy is allowing average domestic prices to vary somewhat from year to year, depending on the crop size and the government's desired trade-off between price variability and fiscal cost. The average annual price will change

very little as long as the gap is less than marketing costs. Introducing a production bonus payment -- even a very small one -- could decrease costs by about one hundred million rupees annually.

Of equal importance to introducing a production bonus payment is lowering interannual supply stabilization stocks to zero unless the world price plummets to unprecedented depths. This change also saves about 100 million rupees annually, depending on the assumption about how much of this type of stock are being held at present. If the government is to lower interannual supply stabilization stocks to zero, however, it is necessary to ensure the availability of foreign exchange for imports when supplies are short. This should not be a problem, as the analysis clearly shows that the average supply of foreign exchange is higher under a policy with low stocks than under one with large stocks. Nevertheless, there are individual years when large imports will be necessary. The IMF Compensatory Financing Facility is one possible source of foreign exchange in such years; it is discussed in Appendix E.

The next most important policy adjustment would be to allow official prices to reflect changes in the world price between September and April by instituting a world price bonus payment system. This would save about Rs 30 million annually, depending on the overall degree of price variability.

The final policy change suggested here is to change the law concerning the ability of government agents to seize private stores in an emergency. The payoff from this change is unmeasurable, but any increase in other incentives will decrease the seasonal price increase required to induce the private sector to store a given

amount of grain, and will thus lower the cost to the government of any particular seasonal price policy. Given the high responsiveness of fiscal cost to the size of the gap, the payoff from a policy change such as this is likely to be large.

Thus, the policy adjustments considered here all move towards making Pakistan's wheat policy more sensitive to uncontrollable parameters, such as weather-induced fluctuations in crop size and changes in the world price. The most efficient way to create this sensitivity is to encourage more private sector involvement in seasonal storage by increasing the price incentive and removing the legal disincentive, and to implement some sensitivity of official prices to outside forces. Interannual government stocks are an inefficient way to stabilize supplies.

In the interannual context, however, it is very important that the government actually sell all that is demanded at its ceiling price, whatever that price may be. As long as private agents expect the government to defend its price, there is no incentive to attempt to hoard since there will be no returns to hoarding. On the other hand, if private agents sense that the government is holding back on supplies, there could be a costly run on government stocks. Even in this situation -- rather, especially in this situation -- it is vital that the government sell sufficient quantities to meet demand, importing all that is necessary to do so. In the long run consistency in meeting demand will be cheaper than restricting

supplies because of the expectations formed that the government will always defend its price.[1]

Thus, if the government is concerned about lowering fiscal cost, ensuring supplies for the market, and allowing the growth of private marketing activities, increasing the gap between the procurement and the release price should be the first priority. Next, lowering interannual supply stabilization stocks and introducing some response of official prices to production size should be considered. Adding sensitivity to the world price would lower costs further. Finally, removing the legal impediments to private storage would have an unmeasurable benefit which may be large.

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[1] See Siamwalla (1988) for a discussion of the importance of this factor in the success of Indonesia's storage, trade, and price policy for rice.

APPENDIX A

District Makeup of the Agroclimatic Zones

RICE/WHEAT-- PUNJAB

Sialkot
Gujrat
Gujranwala
Sheikhupura
Lahore/Kasure

MIXED-- PUNJAB

Sargodha/Khushab
Jhang
Faisalabad/T.T. Singh
Okara*

COTTON/WHEAT-- PUNJAB

Sahiwal*
Bahawalnagar
Bahawalpur
R.Y. Khan
Multan/Vehari

LOW-INTENSITY-- PUNJAB

D.G. Khan/Rajanpur
Muzaffagarh/Leiah
Mianwali/Bhakkar
D.I. Khan

BARANI-- PUNJAB

Attock
Jhelum
Rawalpindi/Islamabad

RICE/OTHER-- SIND

Jacobabad
Larkana
Dadu
Thatta
Badin*
Shikarpur*
Nasirabad*
Karachi*

COTTON/WHEAT-- SIND

Sukkur*
Khairpur
Nawabshah*
Hyderabad*
Tharparkar

OTHER N.W.F.P.

all except D.I. Khan

OTHER BALUCHISTAN

all except Nasirabad

* These districts were divided or created after 1967/68. Data series referring to these districts prior to their creation assume that the proportion of each crop grown in the two districts after a partition is the same as the proportion prior to partition.

APPENDIX B

Key Parameter Values of the Models

	External	Internal
Transactions costs of importing	US$ 30	Rs. 170 *
Transactions costs of exporting	US$ 13 **	Rs. 646
Shadow price premium on foreign exchange	15%	10%
Discount rate	7%	7%
Mean Production		13 mil.t.
Coefficient of variation of production	10%	6%
Normal production year equilibrium price (Rupees per 40 kilograms)	--	Rs. 85
Annual cost of storage per ton	--	Rs. 425
Open market/world price	US$ 110	--
Standard Deviation of world price	US$ 20	--

Food aid equals fifty percent of the shortfall in total supply below 12.5 million tons, where total supply equals production plus opening government stocks.

Notes:

* Lower international transactions for Pakistani wheat as opposed to those for U.S. wheat.

** For the sake of simplicity, government handling costs of domestic wheat are not explicitly modeled. This allows for the separation conceptually of the costs of subsidies on wheat consumption from the costs of interannual supply stabilization. In the model, this is accomplished by not including a charge for government handling of wheat, and having the selling price equal the buying price. This necessitates the excess charge for domestic handling of imported wheat over and above the charges on domestically produced wheat.

APPENDIX C

Marketing Costs

Costs of Buying:

Type of Cost	Amount/ton
Fumigation	2
Bags	160
Delivery Charges	10
Transport to Storage Center	8
Handling at Storage Center	10
Variable Costs Component of Godown Expenses and Departmental Charges	30
Sum	Rs. 220

Costs of Selling:

Type of Cost	Amount/ton
Handling during removal from storage	10
Costs of marketing and transport within Punjab and Sind	70
Average costs of transport and handling to farflung areas	200
Sum	Rs. 280

The Agroprogress study Annex 3.5.1 is the primary source for these numbers, along with Punjab Food Department and PASSCO incidental expenses for 1985/86 and 1986/87. The costs to farflung areas are computed as follows:

Area	Cost per ton	Amount 86/87	Total
	(Rs/ton)	(mil. tons)	(mil. Rs)
A.K., Northern Areas, Defense:	400	0.4	160
Baluchistan:	600	0.3	180
NWFP:	360	0.8	288
Karachi:	225	0.5	112
Sum			740

The sum, 740 million, divided by 3.7 million tons total offtake, is 200 Rupees per ton, the figure in the table above. Figures for NWFP are detailed in the next two tables.

In addition to these costs, the government incurs fixed cost per unit of storage capacity. These total about Rs 80 per ton per year according to Agroprogress, and are inclusive of permanent staff, electricity, depreciation, and other costs which do not go down in the facility is not used. These costs are not included in the model. To the extent that a change in policy allows for a smaller government storage capacity, further savings would be incurred through a decrease in these fixed costs.

Transportation of wheat from Punjab tc NWFP during the year, 1986-87

From Punjab to	Lowest rate approved per ton per km (net weight)
Peshawar District	28.75 paisa
Mardan District	29.11 paisa
Kohat District	29.75 paisa
Abbottabad District	28.74 paisa
Mansehra District	31.95 paisa
Dargai Malakand Agency	29.74 paisa
Swat District	31.94 paisa
Bannu District	38.00 paisa
Timergara(Distt.Dir)	33.44 paisa
DI Khan District	40.99 paisa
Karak District	30.45 paisa

Appendix C (continued)

Statement Showing Transportation and Incidentals on Handling of Wheat in NWFP
(Rs. per tonne)

	1984/85		1985/86		1986/87	
	By Rail	By Road	By Rail	By Road	By Rail	By Road
1. Transportation	50.01	262.90	48.73	286.28	51.17	300.59
2. Handling Charges	1.28	1.28	1.63	1.63	1.71	1.71
3. Tax & Duties	3.63	3.63	3.63	3.63	3.63.	3.63
4. Godown Expenses	6.72	6.72	1.45	1.45	1.52	1.52
5. Ess.II Charges	12.79	12.79	14.16	14.16	14.87	14.87
6. Repair to Storage Bins	2.78	2.78	2.62	2.62	2.75	2.75
7. Storage Surcharge	2.68	2.68	2.62	2.62	2.75	2.75
8. Interest	84.64	84.64	29.37	29.37	29.37	29.37
9. Railway Freight	184.42	---	254.51	---	254.51	---
Total	348.94	377.41	356.09	339.14	362.20	357.12

Source: NWFP Food Department

APPENDIX D

Financing Imports

Under any policy, there will be times when the opening supply stabilization stocks of the country are insufficient to meet the shortfall in supply because of random yield fluctuations. Such situations will require the use of foreign exchange for imports and the use of food aid. Although holding no interannual supply stabilization stocks may maximize net foreign exchange earnings in the long run, it can exacerbate the short run problem of arranging for imports in deficit years.

The international community has attempted to address this difficulty and the parallel problem of a major production shortfall in an export crop. The Compensatory Financing Facility (CFF) of the IMF was introduced in 1963 to mitigate the adverse impact of export instability on the balance-of-payments of the primary-commodities exporting countries. The principal purpose has been to provide timely relief to members with payment difficulties arising from temporary shortfalls in their export earnings due to factors largely out of their control. The assumption is that these payment difficulties are only temporary and do not require policy reforms. The amount of the drawing is constrained by the size of the calculated shortfall, subject to a limit on outstanding drawings. The interest rate charged on CFF drawings is the same as that applied to other drawings from the IMF.

While the underlying rationale for the use of the CFF has not changed since 1963, there have been major changes in the scope and

method of its operation. These changes include the commodity coverage of the facility, method of calculation, and maximum level of drawing. The CFF is not commodity specific, and shortfalls are related to total export earnings, including services such as workers' remittances. The drawings under the CFF are additional to what a member might draw under the normal lending facilities of the IMF. However, the maximum permissible amount of drawings has varied in terms of the members quota limit. Periodic quota increases have allowed a substantial increase in maximum drawings in absolute terms.

In 1981, the CFF coverage was extended by permitting the optional inclusion of a temporary increase in the cost of commercial cereal imports. The objective of the Cereal Imports Excesses provision (CIE) is to minimize the effects of foreign exchange availability constraints by making loans to member countries which experience temporary surges in cereal import bills, thereby avoiding downward fluctuations in food consumption or inappropriate and costly policy adjustments.

Under the CIE the amount of a drawing is calculated as the sum of the export shortfall and cereal imports increase, with the total subject to limits on outstanding drawings. The shortfall is calculated in relation to a trend, defined as an average of the value of exports and cereal imports for five years centered on the year of the export shortfall (or excess cereal imports). The trend calculation thus requires forecasts for cereal imports and total exports for two years into the future.

The CIE has a number of advantages over alternative food security schemes. It is less political than food aid, does not

require any international agreement, allows countries to rely on imports rather than stockholding, and (at least in principle) can be immediately responsive to cereal production fluctuations or changes in the world price. (Huddleston et al., 1984).

For some countries, the actual experience of the CIE has not met expectations, as the assistance provided has been deemed inadequate in relation to need. Supporters of this view suggest that the CIE should be the primary means by which food consumption shortfalls are met and that any corollary features of the provision that interfere with such an objective are counterproductive. Others argue that the CIE has not yet been tested because of low world prices since 1981, minimal shortfalls in cereal production, and abundance of food aid (which is cheaper than using the CIE).

One technical problem with the CIE arises from an IMF decision in 1983 integrating the CFF to the highly-conditional financing of the upper credit tranches. Drawings on lower tranches now require a mission to assess whether policy adjustments may be necessary to address balance-of-payments difficulties. Drawings in upper tranches require the existence of a "satisfactory" balance-of-payments position or the existence of a broadly "satisfactory" performance under arrangement with the IMF.

Determination of the origin of a shortfall is straightforward when it is due to changes in international prices. The assessment is more difficult when changes stem from variations in quantities exported and/or imported. This is where cooperation requirements for drawings between the member country and the IMF become more influential. Since 1966, drawings that represent a relatively large

percentage of a member's Fund quota (upper tranche) have become subject to increasingly higher levels of conditionality than drawings from a lower tranche. Particularly in the 1980's long-term balance-of-payments difficulties have emerged that overshadow temporary shortfalls in export earnings or increases in cereal imports. This change in emphasis has affected the guidelines for drawing from the CFF and the CIE provision in both the lower and upper tranches.

Under current conditions, it is difficult to separate the effects of general balance-of-payments difficulties from those of export shortfalls or cereal import excesses. Concurrently, lower world prices for cereals and higher levels of food aid have guaranteed lower levels of drawings under the CIE provision.

A further element of uncertainty with regard to a country's eligibility under the CIE provision is introduced by the lack of clear definitions as to what is a "satisfactory" balance-of-payments position. Thus, the semi-automatic basis on which the CIE drawings were supposed to be made has to some extent been abolished during the recent years of acute overall balance-of-payments difficulties for so many LDCs.

Currently, the interest charges on CIE drawings is six percent -- low in comparison to international capital markets but high in comparison to the economic cost of food aid to recipient countries. The debt burden of so many LDCs today is a strong deterrent against expanding their foreign debt through such drawings. Nevertheless, the cost of the CIE is considerably less than the cost of building larger buffer stocks.

The CIE provision was reviewed in both 1985 and 1987, but no major changes in policy have been agreed upon. Possible modifications of the provision proposed for discussion at the 1987 review included liberalizing the conditions for low-income LDCs by reducing the interest charges and relaxing the three-year repayment rule. It was also hoped that discussions might focus on a complete divorce of the Cereal Imports Excesses provision from the Compensatory Financing Facility. This initiative had been proposed in 1981, but was rejected on the grounds that increased export revenues could offset excess import costs, thereby nullifying any potential balance-of-payments problems. These same issues will no doubt be those raised in any future review (one is scheduled for mid-1989), but the same factions are as strongly entrenched in their positions now as ever, and thus the prospect of major revisions seems at this point unlikely.

In sum, the CIE provision is one possibility for assisting Pakistan in years of shortfalls in wheat production. Although it is not ideal, the facility does provide foreign exchange for imports during periods when availability may be a problem.

APPENDIX E-- DATA ANNEX

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Appendix Table 1. Meat and Milk Production, 1971/72 - 1984/85
(000 Metric tons)

	Meat Production(+)	Milk Production(*)
1971/72	568	6253
1972/73	592	6369
1973/74	623	6489
1974/75	649	6613
1975/76	684	6742
1976/77	715	6885
1977/78	749	7032
1978/79	783	7181
1979/80	819	7334
1980/81	856	7489
1981/82	894	7648
1982/83	947	7811
1983/84	1002	8281
1984/85	1092	8772

(+) Includes beef, mutton and poultry meat.
(*) Includes cow, buffalo, sheep and goat milk, for human consumption only.
Gross production is roughly 125 percent higher.

Source: "Agricultural Statistics of Pakistan", 1985, Government of Pakistan, Ministry of Food, Agriculture and Cooperatives, Islamabad.

Appendix Table 2. Area Under Major Crops, 1967/68 - 1984/85
(000 Hectares)

Year	Wheat	Basmati	Other Rice	Cotton	Sugar	Edible Oils	Maize	Millet & Sorghum	Pulses	Fruits
1967/68	5983	(*) 403	(*) 1016	1785	504	625	608	1498	1628	157
1968/69	6156	(*) 442	(*) 1113	1745	541	505	616	1210	1391	158
1969/70	6229	486	1136	1756	620	544	647	1122	1339	155
1970/71	5978	435	1068	1733	636	574	640	1308	1317	152
1971/72	5797	332	1125	1958	552	648	633	1266	1418	161
1972/73	5971	338	1142	2010	534	598	645	1112	1457	168
1973/74	6113	375	1137	1845	646	609	633	1323	1627	177
1974/75	5813	494	1111	2031	673	516	614	990	1377	186
1975/76	6111	536	1174	1852	700	543	620	1100	1477	192
1976/77	6392	530	1219	1865	788	596	624	1095	1533	205
1977/78	6360	515	1384	1843	823	498	656	1161	1545	222
1978/79	6687	678	1348	1891	753	520	650	1128	1677	212
1979/80	6924	779	1256	2081	719	501	701	985	1551	223
1980/81	6982	824	1109	2109	825	518	769	799	1253	236
1981/82	7223	844	1132	2214	947	508	739	952	1321	279
1982/83	7398	836	1142	2263	912	500	790	828	1335	299
1983/84	7343	825	1173	2221	897	424	798	944	1307	320
1984/85	7258	757	1242	2242	904	457	809	1001	1413	334

(*) As only total rice area was available for these two years, a weighted average proportion of basmati area out of the total for the three following years (.28) was applied to derive an estimate of basmati area seperate from other rice.

Source: "Agricultural Statistics of Pakistan", various issues, Government of Pakistan, Ministry of Food, Agriculture and Cooperatives, Islamabad.

Appendix Table 3. Yields of Major Crops, 1967/68 - 1984/85
(Metric tons per hectare)

Year	Wheat	Basmati	Other Rice	Cotton	Sugar	Edible Oils	Maize	Millet & Sorghum	Pulses
1967/68	1.073	N/A	N/A	0.286	37.1	0.572	1.302	0.470	0.439
1968/69	1.075	N/A	N/A	0.304	40.7	0.574	1.016	0.490	0.508
1969/70	1.171	1.224	1.596	0.304	42.5	0.597	1.031	0.522	0.508
1970/71	1.083	0.945	1.678	0.314	36.4	0.567	1.122	0.523	0.508
1971/72	1.188	1.158	1.664	0.360	36.2	0.577	1.115	0.530	0.502
1972/73	1.246	1.183	1.694	0.350	37.4	0.574	1.094	0.545	0.515
1973/74	1.248	1.296	1.731	0.360	37.0	0.591	1.213	0.551	0.514
1974/75	1.320	1.220	1.536	0.314	31.6	0.608	1.217	0.536	0.520
1975/76	1.411	1.199	1.683	0.277	36.4	0.626	1.294	0.536	0.531
1976/77	1.431	1.244	1.705	0.233	37.5	0.626	1.224	0.523	0.550
1977/78	1.316	1.088	1.726	0.312	36.6	0.648	1.251	0.519	0.525
1978/79	1.488	1.295	1.776	0.250	36.3	0.606	1.228	0.505	0.439
1979/80	1.568	1.138	1.856	0.350	38.3	0.636	1.248	0.535	0.330
1980/81	1.644	1.190	1.932	0.339	39.2	0.647	1.262	0.555	0.420
1981/82	1.579	1.250	2.098	0.338	38.6	0.668	1.259	0.522	0.370
1982/83	1.678	1.208	2.131	0.364	35.7	0.707	1.273	0.534	0.519
1983/84	1.482	1.170	2.024	0.223	38.2	0.767	1.270	0.507	0.543
1984/85	1.612	1.174	1.954	0.450	35.6	0.722	1.271	0.514	0.513

N/A denotes not available.

Source: "Agricultural Statistics of Pakistan", various issues, Government of Pakistan, Ministry of Food, Agriculture and Cooperatives, Islamabad.

Appendix Table 4. Area Under Wheat, by Agroclimatic Zone (*), 1967/68 - 1984/85
(000 Hectares)

Year	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other NWFP	Other Baluchistan
1967/68	994	1002	1118	713	547	321	586	526	175
1968/69	1101	1045	1187	720	563	298	593	536	113
1969/70	1069	1064	1135	726	555	347	640	554	139
1970/71	1080	1035	1129	716	516	290	591	504	117
1971/72	1034	1017	1091	671	497	263	559	513	153
1972/73	1084	1025	1113	708	527	252	562	592	107
1973/74	1089	1031	1136	739	520	282	603	591	123
1974/75	1055	972	1077	673	519	223	569	617	110
1975/76	1093	1021	1199	742	522	251	569	602	111
1976/77	1128	1026	1282	753	515	289	663	611	125
1977/78	1114	1027	1283	766	516	276	661	591	127
1978/79	1138	1077	1363	791	539	314	746	602	117
1979/80	1185	1092	1420	813	538	331	756	661	128
1980/81	1167	1088	1422	875	529	328	765	686	123
1981/82	1242	1129	1499	870	540	349	789	702	105
1982/83	1252	1169	1555	870	541	323	779	722	187
1983/84	1198	1175	1578	882	514	341	781	695	179
1984/85	1194	1153	1539	881	507	335	797	677	175

(*) Definition of zones can be found in "The Wheat Economy of Pakistan, by N. Hamid et.al., IFPRI, November 1987, p. 2.11.

Source: "Agricultural Statistics of Pakistan", various issues, district-wise data volumes, Government of Pakistan, Ministry of Food, Agriculture and Cooperatives, Islamabad.

Appendix Table 5. Yields Of Wheat, by Agroclimatic Zone, 1967/68 - 1984/85
(000 Hectares)

Year	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other NWFP	Other Baluchistan
1967/68	0.945	1.490	1.508	0.925	0.589	0.806	1.061	0.647	0.545
1968/69	0.953	1.518	1.473	0.957	0.436	0.895	1.062	0.626	0.603
1969/70	1.099	1.639	1.576	1.008	0.443	0.906	1.341	0.611	0.707
1970/71	1.008	1.344	1.482	0.912	0.370	0.957	1.481	0.562	0.373
1971/72	1.084	1.572	1.528	1.160	0.379	1.004	1.518	0.736	0.302
1972/73	1.141	1.646	1.610	1.139	0.474	1.048	1.539	0.851	0.334
1973/74	1.131	1.630	1.551	1.150	0.456	1.097	1.609	0.864	0.634
1974/75	1.237	1.717	1.644	1.258	0.527	1.342	1.573	0.870	0.737
1975/76	1.436	1.751	1.722	1.285	0.568	1.311	1.696	0.929	0.843
1976/77	1.431	1.749	1.757	1.301	0.529	1.452	1.670	0.993	0.784
1977/78	1.228	1.566	1.626	1.076	0.588	1.367	1.677	0.998	0.817
1978/79	1.530	1.804	1.735	1.212	0.809	1.498	1.760	1.024	0.906
1979/80	1.639	1.789	1.835	1.274	0.926	1.529	1.928	1.120	0.916
1980/81	1.718	1.894	1.920	1.339	0.979	1.546	2.053	1.166	0.954
1981/82	1.371	1.921	1.789	1.370	0.870	1.624	2.161	1.159	1.038
1982/83	1.639	1.934	1.914	1.384	1.092	1.547	2.250	1.176	1.228
1983/84	1.412	1.688	1.632	1.159	0.883	1.564	2.107	1.088	1.227
1984/85	1.526	1.912	1.876	1.206	0.895	1.526	2.236	1.117	1.274

Source: Yields are derived from area and production data found in "Agricultural Statistics of Pakistan", various issues, Ministry of Food, Agriculture and Cooperatives, Islambad.

Appendix Table 6. Wheat Area, by Variety, by Agroclimatic Zone (000 Metric Tons)

Year	Rice/Wheat, Punjab--		Mixed, Punjab--		Cotton/Wheat, Punjab--		Low-Intensity, Punjab--		Barani, Punjab--	
	HYV	Local	HYV	Local	HYV	Local	HYV	Local	HYV	Local
1969/70	522.0	453.5	700.3	326.5	690.5	481.5	185.3	540.2	25.9	529.0
1970/71	788.3	250.1	763.3	247.8	597.6	555.3	176.7	539.1	47.3	468.1
1971/72	817.7	191.2	807.2	180.3	601.8	510.0	210.1	460.1	54.2	442.3
1972/73	860.0	214.4	818.5	178.3	615.3	526.5	216.6	490.8	59.4	467.1
1973/74	863.6	205.0	829.6	176.7	645.1	515.5	237.3	501.4	62.7	456.4
1974/75	872.3	181.1	833.3	122.9	713.9	377.9	285.5	386.8	76.8	441.4
1975/76	908.5	184.1	880.6	123.6	825.9	389.2	323.0	419.0	86.8	434.6
1976/77	965.5	161.9	931.6	84.0	1058.5	233.8	422.6	329.5	99.1	415.4
1977/78	947.8	167.0	933.5	83.6	1076.1	217.3	448.7	302.3	96.9	418.9
1978/79	965.0	172.7	1004.0	63.4	1203.7	169.1	517.1	273.4	58.6	482.9
1979/80	1123.6	62.2	1023.9	63.5	1360.3	64.6	559.6	253.2	114.9	423.3
1980/81	1079.0	88.0	1010.5	72.0	1378.5	52.0	636.1	238.6	102.0	427.0
1981/82	1186.6	54.6	1079.4	49.8	1465.9	33.1	700.8	169.0	161.1	378.4
1982/83	1205.6	46.6	1113.0	56.2	1528.1	27.1	739.4	130.6	196.7	344.4

Appendix Table 6 (continued). Wheat Area, by Variety, by Agroclimatic Zone (000 Metric Tons)

	Rice/Other, Sind		Cotton/Other, Sind		Other N.W.F.P.		Other Baluchistan	
	HYV	Local	HYV	Local	HYV	Local	HYV	Local
1969/70	138.4	209.6	292.1	347.7	114.5	411.5	12.4	162.5
1970/71	132.9	157.5	432.1	158.4	175.7	360.1	6.4	106.9
1971/72	131.6	132.9	419.0	139.0	240.8	312.8	4.5	134.8
1972/73	120.1	132.7	418.7	141.8	264.5	239.4	2.5	115.0
1973/74	132.4	152.8	442.5	156.9	258.7	254.6	3.4	149.3
1974/75	137.7	85.8	496.7	71.1	301.8	290.7	3.6	103.3
1975/76	129.3	122.8	458.7	109.8	391.4	210.6	11.0	100.4
1976/77	182.3	109.1	554.2	104.3	376.2	234.8	8.9	116.5
1977/78	187.1	90.6	604.9	53.9	381.3	224.3	9.9	116.7
1978/79	236.4	77.5	681.5	64.2	403.7	198.7	25.1	91.7
1979/80	268.6	62.5	681.5	74.4	429.9	230.8	25.1	102.5
1980/81	N/A	N/A	N/A	N/A	462.5	223.4	27.5	95.4
1981/82	319.2	29.6	770.1	18.8	459.3	242.5	29.8	75.0
1982/83	283.0	40.1	760.3	18.4	488.4	233.5	52.8	133.8

Notes: N/A denotes not available.

Source: "Agricultural Statistics of Pakistan", various issues, Ministry of Food, Agriculture and Cooperatives, Islamabad.

Appendix Table 7. Rainfall, by Agroclimatic Zone (*) (in millimeters)

Year		Rice/Wheat Punjab	Cotton/Wheat Punjab	Mixed Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other N.W.F.P.	Other Baluchistan
1967	January	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	February	16.33	10.88	8.02	4.50	52.18	1.00	0.00	47.50	1.00
	March	100.37	52.22	65.30	103.34	150.83	40.00	32.26	213.11	40.00
	April	4.95	4.35	12.44	15.23	34.00	0.00	1.78	44.70	0.00
	May	1.26	0.00	1.15	0.00	7.36	0.00	4.32	33.78	0.00
	June	10.25	6.63	48.88	5.70	38.36	0.00	0.00	0.51	0.00
	July	131.83	43.97	81.24	33.24	154.49	37.00	198.63	16.51	37.00
	August	128.42	52.10	21.48	72.45	215.68	47.00	147.57	35.31	47.00
	September	84.28	1.99	21.40	10.78	31.51	13.00	12.70	4.06	13.00
	October	8.14	7.47	6.39	10.01	15.03	3.00	0.00	19.05	3.00
	November	2.65	1.00	46.35	1.44	3.21	0.00	1.27	6.86	0.00
	December	109.79	83.76	15.24	64.55	156.44	63.00	28.70	145.29	63.00
1968	January	27.78	5.18	11.21	11.95	75.65	13.00	0.00	57.66	13.00
	February	45.36	27.22	31.30	19.78	70.88	21.00	5.84	37.34	21.00
	March	41.06	14.43	19.38	20.54	49.27	2.00	0.00	48.51	2.00
	April	0.61	0.00	9.26	6.85	14.86	0.00	0.00	38.35	0.00
	May	8.20	21.13	14.66	9.58	17.72	0.00	0.00	33.02	0.00
	June	29.79	1.55	63.29	7.48	6.06	0.00	0.00	2.54	0.00
	July	143.46	34.70	41.52	10.75	186.78	0.00	1.78	16.00	0.00
	August	132.87	0.00	16.42	0.00	240.50	0.00	0.25	69.60	0.00
	September	0.00	4.27	2.51	1.00	5.58	0.00	0.00	1.27	0.00
	October	4.97	5.54	3.43	5.70	13.14	0.00	0.00	14.73	0.00
	November	0.00	0.00	0.00	1.10	23.49	0.00	0.00	19.56	0.00
	December	16.31	6.66	2.97	0.33	35.94	0.00	0.00	24.89	0.00
1969	January	6.03	2.19	5.10	0.53	4.57	0.00	0.00	0.00	0.00
	February	14.61	13.18	19.10	19.59	77.77	1.00	1.02	55.63	1.00
	March	44.56	14.41	18.79	0.73	51.01	0.00	0.00	47.24	0.00
	April	34.63	5.90	17.71	6.25	39.32	3.00	0.00	44.96	3.00
	May	13.98	12.43	13.91	5.02	56.92	0.00	0.51	59.18	0.00
	June	8.14	11.49	8.37	1.00	8.34	0.00	0.00	0.00	0.00
	July	186.37	125.41	179.41	13.40	103.66	6.00	25.91	78.74	6.00
	August	114.99	34.66	72.53	22.97	140.81	0.00	0.00	9.40	0.00
	September	37.18	2.09	7.62	17.34	38.84	0.00	2.03	13.72	0.00
	October	0.98	4.08	2.99	0.00	63.25	24.00	0.00	23.37	24.00
	November	0.00	0.00	4.15	1.46	1.76	0.00	0.00	16.26	0.00
	December	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix Table 7 (continued). Rainfall, by Agroclimatic Zone (*) (in millimeters)

Year		Rice/Wheat Punjab	Cotton/Wheat Punjab	Mixed Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other N.W.F.P.	Other Baluchistan
1973	January	22.32	0.00	10.50	2.19	37.73	0.00	0.00	4.30	0.00
	February	6.76	7.39	17.20	4.72	43.72	0.75	0.00	67.60	0.75
	March	18.31	0.87	70.57	9.50	59.66	0.00	0.00	91.90	0.00
	April	1.58	0.44	0.00	2.74	12.06	0.00	0.00	17.50	0.00
	May	33.02	30.79	10.55	25.70	33.27	0.75	8.90	62.00	0.75
	June	25.99	12.92	7.88	0.00	39.48	0.00	0.00	0.00	0.00
	July	293.19	60.43	168.95	97.89	278.04	40.25	19.80	16.30	40.25
	August	310.57	170.25	207.23	54.12	323.93	2.00	25.90	41.40	2.00
	September	13.99	8.62	7.83	16.07	75.18	0.00	0.00	62.50	0.00
	October	0.00	0.00	0.00	0.00	5.18	0.00	0.00	3.00	0.00
	November	0.00	0.00	0.00	0.00	1.55	0.00	0.50	0.00	0.00
	December	38.79	10.23	22.11	1.76	19.84	17.75	0.00	8.90	17.75
1974	January	7.29	2.27	1.85	2.44	29.96	0.00	0.50	4.80	0.00
	February	9.61	6.81	11.16	16.62	35.10	3.50	0.00	47.10	3.50
	March	0.15	0.17	1.17	2.12	19.43	32.50	0.00	6.80	32.50
	April	1.73	8.36	6.68	9.77	13.07	0.00	0.00	31.70	0.00
	May	0.06	9.21	30.26	6.16	23.54	2.00	0.00	7.90	2.00
	June	52.27	3.83	68.65	21.20	46.41	0.00	0.00	0.00	0.00
	July	145.33	83.63	94.95	53.25	213.91	5.00	0.00	20.40	5.00
	August	111.04	5.68	34.27	16.06	127.09	0.00	0.00	12.60	0.00
	September	13.11	0.72	4.31	2.77	40.22	0.00	0.00	24.80	0.00
	October	1.15	3.17	1.86	0.00	1.29	0.00	0.00	0.00	0.00
	November	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	December	17.70	1.28	0.41	3.99	26.65	0.00	0.00	34.10	0.00
1975	January	10.82	5.54	11.47	1.19	16.88	6.30	3.40	0.40	6.30
	February	29.51	29.33	24.45	13.57	47.52	4.60	6.10	49.10	4.60
	March	30.33	3.60	30.45	10.43	56.76	0.50	2.10	92.80	0.50
	April	6.19	20.89	16.91	25.52	30.47	1.30	0.00	42.00	1.30
	May	3.47	0.08	3.54	7.95	35.68	0.00	0.00	63.20	0.00
	June	65.49	52.49	38.41	36.00	53.22	0.00	4.00	3.00	0.00
	July	183.34	71.51	87.42	44.91	208.42	11.40	35.00	71.10	11.40
	August	169.29	60.99	198.12	72.49	336.94	120.00	103.90	105.40	120.00
	September	90.95	35.39	27.17	19.33	132.06	85.10	7.40	2.30	85.10
	October	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	November	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	December	0.00	3.47	2.73	2.69	2.48	0.00	0.30	5.90	0.00

Appendix Table 7 (continued). Rainfall, by Agroclimatic Zone (*) (in millimeters)

Year		Rice/Wheat Punjab	Cotton/Wheat Punjab	Mixed Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other N.W.F.P.	Other Baluchistan
1976	January	29.61	2.39	16.42	5.25	51.47	2.90	3.90	13.40	2.90
	February	30.09	7.62	10.82	8.75	109.16	9.60	0.00	82.70	9.60
	March	31.39	37.42	36.01	22.97	64.37	4.00	6.00	82.00	4.00
	April	17.70	5.72	14.83	10.68	196.65	0.00	0.00	69.50	0.00
	May	16.65	1.27	11.08	6.65	8.42	3.80	0.30	2.90	3.80
	June	135.54	71.07	82.11	46.36	45.56	0.00	18.80	18.70	0.00
	July	154.54	81.29	102.71	11.19	235.55	56.00	62.70	40.70	56.00
	August	317.65	107.53	193.92	83.79	450.77	6.30	32.50	280.20	6.30
	September	92.81	139.33	62.28	56.28	96.16	105.20	69.00	20.30	105.20
	October	8.01	0.40	22.53	0.00	24.44	0.00	0.00	13.80	0.00
	November	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	December	0.00	0.00	0.00	0.00	0.48	0.00	0.00	1.00	0.00
1977	January	19.28	14.36	6.03	8.68	52.20	7.10	7.10	61.90	7.10
	February	0.00	0.00	0.18	0.18	4.21	0.00	0.00	11.80	0.00
	March	0.01	0.13	0.23	0.65	3.81	0.00	0.00	0.00	0.00
	April	13.37	21.92	27.01	12.56	48.76	0.00	0.00	75.50	0.00
	May	27.58	18.14	21.07	15.47	35.88	0.00	0.20	20.00	0.00
	June	69.04	31.13	16.42	6.36	97.81	28.90	11.70	0.00	28.90
	July	181.53	32.98	190.58	50.03	318.15	0.00	34.50	208.30	0.00
	August	171.22	15.45	78.73	40.09	174.26	130.00	12.50	8.90	130.00
	September	14.19	24.80	49.94	10.84	21.78	21.10	27.10	36.20	21.10
	October	0.16	0.00	1.45	0.00	21.12	0.00	0.00	4.99	0.00
	November	6.34	0.28	3.33	3.00	12.20	12.60	0.00	22.60	12.60
	December	4.74	1.94	1.68	0.07	9.20	0.00	0.00	8.30	0.00
1978	January	4.14	8.63	9.30	6.97	27.90	6.00	0.00	16.30	6.00
	February	11.25	6.93	11.60	7.54	22.71	0.00	0.00	15.50	0.00
	March	37.01	32.78	51.58	45.99	87.95	7.90	2.30	222.60	7.90
	April	59.14	5.41	11.07	14.55	14.59	3.80	2.30	26.30	3.80
	May	0.00	0.00	0.00	0.00	6.17	0.00	0.00	1.00	0.00
	June	10.96	0.48	1.71	1.92	78.31	3.60	12.20	10.60	3.60
	July	234.46	259.64	375.85	133.55	342.42	285.60	238.60	88.30	285.60
	August	88.64	15.79	85.70	7.04	341.66	26.90	86.50	73.60	26.90
	September	30.03	0.72	12.09	11.36	93.14	0.00	0.00	8.40	0.00
	October	0.75	0.00	0.00	0.00	20.25	0.00	0.00	3.80	0.00
	November	0.00	16.70	6.71	0.00	30.56	2.00	0.00	31.20	2.00
	December	0.00	0.00	0.00	0.29	1.64	0.00	0.00	0.00	0.00

Appendix Table 7 (continued). Rainfall, by Agroclimatic Zone (*) (in millimeters)

Year		Rice/Wheat Punjab	Cotton/Wheat Punjab	Mixed Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other N.W.F.P.	Other Baluchistan
1979	January	11.37	29.35	35.14	37.27	48.84	2.00	0.00	80.90	2.00
	February	37.21	41.07	94.91	33.26	59.37	29.70	0.00	82.90	29.70
	March	48.99	51.35	46.74	48.38	86.61	30.00	0.00	53.20	30.00
	April	4.45	6.36	18.90	9.28	12.58	3.30	0.70	9.40	3.30
	May	24.69	12.88	31.17	10.38	37.17	0.00	0.00	36.40	0.00
	June	32.92	0.00	11.12	1.40	39.57	0.00	0.00	11.70	0.00
	July	125.31	23.61	95.19	24.09	188.56	0.00	2.50	15.10	0.00
	August	65.50	39.09	118.34	25.87	169.74	40.20	118.20	94.90	40.20
	September	34.56	15.55	52.80	12.43	62.75	6.50	0.00	0.10	6.50
	October	7.56	0.83	11.33	2.95	8.91	10.80	6.00	0.00	10.80
	November	3.59	2.88	9.52	6.09	22.71	0.00	5.60	18.00	0.00
	December	5.80	7.24	3.27	9.43	17.91	6.50	24.90	1.10	6.50
1980	January	16.64	10.02	19.89	11.02	50.83	0.00	0.00	28.30	0.00
	February	3.20	0.00	1.64	8.51	31.08	0.00	0.00	69.90	0.00
	March	18.03	25.04	33.61	37.68	94.58	7.10	0.00	96.00	7.10
	April	4.19	1.23	14.32	4.32	12.54	0.00	0.00	8.40	0.00
	May	0.00	2.19	8.04	0.54	20.01	0.00	0.60	14.20	0.00
	June	128.10	1.91	45.81	81.12	76.43	0.00	13.40	32.80	0.00
	July	448.42	99.28	103.07	26.56	225.12	0.00	22.70	50.60	0.00
	August	281.08	20.17	125.22	7.98	143.87	0.00	4.20	49.50	0.00
	September	45.04	15.67	58.69	17.19	68.29	0.00	0.00	5.00	0.00
	October	3.52	2.61	9.68	4.35	17.31	2.50	58.30	8.00	2.50
	November	7.92	1.74	6.52	6.09	19.14	3.00	0.70	7.50	3.00
	December	7.54	15.18	10.59	2.08	13.93	1.30	12.50	2.00	1.30
1981	January	72.02	27.73	31.87	15.46	99.99	0.00	28.50	33.90	0.00
	February	12.20	14.08	7.07	16.06	54.76	6.20	0.30	28.60	6.20
	March	33.57	33.53	63.07	44.48	138.67	38.70	17.90	149.60	38.70
	April	0.00	0.89	0.43	1.17	39.43	0.00	0.00	28.30	0.00
	May	0.00	4.76	5.02	5.44	62.96	10.00	1.40	35.10	10.00
	June	1.56	0.00	4.65	2.16	9.18	0.00	3.00	2.00	0.00
	July	258.60	169.98	359.55	161.60	284.67	0.80	131.20	24.40	0.80
	August	35.46	37.28	141.60	47.33	175.78	0.00	60.00	85.30	0.00
	September	5.02	2.84	13.58	0.00	52.17	0.00	0.00	0.00	0.00
	October	3.01	2.21	10.03	3.34	6.82	0.00	0.00	8.90	0.00
	November	9.70	11.19	1.79	1.55	8.03	0.00	0.00	0.00	0.00
	December	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.00

Appendix Table 7 (continued). Rainfall, by Agroclimatic Zone (*) (in millimeters)

Year		Rice/Wheat Punjab	Cotton/Wheat Punjab	Mixed Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other N.W.F.P.	Other Baluchistan
1982	January	73.74	10.44	15.62	9.68	38.26	0.80	0.00	29.90	0.80
	February	20.03	21.50	26.59	9.16	55.67	10.30	11.50	12.60	10.30
	March	74.05	43.82	73.54	48.31	140.55	51.90	2.50	96.00	51.90
	April	65.35	36.05	47.19	15.23	102.26	0.00	0.00	19.60	0.00
	May	44.19	38.78	20.09	38.38	49.17	11.00	0.00	4.30	11.00
	June	18.52	18.53	47.88	0.00	14.92	0.00	0.00	1.40	0.00
	July	122.24	26.79	7.20	11.39	108.54	0.00	57.60	2.00	0.00
	August	65.76	49.40	196.21	54.47	298.35	7.80	48.60	94.70	7.80
	September	1.09	1.71	2.50	1.44	18.78	0.00	0.00	0.00	0.00
	October	1.96	11.09	2.83	12.73	15.37	0.00	0.00	1.00	0.00
	November	15.53	15.86	37.71	9.53	51.44	15.00	0.00	50.60	15.00
	December	13.23	8.14	30.84	9.27	17.62	0.80	0.00	14.00	0.80
1983	January	20.51	2.33	0.68	0.01	60.83	2.50	0.04	38.50	2.50
	February	27.89	9.92	27.61	17.99	33.42	13.00	4.30	38.60	13.00
	March	58.14	7.06	14.73	10.57	65.91	0.00	0.20	80.90	0.00
	April	102.83	14.57	73.73	38.27	179.72	3.10	20.00	179.10	3.10
	May	42.74	36.17	24.91	19.68	41.59	1.60	18.00	39.00	1.60
	June	8.05	7.99	35.09	6.62	34.39	0.00	0.00	14.50	0.00
	July	85.79	83.07	74.65	40.11	174.11	41.20	8.60	62.00	41.20
	August	195.45	57.70	155.38	79.[illegible]	306.56	8.00	68.10	218.00	8.00
	September	30.14	82.54	96.55	22.26	107.62	0.00	18.70	18.30	0.00
	October	7.51	0.00	0.02	0.00	39.59	5.50	19.00	9.70	5.50
	November	0.00	0.00	0.01	0.00	1.28	0.00	0.00	10.00	0.00
	December	0.00	0.02	0.01	0.04	0.02	1.60	0.00	1.60	1.60
1984	January	0.00	1.33	1.77	1.55	0.01	7.10	0.00	3.90	7.10
	February	12.28	9.76	21.26	7.23	59.01	8.60	0.00	29.60	8.60
	March	5.03	10.93	8.82	14.64	46.86	7.60	0.00	42.10	7.60
	April	4.37	10.97	21.09	6.88	41.72	4.00	0.00	65.90	4.00
	May	0.00	0.00	0.00	0.00	4.22	0.00	0.00	3.80	0.00
	June	8.04	5.04	13.91	9.34	92.63	0.00	0.00	5.50	0.00
	July	127.73	17.26	117.94	5.93	227.39	0.00	65.00	101.00	0.00
	August	146.07	46.61	84.14	12.04	214.38	9.10	67.20	236.80	9.10
	September	176.23	61.42	86.68	11.19	83.34	38.10	0.00	21.80	38.10
	October	3.15	0.00	0.00	0.00	4.48	0.00	0.00	0.00	0.00
	November	0.00	1.07	7.25	0.36	10.63	0.00	0.00	9.00	0.00
	December	10.17	3.03	5.84	1.15	17.32	2.30	0.00	4.50	2.30

Appendix Table 7 (continued). Rainfall, by Agroclimatic Zone (*) (in millimeters)

Year		Rice/Wheat Punjab	Cotton/Wheat Punjab	Mixed Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other N.W.F.P.	Other Baluchistan
1985	January	0.32	0.02	1.17	3.99	47.75	0.90	0.00	28.90	0.90
	February	0.43	0.28	0.54	2.08	3.58	0.00	0.00	5.60	0.00
	March	5.76	1.76	2.13	1.62	25.99	0.50	3.50	24.30	0.50
	April	25.22	43.92	45.91	19.20	40.25	8.20	16.60	29.90	8.20
	May	29.38	0.00	4.35	0.01	22.58	0.00	0.00	19.10	0.00
	June	17.92	10.33	21.38	15.47	12.13	0.00	0.00	0.04	0.00
	July		30.40	87.46	19.87	242.37	171.00	39.50	25.00	171.00
	August		62.29	46.00	37.23	117.50	0.00	45.80	95.60	0.00
	September			0.00			0.00	0.00	5.00	0.00
	October			18.06			0.00	0.00	2.00	0.00
	November							0.00	10.50	
	December								94.70	

(*) The original data was collected by city, then aggregated into their respective zones. Weights were assigned to each of the city series according to share of production, in this instance, of wheat. See note, Appendix Table 9.

Sources: (1) "Agricultural Statistics of Pakistan", 1975,1978, and 1984, Ministry Food, Agriculture and Cooperatives, Islamabad.
(2) "Statistical Bulletin of Pakistan", Social Sciences Division, PARC, September 1983, Islamabad.
(3) Data collected by the Department of Atmospheric Science, at the University of Missouri, Columbia, Missouri.
(4) 1984-1985 data from the Meteorological Office, Karachi, from Land Records Directorate, Lahore, and from the Agricultural Directorate, N.W.F.P.

Appendix Table 8. Monthly Average Rainfall, by Agroclimatic Zone, 1967 to 1985
(in millimeters)

Month	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other NWFP	Other Baluchistan
January	19.13	10.37	7.18	7.05	39.90	3.14	2.29	24.59	3.14
February	17.36	19.80	11.84	11.79	46.82	8.09	1.53	43.19	8.09
March	30.87	29.28	17.77	23.39	66.25	11.85	3.54	77.60	11.85
April	19.10	18.40	10.40	11.82	48.15	1.48	2.19	48.47	1.48
May	14.69	12.44	10.34	9.38	26.49	1.53	1.80	25.63	1.53
June	41.81	30.18	14.62	14.17	47.07	1.71	3.69	6.96	1.71
July	173.81	126.00	73.75	44.66	202.15	38.11	52.17	47.75	38.11
August	150.35	102.73	46.32	35.27	224.79	22.32	46.63	88.34	22.32
September	43.84	31.94	23.84	16.19	64.85	14.83	7.21	17.61	14.83
October	3.39	4.98	2.10	2.20	16.67	2.41	4.38	6.28	2.41
November	3.15	6.89	2.86	1.82	11.32	1.83	0.42	11.29	1.83
December	13.19	5.72	8.03	6.29	20.46	5.39	4.16	21.34	5.39

Sources: (1) "Agricultural Statistics of Pakistan", 1975,1978, and 1984, Ministry Food, Agriculture and Cooperatives, Islamabad.
(2) "Statistical Bulletin of Pakistan", Social Sciences Division, PARC, September 1983, Islamabad.
(3) Data collected by the Department of Atmospheric Science, at the University of Missouri, Columbia, Missouri.
(4) 1984-1985 data from the Meteorological Office, Karachi, from Land Records Directorate, Lahore, and from the Agricultural Directorate, N.W.F.P.

Appendix Table 9. Cumulative Rainfall, October through March, by Agroclimatic Zone 1967/68 - 1984/85 (in millimeters)

Year	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other NWFP	Other Baluchistan
1967/68	234.78	129.87	131.59	128.28	370.50	100.00	35.81	314.70	102.00
1968/69	86.46	49.40	36.44	27.96	205.92	1.00	1.02	162.05	1.00
1969/70	58.09	50.44	26.52	53.61	222.15	68.50	0.00	127.25	71.00
1970/71	20.99	39.80	7.42	5.10	71.24	1.75	0.00	91.76	1.75
1971/72	58.32	22.73	7.92	15.78	158.48	11.75	0.00	165.90	11.75
1972/73	80.15	106.21	12.51	35.69	225.89	2.25	8.40	227.00	2.25
1973/74	55.84	36.29	19.47	22.94	111.05	21.25	1.00	70.60	53.75
1974/75	89.51	68.63	39.75	29.18	149.09	10.90	9.50	176.40	11.40
1975/76	91.09	65.99	50.90	39.65	227.49	12.50	4.20	184.00	16.50
1976/77	27.30	29.02	14.49	9.51	85.15	7.10	7.10	88.50	7.10
1977/78	63.63	78.94	50.56	63.56	181.08	18.60	0.00	290.20	26.50
1978/79	98.32	183.51	138.47	119.20	247.26	33.70	0.00	252.00	63.70
1979/80	54.82	79.27	45.17	75.68	226.03	17.30	30.50	213.30	24.40
1980/81	136.76	128.79	92.25	88.53	343.80	13.00	42.00	229.60	51.70
1981/82	180.52	127.57	86.96	72.69	249.33	11.10	11.50	147.40	63.00
1982/83	137.26	114.41	43.31	60.10	244.58	31.30	4.34	223.60	31.30
1983/84	24.82	31.89	22.05	23.46	146.79	22.80	0.00	96.90	30.40
1984/85	19.84	16.94	6.16	9.20	109.74	3.20	0.00	72.30	3.70

(*) District rainfall series were weighted by production of wheat, and used as proxies for the following: Gujranwala, Lahore and Sheikupura for Rice/Wheat Punjab; Sargodha, Faisalabad and Okara for Mixed Punjab; Multan, Sahiwal and R.Y. Khan for Cotton/Wheat Punjab; D.I. Khan and D.G. Khan for Low Intensity Punjab; Rawalpindi/Islamabad, Jhelum and Attock for Barani Punjab; Jacobabad for the Rice/Wheat Sind; Nawabshah for the Cotton/Wheat Sind; Peshawar for Other NWFP, and Jacobabad for Other Baluchistan.

Sources: (1) "Agricultural Statistics of Pakistan", 1975,1978, and 1984, Ministry Food, Agriculture and Cooperatives, Islamabad.
(2) "Statistical Bulletin of Pakistan", Social Sciences Division, PARC, September 1983, Islamabad.
(3) Data collected by the Department of Atmospheric Science, at the University of Missouri, Columbia, Missouri.
(4) 1984-1985 data from the National Meteorological Data Processing Center, Karachi, from Land Records Directorate, Lahore, and from the Agricultural Directorate, N.W.F.P.

Appendix Table 10. Water Availability (Canal only), by Agroclimatic Zone, 1967/68 - 1984/85
(million acre feet)

***** KHARIF *****

Year	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab	Rice/Other Sind	Cotton/Wheat Sind	Total Kharif
1967/68	6.20	7.18	14.40	6.05	12.55	12.41	58.79
1968/69	5.99	7.65	15.40	6.66	13.81	14.12	63.61
1969/70	6.27	7.15	15.63	6.56	14.42	14.40	64.43
1970/71	5.16	6.33	13.53	6.16	13.37	13.64	58.19
1971/72	4.90	6.32	13.06	5.29	14.15	14.53	58.26
1972/73	5.96	7.83	14.22	6.15	15.88	16.14	66.18
1973/74	5.74	6.61	13.91	5.07	15.00	15.49	61.82
1974/75	5.43	6.47	13.29	5.22	14.96	15.39	60.76
1975/76	5.68	6.91	14.88	5.32	13.63	14.30	60.72
1976/77	4.35	6.72	14.45	5.19	12.77	12.92	56.42
1977/78	6.25	7.45	15.13	5.98	13.65	13.94	62.39
1978/79	6.21	6.78	14.04	5.94	12.25	12.65	57.86
1979/80	5.89	7.43	16.02	6.34	14.94	15.12	65.73
1980/81	5.70	7.19	15.34	6.61	15.79	16.23	66.87
1981/82	6.38	6.68	15.30	6.69	14.56	14.96	64.57
1982/83	5.55	7.10	15.13	6.75	14.76	15.47	64.77
1983/84	4.23	6.45	13.96	5.79	14.72	14.98	60.12
1984/85	5.76	7.58	15.14	6.10	14.05	14.77	63.40

***** RABI *****

Year	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab	Rice/Other Sind	Cotton/Wheat Sind	Total Rabi
1967/68	3.06	4.60	8.43	2.82	5.33	7.28	31.52
1968/69	2.88	4.48	6.19	3.42	5.53	7.29	29.79
1969/70	3.14	4.40	5.98	2.33	5.65	7.31	28.81
1970/71	2.43	3.87	5.42	2.03	5.01	6.59	25.36
1971/72	3.36	4.27	4.90	1.55	4.58	6.19	24.85
1972/73	3.79	5.14	7.86	1.90	5.33	7.01	31.03
1973/74	2.90	4.92	7.72	2.47	5.86	7.58	31.45
1974/75	2.16	3.77	5.18	1.53	4.23	5.72	22.59
1975/76	2.98	5.17	10.05	3.03	5.86	7.62	34.71
1976/77	2.74	5.47	10.52	4.47	6.21	7.78	37.20
1977/78	3.04	5.42	9.44	3.18	6.88	8.57	36.53
1978/79	2.93	4.51	8.67	3.17	7.19	8.40	34.87
1979/80	2.94	5.00	8.92	3.29	6.84	8.18	35.16
1980/81	2.82	4.90	9.15	3.51	7.13	8.56	36.06
1981/82	2.77	4.41	8.19	2.99	6.51	8.20	33.07
1982/83	2.76	5.04	8.22	3.29	6.56	8.36	34.24
1983/84	2.71	5.07	8.59	3.92	6.96	8.80	36.06
1984/85	2.73	4.67	7.91	3.24	6.84	8.33	33.73

Source: "Zone-wise Canal Withdrawals", Hydrology and Water Management Organisation,
Water Resource Management Directorate, Planning Division, Water and Power Development Authority.

Appendix Table 11. Cumulative Number of Tubewells Available, by Agroclimatic Zone, 1967/68 - 1984/85

Year	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other NWFP	Other Baluchistan
1967/68	25098	8588	22377	2879	337	75	428	0	1097
1968/69	29230	10395	25135	4409	359	206	1198	0	1496
*1969/70	34464	10962	30378	6234	537	347	2030	105	1901
*1970/71	36270	11437	34785	7137	495	593	3485	565	2311
*1971/72	39069	13688	37633	8751	734	721	4238	620	2557
1972/73	42029	15938	41278	9371	885	849	4992	652	3086
1973/74	46977	17575	43791	10790	1004	970	5698	662	3706
1974/75	55392	19326	50155	14035	1125	1116	6560	1019	4322
1975/76	57362	19910	52287	14504	1186	1220	7166	1226	4692
1976/77	60928	20370	52899	15137	1539	1279	7512	1248	4923
1977/78	62315	21019	54422	15307	1944	1351	7936	1356	5202
1978/79	64021	21191	55567	16692	2110	1445	8483	1568	6067
1979/80	66148	21722	58552	17555	2412	1881	11063	1612	6564
1980/81	71103	22802	59543	18109	2400	2240	13188	1660	7143
1981/82	73770	23384	60075	18449	2394	2522	14857	1399	7561
1982/83	76457	24053	62030	18779	2580	2804	16526	1788	7825
1983/84	82963	25961	67940	20419	3080	3048	17976	1826	8102
1984/85	84681	26464	69498	20873	3214	3337	19688	1854	8375

(*) Denotes years in which Scarp-II-A data is not reported.

Note: District-wise time-series data for much of the Sind, N.W.F.P. and Baluchistan is unavailable. Thus, certain manipulations of existing data (province-wise) were made as follows:
"Rice/Other Sind" is 14.4 percent of Sind totals, "Cotton/Wheat Sind" 85.6 percent.
"Other N.W.F.P." is 33.1 percent of N.W.F.P. totals, with the remainder ascribed to "Low Intensity Punjab".
"Other Baluchistan" is 99.7 percent of Baluchistan totals, with the remainder ascribed to "Rice/Other Sind".

Sources: Data for the Punjab comes from unpublished mimeos provided by the Department of Agriculture of the Punjab. Province-wise data available from the "Pakistan Economic Survey", 1984/85, Planning and Development Division and the Ministry of Production, and from "Agricultural Statistics of Pakistan", various issues, Ministry of Food, Agriculture and Cooperatives, Islamabad.

Appendix Table 12. Average High Temperatures in March, by Agroclimatic Zone, 1967/68 - 1984/85
(degrees centigrade)

Year	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other NWFP	Other Baluchistan
1967/68	27.1	26.3	28.7	32.1	24.2	33.6	23.8	26.4	18.5
1968/69	29.9	30.0	32.0	35.8	27.1	37.4	27.3	31.2	21.9
1969/70	26.6	26.6	28.4	30.2	23.6	32.7	22.8	25.7	16.6
1970/71	28.7	28.7	30.4	32.7	26.6	34.3	26.2	29.5	21.4
1971/72	28.4	27.6	30.0	31.8	24.3	34.8	23.9	27.4	16.7
1972/73	26.7	25.9	28.0	31.6	22.9	34.5	23.2	26.0	18.3
1973/74	29.3	29.3	30.6	34.0	26.7	36.6	27.6	29.2	20.1
1974/75	26.6	26.9	27.4	30.5	23.1	32.6	22.6	26.0	15.5
1975/76	25.4	25.5	27.0	28.9	22.0	31.4	22.3	25.0	13.1
1976/77	31.1	32.0	32.4	35.1	29.1	36.9	30.0	31.4	22.6
1977/78	24.1	24.0	26.6	29.7	21.6	32.8	21.3	24.5	15.6
1978/79	23.6	24.0	25.2	27.7	21.5	31.3	22.7	24.5	14.5
1979/80	25.5	24.5	26.5	29.1	21.3	32.9	20.6	24.1	26.8
1980/81	25.5	25.3	27.5	29.4	22.5	32.4	23.3	28.5	18.0
1981/82	22.6	22.7	24.5	26.9	20.1	31.4	20.1	19.7	12.6
1982/83	24.4	25.1	27.5	28.9	22.2	32.1	21.2	25.7	15.7
1983/84	29.6	29.6	31.6	34.1	27.3	36.5	27.1	30.1	21.8
1984/85	30.8	29.7	31.4	34.1	28.4	37.2	28.1	30.2	22.0

Source: Unpublished data from the Planning Unit, Ministry of Food, Agriculture and Cooperatives, Islamabad, and from the National Meteorological Data Processing Center, Karachi.

Appendix Table 13. Total Sales of Fertilizers, by Agroclimatic Zone, 1967/68 - 1984/85
(000 nutrient tons)

Year	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind	Other NWFP	Other Baluchistan
1967/68	25.3	40.3	51.1	12.4	3.9	6.4	30.4	20.4	0.2
1968/69	39.5	49.7	66.2	10.3	3.5	8.4	39.5	27.0	0.5
1969/70	43.7	65.0	83.3	14.6	2.2	12.8	60.1	25.7	0.3
1970/71	36.7	60.0	77.2	9.7	1.7	14.4	66.9	16.2	0.4
1971/72	52.4	71.5	114.0	13.4	2.8	17.1	79.2	28.3	0.5
1972/73	74.0	84.6	117.4	15.8	4.0	19.1	87.3	31.3	0.7
1973/74	56.0	69.2	96.8	25.6	3.0	24.4	103.8	21.7	1.3
1974/75	62.0	85.8	112.2	25.7	3.0	18.3	91.8	22.5	1.0
1975/76	90.0	103.3	141.7	33.7	6.0	27.8	103.0	27.8	1.6
1976/77	92.0	112.1	161.9	43.0	7.0	29.2	102.7	48.8	1.8
1977/78	114.0	111.5	192.5	45.7	6.0	47.0	138.3	46.8	2.3
1978/79	139.0	155.6	232.4	55.3	10.0	55.2	170.7	52.2	2.0
1979/80	171.0	178.9	289.1	74.5	13.0	63.4	194.2	59.7	2.3
1980/81	157.0	170.1	291.9	74.1	11.0	90.8	215.6	66.7	2.8
1981/82	170.0	169.9	294.1	71.8	13.0	75.9	218.7	65.2	2.0
1982/83	187.0	190.0	348.0	81.7	15.0	106.4	248.2	73.5	4.1
1983/84	182.0	189.0	326.0	77.9	17.0	99.6	236.2	70.7	3.7
1984/85	175.0	194.0	364.0	87.2	15.0	103.5	243.7	64.5	5.0

Notes: (1) While Sind province data was available for the whole period, district breakdown was available only from 1973/74 through 1983/84. Thus, 1965/66 to 1972/73 was derived by applying the average Sind Cotton/Wheat zone proportion of years 1973/74 to 1974/75 (.8255) and Rice/Wheat proportion of the same years (.1745) of the province total. Proportions of Cotton/Wheat and Rice/Wheat zone fertilizer sales for 1984/85 were (.7117) and (.2883) respectively.

(2) Data for D.I. Khan was not available, thus Mianwali's ratio of fertilizer to wheat production was applied to DI Khan's production to derive its fertilizer use. To derive Nasirabad's fertilizer use, we used the ratio of Nasirabad production to total Baluchistan production, and subtracted this from Baluchistan province fertilizer use.

(3) No data was available for Shikarpur. Shikarpur's percentage of Sukkur's wheat production was used as a proxy to derive its fertilizer use.

Source: "Agricultural Statistics of Pakistan", various issues, district-wise data volumes, Government of Pakistan, Ministry of Food, Agriculture and Cooperatives.

Appendix Table 14. Wholesale Wheat Prices, Deflated, Select Cities

Year	Month	Rawalpindi	Multan	Karachi	Faisalabad	Peshawar	Quetta	Hyderabad	Lahore	Okara	Sargodha	CPI (1984/85=100.0)
1970	July	93.34	89.85	102.83	94.84	84.86	97.34					21.47
	August	92.98	89.50	102.43	94.47	84.53	96.96					21.55
	September	100.45	93.52	107.63	95.01	94.02	98.57					21.66
	October	98.59	88.97	105.19	91.39	90.40	97.75					21.74
	November	98.61	89.53	106.95	91.98	87.81	96.25					21.85
	December	102.24	91.72	105.66	100.28	98.32	106.40					21.91
1971	January	95.56	91.74	101.29	91.26	92.69	103.63					22.43
	February	100.34	91.50	102.01	92.69	92.21	100.91					22.43
	March	90.28	88.85	100.25	92.18	101.20	98.21					22.56
	April	95.38	87.75	100.39	87.27	100.63	96.57					22.47
	May	91.99	84.33	100.62	85.91	94.87	97.02					22.37
	June	94.90	93.95	100.63	83.46	84.89	96.14					22.47
	July	94.54	92.89	99.71	91.43	86.07	96.14					22.79
	August	86.38	89.20	98.59	97.09	94.37	100.94					22.83
	September	90.36	94.11	98.79	100.85	85.45	100.05					22.89
	October	91.88	85.60	100.02	93.14	85.14	103.23					23.04
	November	94.65	98.82	101.84	90.01	94.18	105.55					23.10
	December	105.55	103.46	104.62	99.29	103.46	114.14					23.10
1972	January	107.08	110.79	109.86	106.62	111.25	125.16					23.12
	February	106.71	116.58	110.84	128.06	107.86	123.93					23.35
	March	105.86	124.07	116.56	124.30	102.45	129.31					23.54
	April	93.73	111.57	113.38	105.25	101.18	119.25					23.73
	May	91.55	81.43	110.32	120.16	100.71	103.00					23.41
	June	89.63	83.02	106.05	81.65	92.37	102.17					23.50
	July	85.97	83.39	102.45	79.73	94.66	99.11					24.06
	August	86.27	83.15	103.61	85.38	95.60	97.38					24.10
	September	92.03	87.59	104.67	89.59	94.47	97.57					24.16
	October	90.45	88.24	107.66	88.24	92.66	106.78					24.29
	November	88.81	90.66	107.01	90.35	94.30	105.70					24.44
	December	103.23	100.01	104.95	101.51	92.48	113.12					24.92

Appendix Table 14 (continued). Wholesale Wheat Prices, by city, defla ed

Year	Month	Rawalpindi	Multan	Karachi	Faisalabad	Peshawar	Quetta	Hyderabad	Lahore	Okara	Sargodha	CPI (1984/85=100.0)
1973	January	99.81	99.18	111.37	98.76	95.61	113.89					25.50
	February	92.02	86.21	113.57	92.85	103.62	111.91					25.86
	March	82.71	76.95	103.29	77.77	93.62	98.35					26.04
	April	84.32	85.52	108.01	81.91	86.33	99.98					26.69
	May	88.25	87.45	114.21	85.86	87.85	103.83					26.84
	June	87.44	85.72	110.77	86.89	88.07	107.64					27.38
	July	82.30	82.26	113.02	82.30	83.79	98.68					28.78
	August	90.33	81.28	110.09	85.17	79.52	97.19					30.32
	September	95.62	87.79	104.13	88.81	100.04	105.49					31.49
	October	84.74	85.41	107.73	83.90	82.22	104.04					31.93
	November	82.45	86.47	102.56	82.45	89.66	102.23					31.97
	December	87.21	84.76	100.09	79.71	79.22	93.57					32.87
1974	January	91.18	92.80	99.91	89.89	83.10	90.86					33.14
	February	93.62	95.84	94.09	91.24	83.14	92.03					33.77
	March	91.30	90.53	89.13	87.28	86.66	89.75					34.63
	April	92.35	91.13	104.59	90.52	92.51	84.86					35.04
	May	93.24	77.29	102.44	80.36	95.85	84.04					34.94
	June	87.46	81.56	103.63	81.56	92.42	79.22					36.53
	July	92.19	98.63	102.60	101.20	90.77	87.48					37.49
	August	96.92	81.54	118.88	96.37	109.82	87.86					39.03
	September	102.15	87.36	105.24	95.96	112.63	90.32					39.87
	October	104.59	95.06	109.09	98.76	116.50	87.64					40.47
	November	109.52	106.61	121.72	109.39	112.71	89.63					40.41
	December	120.65	114.18	128.67	117.54	128.80	89.32					41.39
1975	January	120.88	113.98	133.14	118.32	135.44	90.72					41.94
	February	132.38	112.24	127.09	117.28	128.35	89.09					42.58
	March	122.53	117.69	124.38	119.92	124.38	87.71					43.25
	April	124.01	105.16	133.84	104.76	127.69	89.62					45.32
	May	122.70	90.53	126.69	100.85	117.18	91.73					44.63
	June	100.52	89.27	119.19	95.02	105.55	93.94					44.78
	July	96.66	90.54	117.12	93.60	99.95	91.72					45.57
	August	111.25	89.93	103.87	92.98	108.67	98.60					45.76
	September	115.06	88.85	104.51	84.91	103.81	104.16					46.20
	October	106.06	85.14	97.67	87.77	112.00	98.86					46.89
	November	105.85	86.06	99.73	89.17	111.83	95.04					46.57
	December	96.47	88.89	104.51	96.01	122.89	97.05					46.66

Appendix Table 14 (continued). Wholesale Wheat Prices, by city, deflated

Year	Month	Rawalpindi	Multan	Karachi	Faisalabad	Peshawar	Quetta	Hyderabad	Lahore	Okara	Sargodha	CPI (1984/85=100.0)
1976	January	92.33	87.14	106.30	94.06	113.11	94.64					46.43
	February	86.48	84.41	101.20	87.17	108.10	93.38					46.59
	March	85.18	83.25	103.32	87.31	100.12	111.43	93.29	85.60	82.83	84.32	46.84
	April	85.96	84.27	110.25	87.44	88.29	99.90	98.74	87.65	83.22	84.06	47.35
	May	82.58	83.22	108.77	83.85	75.61	92.30	93.57	88.50	82.16	82.80	47.35
	June	80.79	81.00	114.33	82.26	81.63	92.60	94.08	87.33	81.21	82.48	47.41
	July	80.99	80.99	103.23	82.25	79.10	93.79	93.79	84.98	80.36	82.04	47.66
	August	84.70	82.22	105.00	82.84	74.97	110.39	92.37	85.95	81.81	80.98	48.29
	September	82.63	81.02	105.46	80.81	75.76	107.48	93.14	83.44	79.00	79.00	49.50
	October	84.99	80.17	105.29	80.17	73.54	106.49	92.63	82.58	79.17	78.56	49.77
	November	81.94	81.15	105.44	79.18	81.94	89.25	96.06	86.29	84.71	81.55	50.65
	December	89.61	87.25	107.65	92.94	81.37	88.23	100.59	93.72	85.88	91.96	51.00
1977	January	87.52	85.00	105.04	87.90	80.55	86.16	93.61	86.35	81.42	89.06	51.65
	February	90.82	86.52	104.86	86.71	79.07	87.67	98.36	86.90	79.07	87.86	52.36
	March	88.07	85.06	104.21	87.50	77.55	85.06	94.26	85.44	81.87	86.56	53.26
	April	88.17	82.43	101.88	83.72	76.50	84.09	92.24	86.32	78.17	85.58	53.99
	May	84.43	76.67	94.72	79.38	80.16	87.34	87.73	82.29	76.08	78.41	51.52
	June	81.09	76.25	92.71	79.16	79.93	93.09	83.42	79.16	78.19	77.80	51.67
	July	80.65	73.51	89.48	78.58	77.64	89.67	83.28	76.14	75.01	75.57	53.19
	August	79.21	73.62	95.43	78.47	78.84	88.90	82.20	78.47	73.62	73.44	53.65
	September	79.99	73.68	99.48	78.50	78.50	88.53	82.03	78.13	77.02	74.61	53.88
	October	81.68	80.20	97.57	85.66	78.17	88.52	81.68	79.65	79.28	79.28	54.11
	November	84.77	87.27	115.12	94.21	82.36	93.28	81.07	87.27	87.27	93.28	54.03
	December	99.02	96.06	115.27	109.91	82.20	99.02	83.50	99.75	100.49	104.00	54.13
1978	January	99.38	97.72	122.06	99.75	82.23	98.82	83.34	98.82	101.77	106.75	54.24
	February	111.45	107.07	125.13	127.50	91.93	97.77	82.45	110.45	123.12	115.32	54.82
	March	115.06	112.54	111.81	138.15	104.42	96.67	81.52	116.32	120.65	134.30	55.45
	April	115.18	89.74	117.15	103.36	96.01	96.01	84.55	103.00	109.27	112.03	55.82
	May	101.83	73.31	109.70	80.44	80.44	97.99	86.20	82.58	74.23	87.57	54.70
	June	97.68	72.40	104.27	83.05	86.66	94.79	85.13	80.34	76.28	86.48	55.39
	July	92.71	81.02	102.25	95.31	83.18	90.98	99.65	93.58	72.35	78.85	57.70
	August	93.07	86.18	112.03	98.25	86.18	90.45	99.54	93.07	82.73	86.18	58.02
	September	90.99	84.00	114.17	94.42	85.84	108.16	81.03	95.28	80.26	85.84	58.25
	October	85.11	79.58	114.90	89.36	85.11	108.31	114.90	94.47	79.15	85.11	58.75
	November	98.15	87.13	112.66	99.01	85.35	115.97	98.15	94.91	90.81	91.63	58.58
	December	97.79	89.21	106.71	100.19	85.78	104.14	91.78	103.62	96.42	99.50	58.29

Year	Month	Rawalpindi	Multan	Karachi	Faisalabad	Peshawar	Quetta	Hyderabad	Lahore	Okara	Sargodha	CPI (1984/85=100.0)
1979	January	99.68	89.03	106.33	96.62	85.20	109.40	99.85	102.92	93.21	98.15	58.69
	February	94.10	93.25	103.77	93.59	94.10	110.21	99.02	102.41	93.59	97.66	58.98
	March	92.24	84.93	93.92	87.88	93.08	109.01	89.89	90.90	86.88	87.21	59.63
	April	91.44	79.30	93.10	84.13	106.40	113.05	88.12	90.44	75.48	81.47	60.15
	May	84.94	86.18	93.48	84.53	107.73	116.02	84.53	83.20	80.55	80.22	60.34
	June	84.26	84.93	96.82	84.51	99.13	99.13	90.87	82.94	80.96	81.37	60.52
	July	79.57	78.41	95.95	80.73	93.16	93.16	85.39	78.25	76.08	78.41	64.41
	August	80.57	81.73	97.92	80.19	92.53	92.53	101.78	77.72	78.65	77.10	64.85
	September	82.66	78.80	95.79	80.73	92.70	92.70	89.61	79.34	78.80	78.64	64.72
	October	83.17	78.55	95.49	82.01	95.49	88.71	92.41	79.32	78.55	78.55	64.93
	November	85.36	77.10	109.52	86.54	97.56	86.54	101.10	84.34	83.00	89.69	63.55
	December	94.72	86.04	109.25	92.35	94.72	93.14	104.19	93.93	89.05	90.78	63.34
1980	January	98.00	86.34	107.03	90.61	93.34	91.78	101.12	93.96	88.67	94.11	64.28
	February	86.15	85.53	105.41	89.77	92.47	104.02	98.63	90.15	85.69	89.77	64.89
	March	85.83	82.79	97.22	86.97	102.54	85.68	89.63	88.87	91.15	88.87	65.83
	April	86.57	86.57	94.93	84.33	82.09	84.33	85.45	87.32	81.35	83.58	67.00
	May	84.35	75.91	90.97	78.32	82.84	93.01	85.85	84.95	76.06	75.31	66.39
	June	78.71	75.15	98.[illegible]	77.97	81.68	105.08	89.85	81.68	75.74	74.26	67.33
	July	77.00	72.10	87.92	74.55	74.90	81.20	85.40	77.00	70.70	70.00	71.43
	August	78.13	71.85	91.52	73.25	70.87	80.92	85.10	76.73	69.06	69.76	71.68
	September	73.28	67.75	88.49	70.52	69.13	80.19	79.50	76.05	67.41	69.13	72.32
	October	71.91	67.79	87.83	79.94	71.36	89.20	79.60	75.48	67.25	72.05	72.87
	November	77.68	75.11	96.36	78.16	78.83	87.97	86.62	79.85	73.76	73.76	73.89
	December	76.33	74.96	96.77	77.69	73.60	91.13	87.23	80.42	73.60	74.96	73.37
1981	January	80.16	74.90	96.63	78.95	75.57	94.00	85.70	80.30	74.90	78.95	74.10
	February	77.36	71.36	93.63	77.02	77.36	97.84	86.69	79.36	74.22	77.02	74.98
	March	78.26	69.63	93.38	77.33	76.93	97.30	84.22	78.92	72.15	75.27	75.39
	April	75.26	71.46	87.32	78.01	85.22	98.33	83.91	78.01	75.39	76.04	76.27
	May	77.63	73.03	92.63	76.51	82.90	94.74	82.90	77.63	75.40	78.95	76.00
	June	72.31	74.90	91.68	75.22	77.48	87.23	84.58	76.19	73.99	77.48	77.44
	July	72.44	70.71	89.31	72.10	76.91	83.79	82.49	76.29	70.09	70.71	80.62
	August	72.02	70.80	89.11	72.05	83.01	89.25	82.40	75.08	68.97	68.97	81.92
	September	72.92	70.72	90.72	71.97	73.16	84.64	84.44	74.93	69.81	71.33	82.01
	October	77.64	76.43	100.20	84.19	78.85	94.20	89.77	86.13	77.16	79.76	82.43
	November	84.25	80.64	100.38	84.85	78.23	86.72	92.68	87.86	80.16	81.84	83.09
	December	86.94	82.07	107.00	86.94	79.03	87.60	99.70	88.76	83.90	87.74	82.26

Appendix Table 14 (continued). Wholesale Wheat Prices, by city, deflated

Year	Month	Rawalpindi	Multan	Karachi	Faisalabad	Peshawar	Quetta	Hyderabad	Lahore	Okara	Sargodha	CPI (1934/35=100.0)
1982	January	91.83	83.43	107.18	87.08	85.26	87.75	99.87	89.52	84.04	90.13	82.10
	February	90.77	83.57	98.82	86.01	87.84	89.52	98.82	91.50	87.84	88.45	81.96
	March	92.89	83.90	98.49	86.33	87.54	93.48	99.70	91.19	83.90	92.41	82.24
	April	86.18	81.93	84.00	79.51	86.18	90.11	78.90	91.04	84.97	86.18	82.38
	May	86.03	70.28	82.88	79.37	86.03	89.96	78.16	79.37	71.49	71.19	82.52
	June	74.75	71.13	86.80	74.75	89.22	89.50	81.38	78.36	71.13	69.44	82.95
	July	76.86	70.42	90.23	74.59	89.51	88.61	89.51	77.58	70.42	74.00	83.79
	August	77.19	70.06	90.49	78.97	85.50	88.16	89.78	81.94	74.22	74.81	84.21
	September	79.60	73.10	93.30	81.49	88.57	87.68	90.60	85.03	77.94	79.13	84.60
	October	82.49	77.56	87.43	83.20	99.89	87.24	86.96	84.61	81.08	81.55	85.10
	November	84.99	77.47	92.73	83.34	99.78	87.15	85.69	84.52	80.41	81.47	85.19
	December	83.63	81.40	91.36	85.50	99.56	86.96	85.50	84.33	84.57	84.92	85.38
1983	January	88.82	80.64	88.59	85.32	99.34	86.77	82.98	86.48	81.52	84.73	85.56
	February	92.14	80.07	87.73	84.71	98.64	93.42	82.97	89.36	81.23	84.13	86.17
	March	93.04	80.25	88.27	83.97	93.04	93.62	80.83	90.71	81.41	80.83	85.98
	April	90.91	78.41	86.37	83.53	90.91	91.48	78.98	88.64	82.05	79.55	88.00
	May	76.80	71.22	85.46	74.06	79.76	89.11	79.19	80.90	71.79	70.53	87.76
	June	74.65	72.38	85.96	74.07	79.17	88.45	78.61	80.30	71.25	70.01	88.42
	July	71.84	69.08	86.66	75.16	85.66	86.43	80.69	78.48	72.95	74.05	90.47
	August	72.64	69.47	91.24	77.67	90.25	85.55	80.96	77.67	72.20	73.30	91.41
	September	76.42	72.60	92.80	77.51	90.07	85.38	82.97	77.51	72.06	73.15	91.60
	October	80.16	73.22	90.21	76.42	85.51	83.58	84.44	75.89	74.82	71.61	93.56
	November	79.53	75.82	92.89	79.00	84.83	82.92	85.89	77.41	76.35	79.53	94.31
	December	79.72	76.54	92.48	81.65	85.04	83.13	89.29	82.91	77.60	81.85	94.07
1984	January	83.48	79.27	95.77	83.05	86.28	84.34	91.14	84.13	79.81	83.05	92.72
	February	83.44	79.23	95.94	81.93	86.24	84.30	90.55	87.32	79.23	83.01	92.76
	March	88.29	79.83	95.37	88.40	85.72	83.79	91.72	91.08	81.44	84.01	93.33
	April	76.96	68.14	78.24	79.19	85.04	83.13	87.17	87.17	80.79	78.13	94.07
	May	77.31	68.84	79.62	79.51	90.72	83.46	74.71	76.84	68.30	71.51	93.70
	June	79.21	70.24	90.83	73.67	79.21	82.59	85.23	72.88	67.60	73.93	94.68
	July	79.02	70.95	92.08	73.50	76.57	79.83	80.65	75.55	67.89	72.99	97.95
	August	78.83	73.33	93.49	73.84	76.38	84.53	85.55	75.37	71.80	78.42	98.19
	September	82.93	73.98	96.22	77.50	90.58	85.55	85.55	79.51	70.35	81.52	99.36
	October	82.62	78.21	92.65	79.71	85.23	87.01	86.23	86.23	75.20	80.22	99.73
	November	86.56	83.03	92.39	81.02	90.58	87.78	85.05	86.56	76.49	85.55	99.36
	December	91.33	85.43	93.77	85.94	91.53	88.70	85.94	90.51	79.73	86.44	98.33

Appendix Table 14 (continued). Wholesale Wheat Prices, by city, deflated

Year	Month	Rawalpindi	Multan	Karachi	Faisalabad	Peshawar	Quetta	Hyderabad	Lahore	Okara	Sargodha	CPI (1984/85=100.0)
1985	January	92.82	85.89	93.43	84.65	90.41	87.62	85.89	89.41	82.88	86.39	99.54
	February	96.85	85.51	97.44	85.51	99.43	86.72	88.00	88.49	82.28	84.52	100.57
	March	89.24	82.86	81.39	85.33	98.06	85.53	81.88	87.28	81.39	86.30	101.98
	April	89.07	82.71	80.85	84.18	88.09	85.37	79.29	87.12	81.44	86.14	102.16
	May	90.80	73.04	86.26	70.07	83.89	86.08	80.34	77.97	70.47	76.98	101.32
	June	90.63	72.90	92.60	75.86	83.74	85.92	91.13	76.35	71.92	76.84	101.51
	July	91.88	71.20	88.71	75.04	81.78	83.91	90.92	75.04	69.27	71.44	103.94
	August	91.78	71.71	89.68	77.44	76.49	0.00	88.92	74.57	75.53	75.53	104.59

Source: Federal Bureau of Statistics, Ministry of Planning, Islamabad.

Appendix Table 15. Average Monthly Real Wholesale Wheat Prices, 1970 - 1985

	Rawalpindi	Multan	Karachi	Faisalabad	Peshawar	Quetta	Hyderabad	Lahore	Okara	Sargodha
July	83.74	80.32	98.32	83.33	85.11	90.53	86.76	79.76	72.87	75.18
August	85.37	79.59	100.25	84.47	87.40	92.64	88.85	80.22	74.78	75.88
September	87.81	80.99	100.09	84.57	88.98	94.43	85.43	81.03	74.74	76.93
October	87.07	81.34	99.93	85.59	88.80	94.77	89.85	82.71	76.96	78.52
November	89.54	85.53	103.82	87.91	91.33	94.13	90.26	85.44	81.44	84.26
December	94.30	89.47	104.58	93.84	93.20	95.71	91.97	90.89	85.69	89.07
January	95.24	90.52	105.59	92.87	93.96	96.37	91.50	90.21	85.36	90.15
February	95.77	90.59	104.10	94.80	95.36	97.51	91.72	91.77	87.37	89.75
March	93.38	89.54	100.07	93.97	95.15	96.33	88.18	91.19	86.76	90.64
April	91.70	85.74	99.62	87.81	92.87	94.41	84.29	88.78	83.21	85.41
May	89.00	78.18	98.58	83.95	89.77	93.97	82.18	80.64	73.82	76.74
June	84.94	78.99	99.62	80.61	86.74	93.17	85.58	78.69	74.12	76.40

NOTE: Prices were deflated by 1985 CPI index.

Source: Federal Bureau of Statistics, Ministry of Planning, Islamabad.

Appendix Table 16. Average Real Harvest Wholesale Prices for Wheat (May and June)(*)

Year	Rawalpindi	Multan	Karachi(*)	Faisalabad	Peshawar	Quetta	Hyderabad(*)	Lahore	Okara	Sargodha
1971	93.45	89.14	100.50	84.68	89.88	96.58				
1972	90.59	82.23	111.85	100.90	96.54	102.58				
1973	87.85	86.59	111.11	86.38	87.96	105.73				
1974	90.35	79.43	103.52	80.96	94.13	81.63				
1975	111.61	89.90	130.27	97.93	111.36	92.83				
1976	81.69	82.11	109.51	83.06	78.62	92.45	96.15	87.91	81.69	82.64
1977	82.76	76.46	98.30	79.27	80.05	90.22	89.99	80.73	77.14	78.11
1978	99.76	72.86	113.42	81.75	83.55	96.39	85.38	81.46	75.25	87.03
1979	84.60	85.55	93.29	84.52	103.43	107.58	86.32	83.07	80.75	80.80
1980	81.53	75.53	92.95	78.15	82.26	99.04	85.65	83.32	75.90	74.78
1981	74.97	73.96	89.98	75.87	80.19	90.98	83.40	76.91	74.69	78.21
1982	80.39	70.71	83.44	77.06	87.62	89.73	78.53	78.87	71.31	70.32
1983	75.72	71.80	85.91	74.07	79.47	88.78	79.09	80.60	71.52	70.27
1984	78.56	69.54	78.93	76.59	84.96	83.03	80.94	74.86	67.95	72.72
1985	90.72	72.97	83.56	72.97	83.81	86.00	79.81	77.16	71.19	76.91

(*) For Karachi and Hyderabad, April and May prices were used due to earlier harvest in these areas.

NOTE: Prices were deflated by CIP index.

Source: Federal Bureau of Statistics, Ministry of Planning, Islamabad.

Appendix Table 17. Percent Wholesale Wheat Price Change, Usually Lowest Month to Usually Highest Month

	Rawalpindi (February / July)	Multan (February / May)	Karachi (January / July)	Faisalabad (March / June)	Peshawar (March / July)	Quetta (February / July)	Hyderabad (February / May)	Lahore (February / July)	Okara (February / July)	Sargodha (March / July)
1971/70	1.07		0.99		1.19	1.04				
1972/71	1.13	1.38	1.10	1.49	1.19	1.29				
1973/72	1.07	1.06	1.09	0.95	0.99	1.13				
1974/73	1.14	1.10	0.88	1.00	1.03	0.93				
1975/74	1.44	1.45	1.30	1.47	1.37	1.02				
1976/75	0.89	0.93	0.91	0.92	1.00	1.02				
1977/76	1.12	1.04	1.02	1.06	0.98	0.93	1.05	1.02	0.98	1.06
1978/77	1.38	1.40	1.36	1.75	1.34	1.09	0.94	1.45	1.64	1.78
1979/78	1.01	1.27	1.04	1.06	1.12	1.21	1.15	1.09	1.29	1.11
1980/79	1.11	0.99	1.12	1.03	1.10	1.12	1.17	1.15	1.13	1.13
1981/80	1.00	0.94	1.10	0.99	1.03	1.20	1.01	1.03	1.05	1.08
1982/81	1.25	1.14	1.20	1.15	1.14	1.07	1.19	1.20	1.25	1.31
1983/82	1.20	1.14	0.98	1.12	1.04	1.05	1.06	1.15	1.15	1.09
1984/83	1.16	1.11	1.11	1.19	1.00	0.98	1.14	1.11	1.09	1.13
1985/84	1.23	1.24	1.01	1.14	1.28	1.09	1.18	1.17	1.21	1.18

Source: Federal Bureau of Statistics, Ministry of Planning, Islamabad.

Appendix Table 18. Price and Expected Revenue Series(*), 1967/68 - 1984/85

Year	Procurement Price of Wheat(+)	Expected Revenue, Wheat	Procurement Price, Basmati Rice	Expected Revenue, Basmati Rice	Procurement Price, Other Rice	Expected Revenue, Other Rice	Price, Cotton	Expected Price, Cotton	Price, Urea	Nonagricultural Price Deflator(++)
	(Rs per 40 Kgs)		(Rs per 40 Kgs)		(Rs per 40 Kgs)		(Rs per 40 Kgs)		(Rs per Metric Ton)	
1967/68	17.69	17.30	32.25	-	20.81	25.18	76.32	93.83	478	1.000
1968/69	17.16	18.65	38.35	-	21.09	28.69	86.97	83.01	548	1.030
1969/70	16.50	19.71	33.96	-	20.28	32.77	87.63	83.00	527	1.062
1970/71	15.78	20.57	29.70	33.35	19.40	31.89	102.48	85.17	553	1.104
1971/72	14.99	18.52	33.49	38.89	18.43	30.83	115.22	94.93	525	1.155
1972/73	17.57	20.91	37.39	44.87	16.21	27.57	128.85	105.88	571	1.216
1973/74	16.03	20.21	38.97	48.24	16.97	29.34	153.84	119.49	722	1.372
1974/75	19.08	24.46	46.40	59.21	20.63	36.26	106.98	138.62	799	1.705
1975/76	16.85	23.20	40.98	56.02	18.22	29.07	122.20	125.41	578	2.078
1976/77	15.35	22.07	42.12	52.48	22.40	36.43	150.39	123.96	527	2.353
1977/78	14.24	21.23	39.07	48.25	17.70	29.42	139.82	133.25	460	2.583
1978/79	16.32	23.15	39.89	43.52	17.77	30.63	162.59	139.47	433	2.785
1979/80	15.21	22.28	35.87	43.79	15.97	29.43	126.79	153.32	579	2.956
1980/81	16.04	24.92	37.88	44.40	17.42	32.65	123.34	140.14	523	3.287
1981/82	14.83	25.10	38.34	45.02	18.53	36.60	120.51	132.23	535	3.616
1982/83	15.41	26.57	37.08	46.65	19.26	41.38	119.67	122.51	577	4.153
1983/84	14.03	23.98	35.08	42.02	18.20	40.85	163.47	120.66	570	4.561
1984/85	15.17	23.50	34.68	42.17	17.99	39.02	123.62	141.74	564	4.614

Notes: (*) Expected Revenue calculated as procurement price times expected yields, where expected yields are series of predicted values of a trend based on the previous five years of data.

(+) These prices are as announced at planting time. In certain years, however, the procurement price was increased between planting and harvest time.

(++) All prices deflated by GDP deflator for non-agricultural goods and services.

Source: Of actual prices, "Pakistan Economic Survey", various issues, Economic Adviser's Wing, Ministry of Planning, Islamabad.

Appendix Table 19. National Wheat Stocks, Procurement, Offtake and Imports, 1970/71 - 1984/85

Year(*)	Opening Stocks	Procurement	Offtake	Net Imports	Computed Closing Stocks (+)	Actual Closing Stocks
1970/71	32	1017	1177	269	141	196
1971/72	196	841	1302	439	174	79
1972/73	79	265	1563	1418	200	143
1973/74	143	1292	2175	1079	339	154
1974/75	154	1265	2260	1173	332	87
1975/76	87	1333	2285	1273	408	416
1976/77	416	2252	2759	505	414	686
1977/78	686	1850	2880	822	478	173
1978/79	173	1093	2977	2112	401	269
1979/80	269	2402	2744	668	595	771
1980/81	771	3043	2768	20	1066	996
1981/82	996	3926	3214	101	1809	1514
1982/83	1514	3132	3115	-53	1478	1511
1983/84	1511	3826	3251	-191	1895	1908
1984/85	1908	2505	3695	544	1262	942
1985/86	942	2487	3477	1562	1450	1237

(*) Scheme Years Computed May to April
(+) Computed as opening stocks plus procurement minus offtake plus imports.

Source: Data originates from provincial food departments, but was collected from the Ministry of Food, Agriculture and Cooperatives, Islamabad.
Also, "Wheat Situation Report", various issues, Planning Unit, Early Warning System Project, Ministry of Food, Agriculture and Cooperatives, Islamabad.

Appendix Table 20. Procurement and Offtake (*), by Province, 1970/71 - 1985/86

	Procurement, Punjab	Procurement, Sind	Procurement, N.W.F.P.	Procurement, Baluchistan	Procurement, Total	Offtake, Punjab	Offtake, Sind	Offtake, NWFP	Offtake, Baluchistan	Offtake, Azad Kashmir	Offtake, Total
1970/71	827	190	0	0	1017	452	230	184	55	100	1177
1971/72	642	191	0	7	841	565	254	253	80	150	1302
1972/73	155	107	0	3	265	608	321	285	140	209	1563
1973/74	1084	201	7	0	1292	803	543	351	224	254	2175
1974/75	826	420	0	19	1265	886	533	380	175	286	2260
1975/76	968	357	0	8	1333	907	502	378	199	299	2285
1976/77	1717	484	23	27	2252	1205	623	484	201	246	2759
1977/78	1437	401	5	7	1850	1245	537	570	251	277	2880
1978/79	652	431	0	10	1093	1115	622	602	248	390	2977
1979/80	1816	558	15	13	2402	1008	562	617	217	340	2744
1980/81	2362	640	24	17	3043	997	627	575	221	348	2768
1981/82	3154	681	60	31	3926	1406	696	569	185	358	3214
1982/83	2478	605	22	27	3132	1220	719	629	219	328	3115
1983/84	2995	754	25	51	3826	1425	715	594	169	348	3251
1984/85	1820	664	3	18	2505	1603	842	701	210	339	3695
1985/86	1952	520	5	10	2487	1264	830	788	256	339	3477

(*) 1985/86 data is reported in this table because procurement and subsequent offtake as reported in 1985/86 is wheat produced in 1984/85.

Source: Data collected from the Ministry of Food, Agriculture and Cooperatives, Islambad. However, data originates from provincial food departments.

Appendix Table 21. Government Procurement of Wheat (*), by Agroclimatic Zone (000 Metric Tons)

Year	Rice/Wheat Punjab	Mixed Punjab	Cotton/Wheat Punjab	Low-Intensity Punjab(+)	Barani Punjab	Rice/Other Sind	Cotton/Wheat Sind
1967/68	0.2	3.2	1.2	0.1	0.0	0.1	4.4
1968/69	96.7	267.8	249.9	34.0	4.9	31.5	97.6
1969/70	168.2	271.3	233.8	21.5	0.7	47.4	172.9
1970/71	215.5	348.2	248.3	14.7	0.3	28.4	130.6
1971/72	175.6	240.0	216.2	9.4	1.1	NA	NA
1972/73	9.6	72.0	37.8	0.6	0.0	16.8	71.5
1973/74	329.7	397.3	352.4	40.7	1.9	23.2	192.7
1974/75	156.8	311.4	309.6	46.1	2.7	78.4	349.0
1975/76	195.8	367.4	346.6	41.7	0.0	54.3	286.8
1976/77	368.4	574.3	716.0	129.3	1.8	100.5	424.9
1977/78	301.5	452.2	610.1	71.8	0.0	34.6	359.4
1978/79	86.5	168.7	374.2	23.7	0.0	65.8	365.9
1979/80	318.7	562.5	830.1	105.5	0.0	70.0	474.7
1980/81	483.0	715.8	1040.5	136.1	0.3	80.5	488.0
1981/82	601.4	936.8	1402.8	215.3	2.5	118.2	656.2
1982/83	476.0	721.2	1133.5	149.9	0.9	91.9	536.7
1983/84	485.5	838.6	1457.6	216.0	0.9	161.6	638.3
1984/85	163.0	462.2	985.7	117.1	0.1	89.4	467.9

(*) Includes procurement of wheat by PASSCO, in the Punjab and in Khairpur (Sind).
(+) Extraction of percentage of D.I. Khan procurement out of total NWFP procurement based on data found in Foodgrains Transport study, see below.

Sources: "Agricultural Statistics of Pakistan", various issues, Ministry of Food, Agriculture and Cooperatives, Islamabad.
Majeed, Abdul, "Foodgrain Transport Economics and Logistics Study", National Transport Research Centre, Planning and Development Division, Ministry of Food, Agriculture and Cooperatives, December 1985, Islamabad.

Appendix Table 22. Four-Month Offtake Aggregates
(in 1000 Metric Tons, per capita in kilograms)

Year	May thru August	(per capita)	September thru December	(per capita)	High-Offtake, Pre-Harvest(*)	(per capita)
1970/71	341.5	5.64	344.7	5.64	475.1	7.67
1971/72	228.6	3.62	334.0	5.17	739.2	11.30
1972/73	387.9	5.91	481.1	7.31	693.7	10.49
1973/74	707.7	10.59	659.7	9.78	807.7	11.85
1974/75	678.3	9.85	739.3	10.63	842.3	11.99
1975/76	737.7	10.40	730.7	10.19	816.7	11.28
1976/77	720.0	9.85	753.0	10.19	1286.0	17.24
1977/78	810.3	10.75	914.3	12.01	1155.3	15.03
1978/79	917.0	11.81	950.0	12.11	1110.0	14.01
1979/80	821.3	10.26	839.3	10.38	1083.3	13.26
1980/81	821.0	9.95	867.0	10.40	1080.0	12.83
1981/82	735.3	8.65	982.3	11.43	1496.3	17.25
1982/83	723.3	8.25	1020.3	11.52	1371.3	15.33
1983/84	707.0	7.83	977.0	10.69	1567.0	16.99
1984/85	829.0	8.89	1224.0	13.00	1642.0	17.27
1985/86	936.0	9.74	1102.0	11.35	1436.0	14.65

(*) January thru April

Source: Collected from the Ministry of Food, Agriculture and Cooperatives, Islamabad.
Data originates from Provincial Food Departments.

Appendix Table 23. Edible Oils (*) Production, Pakistan (000 Metric Tons of Oil)

Year	All Edible Oils	Cottonseed Oil	Rape and Mustardseed Oil	Groundnut Oil	Sesamum Oil	Soybean Oil	Sunflower Oil	Safflower Oil
1967/68	219.2	109.0	76.8	30.0	3.3	N/A	N/A	N/A
1968/69	199.4	111.1	64.0	21.4	2.9	N/A	N/A	N/A
1969/70	212.2	112.8	71.4	25.1	2.9	N/A	N/A	N/A
1970/71	211.7	114.2	75.4	18.1	3.7	0.08	0.15	0.02
1971/72	261.7	149.0	84.3	23.2	4.9	0.08	0.26	0.01
1972/73	250.0	147.8	80.3	17.9	3.7	0.10	0.15	0.00
1973/74	247.1	138.7	81.9	21.9	4.5	0.08	0.07	0.00
1974/75	229.2	133.6	69.4	23.1	2.9	0.04	0.08	0.00
1975/76	212.0	108.2	74.8	24.9	3.9	0.03	0.07	0.00
1976/77	205.0	91.6	83.0	26.0	4.3	0.05	0.06	0.00
1977/78	221.2	121.1	66.1	29.3	4.5	0.11	0.01	0.01
1978/79	194.6	99.7	69.5	18.4	6.7	0.15	0.09	0.06
1979/80	250.2	153.4	69.2	20.4	6.9	0.11	0.11	0.07
1980/81	252.8	150.5	70.7	23.2	6.6	0.11	1.05	0.58
1981/82	262.7	157.6	56.9	29.2	6.0	0.13	1.76	1.18
1982/83	283.6	173.5	68.9	34.1	3.9	0.11	1.90	1.20
1983/84	206.7	104.2	60.8	35.6	3.2	0.12	2.05	0.83
1984/85	316.1	214.2	65.7	28.0	4.9	0.15	2.34	0.84

* The following extraction rates were used above, gleaned from the respective sources cited: cottonseed at 13 percent (1), rape and mustardseed at 28 percent (2), groundnut at 40.5 percent (1), sesamum at 36 percent (1), soybeans at 8.3 percent (3), sunflower at 30.1 percent (3) and safflower at 26.9 percent (3).

Sources: (1) Oilseed production data taken from "Agricultural Statistics of Pakistan", 1975, Ministry of Food, Agriculture Agriculture and Cooperatives, Islamabad.
(2) "How to Improve Market Stability, Lower Import Costs and Save Foreign Exchange in the Edible Oils Trade", U.S.A.I.D., Islamabad, January 1985.
(3) "Pakistan's Edible Oilseeds Industry", USDA/OICD, March 1984.

Appendix Table 24. Primary Pulses, Production and Wholesale Prices (*)
(Production in 1000 metric tons, current prices per 40 kilograms)

Year	Gram, Production	Price	Masoor, Production	Price	Mung, Production	Price	Mash, Production	Price
1967/68	481.0	26.79	25.5	40.12	35.5	32.69	22.4	35.72
1968/69	528.0	26.64	22.9	32.07	27.7	40.56	15.3	41.55
1969/70	506.0	38.70	22.3	43.29	25.4	49.42	14.7	47.20
1970/71	494.0	28.75	21.1	50.81	32.8	44.54	19.6	52.34
1971/72	510.0	27.24	22.8	58.54	35.5	57.94	20.7	44.89
1972/73	553.0	37.85	27.1	67.97	30.0	80.67	17.5	64.76
1973/74	610.0	43.69	33.6	81.58	32.0	110.94	22.3	117.57
1974/75	550.0	56.26	26.5	78.56	28.6	97.78	26.0	110.36
1975/76	601.0	51.63	28.3	98.65	31.9	108.92	29.8	91.64
1976/77	649.0	52.78	30.6	141.13	29.7	157.75	24.9	107.40
1977/78	614.0	90.69	33.5	143.26	30.8	189.39	27.2	141.47
1978/79	538.0	71.86	39.0	131.35	30.0	206.40	24.5	175.50
1979/80	313.0	81.27	36.5	120.25	32.7	186.87	33.3	151.58
1980/81	337.0	189.76	29.5	205.31	31.8	224.95	33.9	282.88
1981/82	294.0	259.87	31.4	343.18	31.6	330.48	32.8	191.54
1982/83	491.0	227.60	29.9	222.93	39.6	293.82	36.3	174.25
1983/84	522.0	161.88	21.7	186.23	41.8	339.71	39.4	228.54
1984/85	524.0	191.59	26.0	382.29	44.6	302.63	47.3	270.12

(*) Employed in estimation of demand elasticities.

Source: Production-- "Agricultural Statistics of Pakistan", various issues, Ministry of Food and Agriculture, Islamabad.
Prices-- "Pakistan Economic Survey", 1985-86, Finance Division, Economic Adviser's Wing, Ministry of Finance, Islamabad.

Appendix Table 25. Ascribed Total Values of Fruit Production, 1980/81 prices (*) (Million Rupees)

Year	Citrus Fruits	Mangoes	Bananas	Apples	Guava	Dates	Others	Total
1967/68	924	3625	94.4	276	219.8	514.7	834	6489
1968/69	964	2600	95.2	306	196.0	532.3	788	5482
1969/70	836	2916	96.3	413	211.8	504.0	1047	6023
1970/71	872	3047	164.7	432	225.3	555.3	770	6066
1971/72	912	3142	164.1	468	190.8	646.4	893	6417
1972/73	969	3240	193.3	443	300.0	543.0	884	6572
1973/74	1101	3405	195.7	666	268.4	629.1	1218	7484
1974/75	1305	3548	216.9	729	286.0	560.6	1098	7743
1975/76	1314	3496	234.9	864	347.2	594.1	1139	7990
1976/77	1393	3397	216.7	968	255.6	713.1	1201	8144
1977/78	1220	3293	229.4	1135	316.6	698.6	1259	8151
1978/79	1443	3159	242.6	1213	316.6	698.3	1279	8352
1979/80	1705	3229	232.9	1284	298.2	700.4	1235	8683
1980/81	1813	3207	243.1	1390	315.3	685.2	1328	8983
1981/82	2271	3824	244.4	1477	503.9	757.2	1319	10396
1982/83	2438	4005	249.8	1664	644.2	789.7	1403	11194
1983/84	2546	3950	250.6	1658	702.9	814.4	1419	11340
1984/85	2661	4127	262.0	1733	734.2	851.4	1483	11852

(*) The following unit values were employed (per metric ton): citrus fruits, 1958 rupees; mangoes, 5868 Rs; bananas, 1858.71 Rs; apples, 12940.5 Rs; guava, 2551.25 Rs; dates, 3530.25 Rs; and "other", see table below.

Appendix Table 25 (continued). Ascribed Total Values of Fruit Production, 1980/81 prices (*) (Million Rupee

(Breakdown of "Other Fruits"-- Ascribed Total Values (**)

Year	Apricot	Peach	Plum	Grape	Pomegranate	Pear	Total
1967/68	83.7	46.5	172.1	172.9	152.0	207.0	834
1968/69	92.6	47.7	107.3	174.5	148.4	217.4	788
1969/70	122.8	52.4	193.6	185.2	215.6	276.9	1047
1970/71	131.1	47.1	35.8	185.2	199.5	170.8	770
1971/72	136.5	50.6	138.5	192.9	194.4	179.9	893
1972/73	68.6	50.6	125.8	169.9	141.8	327.4	884
1973/74	155.1	58.8	178.4	217.5	194.4	414.1	1218
1974/75	169.5	48.9	105.2	218.3	208.3	348.1	1098
1975/76	176.3	57.0	111.5	221.3	190.0	383.0	1139
1976/77	189.4	51.8	117.0	219.0	208.3	415.4	1201
1977/78	207.9	59.9	124.6	225.2	206.8	434.8	1259
1978/79	214.8	63.4	153.6	220.6	195.9	430.9	1279
1979/80	234.0	57.0	135.1	224.4	225.8	358.5	1235
1980/81	245.0	58.8	160.8	201.4	228.8	433.5	1328
1981/82	254.6	59.9	160.8	201.4	214.1	428.3	1319
1982/83	299.9	65.2	170.0	200.6	229.5	437.4	1403
1983/84	319.1	65.7	180.1	202.9	217.8	433.5	1419
1984/85	333.5	68.7	188.2	212.0	227.6	453.0	1483

(**) The following unit values were employed (per metric ton): apricots, 6861.75 Rs.; peaches, 5817.75 Rs; plums, 4208.25 Rs; grapes, 7685.75 Rs; pomegranates, 7308.75 Rs; and pears, 12940.5 Rs.

Source: "Markets and Prices: Annual Bulletin", 1980/81, Issued by Agriculture and Livestock Marketing Adviser to the Government of Pakistan, Karachi.

Appendix Table 25 (continued). Ascribed Total Values of Fruit Production, 1980/81 prices (*) (Million Rupees

(Breakdown of "Other Fruits"-- Ascribed Total Values (**))

Year	Apricot	Peach	Plum	Grape	Pomegranate	Pear	Total
1967/68	83.7	46.5	172.1	172.9	152.0	207.0	834
1968/69	92.6	47.7	107.3	174.5	148.4	217.4	788
1969/70	122.8	52.4	193.6	185.2	215.6	276.9	1047
1970/71	131.1	47.1	35.8	185.2	199.5	170.8	770
1971/72	136.5	50.6	138.5	192.9	194.4	179.9	893
1972/73	68.6	50.6	125.8	169.9	141.8	327.4	884
1973/74	155.1	58.8	178.4	217.5	194.4	414.1	1218
1974/75	169.5	48.9	105.2	218.3	208.3	348.1	1098
1975/76	176.3	57.0	111.5	221.3	190.0	383.0	1139
1976/77	189.4	51.8	117.0	219.0	208.3	415.4	1201
1977/78	207.9	59.9	124.6	225.2	206.8	434.8	1259
1978/79	214.8	63.4	153.6	220.6	195.9	430.9	1279
1979/80	234.0	57.0	135.1	224.4	225.8	358.5	1235
1980/81	245.0	58.8	160.8	201.4	228.8	433.5	1328
1981/82	254.6	59.9	160.8	201.4	214.1	428.3	1319
1982/83	299.9	65.2	170.0	200.6	229.5	437.4	1403
1983/84	319.1	65.7	180.1	202.9	217.8	433.5	1419
1984/85	333.5	68.7	188.2	212.0	227.6	453.0	1483

(**) The following unit values were employed (per metric ton): apricots, 6861.75 Rs.; peaches, 5817.75 Rs; plums, 4208.25 Rs; grapes, 7685.75 Rs; pomegranates, 7308.75 Rs; and pears, 12940.5 Rs.

Source: "Markets and Prices: Annual Bulletin", 1980/81, Issued by Agriculture and Livestock Marketing Adviser to the Government of Pakistan, Karachi.

Appendix Table 26. Major Imports and Exports, 1967/68 - 84/85

YEAR	Wheat Imports(*) (000 MT)	Wheat Exports (000 MT)	(Value) (RS Million)	Edible Oils Imports (000 MT)	Rice Exports, Total (000 MT)	(Value) (RS Million)	Out of which Basmati (000 MT)	(Value) (RS Million)
1967/68	1429.6			81.3	117.7	143.8	109.3	135.0
1968/69	16.3			73.9	126.8	142.1	103.9	128.4
1969/70	179.8			57.9	88.0	90.9	81.7	87.5
1970/71	218.5			82.3	187.5	172.8	161.5	159.9
1971/72	705.1			70.1	196.1	271.1	179.4	263.1
1972/73	1364.6			72.1	385.0	467.2	61.5	162.4
1973/74	1052.6			169.7	309.7	1970.1	181.0	941.3
1974/75	1616.5			197.9	433.7	2094.7	155.9	1192.8
1975/76	1043.5			270.0	794.6	2479.0		
1976/77	346.0			285.0	944.7	2477.9		
1977/78	1052.0			298.0	879.2	2408.5	297.5	1080.3
1978/79	1957.7			361.0	1015.0	3380.0	181.4	1340.1
1979/80	554.2			439.9	1086.6	4179.3	314.8	2232.3
1980/81	96.0			471.4	1243.6	5601.6	409.6	2874.2
1981/82	60.0			460.3	951.0	4127.9	261.8	1956.2
1982/83	0.0	98.4	266.1	436.8	904.8	3682.5	237.7	1884.1
1983/84	0.0	218.5	493.8	729.6	1265.0	5688.3	406.0	3286.9
1984/85	544.6	0.0	0.0	684.0	718.7	3339.7	174.1	1648.3

(*) July 1 thru June 30

Source: "Agricultural Statistics of Pakistan", Ministry of Food, Agriculture and Cooperatives, issues of 1984, 1978 and 1975.

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