

Price Incentives for the Production of High-Yielding Mexican Varieties of Wheat

by

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INTRODUCTION

After stagnating in the 1950's, agricultural production in West Pakistan rose substantially in the early 1960's because of increased area under cultivation and higher crop yields made possible through greater availability of controlled water and the use of fertilizers. Since the mid-sixties, another important source of agricultural growth has been added, namely, the development and spread of high-yielding varieties of wheat, rice and maize. The discovery and development of high-yielding seeds (HYS) amount to a technological change and this has created a very large potential for raising the production of certain crops, provided the necessary inputs are properly used.

Agricultural experts have predicted that with the adoption of the new HYS and the realization of their full-yield potential, the current problem of 'food shortage' will change into a problem of 'food surplus'.

The cultivation of the HYS of wheat, however, requires more water, fertilizers, labour, *etc.*, compared to the old varieties of wheat. Therefore, to encourage the adoption of the HYS, the government is subsidizing seeds, water, fertilizers, *etc.*

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[After this article went to press, my colleague Sarfraz Qureshi raised a serious question about my use of "breakeven pricing" in analysing Mexican wheat supply. It is my conviction that the analysis is essentially correct, as presented, but since it is too late to reformulate the discussion in the text to allay this well-taken criticism, I intend to address the methodological issues through a Comment and Rejoinder in a subsequent issue of this *Journal*.]

The author alone is, however, responsible for any deficiencies remaining in the paper.

By setting a high enough support price for HYS, the government will further encourage the cultivation of these new varieties. On the basis of evidence from the experimental plots and research stations, the government, however, feels that food self-sufficiency will be achieved at the current support price of 17 rupees per maund [9, p. 26; 12, Pp. 20-21]. These studies are defective since they do not consider the opportunity cost of cultivating Mexican wheat in place of local wheat and fail to use actual observations from the field.

This paper attempts to remedy both these defects by collecting data from the field and analysing the opportunity cost of switching over to the Mexican varieties of wheat. We will determine the supply schedule for HYS and show that, given the present HYS and its productivity, food self-sufficiency will not be reached at the existing support price. Further, by using the existing international price of wheat, we will determine whether HYS should be cultivated for export if the rupee were devalued by 50 per cent or 100 per cent.

The paper is divided into four parts. Part II describes the design and coverage of the survey of Mexican wheat-growers conducted in 1969. Part III considers the problem of price incentives required for the adoption of Mexican varieties of wheat. Part IV raises some questions about the desirability of producing the HYS for export. Part V gives a summary of conclusions.

II. THE SURVEY OF MEXICAN WHEAT FARMERS, 1968/69

To get the basic data on the actual yields of Mexican varieties of wheat, inputs used, and other related information, an extensive survey of wheat farmers cultivating HYS was conducted around the harvest time of the 1968/69 crop. The survey concentrated on two provinces of the then West Pakistan, namely, the Punjab and Sind.

In order to obtain an overall view of the diverse production conditions, three districts in each province were identified as average, above-average and below-average districts on the basis of crop yields. In the Province of the Punjab, Districts of Sahiwal, Lyallpur, and Rawalpindi qualified as average, above-average and below-average, respectively. In the Province of Sind, District of Hyderabad was taken as average, and Districts of Nawabshah and Dadu were considered as above and below average, respectively.

The survey covered about 300 farmers in the Punjab and 200 farmers in Sind. Within each district, the number of farmers to be covered was determined by the relative number of households in each of the randomly selected villages. For the purposes of this study, we utilized the CSO random selection of villages for their National Family Expenditure Surveys¹.

¹These surveys are conducted every quarter. The subsample for the April-June 1969 quarter was actually used.

For convenience, farmers (households) were selected systematically to cover only the Mexican wheat-growers within each village. Effort, however, was made to cover a representative set of farmers by covering fields located in all directions from the village². In order to obtain the relevant data, farmers actually cultivating Mexican varieties of wheat were interviewed by the enumerators on the basis of a pre-planned questionnaire.

Farmers covered under the survey had a farm area of 4,843 acres in the Punjab and 6,074 acres in Sind, out of which the area under Mexican varieties of wheat is 1,465 and 1,024 acres in the Punjab and Sind, respectively. Judged by the area under Mexican wheat as a percentage of the total farm area, the Punjab shows a higher degree of adoption (30 per cent) for the HYS compared to Sind (17 per cent)³. The average and range for Mexican wheat plots and farm size are shown in Appendix Table A-1.

III. PRICE INCENTIVES AND THE CULTIVATION OF MEXICAN WHEAT

1)

This section discusses the problem of price incentives required for the adoption of the HYS of wheat⁴. It is obvious that new varieties will only be adopted if they are found *at least* as profitable as the previous crop alternatives. The net profitability of cultivating the previous crop alternatives (mainly local wheat) is, however, not generally known. Even if such information were available for a particular area or farm, it will not help *unless* the information extends over all areas, which is an impossible task.

Hence, the first problem is to conceptualize the minimum level of net profitability which must be preserved in the process of switching over to Mexican wheat. This problem could, however, be easily solved in cases where the previous production alternative was local wheat by taking the yield of the local wheat as the opportunity cost of producing the new varieties of wheat, provided no additional inputs are used in cultivating the new varieties. But, in fact, other inputs like seeds, water, chemical fertilizers, labour and bullocks are used in

²It would have been ideal to adopt a further stratification of Mexican farmers on the basis of the size of the farms. This was, however, ruled out due to the lack of the village lists for the Mexican wheat-growers. Such lists could be prepared, but the task was rather time-consuming.

Nevertheless, it was observed that large holdings owned by the big landlords are very often cultivated by many families who work on smaller operational units as tenant farmers. In order to collect information on production conditions and behaviour of farmers, only the operational units (subholdings) are relevant. Thus, in a way, the survey covered production conditions on many large holdings through the smaller units operated by the tenant farmers or lease-holders.

³It should be noted that the indicated degree of adoption of HYS is in terms of the total farm size. Area under Mexican wheat can, however, be estimated if the area under all types of wheat (local and Mexican) as a percentage of the total farm area is available for the sample.

⁴For the crop of 1968/69, Mexipak-65 was popular. This is because the variety was relatively high-yielding and produced good quality *atta* (flour) compared to the earlier Mexican varieties, e.g., Lerma Rojo-64, Pen gamo-62, adopted for the first time in 1965/66.

larger quantities in cultivating the HYS of wheat compared to the local wheat. Recognizing this fact, the minimum price incentives required for the adoption of the new HYS of wheat should be defined as that 'price' which makes the value of output just cover the cost of production. This price may be called the 'break-even' (or adoption) price and can be easily found by assuming that the sale price of the local and Mexican wheat is the same⁵. In algebraic terms⁶:

$$(Y_M - Y_L^*)P_W = \sum_{i=1}^n (X_{iM} - X_{iL})P_i$$

or
$$P_W = \frac{\sum_{i=1}^n (X_{iM} - X_{iL})P_i}{(Y_M - Y_L^*)} \dots\dots\dots(1)$$

where

Y_M = actual yield of Mexican wheat in maunds per acre,

Y_L^* = normal yield of local wheat in maunds per acre,

P_W = 'breakeven' price per maund of wheat,

X_{iM} = quantity of the *i*-th input used in the cultivation of Mexican varieties of wheat. $i=1, \dots, n$,

X_{iL} = quantity of the *i*-th input normally used in the cultivation of local varieties of wheat. $i = 1, \dots, n$,

P_i = market price of the *i*-th input.

In order to calculate the breakeven price, the essential data refer to the 'yield differential' of the HYS ($Y_M - Y_L^*$) and the cost of the extra inputs applied to the cultivation of the new varieties of wheat, *i.e.*, $\sum_{i=1}^n (X_{iM} - X_{iL}) P_i$.

The yield differential of the Mexican varieties of wheat can be determined on the basis of the data on per acre actual yield of the new HYS and the normal yield of the local wheat. Since the survey was conducted just after the harvest of the 1968/69 crop, the actual yield of the HYS (Y_M) was easily available. The 'normal' yield of the local wheat (Y_L^*) was also easily available as farmers were cultivating it for a long time and had a fairly good idea of the per acre normal yield. On the basis of the yields of the local and Mexican wheat, the yield

⁵It has been observed that due to the preference for local wheat, it is selling at a price premium of 2-3 rupees per maund over the Mexican wheat. We have ignored this price differential in computing the breakeven price since it is small and is largely offset by the value of the extra quantities of straw obtained from the Mexican wheat.

⁶The formulation of the breakeven price can easily be modified if the price of local wheat is taken to differ from the price of the Mexican wheat and also if the crop alternatives were other than local wheat.

differential (Y_d) of the new HYS was computed⁷ as $Y_d = Y_M - Y_L^*$.

In order to estimate the additional costs of cultivating HYS, farmers were asked to report the quantities of various inputs applied in excess of those normally applied in the cultivation of local wheat, and also to report the market prices for them.

In the case of seeds, it was generally noted that good-quality seeds were purchased by the farmers at a price higher than the current price of wheat. In general, the purchase price of seeds was found to be around 20.00 rupees per maund, which has been used in calculating the cost of extra seeds in cultivating the HYS.

In valuing water, two types of water are distinguished, *i.e.*, canal water and tubewell water. In the case of canal water, the supply is not variable on the basis of request or price. Hence, actual water rates charged by the government cannot be used to reflect the cost of extra water applied. This is because during the *rabi* (winter) season, in which wheat is grown, canal water is in short supply⁸. The intensity of cultivation is substantially less than 100 per cent and, instead of land, water is the binding constraint. Water rates (prices) charged are much less than the marginal revenue product of water and the quantities supplied are rationed. Thus, the value of extra water used in the cultivation of HYS becomes its marginal revenue product in the alternative use, namely, the cultivation of local wheat.

In order to find out this imputed value of water, we have taken the yields of the local wheat on marginal irrigated lands. In the Punjab, the survey shows that the yield of local wheat on irrigated lands varies between 10 and 20 maunds per acre. Thus, we have used 10 maunds as the approximate per acre yield of local wheat on the marginal irrigated lands. The officially reported average yield of local wheat for the Districts of Lyallpur and Sahiwal was 12.3 maunds per acre for the period 1959/60—1961/62. The official figures are believed to be underestimated by 30-40 per cent. An adjustment for underestimation will raise the average to about 16-17 maunds. In the light of this average and the survey information, a yield of 10 maunds per acre on the marginal irrigated lands seems to be in the correct range. At an assumed price of 15 rupees per maund, the gross revenue from the cultivation of one acre of local wheat comes to 150 rupees. According to one IBRD study, the estimated average variable cost per

⁷We have computed the yield differential of HYS by comparing the *actual* yield of the new seeds with the *normal* yield of local wheat. A proper comparison would be between the normal yields of HYS and local wheat. The introduction of HYS is very recent and, hence, the normal yields are not available. We have used the actual yield of HYS instead, since nothing better was available to us.

⁸There are two main farming seasons, namely, *kharif* (summer) and *rabi* (winter). During the *kharif* season the intensity of cultivation is quite high due to the rainy season. The main competing crops for this season are cotton, rice, sugarcane, maize, jowar, bajra, etc.,. In the *rabi* season, rain and canal water are in relatively short supply and as a result the intensity of cultivation is lower than the *kharif* season. The main competing crops of this season are wheat, sugarcane, oilseeds, pulses, animal fodder, etc.

acre of wheat cultivation is 47.66 rupees [5, p. 413] out of which the cost of casual labour is 17.12 rupees. At a daily wage rate of 4.00 rupees, the labour cost implies a labour input of 4.28 man-days. This we think is rather low for the type of farms under discussion. From our survey it seems that at least 7 man-days are required to cultivate wheat on a marginal irrigated acre, and on this basis the average variable cost is raised to 60 rupees. After deducting the per acre variable cost from the gross revenue, the imputed value of water comes to 90 rupees. It is estimated that about 3 irrigations are required to cultivate one acre of local wheat and hence the imputed value of water per irrigation becomes 30 rupees which has been used to estimate the value of water on fields for which the only source of irrigation water supply is the canal⁹. In Sind since the average yields of local wheat are about 20 per cent lower than the Punjab, we have used a yield figure of 8 maunds per acre and on its basis the imputed value of water comes to 20 rupees per irrigation.

In the case of *tubewell* water, the supply is variable since water can be obtained at a cost (or price). Hence, the economic value of water cannot exceed the supply price of water.

Ghulam Mohammad's study on tubewells reports that water is purchased and sold at a rental of 4-5 rupees per hour. It may take 3-4 hours to irrigate one acre of wheat, depending on the capacity of the tubewell, location and the type of the crop to be grown [8, p. 67]. We have used an average supply price of 15 rupees per irrigation for cultivating Mexican wheat for all lands on which tubewell water is available.

For chemical fertilizers, the reported prices show large variations among villages and districts. The reported prices for a bag of 23 nutrient lbs. of nitrogen showed an average range of 12.00-18.00 rupees, 12.90-14.50 rupees for the Districts of Sahiwal and Lyallpur, respectively. In the Province of Sind, the price of fertilizers ranged between 12.50 rupees to 17.00 rupees, giving an average of 13.00-14.60 rupees, 13.00-14.66 rupees and 13.75-14.25 rupees for the Districts of Nawabshah, Hyderabad, and Dadu, respectively.

In the case of labour, data were collected on the relevant wage rates for the various critical production operations like land preparation, weeding and harvesting. In the District of Rawalpindi, the daily average wage rate is about 4.00 rupees compared to 3.35-5.00 rupees in Sahiwal and 3.50-5.00 rupees in Lyallpur. The same range was found in the Province of Sind. One rupee was added to the wagherates for covering the cost of food served to the hired labour¹⁰.

⁹Irrigation is a unit of water well understood by the farmers. It means that much quantity of water which will soak the field upto 6 inches or so.

¹⁰In case wages were paid in kind, cash equivalent of the wages paid in kind was used.

For bullock labour, a standard daily rental of 4.00 rupees, which was found prevailing in most villages, was used for all the sample villages.

On the basis of the information collected about the extra quantities of various inputs applied in the cultivation of HYS and the prices paid (or imputed), the direct extra cost (C_d), i.e., $\sum_{i=1}^n (X_{iM} - X_{iL}) P_i$, of cultivating the new varieties of wheat was estimated.

By dividing the cost differential (C_d) of cultivating the Mexican varieties of wheat by its yield differential (Y_d), the breakeven price is calculated for each farmer covered under the survey. If both (C_d) and (Y_d) are positive, there always exists a price at or above which the farmer would find it profitable to shift to the new HYS of wheat. If the yield differential of Mexican wheat is negative, then there is no price at which it would pay to introduce HYS.

Since the information about the area devoted to the cultivation of HYS of wheat is available for each farmer, we have classified the area in each sample village under three categories of breakeven prices: 0-10 rupees, 0-15 rupees and 0-17 rupees. The idea of choosing these three levels of breakeven price is to throw light on the implications of certain important price levels.

We chose 10.00 rupees and 15.00 rupees since the competitive export price converted into domestic currency at an 'appropriate' exchange rate implies them to be the maximum supply prices at the farm level. To elaborate, the *f.o.b.* export price of Australian wheat ranged from 5.5 to 6.4 US cents per kilogram during the period 1955-67 [4, p. 533]. By assuming that the competitive export price of Pakistani wheat is 5.8 US cents/kg. and that the shadow exchange rate implies a devaluation of the rupee by 50 or 100 per cent, the per maund price (*f.o.b.* Karachi) comes to about 15.00 rupees and 20.00 rupees, respectively. By deducting 5.00 rupees as the per maund cost of grading, transportation and forwarding wheat for export, the farm level price comes to 10.00 rupees and 15.00 rupees at a rupee devaluation of 50 and 100 per cent, respectively. Seventeen (17) rupees is chosen because it has been the actual support price since 1967.

Table I (Section A) presents the results of our calculations of the breakeven price in the classified form for all the districts. Table I (Section A) shows that if the price of wheat actually prevailing at and before the time of sowing the 1968/69 crop were 10.00 rupees instead of 17.00 rupees, 93.5 per cent of the farmers (and 91.8 per cent of area under the HYS) in Rawalpindi would find it profitable to continue growing the new varieties of wheat. At the same price, the percentage of farmers accepting the HYS falls sharply to 16.3-20.4 per cent, covering about 15.7 per cent of the present sample area under HYS in the irrigated Districts of Lyallpur and Sahiwal.

TABLE I
AREA UNDER MEXICAN WHEAT AND THE BREAK-EVEN PRICES

District	Total area under Mexican wheat	Percentage of Mexican acreage and farmers who would breakeven at prices ranging:							
		Rs. 0-10		Rs. 0-15		Rs. 0-17		(7)	(8)
		% of area	% of farmers	% of area	% of farmers	% of area	% of farmers		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)		
(acres)									
Section A									
Rawalpindi	24.50	91.8	93.5	100.0	100.0	100.0	100.0	100.0	
Lyalpur	964.25	15.7	16.3	27.7	28.9	33.7	35.2	35.2	
Sahiwal	476.13	15.6	20.4	32.0	29.6	34.3	39.2	39.2	
Province—Punjab	1464.49	16.9	18.9	30.3	30.3	35.0	37.6	37.6	
Hyderabad	397.75	61.3	63.9	73.7	72.9	74.8	79.8	79.8	
Nawabshah	301.75	59.5	67.9	82.7	84.2	89.9	85.8	85.8	
Dadu	324.50	81.9	74.4	84.3	80.5	84.3	80.5	80.5	
Province—Sind	1024.00	67.3	68.4	79.7	78.6	82.3	81.8	81.8	
Section B									
Rawalpindi	24.50	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
Lyalpur	964.25	37.5	37.7	51.4	50.6	55.9	54.7	54.7	
Sahiwal	476.13	35.3	37.1	59.4	58.8	69.0	59.9	59.9	
Province—Punjab	1464.88	37.8	38.6	54.8	54.1	58.0	57.2	57.2	
Hyderabad	397.75	74.1	75.1	76.7	79.3	77.2	80.9	80.9	
Nawabshah	301.50	93.8	91.9	97.5	93.5	97.5	93.5	93.5	
Dadu	324.50	92.2	84.9	91.7	86.3	91.7	86.3	86.3	
Province—Sind	1023.75	85.6	83.2	87.6	85.7	87.8	86.3	86.3	

Source: Computed from [18].

The basic data are available on request.

This may seem paradoxical, but it can be explained by the fact that the extra cost of cultivating HYS is very low in the rain-fed areas (*i.e.*, Rawalpindi), and although the yield of Mexican wheat is low yet it invariably gives a large and positive yield differential due to the genetic impact. On the other hand, in the Districts of Lyallpur and Sahiwal which are irrigated and relatively more developed, the yield differential of HYS was found to be low and is positive only if extra cost is incurred in the form of more water, fertilizers, *etc.*

A similar pattern is found in the Province of Sind. In the rain-fed District of Dadu, 74.4 per cent of the farmers (and 81.9 per cent of the area) find it profitable to grow the new HYS of wheat at the wheat price of 10.00 rupees. In the Districts of Hyderabad and Nawabshah which are irrigated and relatively developed, the percentage of farmers accepting HYS is relatively lower, *i.e.*, 63.9 per cent and 67.9 per cent, respectively. In terms of area, it is even lower.

From the pattern observed above, it can be concluded that farmers' opportunity cost of adopting HYS is lower in the rain-fed and less developed areas of the Punjab and Sind. Consequently, at the price of 10.00 rupees (which is about 40 per cent lower than the present support price) as much as 82-92 per cent of the present area under the HYS can breakeven. But such is not the case for the irrigated districts of the Punjab and Sind where the area that can breakeven falls to about 16 per cent and 60 per cent, respectively.

These facts throw some light on the possibility of exporting wheat, since 10.00 rupees has been estimated as one of the two maximum farm supply prices at which the wheat is competitive in the international market. At this price the bulk of the most productive areas (84 per cent in the Punjab and 40 per cent in Sind) presently under HYS will not find it profitable to continue growing the new varieties of wheat unless they are subsidized further. As a result, if the price of 10.00 rupees is made effective, other things being equal, the present excess demand (imports) will increase substantially through *i*) a shift away from HYS and, hence, cause a reduction in the present production of wheat, and *ii*) an increase in the quantity demanded domestically¹¹. In view of this impact, it seems that the objective of food self-sufficiency will remain frustrated, and an exportable surplus is unlikely to emerge.

Let us now turn to the breakeven price of 15.00 rupees which, in addition to the implied farm level export price under 100-per-cent devaluation of the rupee, was the actual support price for the 1968/69 harvest and remained operative until October 1969. It can be seen from Table I (Section A) that all Mexican wheat farmers in the rain-fed District of Rawalpindi find it profitable to grow HYS of wheat, but in the Districts of Lyallpur and Sahiwal only 29.0 per cent

¹¹Other things may not remain equal if the existing Y_d is raised and/or new Mexican varieties with higher yield potential are developed.

of the farmers and 27.7-32.0 per cent of the present area under HYS find it profitable to continue growing the new varieties of wheat.

In the Province of Sind, the percentage of farmers who would find it profitable to cultivate the HYS of wheat is somewhat higher: about 72.9 per cent (Hyderabad), 84.2 per cent (Nawabshah) and 80.5 per cent (Dadu). In terms of area, the percentages are also close to these levels.

It can be concluded that at the support price of 15.00 rupees the worst affected areas still remain the average and above-average districts of the Punjab where about 30 per cent of the present area under HYS would find it profitable to continue the cultivation of the Mexican wheat.

In order to see the implications of the present support price of 17.00 rupees, we find that the situation does not improve very much. The percentage of farmers who find it profitable to continue with HYS is 100.0 per cent (Rawalpindi), 35.2 per cent (Lyallpur), 39.2 per cent (Sahiwal), 79.8 per cent (Hyderabad), 85.8 per cent (Nawabshah) and 80.5 per cent (Dadu). In terms of area, these percentages are slightly lower than those in terms of farmers except in the case of Nawabshah and Dadu.

In the light of the results above, it is obvious that at the present support price, other things being equal, food self-sufficiency is unlikely to be achieved.

2) Alternative Estimates of Breakeven Prices

In the above analysis, we used the difference of the 'actual' yield of Mexican wheat and the 'normal' yield of the local wheat in calculating breakeven prices for each farmer covered under the survey. It was, however, commonly noted by the agricultural experts and by our field staff engaged in the survey that the actual yield of Mexican wheat in 1968/69 was lower than that in 1967/68. Some observers have attributed this phenomenon to weather conditions while others maintain that the hybrid seeds are degenerating and the seed of Mexipak-65 is converging slowly to the dominant characteristics of local wheat (*i.e.*, lower yield and taller height). For example, Qureshi and Morales [14, p. 3] report that the average yields of HYS were 33 maunds (1965/66), 30 maunds (1966/67) and 26 maunds (1967/68). This may seem to present a meaningful pattern over time except that the yield figures are not based on a sample from the same universe since the Mexican varieties of wheat have been spreading gradually in time. This may have led to the cultivation of Mexican wheat on relatively less efficient farms and, hence, caused a continuous reduction in the average yields.

We are unable to suggest any other reason for the lower yields of the HYS, but are convinced that some adjustments must be made to correct the yields of Mexican wheat. Otherwise the results of our survey will be a poor guide for the future. Unfortunately, the experience of the HYS is so short that

no idea can be formed about its normal yields at the farm. Nevertheless, in order to make adjustments for the possibility of unfavourable weather conditions, we have raised the yields of Mexican wheat by 20 per cent for all farmers and have reworked the yield advantage and breakeven prices for the HYS on an alternative basis¹². The results are shown in Table I(Section B).

It can be seen that under the alternative calculations, the percentage area that will continue under the HYS still remains quite low in the Punjab, *i.e.*, 37.8 per cent (at 10.00 rupees), 54.8 per cent (at 15.00 rupees) and 58.0 per cent (at 17.00 rupees). In the Province of Sind, the percentage area that would breakeven is much higher compared to the Punjab: 85.6 per cent (at 10.00 rupees), 87.6 per cent (at 15.00 rupees) and 87.8 per cent (at 17.00 rupees).

In the light of the above results, one may wonder why did farmers cultivate HYS in the first place if only 58.0 per cent of the sample area under Mexican wheat in the Punjab and 87.8 per cent in Sind could breakeven at the support price of 17.00 rupees per maund, which was operative at the time of sowing the 1968/69 crop.

The answer lies in the fact that the analysis of the survey is based on the *ex post* (realized) yields of HYS whereas at the time of sowing, the *ex ante* (expected) yields were relevant. The yields of Mexican wheat were relatively higher in the years previous to 1968/69 and since the breakeven prices are quite sensitive to the yield differential of the HYS, it is perfectly understandable how farmers adopted the cultivation of Mexican wheat.

3) Implications for the Support Price

In the light of the above analysis it is obvious that the current support price of 17.00 rupees per maund should not be lowered because even at its present level a large proportion of the sample area under Mexican wheat finds it unprofitable to repeat the cultivation of HYS. Moreover, the objective of food self-sufficiency has not yet been achieved.

In the future, the demand for wheat will grow depending on the population and income growth as well as the relative prices of various foodgrains. In order to eliminate the present imports of wheat and achieve food self-sufficiency on a continuing basis, the production of wheat will have to grow substantially. In view of the poor survey results for 1968/69, it might be suggested that if food self-sufficiency is accepted without examination, the current support price should in no case be reduced. In fact, it may have to be raised if food self-sufficiency is the goal.

¹²The yield adjustment of 20 per cent for weather is chosen because careful examination has shown that the year-to-year weather effect in the last 30 years has never exceeded this magnitude [11, Pp. 123-124].

The price policy and the objective of food self-sufficiency, however, should not be set without taking into account the trade possibilities. Setting the support price above the import price (evaluated at an appropriate exchange rate) can lead to economic waste. Thus, it is important to examine the current support price in the light of the import price of wheat.

Earlier, the export price of Australian wheat (*f.o.b.* Australian ports) was estimated at 15.00 rupees and 20.00 rupees by assuming a rupee devaluation of 50 per cent and 100 per cent, respectively. Assuming further that 5.00 rupees is the approximate cost of freight, clearing and transportation, the domestic price of imported wheat should be 20.00 or 25.00 rupees per maund. Since the current support price is less than the estimated import prices, we can say that the present level of the support price (*i.e.*, 17.00 rupees) is low and, hence, there is a substantial margin to raise it.

So far, the analysis has been based on private costs of producing Mexican wheat. But in order to deal with the problems arising from trade possibilities, the social resource cost is relevant. We will touch upon these problems in Section IV.

4) Interfarmer and Interregional Differences

If the percentage of area and the number of farmers are compared for those who can breakeven at the various selected prices (*i.e.*, 10.00, 15.00, 17.00 rupees) and those who cannot breakeven, we find that in the Punjab farmers who can breakeven have less area under HYS per household compared to those who cannot breakeven. This does not hold in Sind, however.

At the three selected breakeven prices, the percentage of area that will continue to grow HYS ranges between 85.6-87.8 per cent in Sind compared to 37.8-57.2 per cent in the Punjab. This can be attributed to the lower opportunity cost of cultivating HYS in Sind on account of the low normal yields of the local wheat and lesser use of the irrigation water and fertilizers.

Moreover, the Province of Sind has been able to gain an average Mexican wheat yield differential of 9.43 maunds compared to the average of 3.76 maunds in the Punjab by applying lower quantities of water (1.22 irrigations compared to 2.22 irrigations) and chemical fertilizers (27.6 nutrient lbs. compared to 59.0 nutrient lbs.).

At first sight it may look paradoxical that the average per acre yield of Mexican wheat in the Punjab is about 21.6 maunds compared to that of 25.92 maunds in Sind. Normally, one expects that the yield of Mexican wheat in the Punjab would be higher than in Sind as the former province is relatively more developed and well endowed in water and other resources.

The phenomenon can be explained, however, when two additional factors are taken into account. *Firstly*, the intensity of crop cultivation in the Punjab is generally much higher compared to Sind, and this leads to relatively poor soil fertility. *Secondly*, the spread of HYS is much wider in the Punjab implying that Mexican wheat has spread to many small and inefficient farmers and this brings down the overall average yield of Mexican wheat. Study by Eckert [3] also testifies to this phenomenon.

But given the fact that the yield of Mexican wheat is higher and the resource cost of producing Mexican wheat in terms of water and fertilizers is lower in Sind than in the Punjab, it can be suggested that the area under HYS should be extended in the former province. This can be achieved through easing the water constraint and by improving the supply of fertilizers. The same can be done within each province — diversion of the most scarce inputs (water and fertilizers) to areas where the marginal productivity of HYS is higher.

Measures reallocating water through government canals, sale of tubewell water to farmers or to government, and adjustment in the price of water can help to raise the production of wheat. The same should hold in the case of distribution of fertilizers.

IV. EXPORTS OF WHEAT

On the basis of the survey data, we can show, in more specific terms, that it is uneconomical for Pakistan to export wheat. The reason for this is that the social marginal resource cost of producing the new varieties of wheat would be greater than the marginal revenue from exports converted at an appropriate (shadow) exchange rate. Under the assumption that only the adoption of HYS will enable Pakistan to achieve food self-sufficiency as well as to generate exportable surplus, we have limited our analysis to resource costs associated with the new seeds.

Table II presents the survey results on the extra yields of Mexican wheat and the extra quantities of water and fertilizers applied to its cultivation for the average and above-average districts of the Punjab and Sind. Since it will be shown that the marginal revenue from exports is not even sufficient to cover the costs of water and fertilizers, the extra quantities of other inputs like seeds, human and bullock labour have been ignored.

Because we are considering only two scarce inputs, *i.e.*, water and chemical fertilizers, the extra resource cost of producing HYS on one acre of land can be worked out easily. In the case of water, the opportunity cost refers to the output of local wheat foregone in the cultivation of HYS. For chemical fertilizers, the cost has been evaluated by using the appropriate exchange rate and by excluding government subsidy.

In order to evaluate the marginal revenue and costs, we have used the previously estimated farm level export price of 10.00 rupees (at 50-per-cent rupee devaluation) and 15.00 rupees (at 100-per-cent rupee devaluation).

Table II (Row 2) shows that the 'yield differential' of the HYS ranged between 2.32 to 10.38 maunds per acre in the average and above-average districts of the Punjab and Sind. The opportunity cost of water in physical terms ranged from 4.10 to 11.69 maunds. The cost of extra water and chemical fertilizers, put together at the export prices, substantially *exceeds* the marginal revenue of adopting the HYS in the Districts of Lyallpur and Sahiwal which are the above-average and average districts of the Punjab. Hence, the cultivation of HYS for exports is clearly uneconomical at a rupee devaluation of either 50 or 100 per cent.

In order to put the comparison of social benefit and costs of producing Mexican wheat for exports in an index form, we computed the benefit-cost ratios for both the provinces. In the Punjab, the benefit-cost ratios based on the survey data are found to be less than unity (Table II, Row 10).

In the Province of Sind, the resource cost does justify the cultivation of HYS for exports since the benefit-cost ratios range between 1.07-1.25 and 1.11-1.36 at a rupee devaluation of 50 per cent and 100 per cent, respectively¹³. It should be noted that to generate an exportable surplus of wheat may involve an increase in the resource cost of cultivating new seeds which in turn may reduce the benefit-cost ratios in Sind below unity. Even if the resource cost remains the same, all of the wheat acreage in the Province of Sind will not be sufficient to meet the domestic demand for wheat. Hence, the Province of the Punjab would have to produce for export, and for this reason we have concluded that export of wheat is an uneconomical proposition.

The above results are reinforced by looking at the yields of HYS obtained at the experimental-*cum*-demonstration plots (Table II). The yields of HYS were raised as high as 28-33 and 36-41 maunds per acre with an application of 69-92 and 119-142 nutrient lbs. of chemical fertilizers. By using 14 maunds as the estimated per acre yield of local wheat, we have worked out the opportunity cost of water which ranges from 9.24 to 14.0 maunds (Row 5).

By using the adjusted exchange rates (50-per-cent and 100-per-cent devaluation of the rupee), the extra cost of water and fertilizers and the value of the extra output of HYS were estimated. The resultant benefit-cost ratios range between 0.89 to 1.13 (50-per-cent devaluation) and 0.99 to 1.21 (100-per-cent devaluation).

¹³It should be noted that although the benefit-cost ratios are above unity, the margin of benefit is so small that if the costs of other complementary inputs (labour, bullocks) are taken into account, one cannot be sure of the benefit of adopting HYS.

TABLE II
AVERAGE RESOURCE COSTS AND BENEFITS OF CULTIVATING MEXICAN WHEAT FOR EXPORTS

	Survey data				Experimental data							
	Lyallpur (Punjab)	Sahiwal (Punjab)	Hyder- abad (Sind)	Nawab- shah (Sind)	Southern region (after fallow)		Northern region (after kharif)		Southern region (after fallow)		Northern region (after kharif)	
					(6)	(7)	(8)	(9)	(10)	(11)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)		
1. Number of respondents/trials	176	106	80	65	26	34	11	26	34	11		
2. Yield differential of HYS ($Y_M - Y_L$) [*]	4.38	2.32	10.38	9.42	18.00	19.00	14.00	27.00	23.00	22.00		
3. Extra fertilizers used in producing HYS (nutrient lbs. of N-P-K)	61.91	55.90	50.51	21.44	92-0-0	92-0-0	69-0-0	92-50-0	92-30-0	69-50-0		
4. Extra water used (number of irrigations)	2.36	2.06	0.84	1.49	2.00	2.00	2.00	3.00	3.00	3.00		
5. Opportunity cost of water (maunds of wheat): $\frac{W_M}{W_L} Y_L^*$	11.69	8.52	4.10	6.98	9.24	9.24	9.24	14.00	14.00	14.00		
<i>Cost and Benefit of HYS at :</i>												
50% devaluation: \$ = Rs. 7.14												
(100% devaluation: \$ = Rs. 9.52)												
6. Revenue from Row 2 at $P_w =$ Rs. 10.00 (Rs. 15.00)	43.80 (65.70)	23.20 (34.80)	103.80 (155.70)	94.20 (141.30)	180.00 (270.00)	190.00 (285.00)	140.00 (210.00)	270.00 (405.00)	230.00 (345.00)	220.00 (330.00)		
7. Opportunity cost of water (Rs.)	116.90 (175.35)	85.20 (127.80)	41.00 (61.51)	69.80 (104.70)	92.40 (138.60)	92.40 (138.60)	92.40 (138.60)	140.00 (210.00)	140.00 (210.00)	140.00 (210.00)		

(Contd.)

TABLE II—(Contd.)

	Survey data					Experimental data				
	Lyallpur (Punjab)	Sahiwal (Punjab)	Hyderabad (Sind)	Nawabshah (Sind)	Southern region (after fallow)	Northern region (after kharif)	Northern region (after fallow)	Southern region (after fallow)	Northern region (after kharif)	Northern region (after fallow)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
8. Cost of fertilizers: C_F^*	51.13 (65.25)	46.17 (58.91)	41.72 (53.24)	17.71 (22.60)	76.00 (97.00)	76.00 (97.00)	57.00 (73.00)	116.00 (137.00)	116.00 (137.00)	97.00 (113.00)
9. Cost of water and fertilizers	168.03 (240.60)	131.37 (186.71)	82.72 (114.74)	87.51 (127.30)	168.40 (235.60)	168.40 (235.60)	149.00 (211.00)	256.00 (347.00)	256.00 (347.00)	237.00 (323.00)
10. Social benefit-cost ratio of adopting HYS for exports: (Row 6 ÷ Row 9)	0.26 (0.27)	0.18 (0.19)	1.25 (1.36)	1.07 (1.11)	1.07 (1.14)	1.13 (1.21)	0.94 (0.99)	1.05 (1.17)	0.90 (0.99)	0.93 (1.07)

Y_M = observed yield of Mexican wheat in maunds per acre.

Y_L^* = normal yield of local wheat in maunds per acre.

W_M = extra water used in the cultivation of one acre of Mexican wheat.

W_L^* = water normally required to cultivate one acre of local wheat.

P_{w}^* = competitive export price of wheat in domestic currency.

C_F^* = estimated average cost of 46 nutrient lbs. of imported and indigenous fertilizers.

Source: Rows 1-4: The survey data are from [18].
The experimental data are from [14, Pp. 3, 33-34].

When the exchange rate of 50-per-cent devaluation is applied, in 3 out of 6 cases the cultivation of HYS for exports becomes uneconomical. With a rupee devaluation of 100 per cent, the situation improves somewhat but still remains mixed and hardly encouraging¹⁴.

Quite clearly, therefore, unless further developments of HYS provide a large yield differential to justify the use of water and fertilizers which are the most scarce resources at this stage of agricultural development, the idea of generating an exportable surplus should be discarded.

If the resource cost does not justify the production of wheat for exports, one may wonder whether Pakistan should not meet part of its consumption requirements through imports. To answer this question, one needs to know what could be done with the available scarce resource if both local and Mexican wheat were not grown. Unfortunately, the results of this study are not helpful in this respect since it examined only the resource cost of producing Mexican varieties of wheat.

Nevertheless, it may be pointed out that due to the high cost of transportation it is quite conceivable that within a broad price range both the production of wheat for exports and the imports of wheat are uneconomical and hence food self-sufficiency is an economically sound goal. But in order to indicate the relevant price range within which food self-sufficiency is an economic proposition, further research effort is required.

V. SUMMARY OF CONCLUSIONS

High-yielding varieties of wheat were introduced in West Pakistan in 1965. They not only have a higher-yield potential but also are relatively more costly to cultivate as they require more water, fertilizers, human and animal labour when compared to the local varieties.

The high-yield potential of Mexican wheat has raised the hopes of achieving the national objective of food self-sufficiency and even introduced the possibility of exports. Since the Mexican wheat requires higher resource cost, problems of setting the support price at the proper level and of examining the economics of importing and exporting wheat are inevitable. In order to give a satisfactory treatment to the above issues, one needs data on costs and yields of Mexican wheat.

In government circles, these issues were examined in the light of the experimental and research data. We have argued that analysis based on such data is unrealistic and, hence, misleading since there is a large difference between

¹⁴It should be noted that the yields obtained at experimental plots indicate the maximum potential and may not be reached on the field in the average sense.

experimental and actual yields. Empirical evidence on this point was provided by the survey of Mexican farmers conducted in the Summer of 1969, covering 500 farmers in the Province of the Punjab and Sind—the main producers of wheat in Pakistan. With the help of the survey data on yield differential (Y_a) and extra costs (C_a) related to the cultivation of Mexican wheat, we have calculated the breakeven price at or above which the farmers would find it profitable to continue cultivating Mexican wheat rather than switching over to other alternatives *i.e.*, C_a/Y_a . In the light of the breakeven prices, the possibility of exporting wheat and the problem of fixing an adequate support price were evaluated.

In order to export wheat, we assumed a competitive farm level price of either 10.00 rupees or 15.00 rupees, depending on a rupee devaluation of 50 per cent or 100 per cent, respectively.

From the breakeven prices, it was found that at the price of 10.00 rupees per maund only 16.9 per cent of the sample area in the Punjab and 67.3 per cent in Sind would find it profitable to cultivate Mexican wheat. In the light of these poor results, exportable surplus would only be feasible under a subsidy. Similar conclusion follows at the farm level export price of 15.00 rupees.

At the current support price of 17.00 rupees per maund, we find that about 38 per cent of the sample area in the Punjab and 82 per cent in Sind would be profitably used to cultivate Mexican wheat. This implies that given the yield differential and extra costs of Mexican wheat, the price of 17.00 rupees is not very favourable for the adoption of Mexican wheat. Hence, we suggest that *i*) new HYS be developed which give higher yield differential without raising the extra costs proportionately, and *ii*) the current support price not be reduced. In fact, it may have to be raised to achieve food self-sufficiency.

In the interregional and interfarmer comparison of breakeven price and yield differential of HYS, it was found that the rain-fed areas and the Province of Sind have a low opportunity cost of cultivating Mexican wheat. Water and fertilizers should be reallocated to those regions which have a higher marginal productivity with respect to these inputs. This can be achieved by removing the government subsidies on both these scarce inputs and by reallocating the canal and tubewell water.

Section IV attempted to reexamine the possibility of exporting wheat in the light of the social resource cost of producing Mexican wheat. It was found that considering the yield differential and the extra costs involved in the cultivation of HYS, the resource cost of water and fertilizers alone does not justify the cultivation of HYS for exports both at the rupee devaluation of 50 per cent and 100 per cent. This conclusion is further reinforced when we look at the results obtained at the experimental plots. Thus, the cultivation of Mexican wheat for export purposes is uneconomical even when the cost of some inputs (labour, bullocks) is ignored.

The conclusions drawn from the study are, of course, based on the observed data. The yields of Mexican wheat have not yet normalized due to its recent introduction. New seeds are being developed to replace the tested but less promising ones. Thus, the future situation on yields is rather unpredictable. It is suggested that more surveys of this nature be conducted in the future to re-examine the important issues involved on a continuing basis.

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TABLE A-1
 FARMERS AND AREA COVERED UNDER THE SURVEY OF MEXICAN WHEAT FARMERS IN THE PUNJAB AND SIND

Province/district	No. of respondents	Total Area under Mexican wheat	Total farm area	Col. (3) as % of Col. (4)	Size of Mexican wheat plot		Farm size	
					average	range	average	range
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Punjab: (.....acres.....) (.....acres.....)								
Rawalpindi	17	24.50	206.0	11.9	1.3	0.4-2.5	13.5	4.0-23.0
Sahiwal	106	476.13	1403.8	33.9	4.5	1.6-10.2	13.7	4.6-31.2
Lyallpur	176	964.25	2687.6	35.9	5.4	1.3-17.5	15.0	3.2-43.7
Sind:								
Daду	58	324.50	2252.5	14.4	5.8	1.0-37.5	42.6	4.5-75.0
Hyderabad	80	397.75	2758.5	14.4	4.7	1.2-25.0	34.0	6.3-210.0
Nawabshah	65	301.75	1091.5	27.6	4.6	1.3-26.3	16.2	2.7-95.0

Source: Compiled from [18]. The detailed village data are available on request.