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The impact of the price rise in petroleum based agricultural inputs on the production of wheat and rice in India

Commonwealth Secretariat

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THE IMPACT OF THE PRICE RISE IN PETROLEUM BASED AGRICULTURAL INPUTS ON THE PRODUCTION OF WHEAT AND RICE IN INDIA

A STUDY PREPARED FOR THE COMMONWEALTH SECRETARIAT BY THE NATIONAL COUNCIL OF APPLIED ECONOMIC RESEARCH, NEW DELHI

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PREFACE

The prices of important agricultural inputs, including diesel fuel and fertilizers, increased sharply following the increase in petroleum prices in 1973. This severely affected farmers in the non-oil producing developing countries. These countries were, therefore, faced with the twin problem of how to expand their food production to displace imports and so contain the adverse effects of higher oil prices on their balance of payments and at the same time do this in the face of the higher input prices with which their farmers had to contend. For national and international planners it was important to know how farm production might be affected. While farmers' decisions must be considered within the framework of national farm policies (including, in this context, policies on input distribution and subsidisation and on product-pricing), it seemed very necessary to derive some awareness of their reactions to changes in input costs and the impact of these costs on production at the farm level. To assist in this exercise, the Commonwealth Secretariat commissioned a survey of farmers' responses to the higher prices of oil-based inputs in India, a large food deficit Commonwealth developing country.

Oil prices have now stabilised and prices of fertilizers have been significantly reduced. It is hoped, however, that the study will have continuing relevance for policy-makers and students in many countries as a close analysis of farmers' responses to changes in farm input and farm product prices in a specified area within a definite period of time.

The views expressed in the study are those of the author and are not necessarily those of the Commonwealth Secretariat.

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Director,
Economic Affairs Division

October, 1976.

FOREWORD

This study was commissioned by the Commonwealth Secretariat, London, from the National Council of Applied Economic Research, New Delhi. The object of the study was to investigate and analyse the impact of the oil price increase on the production of rice and wheat, the two major foodgrains in India, and on the basis of this analysis to gain some knowledge of the likely course of production in the future.

On account of the basic structural changes that have occurred over the last decade in the input-output relationships in both wheat and rice cultivation, the considerable importance of weather in the short run, and the quite extraordinary rise in the prices of petroleum based agricultural inputs, particularly fertilizers, it was felt that much reliance could not be put on the predictive techniques normally used in such cases. Instead, it was decided to go direct to the farmer for primary data on his response to the increase in the prices of petroleum based inputs. It was further decided to use this data for foreseeing the probable course of production in the future, not quantitatively, but in terms of identifying the dynamic forces that would be released under pressure and those that might need to be released in order to absorb the impact of the price rise without endangering the existing trends in production growth or long-term plan targets. Apart from technical considerations, the dominant reason for adopting this approach was the imperative for increased foodgrain production in India and the fact that directive planning is an accepted instrument for economic development.

The sample of farmers selected for the study is relatively small and restricted, but this was a limitation imposed by the constraints both of time and money. However, it provides an adequate basis for the purpose for which it is used. Conclusions do not lead to quantitative estimates but to insights into farmers' behaviour in the face of a dramatic change in the factor price relationships.

In conducting this study, I was ably assisted by Dr. S.N. Kaul, Mr. H.Y. Siddiqui and Mr. P.K. Roy. A group of interviewers did commendable work in assembling the data.

Thanks are due to Mr. A.F.A. Husain of the Commonwealth Secretariat, who requested this study from the National Council of Applied Economic Research, New Delhi, and to Prof. M.V. Mathur, who was Director-General of the National Council for his support.

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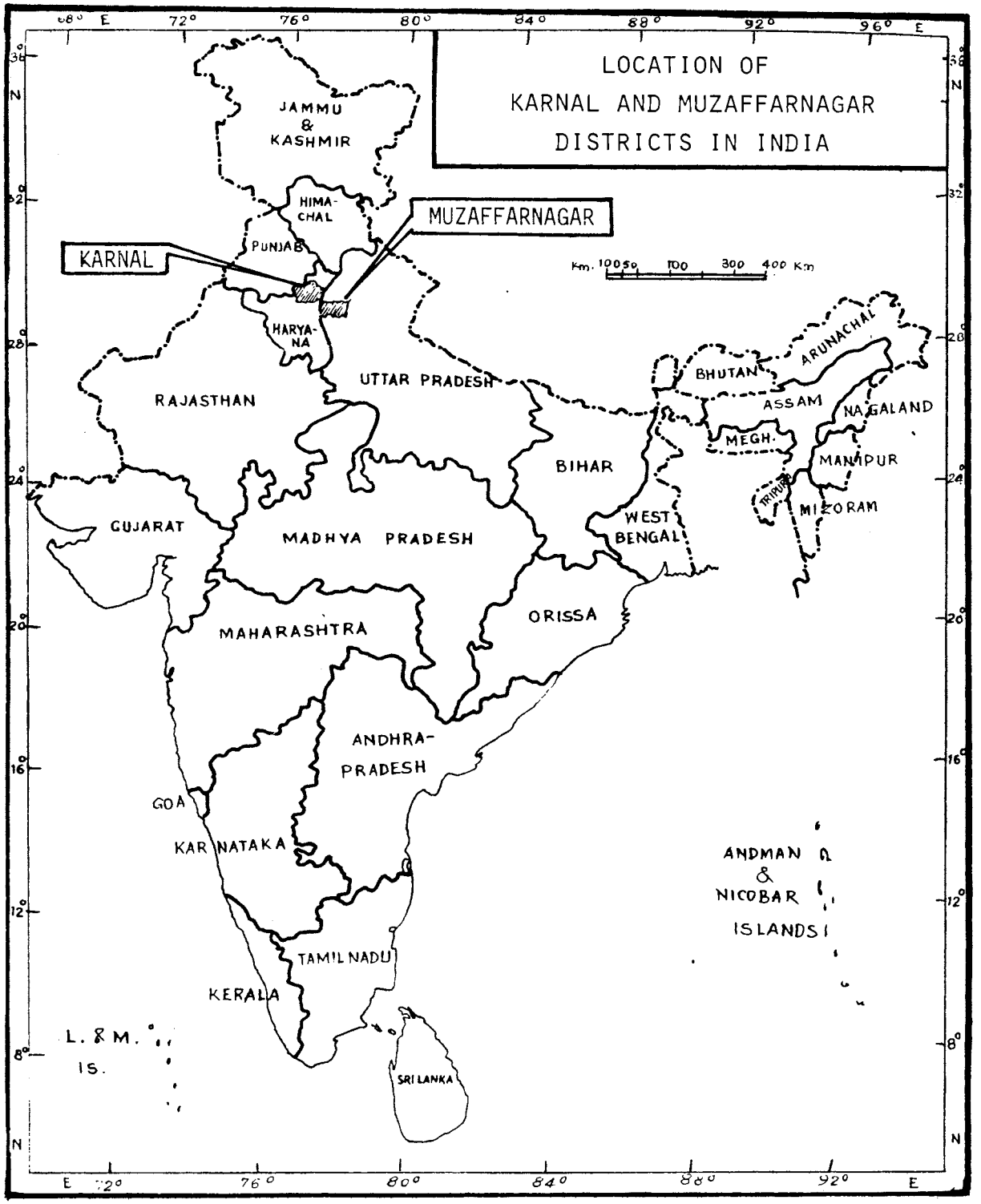
LOCATION OF
KARNAL AND MUZAFFARNAGAR
DISTRICTS IN INDIA
MUZAFFARNAGAR
KARNAL
JAMMU & KASHMIR
HIMA-CHAL
PUNJAB
HARYA-NA
RAJASTHAN
UTTAR PRADESH
BIHAR
BHUTAN
ARUNACHAL
ASSAM
NAGALAND
MEGH.
MANIPUR
TRIPURA
MIZORAM
WEST BENGAL
ORISSA
GUJARAT
MADHYA PRADESH
MAHARASHTRA
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Km. 100 50 100 300 400 Km
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SUMMARY

The object of the study is to examine the impact of the recent price rise in oil based inputs for agriculture on the production of wheat and rice in the agricultural year 1974-75, and on the basis of it, to foresee the future trend in their production.

The two major oil based inputs in Indian agriculture are fertilizers and high speed diesel oil. Of the two the latter in terms of its share in the total cost of production is much less important.

The price of both fertilizers and diesel oil is controlled by the Government. In June 1974, the price of fertilizers was raised, the range of increases for the different varieties being 56 per cent to 90 per cent. The price of high speed diesel oil was raised earlier in March by 15 per cent. Considering the relatively small share of the cost of high speed diesel oil in the total cost of production this increase in price seems to have had little impact on the consumption of high speed diesel oil.

Since data on input consumption and output for rice and wheat crops for 1974-75 were not available, we decided to do a small survey as a case study, with a sample of 50 farmers in two districts. The object of this survey was, (a) to gather facts and (b) to analyse farmers' response to the increase, particularly in fertilizer prices, and to derive, if possible, some general conclusions.

The results of this survey presented in the following table show that the rise in the price of fertilizers led to:

(i) a fall in the quantity of fertilizer input per unit of land,

(ii) a rise in the cost of fertilizers per unit of output as well as land, and

(iii) a fall in the farmer's net return.

The survey also gave evidence of the farmer's effort to improve his input mix with a view to protecting his net return. Of particular interest in this context was the decision of large rice farmers in Karnal to increase the input of P_2O_5 despite a 90 per cent increase in its price, in order to bring the fertilizer mix closer to the recommended N:P ratio.

To attempt quantitative projections of wheat and rice production for the future, incorporating the impact of the rise in fertilizer prices would be hazardous. There have been basic structural changes in the input mix of these crops over the last decade and the only two crop seasons since the rise in fertilizer prices have been strongly influenced by weather. This attempt is, therefore, not made. Instead, it is pointed out that, given the imperative need to augment the production of foodgrains to feed its growing population, India does not have many options. The scope for minimising the cost of fertilizer inputs per

unit of output exists and, spurred on by the high cost of fertilizers, the farmer is likely to exploit it in a manner he has not done before. The Government, on its part, will be induced to encourage farmers' efforts through policy and institutional support. We identify four major responses to the price rise in petroleum based agricultural inputs:

(i) a new drive among farmers to advance their know-how with a view to securing higher levels of efficiency in input use, particularly with respect to fertilizers for which evidence is already available;

(ii) a major expansion in institutional credit facilities to provide a more effective source of credit for smaller farmers, for which the Government has already taken steps through its programme for setting up Regional Rural Banks;

(iii) a strengthening of the distribution network along with a rationalisation of the control system; and

(iv) the Government's use of pricing policy as a means of redressing the balance between input and output prices.

Salient Findings of our Survey of Selected Rice & Wheat Farms in Karnal and Muzaffarnagar Districts - 1973-74 and 1974-75

Variables		Wheat		Rice-IR-8	Rice-Bansmati
		Karnal	Muzaffar-nagar	Karnal	Karnal
1. Cost of fertilizer inputs per hectare in rupees					
a) Before June 1974		301.9	421.8	376.6	127.8
b) After June 1974		426.4	486.2	578.7	212.6
2. Quantity in nutrients, kilograms per hectare					
a) Before June 1974	N	101.3	115.1	130.1	49.0
	P_2O_5	34.2	54.6	16.1	4.2
	K_2O	2.8	9.7	6.9	-
b) After June 1974	N	78.2	73.5	110.9	43.8
	P_2O_5	25.9	33.3	18.5	4.7
	K_2O	1.7	3.8	5.3	-
3. Yield per hectare in kilograms					
a) Before June 1974		2473	1891	4177	2749
b) After June 1974		2646	3054	3507	2386
4. Net returns to cost A_2 per hectare in rupees					
a) Before June 1974		1729	721	1490	1315
b) After June 1974		1657	1897	1054	958

From an analysis of our survey data some observations relevant to the response to the increased cost of fertilizers can be made.

First, it seems clear that an important fact determining the farmer's behaviour in the context of the much higher fertilizer prices is the way he perceives the risk involved in incurring the additional cost for the same input of fertilizers. While we find that the small farmer in our sample gets as high a yield from a hectare of land as any other farmer and a higher net return per hectare because of greater personal (or family) involvement, he seems to be more sensitive to cost increases when perceiving the risk of weather uncertainty at the beginning of a crop season. Because he has limited resources of his own the possibility of a fall in income is magnified as it threatens essential consumption. Also he has comparatively less capacity to hold stock for selling later when the prices tend to be higher and, therefore, usually secures a lower price for his output. On both counts it appears that an assured supply of institutional credit at a reasonable rate of interest would be of considerable help in modifying the framework within which he perceives his risk.

Secondly, a considerable variation was observed in the fertilizer input between farmers. In particular, the NPK ratio employed seems to be very different from the recommended one. While this showed that the farmers were much more interested in nitrogenous fertilizers and did not fully appreciate the utility of phosphatic and potassic fertilizers, there was a difference in the way they reacted after the increase in fertilizer prices in respect of wheat and rice crops. In Karnal they increased the input of phosphatic fertilizers for rice while decreasing it for wheat. This contrary behaviour deserves attention, particularly in the context of the same NPK ratio recommended for both wheat and rice. It seems in general that there is not enough feed back from the farms to the laboratories where the recommended doses are determined.

Thirdly, the increase in the cost of diesel oil, which to start with was moderate, did not induce any farmer to reduce its consumption either for tractors or for pumping water for irrigation. Most farmers in our sample used tractors on hire and found it cheaper even at the increased hiring charges than the alternative of going back to tilling with bullocks. They also did not find it worthwhile to reduce the efficiency of tilling by using the tractor less. No farmer regarded the increased cost of pumping water with diesel tubewells or pumpsets as a matter of any significance.

Fourthly, since our survey was completed, fertilizer prices have been lowered mainly on account of the decline in world prices and a fall in the proportion of imported fertilizer in the domestic supply. Meanwhile, there has been a substantial increase in domestic production as new capacity has come on stream. In the past, because of supply shortages and deficiencies in the distribution network, farmers were often unable to get their full requirements of fertilizers at the controlled price and were forced to pay a much higher price in the black market. Supply bottlenecks are not likely to arise, at least, in the near future. Several of the controls imposed to deal with a shortage situation, which were a hindrance to fertilizer consumption, have now been removed. Attention is also being directed to the strengthening of the distribution network, which at present is weak.

Fifthly, there is evidence that there was an increase in fertilizer consumption in 1975-76, but the extent of the increase is not firmly established.

Lastly, the increase in the world price of crude oil made coal a cheaper base for fertilizer manufacture in India and it appeared as a logical course to consider a shift. It was, therefore, decided to set up three plants based on non-coking coal for producing urea. While the technology for coking coal is well established, it was not so for non-coking coal. But since India's reserves are mainly of non-coking coal, the plants now being set up are, in part, experimental. Over the last three years India has found off-shore oil, its balance of payments position has radically improved and the price of coal is likely to be raised relative to oil. With these developments and the prospects of gas from the new oil finds, the situation seems to have changed. The dominant raw material base for fertilizers in India in the future will depend on the extent to which gas becomes available and how technology can be developed for non-coking coal based fertilizers.

CHAPTER I

Introduction

The problem

The recent sharp rise in the price of petroleum and its products has imposed heavy burdens on the Indian economy. Domestic production of 8 million tonnes of crude oil in 1974-75 met just a third of the total requirement of 23 million tonnes. The balance of 15 million tonnes was imported at prices ranging between $10.42 and $10.67 per barrel. An additional 3 million tonnes of petroleum products were also imported. To absorb the effects of the rise in crude oil prices, the Government of India chose to follow a selective pricing policy for different petroleum products. The price of gasoline attracted the highest rise (101.5 per cent), which had a clear restraining effect on consumption. In order to protect industry and transport services, the price of high speed diesel oil (HSD) was raised by only 14.7 per cent and that of kerosene by 57.4 per cent so as to bring its price to par with high speed diesel in order to prevent adulteration*. Fertilizers were left untouched until June of 1974 when their prices, too, were sharply raised. Depending on the source of the nutrient, the increase in price per unit of nutrient varied between 56 per cent and 90 per cent, and the price index of all fertilizers went up by 80 per cent.

Fertilizers are a critical component in the new technology in agriculture to which the recent Green Revolution is attributed. Substantial increases in per hectare yields, particularly of wheat and rice, have been secured in the past few years as a result of the combination of new high yielding varieties of seeds and larger doses of fertilizer inputs. A steep increase in the price of fertilizers, occurring in a single sharp move, could be expected to have delivered a rude shock to the farm economy, which had just been converted to its use. The impact of this shock on the production of wheat and rice is the object of this study.

The new technology and factor substitution

The new technology in agriculture relies principally on the adoption of techniques derived from biological innovations in the field of genetic manipulation of seeds. The new or high yielding varieties (HYV) of seeds, by greatly increasing the nutrient intake capacity of the wheat or rice plant, substantially raise its yield per unit of land, provided water is available when needed. In India, on account of the peculiar climatic characteristics, irrigation is an equal important component of the package of inputs that constitute the material base of the new technology.

The significance of water or irrigation to the new technology, perhaps, needs further explanation. India depends almost entirely on the monsoon which yields precipitation varying from region to region. With the exception of the southern tip of the Indian peninsula, the country receives most of its rain during the months June to September. In the major wheat growing tracts the annual rainfull varies between 20 and 40 inches; in the rice growing regions, while the rainfall is higher, it varies over a wider range.

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*Percentage rise in prices refers to the period, August 1973 to March 1974. It is these increases in prices that are relevant to our investigation.

In most of the country rain water supports the summer crops, called kharif, of which rice is the most important. Wheat, a winter crop, called rabi, is grown when there is a limited amount of rain. It, therefore, relies on moisture retained by the soil from the precipitation during the monsoons but mainly on irrigation from such sources as, canals, open wells, tubewells and other variants of lift irrigation. It is possible in India to grow three crops of rice during the year, but for the second and third crops irrigation, as for wheat, is necessary.

Monsoon rains are heavy and concentrated within a relatively short period of three months; even so, the precipitation does not necessarily occur in accordance with water requirements for plant growth. Besides exposing the plant, at times, to excessive water and at other times to dry spells, the unpredictable pattern of rainfall makes difficult the regulation of fertilizer inputs to correspond with different stages of plant growth. For securing best results from the new seed-fertilizer technology it is not enough to have water, it is also necessary to have control over its source, so that its use can be regulated. Thus it is found, for instance, that even where canal irrigation is available, farmers prefer to invest in tubewells because it gives them the kind of control over the use of water they need.

The scarcest factor in Indian agriculture, of course, is land. The scarcity is made worse by the peasants' attachment to it whereby, in effect, it is simply not available as a transactable commodity. For raising production the efficient direction of change in the factor mix, therefore, is towards the substitution of land by the less scarce factors. This is indeed what the new technology does; land is substituted by a combination of labour and intermediate material inputs or working capital. It has been observed that this change in technology in India has had the character, by and large, of a shift from an 'inferior' to a 'superior' technology*. /1/

As the change in technology has advanced, the value of land relative to other factors has also increased. Rigidly limited in its supply, the scarcity value of land has been continuously increasing as its productivity has risen with the application of inputs whose supply is relatively elastic. One does not, therefore, envisage a reversal in the substitution process in the short or the long run with any conceivable rise in the cost of intermediate material inputs or labour.

In the wake of the adoption of biological innovations, fixed capital in the form of machines has also been introduced and has directly displaced labour in the operations in which machines are used but not when all operations directly or indirectly connected with the cultivation of a crop are considered. /3/ It is important to recognise that machines have been introduced only where biological innovations have already been adopted. Indeed, given the physical scarcity of land, the scope for extensive cultivation through labour-saving machines for increasing production was generally so limited that there was no case for machines being used before the productivity of land was substantially raised by the adoption of biological innovations. One would, therefore, rule out the substitution of

*In a cross section of a forthcoming study of technological change in tea and coffee plantations prepared by the NCAER /2/ for the ILO, it was found that the observed change in technology was accompanied by a decline in the cost of each input per unit of output, holding land as constant.

machines for intermediate material inputs, notably fertilizers, even with a much more substantial relative price change in favour of machines than occurred in June 1974. Similarly, one would rule out the possibility of the subsitution of labour for fertilizers in an already labour intensive technology where the marginal product of labour is low and can be raised only by making scarce land more productive.

In these circumstances a sharp increase in the price of fertilizers may initially cause a decline in its use, resulting in a fall in output and hence a rise in the price of the output. This rise would be significant, even with a modest decline in production, if the product was a foodgrain which has a relatively inelastic demand. In the following season the rise in the product price would tend to restore the input of fertilizers.

The technology associated with the new biological innovation has two distinguishable aspects: physical inputs (high yielding varieties of seeds, fertilizers, etc.) and the method of using them (cultural practices). In the first phase of the adoption of this technology, the emphasis has been on the physical inputs, in part due to the very varied conditions under which agriculture is practised in India. The 'know-how' for using these inputs is still in the process of being acquired. One can easily see that, confronted with a much higher price of fertilisers the farmer will be goaded into learning how to make more efficient use of fertilizers. If the scope for this exists, as indeed it does, it will have the same effect on fertilizer use as the increase in the price of output, though with a longer time lag. It will have the further effect of reducing the cost of inputs per unit of output and thereby of sustaining fertilizer inputs (or even raising them) without affecting the cost of production.

These are, however, long term considerations. Our immediate task is to estimate the effect of the June 1974 increase in fertilizer and diesel oil prices on their use in rice and wheat cultivation and on the resulting change in the output of these crops. One could, following standard practice, work out the elasticity of fertilizer and HSD consumption in response to changes in their prices, both for the short and the long run, on the basis of past data and with their help estimate the likely use level of these inputs for the 1974-75 as well as future rice and wheat crops. This approach must, however, be ruled out simply because the magnitude of annual price changes in the past and that which occurred in June 1974 are so vastly different that any relationship between fertilizer price changes and its use, derived from past data, would prove quite meaningless when employed to predict farmers' response to the June 1974 increase. One has, therefore, little choice but to examine the response of farmers to the 1974 rise in fertilizer prices directly and to deduce from it inferences as guides for anticipating the future. To this end we have selected a sample of farmers from two districts : in one both rice and wheat are grown and in the other wheat is the main foodgrain crop. From these farmers we have obtained detailed information about their inputs and outputs for the agricultural year preceding the rise in the prices of fertilizers and other petroleum based inputs and for the one following it.

Weather

The influence of weather on short run fluctuations in agricultural production in India is well known. In no direct enquiry, however detailed and meticulously designed and conducted, can the effect of weather on the input decisions

of the farmers or the size of the crop be quantitatively measured. It has been argued that weather uncertainty constitutes a risk factor, which influences the farmer's input decisions. Thus, for instance, the observed lower per hectare yield on large farms in India and their inferior input mix has been attributed to the greater risk borne by them. /4/ What is true between farms of different sizes could also be true between years for the same farmer, provided the farmer is able to assess the risk confronting him before he takes his input decisions. But this is usually not possible. On the output, however, the effect of the weather is clearly manifest, though it would be difficult to isolate it in precise quantitative terms.

The impact of weather in India is felt principally through the quantum of rainful and its distribution over the year. If the rains have been inadequate or badly timed a poor harvest cannot be prevented merely by increasing fertilizer or labour inputs. Only an alternative source of irrigation which is adequate and over which the farmer has some control can prevent it. On the other hand, good and well timed rains can raise yields without any increase in fertilizer inputs. On a rain-dependent farm the use of fertilizers is discouraged if rains fall, but on an irrigated farm the farmer will have more freedom in taking his decision. He will use his normal input of fertilizers unless he has good reason to believe that floods or frost or some other unfavourable turn in the weather will prevent him from realising the additional yield he expects. It is, however, clear that while the farmer will bear the risk of such occurrences, he will have little basis for anticipating them so as to modify his input decisions. On the other hand, electricity cuts induced by overall power shortages or the restricted availability of HSD, both supplying the energy for pumping water for irrigation, could discourage the farmer from using his normal input of fertilizers.

Since the farmer is likely in most years to be guided by the expection of normal weather, while the output varies with the weather, a definite quantitative relationship between an input and the crop yield cannot be empirically established on the limited experience of a year or two. Thus it would be possible to find a rise in the yield rate over any two consecutive years associated with a decline in per hectare input of fertilizers as well as its opposite, depending on how much better or worse the weather was in the second year compared to the first.

This would also mean that ex ante factor proportions per unit of output (expected) would be different from the ex post (actual). Consider, for instance, a year which turns out to be unexpectedly good compared with the previous year which, let us say, was an average or 'normal' year. Yields in the second year would be higher than warranted by the farmer's 'normal' input-output expectations of, say, fertilizers and the ex-post input of fertilizers per unit of output would be lower than the ex ante. On the other hand, while a bigger than expected yield might require more labour input than anticipated, particularly, for post harvest operations, the ex post labour input per unit of output might remain the same as the ex ante. This would lower the quantity of fertilizers per unit of labour. Moreover, one would also observe the seeminly curious phenomenon that the yield rate has increased while the input of fertilizers per unit of land has remained unchanged. It is easy to see that the impact of weather fluctuations on relative changes in the use of different inputs per unit of land would be much less than per unit of output.

The uncertainty inherent in the situation renders the farmer's decision-making task much more complex and explains, in a good part, the variation between the mix of inputs actually applied by the farmers and the one recommended to them, on the basis of input-output relationships that emerge from experimental farm stations. Notwithstanding the observed long term cyclical pattern in annual weather conditions, a farmer must guess the weather prospects at the beginning (July) of any single agricultural year because the probability distribution of a bumper, good, indifferent or bad year is never markedly different. The best bet for the average farmer (not necessarily the more enterprising one) usually is to minimise his risk by anticipating a year which is neither good nor bad and then as the season advances to modify his input decisions in accordance with the manner in which the monsoon progresses. However, the extent to which these mid-course modifications can be made to achieve a closer adjustment with the weather conditions is clearly limited.

If it were true, as indeed it seems, that a farmer generally assumes 'normal' or average weather conditions while taking his input decisions, his response to any change in relative factor prices (or a general rise in factor prices relative to output prices) would be more accurately reflected in the input per unit of land relationship, which is weather free, than the input per unit of output relationship, which is not only influenced by the weather, but is removed from the conditions under which the farmer took his input decision by the extent to which the weather deviates from the 'normal'. In the analysis that follows we shall, therefore, measure change in input use only in relation to a unit of land.

Know-how or disembodied technology

In farming, material inputs and labour are also associated with what are known as cultural practices. These cultural practices do not so much determine the quantum of inputs as the manner and timing of their use. They thus incorporate the knowledge for securing optimum output results from a given combination of inputs. In traditional agriculture, cultural practices are found to be fairly uniform, because continuous farming over centuries in unchanging conditions (including state of knowledge) tends to standardise them at the highest attainable level of efficiency. Introduction of the new seed-fertilizer technology forces the farmer to acquire an entirely new dimension of knowledge and a new set of cultural practices. For this reason and also because the new technology is still in the process of dissemination, there are considerable variations in existing cultural practices. In the study cited earlier /2/ it was shown that a farmer's fund of knowledge, on which the character of his cultural practices depends, constitutes an important explanatory factor for the level of output achieved.

On the whole it can be said that the adoption of the material inputs (viz., high-yielding varieties of seeds, fertilizers, etc.,) of the new technology has spread faster than the knowledge of the efficient or optimal use of these inputs. This fact has rather important implications. In the short-run, it means that the impact of a uniform rise in fertilizer prices would be different for different farmers. Farmers using superior cultural practices and, on this account, securing better returns on fertilizer inputs before the rise in their prices would continue to do so. In the long run, an advance in the level of know-how would be a major means of reducing the cost of fertilizers per unit of output. One can legitimately expect that, among

the first steps in this direction, would be an improvement in the fertilizer mix per unit cost.

Government regulation of prices and distribution of foodgrains

Analysis of the producers' response to price changes is facilitated in an environment where prices are determined mainly by the market mechanism. Such an environment proves particularly helpful where certain input-output relationships are to be studied for the purpose of predicting any future stream of output. But, in an environment characterised by direct Government control over the price and distribution of some (or parts thereof) of all relevant inputs and outputs, as is the case in India, the situation is immediately rendered much more complex. The reliability of any projection of output becomes dependent not only on a proper accounting of all the factors directly influencing output but also on probable shifts in policy regarding the nature and extent of government control.

In respect of wheat and rice - the two products with which we are concerned here - the Government of India exercises direct control over their price as well as distribution. The nature of this control, which is not complete, we shall now describe briefly. Its primary objectives are: (i) to ensure the availability of these staple foodgrains to the low income sections of the population (confined mainly to their urban component, since in normal times a major part of the rural population grows its own foodgrains and most of the others receive part of their wage payment in kind) at prices which would enable them to secure, at least, their customary requirements and (ii) at the same time, to maintain incentives for higher production. The implicit conflict between these two objectives is minimised partly by operating a dual price system and partly by state subsidy.

The Government directly administers the price of wheat or rice, which it buys from the farmers (directly or indirectly) and sells through fair price shops to ration card holders. The quantity of wheat or rice funnelled through the public distribution channel is a fraction (which varies, but is approximately a third) of the total market supply (including imports). The Government's buying price is announced in two stages; before the crop is sown, and then just before the harvest. The former is the minimum guarantee price and the latter the procurement price. Grain is actually purchased at the procurement price which may or may not be different from the minimum guarantee price depending upon the size of the harvest and the associated price expectations in the market; it may be higher if the harvest is relatively poor but it cannot be lower even if the harvest is exceptionally good. The sale of wheat or rice through the fair price shops is at a price higher than the procurement price to cover transportation, handling, storage and other distribution costs. In practice these costs have been only partially covered, the balance being made up by state subsidy. Once fixed, neither the procurement nor the ration price are changed during the year.

Each year a target for procurement is fixed and an effort is made to reach it, on the one hand, by indirectly influencing the market mechanism and, on the other, by a direct grain levy. The former is done by restricting grain movements out of zones producing a surplus, thus forcing the market price downwards in these zones and then exercising the right of pre-emptive buying. The latter simply involves the imposition of a straightforward grain levy in

deficit zones.* The target for procurement depends on the Government's commitment for public distribution and the size of its buffer stocks at the beginning of the agriculture year. When harvests are below par and prices are expected to rise, the gap between the procurement and the market price tends to widen and it becomes more difficult for the Government to achieve its procurement target. The Government then meets its commitments to the public distribution system by running down its buffer stocks and/or larger imports.

After each year's harvest of wheat or rice the farmer confronts two prices: the procurement price and the market price, the latter normally being higher by varying degrees in different regions. After retaining what he requires for his family's consumption, he disposes of the rest either at the procurement or the market price. Where a grain levy is imposed, the proportion of his disposable surplus sold at the procurement price is more or less fixed, but where such a levy is not imposed there is no external constraint on the farmer's freedom to exercise his choice. The more relevant prices in respect of which the farmer has a choice are the ones that prevail soon after the harvest, because many farmers, particularly the smaller amongst them, do not have the capacity to hold stock for more than a short duration. It is at this time also that restrictions on grain movements out of surplus zones (when imposed) exert the maximum downward pressure on the market price bringing it close to the procurement price. The capacity of farmers to hold stocks has, however, been growing over time and the pressure on the farmer to make his choice soon after the harvest has correspondingly decreased. The role of the expected trend of prices during the inter-harvest period in the farmer's decision to sell immediately after the harvest has thus come into greater prominence, though to varying degrees in different regions. As market prices normally tend to rise over the inter-harvest period this development has made procurement more difficult. In a year of bumper harvests, it is quite possible that market prices may fall below the procurement price; in which case, the Government would find it easy to meet its procurement target and may even buy in excess both to support the market price and to build or augment its buffer stocks.

The Indian economy for many years has been characterised by the persistence of an excess demand for foodgrains, whose magnitude has fluctuated from year to year depending on weather conditions. Its impact on prices has been neutralised by imports secured through special arrangements or open market purchases - now mainly the latter - and a partial control on distribution. The burden of these unavoidable imports on the Indian balance of payments is irksome, since the much needed imports of capital goods, intermediates and raw materials for development are reduced. To minimise this burden, the approach to foodgrain imports has been characterised by restraint, particularly in recent years, which has helped to maintain a pressure of demand on prices, sometimes light and at other times insistent.

Meanwhile the administered price for public distribution of foodgrains, which understandably is not immune from political pressures, has exhibited a tendency to be sticky.

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*Other variants have also been tried, for instance, the takeover of the entire wheat trade by the Government in 1973 and the direct involvement of private trade in procurement in the following year.

In fact, it follows from the objective of the policy that in times of rising market prices, the administered price for public distribution must follow with only a short time lag. In fact, quite irrespective of the behaviour of market prices, there has been a pressure for maintaining unchanged the price paid by consumers. This tends to widen the gap between the market price and the price fixed for public distribution, thus increasing the Government's subsidy commitments. Outward pressures on the gap between the procurement and market prices have been a major reason for the less than satisfactory procurement effort of the Government in recent times.

As the market price is almost always higher than the procurement price, it would be natural for the farmer to prefer to sell all his surplus at the market price. This he would not be able to do either because of the direct grain levy on him (if it is imposed) or because of the practice of pre-emptive buying by the Government. The latter purchases are from the quantity that arrives in the market which depends on the decision of the farmer not to stock at the prevailing price differential between the procurement and market prices. The price that a farmer actually secures for his wheat or rice is, therefore, a weighted average of the amounts he sells at the procurement and the market prices. The relative proportions of these amounts out of the total stock sold vary from farmer to farmer and between one region or state and another, because the system of procurement differs between states and because inter-zonal restrictions on foodgrain movements result in wide differences in the market price between regions. Since the market price also follows an upward trend during the inter-harvest period, the average price realised by the farmer also depends on the timing of sales.

Thus in reality the farmer not only confronts two prices but a spectrum of prices which range from the procurement price at one end to the annual peak market price on the other. The price he actually realises for the total stock he sells during a full year is influenced by a complex set of factors, some exogenous (the aggregate demand and supply schedules for the region or the country, import levels, level of procurement and the system of procurement) and some endogenous (the size of the farmer's marketable surplus, the sources and type of credit available to him, his capacity to hold stocks, his expectation of prices in the current year and of the size of the harvest next year). These factors determine the gap between the procurement and market prices and the proportion of his surplus that a farmer sells at either price which, in turn, determines the average price that he actually secures for his total sales.

Government regulation of fertilizer and HSD distribution and prices

The distribution of fertilizers, indigenously manufactured or imported, is controlled by the Government. This control is exercised through a system of allocations which is linked to requirements as estimated periodically. The allocations are made at two levels; first to the States by the Ministry of Agriculture, Government of India, on the basis of requirements estimated by Zonal Conferences of which there are five, each comprising a number of States; and second, to the districts by the State Governments. The Zonal Conferences estimate requirements on the basis of the previous year's consumption, the area under high yielding varieties of seeds, the area irrigated under high yielding varieties of seeds, the rates of fertilizer application recommended for States and the extent of foodgrains procurement. The State Governments in their turn determine district-wise allocations on the same or similar grounds.

Allocations to states are made twice in a year - one for the kharif (summer sowing) season and the other for the rabi (winter sowing) season.

Fertilizers available for allocation are divided into two parts: (i) the Pool, which consists of imported fertilizers and is handled by the Central Government, and (ii) indigenous supply. Allocation of the indigenous supply is done through a Gazette notification issued by the Ministry of Agriculture under The Essential Commodities Act. This notification lays down the quantities of fertilizers (in terms of N and P_2O_5) to be supplied to various states by each manufacturer.

The system of allocation, in effect, not only binds manufacturers to certain markets, but it puts an embargo on inter-state movements of fertilizers.

Fertilizer mixtures manufactured indigenously are not allocated and can be sold directly by the manufacturers without restraint on movement.

Besides allocating specific quantities of fertilizers to states, the Government also controls the channels of distribution. All indigenous manufacturers must channel 60 per cent of their fertilizers through cooperatives nominated by the Government; the remaining 40 per cent can be sold through their own retailers who must, however, be registered with the Government. Previously, these retailers had to be licensed, but with a view to facilitating distribution through other than cooperative channels, a more liberal approach has now been adopted.

During the 1974-75 season, the year with which we are concerned, several State Governments were using a further control on distribution through a system of permits given to the farmers, earmarking the retail outlet from which a stipulated quantity could be purchased. This system was introduced to cope with an excess demand situation or, a situation which was believed to be so. However, it did not function efficiently because there were delays in securing the required permits and, in consequence, the farmers were either unable to obtain the fertilizers in time or in the desired quantity. There is evidence, which will be cited elsewhere, that this system had a depressing effect on the consumption of fertilizers (see Appendix). In view of this and an easy supply position most State Governments have now discarded the system and the farmers are free to buy any quantity of fertilizers from outlets of their choice.

For price control the Government distinguishes three categories of fertilizers: (a) imported fertilizers (Pool), (b) three major indigenously manufactured nitrogenous fertilizers and (c) all other indigenously manufactured fertilizers, both straight and mixtures. The Government, being the sole importer of fertilizers, fixes the retail price of all Pool fertilizers. It statutorily controls the prices of the three major domestically manufactured nitrogenous fertilizers, but does not control the prices of other domestically manufactured fertilizers. Fertilizers comprising each category are as follows:

(a) Pool fertilizers:

1. Ammonium sulphate nitrate (26% N)
2. Ammonium chloride (25% N)
3. Diammonium phosphate (18-46-0)
4. Monoammonium phosphate (11-55-0)
5. Ammonium nitrophosphate (20-20-0)

6. Ammonium phosphate (20-20-0)
7. Muriate of potash
8. Sulphate of potash
9. NPK fertilizers in various combinations.

(b) Fertilizers with statutorily control on prices

1. Ammonium sulphate (20.6% N)
2. Urea (45% N and 46% N)
3. Calcium ammonium nitrate (25% and 26% N)

(c) Fertilizers with no statutory control on prices

1. Ammonium sulphate nitrate (26% N)
2. Ammonium chloride (25% N)
3. Superphosphate (16% w.s. P_2O_5)
4. Triple superphosphate (42.5% w.s. P_2O_5)
5. Pelefos (18% P_2O_5)
6. Urea ammonium phosphate
7. Ammonium phosphate sulphate
8. Diammonium phosphate
9. Nitrophosphate
10. NPK fertilizers

The mechanism for regulating the price of HSD and other oil products is relatively simple. Periodically these prices are reviewed by the Oil Prices Committee which recommends to the Government such changes as it deems desirable. After the Government has considered these recommendations, and taken its decisions, these are communicated to the oil companies, who abide by them. Prices thus fixed do not have any statutory support, but are adhered to on the basis of an understanding. The Oil Prices Committee in recommending prices, takes into account government policy in respect of priority uses of petroleum products and employs discriminatory pricing as a tool to promote or discourage the use of an oil product in one or another industry.

India today produces one-third of its annual requirements of crude oil. The cost of this oil is considerably less than that of imported oil. While domestic oil was priced at parity with the international price earlier, this practice has now been given up and domestic oil is priced considerably lower. However, the Government supplies oil to the refineries at a price which represents an average of the domestic and imported prices and is roughly 20-25 per cent lower than the international price. The three distillates, light, medium and heavy, are priced on the recommendations of the Oil Prices Committee. Following the oil price rise, the Committee was anxious to minimise its impact on fertilizer prices. It therefore let the petro-chemical industry and to a greater extent the consumer of motor spirits take a larger than proportionate share of the increase in the crude oil price. However, the increase in the domestic cost of producing nitrogenous fertilizers was not the only factor determining the increase in their administered prices. The other important factor was the level of imports and the price at which these imports were secured. In 1974-75 there was a world-wide shortage of fertilizers and international prices had shot up to extremely high levels. Despite this, the Government was anxious to meet the requirements of farmers and consequently bore directly a substantial part of the increase in the import bill for fertilizers. This was reflected in the prices fixed for nitrogenous fertilizers by the Government. After 1974-75, the international supply of fertilizers improved relative to demand and international prices fell from the dizzy peaks to which they rose after

the oil price rise and Indian prices declined in line. The Government has reduced the price of fertilizers by 10 per cent.

The cost of petroleum based inputs in the production of wheat and rice before the oil price rise

Since petroleum based inputs constitute one set of inputs among others, it would be useful to know what proportion of the total cost of production they accounted for before the rise in oil prices. If this proportion were very small, then even a high rise in oil prices might not register any significant impact.

There are two principal sources of data on cost of production of agricultural crops: (a) The Farm Management Studies, and (b) The Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops. The Farm Management studies were carried out in selected districts, with at least one in each State. Two to three rounds of these studies were done during the 1950s. In the 1960s they were taken up only towards the end of the decade and even then for only some districts. The latest available data are for the district of Ferozepur in Punjab for 1970-71. It was mainly to overcome the inadequacy of Farm Management studies that the Government launched through the Directorate of Economics and Statistics a comprehensive scheme to obtain information on the cost of production of, at least, the principal crops on a regular basis. Data under the Comprehensive Scheme began to be assembled from 1971-72. Currently, the following cost data from this source are available: (i) Punjab, 1971-72, 1972-73, 1973-74, (ii) Haryana, 1971-72, and (iii) U.P., 1971-72, for wheat; (iv) Andhra Pradesh, 1971-72 and (v) Orissa, 1971-72 and 1972-73 for rice. In what follows we shall present only the data available from the Comprehensive Scheme.

Information is provided on the value of fertilizers used in the cultivation of wheat and rice crops, but not on the cost of HSD purchased by the farmers for running their tractors or other machines. The cost of "machine labour" is, however, presented. This is the expenditure on machine utilisation, including the cost of labour, repair and maintenance and depreciation. Further, the data do not distinguish between types of fuel, viz., HSD and electricity. For hired machinery, the cost is simply the rental paid to the owner which includes all his costs plus profit. Tables 1 and 2 present the available information on fertilizer and machine labour cost per hectare, per quintal and as percentage of total cost.

Normal fertilizer cost per hectare as well as per quintal of wheat is quite substantial in Punjab and significantly higher than in Haryana or U.P. Similarly, the cost of fertilizers per hectare or per quintal of paddy is much higher in Andhra Pradesh than in Orissa. The same pattern holds in respect of fertilizer cost as a percentage of total cost. It will be noticed that two figures - A and B - for percentage of total cost are presented in Tables 1 and 2. Under A total cost includes all costs actually paid out or imputed for the use of factors owned or possessed by the household. Under B the imputed costs of factors owned or possessed are excluded. Subsequently these costs will be referred to as A_2 and C costs respectively.

There appears to be no doubt that for wheat in Punjab and for paddy in Andhra Pradesh an 80 per cent increase in fertilizer prices would make a significant difference to per quintal cost of production, even if other costs were to remain unchanged. This would also be true for wheat in Haryana and U.P. though to a lesser extent. It is only in

Orissa that additional cost of fertilizers for paddy may be comparatively less important.

Table 1

Cost of Fertilizers per Hectare and per Quintal as a Percentage of the Total Cost for Wheat and Paddy

Crop and region		Cost of fertilizers per hectare (Rs.)	Yield per hectare (Kgs.)	Cost of fertilizers per quintal (Rs.)	Cost of fertilizers as a percentage of the total cost A	B
Wheat						
Punjab	1971-72	230.61	26.43	8.72	13.03	21.20
	1972-73	224.76	22.56	9.96	13.62	23.10
	1973-74	299.06	24.87	12.02	14.68	23.99
Haryana	1971-72	99.15	20.98	4.73	7.83	11.94
Uttar Pradesh	1971-72	94.88	21.61	4.39	6.74	10.65
Paddy						
Andhra Pradesh	1971-72	158.41	25.22	6.3	10.73	19.14
Orissa	1971-72	20.53	16.84	1.2	1.19	2.94
	1972-73	22.09	16.72	1.3	0.47	4.10

A = Cost includes imputed values for owned factors.
B = Paid out cost.

Table 2

Cost of Machine Labour per Hectare and per Quintal as a Percentage of the Total Cost for Wheat and Paddy

		Cost of machine labour per hectare (Rs.)	Yield per hectare (Kgs.)	Cost of machine labour per quintal (Rs.)	Cost of machine labour as a percentage of the total cost A	B
Wheat						
Punjab	1971-72	107.59	26.43	4.07	6.08	9.90
	1972-73	101.36	22.56	4.49	6.14	10.42
	1973-74	141.44	24.87	5.69	6.94	11.35
Haryana	1971-72	57.32	20.98	2.73	4.53	6.90
Uttar Pradesh	1971-72	41.33	21.61	1.91	2.93	4.64
Paddy						
Andhra Pradesh	1971-72	22.47	25.22	0.88	1.51	2.69
Orissa	1971-72	0.19	16.84	Negligible	0.02	0.04
	1972-73	-	16.72	-	-	-

A = Cost includes imputed values for owned factors.
B = Paid out cost.

The normal cost of machine labour per hectare or per quintal of output, like the cost of fertilizers, is higher for wheat than for paddy. It varies between States in the same manner. However, it is comparatively less per unit of output and, if the HSD component alone were considered, it would be even lower. Considering that the increase in HSD price, relevant for our period of investigation, was also small compared to the increase in fertilizer prices, one would be right in saying that the major impact of the oil price rise on agriculture would be felt through fertilizers. To this, one must, however, add this qualification that, since the cost of m achine labour involves other costs besides HSD, it is the change in the cost of machine labour that the farmer would respond to. If other costs also increased, as in fact they did, then the individual impact of the increase in HSD price would be indistinguishable.

CHAPTER II

A Cross Section Analysis Based on a Sample Survey

The Sample

For our sample survey we selected the districts of Muzaffarnagar (U.P.) and Karnal (Haryana). Given the limitations of funds we restricted our enquiry to 50 farms, 25 in Muzaffarnagar for wheat and the other 25 in Karnal for rice. For selecting these farms, villages were selected purposively, keeping in mind the availability of irrigation facilities and the use of fertilizers as well as oil fueled machines. From the villages farms were selected randomly after stratifying all farms by size.

Wheat, a winter crop, is grown mostly in the north-western region which is homogeneous in respect of oil, climate and rainfall. Muzaffarnagar is fairly representative of this region, except that it is typical of progressive wheat culture. The latter feature introduces a bias and reliability was also affected by the small size of the sample. More progressive farmers are likely to exhibit greater sensitivity to a rise in fertilizer prices, if not for any other reason, for their higher fertilizer input per unit of land and hence their lower marginal product. It is clear that no quantitative conclusion can be drawn from this sample regarding all farmers cultivating wheat. In the case of rice, the bias and reliability problems are even greater. Firstly, while the predominant crop in Karnal district is rice, the district itself is not a part of any major rice growing tract in the country, such as, Andhra Pradesh, Tamil Nadu, Orissa, West Bengal. Secondly, rice culture in India presents a much more varied picture than wheat even amongst the major rice growing tracts. Here again convenience dictated the choice of the district, and since Karnal, too, is a progressive district, quantitative information obtained from it would perhaps be more applicable to the more progressive districts.

The 50 farms were grouped into three sizes - small, medium and large. In Karnal, holdings below 4.05 hectares were classified as small, those between 4.05 to 8.09 hectares as medium and those above 8.09 hectares as large. In Muzaffarnagar, the proportions of medium and, specially, large farms corresponding to the size classification in Karnal were small in the selected villages and hence, the three size classes used were: below 4.05 hectares (small), between 4.05 and 6.06 hectares (medium) and above 6.06 (large).

While the character of the technology in use in these districts can be regarded as neutral to farm size, resources available to the farmers with holdings of different sizes may not necessarily be the same. For instance, a given dose of fertilizer nutrient per hectare would yield the same output of wheat in a small or a large farm, if other inputs are the same, but it is possible that the small farmer may not be able to secure the same quantity of fertilizers as a large farmer because of lack of funds or access to bank or cooperative credit. Similarly, while a large farmer may be in a position to stock his surplus produce of wheat in order to take advantage of an expected rise in price, a small farmer may not be able to do so and may be forced to sell his produce at the comparatively low post-harvest price. Thus, while for technical reasons, it may not be necessary to distinguish between farms of different sizes, it would be useful to do so for other reasons.

The size-distribution of selected farms along with their land use pattern for crop cultivation is shown in Tables 3 and 4.

Table 3

Number of Sample Farms, Average Cultivated Area, Gross Cropped Area and Intensity of Cropping by Size of Farm, Karnal, 1973-74 and 1974-75

Size of farm (in hectares)	Number of sample farms	Cultivated area (hectares)	Gross cropped area (hectares)	Intensity of cropping * (per cent)
		1973-74		
Small (below 4.05)	11	2.55	5.10	200.0
Medium (4.05 - 8.10)	10	5.51	10.85	196.9
Large (8.10 & above)	4	10.93	21.66	198.2
All farms	25	5.18	10.25	197.9
		1974-75		
Small	11	2.61	5.10	195.4
Medium	10	5.51	10.52	191.0
Large	4	10.53	20.43	194.0
All farms	25	5.04	9.72	192.9

* Ratio of cropped area to cultivated area.

Table 4

Number of Sample Farms, Average Cultivated Area, Gross Cropped Area and Intensity of Cropping by Size of Farm, Muzaffarnagar, 1973-74 and 1974-75

Size of farm (hectares)	Number of sample farms	Cultivated area (hectares)	Gross cropped area (hectares)	Intensity of cropping*	
				A (per cent)	B (per cent)
		1973-74			
Small (below 4.05)	15	2.24	3.46	154.5	205.4
Medium (4.05 - 6.07)	6	4.76	6.64	139.5	205.9
Large (6.07 & above)	4	6.98	9.38	134.4	196.0
All farms	25	3.60	5.17	143.6	202.8
		1974-75			
Small	15	2.24	3.55	158.5	209.4
Medium	6	4.76	7.03	147.7	213.4
Large	4	6.98	9.77	140.0	204.0
All farms	25	3.60	5.38	149.4	209.2

*A = Intensity of cropping computed by counting area under sugarcane once.
= Intensity of cropping computed by counting area under sugarcane twice, because sugarcane is an annual crop whereas most other crops are seasonal.

From each farm detailed information on all inputs (quantity and cost) for each crop grown and the yields (quantity and value) achieved was obtained. In order to assess the impact of the increase in the prices of oil-based inputs, this information was obtained for the agricultural year 1973-74 which preceded, and the agricultural year 1974-75 which succeeded, the rise in these prices.

The survey was conducted in February 1975. By this time most of the rice grown in the 1974-75 kharif season was already sold by the sample farmers and the prices secured by them were known. However, the wheat crop was not yet harvested, though all inputs other than those in harvesting or post-harvest operations had already been employed. For information on these inputs a second visit was made after the harvest. Even at this time, the farmers had not disposed of any of their output. For valuing the sample farmers' output, therefore, the previous year's average price secured by all sample farmers was used.

The cropping pattern of sample farms

With three-fourths of the gross cropped area, rice and wheat dominate the cropping pattern of Karnal farms. Fodder crops (including jowar) command another fifth of the year, with sundry crops (including vegetables, grams, etc.), utilising the remainder (Table 5). Karnal farmers grow rice mainly for the market and wheat both for home consumption and sale.

Table 5

Average Area Under Major Crops per Farm by Size of Farm Among Sample Farmers in Karnal, 1973-74 and 1974-75

(In hectares)

Size of farm	Area under crops							
	Paddy			Wheat	Jowar	Borseem (fodder)	Others	Total
	IR-8	'Basmati'	Total					
				1973-74				
Small	1.56 (30.6)	0.40 (7.8)	1.96 (38.4)	1.81 (35.5)	0.59 (11.6)	0.74 (14.5)	- -	5.10 (100.0)
Medium	3.40 (31.4)	0.97 (8.9)	3.37 (40.3)	4.01 (37.0)	1.09 (10.0)	1.36 (12.5)	0.02 (0.2)	10.85 (100.0)
Large	4.25 (19.6)	3.34 (15.4)	7.59 (35.0)	7.49 (34.6)	1.97 (9.1)	1.92 (8.9)	2.69 (12.4)	21.66 (100.0)
All farms	2.77 (27.0)	1.13 (11.0)	3.90 (38.0)	3.67 (35.8)	1.03 (10.0)	1.19 (11.6)	0.46 (4.6)	10.25 (100.0)
				1974-75				
Small	1.58 (31.0)	0.42 (8.2)	2.00 (39.2)	1.78 (34.9)	0.57 (11.1)	0.67 (13.1)	0.08 (1.7)	5.10 (100.0)
Medium	3.52 (33.5)	0.81 (7.7)	4.33 (41.2)	3.56 (33.8)	1.09 (10.4)	1.32 (12.5)	0.22 (2.1)	10.52 (100.0)
Large	4.20 (20.6)	2.88 (14.1)	7.08 (34.7)	6.58 (32.2)	1.87 (9.2)	1.92 (9.4)	2.98 (14.1)	20.43 (100.0)
All farms	2.78 (28.6)	0.97 (10.0)	3.75 (38.6)	3.26 (33.5)	0.99 (10.2)	1.13 (11.6)	0.59 (6.1)	9.72 (100.0)

Note: Figures in brackets are the percentage of the average area under the crop to total gross cropped area.

Muzaffarnagar farmers devote a much smaller proportion - just a third, - of the gross cropped area to rice and wheat, with rice having only a fourth of the area under wheat. Sugarcane is clearly the major crop of the region , with two-fifths of the area under it. Fodder crops account for a fourth and sundry crops for the remaining area (Table 6). Muzaffarnagar farmers grow rice for home consumption and wheat for both home consumption and sale.

Table 6

Average Area Under Major Crops per Sample Farm by Size of Farm, Muzaffarnagar, 1973-74 and 1974-75

(in hectares)

Size of farm	Area under crops						
	Sugarcane	Wheat	Paddy	Jowar	Berseem	Other	Total
			1973-74				
Small	1.14	1.07	0.31	0.73	0.15	0.06	3.46
	(32.9)	(31.0)	(8.9)	(21.2)	(4.3)	(1.7)	(100.0)
Medium	3.16	1.60	0.40	1.26	0.15	0.07	6.64
	(47.7)	(24.1)	(6.0)	(19.0)	(2.2)	(1.0)	(100.0)
Large	4.30	2.29	0.32	2.12	0.30	0.08	9.38
	(45.7)	(24.3)	(3.4)	(22.6)	(3.2)	(0.8)	(100.0)
All farms	2.13	1.39	0.34	1.08	0.17	0.06	5.17
	(41.2)	(26.9)	(6.6)	(20.9)	(3.3)	(1.1)	(100.0)
			1974-75				
Small	1.14	1.16	0.29	0.78	0.12	0.06	3.55
	(32.1)	(32.7)	(8.1)	(22.0)	(3.4)	(1.7)	(100.0)
Medium	3.13	1.92	0.37	1.32	0.15	0.14	7.03
	(44.5)	(27.3)	(5.3)	(18.8)	(2.1)	(2.0)	(100.0)
Large	4.47	2.12	0.35	2.20	0.30	0.33	9.77
	(45.7)	(21.7)	(3.6)	(22.5)	(3.1)	(3.4)	(100.0)
All farms	2.15	1.49	0.32	1.15	0.15	0.12	5.38
	(40.0)	(27.7)	(5.9)	(21.4)	(2.8)	(2.2)	(100.0)

Note: Figures in brackets are percentages of the average area under the crop to total gross cropped area.

In Karnal the cropping pattern is closely similar on farms of all sizes. In Muzaffarnagar, because of the needs for home consumption, the proportion of gross cropped area under foodgrains rises, displacing sugarcane, as the farm sizes decline.

Changes in the net cultivated and the gross cropped area between 1973-74 and 1974-75

First of all let us consider the possibility that the farmer, having fixed financial resources, decides to use the same input mix at a higher fertilizer price and hence cultivates a smaller area.

It can be seen that, between the two years there was no change in the net cultivated area in Muzaffarnagar (an average of 3.60 hectares in both years) and only a marginal decline in Karnal (from 5.18 hectares to 5.04 hectares) which was caused mainly by a shift in lease arrangements. Among farms of different sizes, the area cultivated in

small farms increased, while there was a decline in the area cultivated on large farms. These facts would tend to indicate that the rise in fertilizer prices had no significant effect on the area cultivated in the selected farms.

Given water, the ecological conditions in India make it possible to raise more than one crop in a year from the same land. It is therefore possible for the farmer to have a larger cropped area than the land area available to him for cultivation. Gross cropped area can therefore be equal to or exceed the net cultivated area to the extent that a farmer cultivates any part of his land more than once.

The principal factor which determines the extent of multiple cropping during any year is irrigation. While in India 22.5 per cent of the cultivated area is irrigated, the farms selected for our enquiry both in Karnal and Muzaffarnagar are fully irrigated. The average gross cropped area on the farms in both districts is thus twice as large as the net cultivated area. The extent to which an area is cultivated more than once is referred to as the cropping intensity and is measured as a ratio of the gross cropped area to the net cultivated area. It can be seen from Tables 3 and 4 that between 1973-74 and 1974-75 there was a marginal decline in the cropping intensity in Karnal, while in Muzaffarnagar there was an increase. The decline in Karnal was shared by medium and large farms only, while in Muzaffarnagar the increase was shared by farms of all sizes. In Karnal, at least, a part of the decline in gross cropped area was due to a fall in the cultivated area; there was also a marginal increase in fallows on a few farms. On enquiry it was found that the slight increase in the fallow area was due to the weather and not to any other reason. One can therefore conclude that, on the whole, there was no discernible impact of higher fertilizer prices on the farmers' cropping intensity.

Another alternative available to the farmer, if he does not reduce his net cultivated or gross cropped area, is to change his cropping pattern in favour of crops which use less fertilizers. It was found that in both districts there was some change in the cropping pattern over the two years under review, though a marginal one (Table 5 and 6). The proportion of gross cropped area under foodgrains remained the same in Muzaffarnagar, but declined slightly in Karnal. In Muzaffarnagar wheat gained in area while rice lost; in Karnal the shift was in the opposite direction. In both districts fodder crops retained their position, while the share of sundry crops increased. Besides being too small to be of consequence, these changes present no consistent pattern that could be attributed to a common cause, such as the rise in fertilizer prices.

Concepts of costs

Before presenting cost information from our survey it is necessary to define the cost concepts used. Four concepts of cost are currently identified in India and used for estimating the cost of production in agriculture. These are called cost A_1, A_2, B and C, and are defined as follows:

Cost A_1 — Value of all material inputs, hired human labour, hired and owned bullock and machine labour, depreciation on implements and farm buildings, irrigation charges, land revenue and taxes and interest on working capital including crop loans.

Cost A_2 — Cost A_1 plus rent paid on leased-in land.

Cost B Cost A_2 plus imputed rental value of owned land (less land revenue paid on it) and imputed interest on present value of owned fixed capital (excluding land).

Cost C Cost B plus imputed value of family labour.

These concepts are being used in the Comprehensive Scheme for studying the cost of cultivation of principal crops referred to earlier. The method of imputing value to non-traded factors is now fairly standardised. Family labour is valued at the going wage cost per day for permanent farm hands. The wage cost per day of a permanent farm hand is estimated by dividing his annual wage by the number of days he actually works. Rent for owned land is imputed at the prevailing rent for identical land in the same locality and interest on owned fixed capital at the current long-term lending rate of commercial banks.

The Comprehensive Scheme adopts the following methods for estimating the value of bullock labour and machine use. The net cost of maintaining bullocks is obtained by deducting from the total maintenance cost amounts received in charges for hiring out bullock labour plus income accruing from the yield of by-products (dung manure). The net maintenance cost of bullocks is attributed to crops in proportion to the hours of bullock labour used. Similarly, the cost of machine input is estimated on the basis of maintenance and operational expenditure plus depreciation and is allocated to crops according to the time the machine is used for each crop. Home grown seeds are valued at the going rate for seeds in the sowing season.

In calculating the cost of production for our sample farms the same cost concepts and methods of estimation were used as in the Comprehensive Scheme.

The average Indian farmer operates with his household as the basic unit of production. Members of the household share the work in accordance with their age and sex. The income earned is the household's income. Decisions relating to production are taken by the household usually through the head of the household. The motivation that guides decision-making is income maximisation or more precisely household welfare maximisation. The income earned is not divisible between its components, such as wages, interest, profit or rent. The entire household as a unit is the recipient of all these incomes. No purpose is served in splitting the household income into its components, attributed to differentiated factorial functions, when such differentiation is not made by the household. We must, therefore, treat the household income as an indivisible whole.

For accounting purposes it may be useful to impute values to factors which in fact receive no specific payments for work done or services rendered. But when these imputed values accrue to the farm household, they essentially represent a way of splitting the household income into known categories. To the farmer this procedure makes no difference; in fact, he is not even aware of it. He takes his decisions in relation to his total household income and allocates the household resources with reference to this income. To him the imputed value of family labour is not a cost but an indistinguishable part of his total income and so also is the imputed rent of owned land or imputed interest on owned fixed capital.

In our analysis we shall, therefore, attach no importance to costs B and C. We shall concern ourselves with A_2 cost only, which consists of the amounts paid out by the household and determines the household's income when deducted from the value of output produced.

Changes in the per quintal cost of production of wheat between 1973-74 and 1974-75

Simply for record we present all four costs, A_1, A_2, B and C. For producing a quintal of wheat, each of the four costs rose between 1973-74 and 1974-75 in Karnal almost equally on small and large farms but considerably less on medium farms (Table 7). A_2 cost, with which we are principally concerned, increased by a little over 15 per cent for all farms, over 23 per cent for both small and large and only 6 per cent for medium farms.

Table 7

Average Cost of Production per Quintal of Wheat and Percentage Change in 1974-75 over 1973-74 by Cost Concepts and Size of Farm Among Sample Farms in Karnal and Muzaffarnagar

Cost	Karnal			Muzaffarnagar		
	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74
			Small farms			
A_1	37.65	45.93	+ 21.99	78.41	60.08	- 23.38
A_2	38.57	47.64	+ 23.52	79.13	60.56	- 23.47
B_2	68.12	79.41	+ 16.57	112.22	82.49	- 28.21
C	72.33	83.39	+ 15.29	130.93	94.91	- 27.51
			Medium farms			
A_1	44.07	47.43	+ 7.62	83.61	63.07	- 24.57
A_2	48.61	51.60	+ 6.15	83.61	63.07	- 24.57
B_2	74.21	77.65	+ 4.64	120.36	87.82	- 27.04
C	76.75	79.64	+ 3.77	135.30	96.61	- 28.60
			Large farms			
A_1	44.32	55.28	+ 24.73	98.23	58.55	- 40.39
A_2	51.04	63.11	+ 23.65	98.23	58.55	- 40.39
B_2	71.01	82.02	+ 15.50	143.79	83.36	- 42.03
C	71.59	82.45	+ 15.17	149.85	87.15	- 41.84
			All farms			
A_1	42.72	49.63	+ 16.18	84.62	60.65	- 28.33
A_2	47.20	54.51	+ 15.28	84.96	60.87	- 28.35
B_2	71.75	79.51	+ 10.82	122.07	84.35	- 30.90
C	73.99	81.46	+ 10.10	136.68	93.60	- 31.52

In Muzaffarnagar, on the other hand, the per quintal A_1, A_2, B and C costs of producing wheat declined significantly in farms of all sizes. The decline in A_2 cost was 23.5 per cent for small 24.6 per cent for medium and 40.4 per cent for large farms with an average of 28.4 per cent for all farms.

The diametrically contrasting cost behaviour in Muzaffarnagar was due mainly to the wide variation in the weather conditions in this district over the two years. Whereas in Karnal 1973-74 was rated as 'normal' and 1974-75 a good year, in Muzaffarnagar 1973-74 was a bad and 1974-75 as exceptionally good year. The extraordinarily low yield rate in Muzaffarnagar in 1973-74 greatly inflated the per quintal cost of production while the bumper crop in 1974-75 did exactly the opposite by deflating it.

On the other hand, if we compare the per hectare A_2 cost of cultivating wheat we find that, not only does it increase in both districts, the increase is greater in Muzaffarnagar (21 per cent) than in Karnal (19 per cent). Here is a telling example of how weather fluctuation can affect the cost of cultivation per unit of output. The farmer normally tends to make his outlay on inputs in the expectation that he will encounter normal weather conditions through the full period of plant growth unless, of course, some untoward turn in the weather conditions in the initial period of crop growth is so damaging as to rule out such an expectation.* Often a farmer will aim to counter the ill-effects of bad weather in the early part of the season by additional effort and inputs. He realises expected yields at planned cost per quintal** if weather conditions maintain their normal course throughout the season. When this does not happen, yields fall or rise in comparison with the expected and the actual cost per quintal is more or less than the planned cost. For a study of the farmer's response to a change in the circumstances influencing his input use, therefore, it is the per hectare cost and not the per quintal cost that should interest us.

Change in the cost of cultivation per hectare of wheat between 1973-74 and 1974-75

The per hectare cost of growing wheat increased in both Karnal and Muzaffarnagar by a fifth between 1973-74 and 1974-75 (Table 8). To this rise all items in cost A_2 contributed in Karnal and all the major items in Muzaffarnagar (Table 9). In Table 10 major items which account for more than four-fifths of the total A_2 cost are listed. The percentage increase in fertilizer cost was clearly dominant in Karnal, although it was high for seeds and tractor use also. In Muzaffarnagar, however, the pattern of cost increase was somewhat different. While the percentage increase in seed cost was similar to Karnal, fertilizer cost increased by much less and both hired labour and machine operation by much more.

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*It is possible, as Srinivasan argues, that a farmer's perception of the vagaries of weather varies with the size of the farm; farmers with larger holdings running a greater risk and therefore optimising their factor mix at lower levels of inputs./3/ However, we are not concerned here with explaining inter-farm variations in inputs or yields, but with comparing cost per unit of output over time for the same farm or the same group of farms.

**This is not to be confused with the optimal cost, for technically it is not so for most farmers. Moreover, two identical combinations of inputs may yield very different results even with the same weather conditions, if one farmer's know-how is superior to another's. Since we measure material inputs only, the optimum mix of inputs becomes highly variable between farmers.

Table 8

Average Cost of Cultivation per Hectare of Wheat by Size of Farm in Sample Farms in Karnal and Muzaffarnagar, 1973-74 and 1974-75

Cost	Karnal			Muzaffarnagar		
	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74
			Small farms			
A_1	1424.0	1620.5	13.8	1825.3	2238.5	22.6
A_1	1448.8	1666.1	15.0	1839.1	2252.8	22.5
B^2	2243.8	2511.2	11.9	2475.3	2905.5	17.3
C	2357.2	2617.0	11.0	2836.3	3274.8	15.5
			Medium farms			
A_1	1389.3	1633.1	17.5	2050.7	2403.8	17.2
A_1	1496.1	1741.9	16.4	2050.7	2403.8	17.2
B^2	2098.2	2422.8	15.5	2795.6	3165.6	13.2
C	2157.9	2474.6	14.7	3098.5	3436.4	10.9
			Large farms			
A_1	1499.5	1883.8	25.6	1930.2	2339.1	21.2
A_1	1667.7	2093.9	25.6	1930.2	2339.1	21.2
B^2	2167.4	2600.6	20.6	2700.4	3128.3	15.8
C	2182.1	2612.1	19.7	2802.7	3248.5	15.9
			All farms			
A_1	1433.9	1711.0	19.3	1915.1	2312.4	20.7
A_1	1544.7	1837.4	18.9	1921.5	2319.0	20.7
B^2	2151.6	2501.4	16.3	2623.4	3036.4	15.7
C	2207.0	2553.1	15.7	2899.7	3318.7	14.4

It is fairly obvious that the seed rate (quantity of seeds sown per hectare) would tend to remain constant on farms with assured irrigation provided the same seed variety is used and there is no other technological innovation affecting the seed rate. Even a substantial change in the price of seeds, as indeed did occur between 1973-74 and 1974-75, would not significantly change the seed rate although some marginal adjustments might be made. The decline (3.9 per cent) in the seed rate in Muzaffarnagar might be attributed to the relatively high price rise (39 per cent), but in it would be difficult to explain the increase in the seed rate (2.9 per cent) with a less (29 per cent) but substantial increase in the price of seeds in Karnal by the same logic. It is more likely that the change in the seed rate in both places was incidental or that, it was caused by factors other than price*.

*We could not find a satisfactory explanation for the higher seed rate in Muzaffarnagar, though the same seeds were used in both places; nor, for the larger dose of fertilizers and manures in 1973-74. These were attributed to cultural practices, but it is possible that a deeper investigation might reveal agronomical features which offer a better explanation.

Table 9

Break-down of Cost of Cultivation Per Hectare of Wheat and Percentage Change in 1974-75 over 1973-74, among Sample Farms in Karnal and Muzaffarnagar

Items	Karnal			Muzaffarnagar		
	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74
1. Human labour	386.5	403.8	+ 4.5	504.1	583.6	+ 15.8
a) family	55.4	51.7	- 6.7	276.3	282.3	+ 2.2
b) hired	331.1	352.1	+ 6.3	227.8	301.3	+ 32.3
2. Bullock labour	234.2	247.1	+ 5.5	422.5	547.0	+ 8.2
3. Seeds	134.8	178.9	+ 32.7	221.9	295.0	+ 32.9
4. Manures	-	-	-	108.5	170.6	+ 57.2
5. Fertilizers	301.9	426.4	+ 41.2	421.8	486.2	+ 15.3
6. Irrigation cost	56.8	65.4	+ 15.1	162.7	151.8	- 6.7
7. Tractor cost	135.4	148.5	+ 9.7	81.3	87.4	+ 7.5
8. Thresher cost	121.5	139.3	+ 14.7	104.1	189.7	+ 82.2
9. Land revenue, etc.	3.2	3.2	0.0	8.8	8.4	- 4.5
10. Depreciation	56.3	68.1	+ 21.0	98.0	95.9	- 2.1
11. Repairs	43.8	55.0	+ 25.6	39.0	37.9	- 2.8
12. Interest on working capital	14.9	27.0	+ 81.2	18.6	31.1	+ 67.2
13. Rent for leased in land	110.8	126.4	+ 14.1	6.4	6.6	+ 3.1
14. Interest on fixed capital	70.4	115.0	+ 63.4	132.0	167.6	+ 27.0
15. Rental value of owned land	536.5	549.0	+ 2.3	569.9	549.8	- 3.5
Total	2207.0	2553.1	+ 15.7	2899.7	3318.7	+ 14.5

Labour input would also tend to be unaltered, if there were no severe mid-season damage to the crop and no major substitution of a mechanical device for labour. Thus, for instance, if ploughing is done by a tractor and continues to be so done, labour input in this operation would remain unchanged irrespective of what other inputs are used or what the size of the crop is. This would be true of all other operations as well. It is, of course, conceivable that at some price of tractor use, the farmer may find it more economical to use bullocks instead, in which case labour input would rise. Labour input, on the other hand, would fall if, as the crop season advances and drought or some other blight makes it evident that a major portion of the crop will inevitably be lost, the farmer decides that no purpose will be served in putting in the normal labour input, in say, the inter-culture operation. In both Karnal and Muzaffarnagar, we find that the rise in the price of tractor use (mostly hiring charges) did not induce the farmers to change over to bullocks and that there was very little change in the total or hired labour input.

Table 10

Price and Quantity Change in the Major Inputs Between 1973-74 and 1974-75 in Sample Farms in Karnal and Muzaffarnagar

	Karnal		Muzaffarnagar	
	Price increase/ decrease (per cent)	Quantity increase/ decrease (per cent)	Price increase/ decrease (per cent)	Quantity increase/ decrease (per cent)
1. Seeds	+ 29	+ 2.9	+ 39	- 3.8
2. Fertilizers (NPK nutrients)	+ 84.9	- 23.5	+ 86.4	- 38.0
3. Manures	-	-	+ 53.0	+ 4.2
4. Hired labour	+ 5.4	+ 1.7	+ 28.0	+ 2.6
5. Bullock labour (feed cost)	+ 2.0	+ 2.6	+ 8.0	+ 0.3
6. Tractor 1/	15 to 25.0	- 12.2	+15 to 20.0	- 10.3
7. Threshers 2/	-	+ 14.7	-	+ 82.0
8. Irrigation 3/	-	+ 11.8 4/	+ 100.0 5/	-

1/ Rent for tractors varies; cooperatives have the lowest rate, while the rate charged by private owners is both higher and differentiated. The rates also vary for ploughing, harrowing and levelling. The rate is fixed per acre for ploughing/levelling/harrowing.

2/ Rent in kind at 3 kgs. per 40 kgs. of wheat threshed in Karnal. Rent @ Rs.12.50 per quintal in Muzaffarnagar in both years.

3/ Irrigation is done by canal as well as tubewells. For wheat in Karnal only tubewells are used, while both tubewells and canals are used in Muzaffarnagar. In Karnal tubewells are run on electricity and in Muzaffarnagar by diesel engines.

4/ Change in the electricity rate per unit.

5/ Change in the price of diesel oil.

There was, however, a rise in wages (earnings of hired labour per day) in both Karnal and Muzaffarnagar, modest (5.4 per cent) in the former and substantial (28.0 per cent) in the latter. In reality, the rise in wages in Muzaffarnagar was due mainly to the higher yield which enabled hired labour to earn more because the wage for harvesting is fixed as a proportion (in kind) of the quantity harvested. It is to be noted that the time taken by a labourer to harvest one hectare, or the area he harvests in a working day, remains more or less the same whether the yield rate is good or poor. But his remuneration rises with the yield rate because the amount of grain he harvests per unit of time increases.* For this reason wages in Muzaffarnagar in 1973-74 must be regarded as abnormally depressed as the yield rate in that year was exceptionally low. It is obvious that changes in this type of yield-tied wages play no part in determining the demand for labour. It should also be pointed out that while payment in kind for harvesting as a proportion of the amount harvested is traditional and constant, when expressed in terms of money it varies with the price at which the conversion is done. Since the normal practice is to make this conversion at the current price of the grain harvested, money wages for harvesting also rise with the rise in the price of the grain harvested. In Muzaffarnagar, however, the price of wheat for both years was the same for all farmers, and hence it did not contribute to the rise in money wages of workers.

Preparation of the soil before sowing usually consists of a set of well defined operations: harrowing, ploughing and levelling. The number of times each of these operations is required to be repeated to ensure optimum results for any crop is fairly fixed and, in normal circumstances, a farmer usually adheres to the established pattern. But, he may find room for deviation, if there is more than normal rainfall just before he starts his preparatory tillage or during its earlier stages. What the farmer ultimately aims to achieve is the desired loosening of the soil and rain helps in the process.

While rain makes preparatory tillage easier, the time available to the farmer acts as a constraint. For wheat, in areas where double cropping is the normal practice, the time available for preparatory tillage is confined to that between the last operation for the kharif (summer) crop and the latest possible sowing period for wheat (a winter crop). This time is limited, and depending on the size of the farm, farmers may or may not find it enough to efficiently prepare all the land they wish to put under wheat. If they do not, either less land is prepared or more land is prepared less well. This constraint has led many farmers to use tractors either by acquiring them or using them on hire. Most farmers in our survey hired them. Since tractors plough, harrow, etc., much quicker, the time constraint has practically disappeared. However, farmers still own bullocks mainly because they need them in certain operations for raising other crops, for instance, rice in Karnal and sugarcane in Muzaffarnagar. These bullocks are maintained throughout the year and could easily be used for preparatory tillage for wheat, if desired, with little additional cost, mainly for labour. It is, therefore, conceivable that a rise in the hiring charge for tractor

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*The proportion of the output that goes to a worker as wages for harvesting might vary from place to place, but it is fairly rigid in the same place. In Muzaffarnagar as well as in Karnal,it is fixed at one out of twenty or 5 per cent.

use could lead farmers to switch over to owned bullocks. If, with a given increase in the hiring charges for tractors, the farmer does not turn to bullocks, it is because he continues to find tractors more gainful even at the higher price.

Between 1973-74 and 1974-75 hiring charges for tractors went up by 25 per cent in Karnal and 20 per cent in Muzaffarnagar, due to the rises in the price of HSD, lubricants, tyres and labour. But, inspite of this no farmer switched over to bullocks. He could, of course, have cut cost by repeating the required operations for a lesser number of times and thereby sacrificing some of the efficiency of preparatory tillage. This he apparently did but with no significant adverse effect, thanks to the exceptionally good rainfall in 1974-75. Thus what might have otherwise caused a 25 per cent increase in the cost of tractor use in Karnal and 20 per cent in Muzaffarnagar, led to an increase of only 9.7 per cent in Karnal and 7.5 per cent in Muzaffarnagar.

While the farmer was seemingly compensated for the reduced use of tractors by good weather, the question remains whether he would have made less use of tractors as a result of higher cost had the weather not been so helpful. This question was put to the farmers at the time of our survey and the answer in almost all cases was that the increase in cost did not deter them from using tractors to the extent required. For a farmer who can use a tractor on hire, it becomes possible to dispense with all his bullocks or, at any rate, to reduce their number, which makes tilling much cheaper. This is the context in which a farmer hiring a tractor takes his decision. He reckoned in 1974-75, for instance, that even with the rise in hiring charges it was still cheaper to use a tractor than to go back to bullocks. Farmers owning tractors had the same view, except that, some responded to the higher cost - of tyres and lubricants more than HSD - by cutting down their pleasure trips into town.

In the case of most wheat as well as rice farmers, one should remember that, the cost of tractor use is less than 10 per cent and, in many cases, closer to 5 per cent of the total paid out cost of production. To this cost HSD contributes only a fraction. Even when other operational costs (tyres, lubricants, labour and repairs) are also considered and the hiring charges go up by 20 per cent or more as they did in 1974-75, farmers do not react by using tractors less. A major reason for this is that the return on efficient preparatory tillage is high.

The pattern of irrigating wheat is fairly standard. Depending on the weather, a farmer irrigates 3 to 5 times between sowing and harvesting. If winter rains are dispersed and adequate, he will irrigate 3 times, if skimpy or concentrated over a short period 5 times. Besides rain, if the temperature rises sharply in spring, or dry, hot westerly winds set in early, the farmer would use more irrigation. Irrigation, where available, is a basic input and specially if high yielding varieties of seeds and chemical fertilizers are used. The cost of irrigation as a proportion of total cost is low and the return to cost, even where no chemical fertilizers are used, high. One can thus expect the use of irrigation, like the seed rate, to be highly price inelastic.

Where only one source of irrigation is available the cost of irrigation, between any two years, would go up if the

weather conditions require a larger number of irrigations or the cost per irrigation increases. If we assume constant labour input and wage rates the cost per irrigation would go up with the rise in the irrigation rate for canal irrigation, the electricity rate for tubewells or pumpsets (worked on electricity) and the price of HSD for tubewells or pumpsets worked by diesel engines. However, where, as in Karnal and Muzaffarnagar, more than one source of irrigation is available, a change in the cost of irrigation can also occur when one source of irrigation is substituted for another. Canals and tubewells are used in both districts, but in Karnal canal water is not available during the winter months, i.e., for the wheat season. Thus in Karnal for growing wheat, tubewells are the only source of irrigation. Further, in Karnal tubewells are mostly run on electricity, while the diesel engine dominates in Muzaffarnagar. If the same number of irrigations were used in both years in Karnal, one would expect the cost of irrigation to go up, if the electricity rate went up. However, in Muzaffarnagar the cost of irrigation may or may not go up if the price of HSD goes up, depending on the extent to which canal irrigation is substituted for tubewell irrigation. It may be noted that the cost of canal irrigation is universally lower than tubewell irrigation, irrespective of whether the tubewell is powered by electricity or HSD. However, despite this tubewell irrigation is preferred because it provides a greater control over irrigation.

The electricity rate in Karnal was raised by 11.8 per cent in 1974-75 compared with the previous year and the cost of irrigation per hectare went up by over 15 per cent. It is possible that, in spite of good and well dispersed winter rains in 1974-75, the farmer used more intensive irrigation compared with the previous year when electricity was rationed on account of an overall shortage.* Moreover, a number of farmers used tubewells on hire and the charge for tubewells went up by more than the increase in the electricity rate.

Between the wheat season of 1973-74 and that of 1974-75,the price of HSD went up by about 15 per cent. But the per hectare cost of irrigation in Muzaffarnagar, where tubewells, powered mainly by HSD are used, declined by 6.7 per cent. For this seemingly contradictory result there were basically two reasons: (1) winter rains were exceptionally good and, as the farmers claimed, almost tailored to their needs which is very unusual; (2) with the rise in the cost of HSD, farmers used more canal irrigation. The latter neutralised the rise in the price of HSD and the former, by reducing the intensity of irrigation, reduced its cost per hectare.

Threshing costs depend largely on the size of harvest; a larger harvest will call for more threshing and a smaller harvest less. At this point the farmer has little choice. He might, if the cost of mechanical threshing rises too high, switch over to bullocks, but he will, nevertheless, thresh his entire harvest. Thus the use of a mechanical thresher will rise or fall directly with the size of the harvest. When mechanical threshers are not owned but hired, one might expect the hiring charge to rise with a good harvest and fall with a bad one. One does not, however, find evidence of this; on the contrary, the hiring charge in both Muzaffarnagar and Karnal was the same in 1973-74 and 1974-75. While in Karnal there was only a modest

*The overall supply of electricity improved during the winter months of 1974-75. The supply of electricity was particularly stringent during the rabi (wheat) season of 1973-74 and kharif (rice) of 1974-75.

increase in yield in the latter year, in Muzaffarnagar the increase was substantial and, in spite of a hiring charge in money (Rs.12.50 per quintal) instead of in kind (7.5 per cent) of the quantity of wheat threshed, as in Karnal, there was no rise in the hiring charge. Because of the highly specialised nature of the equipment, it appears that the owner of a mechanical thresher reckons to gain more when the harvest is good through greater capacity utilisation of the equipment than through a higher per quintal hiring charge. The vastly different increase in the cost of threshing between the two years in Muzaffarnagar and Karnal is thus due entirely to the difference in the increase of yield per hectare experienced in the two districts.

We have dealt with the inputs, the use of which depends mainly on the decision to cultivate. Let us now turn to those that depend either on the yield rate aimed at or actually achieved. Once the quality of seed is given - in this case a high-yielding variety of seed - and the facility for irrigating the crop at will, the yield rate aimed at will depend on the input of organic manures, chemical fertilizers, plant protection chemicals and labour associated with the application of these inputs and 'know-how'. The yield rate actually achieved will depend on all these inputs as well as the weather. Inputs for all post-harvest operations (threshing ,winnowing, etc.) will vary with the yield achieved and not the yield aimed at.

Of all these inputs, two, viz., 'know-how' and weather do not lend themselves to any simple quantitative measure, nor have we made any attempt in this direction. About the relative levels of 'know-how'among the farmers in our sample we know nothing. We do, however, know that the weather in 1974-75 was good to excellent for wheat as compared with poor to moderately good in 1973-74. While weather is an exogenous factor over which the farmer himself has no control, 'know-how' can be acquired and, within limits, depends on the efforts a farmer is willing to put in to acquire it. Between one season and the next,normally no significant change in the general level of 'know-how' may occur, though for a single farmer it is quite conceivable. For our purpose, however, we are assuming that it remains unchanged.

Among the cultural practices for wheat in north India plant protection is relatively unimportant. All farmers undertake a number of inter-culture operations to get rid of weeds when the crop is young and to aerate the soil. Only some farmers use fungicides, insecticides or pesticides. In our sample none used them in Karnal, though some did in Muzaffarnagar. The two common fungal diseases of wheat plants - wheat rust and wheat smut - have been successfully controlled through breeding resistent seeds, and hence the need for using chemicals for plant protection does not usually arise unless there is an attack of some other insect or pest.

The major input shift that occurred in our sample farms in 1974-75 was in respect of chemical fertilizers and, prima facie, can be attributed to the steep, sudden though expected rise in their prices. For the average NPK combination of fertilizer nutrients used by Karnal farmers the composite price in terms of nutrients rose by 85 per cent from Rs.2.18 per kg. to Rs.4.03 per kg. The price rise for Muzaffarnagar farmers, from Rs.2.36 per kg. to Rs.4.40 per kg. was slightly higher at 86.4 per cent. The difference in the increase of the composite price of the NPK bundle is

due to the varying degrees to which the farmers in Karnal and Muzaffarnagar reduced each nutrient and/or switched the source of nitrogen.

As the prices of fertilizers went up sharply farmers decided to use less of them. The overall fall in fertilizer inputs per hectare in terms of the combined nutrients, NPK, was 23.5 per cent in Karnal and 38.4 per cent in Muzaffarnagar. It can be seen from Table 11 that despite the larger percentage fall, fertilizer inputs in Muzaffarnagar in 1974-75 were still higher than in Karnal, though only marginally.

Table 11

Input of Fertilizer (Nutrient) per Hectare of Wheat by Size of Farm in Sample Farms in Karnal and Muzaffarnagar, 1973-74 and 1974-75

(In kgs.)

Size of farm	Karnal				Muzaffarnagar			
	N	P_2O_5	K_2O	Total	N	P_2O_5	K_2O	Total
				1973-74				
Small	86.4	25.0	0.8	112.2	116.0	50.3	3.9	170.2
Medium	96.3	32.9	3.6	132.8	130.3	50.5	12.5	193.3
Large	121.2	46.4	8.0	175.6	97.5	66.5	17.0	181.0
All farms	101.3	34.2	2.8	138.3	115.1	54.6	9.7	178.4
				1974-75				
Small	62.2 (-26.9)	14.5 (-48.0)	0.2 (-75.0)	77.9 (-30.6)	75.2 (-35.2)	35.3 (-29.8)	0.9 (-76.9)	111.4 (-34.5)
Medium	75.2 (-21.9)	32.9 (0.0)	1.6 (-55.6)	109.7 (-17.4)	71.2 (-45.4)	29.9 (-40.8)	0.42 (-66.4)	105.3 (45.5)
Large	93.4 (-22.9)	24.7 (-46.8)	2.9 (-63.7)	121.0 (-31.1)	73.2 (-24.9)	33.4 (-50.2)	9.4 (-44.7)	116.0 (-35.9)
All farms	78.2 (-22.8)	25.9 (-24.3)	1.7 (-39.3)	105.8 (-23.5)	73.5 (-36.1)	33.3 (-39.0)	3.8 (-60.8)	110.6 (-38.0)

Note: Figures in brackets are the percentage change in fertilizer input per hectare in 1974-75 over 1973-74.

The recommended dose of each fertilizer nutrient for the high yielding variety of wheat in common use in Muzaffarnagar and Karnal is 90 kgs. of N.24 kgs. of P_2O_5 and 45 kgs. of K_2O per hectare. This recommended combination of nutrients is, however, not the optimal dose of fertilizers for a variety of reasons. First, it does not specifically relate to soil characteristics which vary from farm to farm; second, to be optimal the fertilizer dose would need to be a part of an optimal mix of all inputs including cultural practices; and third, it would vary with output and input prices. Thus the recommended dose is simply a guide towards a more efficient use of fertilizers than the average current practice. However, even after allowing for these, the use of nitrogen in both Karnal and Muzaffarnagar would appear to be relatively high in 1973-74. It is

a well documented fact that the return to fertilizer nutrients declines as the dose is raised beyond a point.* Consequently if the current use of a fertilizer nutrient is relatively high, its marginal return will be correspondingly low and the quantity used will be more sensitive to a given price change. This is exactly what seems to have occurred when the farmers in Muzaffarnagar responded to the rise in fertilizer prices by reducing their input of N more than the farmers in Karnal. It is interesting to note that the input of each nutrient in Muzaffarnagar and Karnal was much closer after the price rise than it was before it.

While the input of N in both districts was high vis-a-vis the recommended dose before the price rise, this was not true either for the input of P_2O_5 or K_2O in Karnal and K_2O in Muzaffarnagar. Here again one must emphasise that the recommended NPK ratio may not necessarily be the one suited to a particular farmer's needs; even so, it seems to be a normal tendency among Indian farmers to attach major importance to the input of N and to underrate the role of P_2O_5 or K_2O because their individual effect on the crop is not directly perceptible. The significance of the right combination of nutrients to obtain the maximum return from each nutrient is not fully comprehended as yet. A rise in the price of all nutrients has, therefore, resulted in a similar reduction in N and P_2O_5 and a higher reduction in K_2O in spite of its very modest use, probably because its utility is least understood.

While it does not appear to be the practice in Karnal to use organic manures, in Muzaffarnagar all farmers do so. In 1974-75 our sample farmers, on an average, used 4.5 per cent more organic manures than they did in 1973-74 and they did this despite a rise of 53 per cent in the price of organic manures. The observed insensitivity of the demand for organic manure over the given range of its price increase appears to be due to the fact that, (a) for the wheat-sugarcane cropping pattern, besides nitrogen, humus obtained from organic manures in an important input, and (b) there is a higher prefernce for N from organic manures than from chemical fertilizers.

Change in the per hectare yield of wheat between 1973-74 and 1974-75

The extent to which fertilizer inputs per hectare were reduced in Karnal and especially in Muzaffarnagar in 1974-75, with practically no change in the other major inputs, should have resulted in at least some fall in the yield rate. In fact, the yield rate increased, moderately (7.0 per cent) in Karnal, substantially (62.0 per cent) in Muzaffarnagar (Table 12). This contrary outcome was caused by a favourable turn in the weather, from good to better in Karnal and from poor to excellent in Muzaffarnagar. The latter explains the widely different increase in yields between the two districts. A totally extraneous factor intruding in this manner frustrates any analysis of causality between inputs and output for the two years. What makes the situation even more complex is the clear possibility that good weather, especially in Muzaffarnagar, may not only have compensated for the lesser input of fertilizers but may even have induced it, at least in part.

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*Minhas and Srinivasan [4] state that the first kilogram of N per hectare for high yielding variety of wheat yields an additional 16 kgs. of wheat, while the 101st kg. yields only 2 kgs. of wheat. Similarly Panse [5] shows that while the average return per kg. of N per hectare when 56 kgs. of N is used is 13.3 kgs., it is reduced to 8.9 kgs. when 112 kgs. of N are used.

In other words, influenced by the persistence of favourable weather as the crop season progressed, the farmer might have decided to use less fertilizer inputs than he would otherwise have done even at the higher prices.

Table 12

Average Yield of Wheat per Hectare and Percentage Change in 1974-75 over 1973-74 by Size of Farm in Sample Farms in Karnal and Muzaffarnagar

Size of farms	Karnal			Muzaffarnagar		
	1973-74	1974-75	Percentage change	1973-74	1974-75	Percentage change
Small	2691	2660	- 1.2	1925	2976	+ 54.6
Medium	2352	2613	+11.1	2027	3079	+ 51.9
Large	2503	2668	+ 7.1	1690	3180	+ 88.2
All farms	2473	2616	+ 7.0	1891	3054	+ 61.5

Change in the cost of production of rice between 1973-74 and 1974-75

Our sample for rice cultivation is drawn entirely from Karnal, where two types of rice are grown - IR8 (a high yielding variety) and Bansmati, the well-known aromatic, high quality indigenous rice. Normally Karnal farmers put more than twice the area under IR8 rice than Bansmati rice.

Between 1973-74 and 1974-75 the cost of production (A_2cost) for a quintal of IR8 rice increased from Rs.39.57 to Rs.55.22 or 39.6 per cent. The corresponding increase for Bansmati rice was Rs.54.27 to Rs.68.7 or 26.9 per cent. The increase in cost varied among farms of different sizes. For both IR8 and Bansmati rice the increase was the least in large farms (Table 13).

Change in the cost of cultivation per hectare for rice between 1973-74 and 1974-75

The increase in the cost of cultivation (A_2 cost) per hectare between 1973-74 and 1974-75 was from Rs.1,705.4 to Rs.1,980.3 or 16.1 per cent and for Bansmati rice from Rs.1,560.3 to Rs.1,702 or 9.1 per cent. The lower increase in the cost of cultivation as compared with the cost of production was due to a fall in per hectare yield in 1974-75 (Table 14).

Let us again first consider the change in the inputs which are relatively fixed once the decision to cultivate is taken (Table 15).

For preparatory tillage the farmers mainly use tractors supplemented by bullocks for puddling. The hiring charge for tractors went up from 15 to 25 per cent between 1973-74 and 1974-75, whereas the per hectare cost of tractor was increased by 19.2 per cent for IR-8 rice and 21.8 per cent for Bansmati rice, indicating that there was, if at all, a negligible reduction in the use of tractors. There is also no evidence that bullocks were substituted for tractors as there was no increase in bullock-labour days employed for Bansmati rice and, in the case of IR-8 rice, there was, in fact, a small decline.

The price of seeds, both IR-8 and Bansmati, increased by about 4.5 per cent, and the seed rate declined for IR-8 rice and increased for Bansmati, both marginally. There is

Table 13

Average Cost of Production per Quintal of Paddy (IR8 and Bansmati) by Different Cost Concepts and Size of Farm Among Sample Farms in Karnal, 1973-74 and 1974-75

Cost	Paddy - IR8			Paddy Bansmati		
	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74
			Small farms			
A_1	36.55	51.28	+40.30	42.31	56.30	+33.07
A_2	37.21	52.71	+41.66	42.31	56.30	+33.07
B	54.53	74.90	+37.36	68.87	92.63	+34.50
C	56.90	77.85	+36.82	71.81	96.34	+34.16
			Medium farms			
A_1	34.63	50.68	+46.35	46.35	59.33	+28.00
A_2	36.25	52.95	+46.07	53.73	68.60	+27.68
B	50.60	73.31	+44.88	72.38	95.90	+32.50
C	51.39	74.41	+44.79	74.79	98.49	+31.69
			Large farms			
A_1	46.81	57.54	+22.92	52.50	67.74	+29.03
A_2	51.26	62.78	+22.47	59.75	75.47	+26.31
B	67.76	79.75	+17.69	76.83	99.39	+29.36
C	68.24	80.25	+17.60	77.62	100.21	+29.10
			All farms			
A_1	37.61	52.46	+39.48	48.42	62.52	+29.12
A_2	39.57	55.22	+39.55	54.27	68.87	+26.90
B	55.09	75.24	+36.58	73.76	96.75	+31.17
C	56.21	76.68	+36.42	75.53	98.78	+30.78

Table 14

Average Cost of Cultivation per Hectare of Paddy (IR-8 and Bansmati) by Different Cost Concepts and Size of Farm Among Sample Farms in Karnal, 1973-74 and 1974-75

Cost	Paddy - IR8			Paddy - Bansmati		
	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74
			Small farms			
A_1	1656.7	1883.9	+13.7	1637.5	1958.4	+19.6
A_2	1685.6	1935.1	+14.8	1637.5	1958.4	+19.6
B	2445.0	2730.8	+11.7	2608.1	3168.2	+21.5
C	2548.9	2836.7	+11.3	2715.5	3291.7	+21.2
			Medium farms			
A_1	1611.2	1819.9	+13.0	1254.9	1312.8	+ 4.6
A_2	1683.7	1899.7	+12.8	1444.5	1509.7	+ 4.5
B	2327.9	2613.0	+12.2	1923.7	2089.4	+ 8.6
C	2363.6	2651.8	+12.2	1986.4	2144.4	+ 8.0
			Large farms			
A_1	1617.1	2016.0	+24.7	1232.6	1643.5	+33.3
A_2	1766.8	2195.7	+24.3	1621.5	1824.3	+12.5
B	2321.8	2778.0	+19.6	2066.4	2384.0	+15.4
C	2338.0	2795.0	+19.5	2087.0	2403.1	+15.1
			All farms			
A_1	1623.4	1883.5	+16.0	1399.4	1551.4	+10.7
A_2	1705.4	1980.3	+16.1	1560.3	1702.9	+ 9.1
B	2353.7	2682.6	+14.0	2096.0	2367.9	+13.0
C	2400.4	2733.0	+13.9	2144.7	2416.3	+12.7

Table 15

Average Cost of Cultivation per Hectare in Paddy, IR-8 and Bansmati Varieties, and Percentage Change Between 1974 over 1973, in Sample Farms in Karnal

Items	Paddy - IR8			Paddy - Bansmati		
	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74	1973-74 (Rs.)	1974-75 (Rs.)	Percentage change over 1973-74
1. Human labour	625.4	621.7	- 0.6	615.3	607.4	- 1.3
a) Family	46.7	50.4	+ 7.9	48.7	48.4	- 0.6
b) Hired	578.7	571.3	- 1.3	566.6	559.0	- 1.3
2. Bullock labour	189.2	178.1	- 5.9	213.1	208.4	- 1.2
3. Seeds	40.3	42.1	+ 4.5	51.1	53.3	+ 4.3
4. Manures	101.2	103.2	+ 2.0	115.1	111.1	- 3.5
5. Fertilizers	376.6	578.7	+53.7	127.8	212.6	+66.4
6. Pesticides	-	1.7	-	1.8	2.7	+50.0
7. Irrigation cost	125.3	141.1	+12.6	120.9	141.3	+16.9
8. Tractor cost	87.9	104.8	+19.2	97.3	118.5	+21.8
9. Land revenue	3.5	3.5	-	2.7	3.2	+18.5
10. Depreciation	54.7	69.2	+26.5	47.5	62.9	+32.4
11. Repairs	47.2	58.1	+23.1	42.4	57.9	+36.6
12. Interest on working capital	18.9	31.7	+67.7	13.1	20.5	+56.5
13. Rent paid for leased land	82.0	96.8	+18.0	160.9	151.5	- 5.8
14. Interest on fixed capital	66.7	112.6	+68.8	57.4	104.5	+82.1
15. Rental value of owned land	581.6	589.7	+ 1.4	478.3	560.5	+17.2
Total	2400.4	2733.0	+13.9	2144.7	2416.3	+12.7

no evidence here that these slight changes in the seed rate were induced by the increase in seed prices or any other factor. In fact, such variations in the seed rate are likely to be mainly due to random fluctuations.

The bulk of labour input in rice, IR-8 as well as Bansmati, in Karnal is hired (about 93 per cent). The total labour input for Bansmati rice was almost the same in 1974-75 as in the previous year, and for IR-8 rice marginally less (2.9 per cent). There was no significant change in the wage earnings of labour (cost of labour per unit to the farmer) as money wages increased only slightly and the effect of a lower yield and a higher price of the product on payments in kind tended to offset each other.

Turning now to yield-raising or yield-dependent inputs, the pattern of change is similar in character to what was found in the case of wheat. Contrary to the sharp increase in the price of organic manures noticed in the case of wheat in Muzaffarnagar there was a decrease in it, though very slight, in Karnal. The quantity of organic manures used for IR-8 rice rose marginally and for Bansmati declined similarly. There is no evidence that these shifts were any more than random. Inter-culture operations were carried out as usual and a negligible quantity of chemicals for plant protection was used in both years.

In response to the rise in fertilizer prices the farmers in Karnal reduced the input of NPK nutrients by 12.0 per cent for the cultivation of IR-8 rice and 8.8 per cent for Bansmati rice. This reduction separately for N, P_2O_5 and K_2O is shown in Table 16. The composite cost of the average combination of NPK input in nutrients for all farmers for IR-8 rice increased by 74.8 per cent, from Rs.2.46 per kg. to Rs.4.30 per kg. and by 82.5 per cent, from Rs.2.40 per kg. to Rs.4.38 per kg. for Bansmati rice. The larger increase for Bansmati rice was due to the greater reliance on urea (for which the price was higher as a source of N).

The recommended dose of fertilizer for irrigated IR-8 rice in Karnal is 120 to 150 kgs. of N per hectare with a 2 : 1 : 1 ratio for N, P_2O_5 and K_2O*. Farmers in Karnal thus used a relatively high dose of N for IR-8 rice, but a much lower dose of P_2O_5 and K_2O, with an NPK ratio of 19 : 1.4 : 1. The reduction in yield as a result of a 15 per cent reduction in the input of N from 130 kgs. per hectare, other things remaining the same, would be relatively small. However, Karnal farmers decided to increase the input of P_2O_5 despite the rise in price, presumably to improve the NP ratio from 8 : 1 in 1973-74 to 6 : 1 in 1974-75. As Table 16 will show, this was not done equally by all farmers; but those who did it viz., the large farmers, benefited from it. Their yields in 1974-75 increased, though marginally, while the yields of all others declined. Further, it is almost certain that the large farmers would have achieved a more handsome increase in their yields had the weather been as good as it was in the previous year.

It is interesting to note here that the same farmer's response to the same increase in the price of P_2O_5 was quite different for rice and wheat and suggests that, in the farmer's experience the two crops respond differently to N and P_2O_5. If the farmer's experience is valid,

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*The normal recommendation for IR-8 rice is 120 kgs. of N per hectare, but since Karnal soils tend to be alkaline a slightly high dose (upto 150 kgs. per hectare) is advised.

it is in conflict with the common 2 : 1 : 1 recommended ratio of NPK for both wheat and rice.

In the case of Bansmati rice also, the farmer responded similarly by reducing the input of N and increasing the input of P_2O_5. He did not use any K_2O in either year. The percentage reduction in N and the percentage increase in P_2O_5 was less for Bansmati than for IR-8. The former was probably due to the much lower input even in 1973-74 and, therefore, the greater expected loss in output per unit of reduction.

Table 16

Average Fertilizer (Nutrient) Consumption per Hectare of Paddy, IR-8 and Bansmati, by Size of Farm Among Sample Farms in Karnal, 1973-74 and 1974-75

(In kgs.)

Size of farm	Paddy - IR-8				Paddy - Bansmati			
	N	P_2O_5	K_2O	Total	N	P_2O_5	K_2P	Total
				1973-74				
Small	114.0	22.6	4.1	140.7	55.6	11.4	-	67.0
Medium	134.1	15.0	5.5	154.6	52.0	7.1	-	59.1
Large	136.8	12.3	12.3	161.4	44.8	-	-	44.8
All farms	130.1	16.1	6.9	153.1	49.0	4.2	-	53.2
				1974-75				
Small	93.5	19.5	3.0	116.0	48.2	9.8	-	58.0
	(-18.0)	(-13.7)	(-26.8)	(-16.6)	(-13.3)	(-14.0)	-	(-13.4)
Medium	11.8	13.2	4.1	129.1	22.7	8.5	-	31.2
	(-16.6)	(-12.0)	(-25.5)	(-16.5)	(-56.3)	(+19.7)	-	(-47.2)
Large	126.9	28.6	10.1	165.6	56.8	-	-	56.8
	(- 7.2)	(+32.5)	(-17.9)	(+ 2.6)	(+26.8)	-	-	(+26.8)
All farms	110.9	18.5	5.3	134.7	43.8	4.7	-	48.5
	(-14.8)	(+14.9)	(-76.8)	(+12.0)	(-10.6)	(+11.9)	-	(- 8.8)

Note: Figures in brackets are percentage change in the average fertilizer consumption per hectare in 1974-75 over 1973-74.

Change in the per hectare yield of paddy between 1973-74 and 1974-75

The yield of IR-8 paddy* declined from 41.77 quintals per hectare in 1973-74 to 35.07 quintals in 1974-75 (16.1 per cent) and of Bansmati paddy from 27.49 quintals per hectare to 23.86 quintals (13.2 per cent). This decline was the compounded effect of a reduction in fertilizer input, comparatively less favourable weather conditions (mainly inadequate rains) and rationing of electricity for irrigation. This was a year when rainfall in Karnal was below normal and its distribution not in accordance with requirements. Meanwhile, irrigation (for which the farmers use electric tubewells) to the extent needed was not feasible because of cuts imposed on electricity consumption due to a general shortage of electricity supply. Farmers interrogated were very voluble about their dissatisfaction with

*Rice is taken as 62.5 per cent of the weight of paddy. This proportion can vary slightly depending on the variety of rice and whether paddy is dry or wet when milled.

the electricity supply because it had prevented them from coping adequately with the deficiency of rain.

As will be noticed, the percentage reduction in the NPK combination of nutrients in 1974-75 for rice cultivation was half of what it was for wheat in Karnal, yet the per hectare output of wheat increased, while the per hectare output of both IR-8 and Bansmati rice fell (Table 17). Quite obviously the weather more than offset the negative effect of a lower fertilizer input on the yield rate of wheat while it accentuated it in the case of rice. It is, of course, impossible to unscramble the two effects on the yield rate of rice, or even to say with certainty that, had the weather and/or electricity availability been normal the yield rate would have declined. However, it is likely that there would have been some decline, although less than what actually occurred, had the weather been the same in both years. Here again one cannot say with certainty whether the farmer would have used the same amount of fertilizers in 1974-75 as he did, were the weather better than it was.

Table 17

Average Yield of IR-8 and Bansmati Varieties of Paddy per Hectare, and Percentage Change in 1974-75 over 1973-74 by Size of Farm in Sample Farms in Karnal

Size of farm	Paddy - IR-8			Paddy - Bansmati		
	1973-74 (kgs.)	1974-75 (kgs.)	Percentage change	1973-74 (kgs.)	1974-75 (kgs.)	Percentage change
Small	4383	3585	- 18.2	3654	2955	- 19.1
Medium	4490	3505	- 21.9	2569	2123	- 17.4
Large	3365	3431	+ 2.0	2605	2340	- 10.2
All farms	4177	3507	+ 16.0	2749	2386	- 13.2

It is well established that the Indian farmer, given his state of knowledge, is rational in his production decisions. We have seen that the principal change in his input structure, whether for wheat or rice, in response to the change in the relative prices of inputs in 1974-75 was to reduce the input of fertilizers whose prices had increased the most. He made no significant shift in land allocation to the different crops he grows and hence in his product-mix. In the case of both wheat and rice he was expecting a rise in prices, which in fact occurred in the case of rice, but did not occur in the case of wheat. In both years he bore the risk of weather uncertainties, while taking his input decisions. For rice the weather proved worse than what he might have expected and for wheat better. For his future calculations, he will ignore the loss he might attribute to bad weather in the case of rice and the gain to good weather in the case of wheat. Even when he does this he is likely to come to the conclusion that the sharp increase in the price of fertilizers and of hiring charges of tractors (only partly caused by the increase in the price of diesel oil), had led to a decrease in his income from wheat and/or rice cultivation.

Change in the cost structure and net return

As a result of the farmers' response to relative changes in input prices and the expected level of output prices, the cost structure for rice as well as wheat changed in both districts (Tables 18-21). We have seen that the major price-induced quantitative reduction in input use for both wheat and rice was in fertilizers, followed by a moderate one in machine use in the case of wheat. The change in the cost structure was influenced by this fact, and also by the unequal rates by which the price of different inputs had risen and the variations in the base input mix.

Table 18

Percentage Distribution of Cost A_2 for Wheat by Factor Inputs and Size of Farm in Sample Farms in Karnal, 1973-74 and 1974-75

(In per cent)

Inputs	Small		Medium		Large		All farms	
	1973-74	1974-75	1973-74	1974-75	1973-74	1974-75	1973-74	1974-75
1. Seeds	8.8	9.4	8.8	9.0	8.6	10.7	8.7	9.7
2. Fertilizers	17.8	19.7	19.6	25.0	20.5	23.5	19.5	23.2
3. Irrigation	4.3	4.1	3.7	3.6	3.3	3.1	3.7	3.6
4. Machine cost	22.0	21.3	15.4	14.0	15.3	14.2	16.7	15.7
5. Hired human labour	20.1	19.2	21.8	19.3	21.7	19.2	21.4	19.2
6. Animal labour	17.1	14.7	15.4	12.3	13.8	14.0	15.2	13.4
7. Land revenue	0.3	0.2	0.2	0.2	0.1	0.1	0.2	0.2
8. Depreciation	4.7	4.5	4.2	4.7	2.5	2.1	3.6	3.7
9. Repairs	2.3	2.5	2.8	4.0	3.1	2.1	2.8	3.0
10. Interest on working capital	0.9	1.7	1.0	1.7	1.0	1.0	1.0	1.4
11. Rent for leased in land	1.7	2.7	7.1	6.2	10.1	10.0	7.2	6.9
Total (Cost A_2)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 19

Percentage Distribution of Cost A_2 for Wheat by Factor Inputs and Size of Farms in Sample Farms in Muzaffarnagar, 1973-74 and 1974-75

(In per cent)

	Inputs	Small		Medium		Large		All farms	
		1973-74	1974-75	1973-74	1974-75	1973-74	1974-75	1973-74	1974-75
1.	Seeds	12.1	13.4	11.3	12.7	10.9	11.4	11.5	12.7
2.	Manures	5.6	6.3	5.2	8.1	6.2	8.3	5.6	7.4
3.	Fertilizers	22.1	23.0	22.0	20.7	21.7	17.7	22.0	21.0
4.	Irrigation	8.4	5.8	8.5	6.5	8.5	8.1	8.5	6.5
5.	Machine cost	10.4	13.3	12.0	11.8	5.7	9.3	9.7	12.0
6.	Hired human labour	9.6	10.3	11.2	11.9	16.4	19.8	11.9	13.0
7.	Animal labour	24.6	21.5	20.5	19.9	19.4	16.0	22.0	19.7
8.	Land revenue	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.4
9.	Depreciation	4.1	3.3	5.5	4.5	6.3	5.3	5.1	4.1
10.	Repairs	0.9	0.7	2.4	2.2	3.5	2.6	2.0	1.6
11.	Interest on working capital	1.0	1.4	1.0	1.3	0.9	1.1	0.9	1.3
12.	Rent for leased in land	0.8	0.6	-	-	-	-	0.3	0.3
	Total (Cost A_2)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 20

Percentage Distribution of Cost A_2 per Hectare of IR-8 Paddy by Inputs and Size of Farm in Sample Farms in Karnal, 1973-74 and 1974-75

(In per cent)

	Inputs	1973-74	1974-75	1973-74	1974-75	1973-74	1974-75	1973-74	1974-75
1.	Seeds	3.1	2.8	2.5	2.3	1.5	1.2	2.3	2.1
2.	Manures	7.4	6.2	5.1	4.7	6.3	5.1	6.0	5.2
3.	Fertilizers	19.9	27.0	23.3	29.3	21.6	31.4	22.1	29.2
4.	Pesticides	-	0.1	-	0.1	-	-	-	0.1
5.	Irrigation cost	8.7	8.6	7.5	7.3	5.9	5.5	7.3	7.1
6.	Tractor cost	5.3	5.8	5.1	5.2	5.1	5.0	5.1	5.3
7.	Thresher cost	-	-	-	-	-	-	-	-
8.	Hired human labour	33.6	28.3	34.3	29.2	33.6	28.8	34.0	28.8
9.	Bullock cost	12.9	11.0	10.5	7.7	10.7	9.4	11.1	9.0
10.	Land revenue	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2
11.	Depreciation	3.9	3.6	3.4	4.3	2.3	1.9	3.2	3.5
12.	Repairs	2.1	2.1	2.7	3.9	3.4	1.9	2.8	2.9
13.	Interest on working capital	1.2	1.7	1.1	1.6	1.0	1.5	1.1	1.6
14.	Rent for leased in land	1.7	2.6	4.3	4.2	8.5	8.2	4.8	5.0
	Total(Cost A_2)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 21

Percentage Distribution of Cost A_2 per Hectare of Bansmati Paddy by Inputs and Size of Farm in Karnal, 1973-74 and 1974-75

(In per cent)

Inputs	Small		Medium		Large		All farms	
	1973-74	1974-75	1973-74	1974-75	1973-74	1974-75	1973-74	1974-75
1. Seeds	5.4	4.9	2.7	2.7	3.0	2.7	3.3	3.1
2. Manures	7.9	6.5	5.7	7.1	8.3	6.2	7.4	6.5
3. Fertilizers	9.7	15.4	9.9	8.0	6.6	13.9	8.2	12.5
4. Pesticides	-	0.2	0.4	0.4	-	-	0.1	0.2
5. Irrigation cost	7.5	8.4	9.0	10.0	7.0	7.3	7.8	8.3
6. Tractor cost	4.8	5.8	7.0	6.7	6.2	7.6	6.2	7.0
7. Hired human labour	39.7	34.4	33.0	31.2	37.4	33.2	36.3	32.8
8. Bullock cost	15.5	13.9	12.5	9.0	13.8	13.5	13.7	12.2
9. Land revenue	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2
10. Depreciation	5.9	5.8	3.2	5.2	2.1	2.0	3.0	3.7
11. Repairs	2.4	3.1	2.4	5.4	3.0	2.3	2.7	3.4
12. Interest on working capital	1.0	1.4	0.9	1.1	0.8	1.2	0.8	1.2
13. Rent for leased in land	-	-	13.1	13.0	11.7	9.9	10.3	8.9
Total(Cost A_2)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Given the expected level of output prices, the change in cost structure should normally be viewed as motivated by the farmer's objective to maximise his gain under the new price relationships. But since, the price of all inputs and fertilizers rose by an extraordinarily large amount, the weather-risk which normally increases with the cost of cultivation was magnified. In fact, the increase in cost for the same input-mix was so high that the attendent risk would have appeared inhibitive even when the price of output was expected to rise at a high rate. The dominant consideration in the farmer's mind would have, therefore, been to minimise his risk. That it was so can be seen from the evidence presented below.

In Tables 22-24 and 26a the return on both A_2 and C costs for 1973-74 and 1974-75 is compared for the selected farms in Karnal. A similar comparison for Muzaffarnagar with respect to A_2 cost is also made in Tables 26b and 26c, but no analysis is attempted because of the exceptional increase in the yield rate in 1974-75.

The net return on both A_2 and C costs per hectare for wheat as well as rice declined in 1974-75 over the previous year The decline was sharper for rice and was mainly due to fall in its yield rate (16 per cent) though to some extent (8 per cent) it was made good by a rise in price. In contrast, the yield rate of wheat increased (6.7 per cent) and at the time of survey no change in the price of wheat was assumed for 1974-75.

Table 22

Average Surplus per Hectare Over Cost A_1, A_2 and C of Wheat by Size of Farms in Sample Farms in Karnal, 1973-74 and 1974-75

(In rupees)

Size of farms	Average surplus per hectare over cost			
	A_1	A_2	B	C
		1973-74		
Small	2104	2079	1284	1171
	(147.8)	(143.5)	(57.2)	(49.7)
Medium	1707	1600	998	938
	(122.9)	(106.9)	(47.6)	(43.5)
Large	1860	1692	1193	1178
	(124.0)	(101.4)	(55.0)	(54.0)
All farms	1840	1729	1122	1067
	(128.3)	(111.9)	(52.1)	(48.3)
		1974-75		
Small	1890	1845	1000	894
	(116.6)	(110.7)	(39.8)	(34.2)
Medium	1818	1709	1028	976
	(111.3)	(98.1)	(42.4)	(39.4)
Large	1654	1444	937	926
	(87.8)	(69.0)	(36.0)	(35.4)
All farms	1783	1657	993	941
	(104.2)	(90.2)	(39.7)	(36.9)

Table 23

Average Surplus per Hectare Over Cost A_1, A_2, B and C of IR-8 Paddy by Size of Farm in Sample Farms in Karnal, 1973-74 and 1974-75

(In rupees)

Size of farms	Average surplus per hectare over cost			
	A_1	A_2	B	C
		1973-74		
Small	1675	1646	887	783
	(101.1)	(97.6)	(36.3)	(30.7)
Medium	1819	1746	1102	1066
	(112.9)	(103.7)	(47.3)	(45.1)
Large	997	847	292	276
	(61.6)	(47.9)	(12.6)	(11.8)
All farms	1572	1490	841	795
	(96.8)	(87.4)	(35.7)	(33.1)
		1974-75		
Small	1219	1168	372	266
	(64.7)	(60.3)	(13.6)	(9.4)
Medium	1193	1113	400	361
	(65.5)	(58.6)	(15.3)	(13.6)
Large	990	810	228	211
	(49.1)	(36.9)	(8.2)	(7.5)
All farms	1150	1054	351	301
	(61.0)	(53.2)	(13.1)	(11.0)

Note: Figures in brackets are the average surplus per hectare expressed as a percentage of the corresponding cost.

Table 24

Average Surplus per Hectare Over Cost A_1, A_2, B and C of Bansmati Paddy by Size of Farms, in Sample Farms in Karnal, 1973-74 and 1974-75

(In rupees)

Size of farms	Average surplus per hectare over cost			
	A_1	A_2	B	C
		1973-74		
Small	2205	2205	1235	1127
	(134.7)	(134.7)	(47.3)	(41.5)
Medium	1438	1248	769	707
	(114.7)	(86.4)	(40.0)	(35.6)
Large	1481	1092	648	627
	(120.1)	(67.3)	(31.3)	(30.0)
All farms	1476	1315	779	730
	(105.5)	(84.3)	(37.2)	(34.0)
		1974-75		
Small	1743	1743	533	409
	(89.0)	(89.0)	(16.8)	(12.4)
Medium	1038	841	262	207
	(79.1)	(55.7)	(12.5)	(9.6)
Large	983	803	243	224
	(59.8)	(56.2)	(12.4)	(10.1)

Note: Figures in brackets are the average surplus per hectare expressed as a percentage of the corresponding cost.

Since the 1973-74 price of wheat was used to calculate the value of output for 1974-75 also, the percentage increase in the per hectare value of wheat output should have been the same as the percentage increase in its yield rate. A glance at Table 25 will show that, in fact, it is not so, and that, the variation widens when farms of different sizes are considered. This happens because of the method used for valuing the output. For 1973-74 all quantities sold were valued at the price actually secured, and this varied from farmer to farmer, as each of them sold varying amounts at different times and not necessarily in the same wholesale market (mandi). The amount retained for consumption was valued at the average price secured by all farmers and, therefore, was the same for all farmers. Thus the average price at which the farmer's total output was valued varied from the average price at which the entire output of all farmers was valued. It was the latter which was used for valuing the total output of each farmer in 1974-75. There are thus two reasons why the increase in the value of output in 1974-75 could be different from the increase in the yield rate: (i) differences in the average price secured by individual farmers for the amounts sold and (ii) varying proportions of the total output marketed.

In large farms (Table 25) the increase in yield in 1974-75 was higher than that of the value of output. In small and medium farms it was the other way around. Large farms secured higher prices for the amounts sold, a fact that reflects their superior capacity to hold stock and take

advantage of a rise in price later in the year. During 1973-74 inflation in India was at its peak and farmers who had any capacity to hold stocks did so and gained by it. Their relative inability to hold stock at will puts the smaller farmers at a disadvantage vis-a-vis large farmers. As wheat prices normally tend to rise during winter and spring, large farmers usually get a better price for their marketed surplus than other farmers.

Table 25

Average Yield and Gross Value of Output per Hectare of Wheat by Size of Farm in Sample Farms in Karnal, 1973-74 and 1974-75

Size of farm	Yield per hectare (kgs.)	Value of output per hectare		
		Grain	Straw	Total
		1973-74		
Small	2691	3117	411	3528
Medium	2352	2743	353	3096
Large	2503	2970	390	3360
All farms	2473	2896	378	3274
		1974-75		
Small	2660	3112	399	3511
	(-1.2)	(-0.2)	(-2,9)	(-0,5)
Medium	2613	3057	394	3451
	(11.1)	(11.4)	(11.6)	(11.5)
Large	2681	3136	402	3538
	(7.1)	(5.6)	(3.1)	(5.3)
All farms	2646	3096	398	3494
	(7.0)	(6.9)	(5.3)	(6.7)

Note: Figures in brackets are the percentage changes in average values per hectare in 1974-75 over 1973-74.

The net return per hectare for wheat declined by over 4 per cent in 1974-75 (Table 26). The decline was substantially higher for small (11.3 per cent) and large farms (14.7 per cent). Medium farms were the exception, as in their case the net return instead of declining increased (6.8 per cent). This favourable result was achieved mainly because their response to the increase in fertilizer prices was the least elastic. Against a decrease of 31 per cent in fertilizer inputs among small and large farms, the decline in medium farms was only 17 per cent. Consequently the yield rate in medium farms rose and nearly equalled the level in small and large farms, when in the previous year it was significantly lower. Of course, had the weather been the same, it is more than likely that the net return even in medium farms would have declined, though to a lesser extent that in small or large farms. However, the point to be emphasised is that all farmers did not respond in the same manner to the increase in fertilizer prices; some perceived the risk attached to additional input cost to be lower than others or were willing to take greater risk and,in the event, were proved right by receiving a better net return.

TABLE 26

Gross Value of Output, Cost A_2, and Surplus over Cost A_2 per Hectare, Average Area and Total Surplus per Farm, for Wheat in Sample Farms in Karnal, 1973-74 and 1974-75

Size of farms	Per hectare of wheat			Area (hectare)	Total surplus (Rs.)
	Value of output (Rs.)	Cost A_2 (Rs.)	Surplus (Rs.)		
		1973-74			
Small	3528	1449	2079	1.81	3763
Medium	3096	1496	1600	4.01	6416
Large	3360	1668	1692	7.49	12673
All farms	3274	1545	1729	3.67	6345
		1974-75			
Small	3511	1666	1845	1.78	3284
	(-0.5)	(+15.0)	(-11.3)	(-1.7)	(-12.7)
Medium	3451	1742	1709	3.56	6084
	(+14.7)	(+16.4)	(+ 6.8)	(-11.2)	(- 5.2)
Large	3538	2094	1444	6.58	9502
	(+ 5.3)	(+25.6)	(-14.7)	(-12.2)	(-25.0)
All farms	(6.7)	(+18.9)	(- 4.2)	(-11.2)	(-14.9)

Table 26a

Surplus Over Cost A_2 for Wheat, Paddy and Other Crops per Farm by Size of Farm in Sample Farms in Karnal, 1973-74 and 1974-75

(In rupees)

Size of farms	Surplus over cost A_2 per farm				
	Wheat	Paddy IR-8	Paddy Bansmati	Other crops	Total
			1973-74		
Small	3763	2568	882	3211	10424
Medium	6416	5936	1211	9027	22590
Large	12673	3600	3647	17292	37212
All farms	6345	4127	1486	7989	19947
			1974-75		
Small	3284	1845	732	2845	8706
	(12.7)	(28.2)	(17.0)	(11.4)	(16.5)
Medium	6084	3918	681	7264	17947
	(5.2)	(34.0)	(43.8)	(19.5)	(20.6)
Large	9502	3402	2313	12180	27397
	(25.0)	(5.5)	(36.6)	(29.6)	(26.4)
All farms	(14.9)	(29.0)	(37.5)	(23.3)	(22.9)

Note: Figures in brackets are the percentage decline in total surplus per farm in 1974-75 over 1973-74.

Table 26b

Gross Value of Output, Cost A_2 and Surplus Over Cost A_2 per Hectare, Average Area and Total Surplus per Farm for Wheat in Sample Farms in Muzaffarnagar 1973-74 and 1974-75

Size of farms	Per hectare of wheat			Area (hectare)	Total surplus
	Value of output (Rs.)	Cost A_2 (Rs.)	Surplus (Rs.)		(Rs.)
		1973-74			
Small	2721	1839	882	1.07	944
Medium	2864	2051	813	1.60	1301
Large	2277	1930	347	2.29	795
All farms	2643	1922	721	1.39	1002
		1974-75			
Small	4111 (+15.1)	2253 (+22.5)	1858 (+110.7)	1.16 (+ 8.41)	2155 (+128.3)
Medium	4249 (+48.4)	2404 (+17.2)	1845 (+126.9)	1.92 (+20. 0)	3542 (+172.3)
Large	4388 (+92.7)	2339 (+21.2)	2049 (+490.5)	2.12 (- 7. 4)	4344 (+444.4)
All farms	4216 (+59.5)	2319 (+20.7)	1897 (+163.1)	1.49 (+ 7. 2)	2827 (+182.1)

Table 26c

Surplus Over Cost A_2 for Wheat and Other Crops per Farm by Size of Farm in Sample Farms in Muzaffarnagar, 1973-74 and 1974-75

(In rupees)

Size of farms	Surplus of cost A_2 per farm		
	Wheat	Other	Total
	1973-74		
Small	944	6336	7280
Medium	11201	18380	19681
Large	795	20798	21593
All farms	1002	11530	12532
	1974-75		
Small	2155 (128.3)	5676 (-10.4)	7831 (7.6)
Medium	3542 (172.3)	15221 (-17.2)	18763 (-4.3)
Large	4344 (446.4)	16036 (-22.9)	20380 (-5.6)
All farms	2827 (182.1)	9644 (16.4)	12471 (-0.5)

Note: Figures in brackets are percentage changes in average surplus per farm in 1974-75 over 1973-74

It is tempting to speculate that, had all farms used the same quantity of fertilizers in both years, yields would have been much higher, thanks to the weather, and like medium farms all farms would have improved their net return. Such a conclusion would, of course, be an over simplification, for a glance at Table 11 will readily show that although different categories of farms used different quantities of fertilizers per hectare in 1974-75, their yields were roughly the same. Again it would not be correct to conclude that the marginal product of fertilizers in the case of medium and large farms was near zero since, with higher inputs than small farms, they got the same yield, because it is possible that the mix of inputs used by small farms was superior, either because of a more efficient combination of material inputs or of material and human inputs. The latter seems likely. Small farmers usually give more personal attention to their farm operations, depend less on hired labour, and, partly as a result of this, use better cultural practices or the same cultural practices more efficiently. Thus while it is more than likely that the net return for all farms would have increased in 1974-75 had they used the same quantity of fertilizers as they did the previous year, it would be hazardous to quantify this speculation.

The net return for the wheat crop declined more than the net return per hectare because there was some decrease in the area under wheat in each category of farm. It was for this reason that an increase in the per hectare net return for wheat in medium farms turned into a decrease for the wheat crop. Prima facie, it might appear that the rise in per hectare cost of cultivation and the corresponding increase in risk led the farmer to sow less land with wheat. In fact, as we have stated earlier, enquiries revealed that the decline in area was mainly due to the normal annual shifts in land lease arrangements and was independent of the increase in cost.

For a majority of farm households the level of income is so low that any fall in it means a large loss in welfare. The farmer responds to this situation by making a delicate calculation which aims at protecting his family's welfare without unduly increasing the extent of loss in case the weather becomes unfavourable. Increase in productivity occurs cautiously along this narrow ridge, with the farmer always working out his trade-off between possible increments in welfare and the danger of having it rudely slashed. In this calculus he is concerned with maximising household welfare under conditions where risk is exaggerated on account of the low welfare base of the farm household. In the minds of the farmers, both in Karnal and Muzaffarnagar, it appears that the increased risk incumbent on the larger cost for the same input mix dominated and the farmer tried to minimise this with the least sacrifice of welfare. All of this, it must be repeated, the farmer did on the assumption of average weather conditions. If his net return turned out to be better because of good weather, he must have viewed it as a bonus and would not allow it to enter into his calculations next year when he is taking his input decisions.

Srinivasan /3/ has argued that the observed lower productivity of land in large compared with small farms can be attributed to the bigger commitment of input costs (in absolute terms) in large farms, which leads them to use an inferior input mix to reduce risk. While we would not contest the generality of this observation, we must point out that, for our sample of farmers, it was certainly not true. So far as material inputs are concerned large farmers

used a more costly input mix per hectare (though not necessarily superior) in 1973-74 and their cost per hectare increased more compared to others, in 1974-75 after the rise in fertilizer and other prices. This would tend to show that their perception of risk carried a lower profile than either the medium or the small farmers. This is quite plausible since smaller farmers are likely to lose more in terms of welfare, were the weather to fail, than larger farmers. Thus for the same proportionate fall in income due to bad weather, a larger farmer would be prepared to take a greater risk than a small farmer. To this we must add the fact that large farmers normally secure, as pointed out earlier, a better price for their product and hence, to start with, bear a lesser risk than small farmers because they are assured of a better return on the same cost of inputs.

We can conclude that for an increase in input cost, which threatens to lower the net return with average weather expectations the small farmer is likely to impose a bigger cut on his inputs than a large farmer. If the weather is good and the harvest better than average, prices will tend towards stability during the course of the year and the large farmer's ability to stock and sell later will give him only a marginal advantage. On the other hand, if the weather turns out to be adverse and a poor crop causes shortages leading to a sharp rise in price later in the year, small farmers would suffer relatively more. Since our year of enquiry (1974-75) was a good one it tended to narrow the fall in the net return of small and large farms. Estimates of net return for 1974-75 in Table 22 are based on a single price of wheat for all farms, which to be true in reality would mean that there is very little change in the price of wheat throughout the year. A normal rise would benefit the large more than the small farmers. It is quite likely that it was such an expectation that induced the large farmers to raise their cost per hectare by 25 per cent against a much lower increase that the smaller farmers permitted themselves.

Farmers' response to the increase in fertilizer and other prices in the case of paddy was similar to wheat. However, since the weather turned out to be worse than average instead of better, the net return per hectare declined more sharply, though income from paddy declined somewhat less as there was an increase in the area (except in large farms) under paddy (Tables 27 and 28).

As between small, medium and large farms again one finds a similar response in paddy to that in wheat. Large farmers took a greater risk than small or medium farmers and, despite unfavourable weather, it paid off. The decline in their net return was much less than for small or medium farmers, mainly for two reasons: (i) while small and medium farms suffered a substantial decline in their yield (Tables 29 and 30) large farms achieved a marginal increase; and (ii) large farms secured a better price for their crop. In 1973-74 the yield on large farms was substantially lower than that for small or medium farms. In 1974-75, though still lower, it was of the same order of magnitude. Since all farms faced the same weather conditions this transformation must be attributed to the improved input mix of the large farms. Referring back to Table 16 one can notice the specific character of this change in respect of fertilizers. Firstly, as against a decrease of 16 to 18 per cent in fertilizer inputs (quantities) in small and medium farms, there was an increase of 2.5 per cent in large farms. (Similar deviant behaviour was noticed on the part of medium farmers in the case of wheat). Secondly, while small and

Table 27

Gross Value of Output, Cost A_2 and Surplus over Cost A_2 per Hectare, Average Area and Total Surplus per Farm for IR-8 Paddy in Sample Farms in Karnal, 1973-74 and 1974-75

Size of farms	Per Hectare of paddy - IR-8			Area	Total surplus
	Value of output (Rs.)	Cost A_2 (Rs.)	Surplus (Rs.)	(hectare)	(Rs.)
		1973-74			
Small	3332	1686	1646	1.56	2568
Medium	3430	1684	1746	3.40	5936
Large	2614	1767	847	4.25	3600
All farms	3195	1705	1490	2.77	4127
		1974-75			
Small	3103	1935	1168	1.58	1845
	(-6.9)	(+14.8)	(-29.0)	(+1. 3)	(-28.2)
Medium	3013	1900	1113	3.52	3918
	(-12.2)	(+12.8)	(-36.3)	(+3. 5)	(-34.0)
Large	3006	2196	810	4.20	3402
	(+15.0)	(+24.3)	(- 4.4)	(-1. 2)	(- 5.5)
All farms	3034	1980	1054	2.78	2930
	(- 5.0)	(+16.1)	(-29.3)	(+0. 4)	(-29.0)

Table 28

Gross Value of Output,Cost A_2 and Surplus over Cost A_2 per Hectare,Average Area and Total Surplus per Farm for Bansmati Paddy in Sample Farms in Karnal, 1973-74 and 1974-75

Size of farms	Per Hectare of Paddy - Bansmati			Area	Total surplus
	Value of output (Rs.)	Cost A_2 (Rs.)	Surplus (Rs.)	(hectare)	(Rs.)
		1973-74			
Small	3843	1638	2205	0.40	882
Medium	2693	1445	1248	0.97	1211
Large	2714	1622	1092	3.34	3647
All farms	2875	1560	1315	1.13	1486
		1974-75			
Small	3701	1958	1743	0.42	732
	(- 3.7)	(+19.6)	(-21.0)	(+5. 0)	(-17.0)
Medium	2351	1510	841	0.81	681
	(-12.7)	(+ 4.5)	(-32.6)	(-16. 5)	(-43.8)
Large	2627	1824	803	2.88	2313
	(- 3.2)	(+12.5)	(-26.5)	(-13. 8)	(-36.6)
All farms	2661	1703	958	0.97	929
	(- 7.5)	(+ 9.1)	(-27.1)	(-14. 2)	(+37.5)

Note: Figures in brackets are percentage changes in 1974-75 over 1973-74.

Table 29

Average Yield and Gross Value of Output per Hectare of IR-8 Paddy by Size of Farm Among Sample Farms in Karnal, 1973-74 and 1974-75

Size of farms	Yield per hectare (kgs.)	Value of output per hectare		
		Grain (Rs.)	Straw (Rs.)	Total (Rs.)
		1973-74		
Small	4383	3277	55	3332
Medium	4490	3374	56	3430
Large	3365	2558	42	2614
All farms	4177	3143	52	3195
		1974-75		
Small	3586 (-18.2)	3058 (- 6.7)	45 (-18.2)	3103 (-6.9)
Medium	3505 (-21.9)	2969 (-12.0)	44 (-21.4)	3013 (-12.2)
Large	3431 (+ 2.0)	2964 (+15.9)	42 (0.00)	3006 (+15.0)
All farms	3507 (-16.0)	2990 (- 4.9)	44 (-15.4)	3034 (- 5.0)

Table 30

Average Yield and Gross Value of Output per Hectare of Bansmati Paddy by Size of Farm Among Sample Farms in Karnal, 1973-74 and 1974-75

Size of farms	Yield per hectare (kgs.)	Value of output per hectare		
		Grain (Rs.)	Straw (Rs.)	Total (Rs.)
		1973-74		
Small	3654	3752	91	3843
Medium	2569	2629	64	2693
Large	2605	2649	65	2714
All farms	2749	2806	69	2875
		1974-75		
Small	2955 (-19.1)	3618 (- 3.6)	83 (- 8.8)	3701 (- 3.7)
Medium	2123 (-17.4)	2298 (-12.6)	53 (-17.2)	2351 (-12.7)
Large	2340 (-10.2)	2568 (- 3.1)	59 (- 9.2)	2627 (- 3.2)
All farms	2386 (-13.2)	2601 (- 7.3)	60 (-13.0)	2661 (- 7.4)

Note: Figures in brackets are percentage changes in average values per hectare in 1974-75 over 1973-74.

medium farmers reduced the input of N, P_2O_5 and K_2O, large farmers reduced the input of N and K_2O (though by a much smaller amount) but more than doubled the input of P_2O_5. It will also be seen from Tables 31 and 32 that, while the cost of hired labour and bullock labour for small and medium farms declined in 1974-75, it increased for large farms, indicating, perhaps, a more intensive effort on their part. The deviant behaviour of large paddy farmers is very significant, especially in the context of a general tendency in the wake of the rise in fertilizer prices to sacrifice P_2O_5 in favour of N. It is of considerable research interest to find out why the response of the same farmers to the same rise in the price of P_2O_5 was so different for paddy and wheat.

It is a moot point whether a similar shift in the NPK mix in small and medium farms would have retrieved most of their loss. It is possible that it might have, to a considerable degree, though the effect of bad weather would still have given them a lower yield. Further, it should be noted that small and medium farms, despite their seemingly inferior mix of NPK, did obtain better yields than large farms, drawing attention again to the overall superiority of the input mix in smaller farms. Given this, one would be right in concluding that had the risk of a higher cost for the same input mix been externally set off (for instance, by better credit facilities) the loss in paddy cultivation for small and medium farmers in 1974-75 would have been lower and the output of paddy higher.

The decline in the net return per hectare observed for wheat and paddy was true for most other crops grown. For all crops grown by all selected farmers in Karnal, the net return declined by 23 per cent, which is quite considerable. The decline was greatest for paddy (particularly Bansmati) and the least for wheat (Table 26a). In Muzaffarnagar too, where the net return for wheat increased substantially, the net return for all crops declined, though marginally (Table 26c).

Table 31

Average Cost of Cultivation per Hectare in IR-8 Paddy by Size of Farm, Among Sample Farms in Karnal, 1973-74 and 1974-75

(In rupees)

Items	1973-74				1974-75			
	Small	Medium	Large	All farms	Small	Medium	Large	All farms
1. Human labour								
(a) Family	103.9	35.7	16.2	46.7	105.9	38.8	17.0	50.4
(b) Hired	566.7	577.2	593.1	578.7	548.0	553.2	633.2	571.3
2. Bullock labour	217.1	176.5	188.6	189.2	214.2	146.9	205.9	178.1
3. Seeds	51.7	41.6	27.1	40.3	53.5	43.6	27.1	42.1
4. Manures	124.7	85.6	110.6	101.1	120.7	90.3	112.0	103.2
5. Fertilizers	336.4	392.5	381.5	376.6	520.1	555.1	688.5	578.7
6. Pesticides	-	-	-	-	1.7	2.6	-	1.7
7. Irrigation cost	147.2	125.9	104.1	125.3	166.5	138.0	121.2	141.1
8. Tractor cost	89.8	85.8	90.4	87.9	112.1	99.3	109.0	104.8
9. Thresher cost	-	-	-	-	-	-	-	-
10. Land revenue	3.7	3.7	2.7	3.5	3.5	3.8	2.7	3.5
11. Depreciation	63.8	57.8	40.4	54.7	70.4	82.0	40.9	69.2
12. Repairs	35.2	45.7	61.0	47.2	40.4	74.8	41.7	58.1
13. Interest on working capital	20.4	18.9	17.6	18.9	32.8	30.3	33.8	31.7
14. Rent for land leased in	28.9	72.5	149.7	82.0	51.2	79.8	179.7	96.8
15. Interest on fixed capital	79.6	70.6	47.2	66.7	119.2	131.3	66.5	112.6
16. Rental value of owned land	679.8	573.6	507.8	581.6	676.5	582.0	515.8	589.7
Total	2548.9	2363.6	2338.0	2400.4	2836.7	2651.8	2795.0	2733.0

Table 32

Average Cost of Cultivation per Hectare of Bansmati Paddy by Size of Farm Among Sample Farms in Karnal, 1973-74 and 1974-75

Items	1973-74				1974-75			
	Small	Medium	Large	All farms	Small	Medium	Large	All farms
1. Human labour								
(a) Family	107.4	62.7	20.6	48.7	123.5	55.0	19.1	48.4
(b) Hired	649.3	476.9	606.8	566.6	671.4	470.4	606.2	559.0
2. Bullock labour	254.0	180.9	224.2	213.1	271.7	135.4	246.4	208.4
3. Seeds	87.7	38.2	49.4	51.5	96.5	40.4	49.4	53.3
4. Manures	129.6	82.2	134.7	115.1	128.0	107.4	112.6	111.1
5. Fertilizers	158.8	143.2	107.1	127.8	302.0	121.3	254.4	212.6
6. Pesticides	-	5.1	-	1.8	4.8	5.6	-	2.7
7. Irrigation cost	122.7	129.9	113.7	120.9	165.0	150.5	132.7	141.3
8. Tractor cost	79.0	101.5	99.8	97.3	113.4	101.3	137.8	118.5
9. Land revenue	3.9	3.0	2.2	2.7	4.8	3.2	2.7	3.2
10. Depreciation	96.7	46.0	33.8	47.5	113.0	78.8	36.7	62.9
11. Repairs	39.5	35.3	48.5	42.4	60.3	82.2	42.6	57.9
12. Interest on working capital	16.3	12.7	12.4	13.1	27.5	16.3	22.3	20.5
13. Rent for leased in land	-	189.6	188.9	160.9	-	196.9	180.8	151.5
14. Interest on fixed capital capital	130.1	49.2	41.4	57.4	203.7	120.0	62.7	104.5
15. Rent value of owned land	840.5	430.0	403.5	478.3	1006.1	459.7	497.0	560.5
Total	2715.5	1986.4	2087.0	2144.7	3291.7	2144.4	2403.1	2416.3

CHAPTER III

A View of the Future

The new seed-fertilizer technology or the Green Revolution got a firm hold in Indian agriculture by the middle sixties and thereafter spread rapidly, especially amongst wheat farmers. The shift in factor relationships that followed brought about a significant qualitative change in the input mix. A new phase in the development of Indian agriculture had begun. However, the high initial rate of growth in fertilizer inputs per hectare gave place to a slower one in the seventies, as the marginal product declined with an increase in the per hectare dose. Evidence of this can be clearly seen in Table 33 for nitrogenous fertilizers which dominate fertilizer consumption. In many of these years fertilizer consumption was determined by availability, because, at controlled prices, demand exceeded supply. This fact explains, to a large extent, the widely varying rates of growth in annual consumption. The trend in output during the decade was similar though more marked in the case of wheat than rice because the new technology for wheat was more sharply differentiated from the traditional one. During the later sixties as well as the seventies, the farmer concentrated mainly on those components in the new technology package which were immediately the most rewarding,viz., the new seed and nitrogenous fertilizers. Today we appear to be on the threshold of the next phase when the farmer will be forced to pay greater attention to the other, presently neglected, components.

With such structural changes interwoven in the input and output streams over a relatively short span of a decade and further changes in the offing, standard statistical procedures for making projections are likely to prove inept tools for visualising the future. To this is now added a one-move change in the price of fertilizers, whose magnitude takes it out of the proper range of these tools. We shall, therefore, attempt no quantitative projection of wheat and rice production, but will instead concentrate on anticipating how the farmers and the Government are likely to respond to the new fertilizer prices. It is easy to see that these responses will be strongly influenced by the imperative not only to feed a large and growing population but to feed it better.

To start with, let us reiterate the two salient features of the present situation which are revealed by our survey. First, the rise in fertilizer prices in June 1974 caused the farmers to reduce their fertilizer inputs, though the extent of the cut varied from crop to crop, region to region and even from farmer to farmer. While our survey was limited, other evidence is available (Appendix and /6/) to show that, our findings reflect the general response of farmers throughout the country.

Secondly, though the inconstancy of weather complicated the impact of lower fertilizer inputs on production, the net return both for wheat and rice declined. Further, the net return for all crops grown by the farmer during the course of the full agricultural year also dropped and by a significant amount. The latter meant that the income of the farmer in 1974-75 fell below the 1973-74 level. This was true of all farms, irrespective of size and even of the farms in Muzaffarnagar. Here again there is evidence to corroborate our findings. /6/

Table 33

Consumption and Price of Nitrogenous Fertilizers and Production of Wheat, Rice and Foodgrain in India 1964-65 - 1973-74

Years	Consumption of nitrogenous fertilizers in nutrients ('000 tonnes)	Percentage increase in the consumption of nitrogenous fertilizers	Fertilizer prices		Production (Million tonnes)		
			Urea (Rs./ tonne)	Ammonium sulphate (Rs./ tonne)	Wheat	Rice	Foodgrains
1964-65	434.5	6.6	633	445	12.29	39.03	89.90
1965-66	547.4	26.0	633	515	10.42	30.66	72.03
1966-67	838.7	53.4	680	515	11.53	30.44	75.05
1967-68	779.5	-4.6	840	577	16.54	37.60	95.05
1968-69	1,131.9	41.6	860	577	18.65	39.76	94.01
1969-70	1,360.3	20.2	943	626	20.10	40.43	99.50
1970-71	1,487.1	9.3	923	626	23.83	42.23	108.42
1971-72	1,755.4	18.4	959	549	26.41	43.07	105.17
1972-73	1,778.9	1.0	1,050	600	24.92	38.63	95.20
1973-74	1,835.0	2.8	1,050	600	22.00	44.00	104.00

Table 34

Consumption and Price of Phosphatic Fertilizers in India 1964-65 to 1973-74

Years	Consumption of Phosphatic fertilizers in nutrients ('000 tonnes)	Percentage change in the consumption of phosphatic fertilizers	Fertilizer prices
			Super-phosphate 16% P_2O_5 Rupee/Tonne
1964-65	147.7*	26.6	-
1965-66	132.2*	-10.5	249
1966-67	248.6*	88.0	312
1967-68	236.5	- 4.9	312
1968-69	389.2	64.6	282
1969-70	419.8	7.9	319
1970-71	462.0	10.1	291
1971-72	564.0	22.1	302
1972-73	587.4	4.1	353
1973-74	649.9	10.6	385

*From 1964-65 to 1966-67, distribution figures were treated as consumption.

Since the vagaries of weather and the attending uncertainties are likely to be with us, the only way to visualise the future is with references to 'normal' or average weather conditions. This is what the farmer does when he makes his decision on what inputs, and how much, he is going to use, and also the Government, when it decides on a policy or a programme to influence the production of foodgrains. The year 1974-75 was an average year in the sense that, while the weather conditions were below 'normal' for the summer crops, they were better than 'normal' for the winter crops. The production of foodgrains in that year according to recent official estimates was 104 million tonnes and compared unfavourably with 108 million tonnes in 1970-71 and 105 million tonnes in 1971-72. A lower output, associated with a cut in fertilizer inputs, in a year which must be treated as equivalent to an average year represents a situation which would be worthy of concern to the Government as much as to the farmer who suffered a decline in his income. Both would thus try not only to restore the previous levels of fertilizer inputs but to resume, at least, the interrupted upward trend.

Technology

To retrieve loss in income the major avenue open to the farmer is to take another look at the new technology to find means to reduce production costs and especially to increase the efficiency of fertilizer use. Fortunately the farmer will find many and varied means available to him.Of course we have already discovered an important one in our survey. Under the pressure of high fertilizer prices large farmers in Karnal reduced their input of N for paddy cultivation, which was already at the recommended level, and increased their input of P O which was far below the recommended level. The substitution of P O for N meant additional cost, compared to what the cost might have been had the farmer simply reduced the input of N. But the improvement in the fertilizer mix produced a marginal increase in the yield rate in a year of unfavourable weather when all other farmers suffered a decline. As a result, these farmers came out much better financially than others.

Indian farmers have been described as "nitrogen-crazy" and indeed for most of them fertilizer means nitrogen, probably because it produces immediately descernible results which they can readily appreciate. This attitude appears to be typical of the first phase in the adoption of the new technology. Like the large farmers in Karnal there is evidence to show that many others are finding it profitable to move similarly into the next phase. /7/ It is legitimate to expect that the increase in fertilizer prices will speed up the process of raising the efficiency level of fertilizer use. The farmer will now be very anxious to acquire more of the existing knowledge on soil nutrients and their use.

It is also likely that the farmer will not confine his search for cost economies only to redressing the N, P ratio or even the N, P and K ratio. There are several other ways of achieving greater economy in fertilizer use. Important among these are briefly:

(i) the integration of organic manures with chemical fertilizers, and application of combinations taking account not of a single crop, but of the whole cropping system. It is well known that nutrients applied to one crop leave a residue available to the next crop which is often not taken advantage of. When properly formulated combinations of fertilizers are used for a cropping system, these residues would be picked up and would raise the utilisation ratio of fertilizer inputs.

(ii) it is common practice to give a large base application of fertilizers with heavy irrigation, whereas 'split' applications with light irrigation are much more efficient.

(iii) the recovery of applied fertilizer nitrogen by crops is generally low and especially in kharif (including paddy) crops, where it can be less than half. This amounts to a considerable loss which can be saved, at least to a large extent, by the simultaneous application of certain chemicals and also certain non-edible oilcakes which are much cheaper.

(iv) it is also known that closer spacing of plants, than is the normal practice, raises the yield rate with the same application of fertilizer.

(v) Early sowing achieves the same results.

(vi) micro-nutrients are still not used and would, if used along with fertilizers, raise the yield rate.

(vii) several varieties of new seeds have now been developed, of which one tends to give better results than others in similar agro-climatic conditions of a region. The adoption of this "dominant" seed would lead to an almost no-cost improvement for the farmer.

It is not necessary here to delve further into other areas of cost-reducing improvements in farming, but one might mention two, which are particularly important. It might have been noticed that our sample of farmers paid scant attention to plant protection, and though farmers in India may now be more vigilant in general than before, it is true that modern methods of plant protection are still not widely used. The other area of perhaps even greater significance, where progress is still meagre, is water management.

Clearly, all of these avenues of improvements cannot be adopted immediately, but the climate has been created in which the incentive for the farmer to do so has undergone a radical change. In the first instance, the incentive would be for the farmer to acquire new knowledge and the associated new techniques. There are implications here for the extension service and for a more vigorous use of mass media. To the extent that farmers' complacence inhibited the speedier adoption of information or know-how in the past, has been replaced by a sharpened awareness as recipients now could ensure gains even with the existing system. But this would also be the right time for innovations in the techniques of mass communication.*

Credit

The input of new knowledge usually implies additional risk for the farmer, which is further enhanced if additional cost is involved in complementary inputs. This acts as a deterrent to the adoption of innovations. The perception of risk depends not only on the additional outlay involved, but also on the base level of input use and the base level of household income.

In India majority of farms are either not irrigated or not well served with irrigation facilities and hence, either do not use fertilizers at all or use smaller doses than the farms in Karnal or Muzaffarnagar, both of which are relatively advanced districts. Since fertilizers, as much as any other input, are subject to diminishing returns, there is much to be gained in terms of output by transferring the

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*India has just recently started a satellite TV programme specifically oriented to farmers.

the marginal inputs of fertilizers from those farms which use high doses to those that still use relatively small doses or none. There is a prestigious body of opinion in the country [4,6] that would favour such a transfer. However, it should be recognised that control on irrigation is a facility which considerably improves the efficiency of fertilizer application and, therefore, its lack is an impediment. To the extent there is no agronomic bottleneck, the return on marginal cost of fertilizer inputs would be higher in farms using a low rather than a high dose. For the low-dose farms additional fertilizer application even at the present prices may be profitable. A good number of these farms are likely to be small with low incomes and hence, though innovative behaviour in their case may entail less risk, their perception of it, dominated by their low resource base, may magnify it.

There is another kind of small farm which applies a relatively high dose of nitrogen and secures higher per hectare yields than large farms. We seen such farms in our sample and several empirical studies have shown that this is indeed a common phenomenon. Varying explanations for it have been offered, but the one that appears to fit the case we have examined may well have a wider application. It is more meticulous care and greater attention to detail (through closer personal involvement and supervision) that small farmers give and the large farmers cannot, which explain their higher yields. However, despite this, the small farmer may not secure a better net return as he is likely to sell his output soon after the harvest when the prices are low, while the large farmer can hold stocks to secure a higher price later in the year. The small farmer, therefore, rarely gets the full benefit of his greater efficiency. This fact is an indication and proof of his vulnerability, and the more vulnerable he is, the greater the risk he takes for any additional rupee worth of input he uses. The other, and not unrelated, reason for his vulnerability is that credit on reasonable terms is not easily available to him. Indeed, if such credit were to become available to him to the extent of his needs, his ability to bear the risk of crop damage or failure due to adverse weather conditions, and his capacity to hold stocks would considerably improve.

In the past the small farmer has also found himself at a disadvantage in the market for fertilizers which has generally suffered from excess demand. His ability to secure supplies in such a situation has not been the same as that of the larger farmer who has more influence and better financial resources. Fortunately, the availability of fertilizers, of late, has considerably improved and this will be in his favour.

As a part of Government's 20 Point Programme, announced in June, 1975, it was proposed to set up a number of Regional Rural Banks. The first set of these banks have already been set up. It is the object of these banks to specifically meetthe credit needs of the farmers and particularly of the small farmers. To make their operation more efficient they are to have a new type of management with personnel trained in agriculture and geared to understanding the problems of the farmers. Security-oriented policy for advances is to be replaced by a greater leeway for the manager to rely on his judgement of the borrower's potential to re-pay. Currently 50 such banks are planned and are expected along with cooperative societies and new branches of commercial banks to provide full coverage of institutional facilities for rural credit requirements of the entire country.

If the existing plan for establishing Regional Rural Banks, or any modification with the same objectives, is carried through, it would considerably improve the ability of the smaller farmer to use more fertilizers. The economics of fertilizer use in these farms is manifestly superior and they, more than the farmers who already use high doses of fertilizers, are in a position to gain from increased use.

Product prices and controls

The return of our sample farmers need not have fallen had there been a compensatory rise in output prices. In the case of rice, because of lower output due to unfavourable weather and lower fertilizer application, the price rise was not enough to offset the increase in cost. The weather conditions for wheat were so favourable that the decline in output that would have occurred with lower fertilizer inputs was more than offset, and the consequent rise in output prevented a rise in price. This outcome was helped by the curbs on speculation successfully applied after the Emergency of June 1975. The rise in the cost of production (15.3 per cent for wheat and 39.6 and 26.9 per cent for IR-8 and Bansmati rice) was clearly of a magnitude that could not have been compensated for by a rise in the product price in a single year. But it is evident that one way by which the fall in the farmer's income will be restored is an increase in the product price that exceeds the increase in the cost of production, after allowing for such economies in cost as the farmer is able to make by his own efforts.

In India, the Government regulates the price of fertilizers as well as those of wheat and rice. While its direct control of the prices of wheat and rice is limited to the part that goes through the public distribution system, it also influences the open market price through imports, buffer-stock releases/withdrawals and zonal restrictions on the movement of these foodgrains. In the wake of high inflation during 1972-74, the main thrust of policy has legitimately been to keep prices from rising. This has now been successfully achieved. The problem of adjusting output to input prices is in the process of being resolved.

Since the increase in fertilizer prices in June 1974, the Government has revised them downwards more than once,thanks mainly to the fall in import prices and a reduction in the proportion of imports in the total supply. With respect to wheat and rice prices too the Government has intervened,but to prevent them from falling below procurement prices. This effort continued through the 1975 kharif and the 1976 rabi seasons which produced record crops, thanks mainly to the extraordinarily good monsoon that year, but the prices nevertheless fell. Such weather - induced good harvests as we have had in 1975-76 can conceal the danger of a steep fall in output even with average weather conditions. It is necessary, therefore, to create the conditions, as soon as possible, to restore fertilizer consumption not only to the 1973-74 levels but also to the previous rising trend.

Everyone is familiar with the inherent conflict in simultaneously satisfying both the farmer and the consumer. What is a good price for the former is bad for the latter. The Government tries to resolve this conflict by taking upon itself the burden of a subsidy for the consumer's benefit. The principal difficulty in raising the price for the producer is that it directly commits the Government to a higher burden of subsidy because the resistance to a rise in the consumer's price is strong. One answer to this problem seems to lie in taxing agricultural income, which is currently not taxed, to pay for the additional subsidy*.

*This argument is developed further in /8/.

A higher procurement price would particularly help the farmers who tend to sell their surplus soon after the harvest when the gap between the procurement price and the market price is the narrowest. It would also help in procuring more foodgrains and thereby in extending the public distribution system with gains to the low income consumer. Meanwhile the additional benefit derived by the larger farmer if syphoned off through tax would restore the desired balance.

Whether the Government follows this line of approach or another, its regulatory powers are availble and could be used to bring about such price adjustments as to make it possible for the farmers to use more fertilizers. A skilful use of these powers would indeed be necessary as the crude oil prices are not expected to decline and may be raised periodically. Fine adjustments would need to be made in the discriminatory pricing policy of oil products already in operation to minimise the burden of price increases for crude oil on fertilizers. Simultaneously, a flexible foodgrain pricing policy would be required to reflect the changes in fertilizer prices.

Besides its control on prices there are certain other controls that the Government exercises. Many of these relate to the distribution of fertilizers. Although none of the farmers in our sample said that any of the controls inhibited them from using the amount of fertilizers they desired, it is a fact that, in many regions such controls proved a positive bottleneck to fertilizer consumption. Requirement of a permit to buy fertilizers, restriction on the amount that could be bought and the dealer from whom it could be bought, delays in issuing the permit, restriction on the movement of fertilizers between zones, states and even districts, etc., were the kind of controls that were in use in 1974-75. Some of them, for instance, the permit system, were scrapped even before the year was out.

The important point, however, is that the need to exercise direct physical control over distribution arises from a situation where demand exceeds supply at the controlled price. Inadequate domestic production and foreign exchange constraints on imports have been the basic reasons for supply shortfalls. Sometimes the methods chosen for control of distribution may not be the best, and always inefficiencies tend to creep in. These can cause unsatisfied demand to co-exist with surplus stocks in warehouses and imbalances to arise between regions, some regions experiencing shortages while others having surpluses; the latter even when the aggregate supply is adequate. To this,deficiencies in the distribution network and lack of institutional credit facilities also contribute in no small measure.

Since 1974-75 the domestic supply position has radically changed. The domestic output of nitrogenous fertilizers (N) in 1973-74 was 1.05 million tonnes and in 1974-75, 1.19 million tonnes or 13.3 per cent higher. In 1975-76, as new capacities came on stream, a much more substantial increase is expected. The increase in domestic production of phosphatic fertilizers in the same period was negligible - from 0.324 million tonnes of P_2O_5 to 0.327 million tonnes - and it is likely to fall in 1975-76 mainly due to the slack in demand. The fertilizer industry has a priority in Indian planning and the Fifth Plan production target for 1978-79 is set at 4.0 million tonnes of N and 1.25 million tonnes of P_2O_5. An improvement in domestic production is, however, not enough by itself. It needs to be backed by a strengthening of the distribution network and an extension of institutional credit facilities.

Even before the June 1974 rise in fertilizer prices the rate of increase in fertilizer demand had begun to slow down. This was not an altogether unexpected phenomenon. It was natural that while the new technology was spreading rapidly, the demand for fertilizers should also increase rapidly. But as the increase in acreage adopting the new technology became progressively smaller the rate of increase in the demand for fertilizers slowed down. Had the fertilizer price rise not taken place, one would have expected that over the next decade, (i) the rate of increase in fertilizer consumption would be lower than in the past decade though each year more fertilizers would be consumed, (ii) there would be a better spread in the use of fertilizers between farms of different sizes and between different regions, and (iii) the N:P:K ratio of fertilizer inputs per unit of land, which currently deviates widely from what is recommended, would improve, raising the efficiency of fertilizer use. We have argued earlier that the rise in the price of fertilizers would accelerate the realisation of the last expectation. There are also good reasons to believe that a spread of fertilizer use may not be inhibited by the rise in fertilizer prices and may even be helped by it.

The second year after the increase in fertilizer prices

The agricultural year 1975-76 started with the cheerful news that the monsoon had broken in good bountiful showers all over the country. The course of the monsoon later fulfilled the early promise and the season ended with one of the best rains India has had for years. Estimates of both kharif and rabi harvests rate the output to be the highest ever. There is wide agreement that, foodgrain production in 1975-76 would reach a level of 115 million tonnes (rice 50 million tonnes and wheat 28 million tonnes) against the earlier peak of 108 million tonnes (rice 43 million tonnes and wheat 26 million tonnes) in 1971-72 and last year's production of a little over 101 million tonnes.

Two obvious questions arise. Was this increase in production due entirely to the excellent monsoon Or, should one assume that the shock of the high fertilizer prices has already been absorbed by the farmer and, having adjusted himself to the new circumstances, he is back on the earlier use trend. That the weather has contributed a good part of the output increase is abundantly clear. But the extent to which the farmer has restored the previous year's cuts in fertilizer consumption can only be judged in the light of such information as is available.

One incontrovertible fact is that the dealers' offtake during the kharif season increased and this is being taken as an index of the revival in fertilizer demand*. This may, however, not be a true index for two reasons: (i) fertilizer consumption by farmers is always lower than the dealers' offtake and the gap can vary widely from time to time! (ii) dealers had been expecting a reduction in fertilizer prices and were hopeful that their demand for a better commission would be met and on both counts were being deliberately slow in lifting stocks. Eventually both of their expectations were realised and it was only after this that their offtake of fertilizers picked up significantly. One does not, of course, know to what extent this increase is meant to replenish the dealers' run-down stocks, or wheather it amounts to no more than a refurbishment of the normal inventory. Another and, perhaps, a more serious

*Data furnished at Zonal Conferences of the Ministry of Agriculture, Government of India, shows a substantial increase in the consumption of N, but doubts are expressed whether this represents true consumption.

reason for doubt arises from the fact that between last year and now, while fertilizer prices, even after some reduction, are still very much higher than the pre-June 1974 prices, the price of foodgrains have either not risen at all or have declined. Expectations also are clearly not for a rise. In these circumstances the reasons why farmers' behaviour with respect to the use of fertilizer inputs should be different this year from last year become complex.

The answer to this question can only be conjecture at this stage. Firstly, the Fertilizer Association of India investigating the fall in fertilizer demand last year concluded that, on the whole, the restrictive nature of controls on the distribution of fertilizers, prevalent in many States at the time, was the most important reason (see Appendix). It is quite obvious that when two factors were simultaneously inhibiting consumption, it would be highly arbitrary to attribute the fall to any one of them. Nevertheless, it is quite possible that the fall in the demand for fertilizers, or more precisely a fall in consumption in those States where restrictive controls were being employed, might not have been as great if there had not been controls. To that extent, one can expect the consumption of fertilizer to go up, since most of these controls have now been removed.

Secondly, the type of change in the NPK combination of fertilizer inputs in large rice farms found in the survey in Karnal might have occurred more widely this year, raising the demand for phosphatic fertilizers, and perhaps of nitrogenous fertilizers, too, at a new NP combination. However, indications, such as there are, tend to show that, on the whole, the demand for phosphatic fertilizers fell. This, to the extent the farmer regards N and P_2O_5 as substitutable, would increase the demand for N.

Thirdly, the good start of the monsoon rains this year might have been read by farmers - and as it turned out rightly - as a fair indication of a good season; hence they might have perceived the risk involved in using a larger input of fertilizers, particularly N, much less than last year. This would, of course, induce them to raise their input of N.

Finally, the farmer might have accepted the change in fertilizer costs, after the revisions, as irreversible and based on last year's experience decided to put in more fertilizer at the slightly lower prices in a bid to raise his income even at a higher risk.

Which of these reasons has played the more important role if, in fact, there has been a significant increase in fertilizer consumption, will only be revealed when the facts come to be known more fully. Meanwhile, one is confronted with a situation in which for three crop seasons in a row - rabi, kharif and rabi - a slack demand for fertilizers (a fall in the first) been accompanied by the best harvests ever.

Later when men look back on the events of these years they are likely to mutter a prayer of gratitude for the good monsoons which most benevolently intervened to convert a period fraught with potential crisis into a period of blessing. Even today one can perceive that a breathing space has been gained to face a challenge which the farmer and the Government must meet. On the food front India does not have too many options and the compulsions to produce more are strong. Indian yields of both wheat and rice are still low compared with many other countries. There is

scope, therefore, for considerable increases for which technology as well as infrastructure are available. The high cost of fertilizers should spur the farmers on to innovative action, while Government policy should aim to ensure a suitable climate for it. With the right steps taken, there would be every reason to expect a rising trend in production in the future.

We have assumed all along that the radical revision in fertilizer prices has come to stay. The initial response in India to the steep rise in oil prices was to consider coal as an alternative raw material for manufacturing fertilizers. India's known reserves of coal are estimated at 80,000 million tonnes which can last, at the present rate of consumption, for more than 100 years. Mining costs are comparatively low and at the new oil prices a shift to coal-based technology for fertilizer production seemed to be clearly indicated. Without any loss of time the Government went ahead with plans to set up three coalbased plants and the first of these is now nearing completion.

Since this initial response several things have happened to add new dimensions to the problem. First of all, world prices of fertilizers, which had rocketed upwards, have stabilised at lower levels. It seems now that the shock of the rise in oil prices has been absorbed by the world fertilizer industry. Secondly, India's effort at exploring off-shore possibilities for oil have borne fruit beyond early expectations. Oil struck in the Bombay High field is very promising and it is expected that by 1976-77, 2 million tonnes of crude oil will be available and that this amount will rise to 10 million tonnes by 1980. Meanwhile oil has also been struck at Bassein, close to Bombay, and this field also appears to be full of promise. These discoveries have led to optimism in respect of other existing and planned areas of exploration. An increase in the proportion of domestic crude in the total supply would reduce the annual import bill and possibly the domestic cost of oil. It would also increase the availability of lighter distillates since the lighter Bombay High crude would yield a higher proportion of the lighter fractions. Thirdly, Indian coal, now amongst the cheapest in the world, is due for some increase in price. Coal is a nationalised industry and its price is controlled. Cost of raising it has been rising and there is need for considerable investment for modernising the mining operations, for beneficiation to raise the quality of coal and for opening additional mines. Investment in all these is overdue and the industry is anxious to lose no more time. Those who followed the debate on the Fifth Plan target for coal, would recall that considerable doubt was expressed by those with knowledge of the industry about the possibility of reaching the target, mainly on account of inadequate investment in the industry in the past and the relatively long gestation period for making a new mine operative. The coal industry clearly requires to plough back funds for development. However, at the current coal prices this seems a difficult task. It is, therefore, quite on the cards that there may be a significant revision in the coal prices in India.

Fourthly, recently Indian exports have been growing at highly satisfactory rates and the balance of payments position has improved. As a result, the Indian rupee has gained strength. As the gap between the market value of the rupee and the official exchange rate narrows, economic cost of imported oil would tend to get closer to its financial cost. In estimating the cost of imported oil normally, certain premiums of foreign exchange have been allowed which may

now be much lower than assumed earlier and may also fall further. This will have relevance to the relative cost of producing fertilizer from coal or oil.

It would seem, therefore, that the initial comparative advantage of coal would now seem to be less than previously estimated. However, the major question in producing fertilizer from coal in India is the technology based on non-coking and not coking coal. The plant which is nearing completion now is thus in the nature of an experiment to test the commercial viability of the currently known technology. At present, it should be kept in mind that, the capital cost for a coal-based plant is comparatively high and the gestation lag longer.

A new possibility of considerable significance has now emerged with the availability of gas from the Bombay High and Bassein structures as well as from other prospective fields. As the technology with gas as feedstock is well established, if adequate gas as now expected does become available, it would further widen the choice of raw materials for manufacturing fertilizers. Whether it is coal or gas, one can look forward to a mix of fertilizer feedstock which would be an improvement on the present reliance on naphtha.

The question of the future feedstock for fertilizer manufacture in India would, however, take some time to be resolved. Meanwhile the farmer has already shown the capacity to absorb higher fertilizer prices either by his willingness to take greater risks or his efforts to economise through improved cultural practices. The Government's drive to make institutional credit available more widely would reduce risk and an improvement in the farmer's cultural practices would raise productivity levels to offset the rise in cost. In any event, there is sufficient evidence to suggest that the increase in the price of crude oil will not act to the detriment of the growth of agriculture in India even if the base for fertilizers continues to be oil.

APPENDIX

Statistics published by the Fertilizer Association of India reveal an increase in the quantity of fertilizers distributed during 1974-75 over 1973-74, but a decline in consumption.

The distribution of all straight and complex fertilizer materials increased by 5 per cent mainly on account of the 14 per cent increase (in terms of N) of nitrogenous fertilizers because the distribution of phosphatic fertilizers actually decreased by 9 per cent*. The indigenous production of phosphatic fertilizers during 1974-75 was higher than in the previous year and the supply position was on the whole better. The decline in distribution was, therefore,attributed to slack demand.

The consumption estimates for 1974-75 as published in June 1975 showed a decline of 3.3 per cent in the consumption of all fertilizers; nitrogenous fertilizers 0.5 per cent and phosphatic fertilizers 17.5 per cent.** A subsequent estimate, circulated by the Fertilizer Association of India, through its newsletter to its members in August, 1975, puts the decline in the consumption of all fertilizers at 8.7 per cent and potash at 5.8 per cent.*** The first assessment of consumption was based on estimates for the rabi crop provided by manufacturers at the request of the Fertilizer Association of India. The second set of estimates were on firmer grounds and were put out during the half yearly Zonal Conference. Both estimates refer to the offtake.

While the offtake of fertilizers, which relates to the amounts secured by the dealers, is referred to as consumption, it is in fact always higher than actual consumption by farmers. The extent of the difference varies from year to year and it would be difficult to say what it might have been in 1974-75. While the principal reason for the slow offtake was the slack demand for fertilizers, two other reasons are also identified: (i) there was an expectation that the Government might revise the fertilizer prices downward after the June 1974 increase, which the Government subsequently did in mid-July; and (ii) dealers were unhappy with the commission allowed to them and wanted it increased, which also was done but much later. A pick up in offtake more recently is attributed, at least in part, to the 10 per cent decrease in fertilizer prices and the better commission allowed to the dealers.

*Fertilizer Marketing News, Vol.No.6, Fertilizer Association of India, June 1975, page 9.

**Ibid.

***Fertilizer Association of India, Newsletter, Aug. 13, 1975.

The Fertilizer Association of India carried out a study to assess the reasons for the decline in fertilizer consumption and their results were as follows:

States	Dominant reason for the decline in fertilizer consumption
Andhra Pradesh, Bihar, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and Uttar Pradesh.	Physical controls.
Gujarat, Kerala and West Bengal	Price increase.
Not the most significant factor in any State, but the second most important in Andhra Pradesh, Gujarat, Madhya Pradesh and Uttar Pradesh.	Credit constraints.

The physical controls included, the "card/permit system, restriction on inter-district or even inter-block movements, limitations of quantities to be released against cards, renewal of dealership registration certificates only on production of sales tax clearance certificates and linking of release of P and K with N".

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