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THE EFFICACY OF THE MARKET MECHANISM IN TRADITIONAL AGRICULTURE: A REEXAMINATION OF AN OLD CONTROVERSY

by

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THE EFFICACY OF THE MARKET MECHANISM IN TRADITIONAL AGRICULTURE: A REEXAMINATION OF AN OLD CONTROVERSY

In the past few years the preoccupation with the Green Revolution has overshadowed the discussion of the role of agricultural price policy, which for the last two decades had been one of the controversial issues of economic development. Several recent developments are bound to redirect economists' attention once again to the issues of price response in underdeveloped agriculture. First, it is realised that the early optimism about the rapid transformation of agriculture was not warranted. Secondly, in some of the areas where the introduction of the new varieties has been successful, a number of difficulties have arisen with respect to distribution and marketing. Thirdly, where the increase in production is beginning to put pressure on prices, policy makers are concerned with the adverse effect of these lower prices on other regions where no technological change has occured.[1] Although future issues of agriculture price policy will be somewhat different from those in the past, there are enough similarities to warrant a reexamination of the controversy concerning the extent of the response of agricultural producers in the underdeveloped countries to changes in price relationships--a controversy in which, in the author's view, many concepts were imprecise and confused, the various hypotheses were not clearly defined and distinguished from each other, and several important implications were ignored.[2] This paper has several aims: 1) to clear up the existing confusion concerning various hypotheses about peasant behavior; 2) to point out the inherent bias in many of the existing studies; 3) to present an empirical study of agricultural supply in a northern region of India where no price response was observed for a number of food crops; and 4) to discuss in general terms a neglected implication of using the market mechanism to effect agricultural development.

I.

In discussions of the effectiveness of the market mechanism as an agent of change one encounters three hypotheses: 1) peasants are rational; 2) they respond to economic incentives; and 3) peasants respond to relative prices and market incentives. These are three distinct hypotheses, but their differences are not always recognized in the existing literature and they are often used interchangeably.[3] Although rationality is a necessary condition for the existence of response to economic incentives, the absence of such a response does not imply irrationality. Similarly the effectiveness of economic incentives is a necessary but not a sufficient condition for responsiveness to market forces. The confusion arises because economic incentives and market incentives are often equated. Clearly, where markets do not exist, it makes little sense to speak of the market mechanism; but economic incentives, in the sense of material forces, can still have an effect on production and consumption decisions. The absence of markets or their relative unimportance for many activities and products in the rural areas of many underdeveloped countries has been emphasized by a number of writers.[4] Instead of challenging this basic proposition the proponents of the use of price policy have produced studies to show that where markets exist peasants respond to prices. These studies in no way disprove the hypothesis of the ineffectiveness of price policy in situations where reasonably developed markets do not exist

--a condition which still characterizes many activities in substantial parts of rural areas of the underdeveloped world. In making such a statement we do not imply that social and cultural factors are stronger than economic forces and that the spread of markets can long be resisted. The economic transformation of the Third world in the past century disproves such an assertion. The extension of the market economy, with all that it implies about the development of the capitalist mode of production, is basically a different problem from that of response to price changes in a given situation. This difference is not simply the question of short-run versus long-run response which could be treated by, say, a Nerlovian-type adjustment model; rather, the structure itself changes drastically.

Studies of supply response are useful in so far as they provide us with a measure of the degree of responsiveness in particular cases but, as a test of the hypothesis of the effectiveness of the market mechanism in general, they are bound to be inherently biased in favor of accepting the hypothesis. Because the statistical estimation of supply functions requires fairly long and consistent data on production and prices, samples tend to be confined to crops and regions where developed markets exist. Thus, they merely show that once production for market is developed the market mechanism works--a conclusion that not many people would find surprising. The list of supply studies provided in Table 1 illustrates this point. Most of the studies are concerned with cash or export crops, while subsistence crops are not well represented. The reason is clearly the lack of data for crops which are grown primarily for self-consumption. It is therefore difficult to test the hypothesis in truely backward regions in the underdeveloped world.

TABLE I

List of Supply Response Studies Pertaining to the Underdeveloped Countries

Crop	Region or Country	Source	
Rice	Thailand	Behrman	[6]
	East Pakistan	Haussain	[18]
	Punjab	Krishna	[19]
	Philippines	Mangahas	[21]
	Indonesia	Mubyasto	[24]
Maize	Thailand	Behrman	[6]
	Punjab	Krishna	[19]
	Philippines	Mangahas	[21]
Wheat	Punjab	Krishna	[19]
	West Pakistan	Falcon	[14]
Barley	Punjab	Krishna	[19]
Millets	Punjab	Krishna	[19]
Cassava	Thailand	Behrman	[6]
Jute	Pakistan	Hussain	18]
	Pakistan	Clark	[10]
	India - Pakistan	Venkatamaranan	[37]
	India - Pakistan	Stern	[36]
	India - Pakistan	Sinha	[34]
Cocoa	Ghana	Bateman	[3]
	Nigeria	Sanders	[31]
	All the major producing regions in the world	Behrman	[5]
Tea	India, Ceylon	Marti	[25]
Tobacco	Malawi	Dean	[12]
Rubber	Malayasia	Chan	[9]
	Thailand	Behrman	[7]
Sugar	Philippines	Askari	[2]
	Punjab	Krishna	[19]
Cotton	Punjab	Krishna	[19]
	West Pakistan	Falcon	[14]
	Egypt	Stern	[35]
Coffee	Brazil	Arak	[1]
	Colombia	Bateman	[4]

One of the main sources of confusion in the controversy has been the imprecision in the definition of underdeveloped agriculture. It is not always clear what type of agriculture they had in mind. In the literature one encounters words such as traditional, peasant, subsistence, primitive and underdeveloped agriculture. These words are often used interchangeably and are meant to describe the rural sector in what is commonly accepted to be the underdeveloped region of the world. The categories seem to encompass anything from cattle breeders in Argentina and coffee growers in Brazil to completely subsistence agriculture in isolated villages of Asia. Clearly many diverse types of agriculture were being considered with widely different institutional arrangements, cropping patterns, technology, and degrees of commercialization both for outputs and inputs. Schultz has attempted to define traditional agriculture on the basis of the constancy of technology and tastes. With this criterion the degree of market orientation and the imperfection in the market system are only of secondary importance.[5] One suspects, however, that it would be difficult to find this kind of agriculture where fully functioning markets exist. Other attempts at arriving at definitional criteria have emphasized the multiplicity of possible criteria. It is pointed out, however, that most of these criteria reflect the degree of integration of the cultivator with the wider outside world. Furthermore, no matter what set of criteria is chosen no dicotomous classification is possible because there exists a whole specturum of different types of agriculture.[6]

Despite these difficulties, the criterion of commercialization seems to be the most relevant one in the choice of samples to test the effectiveness of the market mechanism. An acceptable test has to include crops that are not fully commercialized because the hypothesis really consists of two parts: 1) peasant respond to economic incentives and 2) even not well integrated and imperfect markets function well as a signalling device.[7] If either of these propositions is false, prices will not be uneffective policy instruments.

II.

In order to separate these two aspects of the hypothesis supply of major food crops, rice, wheat and barley and two cash crops, sugar and ground nuts in Northern India were studied. Both food and cash crops were chosen because if peasants do not respond to economic incentives we would not expect to observe a response for either type of crop. While if the supply of cash crops is related to price and that of food crops is not, then there is evidence that market for the latter crops is not functioning well.

Bihar and the eastern districts of Uttar Pradesh were chosen for this study because the region is one of the poorest and most backward in India. A study[8] of gross output for 1956 shows that nineteen out of 40 districts are among the 29 (10 percent) poorest, while the next 10 percent income level contains ten more of the districts.

The area under study is also one of the least urbanized regions, a majority of the districts having over 90 percent of their population in 1961 in rural areas (see Appendix 1). It is distressing that during the decade from 1951 to 1961 there was no significant increase in urbanization; in fact, in a number of instances, the proportion of rural to total population rose. A high percentage of the population therefore depends on agriculture as its main source of income. In most of the districts in Eastern Uttar Pradesh, cultivators and agricultural laborers constitute over 90 percent of the rural working force (see Appendix 1), and in no district is the percentage lower than 75.

The extent of diversification varies amongst the districts, but the region as a whole has a rather diversified cropping pattern. Even so, a very large portion of the cultivated area is devoted to food crops (see Appendix 1). This is, of course, typical of subsistance agriculture, where a large percentage of the total product does not pass through market channels. A sizeable amount of land under food crops does not necessarily imply that the products are internally consumed, since they are highly sellable commodities. However, in Uttar Pradesh and Bihar there is evidence that the marketed portion of food grains is quite small. In Table II we present estimates of the marketed portion of various food grains in the states of Uttar Pradesh, Bihar, and Punjab and all-India. In comparison with the figures for Punjab and all-India, the Uttar Pradesh and Bihar estimates are quite low (they would still be lower for Eastern Uttar Pradesh). This situation is again a reflection of the poverty of the region. No estimates of the marketed portion of food grains within each district are available. However, there is some evidence that the marketable surplus of any given food crop varies directly with the importance of the crop in the area and inversely with the availability of other cash crops. For instance, the marketed portion of barley is higher in Eastern Uttar Pradesh than in the state as a whole. On the other hand, when a large part of the cultivated area is devoted to cash crops, most of the food grown would be required for local consumption.[9]

An interesting aspect of the marketing of agricultural products in the region under study is the major role played by the village and itinerant merchant.

TABLE II

Approximate Marketable Surplus of the Main Crops and its Disposal by Various Agencies (percent)

	Uttar Pradesh	Bihar	Punjab	All-India
RICE				
Marketable Surplus				
Pre-War	n.a.	30	60	41
Post-War	n.a.	32	30	28
Disposal of Marketable Surplus by:				
Growers	9	9	35	14
Village and Itinerant Merchants	n.a.	10[a]	40[a]	31
Others	n.a.	81	25	65
WHEAT				
Marketable Surplus	35	30	36	37
Disposal of Marketable Surplus by:				
Growers	40	40	70	56
Village and Itinerant Merchants	50	43	30	39
Others	10	17	--	5
BARLEY				
Marketable Surplus	22	11	59	26
Disposal of Marketable Surplus by:				
Growers	28	15	95	37
Village and Itinerant Merchants	62	80	5	45
Others	10	5	--	18

[a]Figures for itinerant merchants.

Source: Report on the Marketing of Rice in India
Report on the Marketing of Wheat in India (Revised edition), 1961
Report on the Marketing of Barley in India, 1945

Compared with Punjab, a much larger portion of the marketed surplus is sold through the village merchant (Table I). Thus the cultivators' contact with the wholesale markets is limited. Also in the region under study large scale food processing is much less common than in Punjab which just before the Second World War, with rice production 1/7th that of Uttar Pradesh has 4 times as many rice mills.

III.

The Model

The model used in this study is the well-known Nerlovian supply-response model whose underlying structural relationships are expressed by Equations (1) to (3):

$$A_t^d = b_1 + b_2 P_t^* + b_3 R_t + b_4 t + e_t \;, \qquad (1)$$

$$P_t^* - P_{t-1} = b_5 (P_{t-1} - P_{t-1}^*) \;, \qquad (2)$$

$$A_t - A_{t-1} = b_6 (A_t^d - A_{t-1}) \;, \qquad (3)$$

where

A_t^d = the desired area,

A_t = the actual area,

P_t^* = the expected relative price,

P_t = the actual relative price,

R_t = the rainfall during either the sowing season, or the agricultural year,

t = a time trend variable,

b_i = the i^{th} structural parameter.

Equation (1) is the basic supply function, relating desired area to the expected relative price, the rainfall at the time of sowing and a time trend. The model of price expectation formation is expressed in Equation (2), while Equation (3) specifies the dynamic adjustment process.[10]

Several remarks should be made about the above model. First, over the long run supply can be affected by changes in factor availability and/or technological change. Population growth, for instance, leads to both a more intensive cultivation of the existing agricultural land and the expansion of the total cropped area. We would, ceteris-paribus, also expect the supply of a crop to expand if its average yield increases relative to that of other crops. Therefore, it seems reasonable to include population and expected relative yield in the supply function. These variables are usually estimated from some time trend and will be highly correlated with time, especially for a period as short as fifteen years. In such circumstances it is justifiable to include a time trend directly in the supply function and thus avoid giving too concrete an interpretation of the coefficient of population and yield variables, which may be nothing but proxies for other slowly changing variables.

Secondly, although the inclusion of variables other than price in the supply equation is required in order to differentiate between the adjustment coefficient and the coefficient of expectation, the procedure is not conceptually satisfactory in some instances. When the supply equation contains a time trend which represents the effect of slowly and predictably changing variables, it is not plausible to assume that the short run response to changes in these variables is identical to that in other factors such as price. The adjustment to such changes may or may not be immediate and complete, but since they are to some extent foreseen, farmers should be more prepared for them. The weather factor presents the same difficulty. Since the weather variable is inherently a short term factor, and ordinarily its long term expectation does not change, it is not quite clear how there can be a long-run response to it. Of course, if farmers somehow knew what weather conditions would be at the time of sowing, they might be better prepared for it. One thing which is inevitable, however, is the variability in the weather, and therefore, one would expect that they would be prepared for an uncertainty in the outcome. For this reason it may be argued that the adjustment to changes in a factor such as rainfall is complete.

Equations (1), (2), and (3) can be reduced to the following single equation which contains only observable variables:

$$A_t = b_1 b_5 b_6 + b_2 b_5 b_6 P_{t-1} + b_3 b_6 R_t - b_3 b_6 (1 - b_5) R_{t-1} + b_4 b_6 t \qquad (4)$$
$$- b_4 b_6 (1 - b_5)(t-1) + [(1 - b_6) + (1 - b_5)] A_{t-1}$$
$$- (1 - b_5)(1 - b_6) A_{t-2} + b_6 [U_t - (1 - b_5) U_{t-1}] .$$

Equation (4) rewritten in matrix notation becomes

$$\underline{A} = \underline{X}\, \underline{\beta} + W , \qquad (5)$$

where

$\underline{A}$ = the vector of observations of the dependent variable,

$\underline{X}$ = the matrix of observations of the independent variables,

$\underline{\beta}$ = a vector whose elements are algebraic combinations of the structural parameters b_i's given by:

$$\beta_1 = b_1 b_5 b_6$$
$$\beta_2 = b_2 b_5 b_6$$
$$\beta_3 = b_3 b_6$$
$$\beta_4 = -b_3 b_6 (1 - b_5)$$
$$\beta_5 = b_4 b_6$$
$$\beta_6 = -b_4 b_6 (1 - b_5)$$
$$\beta_7 = (1 - b_5)(1 - b_6)$$
$$\beta_8 = -(1 - b_5)(1 - b_6) ,$$

$\underline{W}$ = a vector of disturbance terms.

If we restrict any of the structural parameters to zero or one, the vector of β_i's will be correspondingly simplified.

Simple least squares estimation of the parameters of Equation (5) leads to several difficulties. First, if the original disturbance terms were serially uncorrelated, the W's would be serially correlated. Thus, the estimates would not be efficient. Furthermore, simple least squares estimates would be inconsistent, because Equation (5) contains a lagged value of the dependent variable. Secondly, the structural parameters, b_i's , cannot be uniquely recovered from the estimates of the β's . Thirdly, even if the disturbance terms of the reduced equation are assumed to be serially uncorrelated, unrestricted least squares estimation of the β_i's would not be efficient, because it ignores the relationship that exists among the β_i's .

Estimates of the b_i's can be obtained by maximizing the likelihood function of the observations with respect to the b_i's . If we assume that W_t is distributed as $N(0, \sigma^2 I)$, the log of the likelihood function is given by:

$$L(\underline{A}|\underline{X}, \underline{b}, \sigma^2) = -\frac{T}{2}\log(2\pi) - \frac{T}{2}\log\sigma^2 - \frac{1}{2\sigma^2}(A - \underline{X}\,\underline{\beta})'(\underline{A} - \underline{X}\,\underline{\beta}) . \quad (6)$$

The first derivatives of this function with respect to b_i's are not linear in the b_i's , and, therefore a nonlinear estimation procedure has to be used to estimate the structural parameters. The maximum likelihood estimates of b_i's thus obtained are consistent, asymptotically unbiased and efficient.[11]

These estimates can also be easily computated if there is first order autocorrelation in the disturbance terms such that

$$W_t = b_7 U_{t-1} + e_t ,$$

where the e_t's are normally and independently distributed.

The parameters of the model may also be estimated by a method proposed by Dhrymes.[12] Equations (1) to (3) may be reduced to the following:

$$A_t = b_1 b_6 + b_2 b_6 b_5 \sum_{i=0}^{\infty} (1 - b_5)^i P_{t-1-i} + b_3 b_6 R_t + b_4 b_6 t + (1 - b_6) A_{t-1} + b_6 U_t . \quad (7)$$

The infinite sum representing the expectation of the price may be divided into two components:

$$b_2 b_6 b_5 \sum_{i=0}^{\infty} (1 - b_5)^i P_{t-1-i} = b_2 b_6 b_5 \sum_{i=t}^{\infty} (1 - b_5)^i P_{t-1-i} + b_2 b_6 b_5 \sum_{i=0}^{t-1} (1 - b_5)^i P_{t-1-i} . \quad (8)$$

The first term on the R.H.S. of Equation (8) can be rewritten as:

$$b_2 b_6 b_5 (1 - b_5)^t \sum_{s=0}^{\infty} (1 - b_5)^s P_{-1-s} = b_2 b_6 b_5 (1 - b_5)^t b_8 \ . \qquad (9)$$

Dhrymes calls b_8 the "truncation remainder" which is itself a parameter of the model to be estimated. Equation (7) can now be written as:

$$A_t = b_1 b_6 + b_2 b_6 b_5 \sum_{i=0}^{t-1} (1 - b_5)^i P_{t-1-i} + b_2 b_6 b_5 (1 - b_5)^t b_8 \qquad (10)$$

$$+ b_3 b_6 R_t + b_4 b_6 t + (1 - b_6) A_{t-1} + b_6 U_t \ ,$$

the parameters of which can be estimated by a nonlinear maximum likelihood method.

To estimate the supply function for sugar cane the Nerlovian model has to be somewhat modified to take into account the peculiarities of this crop. Rather than being confined to a single agricultural season, the period of growth of sugar cane extends throughout the entire year, and at the end of this time the crop is cut and allowed to sprout again. The Ratooned crop has a smaller yield than the planted crop, but, since its production costs are lower, the method is usually adopted after the harvesting of the first crop.[13] Since the available statistics pertain to the total acreage rather than to each new planting, our model has to be modified for this crop. We assume that the basic supply decision relates to the new planting. Thus, we have

$$S_t^* = b_1 + b_2 P_t^* + b_3 t + U_t \ , \qquad (11)$$

where S_t^* is the desired new planting in the year t and the other variables are defined as before. Equation (11), together with the area adjustment equation, results in the following:

$$S_t = b_1b_6 + b_2b_6P_t^* + b_3b_6t + (1 - b_6)S_{t-1} + b_6U_t \; . \tag{12}$$

Lagging this equation one period and adding the resultant equation to the above, we obtain

$$\begin{aligned} S_t + S_{t-1} = 2b_1b_6 + b_2b_6(P_t^* + P_{t-1}^*) + b_3b_6(2t - 1) \\ + (1 - b_6)(S_{t-1} + S_{t-2}) + b_6(U_t + U_{t-1}) \; . \end{aligned} \tag{13}$$

Since acreage in any year is the sum of the planted area in that and the previous year, Equation (13) reduces to

$$A_t = 2b_1b_6 + b_2b_6(P_t^* + P_{t-1}^*) + b_3b_6(2t - 1) + (1 - b_6)A_{t-1} + b_6(U_t + U_{t-1}) \; . \tag{14}$$

If price expectation is based on the Nerlovian model, by the usual substitution we can obtain

$$\begin{aligned} A_t = 2b_1b_5b_6 + b_2b_5b_6(P_t + P_{t-1}) + b_3b_6(2t - 1) - b_3b_6(1 - b_5)(2t - 3) \\ + [(1 - b_6) + (1 - b_5)]A_{t-1} - (1 - b_6)(1 - b_5)A_{t-2} \\ + (b_6 + b_5 - 1)(U_t + U_{t-1}) \; . \end{aligned} \tag{15}$$

The parameters of this equation may be estimated under the assumption of independently distributed disturbance terms. Alternatively, we may apply the

Dhrymes' reduction to Equation (15) to obtain the following:

$$A_t = 2b_1b_6 + b_2b_5b_6[\sum_{i=0}^{t-1}(1 - b_5)^i(P_{t-1-i} + P_{t-2-i})] + b_2b_5b_6(1 - b_5)^t b_8 \quad (16)$$

$$+ b_3b_6(2t - 1) + (1 - b_6)A_{t-1} + b_6(U_t + U_{t-1}) .$$

Since the number of observations available for each district was too small to estimate supply functions for each region separately, it was decided to combine the observations and estimate the coefficients from the pooled samples of cross-section and time series. A simple pooling of the observations implies that the coefficients for all districts are identical. When both the geographical size and the cropping pattern of the districts vary, this proposition is unreasonable. One simplifying assumption is that regional differences affect the level of the dependent variable alone. Thus, only the coefficient of the constant term varies among the districts, and the estimation can be performed by introducing dummy variables for each district. This procedure is not, however, entirely satisfactory. The presence of the lagged endogenous variable makes it difficult to separate its effect from that of the individual districts. Also, apart from the price expectation and the area adjustment coefficients, the assumption that the magnitude of the other parameters is independent of the acreage under a crop is not very plausible.

A more reasonable postulate is that for districts with similar cropping patterns, the coefficients of the independent variables for a given crop are proportional to the average acreage under that crop. This assumption can be formally expressed as follows:

$$A_{it} = b_1\bar{A}_i + b_2\bar{A}_i P_{it} , \qquad (17)$$

where A_{it} is the planted area of the crop in district i in period t ,

P_{it} is the relative price of the crop in district i in period t ,

and $\bar{A}_i = \frac{1}{n} \sum_{t=1}^{n} A_{it}$.

Dividing both sides of Equation (17) by $\bar{A}_i$, we get

$$\frac{A_{it}}{\bar{A}_i} = b_1 + b_2 P_{it} .$$

Thus, under the above assumption, when the dependent variable is measured in terms of its mean value, the coefficient of each independent variable is the same for different regions and can be estimated from pooled samples. This procedure, which implies equal price elasticities in all regions, is not very appropriate where there are larger differences in the cropping patterns. The more likely situation is that the elasticity declines as a higher portion of the land is allocated to the crop.[14] Therefore, in combining time series and cross-section observations, care has been taken to pool these districts that have similar cropping patterns or a similar portion of land under the crop in question. In every instance only the contiguous districts were pooled. Admittedly, there has been a certain subjective element in the choice of the districts which were combined. A more systematic approach would have been to use a nonlinear equivalent of the test of equality between sets of coefficients in different regressions. However, since the results of the unpooled regressions were not very significant, and the test would have involved considerable computation, no attempt was made to test the homogeneity of the coefficient.

Two further points should be mentioned regarding the pooling of the data. First, an implicit assumption of the above procedure is that the magnitude of the independent variables is comparable among districts. For prices and yields, this condition is satisfied; although the rainfall figures were of the same order of magnitude, they were still expressed in terms of their normal value. The second point concerns the relationship among the disturbance terms for different regions. In order to obtain efficient estimates, it is necessary to assume that the contemporaneous disturbance terms are independently distributed. In some cases this assumption is not justified, since the omitted variables for different regions may be correlated.

IV.

The parameters of the supply response model for rice, wheat, barley, sugar cane and ground nuts were estimated for the years 1953-1963 in Uttar Pradish and 1951-1964 in Bihar. Before and after this period price data was unreliable because of the existence of food controls. These controls were also in effect during several years of the period under study, but their impact was relatively minor.[15] The nonlinear estimations were first carried out with no constraints on the values of the parameters. The statistically insignificant (at the 30 percent level) coefficients for rainfall and time trend were then restricted to zero, while those for price expectation and area adjustment were constrained to one, and the equations were reestimated. In general, there was no appreciable improvement in the coefficients of multiple correlation, corrected for degrees of freedom. Therefore, in order to make the exposition clear, it was decided to report comparable sets of results whenever possible.[16]

The estimates are presented in Tables III to VIII. For the food crops, except for rice in Bihar, we do not observe significant positive response to price. In a number of cases rainfall at the time of sowing appears to have a significant influence on the acreage planted, especially for the winter crops wheat and barley. In areas where flooding occurs the square of the rainfall was included in the equation. As expected its coefficient was usually negative. The coefficient of the time trend was generally positive and significant for rice and wheat and negative for barley---a phenomenon which probably reflects the change of the relative yields of these crops over the period under study. The estimates of the price expectation coefficients and the area adjustment coefficient appear to be reasonable except in some cases where they are significantly greater than one, implying that farmers extrapolate price changes and overadjust.

For the cash crops the coefficients of price response are generally positive and significantly different from zero. Unfortunately, we do not have the estimates for these crops in all of the districts primarily because of two factors: 1) the area allocated for sugar and ground nuts is insignificant in a number of districts; and 2) the likelihood function was not sharply defined in these areas where sugar cane was relatively unimportant. Linear least squares estimates of the parameter of the model consider the constraint that the coefficient of price expectation is one are given in Table VII.

The general impression that one obtains from the above results is that there

Table III

Nonlinear Estimates of the Parameter
of the Supply Response Model for Rice

I. Uttar Pradesh, 1953/1954-1962/1963[f]

	Districts 1-3, 5	Districts 6-8	Districts 9-12	Districts 13-15	Districts 16-18	Districts 19-24
Constant	.874[b] (.239)	1.022[b] (.277)	1.044 (1.045)	.938[b] (.184)	.583 (.427)	.942[b] (.100)
Price	-.005 (.008)	-.008 (.012)	-.003 (.004)	-.003 (.005)	.014 (.012)	-.001 (.004)
Rainfall	.080 (.130)	.058 (.096)	.011 (.046)	.055 (.114)	-.033 (.119)	-.010 (.026)
Time Trend: First District	.038[b] (.012)	.032[d] (.016)	.001 (.004)	.034[b] (.007)	.032[c] (.012)	.015[b] (.005)
Time Trend: Second District	.027[c] (.013)	.016 (.012)	-.001 (.004)	.031[b] (.007)	.045[b] (.011)	.015[b] (.005)
Time Trend: Third District	.029[c] (.012)	.008 (.012)	-.001 (.004)	.018[c] (.008)	.031[d] (.015)	.016[b] (.005)
Time Trend: Fourth District	.044[b] (.013)		.003 (.004)			.016[b] (.005)
Time Trend: Fifth District						.018[b] (.005)
Time Trend: Sixth District						.019[b] (.005)
Price Expectation Coefficient	.613 (.756)	.949[c] (.378)	1.218[d] (.602)	1.646[b] (.295)	.880 (2.184)	.688 (.937)
Area Adjustment Coefficient	.577 (.704)	.380 (.267)	.648 (.609)	.401[b] (.093)	.904 (2.144)	.838 (.963)
$\bar{R}^2$	.843[b]	.680[b]	-.180	.899[b]	.521[b]	.631[b]
Long Run Price Elasticity	-.112	-.104	-.053	-.055	.272	-.018
Number of Observations	40	26	26	24	28	55

TABLE III (continued)

II. Bihar, 1951/1952-1963/1964

	Districts 25-27, 32 33[e]	Districts 28-31[f]	Districts 35, 36, 38[e]
Constant	-.275 (.648)	-.497 (.451)	.301 (.227)
Price	.009[b] (.003)	.004 (.006)	.010[d] (.006)
Rainfall	1.825 (1.286)	2.897[b] (.976)	.391[b] (.130)
Rainfall Squared	-.874 (.627)	-1.476[b] (.499)	— —
Time Trend: First District	.016[b] (.005)	.006[g] (.005)	.010[d] (.006)
Time Trend: Second District	.015[b] (.004)		.012[c] (.006)
Time Trend: Third District	.019[b] (.005)		.013[c] (.006)
Time Trend: Fourth District	.015[b] (.005)		
Time Trend: Fifth District	-.005 (.005)		
Price Expectation Coefficient	.885[d] (.476)	1.213[b] (.242)	1.219[b] (.186)
Area Adjustment Coefficient	.895[d] (.458)	.771[b] (.190)	.555[b] (.138)
$\bar{R}^2$	.351[b]	.277[b]	.350[b]
Long Run Price Elasticity	.218	.006	.197
Number of Observations	65	52	39

TABLE III (continued)

[a]Approximate standard errors are given in parentheses.

[b]Significant at the one percent level.

[c]Significant at the five percent level.

[d]Significant at the ten percent level.

[e]Prices were deflated by an index of the prices of other crops grown during the same season, excluding sugar.

[f]Prices were deflated by an index of the prices of all crops.

[g]Time trends were constrained to be the same for all districts.

TABLE IV

Nonlinear Estimates of the Parameters of the Supply Response Model for Wheat[a]

I. Uttar Pradesh, 1953/1954-1962/1963[f]

	Districts 1-3, 14, 15, 22, 23	Districts 4, 5	Districts 6-8	Districts 9-12	Districts 16-21, 24
Constant	.874[b] (.258)	.921[b] (.154)	.117 (.536)	.183 (.955)	.768[b] (.199)
Price	-.004 (.013)	-.008 (.008)	.039 (.025)	.046 (.053)	.015 (.010)
Rainfall	.089[b] (.031)	.098[c] (.041)	.090 (.065)	-.005 (.086)	-.033 (.047)
Time Trend: First District	.020[d] (.011)	.027[b] (.006)	.025 (.015)	.038 (.032)	.013[d] (.007)
Time Trend: Second District	.012 (.010)	.027[b] (.006)	.026 (.015)	.048 (.047)	.009 (.008)
Time Trend: Third District	.026[b] (.010)		.039[d] (.017)	.043 (.042)	.019[d] (.010)
Time Trend: Fourth District	.018[d] (.010)			.031 (.031)	.010 (.007)
Time Trend: Fifth District	.017[d] (.010)				.010 (.008)
Time Trend: Sixth District	.016 (.010)				.014 (.009)
Time Trend: Seventh District	.016[d] (.009)				.010 (.008)
Price Expectation Coefficient	.648[c] (.253)	1.178[b] (.370)	.613 (.401)	1.260[c] (.459)	.873 (.677)
Area Adjustment Coefficient	.925[b] (.228)	1.055[b] (.300)	.946[c] (.375)	.237 (.316)	.773 (.684)
$\bar{R}^2$	.457[b]	.716[b]	.432[b]	.307	.150[c]
Long Run Price Elasticity	-.077	-.134	.698	.758	.237
Number of Observations	66	20	28	27	66

TABLE IV (continued)

II. Bihar, 1952/1953-1963/1964[f]

	Districts 25-27, 32 33	Districts 28-31	Districts 35,36,38
Constant	.713[b] (.148)	1.012[b] (.286)	-.476 (.560)
Price	.003 (.005)	-.008 (.012)	.019 (.020)
Rainfall	.194[b] (.051)	.089 (.129)	.200[b] (.067)
Time Trend: First District	-- --	.010 (.009)	.093[b] (.017)
Time Trend: Second District	.005 (.008)	.015 (.010)	.073[b] (.016)
Time Trend: Third District	.010 (.008)	-- --	.094[b] (.020)
Time Trend: Fourth District	-- --	-.004 (.010)	
Time Trend: Fifth District	-- --		
Price Expectation Coefficient	.556[b] (.147)	1.341[b] (.210)	.591[b] (.188)
Area Adjustment Coefficient	1.341[b] (.123)	.438[c] (.187)	1.493[b] (.165)
$\bar{R}^2$	.259[b]	.102	.646[b]
Long Run Price Elasticity	.078	-.158	.408
Number of Observations	60	48	36

[a]Standard errors are given in parentheses.

[b]Significant at the one percent level.

[c]Significant at the five percent level.

[d]Significant at the ten percent level.

[e]Prices have been deflated by an index of the prices of all crops.

[f]Prices have been deflated by an index of the prices of the crops grown in the care season, excluding sugar.

TABLE V

Nonlinear Estimates of the Parameters of the Supply Response Model for Barley[a]

I. Uttar Pradesh, 1953/1954-1962/1963[e]

	Districts 1-3, 13-15, 22, 23	Districts 6-8	Districts 9-12	Districts 16-21, 24
Constant	.890[b] (.150)	.948[b] (.101)	.694[b] (.220)	1.091[b] (.211)
Price	.003 (.013)	.002 (.008)	.050[d] (.028)	.008 (.017)
Rainfall	.060[b] (.020)	.041[c] (.016)	.005 (.150)	-.103 (.169)
Rainfall Squared			-.015 (.040)	.038 (.059)
Time Trend: First District		.005 (.003)	-.029[b] (.009)	-.018[c] (.009)
Time Trend: Second District		-.0001 (.003)	-.038[b] (.009)	-.019[d] (.010)
Time Trend: Third District		-.004 (.003)	-.031[b] (.010)	-.023[c] (.011)
Time Trend: Fourth District			-.018[c] (.007)	-.019[c] (.009)
Time Trend: Fifth District				-.021[c] (.009)
Time Trend: Sixth District				-.025[c] (.010)
Time Trend: Seventh District				-.016 (.010)
Price Expectation Coefficient	.566[b] (.177)	.984[b] (.246)	1.606[b] (.183)	.856 (.753)
Area Adjustment Coefficient	.915[b] (.184)	1.211[b] (.240)	.460[c] (.168)	.733 (.740)
$\bar{R}^2$	.300[b]	.408[c]	.689[b]	.260[b]
Long Run Price Elasticity	.037	.025	.495	.088
Number of Observations	76	28	27	66

TABLE V (continued)

II. Bihar, 1952/1953-1963/1964[e]

	Districts 25-27, 32 33	Districts 28-31	Districts 35, 36, 38
Constant	.648[b] (.135)	.293 (.320)	-.249 (.423)
Price	.011 (.007)	.024 (.015)	.025 (.022)
Rainfall	.184[b] (.050)	.704[d] (.400)	.210 (.157)
Rainfall Squared		-.283 (.173)	
Time Trend: First District	-.003 (.006)		.067[b] (.019)
Time Trend: Second District	-.002 (.006)		.055[b] (.018)
Time Trend: Third District	-.002 (.007)		.070[b] (.021)
Time Trend: Fourth District	-- --		
Time Trend: Fifth District	-- --		
Price Expectation Coefficient	.635[b] (.185)	1.445[b] (.174)	.820[d] (.449)
Area Adjustment Coefficient	1.129[b] (.156)	.532[b] (.162)	1.143[c] (.434)
$\bar{R}^2$	.304[b]	.115	.396[b]
Long Run Elasticity	.169	.323	.395
Number of Observations	60	48	36

[a]Standard errors are given in parentheses.

[b]Significant at the one percent level.

[c]Significant at the five percent level.

[d]Significant at the ten percent level.

[e]Prices are deflated by an index of the prices of crops grown in the same season.

[f]Prices are deflated by an index of the prices of crops grown in the same season, excluding sugar

TABLE VI

NON-LINEAR ESTIMATES OF THE PARAMETERS OF THE SUPPLY RESPONSE MODEL FOR SUGAR[a]

Region	Period and Number of Observations	Constant	Truncation Remainder	Price	Time Trend	Price Expectation Coefficient	Area Adjustment Coefficient	$\bar{R}^2$	Price Elasticity
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Districts 16-18[e]	1953/1954-1963/1964 33	-.179 (.186)	12.448 (8.227)	.037[b] (.011)	-.001 (.008) .014[c] (.007) .009 (.008)	.894[b] (.273)	.663[b] (.186)	.693	1.337
Districts 19-24	66	.132 (.249)	26.909 21.442	.020 .013	-- --	.487[d] (.245)	.686[b] (.123)	.226	.781
BIHAR:									
Districts 28-29	1951/1952 1963/1964	-.177 (.281)	23.429[d] (12.921)	.035[c] (.015)	.002 (.008)	.637[c] (.300)	.659[b] (.194)	.337	1.375

[a]Standard errors are given in parentheses.

[b]Significant at the one percent level.

[c]Significant at the five percent level.

[d]Significant at the ten percent level.

[e]The three coefficients of time trend are for Districts 16, 17, and 18, respectively.

TABLE VII

ESTIMATES FOR LINEAR REGRESSION EQUATIONS FOR SUGAR
IN UTTAR PRADESH, 1954-1963[a]
(combined cross-section and time series)

Region	Constant	Price (P_{t-1} + P_{t-2})	Area Lagged (A_{t-1})	R^2	F Ratio	Number of Observations	Short Run Price Elasticity	Long Run Price Elasticity
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Districts 1-3	.149 (.251)	.012[c] (.006)	.426[b] (.131)	.348	7.21[b]	30	.444	.774
Districts 6-8	.512[b] (.173)	-.003 (.003)	.605[b] (.126)	.495	13.21[b]	30	-.115	-.291
Districts 9-12	.385[b] (.129)	-.001 (.002)	.674[b] (.095)	.578	25.32[b]	40	-.037	-.113
Districts 13-15	.051 (.237)	.011[c] (.005)	.542[b] (.118)	.457	11.37[b]	30	.421	.919
Districts 16-18	-.084 (.189)	.018[b] (.005)	.475[b] (.108)	.590	19.43[b]	30	.627	1.194
Districts 19-24	.315[d] (.164)	.008[c] (.005)	.383[b] (.108)	.246	9.30[b]	60	.305	.494

[a]Standard errors are given in parentheses.

[b]Significant at the one percent level.

[c]Significant at the five percent level.

[d]Significant at the ten percent level.

TABLE VIII

NONLINEAR ESTIMATES OF THE PARAMETERS OF THE SUPPLY RESPONSE MODEL FOR GROUNDNUTS[a]

Uttar Pradesh, 1953/1954-1963/1964

	Districts 13, 16, 17
Constant	-.027 (.285)
Price	.007[c] (.003)
Truncation Remainder	140.5 (230.3)
Time Trend: First District	.043[b] (.013)
Time Trend: Second District	.061[b] (.009)
Time Trend: Third District	.056[b] (.010)
Price Expectation Coefficient	.545[b] (.183)
Area Adjustment Coefficient	.733[b] (.204)
$\bar{R}^2$	.911[b]
Long Run Price Elasticity	.891
Number of Observations	33

[a]Standard errors are given in parentheses. Prices have been deflated by an index of the prices of crops grown in the same season.

[b]Significant at the one percent level.

[c]Significant at the five percent level.

is a significantly positive response for cash crops, and for those food crops which have some commercial importance, primarily because of the absence of cash crops, e.g. rice in some regions of Bihar. Any explanatory power the model has for food crops is due to the inclusion of a weather factor and the time trend which probably reflects population growth. The extension of irrigation and the increases in the relative yields. The pattern of the results is not at all sensitive to the estimation technique or the choice of the price deflator, nor is it peculiar to the period under study. For instance, simple least squares with various assumptions concerning the price expectation and the adjustment coefficients or nonlinear estimation under the assumption of first order serial correlation in the disturbances of the Equation (16) produced essentially similar results. Also, applying the various estimation techniques to data from the pre-war period, when more observations were available and pooling was not necessary, did not alter the basic results.

Is it possible that there are such biases in our price data and the weighting system and/or the model is so misspecified that we cannot observe farmers' response to price changes? In order to examine this posiibility, first differences of the acreage for each crop in the various districts were correlated with each other. If they were responding to some common element, such as price, we would expect significant positive correlation among them. The results, which are presented in Table IX, do not indicate strong parallel movements of acreage in the different districts. The number of significant correlation coefficients is higher for the winter crops, wheat and barley, very probably due to the influence of a common weather factor, which, as we found, generally had a significant coefficient in the regressions. We are thus led to the conclusion that relative

TABLE IX.

Correlations between First Differences of Acreage of Various Crops in the Districts of Uttar Pradesh and Bihar (1951/52-1963/64)

		Total Number of Pairwise Correlation	Number of Correlation Coefficients that are Significant at the 5% level
Uttar Pradesh	Rice	276	39
	Wheat	276	57
	Barley	276	65
	Sugar	276	58
Bihar	Rice	66	4
	Wheat	66	42
	Barley	66	17
	Sugar	66	9

price could not have played an important role in determining the supply of crops which were not commercially important.[17] There may be several reasons for this. First, in these regions the markets for food crops are not well developed, and therefore price fluctuations and differentials may be high. Second, since the peasants sell only a small part of their food output, they have little contact with whatever markets exist; hence market signals cannot be effectively transmitted. Thirdly, even if some peasants respond to prices because of the wide fluctuation in the total area allocated to these crops (due to factors such as weather), the effect of price cannot be discerned in the aggregate data. These factors explain why we observe positive price coefficients both for cash crops, which are, by definition, produced for the market, and also for food crops as they become more commercialized.

Our conclusion is consistent with the results obtained in other studies of agricultural supply both in India and in other countries which have an underdeveloped agricultural sector. A recent study of food crops in India found little or no price response for major food crops.[18] Studies that have found significant positive response in India have either considered only cash crops, such as jute or cotton, or have concentrated on relatively commercialized regions, such as Punjab. In the rest of the world the pattern is similar and has led Krishna to conclude that "case studies suggest that crops can be ranged along a subsistence-commercial continuum with their responsiveness to price movements increasing with the degree of commercialization."[19] However, this basic difference has not been generally recognized in the literature and the evidence of low or zero price response for subsistence crops has been often overlooked. The advocates of the use of price policy in traditional agriculture have tended to generalize the results of few studies to all underdeveloped agriculture and assert, as Schultz does that "...responses to changes in product and factor prices are significantly positive. Moreover, the observed lags in these responses are closely akin to the observed lags in the part of farmers, for example, in the United States."[20] The empirical evidence suggests that as yet such a conclusion is not warranted for a substantial portion of agricultural production in the underdeveloped countries. Of course, the present trends indicate the rapid spread of the market system into previously non-market-oriented activities. It will not be long before our distinction between cash and subsistence crops disappears. We can then use price policy to regulate production much more effectively.

V.

Previous studies of the role of agricultural price have centered mainly on economic aspects, such as the increase in production or savings, and the social aspects have generally been neglected. In those cases which issues such as the uneven distribution of gains between the peasants and the "parasitic" middle men have been considered. They have been viewed in static terms rather than as social by-products of the process of the penetration of markets. Dalton is an exception. He stresses that the transition to market change means an inevitable change in social organization "and the destruction of" materially poor but unusually integrated ways of life, wherein economic and social processes were mutually dependent and reinforcing."[21] However, his main concern is the resultant dependence upon impersonal market forces rather than uneven development and the division of the society into owners of capital and wage labourers. It is this latter aspect which we want to emphasize here.

During the one hundred years before the Second World War much of the underdeveloped region of the world was integrated (sometimes by coercion) into the economies of the industrialized center. However, as we argued above, a considerable portion of the economic activity in the rural areas of the underdeveloped countries still remains outside the market system. Once we recognize this fact, we realize that one function of price policy is the extension of the market itself; i.e., the making of market exchange the dominant form of economic organization. Favourable agricultural prices accelerate this transformation, and, once product markets are established, input factors also become commercialized, i.e., land and labour become commodities as well. The transition to a market economy however, has typically been characterized by uneven development. The inequality cannot be accounted for by differences in efficiency or entrepreneurial talent, but other factors, such as chance, geographical location and the initial position in the social hierarchy, have to be considered. Once the process gets started, further development usually enhances the inequality. For instance, benefits from high food price accrue mainly to farmers who are already commercialized. The degree of commercialization is largely a function of geographical location or the size of the farm. Typically, farmers nearer to large cities or with easy access to the transportation system gain most, and geographical disparities are widened. Because the larger farmers market a higher percentage of their output, they stand to profit more from higher prices. Falcon estimates that in India and Pakistan "of [every] $10 transferred via a price support system, only about $1 goes to "small" farmers."[22]

Technological change will accelerate this uneven development. Since new technology usually means new, purchased inputs, production for the market is a prerequisite for its adoption. Commercialized farmers are in a better position to introduce the new technology, because they are better able to perceive the opportunities, obtain credit and benefit from the extra production. For instance, the commercial nature of agriculture in Punjab must have been a dominant factor in the Punjabi farmers' receptivity to the new high yield varieties. Needless to say, new technology leads to further commercialization and the chain reaction continues. The regional disparaties between the developed and underdeveloped regions of the world that appeared in the colonial period will very likely be repeated within the underdeveloped countries.

Our remarks are not meant to be an analysis of this process of transformation. Rather, our aim is to draw attention to its existence and to the need to examine its implications more carefully. We do not want to argue in favor of lower agricultural prices in order to retard the spread of the market system. The choice is not between high prices and keeping agricultural stagnant. Favourable terms of trade certainly stimulate production but within a particular pattern of development. Unfortunately, other policies to develop the rural sector and integrate into the rest of the economy have not received the kind of consideration they deserve. Many of the non-price policies, such as land reform, cooperatives, etc., that have been implemented in the past have not been real alternatives to price policy because they have in fact helped in preparing the ground for the extension of the market economy.

FOOTNOTES

[1]For a discussion of these issues and other aspects of the Green Revolution see [Falcon 15] and references cited therein.

[2]For a comprehensive statement of the controversy and survey of the literature see [Behrman 6, Chapter 1].

[3]See, for instance [Behrman 6, Chapter 1]. It is not implied these have been the only aspects of the controversy. Other questions such as single crop response versus total production response, short term versus long term and production response versus marketed surplus response have also been raised and discussed. These latter questions, however, are only meaningful in the context of the response to prices. See [Behrman 6, Chapter 1] and [Krishna 20].

[4]For example [Dalton 11] and [Neale 28].

[5]See Schultz [33, Chapter 2].

[6]See [Wharton 38] and [Miracle 23].

[7]Again one has to distinguish between the spread of the market system and the functioning of the system. For example, high price may increase supply through market penetration into previously non-commercialized regions. A subsequent fall in price will not necessarily reduce supply.

[8][National Council of Applied Economic Research 6].

[9]A survey of some villages in Deoria, a major sugar cane growing district in Eastern Uttar Pradesh, found that there was practically no marketable surplus for rice. See Gupta and Majid [17, pp. 7-8, 49-50].

[10]For a thorough discussion of the model see Nerlove [29].

[11]See Goldberger [16, p. 131]. For a discussion of the uniqueness of the estimates see Nowshirvani [30, p. 71].

[12]See Dhrymes [13].

[13]The practice of ratooning varies in different regions of India. In Uttar Pradesh and Bihar it is usually ratooned only once.

[14]Apart from its intuitive appeal, this observation is consistent with the findings of Behrman. See Behrman [6, pp. 297-300].

[15]For a discussion of the food controls see [Nowshirvani 30, Chapter 2].

[16]The maximum likelihood estimates were obtained using a alogorithm developed by Marquardt. Although it is possible to estimate variance-covariance matrix of the parameter estimates, the standard errors given the tables are linear approximations; see [Marquardt 22].

[17]This conclusion has important implications regarding the effectiveness of price controls and food zones in India. Since the peasants in the deficit areas generally market little of their food grains, the price rise due to the restriction of imports from the surplus regions fails to increase the local supply. On the other hand, in the surplus regions food grains have commercial importance and, therefore, a price reduction would lead to a contraction in their supply. The asymmetry involved would result in a net decline in total food supplies.

[18]See [National Council of Applied Economic Research 26, Chapter 4].

[19]Krishna [20, p. 508]. This study and Behrman [6] provide a comprehensive survey of the empirical studies of supply response.

[20]See Schultz [32, p. 4].

[21]Dalton [11, p. 376].

[22]Falcon [15, p. 29].

APPENDIX I

THE DATA

The principle source of acreage statistics was the annual publication, Agricultural Statistics of India, which was used in conjunction with the State: Season and Crop Reports and Estimates of Area and Production of Principal Crops in India. On the whole, area statistics are the most reliable of the agricultural data. The major source of inaccuracy is in the method of recording land under mixed crops, which has not changed since the end of the last century. The lowest administrative unit for which published annual data exists is the district, which is, therefore, our geographical unit of observation. Since the 1956 reorganization of the states altered the boundaries of three districts in Binar, these, together with two others for which adequate data was not available, were excluded from our sample.

Price statistics. Price statistics for different commodities in various markets and regions are available from a number of sources. However, many of the series lack uniformity and do not always cover the entire period studied here. Consequently we were forced to use a number of different sources. In Bihar, data was available from the Season and Crop Report on district farm harvest prices which are the average wholesale prices at which the commodities are disposed of at the village site during a specified harvest period. The reported price is the simple average for a number of villages in the districts. Unfortunately, in some districts observations were missing, particularly for the earlier years. The missing observations were estimated by regressing the price series in question on another set of prices in either one or two districts with which it was most correlated. Since this method was not feasible for arhar and sesamum, average month-end wholesale prices in Patna from January to June were used for the farmer, and agricultural year means of the all-India average prices for the latter.

In Uttar Pradesh where farm harvest prices were not available until after 1956, whole prices were used. These were usually the simple averages for a number of markets. The choice of the market was determined by location, the availability of continuous price data since 1952 and the importance of the market as a trading center for the crop in question. For some crops, no major markets existed in the region, and quotations from other markets were, therefore, obtained. The monthly wholesale prices, which are month-end quotations, were averaged over the period from the harvest to the sowing of each crop. For sugar cane a weighted average of the free market price and the government controlled price was used. The price data was obtained primarily from Agricultural Prices in India and Bulletin on Food Statistics.*

Construction of price indexes. The choice of the price deflator was not an easy one, because information on crop substitutability was very fragmentary. Therefore, it was decided to deflate the price of each crop by two indexes, one consisting of the crops which are grown in the same season and the other of all major crops. It should be noted that the deflators do not include

*For a list of market and data sources, see Nowshirvani [, p. 87].

all the crops which are grown in each district, since for many pulses, vegetables, and tree crops consistent price series were not available. In Bihar, where pulses other than gram and arhar occupy a substantial portion of the area in some districts, the omission may be serious.

In other studies of supply response, both area and production weights have been used. The choice between the two depends on whether the land is heterogeneous and the extent to which other inputs are fixed. With heterogeneous land and fixed proportions, area weights are appropriate, while production weights should be used otherwise. Since we have deflated the prices by a rather general index, they were weighted by production rather than area. The weights were the average production of each crop in the district for three years in the middle of the period. Excluding the districts where sugar cane is an important crop, the difference between the two sets of weights is small.

Rainfall data. Monthly rainfall figures for each district were obtained from India Weather Review and were aggregated for the following sowing periods: April to August and September to October in Uttar Pradesh, June to August and September to October in Bihar.

APPENDIX II

Area under Various Crops as Percentage of Total Cultivated Land (55-56 and 56-57 acreage) and Demographic Data

District	Rice	Wheat	Barley	Total Food Grains	Sugar	Total Food Crops	Oil Seeds	Fibres	Other	Rural Population, 1961 (percent of total population)	Cultivators and Agricultural Laborers, 1961 (percent of rural working population)
Uttar Pradesh											
1	10	18	12	88	1	92	5	1	2	59	80.5
2	21	3	15	91	2	95	1	1	3	96	83.1
3	22	9	16	95	1	96	2	1	1	82	84.9
4	1	25	2	90	1	91	8	1	n	92	78.7
5	13	20	3	95	n	95	4	1	n	93	86.9
6	21	8	26	89	5	96	n	2	2	95	87.0
7	28	6	19	92	3	97	n	n	3	97	80.6
8	24	7	18	94	4	99	n	n	1	96	76.8
9	43	13	15	92	3	97	1	n	2	93	98.3
10	31	13	13	86	11	98	1	n	1	98	92.3
11	39	16	12	92	3	97	1	n	1	99	92.2
12	35	4	21	91	6	98	n	1	1	95	84.9
13	19	23	7	90	2	96	3	n	1	51	84.2
14	16	16	15	85	2	89	3	1	7	98	87.5
15	28	14	12	95	1	97	1	1	1	97	87.1
16	20	21	8	84	8	93	3	1	3	92	89.1
17	11	21	11	83	6	93	6	n	1	93	89.0
18	22	20	5	79	12	93	2	2	3	95	89.4
19	31	15	7	90	5	96	n	n	3	92	88.3
20	33	18	6	65	3	96	2	n	2	95	91.1
21	27	20	8	90	1	95	3	n	2	95	91.7
22	31	12	11	92	2	96	n	1	3	98	87.0

APPENDIX II (continued)

District	Rice	Wheat	Barley	Total Food Grains	Sugar	Total Food Crops	Oil Seeds	Fibres	Other	Rural Population, 1961 (percent of total population)	Cultivators and Agricultural Laborers, 1961 (percent of roral working population)
23	23	10	22	93	2	97	n	2	1	98	88.2
24	27	17	5	89	5	95	1	n	4	95	86.7
Bihar											
25	41	8	2	94	1	99	1	n	n	80	78.9
26	50	10	2	94	1	97	2	n	1	93	84.7
27	44	13	3	95	1	97	3	n	n	93	75.9
28	30	11	11	87	6	97	2	1	n	96	84.3
29	49	6	9	83	8	96	2	2	n	95	88.1
30	48	6	6	89	1	97	2	n	1	95	83.6
31	56	8	4	88	2	97	1	6	1	96	79.0
32	30	16	3	95	1	98	1	n	n	89	77.7
33	51	7	24	77	1	96	3	n	n	89	76.7
34	41	6	4	75	n	78	1	21	n	96	83.6
35	67	1	n	97	n	98	2	1	n	95	84.9
36	57	1	n	91	n	93	7	n	n	92	81.5
37	62	n	n	90	n	93	6	1	n	91	80.2
38	28	3	5	89	1	90	10	n	n	95	85.9
39	78	n	n	95	n	97	3	n	n	75	79.4
40	81	n	n	96	n	97	3	n	n	79	81.5
41	49	7	3	75	n	79	2	18	1	94	79.4

APPENDIX III

UTTAR PRADESH

District	Name	Division: District	Name
1	Kanpur	1: 1-3[a]	Allahabad
2	Fatehpur	2: 4,5[a]	Jhansi
3	Allahabad	3: 13-18	Lucknow
4	Hamirpur	4: 19-24	Faizabad
5	Banda	5: 9-12	Gorakhpur
6	Juanpur	6: 6-8[a]	Varanasi
7	Ghazipur		
8	Ballia		
9	Gorakhpur		
10	Deoria		
11	Basti		
12	Azamgarh		
13	Lucknow		
14	Unnao		
15	Rae Bareli		
16	Sitapur		
17	Hardoi		
18	Kheri		
19	Faizabad		
20	Gonda		
21	Bahraich		
22	Sultanpur		
23	Partapgarh		
24	Barabanki		

BIHAR

District	
25	Patna
26	Gaya
27	Shahabad
28	Saran
29	Champaran
30	Muzaffarpur
31	Darbhanga
32	Monghya
33	Bhagalpur
34	Sahrarsa
35	Santal Parganas
36	Hazaribagh
37	Ranchi
38	Palamau
39	Dhanbad
40	Sing Bhum
41	Purnea

[a]Three additional districts are included in the administrative division of Allahabad, and two each in Jhansi and Varavasi.

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