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THE SUPPLY RESPONSIVENESS OF INDIAN FARMERS IN THE POST-INDEPENDENCE PERIOD : MAJOR CEREAL AND CASH CROPS

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INTRODUCTION

In an effort to measure the effects on cultivator market responsiveness of a number of economic, social and political factors, estimates of the supply elasticities of several crops were made using a Nerlove-type model.[1] This approach has been employed on numerous earlier occasions by authors interested in Indian agriculture.[2] Some studies have analysed crop output on the State level, while others have focused on major producing districts. Our overall purpose, however, required data both on several different crops and from a wide variety of geographic regions in order to detect any intersectional differences in price response. In order to amass the necessary supply elasticity information and to ensure its derivation from a common estimating procedure, the work reported herein was undertaken.

I

THE NERLOVE SUPPLY MODEL

In a seminal effort in the late 1950's, Marc Nerlove formulated a supply model that incorporated both price expectation and output adaptation concepts. The original structure has since been used by several dozen researchers who have made various major and minor changes in it in order to suit the circumstances of their particular interests or to avoid some of the statistical estimating difficulties encountered in the analysis process.

The version of the Nerlove model used in this case is quite similar to those used in other Indian studies.[3] In the basic supply equation, the area cultivators wish to plant in some crop is postulated to be a function of the price they expect to obtain after the harvest, the anticipated availability of

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1. Marc Nerlove: The Dynamics of Supply : Estimation of Farmers' Response to Price, John Hopkins University Press, Baltimore, 1958.

2. Among many others : Raj Krishna, "Farm Supply Response in India-Pakistan : A Case Study of the Punjab Region," *The Economic Journal*, Vol. LXXIII, No. 291, September, 1963; National Council of Applied Economic Research: Long-Term Projections of Demand for and Supply of Selected Agricultural Commodities 1960-61 to 1975-76, New Delhi, 1963; Vahid Nowshirvani : Agricultural Supply in India : Some Theoretical and Empirical Studies, M.I.T. Ph.D. Thesis, 1968; A Parikh, "Market Responsiveness of Peasant Cultivators : Some Evidence from Pre-War India," *Journal of Development Studies*, Vol. 8, No. 2, January, 1972; M. G. Madhavan, "Acreage Response of Indian Farmers: A Case Study of Tamil Nadu," *Indian Journal of Agricultural Economics*, Vol. XXVII, No. 1, January-March, 1972.

3. In particular, it resembles the model used by Vahid Nowshirvani, *op. cit.*, to analyse output of rice, wheat and barley in his study of Uttar Pradesh and Bihar.

water at critical periods during the growing season, and a trend available. The model is completed by Nerlove's formulations of price expectation and area adjustment.

$$(1) \quad A_t^D = a_0 + a_1 P_t^* + a_2 R_t^* + a_3 T + U_t$$
$$(2) \quad P_t^* - P_{t-1}^* = b (P_{t-1} - P_{t-1}^*)$$
$$(3) \quad A_t - A_{t-1} = C(A_t^D - A_{t-1})$$

where A_t^D is the desired acreage in the crop;
P_t^* is the expected realised price;
R_t^* is the anticipated water availability;
T is the trend variable; and
A_t and P_t are actual acreage and price respectively.

Equation (2) indicates a learning process on the part of cultivators—this year's price expectations are modified relative to those of last year by some proportion of the discrepancy last year between actuality and expectation, while equation (3) allows for the presence of strictures on complete area adjustment—actual adjustment from last year to this is some proportion of what cultivators would like that adjustment to be.

The supply equation (1), as expressed, cannot be estimated because it includes unobservable variables. However, if (2) and (3) are substituted in (1) and the latter is manipulated algebraically, an equation susceptible to analysis results :

$$(4) \quad A_t - (1-b) A_{t-1} = a_0 bc + a_1 bc P_{t-1} + (1-c) (A_{t-1} - (1-b) A_{t-2}) + a_2 c (R_t^* - (1-b) R_{t-1}^*) + a_3 c (T - (1-b) (T-1)) + c (U_t - (1-b) U_t - 1))$$

A problem of parameter identification is avoided by separately estimating (4) for a range of specified values of b, the price expectation coefficient, which can be reasonably assumed to fall within the range of zero to two. The 'best' of the resulting sets of estimates is then chosen according to what is basically a maximum likelihood criterion—that value of b for which the regression error sum of squares is minimized.

Another estimating problem, that of auto-correlation, is encountered because of the presence on the right-hand side of (4) of lagged values of the dependent variable. Thus an ordinary least squares estimating procedure which incorporated the Cochrane-Orcutt technique[4] was used, resulting in a regression process which was doubly iterative—first, over a range of price

4. J.D. Cochrane and G. H. Orcutt, "Application of Least Squares Regressions to Relationships Containing Auto-Correlated Error Terms," *Journal of the American Statistical Association*, Vol. 44, 1949.

expectation coefficients, and then using the Cochrane-Orcutt method for minimizing the effect of correlated disturbance terms.

An alternative version of the model including yield in equation (1) was also tested in the early stages of the study. The yield variable showed little statistical significance and because yield data were generally available for a shorter time period than acreage and price data, only the simpler model was employed in the full study.

II

THE RESULTS : CROPS

The production of eight crops was analysed—three cereals (rice, wheat and barley), two fibres (jute and cotton), two oilseeds (groundnuts and sesamum) and tobacco. The cereals account for about a third of the cultivated acreage nationally, while the five cash crops claim another 12 or so per cent of the land. The crops are not, of course, cultivated uniformly across the country. Not only are rice and wheat the basic cereals of different regions, but jute and tobacco in particular are found only in specific sections. Cotton and oilseeds are planted in most States, but with considerable variation in yield, relative local importance, and growing season.

For all States and almost all districts, harvest price data were available for the time periods in question—for the few exceptions, prices in contiguous districts were used. Prices were deflated by a cost of living index taken from the nearest urban centre for which such index was available, in the absence of sufficient information on changes in rural areas. Farmer anticipations of water availability, like price expectations, are not directly measurable; as an approximation, we used an index of actual rainfall during the period immediately preceding and accompanying the sowing of each crop, relative to average precipitation during this period in the past.

State-wide parameter estimates obtained from ordinary least squares regressions run on equation (4) are shown in Table I, and supply elasticites for selected major producing districts[5] are listed in Table II.

Rice

If we first consider rice, evidence is indicated for perhaps more market orientation among its cultivators than might be expected for what is essentially a subsistence crop. Positive price parameters were found for the four largest

5. Because of boundary shifts since Independence, two (or more) districts were grouped in some cases for estimating purposes. Most of the affected districts were in the south, but such changes have occurred in most parts of the country.

rice States included[6] (West Bengal, Andhra Pradesh, Tamil Nadu and Assam). Though most elasticities are rather small, for both Andhra Pradesh and the lesser of West Bengal's two rice crops (autumn), the responsiveness is quite strong. Production in more than 100 separate districts was analysed, and these results (only some of which are shown) bolster the case for positive responsiveness. More than half the estimated price coefficients were significant at the 30 per cent level or better, and most of these were positive. Contiguous groups of negative estimates were found only in western Assam and northern West Bengal[7] and in the rather under-developed reaches of Himachal Pradesh. In the former region, rice is the dominant crop, holding well over half the acreage, but in the latter it falls below both wheat and maize in importance, ranking as a cereal with barley.

Wheat

For wheat, the major cereal in more temperate northern regions, uniformly positive price responsiveness is indicated at the State level for both major and minor producing areas, though the calculated elasticities are generally small. From the district wheat regressions a more complex pattern emerges, with negative price coefficients found in nearly half the 100 districts analysed. However, as can be seen from Table II, price responsiveness is fairly consistently positive in the more important States, Punjab and Rajasthan, with most of the negative links indicated for districts in Maharashtra and northern Mysore, where wheat generally accounts for well under five per cent of the total cultivated acreage.

Barley

By comparison with the former two cereals, barley is a much less important crop. Whereas rice and wheat do not much compete with each other for land and other inputs, wheat and barley share mostly the same growing regions and seasons. Though they are as a result competitive, barley is generally considered by its cultivators to be an inferior crop and thus it generally takes second place to wheat as to allocation of the best land. Nevertheless, barley's market resposiveness is not only positive, but definitely stronger than what we found for either rice or wheat. In all but one State shown in Table I and about six of the approximately 35 barley districts analysed, positive price coefficient estimates were indicated, and about three quarters of these were statistically significant at the 30 per cent level or better. The few negative exceptions were again, as with rice, concentrated in Himachal Pradesh. The fairly sizable elasticities tend to confirm the results found by Nowshirvani[8]

6. No estimates were made for Uttar Pradesh and Bihar; those made by Vahid Nowshirvani for rice, wheat and barley production in these States are suitable for the overall study of which our results reported here are part. For Madhya Pradesh and Orissa, data difficulties arose especially with regard to prices, and thus these States were also eliminated from analysis.

7. A similar pattern was also found for four or five adjoining districts in north-western Bangladesh.

8. Which were both higher and more significant than those he calculated for rice and wheat.

for the other major barley States, Uttar Pradesh and Bihar. A plausible explanation for barley cultivator behaviour can be seen in the crop's normally secondary role—price increases readily lead to increases in the rather small acreages generally in barley (and possibly to planting on better land, though the lack of any consideration of crop yield in the model tested here rules out any conclusions in this regard), while a drop in price brings about a considerable retreat of the crop back to its usual inferior status.

Jute

If we turn now to the first of our cash crops, jute, both the State and district computations indicate the very strong market orientation of its cultivators. With only a single exception among five States and 22 districts, the price coefficients were positive, and in all but four or five cases, statistical significance was indicated at the 30 per cent level or better. Furthermore, most of the short run elasticities are sizable, falling between $+0.45$ and $+0.75$.

Cotton

For the other fibre considered, cotton, results were considerably more mixed.[9] Negative parameters are indicated at the State level only in Assam and the southern producing region encompassing Kerala and Tamil Nadu, the three of which together account for less than five per cent of national output. In Gujarat, the major cotton State[10] analysed here, the estimate was positive but quite small, and not statistically significant at even the 30 per cent level. In addition to the States with positive and significant price parameters (Mysore and Punjab), district price coefficient estimates with statistical significance at the 30 per cent level or better are predominantly positive. Only in Andhra Pradesh is there a district level pattern of negative parameters. The general inconclusiveness regarding market influence is somewhat puzzling in the light of the strong post-Independence growth of the domestic textile industry, and this confusion is amplified by the fact that in most districts where statistical significance is indicated for the coefficient of the trend variable, the sign is negative.

Groundnuts

The leading source of vegetable oils in India is groundnut cultivation which occurs in many States; however, it is most important from Gujarat south and east to Tamil Nadu. Altogether, groundnuts claim about five per cent of the nation's planted area. Despite the market destination of most groundnut output, the portrait outlined by our results is like that for cotton—unclear and somewhat contradictory. Among the major producing States, only in Andhra Pradesh is there a positive and statistically significant supply

9. Unfortunately, the State responsible for more than a third of national output, Maharashtra, could not be included in this analysis because of lack of acreage data compatible with that of the other cotton producing States considered.

10. Gujarat is responsible for about a fourth of national cotton output.

responsiveness, and the district level calculations generally back up the State-wide result. In most other States, not much significance is indicated. Rajasthan is a negative exception, but it is a decidedly minor producer; Gujarat, however, also shows a negative market relationship, and her cultivators are responsible for about a third of national output, and the same sign is found in the other half of the erstwhile Bombay State, Maharashtra, which produces another sixth. If we look at the district results in Gujarat-Maharashtra, however, some mitigation of this lack of market orientation is indicated—positive and significant price coefficients were found for more than ten districts, with negative significant estimates in less than half as many cases. All in all, though, district level regressions follow the pattern indicated by the State results—a mixed picture perhaps more to be expected for a subsistence crop.

Sesamum

In acreage terms, sesamum is about a quarter as important as groundnuts; both overlap to a considerable extent in their cultivation, though major sesamum districts tend to be more inland. In Andhra Pradesh alone are the two crops really competitive to any great extent on the district level. On first glance, Table I shows the same mix of positive and negative, statistically significant and non-significant market responsiveness as groundnuts. But only for Tamil Nadu, among the major sesamum areas,[11] is the price coefficient negative, and in this case, significance is lacking even at the 30 per cent level. On the other hand, State-wide price parameter estimates are positive and significant in three States (Rajasthan, Andhra Pradesh and Maharashtra) which together account for more than half of national output; in these States and in Tamil Nadu, Gujarat and Mysore (which produce another 15 per cent) significant positive price coefficients are found in 24 districts. These are balanced by only eight similar negative estimates, which are elsewhere confined to definitely minor sesamum cultivating areas—*e.g.*, Assam, Bihar, Kerala and Punjab—which together produce less than five per cent of the crop nationally.

Tobacco

The last crop analysed, tobacco, is even more specialised than jute. Though it is grown in districts from the extreme southern littoral to nearly in sight of the highest mountains, major production is found in 'spot locations' throughout the country, rather than in belts sweeping the sub-continent. Tobacco cultivation is centred in Andhra Pradesh, in neighbouring districts in Mysore and Tamil Nadu, and at the mouth of the Gulf of Cambay in Gujarat—together these account for nearly 70 per cent of India's tobacco. State-wide elasticities are small and significant in all four of these States (Table I), but district computations indicate, for the most part, not much significance for price responsiveness.

11. After Rajasthan, Madhya Pradesh is the most important sesamum State, but data difficulties ruled out its analysis.

Tobacco is a very specialised crop, particularly as regards soil inputs; thus, it is grown under climatological conditions which range from the nearly natural in parts of Africa to massive quasi-greenhouses in New England. Its cultivators find the rewards worthwhile relative to alternative land uses because of the high returns on a per acre basis.

India is not usually thought of as a major world source of tobacco, yet the future role of Indian tobacco in British (and other European) markets caused considerable controversy in the negotiations surrounding Britain's entry into the European Economic Community. For example, its importance can be seen from the fact than it has in recent years accounted for more than two and a half per cent of exports in value terms, ranking only behind jute, tea and cashews among agriculturally derived products. Of course, the

TABLE I—SUPPLY PARAMETERS BY STATE

State	Time period	Elasticity		Price expectation coefficient	Area adjustment coefficient	R^2
		Short run	Long run			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Rice						
Andhra Pradesh	1950-1967	+0.48[d]	+0.62	+0.6	+0.78	0.90
Assam	1955-1967	+0.07	+0.07	+1.1	+0.93	0.85
Gujarat	1954-1967	—0.07[a]	—0.07	+1.1	+1.06	0.41
Himachal Pradesh ..	1949-1966	—0.07[a]	—0.06	+0.9	+1.10	0.42
Kerala	1951-1966	—0.14[d]	—0.12	+1.0	+1.13	0.91
Maharashtra	1955-1967	—0.12[d]	—0.14	+1.5	+0.84	0.90
Manipur	1955-1967	+0.20[d]	—1.25	+0.7	—0.16	0.89
Mysore	1951-1967	+0.06[a]	+0.07	+0.9	+0.92	0.94
Pondicherry	1958-1968	+0.39[a]	+0.85	+0.9	+0.46	0.51
Punjab	1950-1966	+0.03	+0.05	+1.5	+0.61	0.99
Tamil Nadu	1946-1967	+0.08	+0.08	+1.0	+0.98	0.92
Tripura	1949-1967	+0.01	+0.01	+0.6	+0.96	0.86
West Bengal	1949-1966(A)	+0.37[b]	+0.38	+0.6	+0.98	0.37
	1949-1966(W)	+0.09[a]	+0.08	+1.0	+1.12	0.88
Wheat						
Delhi	1948-1967	+0.17[c]	+0.25	+1.3	+0.67	0.94
Gujarat	1954-1967	+0.93[c]	+1.00	+1.1	+0.93	0.39
Himachal Pradesh ..	1949-1966	+0.02	+0.01	+0.7	+1.54	0.79
Maharashtra	1955-1967	+0.24[d]	+0.23	+1.3	+1.05	0.64
Mysore	1954-1967	+0.23[d]	+0.33	+0.5	+0.69	0.63
Punjab	1950-1967	+0.10	+0.13	+1.3	+0.75	0.98
Rajasthan	1951-1968	+0.02	+0.03	+0.9	+0.62	0.87
West Bengal	1946-1967	+0.23	+0.20	+0.7	+1.13	0.34
Barley						
Delhi	1948-1967	+0·52[d]	+0·69	+0·85	+0·75	0·52
Himachal Pradesh ..	1949-1966	+0·10[a]	—0·26	+1·5	+0·39	0·84
Punjab	1950-1967	+0·22[a]	+0·27	+1·3	+0·83	0·81
Rajasthan	1950-1968	+0·67[d]	+1·46	+0·5	+0·46	0·53

(Contd.)

TABLE I—(*Concld.*)

State	Time period	Elasticity		Price expectation coefficient	Area adjustment coefficient	R^2
		Short run	Long run			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Jute						
Assam	1949-1969	+0·07	+0·05	+0·7	+1·54	0·32
Bihar	1946-1969	+0·12	+0·13	+0·7	+0·91	0·12
Uttar Pradesh	1957-1968	+0·14[b]	+0·14	+1·1	+0·99	0·42
Tripura	1949-1969	+0·80[d]	+1·60	+0·9	+0·50	0·60
West Bengal	1949-1969	+0·40[c]	+0·35	+0·9	+1·15	0·59
Cotton						
Andhra Pradesh	1951-1969	+0.07	+0.11	+0.7	+0.64	0.35
Assam	1951-1969	—0.09	—0.11	+1.3	+0.83	0.71
Gujarat	1954-1968	+0.05	+0.08	+0.9	+0.59	0.63
Kerala	1957-1969	—0.39[a]	—0.41	+1.0	+0.95	0.69
Mysore	1953-1969	+0.29[d]	+0.33	+1.2	+0.88	0.88
Punjab	1950-1968	+0.37[c]	+0.56	+0.5	+0.66	0.74
Tamil Nadu	1950-1967	—0.29[c]	—0.32	+0.5	+0.91	0.50
Tripura	1951-1969	+0.20	+0.29	+0.5	+0.68	0.84
Groundnuts						
Andhra Pradesh ..	1951-1967	+0.69[d]	+0.52	+0.6	+1.33	0·47
Gujarat	1955-1967	—0.11[a]	—0.11	+0.9	+1.03	0·85
Maharashtra	1955-1968	—0.14	—0.14	+0.9	+0.99	0.49
Mysore	1953-1967	—0.06	—0.06	+0.9	+1.05	0.45
Pondicherry	1958-1968	+0.16	+0.14	+0.5	+1.15	0.58
Punjab	1951-1967	+0.89[c]	+4.05	+0.7	+0.22	0.96
Rajasthan	1950-1968	—0.47[d]	—0.57	+1.5	+0.83	0.99
Tamil Nadu	1950-1967	—0.01	—0.01	+0.9	+1.03	0.71
Sesamum						
Andhra Pradesh	1955-1968	+0.29[a]	+0.23	+0.9	+1.25	0.31
Assam	1949-1967	—0.42[c]	—0.98	+1.2	+0.43	0.85
Bihar	1953-1967	—0.74[d]	—0.39	+1.3	+1.92	0.57
Gujarat	1955-1968	+0.08	+0.10	+1.5	+0.82	0.98
Kerala	1958-1968	—0.30[d]	—0.68	+0.7	+0.44	0.95
Maharashtra	1955-1968	+0.23[d]	+0.30	+0.5	+0.77	0.73
Mysore	1955-1968	+0.03	+0.04	+1.5	+0.71	0.89
Punjab	1953-1967	—0.93[d]	—2.33	+1.5	+0.40	0.73
Rajasthan	1951-1968	+0.37[a]	+0.34	+1.1	+1.08	0.73
Tamil Nadu	1949-1967	—0.15	—0.21	+1.1	+0.70	0.72
Tripura	1954-1967	+0.40[a]	+0.56	+0.6	+0.72	0.36
Tobacco						
Andhra Pradesh	1950-1968	+0.18[a]	+0.19	+0.9	+0.96	0.52
Assam	1955-1968	—0.26[d]	—0.33	+1.5	+0.78	0.83
Bihar	1950-1968	—0.07	—0.08	+0.6	+0.85	0.10
Gujarat	1955-1968	+0.16[d]	+1.00	+1.3	+0.16	0.65
Maharashtra	1954-1968	—0.08	—0.12	+1.5	+0.66	0.93
Mysore	1953-1968	—0.04[b]	—0.05	+1.0	+0.84	0.91
Tamil Nadu	1951-1968	+0.22[a]	+0.25	+0.9	+0.89	0.23

Note : (A) indicates autumn crop. (W) indicates winter crop.
Significance level of price parameter estimates from which elasticity was derived :
(*a*) 30 per cent. (*c*) 5 per cent.
(*b*) 10 per cent. (*d*) 1 per cent.

TABLE II—SUPPLY ELASTICITIES : SELECTED DISTRICTS

District	Elasticity SR	Elasticity LR
Rice		
Andhra Pradesh		
Chittoor	−0.26[a]	−0.30
E. Godavari	+0.16[b]	+0.17
Karimnagar	−0.10	+0.08
Krishna	+0.03	+0.03
Nellore	+0.07	+0.11
Nizamabad	+0.19[d]	+0.38
Srikakulam	+0.09	+0.13
Visakhapatnam	−0.15	−0.12
Warangal, Khammam, and W. Godavari	+0.03	+0.03
Assam		
Darrang	+0.17	+0.12
Garo Hills	−1.38[c]	−1.53
Goalpara	−0.27[b]	−0.42
Kamrup	−0.17[d]	−0.22
Lakhimpur	−0.14[a]	−0.12
Cachar, Nowgong and Sibsagar	+0.07	+0.06
Gujarat		
Baroda	−0.02	−0.03
Kaira	+0.02	+0.02
Panch Mahals	−0.04	−0.10
Surat and West Khandesh	+0.21[d]	+1.91
Himachal Pradesh		
Bilaspur	−0.18[c]	−0.33
Mandi	−0.07[b]	−0.07
Kerala		
Ernakulam, Kottayam and Trichur	+0.23[c]	+0.26
Trivandrum and Kanya Kumari	+0.05	+0.04
Malabar and South Kanara	−0.01	−0.01
Quilon and Alleppey	0	0
Maharashtra		
Bhandara	−0.04	−0.04
Chanda	−0.08[d]	−0.07
Kolaba	−0.01	−0.01
Ratnagiri	+0.02[a]	+0.02
Thana	−0.01	−0.01
Mysore		
Chickmagalur	+0.04[a]	+0.04
Coorg	−0.03[b]	−0.03
Mandya	−0.38[d]	−0.29
N. Kanara	+0.01	+0.01
Shimoga	−0.12[d]	−0.28
Punjab		
Amritsar	−0.09[a]	−0.15
Gurdaspur	+0.37[c]	+0.26
Hoshiarpur	+0.47[a]	+0.68
Kapurthala	+0.75[c]	+0.81
Tamil Nadu		
Chingleput	+0.39[a]	+0.42
Madurai	+0.24[c]	+0.16
N. Arcot	+0.07	+0.12
Ramanathapuram	+0.22[a]	+0.26
S. Arcot	+0.14	+0.16
Thanjavur	−0.27[d]	−0.22
West Bengal		
Bankura (A)	−0.03	−0.06
(W)	+0.04	+0.05
Birbhum (W)	−0.15[b]	−0.18
Burdwan (W)	−0.05	−0.05
Cooch-Behar (A)	+0.30[a]	+0.67
Howrah (W)	−0.01	−0.01
Jalpaiguri (W)	+0.07	+0.05
Malda (A)	+0.15[a]	+0.18
Midnapore (W)	0	0
Murshidabad (A)	+0.31[a]	+0.41
Nadia (A)	−0.22[d]	−0.22
24-Parganas (W)	+0.07[d]	+0.06
Purulia, Dhanbad and Singhbhum	−0.11	−0.34
* * * *		
Wheat		
Gujarat		
Ahmedabad	+0.77[c]	+0.61
Kaira	+0.50[b]	+0.41
Mehsana	+1.26[c]	+1.66
Sabarkantha	+0.23	+0.16
Himachal Pradesh		
Bilaspur	+0.22[a]	+0.42
Chamba	−0.03	−0.05
Mandi	−0.06[a]	−0.12
Sirmur	−0.01	−0.01
Mahasu and Kinnaur	−0.12[a]	−0.11

(Contd.)

TABLE II—(*Contd.*)

District	Elasticity SR	Elasticity LR
Wheat		
Maharashtra		
Nagpur	—0.30[c]	—0.56[c]
Nasik	—0.02	—0.02
Wardha	—0.11[a]	—0.12[a]
Mysore		
Bijapur	+0.16[a]	+0.24
Dharwar	+0.05[a]	+0.06
Belgaum and Kolhapur	—0.11[c]	—0.09
Punjab		
Amritsar	+0.02	+0.02
Bhatinda	+0.36[a]	+0.55
Ferozepore	+0.06	+0.08
Gurdaspur	—0.04	—0.07
Gurgaon	+0.06	+0.07
Hoshiarpur	—0.14	—0.20
Jullundur	+0.33[d]	+0.42
Kangra	+0.05	+0.03
Kapurthala	+0.05	+0.05
Ludhiana	+0.21[b]	+0.21
Rohtak	+0.02	+0.02
Ambala and Patiala	+0.14	+0.28
Karnal and Sangrur	+0.22[c]	+0.39
Rajasthan		
Bharatpur	+0.28[c]	+0.30
Bhilwara	—0.01	—0.02
Bundi	—0.08	—0.11
Chittorgarh	—0.27[a]	—0.47
Ganganagar	—0.21	—0.29
Pali	+0.40[c]	+0.55
Sawai Madhopur	+0.03	+0.05
Tonk	0	0
Udaipur	+0.30	+0.59
	* *	
Jute		
Assam		
Darrang	—0.04	—0.04
Garo Hills	+0.21[c]	+1.75
Goalpara	+0.18[a]	+0.11
Kamrup	+0.21[a]	+0.31
Nowgong	+0.16[a]	+0.13
Bihar		
Champaran	+0.83[d]	+1.48
Darbhanga	+0.26	+0.27
Saharsa	+0.73[c]	+0.64
Uttar Pradesh		
Kheri	+0.77[b]	+0.75
Sitapur	+0.35	+0.35
	*	*

District	Elasticity SR	Elasticity LR
Rajasthan—(*Contd.*)		
Jhalawar and Mandsaur	—0.39[a]	—0.66
Kotah and Bhilsa	—0.24[c]	—0.60
	* * *	*
Barley		
Himachal Pradesh		
Chamba	—0.63[d]	—0.69
Mandi	—0.06	—0.06
Sirmur	+0.04[b]	+0.04
Mahasu and Kinnaur	—0.06	—0.10
Punjab		
Bhatinda	+1.20[d]	+1.15
Ferozepore	+0.93[d]	+1.24
Gurdaspur	+0.23[a]	+0.40
Gurgaon	+0.77[d]	+5.92
Hissar	+0.60[a]	+0.66
Kangra	+0.19	+1.00
Mahendragarh	+1.58[c]	+3.95
Rohtak	+1.09[d]	+3.30
Rajasthan		
Alwar	+0.56[d]	+0.85
Bharatpur	+0.21[b]	+0.29
Bhilwara	+0.13[a]	+0.16
Bundi	+0.02	+0.04
Chittorgarh	+0.50[c]	+0.71
Dungarpur	—0.34	—0.36
Ganganagar	+0.86[b]	+0.85
Pali	+0.21[b]	+0.22
Sawai Madhopur	+0.41[a]	+0.44
Sikar	+0.34[a]	+0.30
Tonk	—0.04	—0.04
Udaipur	+0.10	+0.12
Ajmer and Jaipur	+0.13[b]	+0.15
	* *	
West Bengal		
Burdwan	+0.76	+0.67
Cooch-Behar	+0.36[c]	+1.50
Hooghly	+0.66[c]	+1.45
Howrah	+0.79[c]	+1.93
Jalpaiguri	+0.16[a]	+1.45
Malda	+0.51[b]	+1.38
Midnapore	+0.59[c]	+0.70
Murshidabad	+0.24[a]	+0.27
Nadia	+0.75[b]	+0.71
24-Parganas	+0.74[d]	+1.10
W. Dinajpur and Purnea	+0.36[b]	+0.31
	* * *	

(*Contd.*)

TABLE II—(*Contd.*)

District	Elasticity		District	Elasticity	
	SR	LR		SR	LR
Cotton			Mysore		
Andhra Pradesh			Bellary	+0.18[a]	+0.19
			Bijapur	+0.26[a]	+0.36
Anantapur	+0.19[b]	—0.22	Dharwar	—0.10[a]	—0.33
Cuddapah	—0.15[a]	—0.30	Mysore and		
Kurnool	—0.09[a]	—0.10	Coimbatore	—0.17[a]	—0.63
Adilabad and			Gulbarga, Raichur,		
Nanded	+0.03	+0.04	Hyderabad and		
			Mahbubnagar ..	+0.25[c]	+0.30
Gujarat			Punjab		
Ahmedabad ..	—0.31	—0.31	Bhatinda	+0.18[a]	+0.36
Baroda	0	0	Ferozepore	+0.31[b]	+0.60
Broach	+0.22[c]	+0.20	Jullundur	+0.36[a]	+0.64
Junagadh	+3.14[c]	+6.98	Ludhiana	—1.24[d]	—2.64
Kaira	+0.16[a]	+0.10	Karnal and Sangrur	+0.53[b]	+1.04
Kutch	+0.22	—0.76			
Mehsana	—0.04	—0.05	Tamil Nadu		
Sabarkantha ..	—0.47[c]	—0.67			
Surendranagar ..	+0.16[a]	+0.39	Madurai	—0.04	—0.05
Surat and			Ramanathapuram	—0.14	—0.14
W. Khandesh ..	—0.16	—0.53	Tirunelveli	—0.28[c]	—0.42[c]
	* *		* *		
Groundnuts			Maharashtra (*Contd.*)		
			Buldana	—0.66[c]	—0.82
Andhra Pradesh			E. Khandesh ..	—0.16	—0.29
			Nasik	—0.19[b]	—0.18
			N. Satara	+0.06[a]	+0.10
Anantapur	+0.27[a]	+1.29	Parbhani	+0.24	—3.43
Chittoor	+0.43[a]	+0.60	Poona	—0.18	—0.16
Cuddapah	+0.06	+0.08	Sangli	—0.05	—0.08
Kurnool	+0.46[d]	+1.64	Sholapur	—0.11	—0.08
Visakhapatnam ..	—0.29	—0.34	Yeotmal	—0.08	+1.33
			Mysore		
Gujarat					
			Bellary	—0.41[d]	—0.38
Junagadh	+0.35[d]	+2.50	Bijapur	—0.32	—0.25
Panch Mahals ..	—0.09	+0.10	Dharwar	+0.11	+0.11
Sabarkantha ..	—0.39[c]	—0.36	Kolar	+0.11	+0.15
Amreli, Bhavnagar			Belgaum and		
Jamnagar and Rajkot	+0.16[a]	+0.89	Kolhapur	—0.29[d]	—0.35
Surat and			Mysore and		
W. Khandesh ..	—0.07	—0.08	Coimbatore	—0.06	—0.06
			Tamil Nadu		
Maharashtra					
			Madurai	—0.53[d]	—0.37
Akola	+0.17[b]	+0.27	N. Arcot	—0.12	—0.09
Amraoti	+0.34[b]	+0.64	Salem	+0.15[a]	+0.13
Aurangabad ..	+0.72[d]	—1.95	S. Arcot	+0.13[a]	+0.12
Bhir	+0.23	+0.19	Tiruchirapalli ..	+0.15	+0.13
	* *		* *		

(*Contd.*)

TABLE II—(*Concld.*)

District	Elasticity		District	Elasticity	
	SR	LR		SR	LR
Sesamum			Punjab		
Andhra Pradesh			Gurdaspur ..	+0.47[a]	+0.49
E. Godavari ..	−0.03	−0.05			
Karimnagar ..	+0.03	+0.03	Rajasthan		
Bihar			Banswara	+0.44	+0.49
			Bhilwara	+0.64	+1.19
Palamau	−0.71[d]	−1.45	Bundi	+0.64[a]	+1.28
Kerala ..			Dungarpur	+0.57[c]	+0.69
			Nagour	+0.20	+0.14
Alleppey and Quilon ..	−0.79[d]	+6.58	Pali	−0.15	+0.16
			Tonk	+0.49[b]	+1.14
Maharashtra			Ajmer and Jaipur ..	+0.10	+0.08
			Banaskantha and Sirohi	+0.09	+0.12
Chanda	+0.16[a]	+0.47			
Nagpur	+0.45[c]	+0.98			
Wardha	+0.14[a]	+0.26	Tamil Nadu		
Mysore			Chingleput ..	+0.89[d]	+1.14
			Madurai	−0.45[a]	−0.69
Mysore and Coimbatore ..	+1.08[d]	+2.16	S. Arcot	+0.22	+0.45
			Tiruchirapalli ..	−0.18[a]	−0.11
	* *		* *		
Tobacco			Gujarat		
Andhra Pradesh			Baroda	+0.02	+0.11
			Kaira	+0.07	+0.16
East Godavari ..	−0.30	−0.38			
Guntur	−0.07	−0.06	Maharashtra		
Krishna	+0.08	+0.07			
Khammam, Warangal and W. Godavari ..	+0.08[a]	+0.11	Sangli	−0.12	−0.20
			Mysore		
			Kolar	+0.32[c]	+1.33
Bihar			Belgaum and Kolhapur ..	−0.05[a]	−0.11
			Mysore and		
Darbhanga	+0.05	+0.09	Coimbatore ..	−0.02	−0.04
Muzaffarpur ..	+0.12[c]	+0.33			
	* *		* *		

Note : SR = Short Run. LR = Long Run.

(A) indicates autumn crop.

(W) indicates winter crop.

Significance level of price parameter from which elasticity was derived : (*a*) 30 per cent. (*b*) 10 per cent. (*c*) 5 per cent. (*d*) 1 per cent.

domestic market as well has shown considerable growth, contributing to the prosperity of many cultivators.

However, unlike that for the other major agricultural export considered here, jute, the responsiveness picture for tobacco is mixed. Other parts of this study have indicated that a similar situation prevails in both Pakistan and Bangladesh—a positive relationship between output and tobacco prices whose strength seems to depend upon location. Those areas with ample *potential* tobacco land show more responsiveness; in most tobacco areas where the crop has been customarily grown in some quantity, the high crop returns (relative to alternative uses) seem to lead to little or no short run price responsiveness.

III

THE RESULTS : REGIONS

Since regional variation within the Indian union is likely to be at least as important as that related to crops as far as our interest in national market responsiveness patterns is concerned, it seems useful to pursue briefly an analysis based on geographic terms. Beginning in the south, the principal crop in Kerala considered above was rice, planted on more than a third of the State's acreage. In this area with highly fecund soils and the nation's smallest holdings per cultivator family, the calculated supply elasticities are not very far from zero, a condition prevailing in other densely populated rice districts along the west coast to Bombay and above.

In Tamil Nadu, rice elasticities were positive, if generally small, in all but one district. The results for the cash crops are mixed, however; for cotton, negative price coefficients (without much significance) were calculated for the major southern districts and the State as a whole. Groundnuts responsiveness, on the other hand, is small but positive in the north where their production is centred, while for sesamum, a varied pattern of positive and negative coefficients is indicated. Statistical significance is lacking at the State level, but not for the major sesamum districts.[12]

Rice shows the same general isolation from market impulses in Mysore's western coastal districts as in neighbouring Kerala, but wheat elasticities, while small, are positive in the north where it is the principal cereal. For the two most important cash crops, cotton and groundnuts, district level

12. In other studies of Tamil Nadu covering a comparable time period, V. Rajagopalan (Supply Response for Irrigated Crops in Madras State, University of Tennessee Ph.D. Dissertation, 1967) estimated elasticities of +0.11 for rice, +1.28 for cotton and +0.50 for groundnuts; the National Council of Applied Economic Research, *op. cit.*, found an elasticity of +0.30 for rice and +0.23 for groundnuts; and M. C. Madhavan, *op. cit.*, calculated the elasticity of rice to be close to zero, cotton between zero and +0.31, groundnuts between +0.03 and +0.34, and sesamum of about +0.45. Our State-wide results are quite similar to these, with the exception of Madhavan's estimate for sesamum.

regressions fairly consistently yielded positive and significant price coefficients estimates, with similar results for sesamum in the two districts where this crop is important.

In Andhra Pradesh where rice yields are generally above the national average, positive elasticities prevail, with values generally between +0.1 and +0.2, though the figure indicated State-wide is somewhat higher. Andhra cotton yields, on the other hand, are the nation's lowest, and negative links between prices and acreage were found in most districts. Groundnuts are planted on more than twice as many acreas as cotton and are most important in the south. Here fairly large positive elasticities were calculated for all major districts as well as for the State as a whole, a pattern like that indicated as well for the second-ranking oilseed, sesamum.

Rather more market responsiveness is exhibited by cereal cultivators in Gujarat than in Maharashtra, though rice elasticities are seldom far from zero in any of the coastal districts where most of the production in both States takes place. For wheat, however, a strong price influence was found in most Gujarat districts and for the State as a whole, while on the other hand, in Maharashtra, the smaller but still positive and statistically significant responsiveness indicated State-wide is balanced by district level regressions which are frequently marked by small negative elasticities. Oilseed elasticities are generally positive in both States, but this pattern is more consistent in Gujarat. Cotton is of considerable importance in both, but data availability restricted our analysis to Gujarat, where a small insignificant positive elasticity was found at the State level and a mixed pattern among the major producing districts.[13]

In Rajasthan, wheat and barley account for about ten and five per cent of planted acreage respectively. Though the latter is generally considered inferior to wheat, barley cultivators show much greater market responsiveness. Elasticities are positive in almost all districts and significant at the 30 per cent level or better in most, whereas in the wheat calculations, price coefficients are negative in about half the cases. Sesamum is the State's major oilseed; calculated elasticities are almost uniformly positive, with many values greater than +0.4.

All three cereals are found in notable amounts in Punjab, and positive supply elasticities were found for each crop in most districts. However, the significance of the price coefficients in many wheat regressions was quite low, while for the less important rice and barley, most estimates are significant at better than the 30 per cent level. For barley, elasticities greater than +0.5 were indicated in about two-thirds of the districts. Positive res-

13. Comparable studies of this region include estimates by the National Council of Applied Economic Research, *op. cit.*, for wheat of +0.64 and groundnuts of +0.21—both for Gujarat-Maharashtra as a whole. Our results are similar for wheat, but negative for groundnuts. The two time periods are not the same, however—the National Council of Applied Economic Research study comprised the interval 1938-1951.

ponsiveness was found generally for the cash crops, the only exception being the quite minor sesamum crop.[14]

Price response, when significant at all, is generally negative in Himachal Pradesh. This is true even for barley, which elsewhere is the cereal most consistently positively affected by market influences. Since none of the cash crops considered in this study is grown to any extent in the State, we have no evidence from this quarter to contradict the general impression of a traditional market-isolated agriculutral sector.

Finally, in the north-east, rice strongly dominates both West Bengal and Assam. Our calculations indicate small elasticities in each State—generally positive in the former and somewhat negative in the latter. In addition, the two together are responsible for about 60 per cent of the important jute crop, and here as in jute districts in neighbouring States, price responsiveness was generally strong, positive and statistically significant.[15]

IV

SUMMARY AND CONCLUSIONS

As is obvious from the above, this study has in part covered territory already trod by earlier researchers; many estimates of supply elasticity are already available, especially for rice, wheat, jute, cotton and groundnuts. However, our purpose, in the present context, has been two-fold, and in this sense, earlier work has only offered tentative guidelines.

First of all, generally aggregated supply analysis (*i.e.*, at the State or national level) in a country as vast and varied as India cannot hope to identify how much market impulses motivate *individual* cultivators. Such analysis

14. Several earlier studies have analysed post-war Punjabi supply responsiveness. Among others, J. Kaul ("A Study of Supply Response to Price of Punjab Crops," *Indian Journal of Economics*, Vol. XLVIII, No. 188, July, 1967) estimated rice elasticity to be+0.24, that for barley to be+0.53, and for American cotton, a value of +0.29, while that for the *desi* variety was a bit higher, +0.34. Together with D. S. Sidhu, J. L. Kaul reported ("Acreage Response to Prices for Major Crops in Punjab—An Econometric Study," *Indian Journal of Agricultural Economics*, Vol. XXVI, No. 4, October-December, 1971) for a slightly different time period, similar elasticities for rice and *desi* cotton and for wheat a value of about +0.08 on irrigated land and +0.25 on non-irrigated land, while groundnuts showed an elasticity between +0.51 to 0.78. In another study, C. C. Maji, D. Jha and L. S. Venkataramanan ("Dynamic Supply and Demand Models for Better Estimations and Projections : An Econometric Study for Major Foodgrains in the Punjab Region," *Indian Journal of Agricultural Economics*, Vol. XXVI, No. 1, January-March, 1971) estimated the elasticity of rice to be between +0.11 and+ 0.32 and for wheat a value between +0.11 and+0.67. Our elasticities are comparable with these earlier studies.

15. Previous studies of the north-eastern States include elasticity estimates by the National Council of Applied Economic Research, *op. cit.*, of about +0.10 and +0.30 for rice in Assam and West Bengal respectively. Numerous analyses have been made of the region's jute crop; the most important covering a similar time period has been that of A. K. M. Ghulam Rabbani ("Economic Determinants of Jute Production in India and Pakistan," *The Pakistan Development Review*, Vol. V, No. 2, Summer, 1965), who presented elasticities of about +0.70 for West Bengal and between +0.41 and +0.43 in Assam. Only the last estimate (Rabbani's for Assamese jute) is much different than those coming from our analysis, and our district elasticity estimates reinforce the relatively small value found for the State as a whole.

must be based on output and price data gathered from wide cross-sections which mask important local diversities. To evaluate fully individual production decisions, a micro-economic approach would be needed, an impossibility under the present circumstances. A practical compromise is found in conducting supply investigations on the most disaggregated level possible—that of the district—and then proceeding to discuss market responsiveness in terms of patterns displayed by the cultivators at this level.

In this sense, no earlier study has approached the present effort. In terms of crop districts,[16] regressions were conducted for planted acreage in more than 550 cases, in addition to calculations made at the State level. Our analysis above is then based on a cross-section of disaggregated data on responsiveness on the assumption this approach is more valid than one based solely on national or State-wide supply elasticities.

Secondly, as has been mentioned before, what is presented herein is part of a larger effort aimed at an identification of major social, economic and political factors which contribute to regional differences in market responsiveness. Most earlier supply studies have focused on specific crops or States, and some have included, at least in passing, attempts to explain any similarities or diversities in elasticity uncovered. Such explanations, however, have necessarily been of a qualitative nature, since none of these studies has been sufficiently extensive to generate the amount of elasticity data needed for statistical analysis of inter-regional differences. If the more important influences on responsiveness can be isolated, then obviously agricultural policy-makers would have a valuable tool for forwarding their attempts to increase output. Further analysis of the results presented above is being carried out with this goal in mind.

However, though considerable further work remains to be done, the elasticities presented above quite clearly show a greater degree of market responsiveness on the part of Indian cultivators than conventional wisdom might allow in discussing traditional agriculture. Our results confirm in depth what many earlier studies have found—farmers across the country are quite aware of the market and its potential rewards, not only for cash crops, but generally as well for cereals. To be sure, a great degree of variation in responsiveness was found for most crops, and hence, the importance of future analytic efforts. Together with earlier research, however, we have confirmed the *fact* of market orientation, if not yet identified the causes thereof.

16. The eight crops analysed do not of course comprise the most important in the national agricultural sector. Computer cost considerations imposed restrictions on the scope of the study. Decisions as to what to include were made on ground of both crop significance and the general suitability of the market model employed. The three cereals were chosen in part because of supplementary data available from earlier studies, especially that of Nowshirvani, *op. cit.*, and because these three generally find their way to the market place to a greater extent than other important food or forage crops like pulses, jowar, bajra and gram. Alternate major cash crops such as sugar and tea were eliminated from consideration because their perennial nature made the model employed in this study inappropriate for their analysis.