Vol XXXIV
No. 1

ISSN 0019-5014

JANUARY-
MARCH
1979

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

FARMERS' RESPONSE TO ECONOMIC INCENTIVES: AN ANALYSIS OF INTER-REGIONAL GROUNDNUT SUPPLY RESPONSE IN INDIA*

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The fact that the acreages of individual crops in India vary systematically in response to inter-crop price movements is now widely accepted on the basis of numerous acreage response studies.[1] Raj Krishna (9) made a pioneering attempt to apply the Nerlovian adjustment lag model to various crops in Punjab (India-Pakistan) and found that farmers positively responded to prices. His study inspired many researchers in India to undertake such works for various crops in other States. And most of these studies confirmed the hypothesis of positive supply response for farmers in post-Independence India.

In regard to groundnut, Madhavan (11), Misra and Radhakrishna (12), Kaul and Sidhu (7), Sahay (16), Acharya and Bhatia (1) and others have estimated supply response functions for specific regions while Cummings (2) estimated for major States and districts in India. However, no generalisation as to inter-regional behaviour of groundnut supply response is possible in view of the varied, and sometimes conflicting, estimates of supply elasticity arrived at by these researchers (see Appendix 1). The differences in sample period, estimating techniques and specification of variables may be partly responsible for such wide variations. The present study, therefore, seeks to analyse inter-regional behaviour in groundnut supply response for a more or less uniform period (1951-71) employing a common estimating procedure and a common approach to the specification of variables, especially that of price variable. The study makes an important departure from earlier studies in regard to regional dilineation too. States have not been taken as regions; instead, a group of districts that are approximately uniform with respect to cropping pattern, rainfall, etc., is taken as a region for the purpose. Earlier, Sahay (16) made such an attempt, but as against 25 districts forming into nine regions analysed by him, the present study selects 81 out of 111 Indian groundnut districts forming into 14 regions; thus the scope is much wider. Secondly, Sahay experimented with eight different price specifications and chose the best among them, while a single uniform price relative, *i.e.*, farm harvest price of a crop deflated by weighted average farm price of all conceivable competing crops in the region, is employed for all regions in the present study.

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* This work was carried out at the Sardar Patel Institute of Economic and Social Research, Ahmedabad, under the guidance of Dr. R. Radhakrishna, during my stay as ICSSR doctoral fellow during 1974-75. All these equations were estimated once and for all, in late 1974. I am thankful to the referee of this journal for certain comments which helped me to evaluate these results further.

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1. For a review of some of these works, see Shah (17, pp. 44-51) and also Sawant (18). Figures in brackets denote references cited at the end of the paper.

Data

The primary data necessary for the present study have been obtained from various official publications of the Government of India, State Governments and official bodies like Central Statistical Organisation (CSO). These sources are: (1) Area, Production and Yield Per Acre of Forecast Crops: 1949-50 to 1959-60; (2) Abstract of Agricultural Statistics: 1951-52 to 1955-56; (3) Agricultural Statistics of the Reorganised States, 1956; (4) Season and Crop Reports (various annual issues); (5) Estimates of Area and Production of Principal Crops in India, Vol. II (annual); (6) Agricultural Situation in India (monthly); (7) Statistical Abstract, India (annual); (8) Farm (Harvest) Prices of Principal Crops: 1947-48 to 1954-55 and (9) Farm (Harvest) Prices of Principal Crops: 1954-55 to 1964-65.

THE HYPOTHESIS AND THE SPECIFICATION OF VARIABLES

The farmer allocates his land to different crops depending on his expected revenue from different crops. Assuming input costs are either the same or move uniformly over time for different crops, the expected revenue depends on expected prices and expected yields. If yield levels are constant over time due to lack of any significant technological changes, as was the case with groundnut yield during the period, the acreage response equals the output response. As groundnut is grown mainly in rainfed, dry or semi-dry regions, the rainfall in the sowing period may also be expected to influence the sowing decision.

In this study, we have chosen the Nerlovian adjustment lag model. The Nerlovian type model depicting the farmer's behaviour, in its simplest form, is as follows :

$$A_t^* = b_0 + b_1 P_{t-1} + b_2 Z_{t-1} + b_3 R_t + u_t \quad \ldots.(1)$$

$$A_t - A_{t-1} = B (A_t^* - A_{t-1}) \; 0 < B < 1 \quad \ldots.(2)$$

$$A_t = C_0 + C_1 P_{t-1} + C_2 Z_{t-1} + C_3 R_t + C_4 A_{t-1} + V_t \quad \ldots.(3)$$

The first equation is a behavioural relationship stating that the desired groundnut acreage (A_t^*) depends on relative farm prices of groundnut lagged one year (P_{t-1}), relative yields of groundnut lagged one year (Z_{t-1}) and sowing period rainfall (R_t). The second equation is a partial area adjustment equation in which B is coefficient of adjustment. Equation (3) is the reduced form of the previous two equations, which eliminates the unobserved variable (A_t^*) by an observed variable (A_t). The coefficients and error term of the equation (3) are related to those of equation (1) and to the coefficient of adjustment as follows:

$C_0 = b_0 B$
$C_1 = b_1 B$
$C_2 = b_2 B$
$C_3 = b_3 B$
$C_4 = (1-B)$
$V_t = Bu_t$

Variables

The variables used in the estimated equations are presented below. Instead of relative yield variable, yields of groundnut and of competing crops have been introduced separately as the weighted average yields of cotton and bajra might not make any sense.

A_t = acreage under groundnut in the concerned region (in thousand acres).

P_{t-1} = the farm harvest price of groundnut deflated by the weighted average farm harvest price of competing crops in the concerned region.

Z_{t-1} = average groundnut yield in the region (in kilogram per hectare).

Z^J_{t-1} = average yield of jowar (in kilogram per hectare).

Z^B_{t-1} = average yield of bajra (in kilogram per hectare).

Z^C_{t-1} = average yield of cotton (in kilogram per hectare).

Z^M_{t-1} = average yield of maize (in kilogram per hectare).

Z^R_{t-1} = average yield of *ragi* (in kilogram per hectare).

R_t = June-July sowing period rainfall in the current period (in millimetres).

We have estimated the equations using the ordinary least squares method with all variables in their log-linear form. Generally, the study covers the period 1951-52 to 1970-71, except when the data are not available for some regions. The competing crops for each of the regions have been selected on the basis of close scrutiny of data available, empirical evidence, official and other studies on the subject. The estimated equations for all the 14 regions are given in Table I. Various short run elasticities and long run price elasticities of acreage response calculated by us are all presented in Table II. Information regarding the growth rate of area and yield, relative importance of groundnut in the region, etc., is given in Appendix 2. The 14 regions and the districts included therein are given in Appendix 3.

THE ANALYSIS OF THE RESULTS

The explanatory power of all the equations, except that for Tamil Nadu,[2] is satisfactory; the R^2 is above 0.85 in half the cases and never below 0.63.

The computed Durbin-Watson statistic indicated absence of any autocorrelation in most of the equations (Table I). However, when independent variables consist of any lagged dependent variable, Durbin suggested an alternative 'h' statistic.[3] Despite the limitations of small sample, we have calculated 'h' statistic (see col. 11, Table I).

2. In Tamil Nadu groundnut is grown in three seasons—summer, *kharif* and *rabi* but seasonwise data are not available. Madhavan (11), and Kamala Devi and Rajagopalan (3, pp. 33-34) found *cumbu, varagu, samai*, etc., as substitutes but for which data were not available. Thus its results could not be improved.

3. See Durbin (4).

TABLE I—ESTIMATED SUPPLY RESPONSE FUNCTIONS OF GROUNDNUT

Sr. No.	Region	Period	Constant (in logs)	Regression coefficients				R^2	d-statistic	h-statistic
				Pf_{t-1}	Z_{t-1}	R_t	A_{t-1}			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	Punjab	1951-52 to 1970-71 (20)	—1·3790	0·2997** (0·1600)	0·4960** (0·2607)	0·0233 (0·0353)	0·7554*** (0·1115)	0·9094	2·34	1·58
2.	Rajasthan (East)	1951-52 to 1970-71 (20)	—1·6869	0·3862 (0·4922)	—0·0522 (0·2098)	0·1970*** (0·0729)	0·8255** (0·0945)	0·9449	2·76	4·09
3.	Uttar Pradesh	1957-58 to 1970-71 (14)	—0·8887	0·2872* (0·2131)	0·2799* (0·1605)	0·0233 (0·0353)	0·7554*** (0·1115)	0·9094	2·34	1·58
4.	Madhya Pradesh (West) ..	1955-56 to 1970-71 (16)	—0·7170	0·2165@ (0·1649)	0·4433** (0·1880)	—0·0289 (0·1383	0·3604* (0·2331)	0·7351	1·87	0·29
5.	Coastal Andhra Pradesh ..	1953-54 to 1970-71 (18)	0·9261	0·2422* (0·1562)	—0·1530** (0·0742)	—0·0578 (0·0654)	0·6635*** (0·1452)	0·8756	2·32	1·13
6.	Rayalaseema	1953-54 to 1970-71 (18)	1·4423	0·1570@ (0·1610)	0·0960*** (0·0260)	—0·0104 (0·0642)	0·4131*** (0·2052)	0·6377	2·32	0·80
7.	Telangana	1953-54 to 1970-71 (18)	—1·7160	0·6046* (0·3665)	0·4886* (0·3550)	—0·2945@ (0·2589)	0·9351*** (0·1522)	0·7537	1·69	1·05
8.	Saurashtra	1951-52 to 1970-71 (20)	—1·2951	0·5076@ (0·3959)	0·4670*** (0·1464)	0·0981@ (0·0877)	0·6525*** (0·1103)	0·8758	2·57	2·64
9.	North Gujarat	1951-52 to 1970-71 20)	0·5747	—0·2673@ (0·2315)	0·0083 (0·0755)	0·0990* (0·0741)	0·8865*** (0·0577)	0·9430	1·49	4·54
10.	Marathwada	1951-52 to 1970-71 (20)	1·3083	—0·1442* (0·0849)	0·0938@ (0·0758)	—0·0750 (0·0983)	0·6434*** (0·1506)	0·7550	2·59	2·01
11.	Madhya Maharashtra ..	1951-52 to 1970-71 (20)	—0·0014	—0·0505 (0·0753)	0·1194@ (0·0955)	0·1145* (0·0737)	0·8278*** (0·1082)	0·8439	2·74	3·51
12.	Vidarbha	1951-52 to 1970-71 (20)	0·9609	—0·0869 (0·1084)	0·1077** (0·0635)	—0·1425@ (0·1086)	0·7133*** (0·1829)	0·7830	1·87	0·36
13.	Karnataka	1954-55 to 1970-71 (17)	1·5288	—0·1253@ (0·1203)	0·0217 (0·0553)	0·0001 (0·0280)	0·5470** (0·2259)	0·7715	2·63	1·44
14.	Tamil Nadu	1951-52 to 1970-71 (20)	1·0323	—0·1525 (0·1881)	0·1467 (0·3431)	—	0·8278*** (0·2080)	0·5240	—	—

*** Significant at 1 per cent probability level.
** Significant at 5 per cent probability level.
* Significant at 10 per cent probability level.
@ Significant at 20 per cent probability level.
Note:—Figures in parentheses are standard errors.

TABLE II—ACREAGE RESPONSE ELASTICITY WITH RESPECT TO PRICE, YIELD AND RAINFALL AND THE COEFFICIENTS OF ADJUSTMENT

Sr. No.	Region	Price elasticity		Yield elasticity	Sowing period rainfall elasticity	Coefficient of adjustment	Number of years required for price effect to materialise
		Short run	Long run	(Short run)	(Short run)	(B)	(N)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Uttar Pradesh	0·29*	1·17	0·28*	0·02	0·24	10·7
2.	Punjab	0·30†	1·13	0·50†	—0·08@	0·27	9·7
3.	Rajasthan	0·39@	2·21	—0·05	0·20‡	0·17	15·6
4.	Madhya Pradesh ..	0·22@	0·34	0·44*	—0·03	0·64	2·9
5.	Andhra Pradesh						
	(*a*) Coastal Andhra Pradesh	0·24*	0·72	—0·15†	—0·06@	0·34	7·3
	(*b*) Rayalaseema ..	0·16@	0·27	0·10‡	—0·01	0·59	3·4
	(*c*) Telangana	0·60*	9·32	0·49*	—0·30@	0·06	44·6
6.	Gujarat						
	(*a*) Saurashtra	0·51@	1·46	0·47‡	0·10	0·35	7·2
	(*b*) North Gujarat ..	—0·27@	—2·36	0·01	0·10*	0·11	24·9
7.	Maharashtra						
	(*a*) Marathwada ..	—0·14*	—0·40	0·09@	—0·07	0·36	6·8
	(*b*) Madhya Maharashtra	—0·05	—0·29	0·12@	0·11*	0·17	15·9
	(*c*) Vidarbha	—0·09	—0·30	0·11†	—0·14@	0·29	8·9
8.	Karnataka	—0·13@	—0·23	0·02	0·00	0·45	5·0
9.	Tamil Nadu	—0·15	—0·89	0·15	0·00	0·17	15·9

‡ Significant at 1 per cent level.
† Significant at 5 per cent level.
* Significant at 10 per cent level.
@ Significant at 20 per cent level.
N = Number of years required for 95 per cent of the effect of the price change to materialise. Derived with the help of the following formula $(1—r)^n = 0·05$, where r = coefficient of adjustment, n = number of years.

Delayed Adjustment

The coefficient of lagged acreage is significant at one per cent level in most cases. Its large value generally indicates very slow adjustment on the part of farmers; it almost takes 7 to 15 years for 95 per cent of the effect of the price change to realize in most regions (Table II).[4] Thus various techno-institutional and subjective factors seem to influence a great deal the decision-making of groundnut farmers in India.

4. Sahay (16) also found long adjustment periods in groundnut regions/districts. For cotton regions in Maharashtra similar response has been reported by Kaul (6). However, for tobacco in Andhra Pradesh, this adjustment period has been low, around 3 years (Singh, Singh and Rao, 20).

Yield Response

The coefficient of the own yield variable is positive in almost all cases. For two of the most important groundnut regions of the country, namely, Saurashtra and Rayalaseema, it is highly significant at one per cent level; it is significant at 5 per cent or 10 per cent level for many of the remaining regions. In the case of Punjab, Madhya Pradesh, Telangana and Saurashtra, own yield bears a strong positive influence over groundnut acreage, while in the case of Uttar Pradesh, Rayalaseema, Vidarbha, etc., it has a moderate influence.

The coefficient of yield variable is negative and statistically significant in the region of Coastal Andhra Pradesh. The scrutiny of data of this region has revealed that there is a steep and uniform fall in groundnut yield since the beginning of the sixties while there is a rise in area in that period. It is possible that inferior land is being brought under groundnut.

The high significance of yield variable is very well supported by other researchers with regard to groundnut as well as other crops. The coefficient of yield was found significant in respect of all groundnut regions studied by Sahay(16). For Tamil Nadu yield was found "to be the most important factor influencing groundnut acreage".[5] For cotton and rice in Punjab yield was found more important than price by Raj Krishna(9). Parikh's study (14) also indicated significant influence of yield in the groundnut region of Bombay and Sind, and in cotton regions.

The coefficients of yield variables of competing crops show a mixed pattern in terms of signs as well as magnitudes, but most of them were not statistically significant.[6]

Price Response

The price variable is positive in eight cases and negative in six cases. For positive cases the coefficient of the relative price variable is significant at 10 per cent level or better in half the cases and at approximately 20 per cent level in the remaining cases; while for negative cases it is significant at 10 per cent level in only one case, at 20 per cent level in two cases and insignificant in the remaining half the cases. The short run price elasticity ranged from 0.16 to 0.60 and from —0.05 to —0.27 in the case of positive and negative responses respectively.

Our results indicate negative price response for nearly half the acreage under groundnut in India, despite its being a commercial crop. Interestingly, whenever the price coefficient is negative or non-significant, the coefficient of sowing period rainfall turns out to be positive and significant (except in Marathwada and Vidarbha). This suggests that in regions of highly uncertain rainfall, sowing period weather seems to dominate decision-making, rather than the price factor. However, it may be noted that the negative supply response is not an uncommon feature in the literature on supply

5. Madhavan (11, p. 17).
6. As such, these results are not presented in Table I.

response. Sud and Kahlon (21) found negative price coefficients in nearly half the six gram districts in Punjab which they analysed. Cummings (2), who found uniformly positive price response for all the wheat areas at the State level, found negative price coefficients in nearly half the 100 wheat districts he analysed. In the studies of Jai Krishna and Rao (8, 15) also these kinds of conflicting estimates were reported. For groundnut, Cumming's study (2) reported negative price coefficients for many of the district level supply response functions and for the majority of State level (5 out of 7) functions.

Some of the characteristics of the supply responses of various regions are discussed below.

Punjab and Uttar Pradesh: Both these States though minor producing areas recorded fast growth in groundnut acreage during the period (see Appendix 2, col. 5). The main competing crops for groundnut in order of their importance are cotton and maize for Punjab; and bajra, maize and jowar for Uttar Pradesh.

For both these States, not only the explanatory power and the statistical significance of coefficients are highly satisfactory and bear the correct signs, but also the short run and long run price elasticity and the coefficient of adjustments for the two States are almost identical. The short run elasticity of acreage response with respect to price is around 0.30 and the long run elasticity around 1.15. The short run elasticity estimate of 0.30 compares favourably with the estimates for groundnut in Gujarat and Tamil Nadu (Appendix 1) and for other commercial crops[7] arrived at by other researchers.

Rajasthan: Like Punjab and Uttar Pradesh, Rajasthan also recorded rapid growth in groundnut acreage. Maize, jowar and bajra compete with groundnut. The short run elasticity (0.39) and the long run elasticity (2.21) estimated for Rajasthan are higher than those of Punjab and Uttar Pradesh, but the difference is not too large. The estimates arrived at by Acharya and Bhatia (1), who had introduced risk measure (σP_{t-1}) also, are much higher.

Andhra Pradesh: Although all the three regions of Andhra Pradesh indicate positive response, there is considerable variation in the magnitudes of elasticities. In Rayalaseema the competing crops are jowar, bajra, *ragi* and cotton. Both the short run elasticity and long run elasticity are low, being 0.16 and 0.27 respectively. In Coastal Andhra Pradesh bajra and *ragi* compete with groundnut. The short run and long run elasticity are 0.24 and 0.72 respectively. Jowar, bajra, *ragi* and maize compete with groundnut

7.* See, for example :

	Crop	Region	Elasticity	Source
(*i*)	Sugarcane ..	Punjab ..	0·34	Raj Krishna (9)
(*ii*)	Sugarcane ..	Uttar Pradesh ..	0·26	Kumar (10)
(*iii*)	Tobacco ..	Andhra Pradesh ..	0·25	Singh, Singh and Rao (20)
(*iv*)	Jute ..	West Bengal ..	0·46	Venkataramanan (22)
(*v*)	Cotton ..	Maharashtra ..	0·25	Kaul (6)

in Telangana. This region has the highest short run and long run elasticity not among the regions of Andhra Pradesh alone but among all the regions of the country, the values being 0.60 and 9.32 respectively.

Gujarat: The competing crops in Saurashtra are bajra, cotton and jowar while cotton, bajra and maize compete with groundnut in North Gujarat. Saurashtra is the major groundnut producer in the country. Its share in production went up from 6 per cent at the beginning of the period to 26 per cent at the end, its five districts rank among the first ten districts of the country. Groundnut occupies nearly two-thirds of the area and it has been regarded as a 'poor man's commercial crop'.[8] The short run elasticity of acreage response of this region comes next to Telangana, *i.e.*, 0.51 and its long run elasticity is 1.46. The farmers in Saurashtra also seem to take less time (7 years) to adjust their acreages to the given price change. The elasticity with respect to yield is almost equal in both these regions (0.47). The yield variable is highly significant at one per cent level in Saurashtra

The price variable is significant at 20 per cent level. Sahay (16) and Cumming's(2) estimates are similarly at low levels of significance.

North Gujarat shows negative price response which is largest among those types of estimates, and the adjustment period is also quite long. However, in this region, the coefficient of sowing period rainfall is significant, unlike in other regions with a positive supply response.

Madhya Pradesh: Jowar, cotton, bajra and maize compete with groundnut. Its results are similar to that of Rayalaseema.

Maharashtra: Jowar, bajra and cotton in Marathwada, jowar, bajra and *ragi* in Madhya Maharashtra and jowar and cotton in Vidarbha compete with groundnut. All these regions indicate negative price response though the coefficient is significant only in Marathwada, where the short run and long run elasticity are —0.14 and —0.40 respectively. While for Madhya Maharashtra the sowing period rainfall is significant with the expected sign, for the other two regions this coefficient too bears a negative sign. Interestingly, in these two regions the acreage under groundnut shows a temporal decline (see Appendix 2). For a group of some districts of Madhya Maharashtra, Sahay(16) estimated short run elasticity as 0.11 and long run elasticity as 0.32 but for the same districts Cummings has reported negative coefficients at the district level.

Karnataka: The main competing crops are jowar, cotton, *ragi* and bajra. This region indicates negative response to price.

Tamil Nadu: Jowar, *ragi*, cotton and bajra compete with groundnut. It also indicates negative response.

In short, while in the traditional groundnut growing regions of Maharashtra, Karnataka, etc. farmers appear to be price-unresponsive,[10] in the other important producing regions like Rayalaseema the supply response seems to be positive but rather weak.

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8. Vyas, Srivastava and Dharap (23, p. 50).
9. This aspect is discussed later.
10. Cumming's estimates (2) also support this phenomenon for these States.

Sowing Period Rainfall

Like the price coefficient, the coefficient of the sowing period rainfall also shows a mixed pattern of positive and negative response. The coefficient is positive, of large value (0.20), and significant at one per cent level in Rajasthan which is the most dry region and having a variability of sowing period rainfall as high as 60 per cent. Thus whenever rainfall is good in the sowing period they go for groundnut, otherwise for coarse cereals like maize, jowar and bajra. North Gujarat and Madhya Maharashtra are the other two important regions where this variable is positive and significant. It is interesting that in these two regions the price coefficient is negative reflecting the dominance of weather over factors in determining the acreage under groundnut. Saurashtra is another area where this variable is positive, and of the same value (0.10) as for the previous two regions, but the price coefficient is positive.

In the regions of Marathwada and Vidarbha the coefficient is negative and it may be that when rainfall is good in the sowing season farmers prefer cotton to groundnut and vice versa. The regions of Andhra Pradesh, Madhya Pradesh and Punjab, etc., also indicate negative response, while for Karnataka and Tamil Nadu the coefficient is almost equal to zero.

Comparing the yield and sowing period rainfall variables, it appears that farmers in Rajasthan, North Gujarat, etc., seem to be influenced less by past yields but more by the current rainfall conditions.

If the coefficient of the rainfall variable is insignificant it does not mean that it has no influence whatsoever on acreages. For example, in the case of Uttar Pradesh where we found rainfall variable weak and insignificant statistically the directional correspondence of the actual and estimated acreages was much better when rainfall was introduced in the model than it was not. Similarly, for Saurashtra also we found better directional correspondence even though the variable was not significant.

Price and Yield

An impression of desultory regional behaviour of the groundnut farmer may be created if one heeds to prices alone as is often found in the literature. But our hypothesis implies that if price influences acreage allocation decisions one expects that yield also may influence such decisions inasmuch as price and yield are the two inseparable components of revenue.[11]

The Indian groundnut farmer does heed to relative prices and yields concurrently as envisaged by the hypothesis. This can be seen from the fact that the regions where the positive price response is indicated, significant at 10 per cent or 20 per cent level, yield has a strong influence and the regions where the negative price response is indicated, yield has a much weaker

11. Shepherd (19, p. 7) has rightly observed that "changes in yield affect income as much as prices do. The price alone does not measure the farm problem at all accurately".

One example from our study itself corresponds to this. In Saurashtra the farm prices were up by 40 per cent and 71 per cent in 1965-66 and 1966-67 respectively as compared to 1964-65, but per hectare income was less by 35 per cent and 27 per cent respectively in these two years as compared to 1964-65 due to steep fall in yields. This has had a long-term adverse effect on groundnut acreage subsequently.

influence. The regions of Punjab, Uttar Pradesh, Madhya Pradesh, Telangana, Saurashtra, etc., fall in the first group which may be called 'pure groundnut regions' where cotton is a secondary crop. The regions of North Gujarat, Marathwada, Vidarbha, Karnataka, etc., fall in the second group which may be called 'cotton-groundnut' regions as cotton occupies proportionately larger area and competes effectively with groundnut for acreage.

CONCLUSION

The Indian farmer's response to economic incentives is not very much clear and well-defined in the case of an important commercial crop like groundnut. The expansion of groundnut acreage during the first two decades of planning came through the spread of groundnut acreage in newer areas where farmers responded well to economic incentives while in the traditional groundnut producing regions especially coming under 'cotton tract' the farmers were indifferent to price incentives.

The agro-climatic factors, especially yield and the sowing period rainfall, seem to exert a significant influence over groundnut acreage in India which can be seen from the fact that where farmers responded positively to economic incentives, the yield component played a more leading and significant role than the price component of revenue; and where farmers were non-responsive to price movements, the sowing period rainfall seems to exert considerable influence on decision-making.

APPENDIX 1

PRICE ELASTICITIES OF GROUNDNUT ACREAGE RESPONSE FOR VARIOUS REGIONS BY OTHER RESEARCHERS

Sr. No.		Region	Period	Price elasticity		Source
				Short run	Long run	
(1)		(2)	(3)	(4)	(5)	(6)
1.	(*i*)	Punjab State	1951-67	0·89	4·05	Cummings (2)
	(*ii*)	Punjab State	1960-70	0·75*	3·21	Kaul and Sidhu (7)
2.		Rajasthan State ..	1953-70	1·00	3·11	Acharya and Bhatia (1)
3.	(*i*)	Andhra Pradesh (State)	1951-67	0·69	0·52	Cummings (2)
	(*ii*)	Rayalaseema (3 districts)	1954-68	0·38	1·18	Sahay (16)
4.	(*i*)	Maharashtra State ..	1955-68	—0·14*a*	—0·14	Cummings (2)
	(*ii*)	Madhya Maharashtra (5 districts)	1954-68	0·11	0·32	Sahay (16)
5.		Karnataka	1953-67	—0·06*a*	—0·06	Cummings (2)
6.	(*i*)	Gujarat State	1949-69	0·32	0·49	Misra and Radhakrishna (12)
	(*ii*)	Gujarat State	1955-67	—0·11*a*	—0·11	Cummings (2)
	(*iii*)	North Gujarat (2 districts)	1954-68	0·14*e*	0·21	Sahay (16)
	(*iv*)	Saurashtra (5 districts)	1954-68	0·22*a*	0·59	Sahay (16)
	(*v*)	Saurashtra (4 districts)	1951-67	0·16*a*	0·89	Cummings (2)
7.	(*i*)	Tamil Nadu State ..	1951-67	—0·01*a*	—0·01	Cummings (2)
	(*ii*)	Tamil Nadu State ..	1947-65	0·35*b*	0·65	Madhavan (11)
			1947-65	0·22*c*	0·31	Madhavan (11)
	(*iii*)	Tamil Nadu (5 districts)	1954-68	0·40*d*	0·60	Sahay (16)

* Relative profitability (price yield).
a Statistically not significant.
b Competing crop: *ragi*.
c Competing crop: *cumbu*.
d Annual average price in previous year.
e Pre-sowing current year price.

APPENDIX 2

GROUNDNUT REGIONS AND THEIR IMPORTANT ECONOMIC INDICATORS

Sr. No.	Region	Groundnut area (1951-52 to 1970-71 average) (acres)	Area as a proportion to all-India acreage (per cent)	Compound growth rate of area	Average yield (kg. per hectare)	Compound growth rate of yield (per cent)	Coefficient of variation of *kharif* season rainfall (per cent)	Area under the crop as a proportion to gross cropped area in the region (1959-60 to 1961-62 average) (per cent)	
								Area under groundnut	Area under cotton
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Coastal Andhra Pradesh	296	2·1	1·4	1,324	—4·33	22·4	4·5	0·1
2.	Rayalaseema ..	1,741	12·5	0·8	812	—1·63	23·6	19·4	8·7
3.	Telangana	654	4·7	2·6*	622	0·14	18·3	10·3	0·3
4.	Saurashtra	2,893	20·8	7·5*	570	3·88	38·2	36·5	9·1
5.	North Gujarat ..	679	4·9	6·1	603	0·98	32·5	9·6	35·4
6.	Western Madhya Pradesh	845	6·1	3·5	567	1·17	21·1	10·4	13·5
7.	Madhya Maharashtra	890	6·4	2·3	715	0·92	15·2	5·7	1·4
8.	Marathwada	1,125	8·1	0·2	632	—0·88	18·7	10·9	11·7
9.	Vidarbha	290	2·1	—2·2	526	—0·56	18·4	4·7	36·0
10.	North Karnataka ..	1,800	12·9	—0·7	576	0·09	16·2	11·2	14·8
11.	Punjab	243	1·7	9·1	881	2·47	22·0	3·4	6·2
12.	Rajasthan (East) ..	215	1·5	13·7	522	—1·18	23·9	2·5	7·4
13.	Tamil Nadu ..	1,964	14·1	2·0	1,085	—0·58	22·1	11·3	5·9
14.	Uttar Pradesh ..	295	2·1	8·0	918	—2·19	15·9	2·5	0·9

* Linear rate.

APPENDIX 3

DISTRICTS OF THE REGIONS

Sr. No. (1)	Regions (2)	Districts included (3)
Andhra Pradesh		
(1)	Coastal Andhra Pradesh	(1) Krishna, (2) Srikakulam, (3) Visakhapatnam.
(2)	Rayalaseema	(1) Anantapur, (2) Chittoor, (3) Cuddapah, (4) Kurnool, (5) Guntur.
(3)	Telangana	(1) Karimnagar, (2) Khammam, (3) Mehboobnagar, (4) Nalgonda, (5) Warangal.
Gujarat		
(4)	Saurashtra	(1) Amreli, (2) Bhavnagar, (3) Jamnagar, (4) Junagadh, (5) Rajkot.
(5)	North Gujarat	(1) Ahmedabad, (2) Kutch, (3) Mehsana, (4) Panchmahals, (5) Sabarkantha, (6) Surendranagar.
Western Madhya Pradesh		
(6)		(1) Betul, (2) Chhindwara, (3) Dhar, (4) Jhabua, (5) Mandsaur, (6) East Nimar, (7) West Nimar, (8) Rajgarh, (9) Ratlam, (10) Shajapur, (11) Ujjain.
Maharashtra		
(7)	Madhya Maharashtra	(1) Ahmednagar, (2) Kolhapur, (3) Nasik, (4) Pune, (5) Sangli, (6) Satara, (7) Sholapur.
(8)	Marathwada	(1) Aurangabad, (2) Bhir, (3) Dhulia, (4) Jalgaon, (5) Osmanabad.
(9)	Vidarbha	(1) Akola, (2) Amraoti, (3) Buldhana, (4) Yeotmal.
Karnataka (North)		
(10)		(1) Belgaum, (2) Bellary, (3) Bidar, (4) Bijapur, (5) Chitradurg, (6) Dharwar, (7) Gulbarga, (8) Raichur.
Punjab		
(11)		(1) Ambala, (2) Jullundur, (3) Ludhiana, (4) Patiala, (5) Sangrur.
Rajasthan (East)		
(12)		(1) Bhilwara, (2) Chittorgarh, (3) Jaipur, (4) Sawai Madhopur, (5) Udaipur.
Tamil Nadu		
(13)		(1) North Arcot, (2) South Arcot, (3) Chingleput, (4) Coimbatore, (5) Madurai, (6) Ramanathapuram, (7) Salem, (8) Tiruchirapalli.
Uttar Pradesh		
(14)		(1) Badaun, (2) Hardoi, (3) Moradabad, (4) Sitapur.

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