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SUPPLY RESPONSE OF PADDY IN ANDHRA PRADESH

Ever since the establishment of positive supply response of the farmers in under-developed countries through several studies,[1] it has come to be regarded as an important variable in manoeuvring the crop acreages in desired direction and in making farm supply projections for agricultural planning and policy purposes. However, the magnitude of farmers' response to price may vary with the nature of crop and among different regions of a country/State because of differences in agro-climatic factors and technological adoption. This emphasizes the need for regional studies on supply response of different crops. Paddy is an important food crop of Andhra Pradesh State, known as the rice bowl of South India. This State has three distinct agro-climatic regions, *viz.*, Coastal Andhra, Rayalaseema and Telengana, which also happen to be the regional delimitations of the State for administrative purpose. No study has, so far, been made to estimate supply response of paddy at regional levels in the State. This study has made an attempt to do so with the following objectives: (1) to estimate the acreage response[2] of paddy and calculate its price elasticity for different agro-climatic regions as well as the State as a whole, and (2) to project the acreage and production of paddy in these regions and the State for the years from 1975-76 to 1979-80.

Methodology and Data

The researchers in the past generally employed two types of models in estimating acreage response of farmers. The first is called as traditional price-lag model which assumes that the farmers instantaneously and fully adjust their acreage allocations in response to changes in lagged prices. The second is called as adjustment lag model, also known as Nerlovian model, and which postulates that the actual acreage under a crop in any period is adjusted in proportion to the difference between the desired acreage in the long-run equilibrium and the actual acreage in the preceding year. In fact, the original formulation of the Nerlovian adjustment model hypothesizes acreage as a function of expected price. But, the expected price cannot be observed in practice. However, the expected price in any year can be expressed as a function of actual price last year and expected price last year. We can replace last year's expected price by a linear function of last year's acreage. Thus, through these algebraic substitutions the final form of adjustment model expresses acreage in any year as a function of last year's actual price and last year's acreage, and, thereby, ignores the effect of expectational lags in prices, if any. Both these models[3] were estimated in this study through simple least squares method under the usual assumptions in linear as well as double log (Cobb-Douglas) forms. In linear form, these models can be written as follows :

1. For some such studies, refer to (1,5,6). The figures in parentheses indicate the serial numbers of the references cited at the end.
2. Acreage is generally regarded as a proxy for output in agriculture. See Nerlove (8) for reasons for the same.
3. For detailed discussion on these models, refer to Nerlove (8).

(*i*) Traditional model

$$A_t = b_0 + b_1 P_{t-1} + b_2 X_1 + \ldots\ldots\ldots + b_{1+j} X_j + U_t$$

(*ii*) Adjustment lag model

$$A_t = b_0 + b_1 P_{t-1} + b_2 X_2 + \ldots\ldots\ldots + b_{1+j} X_j + b_{2+} A_{t-1} + V_t$$

where,

A=acreage planted under the crop,
P=price of the crop,

X_1 to X_j =other explanatory variables (supply shifters),
U and V=error terms,
b_i (i=0, 1, ..., 2 + j) = regression coefficients and, subscript t refers to time period.

These models pose the serious problems of statistical estimation arising out of the existence of lagged endogenous variables and due to a possibility of errors being serially correlated. Firstly, if the lagged endogenous variables in the model themselves are random variables (lagged acreage, for example), the maximum likelihood estimates will differ from the least squares estimates. However, as the sample size increases, the maximum likelihood estimates will tend stochastically to the least square estimates. This is the cold comfort that can be derived from the large sample properties of estimators, as Hurwicz stated.[4] Secondly, the presence of auto-correlated disturbances, frequently observed in time-series data, makes the simple least squares estimates although unbiased but less efficient. Durbin-Watson 'd' statistic is a simple test for testing auto-correlation in ordinary regression models. However, this test is inappropriate when independent variables in the model include any lagged dependent variables (lagged acreage, for example). Durbin[5] has suggested testing of the following 'h' statistic as a standard normal deviate.

$$h = (1 - \tfrac{1}{2} d) \sqrt{\frac{n}{1 - n \hat{v} (\hat{b}_1)}}$$

where, d=Durbin–Watson statistic, n=sample size, and $\hat{v}(\hat{b}_1)$ = estimate of variance b_1. The 'h' statistic is distributed as standard normal with mean zero and variance unity. Thus, the null hypothesis can be tested by using the standard distribution tables. This test is based on large sample tests.

Several alternative formats of each model were tried with different specifications and combinations of the explanatory variables described as follows: Groundnut and sugarcane were considered as the main competing crops for paddy as these crops compete for the irrigated area in different regions of the

4. See Johnston (4), p. 214 (original not cited).
5. See Durbin (3).

State and that paddy is essentially an irrigated crop. Average post-harvest lagged prices (in Rs. per quintal) of rice ($P_{p, t-1}$) and its competing crops ($P_{g,t-1}$ for groundnut and $P_{s,t-1}$ for sugarcane in terms of jaggery) were used in absolute as well as relative terms, *i.e.*, price of rice deflated by the price of competing crop. Lagged yield (quintals per hectare) of rice ($Y_{p, t-1}$) was deflated by lagged yield (quintals per hectare) of competing crop ($Y_{g, t-1}$ for groundnut and $Y_{s,t-1}$ for sugarcane in terms of jaggery) in order to get lagged relative yield variable. Total rainfall (in mms.) during three months pre-sowing period was considered to represent weather (W_t) variable. Total irrigated area (in thousand hectares) in the current year (I_t), lagged acreage (in thousand hectares) under paddy (A_{t-1}) and time trend (T) were the other explanatory variables considered in the models. For discussion here, the best fits of the models were selected on the basis of the coefficient of multiple determination (R^2), proper sign and significance of the coefficients of explanatory variables, absence of autocorrelation and multicollinearity problems.

In the case of Cobb-Douglas functions, the coefficients of prices of paddy and its substitute crops represent the short-run price and cross elasticities, respectively, of acreage. In the case of linear functions, these were calculated by multiplying the coefficients of prices with the ratio of mean value of price to mean value of acreage. The long-run price and cross elasticities of acreage were obtained by dividing the corresponding short-run elasticities with the coefficient of adjustment.[6] In making projections of area under paddy during the years 1975-76 to 1979-80, the relative prices, relative yields and pre-sowing rainfall were assumed to remain constant at their mean values. It was assumed that the future changes in prices and technology would not affect the relative prices and yields at their mean values. Irrigated area during the years 1975-76 to 1979-80 was projected from the past trend. Thus, acreage projections were made on the basis of projected values of irrigated area and time trend. The production figures were obtained by multiplying the projected acreage with the expected yields for the corresponding years. The expected yield was assumed to grow at the rate of one per cent per year as envisaged in the Fifth Five-Year Plan of the State. An alternative approach would have been to project the yield of rice through a suitable productivity function for the same. But, the required time-series data on the underlying variables of actual fertilizer use and area under high-yielding varieties of paddy on regional basis were not available. However, the rate of growth of one per cent in the expected yield of rice as used in this study was fairly comparable with the past trend in the rice yields in different regions of the State.

The data used in this study pertain to the period from 1954-55 to 1970-71, and were collected from the annual publications (season and crop reports) and the records of the Bureau of Economics and Statistics, Government of Andhra Pradesh, Hyderabad.

6. The coefficient of adjustment $= r = (1 - b_2 + j)$.

Results and Discussion

(*i*) *Acreage Response*

Two sets of finally selected acreage response functions for our purpose are presented in Table I. The first set, listed at serial numbers 1 through 4 in the

TABLE I—REGRESSION COEFFCIENTS OF THE ACREAGE RESPONSE FUNCTIONS

Sr. No.	Regions	Form of function (1)	Intercept (b_0) (2)	A_{t-1} (3)	$P_{p,t-1}$ (4)	$P_{g,t-1}$ (5)	$P_{s,t-1}$ (6)	$\frac{P_{p,t-1}}{P_{g,t-1}}$ (7)
1.	Coastal Andhra	Double log	3·6115	0·4224† (0·1409)	0·2210‡ (0·0482)	—	—0·0406* (0·0206)	—
2.	Rayalaseema	Linear	—126·3100	0·0246 (0·1146)	0·9875 (0·5875)	—0·9533† (0·3243)	—	—
3.	Telengana	Linear	—204·7200	0·2188‡ (0·0603)	0·9268 (1·0161)	—1·1617† (0·4915)	—0.9210* (0·4649)	—
4.	Andhra Pradesh	Double log	5·1009	0·2437 (0·1512)	0·3509† (0·0702)	—	—0·1179‡ (0·0338)	—
5.	Coastal Andhra	Double log	5·3671	0·2051 (0·2066)	—	—	—	—
6.	Rayalaseema	Linear	—236·830	—	—	—	—	68·688‡ (16·829)
7.	Telengana	Linear	—62·363	0·0698 (0·0442)	—	—	—	—
8.	Andhra Pradesh	Double log	—3·442	0·3980† (0·1494)	—	—	—	0·2116‡ (0·0602)

Sr. No.	Regions	$\frac{P_{p,t-1}}{P_{g,t-1}}$ (8)	$\frac{Y_{p,t-1}}{Y_{g,t-1}}$ (9)	I_t (10)	W_t (11)	T (12)	R^2 (13)	h/d@ (14)
1.	Coastal Andhra	—	—	—	—	—	0·84	—0·99
2.	Rayalaseema	—	—	0·8070‡ (0·1133)	—	—	0·88	0·28
3.	Telengana	—	—	1·0555‡ (0·0828)	—	—	0·96	0·78
4.	Andhra Pradesh	—		—	—	—	0·77	—0·45
5.	Coastal Andhra	0·0585‡ (0·0181)	—	—	0·0796* (0·0389)	0·0877‡ (0·0213)	0·91	—0·16
6.	Rayalaseema	—	10·3594 (8·9391)	0·7840‡ (0·0810)	0·2480‡ (0·0625)	—	0·95	1·70@
7.	Telengana	74·577† (27·532)	—	0·8624‡ (0·1031)	—	—	0·87	2·29
8.	Andhra Pradesh	—	0·1837† (0·0789)	0·9075‡ (0·1690)	0·1344* (0·0673)	—	0·91	0·78

Note : Figures in parentheses indicate standard errors.
* Significant at 10 per cent level. † Significant at 5 per cent level. ‡ Significant at 1 per cent level. @ In the case of function at Sr. No. 6, 'd' statistic is given, whereas in all other cases 'h' statistic is given in this column.

table, is comprised of those functions having absolute prices along with other explanatory variables. There was a problem of multicollinearity in two out of four functions in this set. Rice price was highly correlated with groundnut price in Rayalaseema region, while it was highly correlated with both groundnut and sugarcane prices in Telengana region. Also, the coefficient of rice price in the functions for both these regions was positive but insignificant. In the case of Coastal Andhra region and the State as a whole, there was no multicollinearity problem and also the coefficient of rice price was positive and significant. However, in these two latter cases, groundnut price and other shifter variables did not give proper results, and hence, were dropped. This set of functions was retained for the purpose of calculating elasticities. The second set, listed at serial numbers 5 through 8 in the table, is comprised of those functions having relative prices along with other explanatory variables. Because of the problem of multicollinearity, relative prices were taken as explanatory variables in this set of functions. The results were somewhat improved in this set over that of the first set. The second set of functions was retained for the purpose of detailed discussion and making projections.

In the case of the response functions listed at serial numbers 1 through 5 and 8, the 'h' statistic was within the acceptable range at 10 per cent probability, and, hence, the null hypothesis was accepted in favour of absence of serial correlation. But, in the case of the function at serial number 7 (for Telengana region in the second set), the 'h' statistic was higher than the acceptable range at 10 per cent probability. Although its value was well within the acceptable range at 2 per cent probability, the null hypothesis in this case was rejected as for economic time-series data generally 10 per cent probability limit is considered good for the purpose. Thus, the presence of serial correlation in this function made its estimates inefficient, although unbiased, for prediction purpose. The ideal thing in this case would have been to make the estimates through generalised least squares method. However, earlier at the time of estimation we did not know about the use of 'h' statistic for the purpose, and hence, were misled through use of 'd' statistic. Later during the revision of this paper, we calculated 'h' statistic and reached the above different conclusion in respect of the function at serial number 7. As we could not re-estimate this function through generalised least squares during the revision period because of some unavoidable problems, we accepted its simple least squares estimates for the discussion here with a word of caution that the acreage projection made from this function for Telengana region (see Table III) would be less efficient with large variance. In the case of the response function at serial number 6 for Rayalaseema region, only 'd' statistic was calculated for testing autocorrelation as there was no lagged dependent variable, and the same was found to be in the inconclusive range.

The results indicated that relative price variable gave consistently positive and significant coefficient in all the regions. Sugarcane in Coastal Andhra and Telengana regions, and groundnut in Rayalaseema and the State as a whole emerged as better competing crops to paddy. Lagged yield of rice relative to groundnut explained acreage response only in the case of Rayalaseema and the State as a whole, although insignificant in the former case. Irrigated area in the current year emerged as a strong explanatory variable in all the cases, except in Coastal Andhra where time trend took its place. Rainfall in pre-sowing period showed positive and significant impact on paddy acreage in all cases, except in Telengana. The coefficient of lagged acreage, and that of adjustment as shown in Table II, suggested that adjustment was quicker in Rayalaseema and Telengana regions than in Coastal Andhra. This may be due to the fact that there are greater possibilities of putting irrigated area to alternative uses in Rayalaseema and Telengana regions than in Coastal Andhra. Double log functions gave consistently better fit in the case of Coastal Andhra region and the State as a whole, while in the case of Rayalaseema and Telengana regions the linear functions gave marginally better fit. The observation of the data suggested that it was in accordance with the statistical theory that the double log function would give better fit on the data showing either increasing or decreasing trend over time, whereas the linear function would give better fit on the data showing both increasing and decreasing values of the variable over time.

(ii) *Price and Cross Elasticities*

The short-run and long-run price and cross elasticities of acreage calculated from the acreage response functions employing absolute prices as explanatory variables are presented in Table II. It is observed from the table that short-run price elasticity is much higher for the State as a whole than those at the regional levels. Cummings (2) also obtained similar results in his study. His price elasticity coefficients ranged from 0.1 to 0.2 in district level functions whereas it was 0.48 in State level function.

TABLE II—PRICE AND CROSS ELASTICITIES OF ACREAGE UNDER PADDY

Regions	Coefficient of adjustment	Price elasticity		Cross elasticity with reference to			
				Groundnut		Sugarcane	
		Short-run	Long-run	Short-run	Long-run	Short-run	Long-run
Coastal Andhra	0·5776	0·22	0·38	—	—	−0·04	−0·07
Rayalaseema	0·9754	0·19	0·19	−0·18	−0·18	—	—
Telengana	0·7812	0·06	0·08	−0·09	−0·11	−0·05	−0·06
Andhra Pradesh	0·7563	0·35	0·46	—	—	−0·12	−0·16

(iii) Projections of Area and Production

The projected figures of area, yield and production of paddy are presented in Table III. The projections of acreage and production at the State level were found to be in close proximity to those obtained by summing up the regional projections.

TABLE III—PROJECTIONS OF AREA (IN '000 HA.), YIELD (IN QUINTALS PER HA.) AND PRODUCTION (IN '000 TONS OF RICE)

Year	Coastal Andhra			Rayalaseema		
	Acreage	Yield	Production	Acreage	Yield	Production
1975-76	2176	14·38	3129·09	444·42	15·73	699·07
1976-77	2188	14·52	3176·97	452·09	15·88	717·92
1977-78	2199	14·67	3225·93	459·76	16·03	736·99
1978-79	2209	14·82	3273·74	467·43	16·19	756·77
1979-80	2219	14·97	3321·84	475·09	16·35	776·79

Year	Telengana			Andhra Pradesh		
	Acreage	Yield	Production	Acreage	Yield	Production
1975-76	1082·98	13·56	1468·53	3596	14·29	5138·68
1976-77	1094·67	13·70	1499·70	3660	14·43	5281·38
1977-78	1106·36	13·84	1531·20	3725	14·57	5427·33
1978-79	1118·05	13·98	1563·03	3789	14·72	5577·41
1979-80	1129·73	14·12	1595·18	3857	14·87	5735·36

Conclusions

The positive and significant impact of relative price of rice on the area sown under paddy, and the fairly quick adjustment behaviour of the farmers in different regions of the State, provide a strong support for the use of relative prices as a variable for manoeuvring crop acreage in the desired direction. However, before making it an instrument of price policy, adequate caution is needed in analysing the impact of such policy also upon the acreage and production of other crops, particularly in view of the fact that total land available for cultivation is almost fixed and, hence, such a policy would, by and large, bring only relative changes in crop acreages.

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CALORIE INTAKES OF FOOD COMPARISONS ACROSS STATES AND CLASSES*

In recent times, people everywhere are very much concerned about the food problem and every aspect of it is being exhaustively examined and discussed. One of the aspects is the question about the nutritional adequacy of food. Most of the nutritional experts have concluded in their analyses that in India the calorie deficiency becomes the main deficiency of the population to be taken care of. If it can be met by increasing the intakes, most of the incidence of protein deficiency could be taken care of.[1] Except a few, all have confined their analyses to national level in estimating the calorie deficiency. Strictly speaking, it is impossible to mention a single number as the average calorie requirement of the entire nation. Because, the calorie requirement depends on many factors including body structure, type of work performed and climate of the living place. Thus intra-individual variability should be taken into account in depicting the calorie requirement as well the calorie deficiency of the nation. However, it is difficult to look into intra-individual variability because of data constraint. Moreover, in almost all such studies the calorie requirement mentioned is a measure of

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