ESTIMATION OF ACREAGE RESPONSE FUNCTIONS FOR COTTON IN MAHARASHTRA

BY

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INSTITUTE OF AGRICULTURAL RESEARCH STATISTICS

(I.C.A.R.)

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CONTENTS

INTRODUCTION

The major economic problems of agriculture are directly or indirectly related to supply functions* and relationships. Consequently, improved knowledge of agricultural supply is necessary for better understanding of these problems and for formulation and implementation of effective price policy. Better understanding of supply (acreage) response can help farmers in using their resources more efficiently for higher profit. Therefore, knowledge of supply responses is important in all regions of the country.

Very few studies have been conducted in India regarding the widely prevalant notion that farmers do not respond, respond very little or respond negatively to price changes while deciding about crops. The nature and extent to which farmers respond to price changes, however, remain a widely debated and controversial issue. The majority of people will favour that farmers take into consideration the prices of products while plan their acreage. Therefore, the discussion on the role of price machanism and short-run and long-run effects of price changes upon production is essential. The role of relative prices on acreage allocations found explicit expression in

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* Supply Function: Supply function of a product shows the relation between its price and the amount which a firm will produce. The quantity produced generally bears a positive relation with its price.

the third five year plan which stated that:
" The price policy must assure that the movement of relative prices accord with priorities and targets that have been set in the plan."[1] The agricultural prices commission has suggested that " Shifts in the inter-crop (price) ratios perform a useful function of allocating land and other production factors in response to relative changes,..... in the supply and demand positions of different agricultural commodities"2.

In this study supply response for cotton crop in Maharashtra state will be examined. Of the total area under cotton cultivation in India, about 35 percent area pertain to Maharashtra state. It ranks first among the cotton growing states of the country. Nearly 24 percent of the total Indian cotton is produced in this state. Cotton as a cash crop, plays an important role in the economy of Indian farmers.

For the purpose of this study the entire state is divided into three divisions. These divisions are as follows:

1. Bombay Division, 2. Poona Division & 3. Nagpur Division.

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1. Planning Commission, Govt. of India, Third Five Year Plan, 1961, p. 119.

2. Ministry of Food and Agriculture, Govt. of India, Report of the Agricultural prices commission on price policy for khrif cereals for the 1965-66 season, N.Delhi, May - June, 1965 p.2.

Bombay division consists of Dhulia and Jalgaon districts. In these districts cotton is grown in medium black and deep black soils. The average annual rainfall at Dhulia is about 23 inches which is about 7 inches less than at Jalgaon. These districts account for 95 percent and 20 percent of the cotton area in the division and state respectively.

Districts of Ahmedanagar, Poona and Sholapur are included in Poona division. The soil of Ahmednagar and Poona is clay loam and the average annual rainfall is 19.5 inches and 26.5 inches respectively. These districts account for about 84 percent of the total area under cotton crop in this division.

Nagpur division comparises of Buldhana, Akola, Yeotmal and Amravati districts. These are located towards the eastern part of Maharashtra in the black cotton soil tract. The annual rainfall at Akola, Buldhna and Amravati is approximately 34 inches while that at Yeotmal is about 7 inches more. These districts constitute about 82 percent area of the total cotton crop area in the division.

1.2 Objectives:

As already mentioned that this study is concerned with the estimation of supply response of cotton growers in Maharashtra. The specific objectives are as follows:

i) to study the relative suitability of different statistical or econometric models used in depicting price - response relationships;

ii) to study empirically whether cotton-growers plan their acreage on the basis of prices they expect to prevail after harvesting in Maharashtra state;

iii) to forecast the acreage of cotton in Bombay, Poona, and Nagpur divisions, and Maharashtra state and

iv) to derive policy implications from the study.

1.3 Plan of work:

The next chapter provides the details of work done in India and abroad on estimation of supply functions for Agricultural Commodities. Chapter III describes i) the statistical models for estimating farmers response ii) choice of variables and iii) description of the data used in the analysis. Chapter IV is devoted to the estimation of acreage response functions by ordinary least square technique and to the evaluation of short-run and long-run elasticities of cotton acreage. Simple regression model and adjustment lag model on the lines of Nerlove have been used in this study. An attempt for projection of cotton acreage has been made in chapter V. Finally the conclusions and policy implications are presented in chapter VI.

changing production in the current year in almost all cases. The special contribution of Bean's work was the introduction of price of competing crop in the analysis. He concluded that the effect of low price spreads over atleast to two seasons.

Kohls and Paarlberg[3] did a very comprehensive study investigating a large number of commodities. They commented that:

In the analysis of the different crops there was some evidence that farmers as a group do, or intend to do, respond to changing relative crop prices from year to year by changing the acreage planted. However, the amount of variation in either intended or harvested acreage that could be explained by price changes was in many instances quite small... In showing shift acreage response to year to year price changes, farmers are behaving intelligently and in their own interests. A high price for a crop in a given year is little indication that the price will be high in the following year. Consequently, a close response of acreage to price from year to year for crops would mean unwise allocation and lower income to farmers.

Cochrane[4] stated that "the aggregate supply relation for the nation at the firm level is simply the summation of individual firm supply relations and generally the supply relation for farm is severally inelastic, it must follow that the aggreegate supply relation for the nation is severally inelastic....The aggregate supply of farm

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3. R.L. Kohls and D. Paarlberg, The short Term Response of Agricultural Production to Prices and other Factors. Ag.Expt.Station,Bul.No.555,Purdue University Oct.(1950).

4. Willard W. Cochrane, "Conceptualizing the Supply Relation in Agriculture", Jour.of Farm Econ.Vol.37 No.3 (Dec.1955).p.1161-76.

products for the nation changes very little if at all with the changes in price level".

Using adaptive expectation model, Marc Nerlove[5] studied the supply of farm products. He contended that it is impossible to measure the short-run elasticities of supply and argued that there is no unique short-run supply curve. From any point on a long run supply curve passes a fan of short run curves. Each curve is relevant to a given time period. Fixity of factors is main distinction between the short-run and long-run. Nerlove pointed out that fixed factors are not really fixed for all times but can be varied according to economic forces. He suggested the use of distributed lag models to take into account the effects of fixed factors and to estimate the long-run elasticities. He contended that "distributed lags arise in theory when any economic cause produces its effect only after some lag in time". His distributed lag model has been explained in the next chapter.

Nerlove[6] fitted the data of 25 vegetable crops in U.S. in adjustment model in which a linear trend variable besides lagged acreage and lagged price was used. This

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5. M. Nerlove, "Distributed Lags and Estimation of Long Run Supply and Demand Elasticities", Jour. of Farm Econ., Vol.40, 1958 p.301-11

6. M. Nerlove, "Estimation of the Elasticities of Supply of Selected Agricultural Commodities", Jour. of Farm Econ., Vol.38 No.2 (May 1956) p.496-509.

model furnished the values for coefficient of adjustment between 0 to .87 for various crops. The R^2 value ranged from .53 to .97 and any significant serial correlation was not observed. The long-run elasticities exceeded one in many cases.

2.2 Work done in India:

Perhapes the earliest empirical study regarding farmers acreage response to price movements was made by Sinha[7] in 1934-35. He fitted simple linear functions for three commericial crops, viz. cotton, linseed and groundnut and concluded that a significant relation existed between acreage and price for all the three crops studied. He emphasized the need for correcting the price series in order to reflect the relative changes in prices of alternate crops. This study was useful with regard to selection of variables.

Raj Krishna[8], 1963, studied the response of acreage for 11 important crops for undivided Punjab, using 22 years (1914-46) time series data. He used an "adjustment model" and concluded that acreage in all cases, except jowar, responded to prices. All other crops had positive elasticities varying from 0.1 to 1.6

& 7. A.R. Sinha, N.C. Sinha and J.R. Guha, "Indian Cultivators' Response to Price", Sankhya, Vol.1(1933-34),p.155-65.

8. Raj Krishna, "Farm Supply Response in India-Pakistan - A Study of Punjab Region", The Economic Jour., Vol.13,1963.

Jakhande and Mujumdar[9] showed that the area planted under jute was highly influenced by the relative prices of jute and rice. They used time series data pertainingto West Bengal, Bihar and Assam. They concluded that the variation in the acreage of jute and rice was influenced by the changes in relative prices of the two crops under study.

Rao and Jai Krishna[10] (1965) studied wheat acreage response to changes in prices by fitting various price expectation models. It was found that the model that used the average of all previous years prices explained a high degree of variation in acreage. In a later study (1967)[11] They used nine different expectation formulation of price in both the " traditional " and "adjustment" lag models.

A simple log linear regression of wheat acreage on its lagged price and its substitute crop price was worked out by Kahlon, Johl and Dwivedi[12] for Punjab state covering the period 1950-51 through 1961-62. They concluded

9. V.M.Jakhade and N.A. Majumdar, "Response of Agricultural producers to prices - The case study of Jute and Rice in India", Indian Jour.of Agril.Econ.Vol.19 July-Dec.,1964.

10. M.S. Rao and Jai Krishna, "Price Expectation and Acreage Response for Wheat in U.P.", Indian Jour. of Agril. Econ.Vol.20,1965,p.20-25.

11. Jai Krishna and M.S.Rao, "Dynamics of Acreage Allocation for Wheat in U.P. - A study in Supply Response", Indian Jour. of Agril.Econ.,Vol.22,1967, p.37-52

12. A.S.Kahlon, S.S.Johl and H.N.Dwivedi, "Structure of Farm prices in the Punjab", Indian Jour. of Agril.Econ. Vol.20, Jan-March,1965,p.35-40

that wheat acreage responded significantly to changes in its price and inversly to its substitute crop price. The inclusion of two price variables for explaining wheat acreage was feasible only if these two prices did not exhibit a high association amongst themselves.

2.3 Conclusions:

To sum up in the end, it may be said that the importance of prices in allocation of land among crops that can be grown during a crop-year, has been recognised by various researchers. But there are few studies which claim that the impact of price on acreage distribution hold significantly. Some researchers have shown that a rise in price of a commodity causes an increase in planted area of that commodity in the subsequent year, while other showed that in case of certain crops price bears a negative relationship with acreage.

The variations in the results obtained by various workers are due to different definitions of variables used in supply response analysis. Some workers have used output of a commodity as the dependent variable while others considered acreage as the dependent variable. Price variable has been used either in absolute form or it has been deflated by the prices of competing crops or by the price index of food commodities. Secondly all the variables have been used either in absolute values or in terms of first differences. Lastly the quality of variables used in various studies varies according to the area under study, nature of commodity and the availability of reliable data.

Almost all studies in this direction have been conducted on macro-level, unit of observation being a state or group of states. But it has been observed that all producers in a state do not behave in the same fashion when there is change in price for their products. Therefore, with a view to get better results, the state of Maharashtra has been divided into regions. Prices - absolute as well as relative have been used in this study. Other explanatery variables included in the study are yield ratios- absolute as well as relative and time-trend.

C_H_A_P_T_E_R-III

MODELS FOR ESTIMATING FARMERS RESPONSE

In the study of acreage response to price changes one builts up a relotionship between price expected by farmers and planned acreage of the crop. In this chapter traditional, adjustment and expectation models for estimating farmers response have been discussed. These are as follows:

i) Traditional Model:

In this model acreage is explained, largely, by the previous year's price. Depending upon the availability of data non-price variables may also be included in it. The general form of the model is as follows:

$$X_t = a + bP_{t-1} + \sum_{i=1}^{n} b_i X_{it} \qquad \ldots\ldots \quad (1)$$

where X_t is acreage in the year t, P_{t-1} is the past year's price and X_{it}'s are non-price explanatory variables (e.g. weather, irrigated area, yield, competing crops' area, trend and prices of inputs etc.).

Estimates of the parameters a and b_i's are obtained by the least square technique. The estimates of short run elasticity(SRE) with respect to price is obtained by using the following relation:

$S.R.E. = b \, \bar{P}_{t-1} / \bar{X}_t$ where $\bar{P}_{t-1}$ and $\bar{X}_t$ are averages of prices and acreages.

or, S R E = b , when the variables are expressed in logarithms.

The main drawback of the traditional model is that one cannot find out the long run elasticity of acreage.

ii) <u>Adjustment Model</u>:

A linear long-run acreage response function formulated by Nerlove [1] is given by:

$$X_t^* = b_0 + b_1 P_{t-1} + U_t \quad \ldots\ldots\ldots \quad (2)$$

where X_t^* is the acreage in the year t that farmers intend to devote to a crop, b_0 and b_1 are constants and U_t is random error.

The adjustment process is assumed to take place according to the following relation:

$$X_t - X_{t-1} = B (X_t^* - X_{t-1}) \quad \ldots\ldots\ldots \quad (3)$$

where X_t is the observed acreage and $0 < B \leq 1$.

B is called the coefficient of adjustment and it represents the proportion of the adjustment toward equilibrium. It assumes the value unity when current and intended acreages are identical. Equation(3) describes the way in which intended acreage is adjusted towards the long run equilibrium acreage.

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1 Marc Nerlove, The Dynamics of Supply: Estimation of Farmer's Response to Price, The John Hopkings Press, 1958.

substituting (2) into (3), we get :

$$X_t = a + bP_{t-1} + cX_{t-1} + e_t \quad \ldots\ldots\ldots\ldots \quad (4)$$

where $a = a_o B$, $b = b_1 B$, $c = (1-B)$ and $e_t = BU_t$.

The parameters of the reduced form (4) are estimated by ordinary least square method. The SRE is the same as in traditional method and LRE is given by

$$LRE = \frac{b}{1-c} \cdot \frac{\bar{P}_{t-1}}{X_t}$$

Since B lies between 0 and 1, therefore, LRE is always greater than or equal to SRE.

iii) Expectational Model:

Adjustment lags reflect technological and/or institutional constraints which permit only a fraction of the intended levels to be realized during a given short period, while the expectation lags reflect the manner in which past experience determines the expected values of the variables such as prices and yields, which in turn determine the levels of output and inputs intended by producers.

Let our expectation model is

$$X_t = a + b P^*_t + c Y^*_t + U_t \quad \ldots\ldots \quad (5)$$

where P^*_t and Y^*_t denote the expected price and yield respectively this year and are given by

$$P_t^* - P_{t-1}^* = B\ (P_{t-1} - P_{t-1}^*) \quad \ldots\ldots\ldots \quad (6)$$

and $$Y_t^* - Y_{t-1}^* = B\ (Y_{t-1} - Y_{t-1}^*) \quad \ldots\ldots\ldots \quad (7)$$

This model yields the estimating equation:

$$X_t = a_o + a_1 P_{t-1} + a_2 Y_{t-1} + a_3 X_{t-1} + e_t \ \ldots\ldots \quad (8)$$

where $a_o = aB$, $a_1 = bB$, $a_2 = cB$, $a_3 = (1-B)$ and

$$e_t = U_t - (1-B)\ U_{t-1}.$$

This model presents estimation problems. The error term in expectational model has serial correlation while it is not present in the adjustment model. Equation(8) was derived under the assumption that the coefficients of expectation for price and yield variables are identical, which may be questionable. Nerlove[2] has discussed the model when coefficient of expectations is different. It is as follows:

Let $$X_t = a + b\,P_t^* + c\,Y_t^* + U_t \quad \ldots\ldots\ldots \quad (9)$$

$$P_t^* - P_{t-1}^* = B\ (P_{t-1} - P_{t-1}^*) \quad \ldots\ldots\ldots \quad (10)$$

and $$Y_t^* - Y_{t-1}^* = \gamma\ (Y_{t-1} - Y_{t-1}^*) \quad \ldots\ldots\ldots \quad (11)$$

where B and γ are coefficients of expectation.

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2 Marc Nerlove, " Distributed Lags Demand Analysis for Agril. and other commodities", U.S.D.A. Agril. Hand Book, No.141,1958,p.31

Algebraic manipulations of the above three equations yield the following reduced equation:

$$X_t = \Pi_0 + \Pi_1 P_{t-1} + \Pi_2 Y_{t-1} + \Pi_3 X_{t-1} + \Pi_4 P_{t-2} + \Pi_5 Y_{t-2} + \Pi_6 X_{t-2} + e_t \quad \ldots(12)$$

where $\Pi_0 = aB\gamma$, $\Pi_1 = bB$, $\Pi_2 = c\gamma$, $\Pi_4 = -bB(1-\gamma)$,

$\Pi_3 = [(1-\gamma)+(1-B)]$, $\Pi_5 = c\gamma(1-B)$, $\Pi_6 = -(1-B)(1-\gamma)$,

and $e_t = U_t - [(1-B)+(1-\gamma)]U_{t-1} + (1-B)(1-\gamma)U_{t-2}$.

This is the reduced equation of supply response model involving two expectational variables. This equation contains four more variables than in the original equation. If original equation consists of n expectational variables than the final reduced equation will contain n^2 more variables than the original equation. Thus, for an expectational model having three expectational variables, the number of variables in the computational equation will be twelve, and with only twenty to twenty five observations available many degrees of freedom are lost. Moreover, the estimates are not unique. And the estimated coefficients are likely to be affected by serial correlation. It is, therefore, preferable to use adjustment model.

iv) Models used in the present study:

Adjustment lag models are preferred over the "traditional" regression models. Adjustment lag model postulates that actual acreage under a crop in each period is adjusted in proportion of the difference between the desired acreage and actual acreage in the long run. The chief merits of the adjustment lag model are that it 1) facilitates the estimation of long-run and short-run elasticities separately, 2) provides a better fit, 3) gives more reliable supply response coefficients and 4) removes, atleast partially, the serial correlation from the residuals[3].

The following model specifications are used in the present study:

1. $X_t = a_0 + a_1 P_{t-1} + a_2 Y_{t-1} + a_3 T + a_4 X_{t-1} + e_t$

2. $X_t = a_0 + a_1 P_{t-1} + a_2 Y_{t-1} + a_3 T + e_t$

where X_t = current cotton acreage ('000 Hectares). P_{t-1}, Y_{t-1} and T are lagged price, lagged yield and time trend variables respectively. We have tried various specifications of the price and yield variables as follows:

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3 Marc Nerlove and W.Addison, " Statistical Estimation of long Run Elasticities of Supply and Demand, J.F.E., Vol.40,1958, p.861-80.

P_{t-1} = Farm harvest price of cotton in Rs/Qn. (lagged one year).

$P_{t-1}(J)$ = Farm harvest price of cotton deflated by the harvest price of Jowar(lagged one year).

$P_{t-1}(B)$ = Farm harvest price of cotton deflated by the farm harvest price of Bajra(lagged one year).

Y_{t-1} = Cotton yield in kg. per hec.(lagged one year).

$Y_{t-1}(J)$ = Cotton yield relative to Jowar yield (lagged one year).

and $Y_{t-1}(B)$ = Cotton yield relative to Bajra(lagged one year).

These specifications then are incorporated into the empirical models in a manner expected to eliminate multicollinearity among them.

3.2 Choice of variables:

This section includes a brief discussion of the variables used in the study of supply response. Although there are several factors influencing the output of a commodity, yet it is not possible to include all of them in the analysis. The variables for which data are not available or can not be measured quantitatively have been ignored. Only the important variables that are included in the study are discussed.

Dependent variable:

Acreage rather than output has been used as dependent variable. The conventional argument is that farmers respond to price mainly by means of acreage variation, whereas the application of other inputs changes very little. According to the definition of supply as stated earlier, the choice of acreage as a dependent variable does not strictly satisfy the definition of supply. But land is one of the main factors which may be varied in order to affect variations in output. Therefore, acreage rather than output is preferable to use as a dependent variable.

Price:

The role of prices in allocating land among different competing/substitute crops is very important. In a low income farm economy the role of price in production decision is generally less effective specially in agricultural sectors. However, in advance states farmers are expected to be influenced by price changes. There is a controversy as regards to the price that should be used to measure the farmers' response. Farm price* is the price which is realised by the farmers and hence should be used to measure their response.

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* Farm price: Farm price of a commodity is the price at which the commodity is disposed of by the producer to the traders at the village site during specified harvest period.

Heady[4] observed that on the indivisidual farm substitution among crops is relatively easy. This implied that on typical farms small changes in the relative prices of crops may make large changes in croping pattern profitable. This suggested that there may be substantial response to prices in production.

To examine the relative price effects, the farm prices of cotton have been deflated with the farm prices of jowar and bajara. The logic behind introducing the relative prices was that while taking cotton, farmers took into consideration the relative profitability of the crop. It is hypothesized that high relative price will induce farmers to grow more cotton and vice-versa. However, this tendency might be, some what lessened because of agro-climatic reasons. Some regions are suitable for a particular crop and that crop will be undertaken, not because of the profitability considerations but because of technical feasibility.

Yield :

Inclusion of yield variable is useful in two respects i) Changes in yield indicates the change in the level of technology which obviously has a bearing on total supply of cotton and ii) It indicates the gross returns

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4. E.O. Heady, "The Supply of U.S.Farm Products Under Conditions of Full Employment", American Economic Review, Vol.45,1953,p.230.

per unit of area. To account for the relative yield aspects, cotton yield has been deflated by the yields of jowar and bajra. These relative yields are better indicators of the relative profitability than the actual cotton yield. It is assumed that farmers raise their income by devoting more area to cotton crop if its yield is more than jowar or bajra. Thus the use of relative yields may helps the farmers to get more profit through the substitution of crops.

Trend :

Inclusion of time-trend variable is believed to take care of structural shifts and the effects of several other factors for those the quantitative data are not available.

Other variables that are expected to serve an explainatory role in determining the acreage under cotton cultivation are weather, prices of inputs, improved technology and irrigation facilities etc. But due to lack of adequate data they have not been included in the analysis.

3.3 Description of Data:

The period of analysis extends from the years 1950 through 1970. Data relating to acreage, price and average yields have been drawn from various official publications:

Districtwise acreage and yield data have been obtained from various issues of Agricultural Situation in India and Estimates of Area and

Production of Principal crops in India, both published from the Directorate of Economics and Statistics(D.E.S.), Ministry of Agriculture, Government of India and also from Statistical *Abstract of Maharashtra State*, published from Bureau of Economics and Statistics, Government of Maharashtra.

Specification of area under different varieties of cotton is not available for some years which fall in the period under study. Therefore, the analysis has been done by taking total area under all varieties. The State and divisional figures on cotton acreage were obtained by summing up appropriate individsidual district figures. To arive at the regional average yield estimate, weighted average of districts yields was calculated using acreage as weight.

Farm harvest prices have been taken from *Agricultural Prices in India*, D.E.S. and *Farm Harvest Prices*, (Supplement to Agricultural Prices in India) D.E.S. The regional price, P_t, of a crop for year t was assumed as the weighted average of district prices where weights were the quantities produced. That is

$$P_t = \sum_{i=1}^{n} Q_{ti} \cdot P_{ti} \Big/ \sum_{i=1}^{n} Q_{ti}$$

where Q_{ti} = production in i^{th} districts,

P_{ti} = farm price in i^{th} district and

n is the number of districts in a division.

In Maharashtra state jowar, bajara and groundnut are substitutes for cotton crop. Jowar and Bajara meet the subsistance requirement of Maharashtrians and, therefore it was decided to deflate cotton prices by their prices.

CHAPTER - IV

RESULTS AND DISCUSSION

This chapter describes the results and empirical findings. A set of regression equations on the basis of the Nerlovian "adjustment" model given in the previous chapter has been fitted with 1950-51 to 1969-70 data for three divisions and Maharashtra state (nine districts) as the whole.

To avoid the danger of multicollinearity the independent variables having low correlations (approximately below .6) among themselves have been considered together in these regression equations. For testing the serial correlation in the residuals, Watson h statistic* or Darbin-Watson, d statistic** was computed depending upon whether lagged dependent variable was used or not as an explanatory variable in regression equation. The empirical results are presented in the following sections.

4.1 Bombay Division :

The results of the analysis of acreage sown for cotton in this division are presented in table 4.1 The current

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* $h = \left(1 - \frac{1}{2} d\right) \sqrt{\frac{T}{1 - T\,\hat{V}(\hat{B}_1)}}$,

** $d = \sum_{t=2}^{T} \left(e_t - e_{t-1} \right)^2 \Big/ \sum_{t=1}^{T} e_t^2$

where T is sample size, $\hat{B}_1$ is coefficient of lagged dependent variable and $\hat{V}(\hat{B}_1)$ is the estimate of variance of $\hat{B}_1$

year's cotton acreage is mainly influenced by the previous year's acreage, preceeding year cotton-jowar or cotton- bajara price and yield ratios and time-trend. The following general conclusions can be drawn from table 4.1.

The regression coefficients of absolute price variable and variable $P_{t-1}(B)$, the cotton-bajara price ratio, were turned out to be negative in almost all equations, however, not significant. An increase in cotton-jowar price ratio of previous year increased the cotton acreage in the current year. An increase in cotton acreage was associated with an increase in previous year cotton yield and cotton-bajara yield ratio. The coefficients of the yield variables were found to be significant only at the 15 percent level. It was also observed that time-trend variable had a positive and significant (at the 5 percent level) effect on cotton acreage. The lag acreage variable had strong positive relationship with current year cotton acreage and its coefficients were highly significant in all the equations. It was also observed that removal of lagged acreage variable from the regressions lowered down the values of R^2. This suggested that the Nerlovian adjustment lag model is superior to the traditional models.

Logarithmic transfor-mation of variables improved the value of R^2. It increased from 5 percent to 19 percent

TABLE 4.1

Area Response Equations For Cotton in Bombay Division (Period: 1950-51 to 1969-70)

Eq.No.	Constant	Time	$P_{t-1}(J)$	$P_{t-1}(B)$	$Y_{t-1}(B)$	P_{t-1}	Y_{t-1}	X_{t-1}	R^2	d/h
1.	143.2900	-.4152 (2.0663)	11.4080 (14.4184)				.2488 (.2118)	.6060+ (.1549)	.64	1.24
2.	231.0010	4.3039++ (2.3450)	2.8744 (19.4964)				.3581** (.2935)		.24	.88++
3.	115.8790					-.0324 (.3904)	.2187** (.2154)	.5992+ (.1287)	.62	.96
4.	83.4533				105.2150** (98.1393)	.0051 (.3996)		.6689+ (.1379)	.62	.97
5.	118.3980			-2.0690 (13.0889)			.2381** (.2185)	.5896+ (.1309)	.62	.99
6.	328.9330			-21.0447** (18.4042)			.3692** (.3217)		.11	.78++
7.	5.1381	.1477+ (.0458)	.0373 (.1219)				.0590** (.0564)		.43	.92 inc
8.	2.5230					-.0248 (.1291)	.0238 (.0450)	.5669+ (.1032)	.67	.54
9.	2.4207				.0518 (.0566)	-.0003 (.1293)		.5965+ (.1055)	.69	.53
10.	2.4228			-.0030 (.0834)			.0278 (.0448)	.5616+ (.1054)	.67	.50

Note: 1) Standard errors of the estimates are presented in parentheses.

2) Equations 7 to 10 were obtained from logarithmic data.

\+ significant at 1 percent

++ significant at 5 percent

** significant at 15 percent

inc. stands for inconclusive.

for the transformed data.

The test for serial correlation in the residuals indicated no serial correlation in most of the equations.

The supply elasticity for cotton acreage with respect to cotton-jowar price ratios was .037 for equation 7, denoting a .37 percent increase in cotton acreage with a 10 percent increase in the cotton-jowar price ratios.

4.2 <u>Poona Division</u>:

Table 4.2 provides regression equations for cotton acreage in Poona division. The general conclusions from the equations given in table 4.2 can be summarised as follows:

The time trend variable had insignificant and negative influence on current cotton acreage. The cotton price deflated either by jowar price or bajara price was positively associated with cotton acreage and coefficients were significant at the 15 percent level in many equations. Cotton-jowar yield ratio variables coefficient was positive and significant at the 15 percent level of probability. However, the cotton yield variable deflated by bajara yield turned out to be negative which is contrary to our expectation, but it was not significant. The coefficient of lagged cotton acreage variable indicated that acreage for a given year is strongly influenced in the positive direction by the previous year acreage. Equations 1 and 5, 6 and 7, 8 and 9, 10 and 11 showed that the inclusion of lag cotton acreage variable increases the explanatory power of the statistical fit. Thus the adjustment lag model is superior to the traditional regression models.

Acreage response functions when fitted with the logarithmic transformed data indicated that the transformation of data could not improve the statistical fit for this division. The main variation between response functions based on two types of data is that the trend variable, which was negatively related to the cotton acreage in equations based on original data, has a positive but little and insignificant effect in the equations based on logarithmic values.

The test for autocorrelation of the residuals was not significant at the 1 percent level of significance for most equations. The test was inconclusive for few equations.

The supply elasticities for cotton acreage estimated at the mean values of price and acreage, for equation 3 were 0.22 in the short-run and 0.32 in the long-run. Hence, cotton acreage in Poona division was predicted to increase by 2.2 percent in the short run and by 3.2 percent in the long-run for a 10 percent increase in cotton-jowar price ratio. The estimated coefficient of adjustment for this equation was .70.

T_A_B_L_E -4.2

Area Response Equations for Cotton in Poona Division(Period:1950-51 to 1969-70)

Eq.No.	Constant	Time	P_{t-1}(J)	P_{t-1}(B)	Y_{t-1}(J)	Y_{t-1} (B)	Y_{t-1}	X_{t-1}	R^2	d/h
1.	22.8881	-.5465 (.6855)	2.9907 (3.6879)				.0883⊕ (.0783)	.2907** (.2140)	.25	0.59
2.	20.0718	-.3293 (.7518)		4.7325⊕ (4.6630)			.0788⊕ (.0786)	.2722** (.2135)	.27	0.70
3.	23.1126		4.1954** (3.5385)		2.0428 (6.6366)			.3049** (.2300)	.19	1.76*
4.	26.7483			5.7420⊕ (3.9617)		-2.0476 (18.8635)		.2706** (.2078)	.22	1.34
5.	34.4407	-.3867 (.6942)	3.7691⊕ (3.7444)				.0879⊕ (.0805)		.16	1.29inc.
6.	26.2025	.1268 (.8084)		6.1347⊕ (4.8005)		-4.0958 (23.4703)	[illegible]	.2622⊕ (.2214)	.22	2.38
7.	36.0801	.3376 (.7950)		7.3986⊕ (4.7426)		-6.4860 (23.6945)			.15	1.25 inc.
8.	25.6734	-.1347 (.6642)	3.9215 (3.8988)		1.5752 (7.2362)			.3078⊕ (.2381)	.19	1.76*
9.	44.6156	-.0835 (.6777)	4.2199⊕ (3.9780)		-1.6981 (6.9285)				.09	1.21inc.
10.	3.3990	.0371 (.0983)	.2306** (.1751)				.0507 (.1937)		.12	1.38inc.
11.	2.8061	.0037 (.1075)	.1967⊕ (.1841)				.0592 (.1973)	.1667 (.2325)	.15	1.71*
12.	3.4097	.0749 (.0972)		.2990** (.1682)			.0290 (.1868)		.19	1.48 inc.
13.	2.9578	.0460 (.1123)		.2682** (.1810)			.0372 (.1918)	.1266 (.2283)	.21	6.5++
14.	3.0948		.1923⊕ (.1643)		-.0229 (.1694)			.1708 (.2229)	.14	2.96
15.	2.9788			.2211** (.1496)		-0.0632 (.1987)		.1930 (.1947)	.19	1.26

Note: 1) Figures in parentheses are the standard errors of the estimates.

2) Equations 10 to 15 were obtained from logarithmic data.

* Durbin Watson statistic as Watson statistic does not exist.

⊕ significant at the 20 % level.

** significant at the 15% level.

4.3 Nagpur Division:

Table 4.3 shows the results of the estimated acreage response functions for the Nagpur division. The coefficient associated with the trend-variable showed an increase in total cotton acreage and was significant at the 1 percent level. The sign of the coefficients of the price variables and yield variables were positive in all equations. Cotton-jowar price coefficient was significant at the 1 percent level only in one equation and cotton-bajara price variables' coefficient was significant at the 15 percent level. The coefficients of cotton-jowar yield ratio and cotton-bajara yield ratio variables were significant at the 15 percent and 10 percent levels respectively. The lag cotton acreage variable showed a positive influence on current acreage and was highly significant. Inclusion of lagged dependent variable had increased the R^2 value considerably. Nearly 95 percent of the variation in cotton acreage was explained by these explanatory variables.

The Watson statistic and Durbin Watson statistic showed that the serial correlation was not present in the residuals in almost all the estimated equations. The test was made at the 5 percent level.

TABLE 4.3

Area Response Equations For Cotton in Nagpur Division(Period:1950-51 to 1969-70)

Eq.No.	Constant	Time	$P_{t-1}(J)$	$P_{t-1}(B)$	$Y_{t-1}(J)$	$Y_{t-1}(B)$	P_{t-1}	Y_{t-1}	X_{t-1}	R^2	d/h
1.	1015.9000						2.6351+ (.7359)	-.6702 (.8288)		.45	.91inc.
2.	347.1950						0.6787++ (.2999)	.1794 (.2864)	.6616+ (.0582)	.94	-.85
3.	349.4270		4.9831 (9.0875)		2092[illegible]0* (135.0000)				.6935+ (.0572)	.93	-.19
4.	344.4780			5.9987 (9.5951)		108.0840++ (60.1918)			.6932+ (.0635)	.93	-.51
5.	936.8900	16.6660+ (1.0718)	37.4208+ (8.5951)					.0401 (.2756)		.94	1.21inc.
6.	1007.5100	15.8051+ (1.6413)		18.1748** (13.3522)				.0043 (.3970)		.89	.66++
7.	2.4204						0.0629++ (.0252)	.0109 (.0171)	.6140+ (.0532)	.94	-.95
8.	2.5161		0.0043 (.0206)		.0173** (.0129)				.6522+ (.0548)	.92	-.43
9.	2.5790			0.0044 (.0174)		0.0240++ (.0157)			.6426+ (.0616)	.92	-.47
10.	6.7984	0.0949+ (.0044)	0.250* (.0127)					.0169 (.0122)		.97	1.65

Note: 1. Standard errors are presented in parentheses.
2. Equations 7 to 10 were obtained from logarithmic data.
3. inc.stands for inconclusive.

\+ significant at 1 percent level
++ significant at 5 percent level
* significant at 10 percent level.
** significant at 15 percent level.

Acreage response functions were fitted with the logarithmic data and it was observed that there was no considerable improvement in the statistical fit.

The supply elasticities for cotton acreage with respect to the cotton-jowar price ratio were .011 in the short-run and .035 in the long-run for equation 3. Hence, based on this equation the cotton acreage in the current year was expected to increase by .11 percent in the short-run and .35 percent in the long-run for a 10 percent rise in the cotton-jowar price ratio in the previous year. The estimated coefficient of adjustment was approximately 0.30.

4.4 Maharashtra state:

The results of a number of equations for cotton acreage are shown in table 4.4. The conclusions that can be drawn from various equations are discussed below:

The time-trend variable was positively associated with the current cotton acreage and retains its significance only at the 10 percent level. Price ratio variables were positively related with current acreage. The cotton-jowar yield ratio was positively related with the current cotton acreage ;however, not significantly. The cotton -bajera yield variable showed a negative association with cotton acreage. The coefficient of lag acreage variable indicated that a significant proportion of acreage was influenced by the past decision of cotton growers. The adjustment lag model was observed to be superior to the traditional models. The best regression equation accounts for approximately 80 percent of total acreage variance.

The functions fitted with the logarithmic data showed slight improvement in the statistical fit. It was found that serial correlation in the residuals was not present in most of the equations.

The supply elasticities, estimated at the mean values, for cotton acreage with respect to the cotton-jowar price ratio were .031 in the short-run and .089 in the long-run for equation 4. The estimate of the coefficient of adjustment for this equation is .35.

A comparative study of the results of the responsiveness of the area of cotton shows that farmers growing cotton in Poona and Nagpur divisions responded positively to changes in its price (relative to jowar and bajera prices) to a significant extent. The coefficients of price variables (except cotton/jowar price variable) in Bombay division were negative but were not significant. The cotton yield relative to jowar or bajera yield had positive and significant influence on cotton acreage in Bombay and Nagpur divisions, while its effect was not significant in Poona. The time-trend variable which expresses technological improvement, to some extent,

TABLE - 4.4

Area Response Equations for Cotton in Maharashtra State(Period:1950-51 to 1969-70)

Eq.No.	Constant	Time	$P_{t-1}(J)$	$P_{t-1}(B)$	$Y_{t-1}(J)$	$Y_{t-1}(B)$	P_{t-1}	Y_{t-1}	X_{t-1}	R^2	d/h
1	549.6260						.7629 (.8728)	.2982 (.7756)	.6027+ (.1011)	.80	-0.57
2	1262.3500						3.6668+ (1.2876)	-.4396 (1.3611)		.34	0.81++
3	587.4930				-31.8693 (312.0720)		.8342 (.9529)		.5939+ (.1034)	.80	-0.10
4	494.0050		18.7979 (26.3909)		154.3190 (307.5770)				.6523+ (.0845)	.79	- .08
5	619.9650					-68.3901 (226.5440)	.8097 (.8718)		.5846+ (.1075)	.80	-0.21
6	570.3770			8.7866 (26.4948)		-47.0258 (234.0680)			.6515+ (.1034)	.79	-0.26
7.	993.3660	24.6296+ (3.0526)	120.6850+ (29.3366)		106.4210 (296.4310)					.81	1.34 inc.
8	2.9419						.0527 (.0537)	.0143 (.0393)	.5612+ (.0872)	.81	-0.37
9	6.4177						.2300+ (.0868)	-.0233 (.0380)		.31	0.79 inc.
10	3.0336				-.0008 (.0370)		.0546 (.0592)		.5559+ (.0907)	.81	-0.39
11	2.9125		.0221 (.0409)		.0191 (.0357)				.6081+ (.0767)	.81	-0.28
12	3.0297					.0010 (.0399)	.0541 (.0538)		.5571+ (.0905)	.81	-0.38
13	2.8850			.0078 (.0328)		.0027 (.0415)			.6099+ (.0884)	.80	-0.35

Note: 1 Standard errors are presented in parentheses. + significant at 1 percent level.
2 Equations 8 to 13 were obtained from logarithmic data. ++ significant at 5 percent level.
3 inc. stands for inconclusive.

had a highly significant effect in positive direction only in Nagpur division. The lag acreage variable influenced the current year cotton acreage significantly in all the divisions and in Maharashtra state as a whole. The estimates of the elasticities were low in all the regions under study.

CHAPTER - V

FORECASTING THE ACREAGE OF COTTON

In this chapter an attempt has been made to forecast* the acreage that farmers of the three regions in Maharashtra state will devote to cotton cultivation.

5.1 Method of Forecasting:

Two types of forecasts have been made.

1) Unconditional:

These forecasts are based on the assumption that the quantities to be predicted depend on time alone, i.e. forecasts are obtained by extra-polating past trends. In the present study cotton acreage is forecasted according to the following relationship.

$$X_t = a + b\,T \qquad \ldots\ldots \qquad (1)$$

where X_t, T, a and b are as defined in chapter III.

In most situations this method is unsatisfactory as it has less predictive power.

ii) Conditional forecast:

In this method the predicted variable is a function of other variables. To make a forecast, a model is developed which describes a mathematical relationship between the variables. Next, the independed variables

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* A forecast is generally defined as a statement concerning unknown, in particular future events.

are forecasted. Then, finally, the model is solved using the forecasted independent variables.

We have seen in the previous two chapters that cotton acreage is, mainly, described according to the following model:

$$X_t = a_0 + a_1 P_{t-1} + a_2 Y_{t-1} + a_3 T + a_4 X_{t-1} \quad \ldots \quad (2)$$

In order to forecast cotton acreage, we first have to forecast P_{t-1} and Y_{t-1}. This is possible if the behaviour of these variables is known. Over short period we may assume that price and yield variables may behave in the same manner as in the past. These two variables were projected by using time as the explanatory variable.

$$P_t = a_0 + b_0 T \quad \ldots\ldots \quad (3)$$

and $$Y_t = a_1 + b_1 T \quad \ldots\ldots \quad (4)$$

In equation (2), the independent variable lagged area, X_{t-1}, has been replaced by the previous year's forecasted acreage.

5.2 Results.

1) Bombay Division : In this division cotton acreage was predicted by using the following relations:

Unconditional forecasts.

$$X_t = 279.3120 + 3.5944\, T \qquad (R^2 = .16)$$

Conditional forecasts equation:

$$X_t = 73.4832 - .2666\, P_{t-1}(B) + 140.3710\, Y_{t-1}(B) + 1.2578\, T + .6336\, X_{t-1} \qquad (R^2 = .63)$$

where $P_{t-1}(B)$ and $Y_{t-1}(B)$ were generated from

$$P_{t-1}(B) = 3.0796 - .0798\, T \qquad (R^2 = .42)$$

and $Y_{t-1}(B) = 0.3732 - .0109\, T \qquad (R^2 = .39)$

Forecasted acreage figures obtained by the two methods are presented below:

Year	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1979-80
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Uncon.figs. ('000 Hec.)	351.20	354.79	358.38	361.98	365.57	369.17	383.54
Con.figs.	329.68	328.66	327.77	326.95	326.15	325.44	322.62

ii) <u>Poona division:</u>

In this division cotton acreage figures were forecasted only by conditional forecast method as the unconditional forecast equation had very less predictive power. The following equation was used for forecasting:

$$X_t = 20.0718 - .3295\, T + 4.7325\, P_{t-1}(B) + .0788\, Y_{t-1} + .2722\, X_{t-1} \qquad (R^2 = .27)$$

where $P_{t-1}(B) = 3.0760 - .0650\, T \qquad (R^2 = .22)$

and $Y_{t-1} = 103.0590 + 3.7663\, T \qquad (R^2 = .20)$

The following figures were obtained by this method:

Year	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1979-80
Con.figs. ('000 Hec.)	47.78	48.61	48.49	48.12	47.68	47.22	45.35

iii) <u>Nagpur division</u>:

Unconditional forecasts were made by the following equation:

$X_t = 1060.8500 + 14.5282\ T$ $(R^2 = .87)$

and conditional forecasts by

$X_t = 646.8650 + 23.8875\ P_{t-1}(J) + 39.5838\ Y_{t-1}(J)$

$+ 9.6026\ T + .3345\ X_{t-1}$ $(R^2 = .97)$

where $P_{t-1}(J) = 3.2212 - .0565\ T$ $(R^2 = .21)$

and $Y_{t-1}(J) = .0634 + .0052\ T$ $(R^2 = .33)$

Year	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1979-80
Uncon.figs. ('000Hec.)	1351.41	1365.94	1380.47	1395.00	1409.52	1424.05	1482.16
Con.figs.	1336.23	1350.69	1364.08	1376.73	1389.78	1402.32	1434.12

iv) <u>Maharashtra state</u>:

Unconditional forecast equation:

$X_t = 1396.1000 + 17.8977\ T$ $(R^2 = .58)$

Conditional forecast equation:

$$X_t = 696.3860 + 77.8001\,P_{t-1}(J) + 134.6730\,Y_{t-1}(J) + 13.9511\,T + .3320\,X_{t-1} \qquad (R^2 = .86)$$

$$\text{where } P_{t-1}(J) = 3.1893 - .0571\,T \qquad (R^2 = .27)$$

$$\text{and } Y_{t-1}(J) = .1675 + .0015\,T \qquad (R^2 = .03)$$

The following figures were forecasted by the two methods:

Year	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1979-80
Uncon. figs. ('000Hec.)	1754.05	1771.95	1789.85	1807.74	1825.64	1843.54	1915.13
Con. figs.	1723.34	1743.27	1759.16	1773.72	1789.96	1803.95	1863.68

The figures obtained by extrapolating the linear trends are less reliable as these linear trend functions have less predictive power. The conditional forecasting seems to be better as it takes into consideration the price of cotton relative to its substitute crop, relative yield and technology.

CHAPTER - VI

SUMMARY AND POLICY IMPLICATIONS

This study is devoted to the estimation of acreage response functions for cotton. In respect of cotton production, it is confined to the important districts of Bombay, Poona and Nagpur divisions and to the Maharashtra state as a whole.

The current year cotton acreage was mainly explained by its previous year price and yield relative to jowar and bajara. A time-trend variable, to take care of unquantified technological changes, was also included in acreage response functions. Data on prices, yields and acreage for the period 1950-51 through 1969-70 were taken from various publications of the Directorate of Economics and Statistics, Ministry of Agriculture. The adjustment lag models and some traditional models were used for evaluating the acreage response functions. These functions were estimated for the original values of the variables and for logarithmic values, using the classical least square approach.

The results of the analysis indicated that the acreage under cotton was inelastic to changes in price of cotton relative to jowar price in all the divisions and in Maharashtra state as a whole. Contrary to our expections own price and relative (to bajara) price variable's effect in Bombay division was negative. However, it was not significant. The coefficients of cotton yield and relative to jowar yield variables were positive in all divisions except in Poona. Trend variable had a positive significant influence only in Nagpur division. Lag acreage variable made a significant contribution in deciding about the size of the cotton crop in the current year. Functions fitted to the logarithmic data were not established superior over the functions evaluated from the original data.

Forecasting of cotton acreage had also been done which is desirable for policy formulations.

Acreage elasticities for cotton with respect to cotton-jowar price ratios were evaluated. High elasticities of the order of .22 in the short-run and .32 in the long-run were obtained in Poona division. The estimates of elasticities for Bombay division, Nagpur division and Maharashtra state were .037, .011 and .031 respectively in the short-run. The long-run figures for Nagpur division and Maharashtra state were .035 and .089 respectively. The estimates of the coefficient of adjustment revealed that the acreage under cotton got adjusted faster in Poona division than in the remaining areas under study.

Policy Implication:

Study has revealed that increase in cotton price encourages farmers to devote more area to cotton farming and vice-versa. The extent and nature of response, however, vary from division to division. In Bombay division the cotton growers respond to price changes negatively.

This perhapes may be due to some unfavourable agro-climatic conditions and several other factors which do not allow the cultivators to sow more cotton. The cotton growers of Poona and Nagpur division and of Maharashtra state respond to price changes both in the short run as well in the long run. The response, however, is slow because of the allocation of acreage to food crops for the subsistance requirements. The estimates of the magnitude of elasticities have shown that 10 percent rise in price has different results in the areas under study. But for an effective price policy it is not possible for the government to fix different prices in neighbouring regions of a state. Therefore, from the estimates of elasticities for the Maharashtra state, it is expected that a 10 percent increase in cotton-jowar price ratio will result an increase in cotton acreage by .3 percent in the short-run and .9 percent in the long-run.

Thus for raising the general level of cotton production through shifting the acreage from food crops to cotton farming, firstly a reasonable parity between cotton price and food crops jowar and bajera prices should be maintained and secondly a favourable cotton price before its sowing period should be announced.

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