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   REVIEW OF LITERATURE

   NEED/IMPORTANCE OF THE STUDY

   STATEMENT OF THE PROBLEM

   OBJECTIVES

   HYPOTHESES

   RESEARCH METHODOLOGY

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- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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RESPONSE OF PEASANT FARMERS TO SUPPLY INCENTIVES: AN INTER-REGIONAL ANALYSIS OF COTTON CROP IN SINDH, PAKISTAN

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ABSTRACT

Trends in the acreage of cotton, has not been uniform or steady in Sindh and fluctuations in both acreage and production have been considerable from year to year. Fluctuations in crop acreage mainly occur due to relative price structure, owing to varying profitability from crop to crop. Any development programme envisaged in the primary sector is aimed at increasing the overall production of the economy and the success or failure of this programme is mainly dependent on the response of farmers to such programme. The decision of farmers regarding allocation of land and other resources to increase production is directly or indirectly influenced by policies formulated by the government and the economic and climatic factors which are highly operative in production of crops. This study attempts to explain the acreage allocation behavior of cotton cultivators in terms of their response to price and non-price factors. The study is based on secondary data at zonal and provincial levels. The data covers a period of 28 years spanning from 1979-80 to 2006-07. The basic model used in this study is the improvised Nerlovian partial adjustment lagged model. The result of analysis reveals that in the process of making area decisions for cotton cultivation, all variables (relative profitability, irrigation, price and yield risk, area under plant protection measures, cotton ginning capacity by ginning factories and lagged acreage) are more or less equally important. The study indicates the significance of relative profitability, in explaining the variations in acreage under cotton crop across all zones of Sindh. The results of the study indicate a positive response of land resource allocation to relative profitability. This means that farmers can find it possible to make adjustments on the acreage allocation under cotton cultivation through manipulation of relative profitability of cotton and the substitute crops. In order to bring an effective adjustment in acreage allocation, the support price for various crops must be announced well before the sowing season; and the prices thus announced, should carry a long-run guarantee.

GEL CLASSIFICATION
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KEYWORDS
Coefficient of variation, cotton ginning capacity, h-statistic, Nerlove adjustment log model, relative profitability.

INTRODUCTION

Agriculture plays an important role (directly and indirectly) in generating the economic growth. It contributed 20.9 percent of the Gross Domestic Product (GDP) in 2010-11. The contribution of the Agricultural sector to the Gross Domestic Product (GDP), though declined gradually since Pakistan came into being from a level of over 59.9 percent in 1949-50 to 20.9 percent in 2010-11 but it still is the major sector of the GDP composition. The sector provides employment to 45 percent of the labor force (Economic Survey, 2010-11). This sector supplies raw materials to many major industries. The value added and employment opportunities provided by these industries make major contributions to the Pakistan's GNP. In turn, it consumes a large part of the industrial finished goods.

REVIEW OF LITERATURE

Like other developing countries, the topic of supply response has been discussed in Pakistan by various authors, such as (Krishna 1963), (Falcon 1964), (Hussain 1964), (Cummings 1975a, 1975b) and many others. Most of these studies are three decades old and since then many technical, institutional and economic changes have taken place in Pakistan's agriculture sector. However, recent efforts have been made by (Ashiq 1981), (Tweeten 1986), (Ali 1988), (Khan and Iqbal 1992), (Naqvi and Burney 1992), (Wasim 1996-97), (Himayatullah 1994), (Chaudhry 2000), (Khan, et al., and Kalsoom, 2008), Nosheen and Iqbal, 2008). Using Nerlovian Adjustment Lag Model, Ashiq, Tweetne, Himayatullah, Chaudhry, Wasim, Khan, Ikram, Kalsoom, and Nosheen and Iqbal found that farmers of Sindh, Pakitan are rational and respond positively to economic incentives. Contrary to this, Ali concluded that price support policy of the government has little potential to increase overall agricultural production. Khan and Iqbal (1992), on the other hand, used Nerloves partial adjustment adaptive expectational model for ten major crops of Pakistan. They concluded that farmers in Pakistan tends to behave "rationally" in general. Although, it is found that farmers are price-responsive, but the degree of responsiveness differ from crop to crop. Naqvi and Burney (1992) estimated the supply and output demand functions based on the profit function approach[1]. Their estimation confirmed that Pakistani farmers respond to changes in the output prices.

IMPORTANCE OF THE STUDY

The study of farmer's supply/acreage response is of considerable importance for devising a suitable policy for the agricultural sector of any economy, particularly in Pakistan where agriculture is by far the most important sector in the national economy. Developing economies needs to understand the supplying phenomenon of crops in order to implement viable policies. Even in developed countries, understanding the supply phenomenon is of crucial importance in controlling surplus for raising the farm income and resource productivity (Heady, 1961).

THE STATEMENT OF THE PROBLEM

Trends in the acreage of cotton, has not been uniform or steady in Sindh and fluctuation in both acreage and production have been considerable year to year. Fluctuations in cotton acreage have always been a matter of concern to ginning factories, exporters of raw cotton and importers of cotton, and have recently assumed to grave dimensions. Fluctuation in crop acreage mainly occurs due to relative price structure, owing to varying profitability from crop to crop. In every economy shift in the acreage under different crops is very obvious. Agricultural economists have, therefore, naturally been interested in identifying the important factors causing shift in the acreage of individual crops. Whether and to what extent Sindhi farmers are influenced in their production decisions by economic stimuli is a question of central importance for agricultural planning in Pakistan. In a developing economy like ours, the overall economic development depends to a greater extent inter-alia on the rate of growth in agriculture. Any development programme envisaged in the primary sector is aimed at increasing the overall production of the economy and the success or failure of this programme is mainly dependent on the reaction of the farmers to such programmes. The decision of farmers regarding allocation of the land and other resources to increase production is directly or indirectly influenced by the policies formulated by the government, in addition to the economic and climatic-factors which are highly operative in production.

All earlier studies on Pakistan (except Wasim 1996-97) have primarily focused either on Punjab or at the national level. The estimates of supply elasticities have been on the aggregate or at macro-level, implicitly assuming that various regions/sub-regions producing one or more commodities possess homogeneous characteristics; and the level of supply and the nature of producer's response everywhere would be same. This is questionable; firstly, because when there are inter-regional differences in resource endowments including agro-climatic conditions (i.e., soil, climate, physiography, irrigation facilities, etc.) and the managerial skills, the macro supply response relationship may not provide a true picture of the resource allocative decision of the farmers. Secondly, all studies have considered price as an important factor for decision. Price may be the only consideration if the yield rate of crops remains unchanged over the period. But, as we know the yield of the crops in Pakistan, mostly varies due to unavoidable circumstances (i.e., floods, pest attack, etc.). In such a situation price may not be the sole decisive factor. In fact, when technological development take place, the year to year change in land allocation reflect change in the farmers decision not only due to variation in price but also because of variation in yield rates (as cotton yield in Sindh). In such a situation, the relative price variable is inappropriate to assess farmers response to change in the commercial policy. Instead "relative profitability/net return per unit of land" is a much better choice as a key determinant of farmer's production decision. None of the studies (except Wasim, 1996-97) have included this variable in their model specification. Thirdly, none of these studies (except Wasim) include the element of risk in the supply response studies, thereby ignoring the risk-minimizing tendency of farmers in developing countries. It is also well known that risk arising from price and yield variations may influence the farmers decision regarding the choice of crops to be cultivated. Fourthly, none of the studies have included "area under plant protection measures" in their model specification. Though, we know that in most of the year the production of crops fell due to the pest attack. Fifthly, the studies have failed to include cotton ginning capacity by cotton ginning factories as an independent variable in their model specifications. This variable must be included in the model to see whether growers are influenced by variation in the factory output.

Although, cotton is also cultivated in other provinces, the province of Sindh was selected for the analysis as it recorded relatively better yield per acre of cotton as compared to other provinces and also due to the availability of data on more independent variables. Sindh also exhibited a yield pattern similar to the national trend.

On the basis of distinct characteristics of topography (climate and soil), the province of Sindh can be divided into six ecological zones[2], viz., northern zone, central zone, southern zone, Kohistan and adjacent area, Thar desert and saline alkali area. These zones possess distinctly different characteristics that clearly differentiate them from one another.

The estimation of acreage function for the micro producing zones, where each zone represents more or less homogenous agricultural conditions would help envisage better the possible effects of a macro level policy at the zonal level.

OBJECTIVES

This study attempts to explain the acreage allocation behavior of cotton cultivators in terms of their responsiveness to price and non-price factors. The main objectives of the study are:

i) to test whether the farmers of Sindh respond to price/relative profitability movements,

ii) to estimate elasticities of acreage with respect to cotton crop; (a) relative profitability, (b) irrigation, (c) risk variables arising from price and yield, (d) area under plant protection measures, and (e) cotton ginning capacity by ginning factories.

iii) to make a comparison of short-run and long-run price/relative profitability elasticities with that of other underdeveloped and developed countries.

iv) to identify policy measures in respect of price, yield, irrigation, plant protection measures etc., so that production of cotton can be increased in order to increase the export of raw cotton, and cotton manufactured goods and it can also be exported to increase trade balance in favor of export.

STUDY AREA AND DATA SOURCES

To build up an economic model on the objectives given above, it is necessary to have adequate data relating to the area under cotton and the said Stimuli in order to make a quantitative assessment possible. The study is based on secondary data at the zonal and provincial levels[3]. After lossing three years due to the calculation of price risk, (past three-year prices) the cotton data covers a period of 28 years[4]. The study mainly depends upon the availability of data.

RESEARCH METHODOLOGY

The farmer allocates his land to different crops, depending on his expected revenue from them. Assuming that the input cost is either the same or more uniformly distributed overtime for different crops, the expected revenue depends on the expected price. It is very seldom that they are able to make hundred per cent adjustment while responding to various economic factors, or adjust instantaneously. In Pakistan cotton cultivation decisions are made in January-February while government announces the support price[5] for that as well as for substitute crops much earlier. This indicates that, cultivators do not have to form any expectations about future output prices, but they might experience some technological and institutional constraints in the procurement of requisite inputs in such cases. Under these conditions the Nerlove's partial adjustment lag model is considered appropriate for cotton growers and is widely used by majority of researchers for measuring the farmers' response behavior. Therefore, the basic model used in this study is the improvised Nerlovian partial adjustment lagged model[6] (Nerlove 1958).

Since the price of cotton seed is announced before cultivation time, cotton growers can easily formulate their desired acreage. Assuming that the desired acreage is linearly related to the price of seed cotton, a typical specification comes up as follows:

$$A^*_t = a + bP_{t-1} + U_t \quad (1)$$

where A^*_t is a desired or long-run acreage and P_{t-1}, is the lagged price of cotton seed. Since the desired acreage, A^*_t, is an unobservable variable, Nerlove formulation suggests that it can be specified as:

$$A_t - A_{t-1} = \beta(A^*_t - A_{t-1}) \quad 0 < \beta \leq 1 \quad (2)$$

then the current supply is:

$$A_t = A_{t-1} + \beta(A^*_t - A_{t-1}) \quad (3)$$

β is the coefficient of adjustment, which accounts for forces which cause the difference between the short-run and long-run supply-price elasticities. $A_t - A_{t-1}$ is actual change and $A^*_t - A_{t-1}$ is desired or long-run change. The first equation is a behavioral relationship, stating that the desired acreage under the crop studied depends on the relative farm prices in the preceding year. Equation (2) states that the actual planted area of cotton in period t is equal to the previous actual planted area plus a proportion of difference between the desired planted area in period t and actual planted area in period t-1. This hypothesis implies that farmers cannot fully adjust their actual planted area to the desired area in response to changes in the explanatory variables due to constraint, such as fixity of assets, physical land conditions, habitual production patterns of the farmers, etc.

'β' is, therefore, an indication of how fast the farmers make adjustments to their expectations. The value of 'β' close to zero would mean that the farmers are slowly adjusting to the changing prices, yield, etc. The value of 'β' close to one would mean that the farmers are quickly adjusting to the changing levels of prices, yield, etc., almost instantaneously. When adjustment is perfect β=1. In real world however, the value of β lies between 0 and 1.

Relations with Equations (1) and (2) give the reduced form, which eliminates the unobserved variable (A^*_t) by an observed variable (A_t):

$$A_t = A + BP_{t-1} + CA_{t-1} + V_t \quad (4)$$

where,

$A = a\beta$,

$B = b\beta$,

$C = (1-\beta)$,

$V_t = \beta U_t$

Equation (4) provides a simple version of partial adjustment model and the parameters of this model can be estimated using OLS if the original U_t's are serially uncorrelated (Gujrati, 1995). There are also other Autoregressive models other than the partial adjustment model, such as, Koyck and Adaptive expectation. In the Koyck model as well as the adaptive expectations model the stochastic explanatory variable Y_{t-1} is correlated with the error term V_t? If an explanatory variable in a regression model is correlated with the stochastic disturbance term, the OLS estimators are not only biased but also not even consistent; that is even if the sample size is increased indefinitely, the estimators do not approximate their true population values[7]. Therefore, estimation of the Koyck and adaptive expectation models by the usual OLS procedure may yield seriously misleading results. However, the partial adjustment model is different. In this model V_t of equation 4 is $= \beta U_t$. Therefore if U_t satisfies the assumptions of the classical linear regression model, such as zero mean value of U_t, no autocorrelation between the U's, Homoseedasticity or equal variance of U_t, and zero covariance between U_t and x_t, so will βu_t. Therefore, OLS estimation of the partial adjustment model will yield consistent estimates although the estimates tends to be biased (in finite or small samples)[8]. Although A_{t-1} depends on U_{t-1} and all previous disturbance term, it is not related to the current error term U_t. Therefore, as long as U_t is serially independent A_{t-1} will also be independent or at least uncorrelated with U_t, thereby satisfying an important assumption of OLS, namely, non-correlation between the explanatory variable(s) and the stochastic disturbance term (Gujrati 1995). The reduced form would basically remain the same, if we include more independent variables than these included in equation (4), which is the basic frame of our model, but more independent variables are included in it. The model will be in log form. The logarithmic form provides estimates of short-run and long-run supply elasticities directly.

Using the Adjustment lag model as the basic frame for analysis, the response relationship in the study will be estimated more or less with the help of the following short-run equation.

$$\log A_t = \log C_0 + C_1 \log RP_{t-1} + C_2 \log I_{t-1} + C_3 \log CV_P + C_4 \log CV_Y + C_5 \log PP_{t-1} + C_6 \log GC_{t-1} + C_7 \log A_{t-1} + \log V_t \quad (5)$$

where,

A_t = Acreage under cotton in year t.

RPt-1 = Relative profitability[9] of the crop in year t-1.

I_{t-1} = Irrigated area under Kharif crops in year t-1;

CV_p = Coefficient of variations[10] of the prices of cotton for the years t-1, t-2, t-3 is used as a measure of price risk;

CV_Y = Coefficient of variations of the yields of cotton for years t-1, t-2, t-3 is used as a measure of yield risk;

PPt-1 = Area under plant protection measures for cotton in year t-1;

GCt-1 = Cotton ginning capacity by cotton factories in year t-1;

A^*_t = Desired or long-run area under cotton which will be different from the planned area in the period due to the partial accounting of farmer's expectations in the planning;

V_t = Error term in year t;

β = Adjustment coefficient

Other inputs like labor utilization and fertilizer consumption per hectare and per crop was also considered important but due to non-availability of data it was not possible to capture their effects. Because of the presence of lagged value of the dependent variable on the right hand side of equation (5), the Cochrane-Orcutt technique will be employed in the Ordinary Least Square (OLS) regression procedure, in order to account for possible auto-correlation problems. The time-series data for the relevant districts in the zone were pooled for the purpose of estimating the above equation for the four zones. Such disaggregated results provide a better understanding of the factors which influence the farmer's acreage decisions because they highlight the inter-zonal differences in response behavior.

We have estimated the equation with all variables in their log-linear form. The log form of the function was chosen because it yielded consistently better results with respect to signs, values and levels of significance of the regression coefficients. Besides, the logarithmic forms also provide readymade estimates of short-run elasticities.

The Long-run elasticities are calculated by using the short-run elasticities.

$$\text{Long-run price elasticity of acreage} = \frac{\textit{Short run elasticity}}{\textit{Coefficient of adjustment}}$$

Whether this model suffers from the auto-correlation problem or not, it can not be tested by using the DW d-statistic, since it includes a lagged-dependent variable (lagged acreage in this case) in a regression equation, the DW d-statistic is likely to have reduced power and is biased toward the value 2, (Durbin 1970) and (Nerlove 1958). For such an equation, Durbin has suggested an alternative test statistic known as Lag range Multiplier Test or the h-statistic[11], defined as:

$$h = \left(1 - \frac{1}{2} d\right) \sqrt{\frac{n}{1 - n\hat{v}(\hat{c}_7)}} \quad (6)$$

where,

$\hat{v}(\hat{c}_7)$ = least sqaures estimate of the variance of c_7

d = usual DW d-statistic

n = number of observations

Under the null hypothesis of no autocorrelation, h is asymptotically normal with zero mean and unit variance. The test statistic can also be used to test the hypothesis of no serial correlation against first-order auto-correlation, even if the set of regressor in an equation contains higher order lags of the dependent variable. However, if $\hat{v}(\hat{c}_7) > \frac{1}{n}$, it cannot be computed, (Green, 1990). Cochrane-Orcutt iterative process was applied where the existence of autocorrelation was detected. "Intercorrelation of variables is not necessarily a problem unless it is high relative to the overall degree of multiple correlation" (Klein 1962). If there are a strong interrelationships among the independent variables, it becomes difficult to disentangle their separate effects on the dependent variable. If there are more than two explanatory variables, it is not sufficient to look at simple correlations. Thus, the term "intercorrelations" should be interpreted as multiple correlation of each explanatory variable with the other explanatory variables. Thus, by Klein's rule mutlicollinearity would be regarded as a problem only if $R^2_y < R^2_i$, where $R^2_y = R^2_{y}.x_1x_2..x_k$ and $R^2_i = R^2_{xi}$. other x's. With the non-experimental data, it would be impractical to ascertain a priori that the multicollinearity problem among the explanatory variables is not severe. Therefore, a categorical test of intercorrelations among the explanatory variables is conducted and results are presented in Appendix (Table 2). All these ensures the best linear unbiased estimates.

For empirical research, the model has to be not only logically sound but also computationally feasible.

JUSTIFICATION OF THE VARIABLES

The estimating Equation (5) indicates that acreage under cotton in a given period is a log-linear function of a constant term, seven variables and an error term. The theoretical justification for different variables being included as arguments in equation is as follows. The second term in the right hand side of the equation refers to relative profitability of the crop. Most of the earlier studies have considered price [except (Wasim, 1996-97) and (Kainth, 1986)], as an important factor of decision. Price may be the only consideration if the yield rate remains unchanged over the period. But, as we know that the yield of crops (in our case the yield of cotton fluctuated in Sindh during the study period) in Pakistan mostly vary due to unavoidable circumstances i.e., floods, pest attacks, etc. In such a situation price may not be the sole decisive factor. In fact, when technological development takes place, the year to year change in land allocation reflect changes in the farmers' decision not only due to variations in prices but also because of variations in the yield rate. In such a situation, "relative profitability/net return per unit of land", instead "relative price" variable is a much better choice to assess farmer's response to changes in the commercial policy. Increases in the relative profitability, (other things remaining the same) would provide an incentive to farmers to allocate more land to that crop. We would expect, and the model yields, the coefficient c_1 to be positive. Negative relative profitability, on the other hand, will encourage farmers to produce more competing crops. In other words, we expect a negative sign of the coefficient c_1. Increase in relative profitability will increase acreage, therefore, we expect a positive relationship between these two variables. The third term on the right hand side is lagged irrigation. As we know that better production of cotton depends on better irrigation facilities and farmers will shift to cotton cultivation if irrigation facilities are improved. Therefore we would expect the coefficient c_2 to be positive. A negative sign of the coefficient, on the other hand, would mean that (for a farmer) to grow competing crops means more profitable. The fourth and fifth terms are price risk and yield risk variables. It is also well known that the risk arising from price and yield variations may influence the farmer's decision regarding the choice of crops to be cultivated. Fluctuation in prices reflects conditions of demand and supply including uncertainties and imperfections in the marketing systems. Variability in yield, on the other hand, is caused by weather conditions as in the case of most cereal crops in Pakistan or by changes in production technology. As far as the two risk variables are concerned, assuming that farmers are risk-averse, (putting less acreage under the crop) we expect, a priori, a negative sign for these two variables. The sixth term is the area under plant protection measures. This variable indicates that whether the cotton growers altogether ignore or do not ignore the effects of plant protection measures while allocating the land to the crop, we expect a positive/negative response of the variable. Cotton ginning capacity is included to see whether cotton growers are influenced by variations in the factory output. We expect a positive/negative sign of the coefficient c_6. The coefficient of lagged acreage is included in the model to see whether the farmers are adjusting slowly or quickly. We expect a positive sign of the variable. Its large value generally indicates the farmer's slow adjustment, while a small value generally indicates their quick adjustment.

CRITERIA FOR CHOOSING THE COMPETING CROPS

In selecting the competing crops, we prefer to select only the important crops per district, per zone and province. As far as the mode of selection of competing crop is concerned, we have taken into account the sowing and growing period of different crops in the (Kharif) season, their percentage share in the total crop area of the zone and information contained in the past literature on competing crops. An intercorrelation matrix of change in the area under cotton and its competing crops is fitted for different zones and province, and these results were also taken into account while selecting these crops. Another consideration is the selection of crops which should be a major crop in the respective zone and province.

COMPETING CROP (s) FOR COTTON

Competing crop(s) for cotton are given in Table 1:

TABLE – 1: COMPETING CROP SELECTED IN EACH ZONE FOR COTTON CROP

Zone/Province	Major Competing Crop
Northern	Jawar
Central	Jawar
Thar Desert	Chilli
Southern	Sugarcane
Sindh Province	Rice

The competing crop for cotton is jawar in the northern and central zones, chilli in Thar desert, sugarcane in southern zone, and rice in Sindh province. More than one competing crops were also taken in the equation but it yielded consistently poor results with respect to signs, values and level of significance of the regression coefficients.

Zone-wise estimated results for cotton crop are presented in Table 2. The estimating equation indicates that the acreage of a crop in a given period is a log-liner function of a constant term, seven variables and an error term. The equations were estimated in logarithmic forms. The log-linear form of variables gave higher coefficients of determination, expected signs and highly significant values of T-statistics as compared to linear form. The coefficient of determination R^2 (adjusted to degrees of freedom) is between 0.81 and 0.93. The results of the multicollinearity indicated that there was no serious problem of multicollinearity (Klein rule) in any one of the equation. Since $\hat{V}(\hat{B}_7)$ is (1/n), the computation of 'h' statistic is possible, the 'h' statistic ($<\pm1.645$) is within the acceptable range. Hence, the null hypothesis was accepted in favor of absence of serial correlation in any of the zone and province.

TABLE – 2: ZONE-WISE ESTIMATED REGRESSION COEFFICIENTS OF ACREAGE RESPONSE FUNCTIONS FOR COTTON IN THE PROVINCE OF SINDH FOR THE PERIOD 1979 TO 2007

Zone/Province	Major Competing Crops	Constant	Regression Coefficients							Coefficient of Adjustment	Multiple Coefficient of Determi-nation	Durbin 'h' Statistic	Relative Profitability	
			Relative Profitability in t-1	Irrigated Area in t-1	Price Risk	Yield Risk	Area Under Plant Protection Measures in t-1	Cotton Ginning Capacity in t-1	Cotton Acreage in t-1				Short-Run Elasticity	Long-Run Elasticity
			RP_{t-1}	I_{t-1}	CV_P	CV_Y	PP_{t-1}	GC_{t-1}	A_{t-1}	β	R^2	'h'	SRE	LRE
Northern Zone	Jawar	6.365	0.226 (2.275)**	0.137 (1.943)***	–0.013 (1.713)	–0.011 (0.791)		0.217 (2.516)**	0.843 (3.316)*	0.157	0.901	0.417 (NSC)	+0.226**	+1.439**
Central Zone	Jawar	3.981	0.236 (2.947)*	1.179 (5.517)*	–0.016 (2.151)**	–0.032 (2.433)**		0.329 (3.169)*	0.765 (2.859)**	0.235	0.926	0.311 (NSC)	+0.236*	+1.004*
Thar Desert	Chilli	–2.416	0.260 (1.763)***	0.315 (2.219)**	–0.035 (2.132)**	0.033 (1.743)		0.154 (2.010)***	0.824 (2.564)**	0.176	0.812	0.119 (NSC)	+0.260***	+1.477***
Southern Zone	Sugarcane	4.310	0.286 (2.231)**	0.305) (5.381)*	–0.177 (1.796)***	–0.061 (2.161)**		0.230 (2.515)**	0.825 (2.231)**	0.175	0.854	0.510 (NSC)	+0.286**	+0.634**
Sindh Province	Rice	2.161	0.230 (2.516)**	0.319 (2.610)**	–0.141 (1.985)***	–0.335 (2.141)**	0.173 (2.716)**	0.468 (2.591)**	0.863 (2.947)*	0.137	0.886	0.315 (NSC)	+0.230**	+1.679**

Note: Figures in parentheses are 't' values.

*** = *Significant at 1 percent level.*

**** = *Significant at 5 percent level.*

***** = *Significant at 10 percent level.*

NSC = *No serial correlation*

RESUTLS AND THEIR INTERPRETATIONS IN DIFFERENT ZONES

The results of cotton crop in Table 2 are discussed as under.

RELATIVE PROFITABILITY

The impact of the economic incentives on cotton acreage is found significant, as evident from the significant positive impact of relative profitability on cotton acreage. The variable is significant at 5 percent level in northern zone, southern zone and the Sindh province; while in the Thar desert it is significant at 10 percent level. In central zone the coefficient is significant at 1 percent level. This suggests that additional income from the crop in the preceding year was generally led to higher investment in the acreage of cotton crop in all zones and the province under study. It may be due to suitable agro-economic conditions which prevail and for the successful propagation of the HYV's, hence, additional investment is profitable. In a way it suggests that for the producer, growing competing crops mainly for family consumption is of little importance. The farmers would generally like to meet his subsistence requirement out of their own farm to feel secure. An excess of production over subsistence requirement in a good year of the competing crop is generally saved for future consumption rather than to sell it out; which means that farmers in Pakistan do respond to economic incentives. The price support policy of the government also has potential to increase cotton production. Therefore, the conclusion does not support the widely prevalent notion that peasants in poor countries (like ours) do not respond, or respond very poor, or respond negatively, to the price movements[12].

IRRIGATED AREA

Regarding this supply shifter, with expansion in irrigation, the acreage under cotton crop has tended to increase as indicated by significantly positive coefficients for this variable in all zones and the province. Among these crops the effect of irrigated area on acreage allocation needs to be examined in light of the total water available for irrigation and the water required for crop consumption. In principle, the annual acreage of high water delta crops may not show a wide variation because their full potential cannot be realized without an assured irrigation in adequate quantities. The crops with relatively low consumption of water requirements can on the other hand, lend themselves for acreage adjustment more readily in response to water availability reflected in the form of total irrigated area in the country. Cotton is less irrigation-intensive and is also relatively short duration crop. The extent of the impact of irrigation variable differs between zones to crop. The coefficient is significant at 1 percent level in the central and southern zone, 5 percent level in Thar desert and Sindh province and 10 percent level in the northern zone. The values of coefficient are higher for Sindh province, Thar desert and southern zone than those for the central and northern zones. This may be taken to indicate that the Sindhi farmers will shift to cotton cultivation if irrigation facilities are improved. The farmers of Sindh province, Thar desert and the southern zone appear to be more responsive if irrigation facilities are improved than those in the northern and central zones.

RISK VARIABLES

Changes in acreage allocation and cropping pattern involve risk. Generally, such changes give rise to two major sources of risk, one, the price, and the other is the yield. Depends how farmers have varied acreage under crops. Response to the risks of variations in yield and price; is important to be known. Fluctuation in price reflects conditions of demand and supply including uncertainties and imperfections in the marketing systems. Variability in yield, on the other hand, is caused by weather conditions as in most of the crops in Pakistan and/or by changes in production technology. The relative incidence of these risks may differ in individual crops and zones. The variability due to price and yield gives expected negative signs in all zones, except the Thar desert where it is positive. The price risk coefficience is significant at 5 percent level in the central zone and the Thar desert, and at 10 percent level in the southern zone and Sindh province. In northern zone the price risk coefficient is negative but statistically it is insignificant. The negative sign of the price risk variable indicates that cotton growing farmers appear to be risk-lovers by putting less acreage under the crop. The variability due to yield also upholds our expectation (negative signs) in the northern, central and southern zones and the province of Sindh. The coefficient is significant at 5 percent level in central and southern zones and Sindh province. In Thar desert the coefficient is positive but statistically insignificant. In northern zone the coefficient is though negative but statistically insignificant.

The positive coefficients for both the risk variables are not in line with our expectations. The signs opposite to our expectation in the model for yield and price risk (not in our case) variables may be due to continuous trend in the yield and price levels of cotton. The negative and significant signs of the price risk variable indicates that cotton growing farmers appear to be risk-lovers by farming less acreage under the crop. The positive sign of price risk variable (not in our case) means that farmers appear to be risk-averse by putting more acreage under the crop. The sign opposite to expectation in the model for yield and price risk variable may be due to continuous trend in the yield and price levels of cotton. In fact, the total variability considered by us consists of expected and unexpected variability and it is the latter which actually accounts for risk. If some crops have continuous expected trend in yield or price, the expected variability may predominate the total variability and so the sign opposite to the expected one may occur for the risk variable. For example, the variability in the price and yield of cotton may increase, but if the increase is always upward in the price and yield, the resulting effect of this variability will not be negative as the variability (as expected).

PLANT PROTECTION MEASURES

The regression coefficient for the area under plant protection measures[13] variable turns out to be positive and significant at 5 percent level in the province. The positive response of farmers, indicates that cotton growers do not ignore the effects of plant protection measures, while allocating the land to the crop concerned.

COTTON GINNING CAPACITY

This variable[14] is included in the model to see whether cotton growers are influenced by variations in the factory output. Ginned or raw cotton production by cotton ginning factories in all the zones and province do have a direct positive bearing on an acreage under cotton, because the coefficient of this variable is significant. In the northern zone, Southern zone and Sindh province, it is significant at 5 percent level; at 1 percent level in central zone, and 10 percent level in Thar desert. This means that the factory price is attractive to the producer and there is a significant regulation in cotton supply to cotton ginning factories in all zones and the province.

COTTON ACREAGE

The elasticity estimates of lagged cotton acreage are found to be consistently positive and highly significant. It is significant at 1 percent level in northern zone and Sindh province, while it is at 5 percent level in central zone, Thar desert, and southern zone. The magnitude of coefficients of this variable varied in the province of Sindh from 0.767 and in the central zone to 0.863 in the province. Its large value generally indicates the farmer's are slow at adjustments. The coefficient of adjustment is very low (0.14) like, adjustment between the desired and actual level of acreage; or in other words, we can say that various technical, institutional and subjective factors seem to have a great deal of influence on the farmers' decision like cotton crop in the province.

ADJUSTMENT BEHAVIOUR, SHORT-RUN AND LONG-RUN RELATIVE PROFITABILITY/ PRICE ELASTICITIES

As our model is based on the Nerlove's adjustment hypothesis, it will be interesting to know how far the estimated equations for actually planted area, support this argument. The rapidity with which the farmers adjust the acreage under a crop in response to movements in factors discussed above, is seen from the numerical values of the coefficient of adjustment (β). For cotton crop, lagged dependent variable (A_{t-1}) is entered positively in all zones and the province. The coefficient of lagged acreage is significant at 1 percent level in the northern zone and the Sindh province, while in the central zone, Thar desert, and southern zone, it is significant at 5 percent level. The adjustment coefficient obtained for this crop ranges from 0.137 in Sindh province to 0.235 in the central zone. Thus, both the extreme values are within the assumed range of zero to one. This low rate of adjustment coefficient points out that cotton farmers in Sindh are significantly influenced by institutional and technological constraints, while, slow/gradual expansion or contraction of area under cotton cultivation depends on inducement of cotton price.

As it is obvious, the long-run elasticity with respect to relative profitability is higher than the short-run elasticity in all the zones and the province for both the crops. This is because cotton growers of Sindh have more time to adjust their areas under crop cultivation for long-run than in the short-run.

COMPARISON OF RELATIVE PROFITABILITY/PRICE ELASTICITIES OF COTTON IN SOME DEVELOPED/UNDERDEVELOPED COUNTRIES

To make a relative comparison of Relative Profitability/Price elasticities of cotton acreage obtained, the elasticities of acreage estimated by other researchers in some developed and developing countries of the world are presented in Table 11. The results of our study show that cotton farmers respond to relative profitability changes, positively. Degree of this positive responsiveness, however, depends on positions of individual crops in the national economy, degree of commercialization, availability of resources and alternatives, development of transport and monetization and the degree of risk and uncertainty; involved in crops cultivation. Results of Table 3 indicate that our estimated acreage elasticity with respect to relative profitability in the Short and Long-run compares favorably with Khan and Iqbal (Pakistan) estimates. Since no study relating to the topic on Sindh province has been undertaken in the past, therefore, an exact comparison can not be made.

TABLE – 3: COMPARISON OF RELATIVE PROFITABILITY/PRICE ELASTICITIES OF COTTON IN SOME DEVELOPED/UNDERDEVELOPED COUNTRIES

Province/State/ Region/Country	Period	Relative Profitability/ Price Elasticity		Source
		Short-Run	Long-Run	
U.S.A.	1909-32	+0.34	+0.67	Mare Nerlove
U.S.A.	1882-1914	+0.08 to +0.34	+0.23 to +0.85	DeCanio
Sindh (Pakistan)	1979-2006	+0.23[a]	+1.68	Our Estimates
Pakistan	1956-87	+0.24	+1.70	Khan and Iqbal
Pakistan	1957-86	+0.71	+1.34	Mubarik Ali
Pakistan	1933-59	+0.40	–	Walter P. Falcon
Pakistan	1949-68	+0.40	0.47	John Thomas Cummings
Pakistan	1957-79	+0.12	–	Mohammad Ashiq
Pakistan	1962-82	+0.10	0.54	L. Tweeten
Pakistan	1972-91	+0.65	_1.14	Himayatullah
Punjab (India)	1922-41	+0.72	+1.62	Raj Krishna
Haryana (India)	1960-77	+0.79	+1.30	S.S. Sang Wan
Punjab (India)	1960-69	+0.68	+1.17	Kaul and Sidhu
Tamil Nadu (India)		+0.31	+0.54	M.C. Madhawan
Gujrat (India)	1954-68	+0.05	+0.08	J.T. Cummings
Punjab (India)	1967-96	+0.23[A] +0.45[D]	– –	Sundeep Kumar, R.S. Sidhu and J.S. Sidhu
Sudan	1951-65	+0.39	+0.50	Medani
Nigeria	1948-67	+0.38	+0.28	Oni
Uganda	1945-66	+0.50	+0.63	Alibaruho
Bangladesh	1972-81	+0.14	+6.80	Sultan H. Rehman
Bangladesh	1972-89	+0.16	+0.16	M.Yunus

a *Relative Profitability (Price * Yield)*
[A] *American Cotton*
[B] *Desi Cotton*

The estimated elasticities as presented here will (it is hoped), be a useful addition to the existing repertory of the elasticities of acreage of cotton in different parts of the world. The estimates will also be useful for cross-checking the acreage forecasts for crops as well.

SUMMARY AND CONCLUSIONS

The study of farmer's acreage/supply response is of considerable importance for devising a suitable policy for the agricultural sector of any economy, particularly, in Sindh, Pakistan, where agriculture is by far the most important sector in the national economy. The decision of farmers regarding allocation of land and other resources to increase production is directly or indirectly influenced by policies formulated by the government and the economic and climatic factors which are highly effective in production.

The present study has been directed to identify the economic and non-economic factors responsible for variations in cotton acreage over the period from 1979-80 to 2006-07 in the major growing zones of Sindh and changes therein over the period. To test the hypothesis relating to the factors influencing the farmers acreage allocation, the Nerlove adjustment lagged model has been used. The result of the analysis reveals that in the process of making decisions for cotton cultivation area all the variables (relative profitability, irrigation, price and yield risk, area under plant protection measures, cotton ginning capacity and lagged acreage) are more or less equally important. The cotton growers of all the zones and province responded positively and significantly to the relative profitability. This suggests, that additional income from the crop in the preceding year generally lead to higher investment in cotton acreage in the northern zone, central zone, Thar desert, southern zone and Sindh province. This, in a way, suggests that for a producer, growing competing crops, mainly for family consumption, is of little importance. This lends support to the general view that supply of cash crops is more responsive to price changes than the largely cultivated crops for subsistence[15] needs of the farmers. Even in the case of cotton, the relative profitability varied over zones of the province. It is also revealed that some of the zones have recorded more higher increase in the cotton acreage where the positive impact of both the price and yield variable was more. It supports the widely held view that the profitability is the main concern of farmers while allocating acreage under individual crops.

Irrigation, the potential variable for adoption of modern inputs with positive and significant impact in all zones and the province. This points to the fact that farmers will shift to cotton crops if irrigation is improved.

Being a commercial crop, cotton is highly vulnerable to price level and thereby yields changes. Cotton and readymade garments are main export of Pakistan. If in any year the crop is damaged due to flood or pest attack, the yield of crop deteriorates, and the export declines. In the some years when cotton crops were damaged its effect was felt. The results reveal that cotton farmers appear to be risk-averters (price and yield) rather than the risk takers in their attitudes in most of the zones. The price risk variables in northern zone had no effect on the acreage allocation decisions of farmers as the regression coefficient of this variable was found to be negative but statistically non-significant. Similarly, the yield risk variable in the northern zone and Thar desert had no affect on the acreage allocation decisions of farmers because the coefficient is statistically insignificant.

The cotton growers in Sindh consider and are aware of the effects of plant protection measures. For cotton growers the factory price is attractive[16] and there is significant regulation in the cotton supply to cotton ginning factories in all zones and the province. Cotton lagged acreage is found to be positive and significant in all zones and the province. The main reason for this may be that cotton farmers follow some traditions and do not easily decide to reduce the area under the crop in comparison with the area they sowed in the preceding year. In this connection their own requirements of food, ignorance about determining the appropriate cropping pattern due to illiteracy and the other social and traditional standards adopted by farmers and the lack of suitable competing crops are the possible causes. The coefficient of adjustment is very low (0.14), suggesting that adjustment between the desired and actual level of acreage is low. In other words we can say that various technical, institutional and subjective factors seem to have a great deal of influence on farmers decision regarding the cotton crop in the province.

The adjustment coefficients obtained are in the range of 0.137 for Sindh province and 0.235 for central zone. Thus, both the extreme values are within the assumed range of zero to one. This low rate of adjustment coefficient points out that cotton farmers in Sindh are significantly influenced by institutional and technological constraints while expanding or contracting the areas for cotton crop and the price inducement operate slowly and gradually.

The long-run elasticity with respect to relative profitability is higher than the short-run elasticity in all the zones and the province, for both crops. This means that cotton growers of Sindh have more time to adjust their areas under the crop in the long-run than in the short-run.

Our estimated acreage elasticities with respect to relative profitability in the short and long-run compares favorably with Khan and Iqbal's (Pakistan) estimates. Since no study in Sindh province has been undertaken on this topic for any of the crop, therefore, an exact comparison can not be made.

Finally, it should be noted that the conclusions drawn here are based on the data from 1979-80 to 2006-07. Further, we can say that in the absence of any significant change in the cotton; ginning factory, these conclusions may be still valid. However, further research could be undertaken to investigate whether there is any significant structural change in cotton area after since 2006-07.

POLICY IMPLICATIONS

The results obtained in this study leads to important implications that seems relevant from the point of the policy formulation.

1. The results of the study indicate a positive response of land resource allocation to relative profitability for cotton crop under study. This means that farmers can make adjustments on the acreage allocation under cotton cultivation through manipulation of the relative profitability of cotton and its competing crops. It also means that there exists more potential to increase the production of cotton by increasing their support prices in Sindh. In order to bring about an effective adjustment in acreage allocation, the support prices for various crops must be announced well before the sowing season and the prices thus announced, should carry a long-run guarantee[17]. The imperative need is to secure varietal improvement for minor crops to compete with major crops in terms of stable revenue. Price support for one crop will adversely affect the production of other crops. For example, price support policy for cotton may reduce the production of rice in Sindh. This policy will not only enable farmers to plan their production programmes better but might also help to correct the inter-commodity imbalance to some extent. The result also indicate that the yield per hectare of cotton has to be increased up to the international standard. For this purpose drought resistant and pest resistant high-yield varieties should be developed for different zones. Proper doses of fertilizers, timely supply of irrigation water and latest farm technology are also needed.
2. The study shows that there is a positive association between irrigation and acreage of the crop. It means that farmers of cotton will increase acreage of the crop, if irrigation facilities are improved. Waterlogging and salinity, over exploitation of fresh groundwater, low efficiency in delivery and use, inequitable distribution, unreliable delivery, and insufficient cost recovery are the major problems in Pakistan's irrigation system. Again, there is an inequality in distribution of water within a water course. Farmers at the head get 2 percent more water as compared to middle and tail and inequality in water distribution at the tail ends may vary up to 50 percent. Some farmers at the tail-end do not receive any water in Sindh where powerful feudals and influentials at the head and middle ends use all the water. This is, off-course, done with the connivance of corrupt persons in the irrigation department. Therefore, the irrigation department must be strongly directed to see that there is an equity of water distribution in canals and minors. They should be provided protection from the powerful influentials who often threaten them. The equity of water distribution must be monitored and those found guilty should be punished irrespective of their social status.
3. The coefficient of risk factors registered its negative and significant influence on cotton acreage in most of the zones and the province. Therefore, price and yield risk factors need to be considered to provide necessary incentives to the producers to maintain cotton acreage at the desired levels.
4. The result of the study indicates that cotton growers do not ignore the effects of plant protection measures while allocating the land to the concerned crop. The farmers should apply pesticides to the crop in the required quantity. It is a fact that use of insecticides can increase crop yield by reducing the level of damage caused by insect pests. However, there is a great deal of evidence to suggest that injudicious use of pesticides is responsible for causing irreparable damage to the crop eco-systems through killing crop pollinators, pest predators, and parasitoids, and poison the environment as well. Besides, heavier pesticide applications can accelerate the evolution of resistance or induce new pest problem as natural enemies are depleted. Thus, it is necessary that farmers, as a group, decide whether they would bear some losses now or face more loss at the later stage. This is mainly due to illiteracy of the farmers. So there is a need to educate farmers through adult education programs and training by the government extension and field workers.
5. The study indicates that cotton growing farmers are positively influenced by variations in the factory output. It means that the mill price is attractive to the producer and accordingly they bring their cotton to the cotton ginning factories in large quantity. The cotton ginning factories are required to purchase their cotton at the price announced by the government. The mill owners shall not make the farmers conscious[18]. Trading corporation of Pakistan (TCP) must collect cotton from the start.

ENDNOTES

1. Short-run and long-run price elasticities and related information in some developed and underdeveloped countries are reported in the Appendix, Table 1.
2. A detailed description about the Ecological zones of Sindh is presented in the research report no.13, of Applied Economics Research Centre with the title "A Study of Cropping Pattern in Sindh Province".
3. The analysis is mainly based on the data drawn from various issues of the Development Statistics of Sindh, published by the Government of Sindh and the Agricultural Statistics of Pakistan, published by the Government of Pakistan.
4. The support prices of cotton starts from 1976) spanning from 1979-80 to 2006-07.
5. The price of agricultural commodities plays a vital role in the resource allocation improving farm incomes. The open market price during the immediate post-harvest period is generally depressed particularly in years of bumper harvest. The farmers, in general and small farmers in particular, neither have adequate storage facilities nor sufficient staying power to hold their marketable surplus.
   In order to counter the adverse effects of fluctuating prices, the government has instituted the support price programme for the important crops. The support price acts as minimum guaranteed price for growers and safeguards their interest if the open market price tend to fall during the post harvest. Support price is generally announced before the sowing time. In recommending the support prices to the government the Agriculture Price Commission (APCOM) considers a number of criteria, including cost of production, domestic and world demand and supply situation, market price, international prices and (import and export parity prices).
6. Research workers have preferred to use the Adjustment Lag Model instead of the Traditional Model because it is said to present a more realistic picture by incorporating distributed lags and thereby introduce a realistic assumption about farmers adjustment behavior (if the traditional model adjustment is assumed to be instantaneous). The advantage of such adjustment lag model as claimed by Nerlove is, that, as compared to the traditional model it explains the data better by yielding coefficients, more reasonable in sign and magnitudes, and thereby, provides better estimates of supply elasticities.
7. The proof may be found in Griliches, (1967), op.cit., pp.36-38.
8. For proof see Johanston, (1989), Econometric Methods, (1984), 3rd edition.
9. The prices of cotton/sugarcane are not taken but a measure of relative profitability is used instead, and is used as a variable instead of relative price.

   $$\text{Relative profitability} = \frac{\text{Support price of cotton x per acre yield}}{\text{Support/wholesale price of competing crop(s) x per acre yield}}$$

   See also Kainth and Gupta (1978).
10. Coefficient of variation was used to measure the risk because its distribution is normal and yields statistically unbiased estimates compared with standard deviation which does not follow normal distribution. For details see M.G. Kendall and A. Stuart, 1961, Advanced Mathematical Statistics, London, Charles Griffen and Co.
11. The serial correlation is tested through 'h' statistics and the use of classical Linear Regression Model (CLRM) incorporating the assumption that U_t is distributed identically and independently with zero mean and constant variance (Jaikrishna and Rao, 1967; Swant, 1978).
12. Mahesh Chand, "Agricultural Terms of Trade and Economic Growth", Indian Journal of Agricultural Economics, 1958, pp.191-192. B. Misra and S.P. Sinha, "Agriculture and its Terms of Trade with Special Reference to India", Indian Journal of Agricultural Economics, 1958, 196-197. B.K. Madan, "Presidential Address", Proceedings of the Eighteenth Conference of the Indian Society of Agricultural Economics, 1958, pp.13-14. Walter C. Neale, "Economic

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The last three references contain very pointed opinion in favor of negligible or negative supply response.

13. Zone/District-wise area under plant protection measures was not available, therefore this variable is taken only for the province.
14. The ginning operation produce ginned or raw cotton/and cotton seed. When picked from the field, the raw cotton usually contains lint, hulls, some leaves and other material which must be removed before lint is separated from the seed. Both, cleaning and ginning are mechanically. The dried seed and cotton lint is separated either manually or by a suction system conveyed to the cleaning machines. In Pakistan, there are two types of cleaners attached to the ginning machines: (1) Feeder Extractor and Cleaner (FEC), and (2) Willow. The main function of these machines is to feed the seed cotton into the gin-stands at uniform rate. Secondly, it performs the function of fluffing up the seed cotton for ginning and at the same time extract foreign matter from the seed cotton. The ginning process may either be roller-ginned or saw-ginned. In a roller the main components are: (a) a fixed knife, (b) moving knife, and (c) leather roller. The seed cotton is fed into the gin-stand manually. The moving knife with a vertical action against the fixed knife shaves the cotton fibre from the seed. The cotton is then engaged by the revolving leather rollers, which carry it and drop it in front of the gin. One single roller-gin has a capacity to produce about 25 Lbs. of lint per hour, while a double roller may produce upto 80 lbs.
15. In our earlier studies of rice and wheat acreage response the short-run and long-run relative profitability/price elasticities were +0.208 and +0.635 and +0.218 and +0.386, respectively.
16. In the year 2000 the cotton farmers in Sindh faced many problems in selling their cotton to Ginning factories, because the ginners did not maintained the price which the government announced before the sowing of the crop. The cotton farmers had to bear much loss because they were compelled to sell their crops at half the price. The reason was the import of raw cotton at less prices as compared to governments announced price.
17. Not like the cotton support price announced by the government in 1999 when the Trading Corporation of Pakistan did not purchase cotton from the growers.
18. In 2000 the Ginning factories were not purchasing cotton at the government announced prices. The cotton growers in Sindh were helpless to sell their cotton at low price.

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APPENDIX

TABLE – 1: ESTIMATED RELATIVE OWN AND CROSS PRICE ELASTICITIES IN SOME DEVELOPED AND UNDERDEVELOPED COUNTRIES AND RELATED INFORMATION

	Author	Province/State/ Region/Country	Crop	Period	Model Used	SRRE (Short-Run Relative Elasticity)	LRRE (Long-Run Relative Elasticity	SROE (Short-Run Own Elasticity)	LROE (Long-Run Own Elasticity)	SRCE (Short-Run Cross Elasticity)	LRCE (Long-Run Cross Elasticity)	Method of Estimation
1.	Nerlove (1958)	USA	Cotton Wheat	1909-32 1909-32	Nerlove adjustment lag-model	0.34 0.48	0.67 0.93					OLS
2.	DeCanio (1971)	USA	Cotton	1882-1914	Nerlove adjustment lag model	0.08 to 0.34	0.23 to 0.85					Logarithmic
3.	Read and Riggins (1981)	England	Corn	1960-79	Multiple regressions model			0.34 to 0.54	0.93 to 2.07	–0.54 to –1.00	–1.78 to –4.17	SUR
4.	Revell (1974)	England	Potato	1957-70	Simple Acreage Model			0.1 to 0.2	0.14 to 0.43	–0.21 to –0.07	–0.20 to –0.12	OLS
5.	Frederik (1969)	Uganda	Cotton	1922-38	Simple Price Model			0.25		–0.31		OLS
6.	Raj Krishna (1963)	Punjab (India) – Pakistan	Cotton (A) Cotton (D) Sugarcane	1922-41 1922-43 1915-43	Nerlove adjustment lag-model	0.72 0.59 0.34	1.62 1.08 0.60					OLS

	Author	Province/State/ Region/Country	Crop	Period	Model Used	SRRE (Short-Run Relative Elasticity)	LRRE (Long-Run Relative Elasticity	SROE (Short-Run Own Elasticity)	LROE (Long-Run Own Elasticity)	SRCE (Short-Run Cross Elasticity)	LRCE (Long-Run Cross Elasticity)	Method of Estimation
7.	Jha (1970)	Bihar (India)	Sugarcane	1950-64	Nerlove adjustment lag-model	0.65	0.79					OLS
8.	Kaul and Sidhu (1971)	Punjab (India)	Wheat Paddy Cotton (D)	1960-69	Nerlove adjustment lag-model	0.24 0.190 0.683	0.151 0.635 1.174					OLS
9.	Parikh (1972)	Uttar Paradesh (India)	Sugarcane	1900-39	Nerlove adjustment lag-model	0.399	0.906					OLS 2SLS
10.	M.C. Madhawan (1972)	Tamil Nadu (India)	Sugarcane Cotton		Production function	0.63 0.31	0.76 0.54					OLS
11.	Cummings (1975)	Punjab (India)	Cotton	1950-68	Nerlove adjustment lag-model	0.37						OLS
12.	Bapna, Binswanger and Quizon (1984)	India	Wheat Rice Cotton	1955-73	Profit function approach	0.33 0.47 0.70						
13.	S.S. Sang Wan (1985)	Haryana (India)	Sugarcane Cotton (A) Wheat Groundnut	1960-77	Nerlove partial adjustment adaptive expectational model	0.44 0.79 0.25 0.40	-6.29 1.30 0.25 0.46					OLS
14.	Saxena and Khare (1988)	Uttar Pradesh (India)	Groundnut	1950-84	Nerlove adjustment lag-model	0.08 – 0.55						OLS
15.	Stern (1962)	India	Jute	1893-1938	Simple Model	0.68	1.03					OLS
16.	Savadatti and Narappanavar (1996-97	India	Gram	1963-88	Nerlove adjustment lag model	0.02	0.03					OLS
17.	Nowshirvani (1962)	Uttar Paradesh (India)	Rice Wheat	1953-62	Nerlove adjustment lag-model		-0.11 to +0.27 -0.13 to + 0.76					OLS
18.	Falcon (1964)	Pakistan	Cotton Wheat	1933-59	Partial adjustment model	0.40 0.1 to 0.2	-					OLS
19.	Hussain (1964)	East Pakistan (Pakistan)	Rice (Aus only)	1948-63	Simple Regression Model	0.12						OLS
20.	Cummings (1975)	Pakistan	Wheat Cotton (A) Rice	1949-68	Nerlove partial adjustment adaptive expectational model	0.10 0.40 0.12	0.22 0.47 0.17					OLS C–O
21.	Ashiq (1981)	Pakistan	Wheat Rice Cotton Sugarcane	1957-79	Nerlove adjustment lag-model	0.25 0.14 0.12 0.45						OLS
22.	Ahmad (1986-87)	Punjab (Pakistan)	Rice	1952-80	Nerlove adjustment lag-model	0.28	0.53					OLS
23.	Ali (1988)	Pakistan	Cotton Sugarcane	1957-87	Simultaneous equation model			0.71 0.52	1.34 0.81	–0.33 –0.15		GLS
24.	Khan and Iqbal (1992)	Pakistan	Cotton Sugarcane	1956-87	Partial adjustment and expectational model			0.24 0.06	1.70 1.88	–0.17 –0.13	–1.21 –4.40	OLS
25.	Naqvi and Burney (1992)	Pakistan	Wheat Rice Maize		Profit function approach	0.09 0.04 0.07						
26.	Wasim (1996-97)	Sindh (Pakistan)	Sugarcane	1972-93	Nerlove adjustment lag-model	0.216*	1.091					OLS
27.	Ghulam Rabbani (1965	Pakistan – India	Jute	1931-61	Nerlove adjustment lag model	0.40 0.70	0.65 0.74					OLS
28.	Ashiq (1992)	Punjab, Sindh (Pakistan)	Wheat	1975-87	Nerlove partial adjustment model			0.17 0.18	0.46 0.49	–0.19 –0.28	–0.40 –0.58	3SLS

	Author	Province/State/ Region/Country	Crop	Period	Model Used	SRRE (Short-Run Relative Elasticity)	LRRE (Long-Run Relative Elasticity	SROE (Short-Run Own Elasticity)	LROE (Long-Run Own Elasticity)	SRCE (Short-Run Cross Elasticity)	LRCE (Long-Run Cross Elasticity)	Method of Estimation
29.	Tweeten (1986)	Pakistan	Cotton Sugarcane	1963-83	Nerlove adaptive expectation and partial adjustment model	0.10 0.22	0.54 0.70					C – O
30.	Himayatullah (1994)	Pakistan	Cotton Sugarcane	1972-91	Nerlove partial adjustment model			0.65 0.63	1.14 1.05			OLS
31.	Wasim (1997)	Sindh (Pakistan)	Onion	1950-83	Nerlove adjustment lag model	0.38	3.61					OLS
32.	Chaudhry (2000)	Pakistan	Wheat Sugarcane Cotton Rice	–	Nerlove adjustment lag model	0.03 0.04 0.11 1.74	0.10 0.10 0.31 3.07					OLS
33.	J.T. Cummings (1974)	Dacca (Bangladesh)	Rice	1949-68	Nerlove partial adjustment adaptive expectational model			0.13	0.19			OLS
34.	Sultan Rahman (1986)	Bangladesh	Sugarcane Cotton	1972-81	Nerlove adjustment lag-model	0.34 0.14	0.51 0.80					OLS
35.	Jaforullah (1992)	Bangladesh	Sugarcane	1947-81	Partial adjustment model	0.360	0.435					OLS
36.	M. Yunus (1993)	Bangladesh	Rice (Aman) Wheat Cotton Sugarcane Jute	1972-89	Nerlove adjustment lag-model	0.36 0.61 0.16 0.15 0.49	0.55 5.24 0.16 0.73 0.68					OLS
37.	Nosheen and Iqbal (2008)	Pakistan	Cotton Wheat Sugarcane	1971-07 1971-07 1971-07	Nerlove adjustment lag-model			+0.26 +0.04 +0.23	+1.09 +0.10 +0.65			OLS
38.	Khan, Ikram and Kalsoom (2008)	Punjab (Pakistan)	Cotton	1976-02	Nerlove adjustment lag-model			+0.40	+0.63			OLS

A = American
D = Desi
* = Relative profitability

TABLE – 2: TEST OF MULTICOLLINEARITY OF THE EXPLANATORY VARIABLES (BY KLEIN'S RULE) USED IN THE REGRESSION ANALYSIS OF COTTON

Zone/Province	Crop	Total R^2	Partial R^2 (Each explanatory variable as a dependant variable)							
			Relative Profitability	Irrigated Area	Price Risk	Yield Risk	Area Under Plant Protection Measures	Cotton Ginning Capacity	Sugar Production by Factories	Cotton/ Sugarcane Acreage
Northern Zone	Cotton	0.90	>0.40	>0.36	>0.33	>0.46	–	>0.39	–	>0.59
Central Zone	Cotton	0.93	>0.35	>0.26	>0.61	>0.42	–	>0.50	–	>0.48
Thar Desert	Cotton	0.81	>0.46	>0.40	>0.45	>0.45	–	>0.41	–	>0.61
Southern Zone	Cotton	0.85	>0.53	>0.54	>0.49	>0.34	–	>0.59	–	>0.63
Sindh	Cotton	0.89	>0.41	>0.38	>0.52	>0.48	>0.58	>0.45	–	>0.59

Note: Each explanatory variable used as dependant variable, in turn, on other explanatory variables (according to the model type of the Table Equation). If the partial R^2 is greater (>) than the total R^2, then there is harmful multicollinearity of the variable on the other variables. Conversely, (i.e. R^2 total > R^2 partial), the collinearity problem is not serious (see Maddala, 1977). The associated symbol of the explanatory variables, i.e. > indicates that the total R^2 is greater than the partial R^2. All the variables are in natural logarithms.

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