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Economic Efficiency in Rice Farming in Bangladesh

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"Economic efficiencies are estimated through stochastic Cobb-Douglas normalised cost frontiers for Boro, Aus and Aman rice crops using primary data. The study reveals that there are significant economic inefficiency effects in the production of rice in Bangladesh. The estimated average economic efficiency indices for Boro, Aus, Aman and all rice crops are 79, 72, 71 and 75 per cent, respectively. The study also reveals that on the average about 25 per cent cost of production for all rice crops could be reduced keeping the output constant. Farmers of Brahmanbaria region attained the highest economic efficiency followed by those of Dinajpur and Mymensingh regions. Medium farmers attained the highest economic efficiency followed by small and large farms. The farmers with more experience and extension contact tend to be economically more efficient than their counterparts while the farmers with more age and education are economically less efficient."

I. INTRODUCTION

The scarcity of resources has led the production economists to think about the reallocation of existing resources to have more output with given level of input combinations or to produce a prescribed level of output with the minimum cost without changing the production technology. The measurement of the productive efficiency in agricultural production is an important issue from the standpoint of agricultural development exercises in developing countries since it gives pertinent information useful for making

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sound management decisions in resource allocations and for formulating agricultural policies and institutional improvements.

The measurement of the productive efficiency of one firm relative to other firms or to the "best practice" in an industry has long been of interest to agricultural economists. Efficiency measurement has received considerable attention from both theoretical and applied economists. From a theoretical point of view, there has been a spirited exchange about the relative importance of various components of firm efficiency. From an applied perspective, measuring efficiency is important because this is the first step in a process that might lead to substantial resource savings. These resource savings have important implications for both policy formulation and firm management.

In the productive efficiency arena, we are familiar with three types of efficiency, namely technical, allocative and economic. Technical efficiency refers to the ability of a firm to obtain maximal output from a given set of inputs under certain production technology while the allocative efficiency reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. Economic efficiency, a combination of technical and allocative efficiencies, reflects the ability of a production unit to produce a well-specified output at the minimum cost. Efficient firms are more likely to generate higher incomes and thus stand a better chance of surviving and prospering.

This study aims at estimating farm-specific, crop-specific, region-specific and farm size-specific economic efficiency in the production of rice in Bangladesh. It is also designed to test whether there is any significant economic inefficiency in rice production.

This paper is organised in five sections. Section II describes about data and sampling technique, Section III describes model specification and estimation, Section IV deals with results and discussion and some conclusions are drawn in the final section.

II. DATA AND SAMPLING TECHNIQUE

The primary data were collected for the crop year July 1998 to June 1999 for this study. Data from 500 farmers were collected with direct interview method comprising small (below 1 hectare), medium (1-3 hectares) and large (above 3 hectares) farms. Within the sample, 50 percent were small, 30 percent medium and 20 percent large farms. The sampling technique used in this study to select farmers was stratified random sampling technique. The study included three regions, i.e. Brahmanbaria, Dinajpur and Mymensingh. These regions were selected purposively considering their relative importance in producing rice. These regions collectively produce about 16 percent of the total rice in Bangladesh (BBS 1998). Farmers in these regions produce both high yielding varieties (HYV) and local varieties (LV) of Boro, Aus and Aman rice*. The data were collected by the trained enumerators. After the collection of data all questionnaires were rechecked to avoid any mistakes and the collected data were edited and coded accordingly.

III. MODEL SPECIFICATION AND ESTIMATION

The economic efficiencies are estimated for all regions, for all rice crops and for different farm-size groups with the help of stochastic Cobb-Douglas normalised cost frontier functions. For *Boro* rice, cost function was normalised with fertiliser price, and for *Aus* and *Aman* rice cost functions were normalised with seed price. We used the input prices to normalise the cost function to make it compatible with the theory of cost function. Since the Cobb-Douglas cost function is linearly homogeneous in input prices, we have to normalise it before its estimation. It makes no difference, economically or statistically, which price is used to normalise the cost function (Schmidt and Lovell 1979). The stochastic Cobb-Douglas normalised cost frontier function is given below:

* Local names

$$\ln (C_i/P_{fi}) = \beta_0 + \beta_1 EDU + \beta_2 EXT + \beta_3 \ln(AGE) + \beta_4 \ln (EXPERIENCE) + \beta_5 \ln (Q_i) + \beta_6 \ln (W_i/P_{fi}) + \beta_7 \ln (P_{si}/P_{fi}) + \beta_8 \ln (P_{bi}/P_{fi}) + \beta_9 \ln (C_{ii}/P_{fi}) + \beta_{10} \ln (R_{li}/P_{fi}) + (V_i+U_i) \quad \textbf{(1)}$$

where C_i is the observed cost of production for the ith firm;
EDU, EXT, AGE and EXPERIENCE are respectively education, extension service, age and experience of farm operators;
Q_i is the output quantity (kg) for the ith farm;
P_{fi} is the price of fertiliser per kg for the ith farm;
W_i is the wage rate for the ith farm;
P_{si} and P_{bi} are price of seed and bullock power for the ith farm, respectively; and
C_{ii} and R_{li} are cost of irrigation and rent of land per hectare for the ith farm, respectively.
U is a non-negative cost inefficiency effect which is assumed to have a half-normal distribution;
V is a random variable which is assumed to be independently and normally distributed with 0 mean and constant variance σ_v^2.

We may note that the inefficiency effect, U, is added in the cost frontier, instead of being subtracted, as in the case of the production frontier. This is because the cost function represents minimum cost, whereas the production function represents maximum output. The Us provide information on the level of the cost efficiency or overall economic efficiency (EE_i) of the ith farm.

The parameters of the cost frontier of equation (1) can be estimated by using standard econometric methods since the output and prices of inputs are assumed to be exogenously determined. Schmidt and Lovell (1979) showed that the stochastic cost frontier can be estimated in a similar manner to the stochastic production frontiers using either ML or COLS estimators.

Cost frontier (1) has been applied for *Boro* rice, for *Aman* and *Aus* rice. The corresponding stochastic cost frontier is given below :

$$\ln(C_i/P_{si}) = \beta_0 + \beta_1 EDU + \beta_2 EXT + \beta_3 \ln(AGE) + \beta_4 \ln(EXPERIENCE) + \beta_5 \ln(Q_i) + \beta_6 \ln(W_i/P_{si}) + \beta_8 \ln(P_{bi}/P_{si}) + \beta_{10} \ln(R_{li}/P_{si}) + (V_i+U_i) \quad \textbf{(2)}$$

Here cost function has been normalised with seed price. All the variables are defined as earlier.
Now we can write economic inefficiency effect model as below :

$$U_i = \delta_0 + \delta_1 AGE_i + \delta_2 EDU_i + \delta_3 EXPERIENCE_i + \delta_4 CONTACT_i + \delta_5 FARMSZ_i + Wi \quad \textbf{(3)}$$

All the variables of model (3) are defined as earlier.
CONTACT represents extension contact by the extension agents to the farmers;
FARMSZ represents farm size; and
the W_i are unobservable random variables, which are assumed to be independently distributed with a positive half normal distribution.

The β and δ coefficients are unknown parameters to be estimated, together with the variance parameters which are expressed in terms of

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \quad \textbf{(4)}$$

and

$$\gamma = \sigma_u^2 / \sigma^2 \quad \textbf{(5)}$$

Where the γ-parameter has a value between zero and one. The parameters of the stochastic cost frontier models are estimated by the maximum likelihood method, using the computer program, FRONTIER Version 4.1.

It is important to note that the model for the inefficiency effects (3) can only be estimated if the inefficiency effects are stochastic and have a particular distributional specification. Hence there is interest to test the null hypotheses that the inefficiency effects are not present, $H_0 = \gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$; the inefficiency effects are not stochastic, $H_0 = \gamma = 0$; and the coefficients of the variables in the model for the inefficiency effects are zero, $H_0 : \delta_1 = \delta_2 = ... = \delta_5 = 0$. These and other null hypotheses of interest are tested by using the generalised likelihood ratio (LR) test and t-test. The generalised likelihood ratio test is a one-sided test since γ can not take negative values. The test statistic is calculated as

$$LR = -2\{\ln [L(H_0)/L(H_1)]\} = -2\{\ln [L(H_0)] - \ln [L(H_1)]\} \quad (6)$$

Where, $L(H_0)$ and $L(H_1)$ are the values of the likelihood function under the null and alternative hypotheses, H_0 and H_1, respectively.

Economic efficiency or cost efficiency of a farmer is defined as the ratio of frontier minimum cost to the observed cost. Given the specifications of the stochastic frontier model (1) - (3), the economic efficiency of the ith farmer can be shown to be equal to

$$\begin{aligned} EE_1 &= \exp(-U_1) \\ &= \exp\{-E(U_1/\varepsilon_1) \\ &= 1 - E(U_1/\varepsilon_1) \end{aligned} \quad (7)$$

Thus the economic efficiency of a farmer is between zero and one and is inversely related to the inefficiency effect. The farm-specific efficiencies are predicted using the predictor that is based on the conditional expectation of U_1 given composed error $\varepsilon_i = (V_i + U_i)$.

Farm-specific estimates of economic inefficiency, U (subscripts can safely be omitted here), can be obtained by using the expectation of the inefficiency term conditional on the estimate of the entire composed error term, as suggested by Jondrow *et al.* (1982) and Kalirajan and Flinn (1983). One can use either the expected value or the mode of this conditional distribution as an estimate of U :

$$E(U/\varepsilon) = \sigma_* \left[\frac{f\left(\varepsilon\lambda/\sigma\right)}{1-F\left(\varepsilon\lambda/\sigma\right)} - \left(\frac{\varepsilon\lambda}{\sigma}\right)\right] \quad \textbf{(8)}$$

where f and F are, respectively, the standard normal density and distribution functions, evaluated at $\varepsilon\lambda/\sigma$, $\sigma_*^2 = \sigma_u^2\sigma_v^2/\sigma^2, \lambda = \sigma_u/\sigma_v$ and $\sigma^2 = \sigma_u^2 + \sigma_v^2$.

The mean economic efficiency can be defined by

$$\text{Mean E.E.} = E[\exp\{-E(U_1/\varepsilon_1)\}] = E\{1-E(U_1/\varepsilon_1)\} \quad \textbf{(9)}$$

Because the individual efficiencies of sample farms can be predicted, an alternative estimator for the mean efficiency is the arithmetic average of the predictors for the individual economic efficiencies of the sample farms. With the help of the FRONTIER programme the parameters of the stochastic frontiers (1) and (2) are estimated, together with farm-specific efficiencies and mean efficiency for the farms involved (Coelli, 1996).

The above models have been estimated for three different rice crops, *Boro*, *Aus* and *Aman*, for all farms and for different farm-size groups separately in all regions. The data used in this model are cross-sectional data and sample sizes for *Boro*, *Aus* and *Aman* rice are 490, 82 and 460, respectively.

RESULTS AND DISCUSSION

Measurement of efficiency has two perspectives – theoretical and applied. From a theoretical perspective, there has been a spirited exchange about the relative importance of various components of firm efficiency (Leibenstein 1966, 1977; Comanor and Leibenstein 1969; Stigler 1976). From an applied perspective, measuring efficiency might lead to substantial resource savings. These resource savings have important implications for both policy formulation and firm management (Bravo-Ureta and Rieger 1991).

The estimated results suggest that the coefficients of education and age are significantly negative for all rice crops in the cost frontiers. For *Boro* rice, the coefficients of experience, output, wage, irrigation cost and land rent are positive and significant in the stochastic cost frontier. In the economic inefficiency effect model, the coefficients of age and farm size are significantly positive, indicating that the economic inefficiency effect increases with the increase in age and farm size. It implies that the economic efficiency has an inverse relationship with age and farm size. The coefficients of experience and extension contact are found to be negative and significant which means that the economic inefficiency effects dilute with the increase in experience of farmers and with high extension contact with farmers (Table A1 in appendix).

For *Aus* rice, the coefficient of land rent is positive and significant in the cost frontier. In the economic inefficiency effect model, the coefficients of age and farm size are positive and significant while the coefficient of extension contact is significantly negative.

The coefficient of land rent is positive and significant in the cost frontier for *Aman* rice. The coefficients of age, education and farm size are found to be positive and significant while the coefficient of extension contact is significantly negative in the economic inefficiency effect model for *Aman* rice.

The significant value of γ indicates that there are significant economic inefficiency effects in the production of *Boro, Aus*, and *Aman* rice crops (Table A1 in appendix).

Simultaneously estimated ML estimates of region-specific stochastic Cobb-Douglas normalised cost frontiers and economic inefficiency effect models for *Boro* rice suggests that the coefficients of education, age and irrigation cost are significantly negative while the coefficients of bullock power and land rent are found to be significantly positive in Brahmanbaria region. In the economic inefficiency effect model, the coefficient of age is significantly positive. It means longer the age of farmers, more the economic inefficiency effect. In other words, younger farmers have less economic inefficiency than elders. The coefficient of experience is negative and significant, implying that the economic inefficiency effect reduces as the experience of farmers increases (Table A2 in appendix).

In Dinajpur region, the coefficients of experience, output and land rent are positive and significant but the coefficients of education and age are found to be significantly negative in the cost frontier, while the coefficient of age is positive and significant. However, the coefficients of extension contact and farm size are negative and significant in the inefficiency effect model.

In the cost frontier in Mymensingh region, the coefficients of experience, output, wage rate and land rent are positive and significant while the coefficients of education and bullock power are significantly negative. In the economic inefficiency effect model, the coefficients of education and farm size are significantly positive. It indicates that the economic inefficiency effect increases with the increase in the magnitudes of these variables. The coefficient of experience is significant with the expected negative sign (Table A2 in appendix).

The generalised likelihood-ratio statistic to identify the presence of economic inefficiency effects in the production of different rice crops suggests that there are significant economic inefficiency effects in the production of all rice crops in all regions. (Table A3 in appendix).

The generalised likelihood-ratio test statistic to detect the presence of economic inefficiency effects in the farm-size-specific stochastic Cobb-Douglas cost frontiers for all rice crops identifies that in the production of *Boro* and *Aman* rice crops there are significant economic inefficiency effects in all farm size groups. For *Aus* rice, there is no significant economic inefficiency effect in small farms but it is significant in medium and large farms (Table A4 in appendix).

The frequency distributions of economic efficiency estimates for *Boro*, *Aus* and *Aman* rice from the stochastic Cobb-Douglas frontiers reveal that only about 3% of *Boro* rice farmers had observed costs of production close to the frontier minimum cost (economic efficiency is 90% to 100%) while that of others lies above the frontier minimum cost. For *Aus* rice, there are only about 2% of sample farmers whose observed costs are very close to the frontier minimum cost. For *Aman* one farmer out of 460 farmers is found to have observed cost close to the frontier minimum cost.

The average economic efficiencies for *Boro*, *Aus* and *Aman* rice in all regions are 79, 72, and 71 per cent, respectively. The mean economic efficiency for all rice crops in all regions is 75%. The mean economic efficiencies for Brahmanbaria, Dinajpur and Mymensingh regions for all rice crops are 80, 75 and 70 per cent, respectively. It is obvious that the highest economic efficiency is observed for *Boro* rice in all regions followed by *Aus* rice and *Aman* rice. Similarly, the highest economic efficiency is observed in Brahmanbaria region for all rice crops followed by Dinajpur region and Mymensingh region (Table 1).

Table-1: Region-Specific Economic Efficiency Estimates from Stochastic Cobb-Douglas Cost Frontiers.

Region	Crops			
	Boro	***Aus***	***Aman***	**All crops**
Brahmanbaria	92 (197)	70 (72)	69 (163)	80 (432)
Dinajpur	68 (193)	77 (10)	82 (199)	75 (402)
Mymensingh	76 (100)	-	65 (98)	70 (198)
All	79 (490)	72 (82)	71 (460)	75 (1032)

Figures in the parentheses indicate sample sizes.

The crop-specific and farm-size-specific economic efficiency estimates reveal that the economic efficiency is the highest for medium farms (80%) followed by small farms (75%) and large farms (71 per cent). It is obvious that medium sized farmers are the most efficient and achieve maximum economic efficiencies for all rice crops (Table 2).

Table-2: Crop-Specific and Farm-Size-Specific Economic Efficiency Estimates from Stochastic Cobb-Douglas Cost Frontiers

Farm Size	Crops			
	Boro	***Aus***	***Aman***	**All crops**
Small	80 (243)	85 (34)	70 (229)	75 (506)
Medium	86 (148)	67 (27)	75 (139)	80 (314)
Large	70 (99)	70 (21)	71 (92)	71 (212)
All	79 (490)	72 (82)	71 (460)	75 (1032)

Figures in the parentheses indicate sample sizes.

V. SUMMARY OF CONCLUSIONS

Economic efficiencies are estimated by using stochastic Cobb-Douglas normalized cost frontiers for all rice crops and also for all farm groups in different regions of Bangladesh. There are significant economic inefficiency effects in the production of all rice crops.

The average economic efficiency indices for *Boro*, *Aus* *Aman* and all crops are 79, 72, 71 and 75 per cent, respectively. It indicates that production cost on the average can be reduced by 25 per cent keeping the output constant.

The region-specific economic efficiency indices for Brahmanbaria, Dinajpur, Mymensingh and all regions are 80, 75, 70 and 75 per cent, respectively.

The farm-size-specific economic efficiency indices for small, medium, large and all farm groups are 75, 80, 71 and 75 per cent, respectively.

Medium farmers attained the highest economic efficiency for all crops in all regions.

Experience and extension contact have shown negative impact on the economic inefficiency effect, indicating that experienced farmers and farmers with more extension contact are economically more efficient than their counterparts.

Longer the farm experience and close the extension contact, more the economic efficiency among the farming community.

On the contrary, the age and education have given positive impact on the economic inefficiency effect.

Table A1: Maximum Likelihood (ML) Estimates for Parameters of Stochastic Cobb-Douglas Normalised Cost Frontier and Economic Inefficiency Effect Model *Boro, Aus* and *Aman* Rice

Variables	Parameters	Rice crops		
		Boro	*Aus*	*Aman*
Intercept	β_0	-0.1393357 (0.365222)	0.48056 (0.88409)	0.749115 (0.411309)
Education (EDU)	β_1	-0.00000921* (0.0000046)	-0.0000112** (0.00000148)	-0.0000097* (0.00000078)
Extension (Dummy)	β_2	-0.0037849 (0.0043796)	0.01286 (0.01218)	-0.00248870 (0.00564227)
Age	β_3	-0.3293718** (0.0406014)	-0.29884** (0.08853)	-0.315697** (0.05396)
Experience	β_4	0.8142846** (0.022885)	0.21215 (0.27679)	0.08645 (0.11019)
Output	β_5	0.00000966** (0.00000036)	0.00000178 (0.00000362)	0.000000578 (0.00000138)
Labour price (wage)	β_6	0.2434224** (0.0943733)	-0.007351 (0.10569)	0.049843 (0.054028)
Seed price	β_7	0.00000164 (0.0000081)	-	-
Bullock power price	β_8	0.0936754 (0.0437707)	0.0000000269 (0.00000168)	0.000000073 (0.00000085)
Per hectare irrigation cost	β_9	0.00000159** (0.00000065)	-	-
Per hectare rent of land	β_{10}	0.3276076** (0.0592764)	0.608917** (0.076258)	0.7198295** (0.0279797)
Inefficiency effect model :				
Intercept	δ_0	-0.000000000053 (0.00000000065)	0.007668 (0.565308)	-1.52219 (0.07321)
Age	δ_1	0.00000483** (0.000000447)	0.0000048399 (0.00000172)	0.0000075** (0.00000093)
Education (EDU)	δ_2	0.00000000011 (0.0000000021)	0.219793 (0.22201)	0.964716** (0.04778)
Experience	δ_3	-0.000005293** (0.000000239)	0.00000142 (0.00000223)	0.00000868 (0.00000091)
Extension contact	δ_4	-0.000661** (0.0000562)	-0.00045** (0.000036)	-0.0000667** (0.0000075)
Farm size	δ_5	0.000000000023* (0.00000000001)	0.217822* (0.100999)	0.1348833** (0.0415128)
Variance parameters:				
	σ^2	0.17544** (0.01456)	0.09513** (0.018379)	0.1446007** (0.011042)
	γ	0.440** (0.0627)	0.99999** (0.25866)	0.7190691** (0.015962)
Log likelihood function		-169.34	-18.03	-198.01

**** and * indicate significance at 0.01 and 0.05 probability level, respectively.**
Source : Own estimation.

Table A2: Maximum Likelihood Estimates of Region-Specific Stochastic Cobb-Douglas Normalised Cost Frontier and Economic Inefficiency Effect Model *Boro* Rice
**** and * indicate significance at 0.01 and 0.05 probability level, respectively**

Variables	Parameters	Regions		
		Brahmanbaria	Dinajpur	Mymensingh
Intercept	β_0	1.188266*	0.259055	0.275343
		(0.49627)	(0.390689)	(1.130849)
Education (EDU)	β_1	-0.00000968**	-0.00000916**	-0.0000095**
		(0.00000074)	(0.00000075)	(0.0000012)
Extension (Dummy)	β_2	0.009457	0.006546	-
		(0.00512)	(0.007259)	
Age	β_3	-0.248336**	-0.392366**	0.0022969
		(0.047168)	(0.053442)	(0.009631)
Experience	β_4	·0.772681**	0.892882**	0.550399**
		(0.03505)	(0.026465)	(0.105323)
Output	β_5	0.00000765	0.00001004**	0.00000545**
		(0.00000085)	(0.00000078)	(0.00000165)
Labour price (wage)	β_6	0.164153	-0.127785	0.471001*
		(0.12336)	(0.126229)	(0.214812)
Seed price	β_7	0.0000134	-0.0000026	0.00000386
		(0.00000152)	(0.0000017)	(0.0000031)
Bullock power price	β_8	0.147058**	0.089963	-0.178689*
		(0.057474)	(0.067599)	(0.080201)
Per hectare irrigation cost	β_9	-0.00000267**	-0.0000014	-0.00000057
		(0.00000088)	(0.00000091)	(0.00000136)
Per hectare rent of land	β_{10}	0.256031**	0.277506**	0.532745**
		(0.06876)	(0.080599)	(0.182109)
Inefficiency effect model:				
Intercept	δ_0	-0.000000058	-8.446079	-2.100383**
		(0.000000035)	(5.064291)	(0.411271)
Age	δ_1	0.00000399**	0.0000361*	0.0000104
		(0.00000123)	(0.0000172)	(0.000058)
Education (EDU)	δ_2	0.0000000325	4.7337988	0.878556**
		(0.00000022)	(2.5370424)	(0.262233)
Experience	δ_3	-0.00000122**	0.0000543	-0.0000119**
		(0.000000401)	(0.0000281)	(0.0000037)
Extension contact	δ_4	-0.000000054	-0.0000098*	-0.0000657
		(0.000000044)	(0.0000048)	(0.0000542)
Farm size	δ_5	-0.000000011	-1.573615*	0.567059**
		(0.000000012)	(0.688258)	(0.202622)
Variance parameters:				
	σ^2	0.171*	1.3292*	0.0992**
		(0.0831)	(0.5989)	(0.0115)
	γ	0.642*	0.9625**	0.0554
		(0.3202)	(0.0185)	(0.3977)
Log likelihood function		-9.79	-43.44	-20.28

Source: Own estimation.

Table A3: Test of Hypotheses for Coefficients of the Explanatory Variables for the Economic Inefficiency Effects in the Cobb-Douglas Stochastic Frontier Normalised Cost Functions.

Null Hypothesis	Log-likelihood value	Test statistic LR	Critical value	Decision
$H_0: \gamma = \delta_0 = \delta_1 = .. = \delta_5 = 0$ All regions,				
Boro	-169.34	34.94	12.02	Rejected
Aus	-18.03	21.04	12.02	Rejected
Aman	-198.02	235.49	12.02	Rejected
Region-Specific *Boro* rice :				
Brahmanbaria	-9.79	14.21	12.02	Rejected
Dinajpur	-43.44	52.54	12.02	Rejected
Mymensingh	-20.28	26.79	12.02	Rejected
Aman rice :				
Brahmanbaria	-60.04	73.76	120.2	Rejected
Dinajpur	-45.82	108.59	12.02	Rejected
Mymensingh	-23.64	47.22	12.02	Rejected

Source: Own estimation.

Table A4: Test of Hypotheses for Coefficients of the Explanatory Variables for the Economic Inefficiency Effects in the Stochastic Cobb-Douglas Frontier Normalised Cost Functions

Null Hypothesis	Log-likelihood value	Test statistic LR	Critical value	Decision
$H_0: \gamma = \delta_0 = \delta_1 = \ldots = \delta_5 = 0$				
Boro rice :				
Small farm	-35.88	18.89	12.02	Rejected
Medium farm	-61.41	21.02	12.02	Rejected
Large	-28.19	13.24	12.02	Rejected
Aus rice :				
Small farm	-7.79	0.44	12.02	Accepted
Medium farm	3.92	12.76	12.02	Rejected
Large	12.01	28.18	12.02	Rejected
Aman rice :				
Small farm	-100.54	111.77	12.02	Rejected
Medium farm	-34.07	85.96	12.02	Rejected
Large	-6.16	95.02	12.02	Rejected

Source: Own estimation.

Table A5: Frequency Distribution of Economic Efficiency (E.E.) Estimate from Stochastic Cobb-Douglas Frontiers.

Efficiency level (%)	Crops		
	Boro	*Aus*	*Aman*
35-40	1 (0.2)	1 (1.22)	2 (0.44)
40-45	2 (0.41)	0	2 (0.44)
45-50	1 (0.20)	2 (2.44)	2 (0.44)
50-55	1 (0.20)	3 (3.66)	8 (1.74)
55-60	1 (0.20)	6 (7.32)	16 (3.48)
60-65	3 (0.61)	4 (4.88)	49 (10.65)
65-70	13 (2.66)	8 (9.76)	72 (15.65)
70-75	42 (8.58)	10 (12.20)	107 (23.25)
75-80	153 (31.22)	19 (23.16)	117 (25.43)
80-85	189 (38.57)	20 (24.38)	66 (14.35)
85-90	71 (14.49)	7 (8.54)	18 (3.91)
90-95	13 (2.66)	2 (2.44)	1 (0.22)
95-100	0	0	0
Total numbers of farms	490 (100)	82 (100)	460 (100)
Mean Efficiency	79	72	71
Minimum Efficiency	38	39	35
Maximum Efficiency	93	92	90

Figures in the parentheses indicate percentage.
Source : **Own estimation.**

REFERENCES

Bangladesh Bureau of Statistics (BBS) (1998). Statistical Year Book of Bangladesh, Dhaka, Government of Bangladesh.

Bravo-Ureta, B.E. and L. Rieger (1991). "Dairy Farm Efficiency Measurement Using Stochastic Frontiers and Neoclassical Duality", American Journal of Agricultural Economics, 73(2): 421-428.

Coelli, T. J. (1996). "A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic-Frontier Production and Cost Function Estimation". CEPA Working Paper 96/07, Department of Econometrics, University of New England, Armidale, NSW, 2351, Australia.

Comanor, W.S. and H. Leibenstein (1969). "Allocative Efficiency, X-Efficiency and the Measurement of Welfare Losses", Economica, 36: 404-9.

Jondrow, J., C.A.K. Kovell, I.S. Materov and P. Schmidt (1982). "On the Estimation of Technical Efficiency in the Stochastic Frontier Production Function Model", Journal of Econometrics, 19: 233-238.

Kalirajan, K. P. and J. C. Flinn (1983). "The Measurement of Farm Specific Technical Efficiency", Pakistan Journal of Applied Economics, 2: 167-180.

Leibenstein, H. (1996). "Allocative Efficiency vs 'X-Efficiency' ", American Economic Review, 56: 392-415.

Leibenstein, H. (1977). "X-Efficiency, Technical Efficiency and Incomplete Information Use: A Comment", Economic Development and Cultural Change, 25: 311-16.

Rahman, K. M.M. (2002). "Measuring Efficiency of Producing Rice in Bangladesh – A Stochastic Frontier Analysis." A Published Ph.D. Thesis, Wissenschaftsverlag Vauk Kiel KG Postfach 4403, 24043 Kiel, Germany.

Schmidt, P. and C.A.K. Lovell (1979). "Estimating Technical and Allocative Inefficiency Relative to Stochastic Production and Cost Frontiers", Journal of Econometrics, 9: 343-366.

Stigler, C. J. (1976). "The existence of X-Efficiency", American Economic Review, 66: 213-26.

Is Pakistan's Crop Sector Optimal: A Test Using LP Model

By

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The special case of the LP model, with restriction imposed on areas under Pakistan's 14 major crops to remain within a 50% plus-and-minus range, suggested that an economically feasible sustained growth in agriculture would require expansion in areas under 6 crops (wheat, basmati and Irri rice, sorghum, rapeseed and onion), contraction in areas under 6 crops (sugarcane, maize, barley, gram, mung and potato) and staying with the same areas under 2 crops (cotton and millets). The models further recommended that growers be educated for gradual adoption of the above said sustainable cropping pattern alongwith continuing efforts for identifying and inclusion of new and non-traditional crops capable of expanding Pakistan's existing cropping pattern on a pure economically feasible basis.

Introduction

The analysis of cropped area in Pakistan reveals that there are only 14 major crops, which occupy almost four-fifth of total cropped area (Table 1). The remaining one-fifth of Pakistan cropped area is allocated to numerous other crops, vegetables and orchards. These major crops include wheat, basmati and IRRI rice, maize, sugarcane, cotton, mung, millets, sorghum, onion, potato, barley, gram and rapeseed.

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These 14 crops appear to have been a part of Pakistan's cropping pattern since long. However, with the exception of a few recent studies (Arifullah, 2007; Hassan, Ahmad, Akhter and Aslam, 2003; Ishaq and Chishti, 2004; Khaliq, 2001), there is little literature available wherein Pakistan's major crops were found tested for their economic feasibility. With the understanding that economic feasibility of individual crops would provide stability to the existing cropping pattern and encourage sustained development in Pakistan agriculture. This research paper attempts to test whether the existing cropping pattern, consisting of 14 above named crops, is economically feasible versus the situation where modern practices based on new/recommended technology are adopted. *Linear Programming* (LP) modeling technique (Taha, 2007; Hillier and Lieberman, 1995; Bhatti and Bhatti 2002) has been used, with different formulations, to analyze the situation and pursue the objectives discussed.

Table-1: Pakistan's Major Agricultural Crops

(Area in '000'Hectares)

Crops	**2000-01**	**2002-03**	**2005-06**
Wheat	8181	8034	8448
Rice: Basmati	1158	1377	1659
IRRI + Others	1218	848	750
Cotton	2928	2794	3103
Maize	944	935	1028
Sugarcane	961	1100	907
Gram	905	963	1029
Mung	219	258	209
Millet	390	349	441
Sorghum	354	338	254
Onion	106	108	149
Potato	102	116	117
Barley	113	108	90
Rapeseed	272	281	217
Total Area:	17851 (81%)	17609 (81%)	18401 (80%)
Cropped area	22040	21850	23130

Source: Agricultural Statistics of Pakistan 2005-06, Ministry of Food, Agriculture and Livestock, Islamabad

Methodological Framework/LP Model

Like all other producers, crops growers try to maximize their total profits obtained from the pieces of land holdings allocated to various crops during the year. While doing so, growers are not free of constraints; they have limited land holdings, which they have to allocate to various crops depending upon the profitability or net revenues of each crop. Allocation of areas to various crops is further limited to the availability of various inputs or factors of production like manual labour, animal power, mechanical power, inorganic and organic fertilizers, pesticides, irrigation water and funds required for the needed inputs and operations involved. Mathematical programming and more specifically, the linear programming (LP) techniques specify the abovesaid growers' behavior into the following LP model:

Maximize $Z = CX$ (1a)

Subject to $AX \leq B$ (1b)

$X_i \geq 0$ (1c)

Where Z = net revenues from all crops

$C = c_1, c_2, c_3 \ldots\ldots c_n$ (profit from unit area allocated to each crop)

$X = x_1, x_2, x_3 \ldots\ldots x_n$ (areas to be allocated to each crop)

A = technology matrix (containing technology coefficients a_{ij})

B = constraints b_i (maximum values of each constraint)

In the above model, A is a M x N matrix, B is a M x 1 vector and C is a N x 1 vector and the values of their elements are known in the sense that researchers have to provide such values. The elements of vector X are unknown and the LP model uses *Simplex Algorithm* to solve for the values.

In addition, the estimated model computes value of the objective function Z and also provides shadow prices for the constraints, which have very important implications for practical purposes and policy guidance (Taha, 2007; Hillier and Lieberman, 1995; Bhatti and Bhatti 2002). The above said Model 1 (a,b,c) is a general Linear Programming Model. However we felt the need to modify this model to enable it to generate the results as per our stated objectives. For this purpose, we changed condition (1c) only, replacing it with the following one.

$$0.50\, x_i \leq X \leq 1.50\, x_i \qquad (1d)$$

The restriction imposed in (1c) allows the X-variable, representing the areas to be allocated to various crops, to fluctuate between zero and infinity, while new restriction (1d) allows areas to fluctuate between a 50% plus and minus range, and consequently no crop completely drops from the model. The beauty of this new restriction is that it helps researchers to suggest changes for a gradual and sustained growth, implemented over a 5 – 10 years period.

The data on costs, net revenues and inputs use were collected for the year 2003-04. These data were further modified to provide the needed values of elements of vector C, matrix A and vector B of Model 1 (a, b & d)[2]. Putting the needed values, LP Model 1 (a, b & d) adopts the following specific form:

$$\text{Maximize } Z = 8266.75X_{wt} + 23694.30X_{br} + 14355.29X_{ir} + 9213.94X_{cn}$$

$$+ 16680.90X_{se} + 3490.87X_{me} + 5052.21X_{sm}$$

$$+ 4112.98X_{mt} + 2266.42X_{by} + 1255.04X_{gm}$$

$$+ 763.66X_{mg} + 10940.72X_{rd} + 48620.85X_{po}$$

$$+ 69537.09X_{on}$$

$$\text{Subject to: } 42.35X_{wt} + 41.83X_{br} + 44.25X_{ir} + 78.32X_{cn} + 87.42X_{se}$$

$+ 38.31X_{me} + 25.50X_{sm} + 23.40X_{mt} + 16.60X_{by}$

$+ 18.30X_{gm} + 19.15X_{mg} + 21.70X_{rd} + 147.62X_{po}$

$+ 104.18X_{on} \leq 708.93$ **(Human Labour)**

$0.00X_{wt} + 0.00X_{br} + 7.41X_{ir} + 0.00X_{cn} + 10.75X_{se} + 0.00X_{me}$

$+ 0.00X_{sm} + 0.00X_{mt} + 0.00X_{by} + 0.00X_{gm} + 0.00X_{mg}$

$+ 0.00X_{rd} + 2.77X_{po}$

$+ 0.00X_{on} \leq 20.93$ **(Animal Power)**

$15.69X_{wt} + 9.21X_{br} + 10.01X_{ir} + 22.95X_{cn} + 25.25X_{se}$

$+ 9.74X_{me} + 3.94X_{sm} + 3.94X_{mt} + 3.94X_{by} + 5.60X_{gm}$

$+ 3.94X_{mg} + 5.12X_{rd} + 15.55X_{po}$

$+ 15.77X_{on} \leq 150.65$ **(Tractor Hours)**

$95.73X_{wt} + 34.36X_{br} + 67.62X_{ir} + 107.49X_{cn} + 236.89X_{se}$

$+ 99.19X_{me} + 79.11X_{sm} + 65.32X_{mt} + 44.10X_{by}$

$+ 15.15X_{gm} + 21.21X_{mg} + 49.08X_{rd} + 186.99X_{po}$

$+ 141.89X_{on} \leq 1244.13$ **(N-fertilizer)**

$52.24X_{wt} + 22.12X_{br} + 37.07X_{ir} + 56.84X_{cn} + 172.67X_{se}$

$+ 59.44X_{me} + 49.01X_{sm} + 35.88X_{mt} + 20.20X_{by}$

$+ 23.24X_{gm} + 21.01X_{mg} + 26.84X_{rd} + 148.31X_{po}$

$+ 48.88X_{on} \leq 773.75$ **(P-fertilizer)**

$0.00X_{wt} + 0.00X_{br} + 0.00X_{ir} + 0.00X_{cn} + 0.00X_{se} + 0.00X_{me}$

$+ 0.00X_{sm} + 0.00X_{mt} + 0.00X_{by} + 0.00X_{gm} + 0.00X_{mg}$

$+ 0.00X_{rd} + 80.31X_{po}$

$+ 45.52X_{on} \leq 125.83$ **(K-fertilizer)**

$1103.17X_{wt} + 0.00X_{br} + 593.21X_{ir} + 495.40X_{cn} + 3992.41X_{se}$

$+ 0.00X_{me} + 0.00X_{sm} + 0.00X_{mt} + 0.00X_{by} + 0.00X_{gm}$

$+ 0.00X_{mg} + 0.00X_{rd} + 3564.95X_{po}$

$+ 3586.00X_{on} \leq 13335.14$ **(FYM availability)**

$2.94X_{wt} + 1.81X_{br} + 3.02X_{ir} + 14.82X_{cn} + 8.89X_{se} + 2.47X_{me}$

$+ 0.00X_{sm} + 0.00X_{mt} + 0.00X_{by} + 1.00X_{gm} + 1.00X_{mg}$

$+ 1.00X_{rd} + 9.88X_{po}$

$+ 4.09X_{on} \leq 50.92$ **(Pesticides availability)**

$18X_{wt} + 72X_{br} + 72X_{ir} + 18X_{cn} + 72X_{se} + 28X_{me} + 14X_{sm}$

$+ 14X_{mt} + 14X_{by} + 22X_{gm} + 18X_{mg} + 10X_{rd}$

$+ 44X_{po} + 22X_{on} \leq 438$ **(Water availability)**

$21007.06X_{wt} + 17005.05X_{br} + 19680.83X_{ir} + 29618.09X_{cn}$

$+ 50886.51X_{se} + 15747.52X_{me} + 11492.08X_{sm}$

$+ 10575.30X_{mt} + 9581.19X_{by} + 10250.90X_{gm}$

$+ 9391.08X_{mg} + 10757.89X_{rd} + 64266.07X_{po}$

$+ 37773.92X_{on} \leq 318033.50$ **(Cost constraint)**

$X_{wt} + X_{br} + X_{ir} + X_{cn} + X_{se} + X_{me} + X_{sm} + X_{mt}$

$+ X_{by} + X_{gm} + X_{mg} + X_{rd} + X_{po}$

$+ X_{on} \leq 14.00$ **(Land Constraint)**

$0.50x_i \leq X \leq 1.50x_i$ (2)

Where X_i is area to be allocated with subscripts abbreviated for the name of crops (like wh = wheat; br = Basmati rice; ir = Irri rice; cn = cotton; se = sugarcane; me = maize; sm = sorghum; mt = millets; by = Barley; gm = gram; mg = mung; rd = rapeseed; po = potato & on = onion).

The above said model LP 2 is a special case of the general Linear Programming model specified in Model 1 above. The addition of the last two constraints (land constraint and $0.50x_i \leq X \leq 1.50x_i$ constraint) makes this model different from a general LP model. The 'land constraint', with weight ≤ 14 hectare, imposes restriction how a Pakistani grower, having at his disposal one hectare each for each of the 14 major agricultural crops, would behave while allocating his resources among these commodities. The constraint ($0.50x_i \leq X \leq 1.50x_i$) further restricts to allow areas under crops to fluctuate between a ±50% range of the existing scenario (1 hectare allocated to each crop). This restriction would help to plan and achieve a gradual and sustained growth based on the positive and negative changes, if suggested by the model.

Results and Discussion

The estimation of LP model, specified in (2), yielded the empirical results given in Table 2, with details under sub-headings 'maximized objective function value (Z^*)', 'optimal allocation of crop areas (X^*)', 'slack values of constraints (S^*)' and 'shadow prices of the constraints (Y^*)'; the present values of the variables involved have also been provided in the same table for comparison purposes.

1. The results of LP-2 suggest that the growers' net revenues can increase through reallocating areas under 12 out of the 14 crops under study. Cotton and millets are the two crops, which do not require alteration in areas, while expansion in areas is needed under wheat, Basmati and Irri rice,

sorghum, rapeseed and onion and contraction in areas under sugarcane, maize, barley, gram, mung, and potato. The proposed reallocation of areas under crops would maximize net revenues to Rs.255329 against the present level of Rs.218251 for sowing one hectare to each of 14 commodities. The profits would maximize because of the optimally allocated scarce resources and savings in some of the resources (showing positive slack values).

2. Model further suggests that contributions to the maximized net revenues attributed by human labour, potashic fertilizer and irrigation water (measured in the form of shadow prices) are higher than the market prices of these inputs; hence, the use of such inputs should increase upto certain limits.

3 While the above results are clearly indicative of suggesting the necessity of introducing a planned change in our existing cropping pattern over the next 5 to 10 years, the model still has the limitation of being based on the existing data on input use for only one year period (2003-04), and not based on recommended practices and for several year average data. This shortcoming of the model should be taken into account in future research.

Summary of Conclusions and Recommendations

1. The special case of the LP model applied here differed from the general Linear Programming model; it imposed restrictions on areas under crops to remain within a 50% plus-and-minus range. This restriction was aimed to introduce basis for getting the proposed changes for gradual and sustained growth, instead of a one-time abrupt change, which the general LP model usually suggests. The model, as a whole, performed well in delivering results in accordance with the LP theory and as per the objectives set for the intended study.

2. The results suggest that an economically feasible sustained growth in agriculture would require expansion in areas under 6 crops (wheat, basmati and Irri rice, sorghum, rapeseed and onion), contraction in areas under 6 crops (sugarcane, maize, barley, gram, mung and potato) and staying with the same areas under 2 crops (cotton and millets).

3. The growers should be educated for gradual adoption of aforementioned sustainable cropping pattern. Efforts should also be made for identification and inclusion of some new and non-traditional crops, which expands Pakistan's existing cropping pattern on a pure economically feasible basis.

Table 2: Empirical Results of LP Model 2

Particulars/Variables	*Optimal Values*	Existing Values
Z^*-Maximized profit	Rs.255329.23	Rs.218251.00
X^*-Crop-areaAllocations	*Optimal Values*	**Existing Values**
Wheat	1.50 Hectare	1.00 Hectare
Basmati	1.50 Hectare	1.00 Hectare
Irri	1.30 Hectare	1.00 Hectare
Cotton	1.02 Hectare	1.00 Hectare
Sugarcane	0.50 Hectare	1.00 Hectare
Maize	0.50 Hectare	1.00 Hectare
Sorghum	1.50 Hectare	1.00 Hectare
Millets	0.96 Hectare	1.00 Hectare
Barley	0.50 Hectare	1.00 Hectare
Gram	0.50 Hectare	1.00 Hectare
Mung	0.50 Hectare	1.00 Hectare
Rapeseed	1.50 Hectare	1.00 Hectare
Potato	0.72 Hectare	1.00 Hectare
Onion	1.50 Hectare	1.00 Hectare
S^*-Slack Variables	*Slack Values*	**Total Existing Availability**
Human-Labour	0.00 Man-days	708.93 Mandays
Animal-Labour	3.93 Animal-hours	20.93 Animal-hours
Tractor-	0.47	150.65 Tractor-hours

Hours	Tractor-hours	
N-Fertilizer	41.17 Kgs	1244.13 Kgs
P-Fertilizer	79.84 Kgs	773.75 Kgs
K-Fertilizer	0.00 Kgs	125.83 Kgs
FYM	474.24 Kgs	13335.14 Kgs
Pesticides	3.37 Litres	50.92 Litres
Water	0.00 Hectare-inches	438 Hectare-inches
Cost of Production	Rs.11026.93	Rs.318033.50
Land Constraint	0.00 Hectare	14.00 Hectare
Y*-Shadow Prices	***Shadow Prices***	**Existing Market Prices**
Human-Labour	***Rs.82.17***	Rs.65.00 per man-day
Animal-Labour	0.00	Rs.25.00 per hour
Tractor-Hours	0.00	Rs.250.00 per hour
N-Fertilizer	0.00	Rs.20.00 per nutrient Kg
P-Fertilizer	0.00	Rs.34.00 per nutrient Kg
K-Fertilizer	Rs.372.17	Rs.34.00 per nutrient Kg
FYM	0.00	Rs.1.00 per Kg
Pesticides	0.00	Rs.300.00 per litre (average)
Water	Rs.147.05	Rs.17.56 per hectare-inch (average)
Cost of	0.00	Rs.22716.68 (average/hec)

Production		
Land Constraint	Rs.131.47	Rs.6473.90 (average rent/hec)

Source: Empirical results of LP Model 2

[1] Dr. Shahnaz A. Arifullah and Dr. Ghazal Yasmeen and Dr. Anwar F. Chishti, respectively, are assistant professor and professor at NWFP Agricultural University, Peshawar and Dr. Ghazala Yasmeen is lecturer at Home Economics College, Peshawar University.

[2] The details how these data are modified and used for the stated purposes are available in Arifullah 2007.

REFERENCES

Arifullah, Shahnaz A. (2007). *Pakistan's Crop Sector: An Economic Evaluation.* PhD Thesis, Deaprtmnet of Agricultural Economics, NWFP Agricultural University, Peshawar.

Bhatti, S.A. and N. A. Bhatti (2002). *Operations Research: An Introduction.* Shaharyar Publishers. Lahore.

Govt. of Pakistan (2006). *Agricultural Statistics of Pakistan 2005-06.* Ministry of Food, Agriculture & Livestock, Islamabad.

Hassan, I., B. Ahmad, M. Akhter and M. M. Aslam (2003). Use of linear cropping model to determine the optimum cropping pattern: a case study of Punjab. University of Agriculture Faisalabad, Pakistan.

Hillier, Frederick S. and Gerald J. Liebernman (1995). *Introduction to Mathematical Programming.* McGraw-Hill. New York.

Ishaq, M. and Anwar F. Chishti (2004). *Replacement of Poppy Cultivation with Onion Crop In District Dir: Analyzing Policy Options Through LP Model.* Pakistan Journal of Agricultural Economics. Vol.5. No.1. Agricultural Prices Commission, Islamabad.

Khaliq, Ejaz.(2001*). Optimal Allocation of Land to Various Crops in Thana Malakand Agency.* (unpublished MS Thesis). Dept. of Agricultural Economics, NWFP Agricultural University, Peshawar.

Taha, Hamdy A. (2007). *Operations Research: An Introduction.* 8th Ed., Prentice-Hall of India Private Limited. New Delhi.

IMPACT OF SUPPORT PRICE ON COTTON PRODUCTION IN PUNJAB, PAKISTAN

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"This study makes an effort to determine the relationship between the support price policy and the major variables of the seed cotton production in Pakistan. Time-series data have been utilized for this purpose over a period of 26 years, from 1975-76 to 2001-02. The analysis is carried out by employing Nerlovian Adjustment Model (NAM) for the statistical measures of the impact of support price on cotton production in Punjab, Pakistan. Three single equation specific form models are formulated each with one of the major variables of the cotton production as the dependent variable. The three dependent variables of the analysis include output, yield and area of seed cotton. Alongwith the support price, the set of independent variables also include a few other theoretically relevant exogenous variables. The results are obtained by applying Ordinary Least Squares (OLS) techniques of estimation. No significant relationship of the support price is observed with the output and area of seed cotton. However, significant and positive relationship is observed between the yield and the support price. Finally, the authors recommend that the support price policy of seed cotton in Pakistan needs to be sustained since not only it is directly helping the rural uplift by increasing the households' income in the farm sector, but also warrants for maintaining the comparative advantage of the country, given the contemporary agricultural subsidies regime in the international arena."

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Introduction

Cotton remains the most miraculous fibre under the sun. Its use goes back beyond the records of history. As early as 3000 BC cotton was grown and used in the Indus Valley. Pakistan is one of the major world cotton producer, after China, United States (US), Common Wealth of Independent States (CIS) and India. Cotton not only provides thousands of useful products domestically, but also a major source of foreign exchange earnings of Pakistan. More importantly, it supports millions of jobs in the country while moving from field to fabric. This study attempts to estimate short run and long run price elasticity response of production, area and yield of seed cotton in Punjab, Pakistan, over a period of 26 years, 1975-76 to 2001-02. The analysis is carried out in three parts. Part-I highlights terms of reference of the study. Part-II explains the model applied for analytical formulations of the comparative price impacts. Finally, Part-III presents the results and discussion of major findings.

PART - I

Punjab and Sindh are the cotton producing provinces in Pakistan. Their respective average shares in production are about 81 and 19 per cent. Punjab has the geographical area of 20.63 million hectares of which 12.4 million hectares are cultivated and about 1.6 million hectares is cultivable waste. The total cropped area is 15.8 million hectares, of which irrigated area is 14.09 million hectares including 11.11 million hectares irrigated by government and private tubewells and wells (Agricultural Statistics of Pakistan, 2005-06). The Province offers a variety of soil types and climatic conditions. However, there are two principal crop seasons, Kharif and Rabi[1]. Cotton is the major crop of the Kharif season alongwith rice, sugarcane, maize and millet. It is the largest cash crop which, apart from being the principal raw material of the textile industry, is the major source of foreign

[1] Sowing seasons of the former begin in April-June and harvesting during October-December, while the latter begins in October-December and ends in April-May.

exchange earnings of Pakistan. Hence, the production level of seed cotton in Pakistan not only affects the cotton growers, its implications for macro balances of the country also happen to be very serious.

In the post World War II period, support price has been almost universally employed as one of the most important fiscal policy instruments[1]. The highly controversial Common Agricultural Policy (CAP) of the European Union (EU) is an elaborate system to support the farmers' income through the support of the market price (Bukwell) 1982; Bale and Koster 1990; Christopher 2002). The second largest cotton grower of the world, the USA, considers its farm policy important to national security (Schnepf and Edwin 2001). Similarly, there has always been an extensive use of price supports in Japan (Kaur 1998; Honma 1999). Finally, the largest cotton grower of the world, China has also raised price incentives since the agricultural reforms in 1979 (Baifu and Zhenyu 1987; Hafiz 1993; Alexandratos 1997).

Government of Pakistan has also made efforts to help determine the cotton market outcomes in Pakistan. Government intervention in cotton markets has been typically characterized in one of the three ways, namely, direct control, managed domestic prices and free market prices. During 1980s and 1990s, however, Pakistan mostly practiced the policy of managed domestic prices (Townsend and Gutichounts 1994). The Government of Pakistan had already started fixing the support prices of seed cotton (phutti) and cotton lint in mid 1970s. The Cotton Export Corporation (CEC), established in 1974, enjoyed monopoly in cotton exports till late 1980s when the private sector was again allowed to export cotton. The CEC worked efficiently till 1991-92. Afterwards, due to failure of cotton crop for a

[1] Support price is the guaranteed minimum price meant to provide a floor to the market in the immediate post-harvest period. It is intended to provide a guarantee to the growers that in the event of the market prices falling below the fixed level, the government would purchase all the produce offered by the growers for sale at the fixed price. However, if prices are high, the growers have the option to sell their output in the open market (See, Afzal et al. 1992).

number of years, it purchased just nominal quantities of cotton. As the private sector had already been allowed to export cotton in late 1980s, the CEC was wound up in 1997. The Government did not fix the support price of cotton lint for 1997-98. Also, no public sector organization was nominated to intervene in the market. But good crop of 1999-2000 obliged the Government to revise its policy and it hurriedly fixed the support price of seed cotton and asked the Trading Corporation of Pakistan (TCP) to implement it (Salam 2001).

The findings of many studies show that farmers in Pakistan are responsive to price changes and they accordingly adjust their resources for growing seed cotton (Falcon 1964; Luther 1987; Hudson and Ethridge 1997). It has also been determined that, compared to Sindh, the farmers in Punjab face quite different constraints as they respond to changes in support price. The magnitude of the response co-efficient and the cross effects of other prices were also found to differ significantly, depending on the prevalent cropping pattern of the zone (Pickney 1989).

PART – II

Nerlovian Adjustment Model (NAM) is employed for the statistical measures of the impact of support price on cotton production in Punjab, Pakistan. In its simplest form, NAM can be presented as a single variant linear relationship model of the following form:

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

U_t is the stochastic error term. The left hand side variable, A^*_t is the acreage, farmers would plant in period $_t$ if there were no difficulties of adjustment. However, equation (I) cannot be estimated as A^*_t is not observable. One way out of this impasse is to assume that acreage actually planted in period $_t$ equals acreage actually planted in period $_{t-1}$, plus a term that is proportional to the difference between the acreage farmers would like to plant now and the acreage actually planted in the preceding period. This hypothesis is formulated in the following:

$$A_t - A_{t-1} = \beta(A^*_{t-} A_{t-1}) \qquad 0 \leq \beta \leq \qquad (2)$$

Technological and institutional factors prevent the intended acreage from being realized during a period and the proportionality parameter, **β,** is called the acreage adjustment coefficient.

From equation (2), A^*_t is rewriting in terms of directly observable variables:

$$A_t - A_{t-1} = \beta A^*_t - \beta A_{t-1}$$

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

$$A^*_t = 1/\beta \{ A_t \} - [1-\beta/\beta] A_{t-1} \qquad (3)$$

By substituting the value of A^*_t into equation (1)

$$1/\beta \{ A_t \} - [1-\beta/\beta] A_{t-1} = a + bP_{t-1} + U_t$$

$$A_t = a\beta + b\beta P_{t-1} + \{ 1- \beta \} A_{t-1} + \beta U_t$$

or

$$A_t = a_o + b_o P_{t-1} + c_o A_{t-1} + V_t \qquad (4)$$

Where, $a_o = a\beta$

$b_o = b\beta$

$c_o = (1-\beta)$, **and**

$V_t = \beta U_t$

Additional explanatory variables can be incorporated into the NAM model. For example, if the yield in the previous year Y_{t-1} is included as another explanatory variable, the model simply takes on $c_o\ Y_{t-1}$ as another independent variable:

$$A_t=a_o+b_oP_{t-1}+c_oY_{t-1}+d_oA_{t-1}+V_t \qquad (5)$$

In fact, farmers respond to expected price (P^e_t). The model described so for implies that $P^e_t = P_{t-1}$ which corresponds to only one way of farming expectations. The adaptive expectation model $P^e_t = P^e_{t-1} = \gamma\ [P_{t-} P^e_{t-1}]$ is more flexible and it would coincide with the above rule only if the elasticity of expectations coefficient varies. In the present study, the adaptive expectations are not required since support prices are used which are pre-announced in which case $P^e_t = P_t$. Thus, equation (4) takes on the following form:

$$A_t = a_o + b_oP_t + c_oA_{t-1}+V_t \qquad (6)$$

Nerlovian adjustment model is usually given in the linear form. An alternative way of presenting the NAM is to postulate that the percentage change in the acreage planted is a proportion **β**, of the percentage difference between intended acreage in period $_t$ and actual acreage in the previous period. The model, with price in the previous period as the determinant can be rewritten as:

$$A^*_t = aP^b_{t-1}\ U_t \qquad (7)$$

$$A_t / A_{t-1} = [A^*_t / A_{t-1}]^\beta \qquad 0 \leq \beta \leq 1 \qquad (8)$$

From equation (8),

$$[A_t/A_{t-1}]^{1/\beta} = A^*_t/A_{t-1}$$
$$[A_t/A_{t-1}]^{1/\beta} = \{A_{t-1}\}^{-1}A^*_t$$
$$A^*_t=[A_t]^{1/\beta}\ \{A_{t-1}\}^{1-1/\beta}$$

Substituting equation (7):

$$\mathbf{aP^{b}{}_{t-1}\ U_t=[A_t]^{1/\beta}\{A_{t-1}\}^{1-1/\beta}}$$

$$\mathbf{A_t^{1/\beta} = aP^{b}{}_{t-1}\ U_t\{A_{t-1}\}^{\beta/\beta-1}}$$

or

$$\mathbf{A_t= a^{\beta}\ P^{b\beta}{}_{t-1}\{A_{t-1}\}^{1-\beta}\ U^{\beta}{}_t}$$

Taking log on both sides:

$$\mathbf{\log A_t = \beta\log a+b\beta\log P_{t-1} + [1-\beta]\ \log A_{t-1}+ \beta\log U_t}$$

or

$$\mathbf{\log A_t = \log a_o+b_o\log P_{t-1}+c_o\log A_{t-1}+V_t}$$

This is the logarithmic form of the estimated equation and:

$$\mathbf{\log a_o = \beta \log a}$$

$$\mathbf{b_o = b\beta}$$

$$\mathbf{c_o = 1-\beta}$$

and, $\mathbf{V_t = \beta\log U_t}$

The percentage adjustment differs from the linear adjustment model in assuming that the proportion of disequilibrium, which is eliminated, is smaller. The greater the disequilibrium, the more inclined farmers are to eliminate it (hence, the assumption incorporated in the model is perhaps more realistic as it is likely that the closer producers are to equilibrium, the less there is to learn about it). The economic adjustment measured by **β**, the adjustment coefficient, is the same whether the linear or log-linear formulation is adopted. When **β** is equal to one it means that there are no technological or institutional constraints to prevent the producers from realizing the intended acreage level. Smaller is the **β**, greater is the constraint that these technological and institutional factors place on the producers planned acreage level. The price elasticity can also be calculated within NAM[1].

PART – III

For determining the farmers' supply response to change in the support price of seed cotton, a single equation model is estimated. Since the increase or decrease in production depends upon the changes in area and yield, another two models are estimated to separately determine the responsiveness of each to a change in support price. The logarithmic form of the models is given below:

$$\log QC_t = a_o \log SP_t + a_1 \log FP_{t-1} + a_2 \log PP_{t-1} + a_3 \log WA_t + a_4 \log Cr_t + a_5 \log QC_{t-1} + V_t \quad (1)$$

$$\log YC_t = c_o \log SP_t + c_1 \log FP_{t-1} + c_2 \log PP_{t-1} + c_3 \log WA_t + c_4 \log Cr_t + c_5 \log YC_{t-1} + V_t \quad (2)$$

$$\log AC_t = b_o \log SP_t + b_1 \log FP_{t-1} + b_2 \log PP_{t-1} + b_3 \log WA_t + b_4 \log Cr_t + b_5 \log AC_{t-1} + V_t \quad (3)$$

Where,

QC = Production of seed cotton (1000 tonnes)
AC = Area of seed cotton (1000 hectares)
YC = Yield of seed cotton (kgs per hectare)
SP = Support price of seed cotton (Rs per 40 kgs)
FP = Fertilizer price (Rs per 50 kg bag)
PP = Pesticide price (Rs per litre)
WA = Irrigation water availability in kharif season (million acre feet)
Cr = Credit by all sources (Rs per hectare)

[1] Short-run elasticity is the coefficient b_o, while the formula for calculating the long-run elasticity is calculated as $\mathbf{b_o / \beta}$, i.e. $\mathbf{b_o}$ divided by the coefficient of adjusted variable.

The variable Cr is included in all the three models, keeping in view the importance of credit as a vital tool for raising farmers' productive capacity. Indeed, average farmers are universally in need of credit for having access to pesticides and other agriculture inputs like fertilizers, machinery, etc. All monetary values have been taken in constant market prices in view of inflationary trends.

Utilizing the secondary data available in various issues of both Agriculture Statistics of Pakistan and Economic Survey of Pakistan, regression is run on the log linear variation of the models by applying the Ordinary Least Squares (OLS) method. The results are reported in Table 1 and Table 2. The former lists the estimated coefficients along with $_{t}$- ratios and the coefficient of multiple regression (R^2), while the adjustment coefficients and the short run and long-run own price and other elasticities of supply are given in the latter[1].

The figures reported in Table 1 provide useful insight into the interplay of the factors responsible for change in the dependent variables of the three models. The estimated coefficient of the support price variable, SP_t, carries theoretically right sign in all the three models, but it turns out to be significant only in Equation 2, the yield model with YC_t as the dependent variable. The results show that no significant relationship is observed of the support price with both the level and acreage of seed cotton in Punjab. The success of the support price policy, however, is still underscored by the increase in farmers' incomes, reflected in the positive and significant coefficient of SP_t in Equation 2 (Table 2). In the short run, an increase of one rupee in support price increases farmers' income by 43 paisas. In the long run, the yield impact of one rupee increase in support price is realized in an addition of 52 paisas in the farmers' income from growing seed cotton in Punjab.

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[1] The adjustment coefficient β is derived by subtracting the coefficient of lagged variable from one. The long run elasticity is derived by dividing the short-run elasticity with the adjustment coefficient β.

The estimated coefficients of the fertilizer price variable, FP_{t-1}, carry negative signs in all the three models. Although theoretically relevant signs, the estimated coefficients do not have the scientific validity as all three happen to be insignificant. The positive coefficients of the variable for pesticide price, PP_{t-1}, are significant in two of the three equations, indicating that pesticides happen to be important input for the farmers once they have invested in all the other major inputs. However, the increase in pesticide price is not observed to reduce the farmers' yield, rather it happens to be positively related with the latter, possibly because of relatively smaller share in total input cost and greater benefits in terms of protecting the cotton from the attacks by the pests. Moreover, the estimated coefficients of PP_{t-1}, are relatively small and wide divergence is not observed in Table 2 between the short run and long run elasticity coefficients.

Irrigation water availability, W_t, is the only variable having significant coefficients, with right signs, in all the three models. This is both a valid and expected result which also shows the widest divergence between the short run and long run elasticity estimates listed in Table 2, particularly in Equation 3 where the dependent variable, AC_t, is the area under cotton cultivation.

The coefficients of the credit variable, cr_t, are positive and highly significant for the production and yield models, Equation 1 and Equation 2 respectively.

The coefficient of the multiple regression reported in Table 1, shows a strong relationship between the dependent variable of all three models with the respective independent variables as the size of the R^2 is 0.941, 0.885 and 0.975, respectively.

Finally, all three models were estimated exclusive of 1983-84 when the cotton crop was severely damaged by the attack of cotton leaf curl virus in Punjab. It was observed that by excluding 1983-84, the values of all coefficients generated by regression were higher compared to the values reported in this study.

Table-1: Estimates of Supply Response of Seed Cotton (Punjab: 1976-2002)

No. of observations = 26

Equation 1 Dependent variable QC_t		Equation 2 Dependent variable YC		Equation 3 Dependent variable AC	
Variable	Coefficient	Variable	Coefficient	Variable	Coefficient
Constant	-8.537 (-3.117)***	Constant	-4.817 (-1.978)*	Constant	-0.022 (-0.017)
SP_t	0.404 (1.552)	SP_t	0.431 (1.814)*	SP_t	0.058 (0.501)
FP_{t-1}	-0.046 (-0.199)	FP_t	-0.130 (-0.627)	FP_{t-1}	-0.039 (-0.315)
PP_{t-1}	0.128 (1.790)*	PP_{t-1}	0.152 (2.254)**	PP_{t-1}	0.026 (1.229)
W_t	2.128 (3.221)***	W_t	1.581 (3.054)***	W_t	0.639 (2.098)**
C_t	0.301 (2.652)**	C_t	0.332 (3.242)***	C_t	-0.016 (-0.405)
Q_{t-1}	0.364 (2.186)**	Y_{t-1}	0.184 (1.087)	A_{t-1}	0.633 (2.308)
R^2 = 0.941		**R^2 = 0.885**		**R^2 = 0.957**	

* Significant at 10%
** Significant at 5%
*** Significant at 1%

Table-2: Adjustment Coefficients, Price Elasticity and Other Elasticities

Dependent variable	Adjustment coefficient (β)	Price elasticity		Other elasticities		
		Short-run	Long-run	Variable	Elasticity	
					Short-run	Long-run
Q	0.636	0.404	0.635	FP	-0.046	-0.072
				PP	0.128	0.201
				W	2.128	3.346
				C	0.301	0.473
Y	0.816	0.431	0.528	FP	-0.130	0.159
				PP	0.152	0.186
				W	1.581	1.937
				C	0.332	0.406
A	0.367	0.058	0.158	FP	-0.039	-0.106
				PP	0.026	0.071
				W	0.639	1.741
				C	-0.016	-0.043

Summary of Conclusions and Recommendations

No relationship of the support price is observed with the acreage and production of seed cotton.

However, a positive and significant relationship is observed between yield and support price of seed cotton, which happens to be a very important variable for Pakistan to maintain its edge as one of the major cotton producers in the international market.

The farmers are being compensated all over the world, especially in the developed countries where the welfare transfers by the governments already ensure the provision of basic needs to all citizens.

No such safety nets exist in developing countries like Pakistan. Unless the support price cushion is provided the producer are reluctant to take the risk of high farm investments in the face of uncertain market conditions.

The observed positive and significant relationship between support price and cotton yield in Pakistan more than justifies the support price policy of the country.

The success of the support price policy of the seed cotton is underscored by its positive effect on yield which could be taken as a proxy for increase in the farm sector welfare resulting from higher incomes of the rural households.

In order to secure competitive edge in the international market, it is important that Pakistan's comparative advantage in cotton production is shielded with the support price policy, at least till the time the developed countries agree and practically remove all the subsidies, which they presently provide to their farm sectors.

REFERENCES

Afzal M. et al. (1993), "Support Price System in Pakistan", Pakistan Journal of Agricultural Economics, vol 1, No.2.

Alexandratos N. (1996), "China's Consumption of Cereals and ?Capacity of the Rest of the World to Increase Exports", food Policy, Vol.22, No.3.

Baifu L. and Y. Zhenyu (1987), "The Common Agricultural Policy", Research Observer, Vol.5, World Bank.

Bukwell K. (1982), "Common Prices and Europe's Farm Policy", Trade Policy Research Council, London.

Christopher J. (2000), "Present and Future of Agricultural Policy Reforms: The European Union", International Development Bank, Washington, D.C.

Ender G. (1990), "Government's Intervention in Pakistan's Cotton Sector", U.S. Department of Agriculture, Economic Research Service, Washington, D.C.

Falcon W (1964), "Farmers' Response to Price in a Subsistence Economy", Case of West Pakistan", American Economic Review, Vol.54, No.3.

Hafiz A. (1993), "Balanced Pricing Structure and Agricultural Productivity", Pakistan Journal of Agricultural Economics, Vol.2, No.1.

Honma M. (1999), "Agricultural Policy Reform in Japan and WTO, Negotiations", Agricultural Policy Discussion Paper No.16, Centre for Applied Economics, New Zealand.

Hudson D., and D. Ethridge, (1997), "The Effects of an Export Tax on Cotton Lint on the Domestic Cotton and Yarn Sectors: Trade and Sectoral

Economic growth in Pakistan", Department of Agricultural and Applied Economics, CER-93.

Ikram M. (1990), The Impact of Agricultural Pricing Policy on Wheat Production in Paikistan, M.Sc. dissertation submitted to University of Oxford, U.K.

Luther T. (1987), "Supply Response in Pakistan's Agriculture", Department of Agricultural Economics, Washington, D.C.

Mellor J. (1994), "Agricultural Price Policy for Growth", The Pakistan Development Review (PDR), Vol.33, No.4.

Prinkney T.C. (1989), The Multiple Effect of Procurement Price on Production and Procurement of Wheat in Pakistan, PDR, Vol. 28.

Salam A. (2001), "Agricultural Price Policy in Pakistan: Current Status and Issues", Proceedings of National Conference on Agricultural Policies and Farmers in Pakistan.

Schnepf D. and C. Edwin (2001), "Production and Price Impacts of U.S. Crop Insurance Program", American Journal of Agricultural Economics, Vol.83.

Townsend T. and A. Gutichounts (1994), "A Survey of Income and Price Support Programmes", Cotton Economics and Marketing Conference, National Cotton Council, Memphis, TN.

IMPACT OF GOVERNMENT EXPENDITURE ON AGRICULTURE AND AGRICULTURAL GROWTH IN PAKISTAN

By

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"The government in any country influences the economy through their policies such as expenditure, taxes, prices, credit, and monetary policies, etc. Government expenditure on agriculture is a primary determinant of the pace and pattern of agricultural growth. The size of government funds allocation to agriculture is an important indicator of government commitment to agricultural growth. This paper assesses the impact of agricultural government expenditure on agricultural output using time series data over the period 1965-66 through 2001-02. The adverse effect of expenditure instability on agricultural growth has also been analyzed. The results indicate that the government expenditure policies exhibit a vital importance towards the growth of agricultural sector, and any reduction in government expenditure on agriculture adversely affects agricultural sector performance. It is also evident from the analysis that instability in government expenditure on agriculture is inversely related towards the growth of the sector."

Introduction

1. Agriculture in the Economy of Pakistan

Agriculture is the predominant sector of the Pakistan's economy. The performance of this sector (i.e., crops, livestock, fisheries and forestry) has a strong impact on the overall economic growth of the country.

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Agriculture is still Pakistan's largest single sector of the economy, ahead of manufacturing, and accounts for 20.9 percent of the total gross domestic product (GDP).

Agriculture contributes to growth as a supplier of raw materials to industry as well as a market for industrial products and also contributes substantially to Pakistan's export earnings. Almost 66 percent of country's populations are directly or indirectly linked with agriculture for their livelihood. (Pakistan Economic Survey, 2006-07). It is clear from the Table 1 that during the year 1949-50, the contribution of agriculture to GDP was more than 53 percent, which was reduced to 47 percent in 1960, 36 percent in the early 1970's, 28 percent, and 26 percent noticed during 1980s and 1990s, respectively.

Table-1: Contribution of Agriculture to National Income between 1949-50 and 2001-02

(Rupees Billion)

	1949-50	1960-61	1970-71	1980-81	1990-91	2001-02
GDP	84.46	76.40	147.83	251.30	444.61	679.31
Agriculture GDP	44.93	35.91	52.7	70.67	114.11	157.65
Percent Share	53.2%	47%	35.6%	28.1%	25.7%	23.2%

Source: Pakistan Economic Survey.

The augmentation of this sector was planned since the inception of first five-year plan. Consequently, there has been substantial development in agricultural sector and the achievement in the output expansion has been made possible with the increase in land productivity through introduction of the new technologies and the structural adjustments in the sector.

The geographical area of the country is 79.6 million hectares, of which 22.27 million hectares are actually cultivated; the cultivable area is more than 31.22 million hectare. A considerable part of the remaining 9 million hectares could be developed for cultivation, if additional irrigation water availability is ensured.

The national average yields of major crops are far below the production potentials. There is a wide yield gap (50-80 percent, PARC Research Studies) reported between national average and experiment stations yields. The existing yield potential needs to be exploited to meet the future challenges.

Three main sources of demand exist for Pakistan's agricultural output in the future. The first source is for food and fiber for Pakistan's population of 140 million, which is currently growing at a rate of around 2.8 percent per annum. The time required for doubling of population with a growth rate of about three percent would be approximately 25 years. This means that Pakistan's population could reach 250 million by the year 2020 and 375 million by the year 2030 (Nagy and Quddus, 1996). The second source is of the moderately rising per capita income of Pakistan, which is currently increasing at a real rate of 5 percent per annum. Taste and preferences changes with rising of incomes often lead to a greater demand for edible oils and livestock products, in particular milk, milk products and poultry meat. The third source is the demand for exports and the resulting foreign exchange earnings. These three sources of demand will help defining future production, demand, and trade of agricultural commodities. Most food supply and demand projections for Pakistan forecast large agricultural commodity imports in the future, 'if investment in the agricultural sector remains at its current low levels.

Previous Studies:

A number of studies conducted to analyze the government expenditure from different point of view, such as research and extension, fertilizer and seed and irrigation, etc. In these studies it was revealed the size of these expenditure and their effects on agricultural production.

Victor Elias (1981, IFPRI Research Report 23) analyzed data for government expenditure on agriculture for nine Latin American countries for the period 1950-78. In the study included many kind of expenditure, such as research and extension, irrigation, marketing, transport, health education, administration agrarian reform and so forth. The objective of the study was to identify government expenditure policies for the agricultural sector and to measure their importance in relation to the total government budget and agricultural output. It also aimed at to analyze their trend and variability during the period 1950-78 by country and study their effects on agricultural production. The total amount spent by the governments of the nine countries on the agriculture sector was about $200 million in 1950 and $2.1 billion in 1978 (Constant US dollars-1960). According to the study, the components of government expenditure on agriculture such as on irrigation and education are generally the most important factors. It was found that aggregate government expenditures for the agricultural sector have increased at an average annual rate of 8 percent for the nine countries together. These aggregate government expenditures for agriculture represented about 1 percent of the GDP on an average; the maximum was 4 percent for Colombia. It was revealed in the study that government expenditure policy is responsible for at least 10 per cent of the growth of agricultural output.

It was also studied in 1985 as IFPRI Research Report No.50 that how government expenditures affected agricultural output between 1950 and 1980 in nine Latin American countries. The methodology used was based on the sources of economic growth and production function techniques. The average contribution of government expenditure on agriculture to the rate of output growth was around 0.25 percent that is almost 7 percent of the growth of agricultural output. A higher contribution of the government expenditure on agriculture was seen in Colombia, Costa Rica and Venezuela. The contribution of government expenditure on agriculture was higher when either irrigation or research and extension had the highest share of government expenditure on agriculture. A positive relationship was found between government expenditure on agriculture (GEA) per hectare and rate of agricultural growth. On an average, GEA caused agricultural output to increase by about 0.2 percent. It was also observed that the contribution of GEA was lower than the rate of growth of agriculture.

In another study conducted by Selvaraj (1993) revealed that the government expenditure policies exhibit a vital importance towards the growth of agricultural sector and any reduction in agricultural government expenditure adversely affects agricultural sector performance. It was also found that instability in agricultural government expenditure would be inversely related to the growth of the sector.

This paper has to assess the impact of government expenditure on agriculture and agricultural output growth using time series data over the period from 1965-66 to 2001-02. Moreover, the adverse effects of expenditure instability on agricultural growth will also be analyzed.

The paper presentation is organized into four sections. Section II explains the data used and test of structural stability. Section III will study the investment pattern in agriculture and agricultural sector performance. Section IV will work out the contribution of government expenditure on agricultural growth. Section V will provide estimates of the magnitude of instability in agriculture expenditure and also look into the effects of instability on agricultural growth. Finally, section VI summarizes the results and policy implications.

II. Data Sources and Structural Stability

Data on agricultural GDP, government expenditure on agriculture, gross cropped area, agricultural labor force and the basic inputs like number of tube wells were collected from various issues of Pakistan Economic Survey and Agricultural Statistics of Pakistan covering the period from 1965-66 to 2001-02 (Appendix).

To find out whether there is a structural change in the agricultural GDP and government expenditure on agriculture, the production function was employed by using Chow Test to carry out statistical tests under the time series available data set (Damodar N. Gujrati, 1995). The data were divided into two periods, 1965-66 to 1986-87 (Green revolution period)[1] and 1987-88 to 2001-02 (Post-Green revolution period). The functions for the two periods were as follows:

Green Revolution Period

$$Y_t = \lambda_1 + \lambda_2 X_t + \mu_{1t} \ldots\ldots\ldots \textbf{(1)}$$

$$t = 1, 2, \ldots n_1$$

Post Green-Revolution Period

$$Y_t = \gamma_1 + \gamma_2 X_t + \mu_{2t} \ldots\ldots \textbf{(2)}$$

$$t = 1, 2, \ldots n_2$$

Where Y = Agricultural GDP

X = Explanatory variable

μ_{1t}, μ_{2t} = Error Terms in the two regression equations.

n_1 and n_2 were the number of observations in the two periods. Structural change means that the two intercepts are different, or the slopes are different, or both are different. If there is no structural change, we can combine all n1 and n2 observations and estimate one function such as;

$$Y_t = \delta 1 + \delta_2 X_t + \mu_t \ldots\ldots \textbf{(3)}$$

The underlying assumptions in the Chow test are two folds:

i $\mu_{1t} \sim n(0, \sigma^2)$

ii $\mu_{2t} \sim n(0, \sigma^2)$

The two error terms are normally distributed with the same variance, σ^2, (homoscedastic), and μ_{1t} and μ_{2t} are independently distributed.

[1] The breakdown of post-green revolution period was made after reviewing various studies. For example, Byerlee (1987); and Hamid, et al. (1987) indicated that green revolution phase was completed by 1986-87 because by this time more than 90 percent of wheat area was planted under HYVs, most of the farmers were applying fertilizers to the wheat crop and irrigation development through extensive installation of tube wells has intensified crop production.

With these given assumptions, the Chow test proceeded as follows:

- Consequent upon combining of all the n_1 and n_2 observations, we estimated (3) and obtained its Residual Sum of Square (RSS), say, S_1 from the pooled data with degree of freedom (df) = $n_1 + n_2 - K$, where K is the number of parameters to be estimated.

- Two regression equations (1) and (2) were estimated for two separate periods and RSS were obtained including S_2 and S_3 with $n_1 - K$ and $n_2 - K$, respectively. Two RSSs were added, i.e., $S_4 = S_2 + S_3$ with df = $n_1 + n_2 - 2K$.
- S_5 was obtained by subtracting S_4 from S_1, i.e., $S_5 = S_1 - S_4$.
- F test was applied as follows:

$$F = S_5/K/\ S_4/(n_1 + n_2 - 2K) \text{ with df} = K,\ n_1 + n_2 - 2K$$

$$F = \frac{0.0511/4}{0.1349/27}$$

$$= 2.56$$

If the computed F exceeds the Critical F value, then the hypothesis (i.e., the two regressions are the same) can be rejected.

Now $F_{4, 24}$ at 1 percent and 5 percent confidence levels are 4.22 and 2.78, respectively. Therefore, the computed F of 2.56 is not significant at both of these levels, indicating that the coefficients remain stable overtime and hence, estimation was carried out for the whole period (i.e., 1965-66 to 2001-02).

III. Agriculture Sector Performance and Investment in Agriculture

Investment in agriculture as distinguished from expenditure on current inputs, include only such items as would add to farm capital in the shape of improvement of land, provision of irrigation facilities, agricultural machinery, farm building, livestock, agricultural services and other agricultural and irrigation infrastructure. The public and private sectors are active partners in the development of agriculture. The public sector is responsible for building up agricultural infrastructure and providing support services besides expenditure on irrigation works, drainage, reclamation, flood protection and water management. The private sector i.e. the farmers themselves through assistance from credit agencies invest in farm capital including land improvement, farm building, agricultural machinery and livestock.

The most striking feature of the past history is that investments in agriculture have been declining over the years and did not commensurate with either the importance or the contribution of the sector to the national economy. In the recent years, public sector allocations for agriculture infrastructure have also declined. The National Commission on Agriculture (1988) recommended 6.0 percent of the plan outlay on agriculture for the Seventh Plan period (1988-93) but the actual allocation was 3.5 percent. Public sector expenditure for Agriculture in different plan periods declined from 10.4 percent in the Third Plan to 0.8 percent in the Eighth Plan. In the Ninth Plan (1998-01), government expenditure on agriculture further declined to 0.2 percent.

Total expenditure, government expenditure on agriculture and share of agricultural expenditure in total government expenditure is summarized in Table 2.

Table-2: Share of Government Agricultural Expenditure in Total Expenditure

(Rs. Billion)

Plan Period	Total Expenditure	Government Agricultural Expenditure	Percentage Share of Agri. Government Expenditure in Total Expenditure
I. (1955-60)	4.86	0.46	9.5
II. (1960-65)	10.61	0.91	8.5
III. (1965-70)	13.20	1.38	10.4
IV. (1970-78)	75.54	6.49	8.6
V. (1978-83)	153.21	14.86	9.7
VI. (1983-88)	242.41	17.30	7.1
VII. (1988-93)	350.00	15.60	4.5
VIII. (1993-98)	752.10	5.70	0.80
IX. (1998-01)	293.40	0.61	0.20

Source: Economic Survey of Pakistan.

Since the beginning of first Five Year Plan (1955-60), the agricultural production increased from 15 million tons to 75 million tons in 2001-02 (Economic Survey of Pakistan, 2002-03). As far as export sector is concerned, agriculture has made a comprehensive progress, occasionally, due to favorable policies of the Government. During 1949-50, agriculture exports were of Rs. 28 million, which rose to Rs. 316 million in 1959-60, Rs. 880 million in 1969-70, Rs. 22 billion in 1979-80, Rs. 110 billion in 1989-90 and Rs. 408 billion during 2000-01, respectively. The growth of agriculture sector in terms of production and productivity of agricultural crops and livestock products was assessed by estimating the compound growth rate. These estimates are presented in Table 3.

Table 3: Performance of Agriculture: 1949-50 to 2001-02

S.NO	Particulars	Production Compound Growth Rate (Percent)	Productivity (Percent)
1	Wheat	4.01	2.50
2	Rice	3.80	1.83
3	Maize	2.91	1.03
4	Total Grains	3.64	- 0.14
5	Gram	3.66	-
6	Sugar-Cane	3.87	0.95
7	Cotton	4.50	2.38
8	Fruits (1960-02)	4.45	-
9	Meat (beef + mutton +		
10	poultry)	4.95	-
11	Milk (1971-2001)	4.61	-
	Fish	5.61	-

The compound growth rate indicated that production and productivity of almost all the field crops and livestock products increased over the time. The growth is mainly due to investment made in agriculture sector.

Trend of Government Expenditure on Agriculture

Government expenditure on agriculture (G_{AG}) includes all expenditures of federal and provincial governments that are used for agricultural production. G_{AG} in real terms grew at a snail's pace in Pakistan between 1966 and 2002 (Table 4 and in Figure 1 and 2). The indexed as well as real government expenditure on agriculture sector may also be seen in graphic form in figure-1 and 2. The average annual rate of growth of government expenditure on agriculture in real terms for the whole period 1966-2002 was negative 6.45. G_{AG} did not follow the same and smooth trend during the study period. It increased during the period from 1970-80 and its growth was about 16 percent per annum but rate of growth of G_{AG} declined considerably during the other periods ranging between 3 to 29 percent.

Table 4: Indexes of Real Government Expenditure on Agriculture and their Average Compound Growth Rates between 1966 to 2002

Year	Average annual growth rate	Year	Indexes of real government expenditure on agriculture
1966-70	- 3.21	1995-66	70.61
1971-81	+15.95	1970-71	22.64
1982-91	- 6.36	1980-81	100.00
1992-02	-29.18	1990-91	44.58
1966-02	- 6.45	2001-02	1.01

Relative Importance of Government Expenditure on Agriculture

The relative size of government expenditure on agriculture (G_{AG}) will now be shown in comparison to three important variables viz. Public Sector Development Plan (G), agricultural gross domestic product (AGDP), and gross domestic product (GDP). Each of three variables satisfies a different purpose of comparison, explained as under:

G_{AG} / G = percent share of government expenditures on agriculture in total public sector development plan budget;

$G_{AG} / AGDP$ = percent share of government expenditure on agriculture in agriculture gross domestic product;

G_{AG}/GDP = percent share of government expenditure on agriculture in the gross domestic product.

The first ratio (G_{AG}/G) indicates the degree of concern for agriculture of each government during the study time period.

The second ratio ($G_{AG}/ AGDP$) gives another view of each government's efforts to support its agricultural sector. The effect of government expenditure on agriculture is studied and presented in the next section by using marginal analysis (how much change in AGDP is due to G_{AG}).

The third ratio (G_{AG}/ GDP) indicates the importance of G_{AG} towards the whole economy making it comparable to other variables expressed in gross domestic product.

Table 5 depicts the estimates of the three ratios. To obtain an overall comparative picture of the three ratios for the study period, the arithmetic means, the standard deviations, and the coefficient of variations are computed. The descriptive statistics results of these ratios are presented in Table 6. A number of conclusions can be drawn from it. The average values for the ratios G_{AG}/ G, G_{AG}/ AGDP, and G_{AG}/GDP are 6.56 percent, 2.32 percent, and 0.75percent, respectively. The Table also shows the variation (measuring the degree of stability by the coefficient of variation) amongst all the ratios (i.e., G_{AG}/ G, G_{AG}/ AGDP and G_{AG}/GDP) but the most was noticed in case of G_{AG}/GDP.

Table-5: Importance of Government Expenditure on Agriculture (G_{AG}) Compared to Public Sector Development Plan (G), Agriculture GDP (AGDP), and Gross Domestic Product (GDP): 1965-66 to 2001-02

(Ratio)

Year	G_{AG} / G	G_{AG} / AGDP	G_{AG}/GDP
1965-66	-	5.64	2.24
1970-71	7.56	1.37	0.49
1974-75	8.89	2.85	0.91
1979-80	14.54	5.11	1.50
1984-85	8.96	2.41	0.69
1990-91	3.44	1.30	0.33
1995-96	0.90	0.32	0.80
2001-02	0.13	0.02	0.005

Table-6: Arithmetic Means, Standard Deviations, and Coefficient of variation of the Ratios G_{AG}/G, $G_{AG}/AGDP$ and G_{AG}/GDP: 1965-66 to 2001-02

	Ratios
G_{AG}/G	
Mean	6.56
Standard deviation	4.51
Coefficient of variation	0.69
$G_{AG}/AGDP$	
Mean	2.32
Standard deviation	1.64
Coefficient of variation	0.71
G_{AG}/GDP	
Mean	0.75
Standard deviation	0.59
Coefficient of variation	0.79

Notes: G_{AG}/G = percent share of government expenditure on agriculture in total public sector development plan budget;

$G_{AG}/AGDP$ = percent share of government expenditure on agriculture in agriculture gross domestic product; and

G_{AG}/GDP = percent share of government expenditure on agriculture in the gross domestic product.

IV. Government Expenditure on Agriculture and Agricultural Growth

The regression analysis was used to find out the influence of agriculture on agricultural performance using an intensive form of Cobb-

Douglas production function. The gross domestic product for agriculture can be defined as under:

$$AGDP = f(N, L, K), \qquad (1)$$

Where:

AGDP = Agriculture Gross Domestic Product

N = Land input,

L = Labor input, and

K = capital input.

The contribution of government expenditure on agricultural development was analyzed by using a neo-classical production function form of the Cobb-Douglas production function. The model was estimated by using Ordinary Least Square (OLS) method through incorporating expenditure variable alongwith other conventional inputs such as land and labor. The function is given by the following equation:

$$LN(AGDP)_t = \beta_0 + \beta_1 LN(GEA)_t + \beta_2 LN(AGL)_t + \beta_3 LN(GCA)_t + \beta_4 LN(TWN) + \mu$$

Where the dependent variable AGDP is Agricultural GDP at current prices expressed in Million Rupees. Land and Labor, representing resource endowments, measured by gross cropped area (GCA) expressed in million hectares, and agriculture labor (AGL) expressed in million numbers. The government expenditure on agriculture at current prices (GEA) is expressed in million rupees. Number of tubewells installed (TWN) were also included in the model. μ_t is the stochastic disturbance term with $\mu_t \sim N(0, \sigma)$. The time period considered for the analysis is from 1965-66 to 2001-02. β_1, β_2 and β_3 are respective elasticities and β_0 is regression constant. The results of the equation are presented in Table 7.

The estimated elasticity of the government expenditure on agriculture is 0.2 that is significant at 1 per cent level of probability. The elasticity of government expenditure on agriculture indicates that 10 per cent increase in government expenditure would bring 2 per cent increase in agricultural production. These results indicated that government expenditure policies on agriculture are very important for boosting agricultural sector performance.

Table-7: Estimates of Production Function for the Period: 1969-70 to 2001-02

CONSTANT	-7.49 (14.6)*
LNGEA	(4.6)*
LNAGL	5.35 (20.1)*
LNTWN	0.21 (9.3)*
R^2	0.986
R^2 (Adjusted)	0.985
F	642

Note: The numbers in the parenthesis are t values. * Means significant at 1% level of confidence.

V. Government Agriculture Expenditure Instability

Instability in government expenditure may affect differently on the performance of agriculture sector. Unsteadiness in government expenditure might put at risk the planning skills of the government and parastatal organizations, thereby it affects negatively on the pace of economic development. Instability index was used to analyze the adverse effect of expenditure instability on agricultural growth.

Instability effect was measured by Instability Index, as below:

Instability Index:

$I = (C.V)^2 * (1-R^2)$ obviously, $1 < (C.V)^2$

Where I = Instability Index
CV= Co-efficient of Variation
R^2 = Co-efficient of Determination

The results of Instability Index reveal in Table 8 that a maximum of 15.53 Instability Index was noticed during the period from 1995-96 to 2001-02, while a minimum of 0.5 was observed during the third five-year plan 1965-66 to 1969-70. The overall instability index was 11.94. Due to the instability of government expenditure on agriculture during the period 1995-96 to 2001-02, the performance of agriculture sector was unsteady.

Table-8: Instability Index Analysis of Government Expenditure on Agriculture during 1965-66 to 2001-02

Period	Instability Index
1965-66 to 1969-70	0.50
1970-71 to 1975-76	4.00
1976-77 to 1979-80	2.13
1980-81 to 1984-85	1.23
1985-86 to 1989-90	2.20
1990-91 to 1994-95	3.40
1995-96 to 2001-02	15.53
1965-66 to 2001-02 (Overall)	11.94

In order to diagnose the negative effect of government expenditure's fluctuations on its performance, the rate of change of agricultural gross domestic product is assume to be explained by the instability of expenditure on agriculture and the other relevant factors such as cropped area and labor employed in agriculture. The intensive form of Cobb-Douglas production function was specified, i.e., output and cropped area were expressed in terms of labor. The equation was predicted by using OLS method. The model is specified as follows:

$$LN\ (AGDPL)_t = \alpha_0 + \alpha_1\ LN\ (LNDPL)_t + \alpha_2\ LN\ (IND)_t + V_t$$

AGDPL = Output per labor rate change,
LNDPL = Land per Labor rate change,
IND = Instability Index of agricultural government expenditure
V_t = Stochastic disturbance term with $V_t \sim N(0, \sigma^2)$.

The time period used for the analysis was from 1965-66 to 2001-02 and α_0, α_1 and α_2 are the parameters of the estimated equation. The results of the equation are presented in Table 9.

The instability index estimation has arrived at as per see the expected negative sign and also significant at 10 percent level of confidence. However, it is obvious from the estimated results that instability in government expenditure patterns on agriculture sector has shown negative effects on its performance. These estimates guide the investors (government) to allocate ample funds in Pakistan's case on regular basis that proves to be catalytic, a source of higher agricultural growth rate.

Table-9: Instability in Government Expenditure on Agriculture and its Impact on Agricultural Growth

Variables	Values
Constant	7.63 (194)* (α_0)
LNDPL	0.79 (29.41)* (α_1)
IND	-0.02 (1.84)** (α_2)
R^2	0.964
R^2 (Adjusted)	0.962
F	454.58

Note: The numbers in the parenthesis are the t values.
* Means significant at 1% level of confidence; ** Significant at 10% level of confidence

VI. Conclusions and Policy Implications

The core objective of the study paper is to review the contribution of government expenditure on agricultural growth over the last 37 years commencing from 1965-66 to 2001-02. The analysis indicated that the government expenditure on agriculture has declined considerably over the study period. For this entire period, the rate of instability was very high vis-à-vis a reduction in expenditure on agriculture. It has affected the performance of agriculture sector through declining the growth rate that induces to poverty increase, especially among the rural including farming community.

The results showed that in Pakistan a substantial decline in the share of government expenditure in total budgetary outlay from the maximum with the tune of Rs. 35 hundred million to Rs. 34 million only vis-à-vis the rate of instability was also on higher side. It also gives the clear message to the policy makers in Pakistan that reduction in government expenditure on agriculture sector adversely affected the performance of agriculture sector, especially the weak sub-sectors including minor field crops, and neglected small and large ruminants.

On an average the model shows that 10 percent increase in government expenditure on agriculture would increase only 2 percent in agriculture GDP that is because the share of agriculture expenditure of the Agriculture GDP continues to be declining. For example, it was 5.64 percent during 1965-66 while 2.85 percent in 1974-75 (on-going green revolution period). It increased to 5.11 percent during 1979-80 and kept on declining while reached 0.32 percent during mid 90s (post green revolution period). It declined further to the ever lowest level of 0.02 percent during 2001-02, which is an alarming situation

The potential of Pakistan's agriculture is enormous, which could be effectively tapped through government policy interventions. Government commitment may be essential for creating exportable surplus through assurance of ample investments on infrastructure development including communication, market intelligence and farm to market road networking, irrigation management, agricultural research and extension.

The results of this study have important policy implications. In order to increase agricultural productivity, the Government of Pakistan should give priority to increase its spending on rural roads, and agricultural research and extension.

These types of investment not only have a large impact on the growth in agricultural productivity but also entail number of spill over effects on the regional as well as national economy. Ultimately, it shall be reducing the poverty amongst the farming community in particular but non-farming community in general by providing the enabling environment.

Additional government spending on irrigation management through increasing the water conveyance efficiency as well as saving water by conservation techniques including lining of water courses and canals, laser leveling of farmers fields, etc induces substantial productivity gain effects.

For attaining sustainable growth in agriculture sector, Pakistan requires high investment plans on sustainable grounds in order to maintain higher productivity and fetch high growth strategy for agriculture including both crop and livestock sub-sectors of the agriculture economy.

REFERENCES

Byerlee, D. (1987). Maintaining the momentum in post green revolution agriculture: A micro level perspective. Michigan State University, East Lansing. (MSU International Development Paper No. 7)

Delgado, C., J. Hopkins and V. Kelly. (1998). "Agricultural Growth Linkages in Sub-Saharan Africa, IFPRI Research Report No. 107, Washington DC, USA.

Elias, J. V. (1985). "Government Expenditure on Agriculture and Agricultural Growth in Latin America. Research Report 50; International Food Policy Research Institute (IFPRI)", Washington DC, USA.

FAO. (2001). "Agricultural Investment and productivity in Developing Countries, FAO Economics and Social Development Paper 148. Rome.

Fan, S., and P. Parduy. (1997). Government Spending on Asian Agriculture: Trends and Production consequences Resource Paper Presented in the Study Meeting on Agricultural Finance Policy, Organized by Asian Productivity Organization, Taipei, June 4-12.

GoP. Pakistan Economic Survey (various issues).Finance Division, Economic Advisors Wing, Government of Pakistan, Islamabad.

GoP. (1981). "Government Expenditure on Agriculture in Latin American Countries." Research Report 23; International Food Policy Research Institute (IFPRI), Washington DC, USA.

GoP. (1947-1997). "50 Years of Pakistan in Statistics." Federal Bureau of Statistics, Government of Pakistan, Islamabad.

GoP. (2001). Pakistan Statistical Year Book. Federal Bureau of Statistics Division, Government of Pakistan, Islamabad.

Gujarati, D. N. (1995). Basic Econometrics, Third Edition, McGraw-Hill, Book Company, New York.

Nagy, J.G. and M.A. Quddus. (1998). "The Pakistan Agricultural Research System:

Present Status and Future Agenda. The Pakistan Development Review. 37 (2) 167-187.

Lim, D. (1983). "Government Recurrent Expenditure and Economic Growth in Less Developed Countries". World Development, 11:337-380.

Lindaner, D. L. and A. D. Velenchik. (1992). Government Spending in Developing Countries: Trends, Causes, and Consequences, The World Bank Research Observer. 7(1): 59:78.

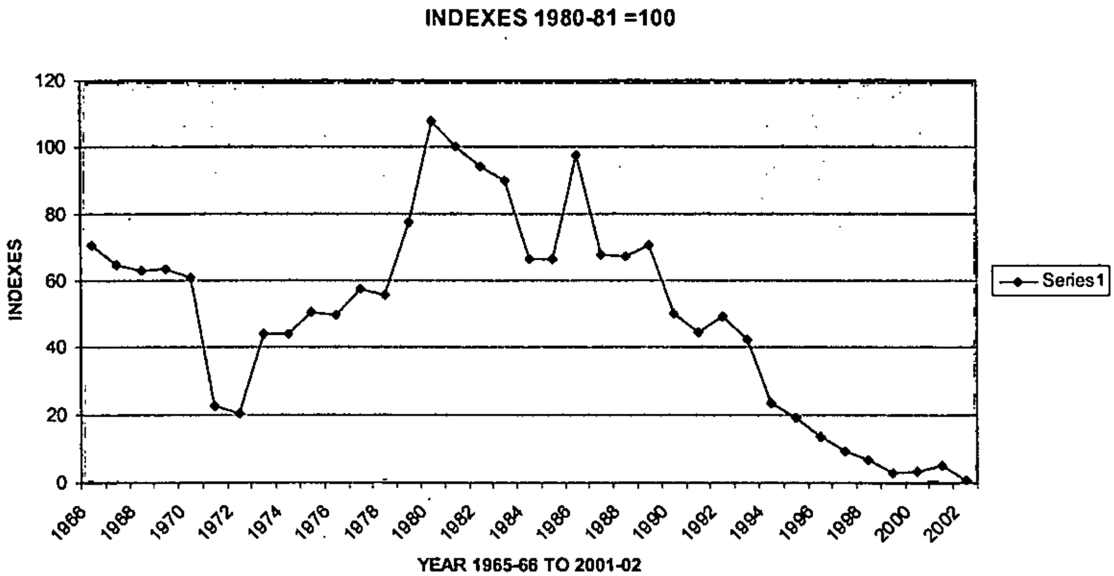
Selvaraj, K.N. (1993). Impact of Government Expenditure on Agriculture and Performance of Agricultural Sector in India, Bangladesh Journal of Agricultural Economics, XVI (2): 37-49.

APPENDIX

GOVERNMENT AGRICULTURE EXPENDITURE, AGRICULTURE GDP, GROSS CROPPED AREA, LABOR EMPLOYMENT IN AGRICULTURE AND NUMBER OF TUBE-WELLS IN PAKISTAN

Year	Cropped Area (Million Hectare)	Labor in Agriculture (Million)	Agri. GDP at Constant Prices 1980-81 (Rs.in Million)	Agriculture Expenditure at Constant Prices 1980-81 (Rs.in Million)	Tube-Well (000)
1965-66	15.54	9.78	41836.17	2358.53	-
1966-67	16.41	9.75	45128.58	2158.64	-
1967-68	16.94	9.73	49188.05	2094.90	-
1968-69	16.24	9.71	49656.88	2108.24	83.70
1969-70	16.78	10.13	54317.80	2027.90	86.61
1970-71	16.62	10.58	52697.18	756.25	97.64
1971-72	16.60	10.63	55046.04	690.61	102.85
1972-73	16.93	10.86	58201.38	1463.87	119.29
1973-74	18.28	10.99	60279.03	1474.57	130.79
1974-75	17.37	11.12	58974.67	1681.32	154.29
1975-76	18.02	11.44	60213.60	1652.27	160.96
1976-77	18.21	11.76	62341.06	1915.80	167.23
1977-78	19.11	12.09	65591.19	1852.43	172.36
1978-79	19.30	12.43	68066.63	2575.72	178.51
1979-80	19.22	12.72	70213.44	3587.96	188.91
1980-81	19.33	13.01	70669.00	3340.00	199.67
1981-82	19.78	13.32	74844.11	3133.40	207.08
1982-83	20.06	13.63	78717.21	3002.43	213.23
1983-84	19.99	13.63	72996.20	2216.06	230.54
1984-85	19.92	13.63	91895.60	2212.29	248.88
1985-86	20.28	14.60	94477.37	3253.14	257.31
1986-87	20.90	14.13	94959.65	2260.51	268.35
1987-88	19.52	14.83	100118.4	2236.38	288.45
1988-89	21.82	15.29	108534.2	2352.59	305.23
1989-90	21.46	15.43	109343.2	1668.05	325.18
1990-91	21.82	13.78	114106.0	1488.91	339.84
1991-92	21.72	14.51	125672.7	1643.15	355.84
1992-93	22.44	14.70	121970.8	1417.46	374.10
1993-94	21.87	15.85	129885.3	785.28	389.49
1994-95	22.14	14.88	138789.4	636.41	463.46
1995-96	22.59	15.24	144691.2	459.27	485.05
1996-97	22.73	15.27	154333.4	314.09	489.60
1997-98	23.04	17.18	163358.9	226.64	532.70
1998-99	23.07	17.57	168384.6	98.49	537.69
1999-00	22.75	17.78	173353.5	120.06	541.84
2000-01	22.04	18.16	166088.7	172.61	545.57
2001-02	22.04	18.54	166833.9	33.79	680.47

GOVERNMENT EXPENDITURE ON AGRICULTURE



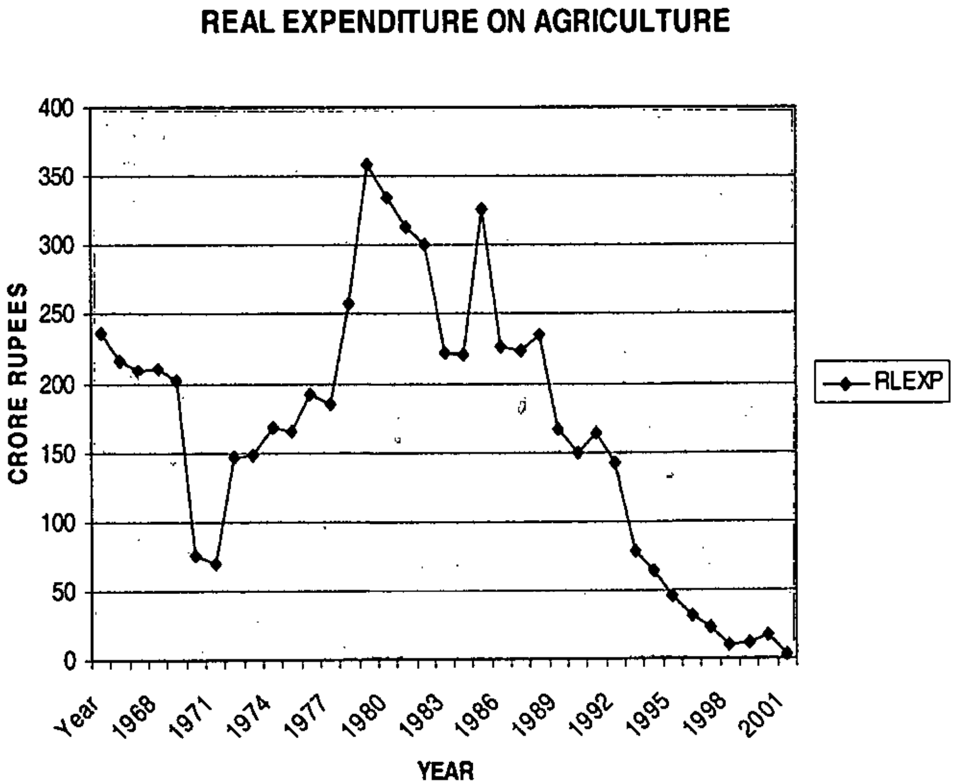

REAL EXPENDITURE ON AGRICULTURE
400
350
300
250
200
150
100
50
0
CRORE RUPEES
Year
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
YEAR
RLEXP

Figure-2

Agricultural Growth and its Impact on Poverty Alleviation (Some Evidence from PFCAD Project)

By

Abdul Rashid Khan*

"This paper explains how an agricultural development project with participatory approach has reduced poverty in the project area of Pat Feeder Command Area Development Project located in Naseerabad Area of Balochistan. The pattern of analysis is based on effects, impact and implications. Project's effects on agricultural growth and its impact on income level of all categories of farmers are analyzed. Finally its implications for poverty alleviation are assessed. Simple descriptive statistical tools were applied to find out variation in the level of income. The major findings include positive effects of project on agricultural sector and poverty reduction. However, redistribution effects of income confirm that big farmers have benefited more than small farmers suggesting both structural change in the feudal areas of Balochistan and more effective pro poor efforts at grass root level."

Introduction

In recent years the focus of agricultural development strategy has been shifted towards the capacity building of farmers at grass root level through participatory approach. Taking such approach on high profile is mainly due to the fact that the farmers based- development

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initiatives are more effective and efficient especially in reducing poverty than the traditional top down government approach (Berrien 1991). Realizing the benefits of participatory approach, the donor agencies with the collaboration of Government of Balochistan have adopted it in some of the development projects of different sectors. In this regard, Community Irrigation and Agricultural projects , Social Action Program, Pat Feeder Command Area Development Project and District Trial Program are some of the living examples However, no scientific study has been conducted at the provincial level to determine the effects of such projects on poverty alleviation and income distribution. Rather there is a general perception that the benefits of such projects still go to the economically better off and politically more powerful groups of the society

To assess the situation, a case study of Pat Feeder Command Area Development Project has been taken for analysis. The project, which is the largest agricultural project, was carried out in the Naseerabad area of Balochistan in 1997 and was completed in 2002. The overall purpose of project was to exploit the potential in the agriculture sector resulted from the improved water supply. The approach adopted in the project was multi- sector in nature, and was based on a participatory strategy. In this regard farmers were organized into groups; Agricultural Development Groups (ADGs} and were trained under the project components such as agriculture extension, on farm water management, livestock, micro credit and community support. It was envisaged that poverty would be reduced through effective participation of farmers. The main purpose of this paper is to assess the validity of project assumption in terms of poverty alleviation. The paper also intends to suggest the measures for effective reduction of poverty in future agricultural projects.

2 Data & Methods of Analysis

The data used in this paper were mainly drawn from the cross-sectional sample survey conducted in the all ten distributaries of project area in 2003. Farmer was taken as a sampling unit both random and stratified sampling techniques were applied. The sample size was 1.23% of total population representing all ten distributaries and 126 minors. The tools used as primary data in the survey include: Questionnaire' observation guide' and discussion with key informants for collection of data while the secondary source of data was based on project documents, Governments reports and other related literature review. To estimate and compare the impact of project on reduction of poverty 'pre and post project agricultural indicators were developed out of PC-I and other project documents. Poverty was estimated on the basis of house hold income.

Data analysis is carried out both at the project and distributory level. The data were organized and presented in tabular form. Appropriate descriptive methods have been applied for data analysis. Descriptive tools include measure of central tendency, dispersions, proportions and frequency distribution.

3 Empirical evidence & Discussion

Before analyzing the effects of project on agricultural output and its implications for poverty alleviation, a brief picture of farming sector in the study area will be helpful in understanding the overall justification of project. The characteristics of pre-intervention scenario of farming sector reveal that overall agriculture productively was low in the study area due to primitive methods of cultivation and shortage of water. Agricultural and institutional capabilities such as extension services input supply and marketing etc had no prominent effects in the project area. The traditional cropping pattern in the project area. The traditional cropping pattern in the area was defined for kharif mostly by rice and while Rabbi mostly by wheat; so only one crop was produced in the season. The outcome of all crops was far below the potential level. Therefore, 80% of population was living below poverty level (PC- 1, 1995).

The project envisioned realizing the potential in agriculture sector by its complimentary components like research in crop sector and agriculture extension. Other major component of project such as community development has also put positive effects on the productivity of agriculture sector.

3.1 Project Effects on Agricultural Growth

The post project scenario shows encouraging results in the agricultural sector. The performance in terms of growth rate of key indicators such as area, production, per acre yield and cropping intensity is commendable. The comparative analysis of area, production, and per acre yield clearly indicates that there has been consistent proportionate positive growth in these performance indicators. Strong positive coefficient has been found between production and area. The comparison between area and (table -1) yield also reveals that more area has come under cultivation confirming the positive impact of improved supply of water and other on farm management practices. On the basis of these results, it can be inferred that the production capacity of crop sector has been increased as visualized during project appraisal. However, the tremendous potential for agricultural growth still exits which can be exploited by sustaining its growth in the future, which by and large depends on the sustainability of efficient irrigation system.

Table-1: Percentage growth in Area, production and yield of all major crops In the project area during 2002 over 1997

(Per cent)

S.No.	Kharif Crops	Area	Production	Yield per Acre
1	Rice	36.33	526	270
2	Cotton	67.7	788	384
3	Chokar	-15.5	N.A	N.A
	Rabi Crops			
1	Wheat	35.97	50	6.3
2	Masoor	22.4	64	33
3	Mutteri	13.8	185	265
4	Sarsoon	11.5	1307	625
5	Onion	7.5	100	533

Source; Survey Results, 2003.

Cropping Pattern

The important finding emerging from the analysis of new cropping pattern is that overall cropping intensity for new crops has increased by 150% in the study area due to increased water and introduction of high value variety crops. Comparing project wide Kharif cropping pattern, rice was widely cultivated crop at the inception of project while Rabi cropping pattern was mainly dominated by wheat. Under the crop diversification other than cotton promotion, the project-cropping pattern is more productive in the sense that per hectare income from the crop Cotton, Onion, and Gram is much higher than the traditional crops like Rice and Wheat.

Increasing trend is noticed in the cultivation of all major crops especially in cotton one. Change in the cropping pattern also brings positive change in the cropping intensity of area. As per survey results, the average cropping intensity has increased for both Rabi and Kharif crops due to increase both in water quantity and increase in the efficiency of irrigation.

Change in Household Farm income

The second tier of agriculture sector's effects is assessed on the average household farm income. Change in household income is carried out both by distributary level and farm class. The results pertinent to average household income reveal significant change in the income of the all farmers residing in ten distributaries of project which is evident from the Table-3 shown below.

The statistical analysis of the data regarding the extent of income on head, middle and tail brings out the following results. First, average house hold income on head distributaries is the highest and more consistent implying that project has put more positive effects on poverty reduction of farmers living on Head. The reasons for high income can be attributed to high flow of water in the distributaries such as Nasser, Jud her and Temple. Secondly, the positive effects can be seen in the area of tail where average income has increased by 73.5%, and the degree of variation is found comparatively less. Whereas the income in the distributaries located on middle was found least and the degree of dispersion is highest. This is simply because of the same level of increase in agriculture production at middle distributaries. However, the magnitude of change in income differs by distributory depending on the level of production, For example; change in average income is more skewed towards Umrai, Ballam and Jatput than Rupa and Magsi. While the latter is low-income distributaries as they have low water flow.

Table-2: Change in Average Household Income during 1997-2002

Stributory	Average Income(%)	Min	Max	St. deviation	C.V (%)
Head	74.5	50	92.8	14.68	19.17
Middle	69.8	37.5	100	18.61	26.85
Tail	73.5	50	100	15.60	21.23

Note: Increase in income includes agriculture, livestock and non farm income.

Source: Estimated from the impact Survey data

Distributional Effects

The analysis of income distributional effects of intervention is essential both for poverty alleviation and sustainability of agriculture sector. It is argued that positive distributional effects ensure long-term viability of projects for the reason of smooth class relation and cordial social atmosphere. Moreover, an improvement in income distribution is consistent with egalitarian society, which follows that the better income distribution is prerequisite for reducing, the magnitude of poverty

Assessing the results pertaining to average household income of all the categories from income distribution point of view, it is found that large farmers are taking lion's share of cake [93%] while the average income of medium farmers has increased by almost 79%. The percentage increase in income of small farmer is lowest [73%]. The results clearly indicate that large farmers have the highest share in the growth of income while small farmers who are in majority witnessed the lowest increase in their income. Expl ıing the variation in the level of income and its growth, the highest degree of dispersion is found among the small farmers followed by medium farmer. The dispersion in the income of large farmer is found more consistent. This implies that the income of large farmer is comparatively sable, because of their permanent source of income, which is associated with the large size of holding.

Table 3: Change in the Average Income of Large, Medium & Small farmers: 2002 vs 1997

(Rs in thousand)

Distributaries	Large*		Medium*		Small*	
	1997	2002	1997	2002	1997	2002
Naseer	322	1026	96	285	64	105
Judher	221	473	100	240	46	107
Temple	207	388	158	344	51	88
Jhatpat	254	338	162	270	66	96
Mohabat	589	782	285	356	75	136
Ballan	362	678	99	229	98	186
Bari	152	275	106	189	82	132
Rupa	148	223	99	133	70	102
Umrani	277	734	137	210	50	100
Magsi	112	171	88	122	34	54
Total	2644	5090	1331	2380	637	1106
Average	264	509	133	238	64	111

Note: i) Small up to 16 acres, medium 17-40 acres and large greater than 40 acres.
ii) Average annual income is per farmer of each category based on sample population.

Source: Field survey Results, 2003.

The question arises why the income level of small farmers has not proportionally increased despite adopting poverty-focused strategy. Analysing the following data regarding pattern of income distribution (Table-4), one can say that it is highly skewed towards large farmers due to following three reasons. First, the tenancy arrangements in the study area favour the feudal class. The tenure structure as per survey of Base Line Socio Economic, 1999,exist in four categories owner 34% owner cum tenant 12%, tenant 37% and share cropper 17%, which implies that the majority are share croppers, tenants, and small farmers, but the land lords are fewer in the percentage, yet holding big share of land.

The second explanation for skewed distribution of income lies in the holding of farm size. The average farm size of owner was 27.8 acre owner cum tenant's 8.9 acre, tenant's 6.5 acre and share cropper 9.38 acre respectively. The third reason is accessibility of large farmers who are usually the early adopters, because of their access to information and extension services. The big landlord owners also earn more income as they cultivated more crops during Rabi and Kharif season. In the same way, the nature of water distribution also favors large farmers due to holding of big lands.

Implications of Agricultural Growth for Poverty Alleviation

Positive implications of agricultural growth for poverty reduction can be traced out from the above analysis. The overall scenario of poverty has changed as all the indicators of poverty reduction have shown positive results. Generally the incidence of poverty has come down as is evident from the Table-4. The evidence regarding income poverty reduction from all the sources is consistent and convincing therefore, it can be said that due to increase in agricultural output, the level of poverty has come down for all categories of farmers. What is important to mention is that absolute poverty has reduced among the farmers "as per farm family nominal income excluding the non agricultural sources of income has increased fromRs82, 000 to 171,000 during the project period"[1]

Comparing the change in poverty before and after project on the basis of available project data, it may be claimed that absolute income poverty (one $ per day) is no more existent in the project area especially among farmers, while before intervention. One half of rural farmers were living below poverty line. In the same way, during implementation of project about 70percent population was living below the poverty line in the province (Balochistan Poverty Alleviation Strategy, 1999).

The results related to agricultural growth are encouraging Assessment based on two indicators such as average family income and job creation in the study area supports the hypothesis that agriculture growth can reduce poverty significantly especially when it is done through farm development approach According to impact evaluation study 2003; average farm family income has increased by 87 percent, which is higher than the provincial and national level. Similarly, general employment situation has improved. Job creation related to farming activities has also increased by 14 percent .It was observed that most of the poor women were doing work in cotton and vegetable farms, which implies that women's involvement has increased in the agricultural activities.

The family labor has been almost absorbed due to more job opportunities; migration from the neighboring villages has also been noticed implying that the project has positive spillover effects on the adjacent villages. Pressure on wages is an indicator of increase in

[1] The totals per house hold family income including all sources recorded to be 152,437 in year 1997 that went up in 2002 to 285,300 more than 87 present. The real income stood at Rs. 285,246 after deflating nominal Average Income by 21%. Average Inflation Rate during 1997-2002 remained as 7% as per different Economic Survey Reports published during 97-2002

marginal productivity of labor, as well as increase in demand for labor. The increase in the income of farmers also leads to expansion of market for agro-based industries. Experience shows that increase in agriculture income is usually spent on locally produced goods and services, which in turn increases employment. In this regard; rice-ginning factories and spinning mills are living examples in the Project Area.

Diversification of agriculture production means that the vulnerability of farmers has been reduced. Increase in farm income, livestock and off farm activities indicates that economic opportunities both for male and female have enhanced in the study area. As per impact survey results, 64% increase in the average household income is due to farm activities and 19% increase from off farm activities Especially the results related to livestock of 202 percent increase in income; have produced significant poverty reduction impacts confirming the results of study that raising the productivity of livestock sector is crucial to poverty reduction (Amjad Rashid, 1995).

Considering the forward and backward linkages in the livestock sector, one may argue that increase in the production of livestock can substantially reduce poverty, as the majority of tenants and poor women are involved in the livestock sector. According to Traqee Trust [TT] 85 percent of loan has been utilized by women in the Study Area for live stock rearing reducing their poverty level More number of livestock also means that there is a more demand for fodder crops. The people involved in the production of such crops will be having more jobs and income. People are now spending their most of earnings on agriculture particularly livestock which means that the level of investment in the livestock has increased. The trained farmers particularly in disease control are asset in the study area, which can be a potential source for future reduction in the mortality rate of livestock.

Similarly, the low prices of meat and low prices of dairy products have greater positive implications for poverty alleviation for those who were previously suffering from serious malnutrition. It is well established that a reduction in income poverty will lead to a reduction in malnutrition (Strauss and Thomas 1998). Moreover, increase in the income of common man of the project is consistent with the trickle down theory that some benefits of growth will always trickle down to the poor whether or not follow the pro poor growth strategy.

However with regard to income sources and their relation to poverty analysis, the data reveal that poverty status is clearly related to land holdings. The landlord/large farmers have benefits more than the small farmers due to having big size of land which further strengthened their influence on the social and agricultural institutions

On the bases of overall impact, it can be inferred that growth in agriculture sector has reduced the incidence of income poverty among all categories of farmers in the project area thus providing empirical support for the basic research question whether agriculture growth with participatory approach can reduce poverty. In the same way, non-agricultural activities suggest that the poorer of poor now have more opportunities for income generation; it is of great importance as it has positive effects on income inequality while dependence only upon agricultural income has the opposite effects on income inequality. In fact, diversification in income is basically due to agricultural development that provides base for non-farm and non-crop sector development. However, the project impact in terms of equity was discouraging as it was found skewed towards large farmers.

5. Conclusions and Recommendations

The study confirms that income level of beneficiaries has increased due to agricultural growth. The project has succeeded in increasing yield of existing crops and introducing new high value crops such as cotton and oilseeds.

The changing cropping pattern shows tremendous potential in the agricultural sector of project area. This finding implies that if project is extended and replicated with the same approach to the remaining area, it would prove a new frontier of agriculture growth.

Diversification in the source of income also reflects positive change in the income of all groups suggesting that the Project Area has tremendous potential for non agricultural activities.

Change in the spending pattern reflects improvement in the standard of living. They have now more income and comparatively a wider range of choice of consumption.

The results further confirm the enterprising mind of farmer as most of their income is being ploughed back as investment in the agriculture sector.

Such encouraging results imply that any agricultural development project, if coupled with participatory approach can have positive impact on the reduction of income poverty in the other areas of Balochistan.

However, increase in income has been disproportionate due to big differences in the social and economic assets of beneficiaries. Small farmers' share in total income is less than the large farmers suggesting more efforts for the small farmers especially for the poorest of the poor.

The findings also suggest targeting the small farmers, tenants and landless in future agricultural development programs and projects for sustainable reduction of poverty. In this regard, there is a need to design poverty profile before launching any development project.

REEFERENCES

Ahmed Mushtaq (1999), Socio Economic Baseline Survey, Pat Feeder Command Area Balochistan, Government of Balochistan.

Balochistan Planning and Development Department Strategy for Poverty Alleviation (1999)

Directorate General Agriculture (Extension) Balochistan, Quetta Agriculture Statistics Balochistan, (2001-02)

Farooqui, Rashid, (October 1995, pp. 12, 16, 11,) Structure and Policy Reform Agriculture Growth, (The case of Pakistan) (World Bank)

IFADR Review Reports on Pat Feeder Command Area Development Project 2002

Livestock and Diary Development Balochistan [An overview of livestock in Balochistan (2003, 2004)].

IUCN (2000), Balochistan Conservation Strategy. Chapters 12 and 14, pp. 183,203.

National Commission on Agriculture (1998), Ministry of Food and Agriculture Government of Pakistan, Islamabad

PC- 1 (1995) Pat Feeder Command Area Development project Government of Balochistan.

PFCADP, Project Appraisal Report (1993).

Project Completion Report (2003)P&DDepartment , Government of Balochistan

S.M.Arif, (2003) Impact Evolution Study, PFCADP.

Strauss, John, and Duncan Thomas. 1995. "Human Resources: Empirical Modeling of Household and Family Decisions." In Jeri R. Behrman and T. N. Srinivasan, eds., tenants and poor women handbook of Development Economics, vol. 3A. Amsterdam: North Holland.

Traqee Trust performance report 2003 NGO

Waheed-uz-Aaman (1998) Impacts of Irrigation and Drainage Development Projects in Pakistan pp. 131- 152.PIDE; Islamabad

WAPDA, (1993), Socioeconomic Survey of R& I Project.

World Bank (1992), Poverty Reduction Handbook.

World Bank (2000), "World Development Report", Washington D.C.

FORECASTING MODEL FOR WHEAT PRODUCTION IN THE PUNJAB

By

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Agriculture sector is one of the largest sector of Pakistan's economy. It generates one fifth of the gross domestic product (GDP) and provides employment to 45 per cent of the total active labour force. People engaged in agro-based industries or in agriculture trade are in addition to these. Over 60 percent of the foreign exchange is earned through exports of raw products or agro-based products. From income generation and employment point of view, crop production is the most important activity of agriculture sector. Therefore, timely and reliable crops statistics are needed for proper planning and timely policy decision making. From the existing system, crops production estimates become available very late. But the Government is very particular in taking timely actions to maintain balance between demand and supply of food items, particularly of wheat. For this purpose government needs timely information regarding current year production so that in case of short or surplus production it may take necessary measures regarding import or its export, storage, marketing etc; well in time. These data gaps can be filled in only through crop forecasting. Hence there is a need for developing a system for forecasting production, especially of important crops. Development of such a system is in the interest of government, agribusiness and growers. Advance information in their areas of interest would make them wiser to take strategic decisions.

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1. Introduction

The literature on supply response shows that area under a crop mainly depends upon its post-harvest market/support prices, water availability and rainfall at the sowing time of a crop. Similarly, its yield depends upon a number of inputs/factors, like fertilizer application, water availability, rainfall, temperature, during both growth and maturity periods. These factors have varying levels of impact at different stages of the crop in various zones. The attractive market prices, proper supply of canal water and adequate rainfall at sowing time have positive impacts on area of a crop. Similarly, proper supply and use of phosphatic and nitrogenous fertilizers, irrigation water, normal rainfall and normal temperature during growth period of the crop have positive impacts on its yield. Contrary to these, shortage of irrigation water and less or heavy rains before sowing have negative impacts on the area. Similarly short supply of fertilizers, less or heavy rains and very high temperature at the growth and maturity stages of a crop have negative impacts on the yield.

First of all, through detailed study of the behavior of various factors with the area and yield of wheat crop as well as, data analysis the factors those have significant impact at different stages of the crop are identified. Thereafter, mutual behavior of the selected factors is studied. Using this approach, these models were established by adopting very simple equations, and were tested through ANOVA and regression analysis.

2. History of Crop Forecasting Models, in Pakistan

The crop forecasting based on econometric models has not been tried in Pakistan on rigorous basis, so far. In the past some efforts were made to develop such models but only as a piece of research and at the individual levels. Azhar in 1973 formulated a forecast model for wheat using a production function approach and multiple linear regression techniques for the province of Punjab as under:

$$Y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4$$

Wherein 'a's are regression coefficients and other variables are defined as below:

Y	=	Total production of wheat
X1	=	Area under Maxi Pak variety
X2	=	Area under other varieties
X3	=	Total fertilizer in nutrient tonnes applied to wheat
X4	=	Rainfall in inches from November to January.

Irrigation water, which is a very important factor affecting area and yield of wheat crop has not been taken in this model. Similarly, rainfall and temperature during the months of February, March and April have significant effects on yield of the wheat crop. These factors have been ignored.

Another attempt was made in 1986, when Amir and Naseer Alam developed their models for wheat and rice, respectively. Amir prepared separate models to predict both area and yield. His Area model is depicted by the following equation:

$$A = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4$$

Where 'a's are regression coefficients and other variables are defined as below:

A	=	Wheat crop area.
X1	=	Area under wheat lagged by one year.
X2	=	Procurement price of wheat divided by Consumer Price Index (CPI).
X3	=	Procurement price.
X4	=	Trend which captures the effect of technological changes Overtime.

Analysis of data shows that the time trend, area lagged and procurement prices of wheat are mutually highly correlated. Therefore, all these variables can not be taken together in a model. For an efficient model, only one variable, that affects the area more should be taken. Further, irrigation water and rainfall, which have significant effects on area of wheat crop are ignored.

The yield model is described in the following equation:

$$Y = b_0 + b_1F + b_2W + b_3R + b_4T + b_5S$$

Where 'b's are regression coefficients and other variables are defined as below:

Y	=	Wheat yield
F	=	Fertilizer consumption
W	=	Total irrigation water availability at farm gate + total rainfall Oct.- Feb.
S	=	Interaction term of rainfall and temperature

The product of area and yield equations provides wheat production. He used his models to estimate area and production by provinces as well as by irrigated areas.

In 2004, another attempt was made by Asif and Javed. They developed area and yield models for wheat crop and respectively following equations were established:

$$\text{Area} = b_0 + b_1A_{t-1} + b_2PRP.$$
$$\text{Yield} = b_0 + b_1FCW + b_2WA$$

Where 'b's are regression coefficients and other variables are as under:

A_{t-1} = Lagged area under wheat in the year t-1.
PRP = Procurement price of wheat in the year t.
FCW = Fertilizer consumption on wheat area in the year t.
WA = Water available at the farm gate during rabi season in the year t.

The rainfall and temperature have significant impacts on the wheat crop, especially on yield, at various stages of the crop. But these factors were not included in the models.

In Pakistan, need for crop forecasting system was felt in mid eighties and with technical and financial assistance of FAO/UNDP, econometric forecasting models for wheat crop were developed. Primary aim of developing these models was to forecast the size of production at least one month before harvest. As documented by S.M.Aslam Jafri (1989), equation and variables for area model by cropping zone were:

$$A = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6$$

Where 'a's are regression coefficients and other variables are:

A	=	Area sown to wheat.
X1	=	Area sown lagged one year.
X2	=	Total Rainfall (September to December).
X3	=	Total irrigation water availability at farmgate (September to December)
X4	=	Support price index (1970 base)
X5	=	Relative price ratio
X6	=	Time trend.

Equation and variables for yield model, of each cropping zone, were:

$$Y = f(N, P, Rain, Water, Maxtemp, Mintemp, T),$$

Where

Y = Yield of wheat, in kgs/hectare.
N = Amount of nitrogenous fertilizer applied, in kgs/hectare.
P = Amount of phosphatic fertilizer applied, in kgs/hectare.

Rain = Effective rainfall either during October to January or October to February, or October to March.

Water = Total irrigation water availability at farm gate, either during October to January or October to February, or October to March.

Maxtempt = Average maximum temperatures for the months of February, March and April.

Mintempt = Average minimum temperatures for the months of February, March and April.

T = Time trend.

The above equations, both for area and yield may be good for hypothetical models. Inclusion of all the independent variables is not possible for any real model. Process of developing a 'Best Fit' model is based on selection of minimum number of such independent variables, whose affect on dependent variable is more significant and which are not mutually highly correlated. It is done after detailed analysis of data and study of the behavior of each variable. There is no logic to select all these variables for any workable model. However, it was good start by any government organization.

These models were developed using SAS computer package for data processing and analysis. However, due to lack of organizational will all these activities were stopped as the project ended in 1990. Therefore, process of testing, modification, improvement and implementation of these models could not be continued.

3. Methodology

3.1 Identification of cropping zones.

Different parts of the Punjab province get various levels of rain during the year. Similarly, temperature varies from area to area. Soil texture and cropping patterns are also different in various parts of the province.

Thus, impact of these factors on a crop differs from region to region. To have homogeneous areas, with respect to impact of these factors on wheat crop, the province has been divided into following four cropping zones:

S.No.	Cropping zone	Description of Zones
1	Cotton/wheat zone	Comprises those areas, where cotton in rotation with wheat is dominant crop.
2	Rice/wheat zone	Comprises those areas, where rice is cultivated in rotation with wheat.
3	Mixed crops/wheat zone	Comprises that area, where no single crop is dominant except wheat.
4	Barani area zone	Comprises un-irrigated / rain fed areas.

The cotton/wheat zone of the Punjab Province includes Multan, Sahiwal, Pakpattan, Khanewal, Vehari, Muzaffargarh, Rajanpur, Bahawalpur, Bahawalnagar, R.Y.Khan, Lodran, T.T.Sing and D.G. Khan, districts. Rice/wheat zone includes Sialkot, Gujranwala, Sheikhupura, Narowal and Hafizabad districts. Rest of the districts, excluding Rawalpindi and Jehlum, were counted in mixed crops/wheat zone. District Rawalpindi, Jehlum and rainfed un-irrigated area in rest of the province were included in barani zone.

3.2 Collection of Data and Analysis

Analysis has been based on historical data for the period, 1970-2004 on the following parameters:

- District-wise area and production of wheat by source of irrigation.
- Monthly/station-wise total rainfall.
- Monthly/station-wise mean minimum and mean maximum temperature.
- Monthly/district-wise off-take of N and P fertilizers.

- Monthly/canal-wise withdrawals.
- Support/procurement prices of wheat.
- Support/procurement as well as market prices of competing crops.

The district-wise data regarding area and production were obtained from the Punjab Agriculture Department (Crop Reporting Service). Monthly, rainfall and temperature data were supplied by Meteorological Department. Punjab Agriculture Extension Department provided district-wise monthly data of fertilizer sales. Punjab Irrigation Department supplied canal-wise monthly withdrawals. Agricultural Prices Commission and Federal Bureau of Statistics supplied support prices and market prices, respectively.

Behaviour of independent variables both mutual and with the dependent variable was identified through the study of scatter plots, correlation coefficients and analysis of variance. Thus, different sets of independent variables having significant effects on dependent variables were identified through regression analysis.

4. Results and Discussion

4.1 Area Forecasting Models

Area under wheat crop mainly depends upon the canal water supply, rainfall, post sowing support harvest prices of wheat. Rainfall and canal water supply has different levels of impact at different stages of the crop, which is not always significant or positive at each level. To study the impact of each variable, these were tested through the following model equation for each zone:

$$\text{AREA} = b_0 + b_1\,\text{TREND} + b_2\,\text{WATER} + b_3\,\text{RAIN}$$

Wherein 'b's are regression coefficients, which measure effect of an independent variable on the dependent variable. Other variables are as defined below:

Variable	Description of Variables
AREA	Irrigated area of wheat crop in Cotton zone of Punjab Province in thousand hectares.
TREND	Time trend represents, improvement in technology, cultural & farm management, seed varieties etc.
WATER	Monthly canal withdrawals of canals, commanding the zone, during October, November and December in acre feet.
RAIN	Monthly rainfall at the Metrological Stations, in the zone, during October, November and December in millimeters.

Through the analysis of data of above variables and testing of fix hypothesis estimated equations of 'BEST FIT' models for area of each zone are as given below:

Zone	Model equation, t-value, level of significance				
Cotton/wheat zone	**AREA = -102563.553**	**+ 52.792*TREND**	**+ 1.723*WDEC**	**+ 2.931*RNOV**	
	t	(35.57)	(36.594)	(3.028)	(1.786)
	Sig.	(0.000)	(0.000)	(0.005)	(0.084)
Rice/wheat zone	**AREA = -22189.753**	**+ 11.521*TREND**	**+ 1.723*RDEC**	**+ 0.375*ROCT**	
	t	(32.81)	(33.84)	(2.40)	(2.10)
	Sig.	(0.000)	(0.000)	(0.023)	(0.044)
Mixed crops/ wheat zone	**AREA = -23824.41**	**+ 12.50*TREND**	**+ 0.282*WOCT**	**+ 0.376*WNOV**	
	t	(20.27)	(21.33)	(2.83)	(2.64)
	Sig.	(0.000)	(0.000)	(0.008)	(0.013)
Barani areas zone	**AREA = 32361.4**	**- 15.887*TREND**	**+ 0.829*ROCT**	**+ 1.342*RNOV**	
	t	(10.39)	(10.16)	(2.09)	(1.90)
	Sig.	(0.000)	(0.000)	(0.050)	(0.072)

(All the coefficients were found significant at zero to 8% probability level).

Regression coefficient measures the effect of an independent variable on the dependent variable. For the cotton/wheat zone, coefficient of TREND is 52.792, that means that if government's policies to grow more wheat remain intact and other factors remain normal then this year area of wheat will increase by 52.792 thousand hectares. Coefficient of WDEC, that is 1.723, shows that with one-acre feet additional water supply, during the month of December, area under the crop will increase by 1.723 thousand hectares. Similarly, due to one-millimeter additional rain (RNOV) during the month of November, area under wheat crop will increase by 2.931 thousand hectares.

The terms used for other variables are defined below:

REA	=	Irrigated area of wheat crop in the zone of Punjab Province in thousand hectares.
TREND	=	Time trend represents, improvement in technology, cultural & farm management, seed varieties etc.
WDEC	=	Canal withdrawals of all canals during December in thousand acre-feet.
WNOV	=	Canal withdrawals of all canals during November in thousand acre-feet.
WOCT	=	Canal withdrawals of all canals during October in thousand acre-feet.
RDEC	=	Rainfall during the month of December in millimetres.
RNOV	=	Rainfall during the month of November in millimetres.
ROCT	=	Rainfall during the month of October in millimetres.

For area models of each zone, value of R Square, significance of effects of selected independent variables and Durbin Watson values are as under:

Zone	Adj. R Square	F	Durbin Watson
Cotton/wheat	0.977	450.5	1.944
Rice/wheat	0.973	390.4	1.967
Mixed crops/wheat	0.935	155.6	1.851
Barani areas	0.844	40.8	1.684

Value of Adjusted R square is a measure of the effect due to the variables selected in the model. For example, in case of cotton/wheat zone, value of R square is 0.977. It shows that 97.7 percent change in area occurs due the time trend, water supply during the month of December and rainfall during the month of November. The effect due to all other factors, either whose individual impacts on area are not significant or are highly correlated with the variables selected in the equation will be 1 – R squre.

Wheat crop area for the year 2003-04 predicted on 15th of January 2004 through the above models was 6393.1 thousand hectares which is 2 percent more than 6255.0 thousand hectares estimated by the Punjab Agriculture Department and reported in October, 2004.

4.2 Yield Forecasting Models

Yield of wheat mainly depends upon quantity of fertilizer applied, rainfall, canal water availability and temperatures at different stages of the crop growth. To study the impacts of these variables, each one has been specified as given in the following equation:

$$YIELD = b_0 + b_1 TREND + b_2 N + b_3 P + b_4 TMPX + b_5 TMPN + b_6 RAIN + b_7 WATER.$$

Wherein 'b's are regression coefficients, which measure effect of an independent variable on the dependent variable. Other variables are as defined below:

Variable	Description of Variables
YIELD	Yield of wheat in kgs. per hectare, in the zone.
TREND	Time trend represents, improvement in technology, cultural & farm management, seed varieties etc.
N	Monthly off-take of nitrogenous fertilizers, in the zone, nutrient tonnes.
P	Monthly off-take of phosphatic fertilizers, in the zone, nutrient tonnes.
TMPX	Monthly average of maximum temperature, in the zone, in centigrade.
TMPN	Monthly average of minimum temperature, in the zone, in centigrade.
RAIN	Monthly rainfall, in the zone, in millimeters.
WATER	Monthly canal withdrawal during Dec, Jan, Feb and March in acre-feet.

Through the analysis of data of above variables and testing of fix hypothesis estimated equations of 'BEST FIT' models for yield of each zone are as given below:

Zone	Model equation, t-value, level of significance
Cotton/ wheat Zone	YIELD = 1407.20 + 0.0733*NDEC + 0.0846*NFEB – 6.798*RMARCH t (17.451) (5.065) (3.442) (3.488) Sig. (0.00) (0.00) (0.00) (0.00)
Rice/wheat Zone	YIELD = 1514.195 + 4.069*PRICE + 0.02439*NDEC + 0.08667*NFEB – 1.628*SMARX t (9.05) (11.20) (1.24) (1.69) (1.75) Sig. (0.00) (0.00) (0.03) (0.01) (0.05)
Mixed crops/ Wheat zone	YIELD =-72606.4+37.45*TREND+0.11*NDEC+1.44*RFEB–36.24*RMAR +0.13*NJAN t (11.29) (11.36) (3.24) (1.81) (1.91) (1.98) Sig. (0.00) (0.00) (0.00) (0.081) (0.07) (.07)
Barani zone	YIELD = -47040.76 + 24.4*TREND + 1.32*RAND_F – 1.088*SMARX t (7.64) (7.87) (2.50) (4.29) Sig. (0.00) (0.00) (0.02) (0.00)

It may be noted that the effects of rainfall and temperature are both positive and negative, at different stages of the crop, are highly significant.

The terms used for other variables are defined below:

YIELD = Yield of wheat, of the zone, in kgs per hectare.

TREND = Time trend represents, improvement in technology, cultural & farm management, seed varieties etc..

NDEC = Sale of nitrogenous fertilizer, in n/tones, during the month of December.

NFEB = Sale of nitrogenous fertilizer, in n/tones, during the month of February.

RMARCH = Rainfall during the month of March in millimetres.

PRICE = Support price of wheat, in Rs. Per 40 kgs.

SMARX = Square of maximum temperature during the month of March, in centigrade

RFEB = Rainfall during the month of February, in millimetres.

RAND_F = Rainfall during the months of December to February, in millimetres.

For yield models, value of R_square, significance of effects of selected independent variables and Durbin Watson values for each zone are as under:

Zone	Adj. R Square	F	Durbin Watson
Cotton/wheat	0.85	44.4	1.935
Rice/wheat	0.89	56.8	2.101
Mixed crops/wheat	0.90	37.0	2.057
Barani areas	0.75	30.0	1.996

Wheat crop production, for the year 2003-04, predicted as on 15th April 2004 is 15855.6 thousand tones. It only differs by 1.4 percent as against 15639 thousand tonnes reported by the Punjab Agriculture Department in October 2004.

Efficiency of any model can not be tested, first of all, from the significance level of the parameters like R-Square, F, t, SSR or SSE only. In addition to these a good model should fulfill some other conditions as well. The first one is problem of colinearity (or multi colinearity) between the independent variables included in the model. If there is colinearity between the independent variables then, despite all good things, the model will not give proper forecast. It can be determined from the size of Condition Index (CI). If value of CI for a model is less then 10 there is insignificant colinearity between the independent variables. If it is between 10 to 30 than there is moderate and if more than 30 then severe colinearity. The second check of colinearity is the value of Variance Inflator (VIF) and Tolerance (1/VIF) level. Tolerance for a variable should be close to 1 if it is not significantly correlated with any independent variable. If it is so for all variables selected for the models then we can say that model is free from the effect of colinearity.

The second problem is of autocorrelation in random error terms. If the error terms in the regression model are positively auto correlated, then the values of MSE, standard deviation of estimated coefficients will be under estimated, tests using t and F distributions are no longer strictly applicable and model will be quit inefficient. Applying Durbin-Watson Test existence of autocorrelation can be checked. For any model, value of Durbin-Watson ranges between 0 to 4. If its value is equal to 2 then there is no autocorrelation and if it is between 1 and 2 then moderate positive autocorrelation. If value of Durbin Watson is less than 1 then there is high positive autocorrelation. Similarly, if it is between 2 and 3 then moderate negative autocorrelation. If value of Durbin Watson is greater than 3 then there is high negative autocorrelation.

Multi-colinearity and Autocorrelation for the above models, have been tested applying CI, VIF and Durbin Watson tests. For area and yield models of various zones, level of Multi-colinearity and Autocorrelation is as under:

Level of Multicollinearity and Autocorrelation in the Models

Zone	Area models		Yield models	
	Multi-collinearity	Autocorrelation	Multi-collinearity	Autocorrelation
Cotton/Wheat	Insignificant	Moderate	Moderate	Moderate
Rice/Wheat	Insignificant	Insignificant	Insignificant	Insignificant
Mixed Crops	Moderate	Moderate	Insignificant	Insignificant
Barani Areas	Insignificant	Insignificant	Insignificant	Insignificant

Problem of moderate Autocorrelation and Multicollinearity in selected area and yield forecasting models for some of the zones can be solved through further research and by including additional variables.

The following table shows area and production of wheat crop for the Punjab Province, predicted through the system, compared with the actual. The graph, which follows the table shows that the predicted values have the same trends as the actual values. It indicates that the models established for area and yield have given quite reliable results.

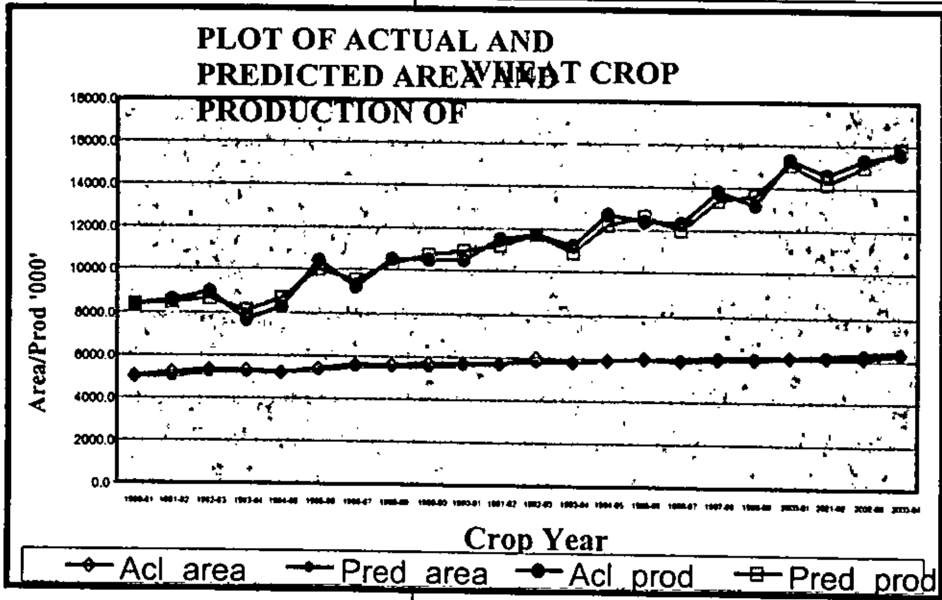
Actual and Predicted Area & Production of Wheat Crop for the Punjab Province

Year	Area'000'hect. Actual	Area'000'hect. Predicted	% Diff.	Prod.'000'tonnes Actual	Prod.'000'tonnes Predicted	% Diff.
1980-81	4978.0	4978.6	0.0	8350.0	8396.4	0.6
1981-82	5167.2	5032.9	-2.6	8573.3	8438.1	-1.6
1982-83	5285.0	5192.7	-1.7	8935.1	8803.6	-1.5
1983-84	5248.2	5167.1	-1.5	7622.8	7562.2	-0.8
1984-85	5165.7	5213.2	0.9	8315.1	8456.6	1.7
1985-86	5343.0	5237.8	-2.0	10431.6	10350.5	-0.8
1986-87	5573.7	5423.2	-2.7	9200.0	9433.3	2.5
1989-89	5589.4	5478.6	-2.0	10517.0	10319.2	-1.9
1989-90	5667.5	5534.9	-2.3	10518.2	10720.6	1.9
1990-91	5711.7	5628.6	-1.5	10513.8	10723.3	2.0
1991-92	5669.2	5633.4	-0.6	11492.3	11252.8	-2.1
1992-93	5960.5	5874.1	-1.4	11742.0	11734.9	-0.1
1993-94	5770.7	5769.4	0.0	11218.0	10986.4	-2.1
1994-95	5902.3	5845.6	-1.0	12713.0	12514.6	-1.6
1995-96	5973.5	5943.9	-0.5	12430.0	12629.2	1.6
1996-97	5839.9	5936.2	1.6	12371.0	12175.3	-1.6
1997-98	5934.6	6017.2	1.4	13807.0	13643.2	-1.2
1998-99	5934.6	6018.1	1.4	13212.0	13445.7	1.8
2000-01	6113.9	6088.1	-0.4	15321.9	15095.2	-1.5
2021-02	6101.8	6119.7	0.3	14594.4	14365.6	-1.6
2002-03	6097.3	6133.7	0.6	15355.0	15104.2	-1.6
2003-04	6255.0	6333.1	1.2	15639.0	15855.6	1.4

Note: Data of independent variable(s) were missing for 1987-88 and 1999-2000.

4.3 Calendar for Area and production Forecasts.

From this system, area and production forecasts will be available as per following schedule:



Area Forecasts		Production Forecasts	
First forecast	15th December	First forecast	15th February
Final forecast	15th February	Final forecast	15th May

The first forecasts provide provisional estimates of area and production based on todate crop inputs supply and weather conditions, while the final forecasts provide final estimates of area and production of the crop.

Summary of Conclusions and Recommendations

Timely availability of information on crop production can be very helpful to the government, agribusiness and growers in taking wiser policy decisions. Therefore, development of a system for crop area and production forecasts can help a lot to achieve this end. In this respect following recommendations are made:

- In Pakistan, different approachs and models are being recommended for crop forecasting. Some recommend that data of plant population, fruit count, soil moisture, plant health etc. may be used. Others recommend to use crops data obtained from satellite for this purpose. For crop forecasting, more suitable models will be those which are comparatively cost effective, more efficient, statistically well tested, simple and easily adaptable.

- It has been observed that major constraint in giving timely crop forecasting is time lag in availability of data of influencing factors. Therefore, only such models should be adopted for which data of all variables included in the models are available on time.

- In the province, there is proper organizational set up and system for collection of crops yield data only. Similarly, a system for collection of crops area, fertilizer off-takes, canal / tubewell water supplies, climate, farm-gate prices, pest & diseases attack and plant protection data should also be established in the provinces.

- A technical committee comprising experts from Provincial Crop Reporting Service, National Agricultural Research Centre, Economic Wing of MINFAL and Federal Bureau of Statistics should be constituted to develop the system.

- An advisory committee, comprising technical heads of Provincial Crop Reporting Service, Economic Wing of MINFAL and Federal Bureau of Statistics should be constituted to examine the forecasts before their release for the users.

REFERENCES

Azhar, Ghaffar Chaudhary & Shafique. A Forecast of Wheat Production in Punjab, 1973-74.

Box George E.P. and Jenkins Gwilym M. 1970: "Time Series Analysis, Forecasting and Control". Holden-Day, Inc; San Francisco.

Muhammad Asif Masood & Anver Javed (2004). "Wheat Production Forecast Model For Pakistan" Pak. J. of Agricultural Economics Vol. 5. No.1, 2004, 69-80.

Neter John & Wasserman Willian, 1974 : "Applied Linear Statistical Models".

S.M. Aslam Jafri, (1989). Crop Forecasting Techniques as an Input to Early Warning System (A Pakistan Study) unpublished.

Perveiz & Ramzan (1986). A Model for Forecasting Wheat Production in Four Provinces of Pakistan.

Wheel Wright Steven C. and Makridakis Spyros 1973: "Forecasting Methods for Management". John Wiley and Sons, Inc., New York.

STATISTICAL APPENDIX

Table 1: Headline and Core Inflation: 1991-92 to 2006-07

Year	Consumer Price Index by Group			*Core	Headline and Core Inflation			
	General	Food	Non-Food		General	Food	Non-Food	*Core
	Base 2000-01=100)				(Percent)			
1991-92	47.41	46.33	48.52	48.84	10.58	10.64	10.52	10.52
1992-93	52.07	51.84	52.31	52.51	9.83	11.74	7.81	7.5
1993-94	57.94	57.72	58.18	58.21	11.27	11.34	11.22	10.9
1994-95	65.48	67.24	64.09	64.43	13.02	16.67	10.17	10.7
1995-96	72.55	74.05	71.36	71.46	10.79	10.13	10.34	10.9
1996-97	81.11	82.86	79.73	79.62	11.80	11.89	11.73	11.4
1997-98	87.45	89.20	86.07	85.60	7.81	7.65	7.94	7.5
1998-99	92.46	94.46	91.12	89.47	5.74	5.90	5.61	4.5
1999-00	95.78	96.56	95.16	92.59	3.58	2.23	4.69	3.5
2000-01	100.00	100.00	100.00	100.00	4.41	3.56	5.09	4.2
2001-02	103.54	102.50	104.28	103.00	3.54	2.44	4.28	3.0
2002-03	106.75	105.40	107.66	103.10	3.10	2.89	3.24	2.0
2003-04	111.63	111.74	111.55	106.08	4.57	6.01	3.62	3.0
2004-05	121.98	125.69	119.47	113.67	9.28	12.48	7.10	7.2
2005-06	131.64	134.39	129.77	122.22	7.92	6.92	8.63	7.5
Jul-Apr								
2005-06	130.90	133.66	129.04	121.56	8.03	6.97	8.78	7.7
2006-07	141.23	147.34	137.07	128.91	7.89	10.24	6.24	6.0

* Core inflation is defined as overall inflation adjusted for food and energy.

Source: Pakistan Economics Survey, 2006-07.

Table-2: Price Indices: 1991-92 to 2006-07

Year	Wholesale Price Index by Group						Sensitive Price Index	GDP Deflator
	General	Food	Raw material	Fuel lighting & lubricants	Manufac-tures	Building material		
1991-92	44.84	45.42	43.78	34.09	52.38	56.72	46.26	224.33
1992-93	48.14	50.24	48.67	34.83	54.63	57.97	51.22	244.28
1993-94	56.03	57.23	62.55	40.81	63.67	66.47	57.26	274.73
1994-95	65.00	67.50	72.16	44.90	73.40	81.04	65.85	312.60
1995-96	72.22	75.44	75.95	52.95	79.88	87.23	72.90	338.48
1996-97	81.62	84.37	87.01	62.17	89.41	98.63	81.98	388.00
1997-98	86.99	90.45	93.81	69.65	91.62	98.62	88.01	413.39
1998-99	92.51	96.55	103.21	75.81	94.45	99.62	93.68	437.59
1999-00	94.15	97.09	92.39	83.16	98.76	97.15	95.39	100.00
2000-01	100.00	100.00	100.00	100.00	100.00	100.00	100.00	108.02
2001-02	102.01	101.95	100.31	103.14	101.87	101.10	103.37	110.71
2002-03	107.77	105.62	115.51	115.95	103.67	102.90	107.06	115.61
2003-04	116.29	112.99	135.12	119.23	111.83	126.48	114.38	124.55
2004-05	124.14	125.03	110.44	138.01	113.05	143.79	127.59	133.30
2005-06	136.68	133.78	121.93	174.57	116.27	144.18	136.56	145.59
Jul-Apr								
2005-06	135.86	133.07	120.97	173.02	115.90	143.58	135.45	-
2006-07	145.26	144.40	137.63	183.40	119.56	150.91	150.52	156.97

Source: Federal Bureau of Statistics.

Table-3: Indices of Crop Acreage and Production: 1990-91 to 2006-07

Year	Acreage Index				Production Index			
	All crops	Food crops	Fiber crops	Other crops	All crops	Food crops	Fiber crops	Other crops
	(1980-81=100)							
1990-91	113	112	126	97	142	122	230	110
1991-92	112	109	134	98	161	126	306	120
1992-93	115	114	134	99	141	124	216	118
1993-94	114	112	133	102	143	129	192	134
1994-95	116	115	126	108	152	139	208	140
1995-96	119	117	142	107	165	144	253	136
1996-97	118	114	149	110	158	145	224	130
1997-98	121	118	140	116	170	157	219	160
1998-99	121	118	139	122	171	159	210	166
1999-00	121	118	141	110	191	180	268	143
(1999-00=100)								
2000-01	97	97	98	95	93	91	96	94
2001-02	97	94	104	101	97	85	94	104
2002-03	95	95	94	107	104	92	91	112
2003-04	100	100	100	103	107	95	89	115
2004-05	101	100	107	95	104	106	127	102
2005-06	101	102	104	90	101	107	116	96
2006-07	103	103	103	101	117	115	114	118

Source : Federal Bureau of Statistics.

Table-4: Composition of Value Addition by Major Crops (At Constant Factor Cost 1999-2000)

(%age share)

Fiscal year/Crops	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
All major crops	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Food crops	63.30	62.32	60.34	62.66	63.52	61.55	63.28	64.00
Rice	15.40	15.62	14.54	15.85	16.94	15.28	17.30	15.75
Wheat	41.30	40.39	39.48	39.26	38.98	37.58	38.28	39.63
Barley	0.20	0.20	0.21	0.19	0.19	0.15	0.15	0.14
Jowar	0.40	0.44	0.46	0.39	0.46	0.31	0.27	0.29
Bajra	0.30	0.45	0.50	0.41	0.59	0.36	0.43	0.43
Maize	2.80	3.10	3.21	3.13	3.32	4.14	4.71	4.26
Gram	2.80	2.11	1.95	3.41	3.05	3.73	2.15	3.51
Fibre crops	24.00	24.89	25.26	22.98	22.06	27.21	25.64	23.62
Cotton	24.00	24.89	25.26	22.98	22.06	27.21	25.64	23.62
Cash crops	11.00	11.27	12.63	12.95	13.00	9.95	9.77	11.19
Sugarcane	11.00	11.27	12.63	12.95	13.00	9.95	9.77	11.19
Other crops	1.60	1.52	1.77	1.41	1.43	1.28	1.31	1.19
Sesamum	0.20	0.34	0.47	0.12	0.15	0.16	0.20	0.16
Rapeseed & mustard	0.80	0.70	0.75	0.81	0.81	0.65	0.57	0.47
Tobacco	0.60	0.84	0.55	0.48	0.46	0.47	0.54	0.57

Source: Federal Bureau of Statistics

Table-5: Growth Rates of Major Crops in Pakistan 1947-48 To 2006-07

Period	Parameter	Crops				
		Wheat	Rice	Maize	Sugarcane	Cotton
		---------------- Per cent per annum ----------------				
1947-48 to 1959-60						
Area		1.53	2.74	2.10	7.61	1.79
Yield		-1.18	-0.19	0.66	-1.53	2.09
Production		0.33	2.54	2.62	6.12	3.86
1959-60 to 1969-70						
Area		2.85	3.22	3.41	4.24	3.39
Yield		3.37	4.44	0.98	3.67	3.23
Production		6.32	7.80	4.42	8.06	6.48
1969-70 to 1979-80						
Area		1.27	3.31	0.43	3.19	0.80
Yield		3.18	0.59	1.79	-0.46	-1.54
Production		4.49	3.92	2.24	2.72	-0.76
1979-80 to 1989-90						
Area		1.06	0.36	1.85	0.24	2.48
Yield		1.52	-0.52	1.01	0.79	6.96
Production		2.60	-0.16	2.88	1.03	9.61
1989-90 to 1999-00						
Area		0.77	1.82	0.41	2.04	1.34
Yield		2.01	3.11	0.82	1.84	-0.88
Production		2.80	4.98	1.25	3.92	0.31
1947-48 to 1999-00						
Area		1.57	2.07	1.90	3.17	1.99
Yield		2.36	1.81	0.88	0.93	2.46
Production		3.98	3.92	2.79	4.10	4.50
1996-97 to 2006-07						
Area		0.27	0.47	0.37	-0.51	0.12
Yield		2.14	0.39	3.00	1.09	1.54
Production		2.41	0.86	3.37	0.57	1.65
1947-48 to 2006-07						
Area		0.56	0.82	0.78	1.19	0.81
Yield		1.07	0.71	0.59	0.40	1.04
Production		1.64	1.57	1.38	1.60	1.99

Note: The above growth rates are trend growth rates and have been calculated through Ordinary Least Squares (OLS) Method.

Table-6: Farm Level Cost of Production of Important Crops

Crop/ Year	Wheat		Seed Cotton		Rice Paddy			Sugarcane		
					Basmati	IRRI	IRRI			
	Punjab	Sindh	Punjab	Sindh	Punjab		Sindh	Punjab	Sindh	NWFP
------------------------- Rupees per 40 kgs --------------------------										
1982-83	65	54	-	-	93	55	56	-	-	-
1983-84	73	64	166	-	85	56	37	-	-	-
1984-85	70	64	176	107	85	57	37	7.10	7.10	7.10
1985-86	72	66	182	112	88	59	40	7.17	7.17	7.17
1986-87	77	70	170	163	104	68	52	7.73	6.92	7.67
1987-88	77	77	175	167	109	69	53	7.60	7.15	7.86
1988-89	81	80	175	167	114	73	56	8.21	7.60	8.36
1989-90	81	79	185	175	114	73	56	9.14	8.34	9.31
1990-91	93	94	214	211	136	82	67	10.53	9.39	10.90
1991-92	109	108	248	247	165	101	75	12.55	10.86	12.18
1992-93	123	121	278	273	174	106	83	13.23	12.72	13.57
1993-94	133	136	294	288	189	114	88	14.75	13.88	15.23
1994-95	153	155	328	330	213	128	103	16.13	15.81	16.39
1995-96	167	170	364	373	228	139	114	16.94	16.80	17.40
1996-97	204	201	412	425	259	161	130	18.72	18.40	18.79
1997-98	244	241	544	519	297	182	144	22.21	22.22	22.18
1998-99	254	247	581	557	310	189	158	25.11	24.57	24.57
1999-00	269	261	606	582	329	204	167	26.25	25.48	25.58
2000-01	285	264	660	610	353	210	168	27.22	26.39	26.51
2001-02	307	283	734	666	382	227	176	32.40	30.39	32.29
2002-03	322	291	757	685	400	241	184	31.71	31.35	30.29
2003-04	344	313	815	718	439	258	195	34.59	33.33	31.71
2004-05	389	358	839	786	439	258	195	35.98	34.59	32.31
2005-06	428	406	856	791	517	297	232	39.27	40.86	34.70
2006-07	449	423	963	884	566	324	255	46.48	47.56	40.53
2007-08	436	420	1,015	935	605	346	274	46.48	51.73	45.66

Source: Agriculture Policy Institute (API), Islamabad.

Table-7: Farm Level Cost of Production of Selected Crops

Crop/ year	Non-traditional Oilseeds		Potatoes	Gram	Onions	
	Sunflower	Canola			Punjab,Sindh & N.W.F.P	Balochistan
	Rupees per 40 kgs					
1982-83	127	-	38	141	23	23
1983-84	139	-	-	-	-	-
1984-85	139	-	41	138	-	-
1985-86	144	-	44	139	29	29
1986-87	146	-	43	149	29	29
1987-88	152	-	41	149	31	31
1988-89	165	-	47	157	34	34
1989-90	165	-	49	172	37	37
1990-91	186	-	49	173	43	43
1991-92	203	-	58	176	50	42
1992-93	218	-	61	192	55	48
1993-94	238	-	68	225	61	52
1994-95	282	-	73	263	67	59
1995-96	318	-	79	298	72	64
1996-97	377	371	98	313	82	73
1997-98	412	397	123	347	91	84
1998-99	434	421	125	323	102	93
1999-00	448	455	123	376	108	106
2000-01	461	461	124	436	106	125
2001-02	-	-	-	-	-	-
2002-03	-	-	-	-	-	-
2003-04	522	525	-	-	-	-
2004-05	549	-	-	-	-	-
2005-06	678	662	200	-	149	-
2006-07	715	688	200	720	-	-

Source: Agriculture Policy Institute(API), Islamabad.

Table-8: Nominal and Real Support Prices of Food Crops 1990-91 to 2006-07

Year	Wheat		Rice Paddy			
			Basmati		IRRI (FAQ)	
	Nominal	Real	Nominal	Real	Nominal	Real
1	2	3	4	5	6	7
---------------------- Rupees per 40 kgs --------------------						
1990-91=100						
1990-91	**112.00**	**112.00**	**142**	**142.00**	**77**	**77.00**
1991-92	124.00	112.14	154	139.27	100	90.43
1992-93	130.00	107.04	189	155.62	114	93.87
1993-94	160.00	118.40	193	142.81	100	74.00
1994-95	160..00	104.76	190	124.40	142	92.97
1995-96	173.00	102.24	234	138.29	184	108.74
1996-97	240.00	126.86	283	149.59	161	85.10
1997-98	240.00	117.67	290	142.18	207	101.49
1998-99	240.00	111.29	370	171.57	231	107.11
1999-00	300.00	134.29	364	162.94	203	90.87
2000-01=100						
2000-01	**300.00**	300.00	410	410.00	180	180
2001-02	300.00	289.74	470	453.93	205	198
2002-03	300.00	281.03	502	470.26	218	204
2003-04	350.00	313.54	505	452.35	257	230
2004-05	400.00	325.26	560	459.09	338	277
2005-06	415.00	312.69	537	409.36	290	221
2006-07	425.00	296.83	594	419.11	310	219

Source: Agriculture Policy Institute (API), Islamabad.

Table-9: Nominal and Real Support Prices of Cash Crops: 1990-91 to 2006-07

Year	Seed Cotton MNH-93		Sugarcane Punjab		Sugarcane Sindh	
	Nominal	Real	Nominal	Real	Nominal	Real
1	2	3	4	5	6	7
	Rupees per 40 kgs					
	1990-91=100					
1990-91	330	330.00	15.25	**15.25**	**15.75**	**15.75**
1991-92	342	309.28	16.75	15.15	17.00	15.37
1992-93	386	317.83	18.50	15.23	18.75	15.44
1993-94	471	348.53	19.00	14.06	20.40	15.10
1994-95	810	530.35	20.50	13.42	21.90	14.34
1995-96	753	445.01	25.00	14.77	25.00	14.77
1996-97	872	460.94	38.00	20.09	40.00	21.14
1997-98	857	420.18	35.00	17.16	39.00	19.12
1998-99	936	434.94	32.00	14.84	36.00	16.69
1999-00	614	274.86	35.00	15.67	42.00	18.80
	2000-01=100					
2000-01	957	957	45.00	45.00	50.00	50.00
2001-02	813	785	37.00	36.00	47.00	45.00
2002-03	921	863	35.00	33.00	36.00	34.00
2003-04	1370	1227	34.00	30.00	35.00	31.00
2004-05	885	726	40.00	33.00	41.00	34.00
2005-06	1017	773	60.00	46.00	60.00	46.00
2006-07	1110	779	60.00	42.00	67.00	47.00

Source: Agriculture Policy Institute(API), Islamabad.

Table-10: International Prices of Major Agricultural Commodities: 1980-81 to 2006-07

Year	Cotton (cif North Europe)		Wheat	Rice	Sugar		Edible oils		
	Sindh/ Punjab Afzal 1-1/32"	Index-B Cottons	(Fob, pacific) US Western white	100% second grade (fob, Bangkok)	Raw sugar ISA price (fob & stowed caribbean) port in bulk	White sugar (fob & stowed London)	Soybean oil (fob Decature)	Palm oil (fob Malay-sia)	Sun-flower (fob NW Europ-ean ports)
	- US cents/lb--		US $ per tonne						
1980-81	-	-	-	-	-	-	519	588	-
1981-82	64.96	63.96	-	-	203	284	464	571	-
1982-83	65.95	67.25	165	272	174	243	405	445	-
1983-84	74.13	79.68	145	267	139	190	520	502	-
1984-85	54.00	57.55	140	217	139	146	681	742	-
1985-86	36.13	39.25	134	188	133	185	572	498	-
1986-87	59.84	59.59	108	186	139	187	343	283	-
1987-88	63.94	64.97	119	220	206	246	349	344	-
1988-89	61.42	63.50	168	284	263	351	519	443	476
1989-90	76.51	77.27	158	296	301	402	417	328	482
1990-91	76.32	77.22	117	292	203	303	458	317	480
1991-92	56.67	57.06	154	290	202	280	417	365	459
1992-93	53.99	53.25	150	253	211	274	471	379	492
1993-94	61.45	69.39	133	297	248	323	596	448	627
1994-95	75.89	75.44	163	282	302	397	605	647	691
1995-96	80.95	80.48	200	365	270	384	550	523	617
1996-97	76.23	75.27	163	342	245	319	504	525	545
1997-98	72.23	68.00	139	308	218	272	571	605	726
1998-99	51.28	68.00	115	290	146	216	439	487	560
1999-00	47.46	49.28	112	235	159	202	349	331	410
2000-01	56.78	53.70	113	185	206	250	335	235	428
2001-02	3841	38.95	132	189	151	232	411	329	587
2002-03	51.36	51.42	146	198	179	228	539	421	592
2003-04	60.10	63.17	149	220	145	224	632	481	663
2004-05	46.10	51.19	143	274	198	275	545	392	703
2005-06	54.59	55.06	134	298	327	408	572	416	635
2006-07	58.63	56.61	188	312	257	376	771	655	846

Sources:

- For wheat: International Grains Council, London.
- For cotton: Cotton Outlook, UK.
- For rice: Food Outlook. FAO, Rome.
- For sugar: International Sugar Organization (ISO), London.
- For edible oils: Oil World.

Table -11: Average Export Prices (fob Karachi) of Agricultural Commodities: 1980-81 to 2006-07

Year	Export prices (fob Karachi)					
	Cotton	Rice		Sugar	Onions	Potatoes
		Basmati	IRRI			
	Rupees per tonne					
1980-81	15,994	7,029	3,168	-	1,580	1,820
1981-82	12,694	7,599	3,061	2,887	1,830	1,800
1982-83	15,288	8,005	2,668	2,619	1,220	1,940
1983-84	18,041	8,090	2,697	3,341	1,240	1,850
1984-85	16,612	9,394	3,030	-	1,460	2,270
1985-86	12,976	10,813	2,582	-	1,290	1,640
1986-87	11,976	12,369	2,577	-	1,140	1,500
1987-88	21,429	12,672	3,520	-	1,260	1,800
1988-89	21,459	13,259	4,420	5,820	2,260	2,140
1989-90	32,424	14,583	3,860	9,699	1,850	1,380
1990-91	33,912	10,494	3,881	-	3,460	2,400
1991-92	28,435	10,261	4,825	-	2,080	1,980
1992-93	26,629	11,189	5,364	-	2,190	2,140
1993-94	31,818	12,427	5,166	9,912	4,170	2,580
1994-95	62,059	12,526	5,961	11,936	3,900	2,540
1995-96	56,029	13,830	7,923	12,015	3,840	1,770
1996-97	59,135	17,469	7,847	-	4,250	3,820
1997-98	61,847	19,827	8,676	13,757	5,930	5,420
1998-99	66,565	24,050	10,450	12,739	17,710	6,960
1999-00	45,335	26,390	9,587	16,524	7,995	5,532
2000-01	59,753	27,527	9,496	-	7,789	6,661
2001-02	42,971	28,830	10,273	6,605	6,234	6,555
2002-03	51,906	29,408	10,293	1,305	5,580	5,746
2003-04	89,616	29,759	12,133	13,689	7,429	5,966
2004-05	81,289	31,964	14,110	18,782	7,497	8,862
2005-06	78,572	34,340	14,356	26,055	9,839	11,250
2006-07	67,632	37,154	15367	-	9578	10,952

Source: Federal Bureau of Statistics.

Table-12: Average Import Prices (cif Karachi) of Agricultural Commodities: 1980-81 to 2006-07

Year	Import Prices (cif Karachi)							
	Wheat	Gram	Sugar	Onions	Potatoes	Edible oils		
						Soyabean	Palm	Sun-flower
	Rupees per tonne							
1980-81	2,076	-	6,704	8,760	1,710	5,770	5,450	-
1981-82	2,224	-	5,873	5,530	1,640	5,450	5,370	-
1982-83	2,204	-	4,248	5,280	5,420	5,760	2,270	-
1983-84	2,952	-	4,265	3,900	2,170	8,620	5,270	-
1984-85	2,807	-	-	-	-	12,470	8,640	-
1985-86	2,472	-	3,601	-	-	9,830	9,480	-
1986-87	3,132	-	3,686	-	-	6,830	6,490	-
1987-88	3,079	-	3,815	-	1,220	8,060	4,910	-
1988-89	3,229	-	4,708	-	-	11,560	6,960	-
1989-90	4,197	10,580	9,102	-	-	10,410	6,890	-
1990-91	3,208	8,360	8,269	3,730	1,070	13,733	8,340	-
1991-92	4,205	11,960	7,832	-	4,410	12,599	9,098	-
1992-93	4,212	8,730	7,357	2,560	3,900	11,494	11,296	18,234
1993-94	3,804	8,870	9,335	1,100	1,110	15,848	12,549	19,816
1994-95	4,874	12,450	13,228	2,070	1,030	21,394	22,214	22,683
1995-96	7,718	13,430	15,606	1,170	2,900	24,599	25,170	23,100
1996-97	7,570	10,860	14,480	2,360	2,560	23,489	22,420	24,400
1997-98	7,413	11,370	15,189	5,990	2,620	33,964	28,244	32,793
1998-99	5,886	17,420	15,122	3,800	1,570	30,881	30,488	36,378
1999-00	7,316	16,700	15,850	3,178	1,822	43,360	19,850	-
2000-01	-	19,370	15,557	3,514	1,162	36,320	16,240	-
2001-02	-	19,790	17,185	5,661	1,258	36,980	19,990	-
2002-03	-	18,290	18,158	3,063	1,214	36,730	25,300	-
2003-04	12,550	18,234	16,539	3,090	1,227	32,460	27,574	-
2004-05	12,924	18,990	19,606	8,294	3,756	44,261	27,254	-
2005-06	9,729	17,533	24,465	5,275	5,275	39,436	25,810	-
2006-07	18,520	35,659	26,804	10,632	5,479	-	-	-

Sources: Federal Bureau of Statistics.

Table-13: Import Parity Prices of Agricultural Commodities 1980-81 to 2006-07

Years	Wheat based on fob (Pacific) price of US western white wheat		Sugarcane based on fob (London) price of white sugar		Onions	Potatoes	Edible oils		
					Based on actual import prices		Soyabean	Sunfl-ower	Canola
	If consumed at Karachi	If consumed at Lahore	Punjab & NWFP	Sindh			Based on their respective quoted price		
	---------- Rupees per 40 kgs ----------								
1980-81	-	-	-	-	-	-	-	-	-
1981-82	-	-	-	-	-	-	-	-	-
1982-83	-	-	-	-	-	-	-	-	-
1983-84	-	-	-	-	-	-	-	-	-
1984-85	-	-	-	-	-	-	-	-	-
1985-86	-	-	-	-	-	-	-	-	-
1986-87	-	-	7	7	-	-	-	-	-
1987-88	-	-	-	-	-	-	-	-	-
1988-89	-	-	19	19	-	-	-	-	-
1989-90	171	-	20	20	-	-	-	-	-
1990-91	-	-	19	19	-	70	-	-	-
1991-92	170	200	20	20	-	223	129	178	-
1992-93	190	240	24	25	-	-	138	207	-
1993-94	175	227	-	-	-	-	163	296	-
1994-95	236	293	-	-	-	-	342	391	-
1995-96	323	397	46	47	-	280	422	368	391
1996-97	280	368	-	-	115	256	430	368	417
1997-98	265	357	-	-	151	-	476	547	536
1998-99	280	357	-	-	-	-	379	420	427
1999-00	281	366	-	-	-		357	325	330
2000-01	320	404	45.16	46.22	-	-	-	-	-
2001-02	365	449	43.44	44.46	-	-	-	-	-
2002-03	403	453	39.13	40.05	-	-	-	-	-
2003-04	476	556	34.12	34.92	-	-	-	-	-
2004-05	457	544	43.71	44.74	-	-	-	-	-
2005-06	384	480	52.73	53.97	-	-	-	-	-
2006-07	637	696	62.49	63.96	-	-	-	-	-

Source: Agriculture Policy Institute (API), Islamabad.

Table-14: Export Parity Prices of Agricultural Commodities: 1980-81 to 2006-07

Years	Seed cotton based on Afzal 1-1/32" cif (North Europe) price	Rice (paddy) based on actual export prices		Sugarcane based on fob (London) price of white sugar		Onions	Potatoes
		Basmati	IRRI	Punjab & NWFP	Sindh	Based on actual exports prices	
	---------------------- Rupees per 40 kgs --------------------						
1980-81	-	-	-	-	-	-	-
1981-82	-	-	-	-	-	-	-
1982-83	-	-	-	-	-	-	-
1983-84	-	-	-	-	-	-	-
1984-85	-	-	-	-	-	-	-
1985-86	-	169	30	-	-	39	-
1986-87	191	229	46	-	-	-	-
1987-88	352	229	46	-	-	-	-
1988-89	279	228	66	-	-	20	9
1989-90	426	237	94	-	-	164	87
1990-91	477	134	40	-	-	49	39
1991-92	-	155	84	-	-	52	112
1992-93	391	167	82	-	-	33	136
1993-94	539	201	70	19	19	169	121
1994-95	711	162	74	27	26	127	79
1995-96	851	168	110	-	-	117	87
1996-97	903	244	129	33	34	125	105
1997-98	844	359	155	34	34	190	118
1998-99	514	421	189	22	22	530	223
1999-00	514	489	165	22	23	193	142
2000-01	936	509	170	26.90	27.53	-	-
2001-02	660	486	161	25.36	25.96	-	-
2002-03	807	494	168	26.05	26.66	-	-
2003-04	1,211	514	229	22.15	22.67	-	-
2004-05	840	549	278	30.72	31.44	-	-
2005-06	903	713	304	37.61	38.49	-	-
2006-07	1,099	738	333	46.00	47.08	-	-

Source: Agriculture Policy Institute (API), Islamabad.

Table-15: Support and Market Prices of Wheat and Quantities Procured: 1980-81 To 2006-07

Year	Support price	Market price *	Difference between market and support prices	Procurement by government agency	Government agency
	Rs per 40 kgs		Percent	Million tonnes	
1980-81	58	60	3	3.99	PASSCO and Provincial Food Departments
1981-82	58	62	6	3.13	
1982-83	64	67	4	3.82	
1983-84	64	71	10	2.28	
1984-85	70	77	9	2.53	
1985-86	80	82	2	5.04	
1986-87	80	80	-	3.98	
1987-88	83	85	2	3.49	
1988-89	85	93	9	4.13	
1989-90	96	102	6	4.41	
1990-91	112	121	8	3.16	
1991-92	124	134	8	3.25	
1992-93	130	139	7	4.12	
1993-94	160	170	6	3.64	
1994-95	160	176	10	3.74	
1995-96	173	185	7	3.45	
1996-97	240	273	14	2.72	
1997-98	240	259	8	3.98	
1998-99	240	261	9	4.07	
1999-00	300	297	-1	8.55	
2000-01	300	275	-8	4.00	
2001-02	300	292	-3	4.04	
2002-03	300	305	2	3.51	
2003-04	350	388	11	3.51	
2004-05	400	471	18	3.45	
2005-06	415	420	1	3.88	
2006-07	425	432	2	4.42	

* Average wholesale price of Multan, Okara and Hyderabad during post harvest period: April – July.

Sources:

- MINFAL, Islamabad.
- ALMA, Karachi.
- Agriculture Marketing Information Services, Lahore.
- PASSCO, Lahore.
- Provincial Food Departments.

Table-16: Support and Market Prices of Basmati and IRRI Paddy: 1980-81 to 2006-07

Year	Basmati		IRRI	
	Support price*	Market price **	Support price*	Market price**
	Rs per 40 kgs			
1980-81	75	-	39	-
1981-82	85	-	45	-
1982-83	88	90	49	-
1983-84	90	92	51	-
1984-85	90	92	51	-
1985-86	93	114	53	59
1986-87	102	113	53	53
1987-88	130	141	55	70
1988-89	135	135	60	73
1989-90	143	136	66	69
1990-91	143	143	73	78
1991-92	155	158	78	98
1992-93	175	190	85	112
1993-94	185	194	90	98
1994-95	211	192	103	137
1995-96	222	231	112	181
1996-97	255	296	129	164
1997-98	310	297	153	205
1998-99	330	362	175	234
1999-00	350	358	185	206
2000-01	385	302	205	179
2001-02	385	361	205	205
2002-03	-	471	-	221
2003-04	400	473	215	252
2004-05	415	453	230	346
2005-06	460	427	260	289
2006-07	-	451	-	320

* Support/indicative price of Basmati-385 paddy(Punjab) and IRRI paddy in sindh

** Average wholesale prices in the main producing area markets during post-harvest (November to January) for Basmati paddy in the Punjab and for IRRI paddy in Sindh.

Sources:

Agriculture Marketing Information Services, Lahore for Basmati and Agriculture Market committees of respective area of Sindh for IRRI.

Table-17: Support and Market Prices of Seed Cotton and average Spot rate of Cotton Lint : 1980-81 to 2006-07

Year	Seed cotton		Cotton Lint	
	Support price	Market price(*)	Support price	Market price
	-------------------Rs per 40 kgs----------------------			
1980-81	182	174	476	482
1981-82	192	193	473	453
1982-83	197	188	473	496
1983-84	200	336	496	824
1984-85	203	182	500	549
1985-86	207	196	500	509
1986-87	207	211	500	538
1987-88	207	234	504	610
1988-89	210	238	507	617
1989-90	225	279	539	732
1990-91	260	334	645	840
1991-92	290	337	715	883
1992-93	310	382	770	982
1993-94	325	475	801	1,232
1994-95	423	794	986	2,060
1995-96	423	739	986	1,962
1996-97	540	840	-	2,575
1997-98	540	808	-	2,525
1998-99	-	876	-	2,722
1999-00	825	580	-	2,051
2000-01	725	941	-	2,961
2001-02	780	783	-	2,289
2002-03	800	842	-	2,577
2003-04	850	1282	-	3163
2004-05	925	893	-	2296
2005-06	975	1,038	-	2577
2006-07	1,025	1,144	-	2750

* Average wholesales prices of seed cotton (phutti) in the main producing area markets of the Punjab and Sindh.

Sources:

- Pakistan Central Cotton Committee (PCCC), Karachi.
- Agriculture Marketing Information Services, Lahore.
- Karachi Cotton Association for Cotton Lint Prices.

Table-18: Support and Market Prices of Gram, Onions and Potatoes: 1980-81 to 2006-07

Year	Gram		Onions		Potatoes	
	Support price	Market price*	Support price	Market price*	Support price	Market price*
	Rs per 40 kgs					
1980-81	-	186	19.30	27	26.80	61
1981-82	-	249	19.30	77	26.80	53
1982-83	-	189	25.00	49	40.50	35
1983-84	153	149	30.00	82	40.50	60
1984-85	153	169	30.00	62	40.50	61
1985-86	153	151	32.50	36	42.00	45
1986-87	161	131	34.50	76	44.50	47
1987-88	161	242	36.50	66	44.50	94
1988-89	180	245	40.00	94	50.00	85
1989-90	200	182	44.00	76	55.00	38
1990-91	210	177	54.50	123	55.00	104
1991-92	230	267	65.00	85	65.00	81
1992-93	235	338	70.00	156	67.00	82
1993-94	275	479	84.00	136	77.00	77
1994-95	315	632	84.00	168	84.00	103
1995-96	330	332	92.00	125	84.00	238
1996-97	400	423	106.00	201	115.00	288
1997-98	425	401	125.00	234	145.00	116
1998-99	425	628	140.00	257	145.00	106
1999-00	-	760	-	105	145.00	111
2000-01	425	798	-	120	-	144
2001-02	-	882	-	243	-	195
2002-03	-	933	-	108	-	231
2003-04	-	610	-	262	-	148
2004-05	-	694	-	266	-	157
2005-06	-	720	-	198	-	379
2006-07	-	1,102	-	198	-	469

* Average wholesale during post-harvest prices in main producing area markets.

Sources:

- ALMA, Karachi.
- Agriculture Marketing Information Services, Lahore.

Table-19: Support/ Indicative Prices of Sunflower and Canola Oilseeds: 2000-01 to 2006-07

Crop year	Sunflower		Canola	
	Support price/ indicative price	Market price*	Support price/ indicative price	Market price*
	---Rs/40 kgs---			
2000-01	-	650	-	600
2001-02	-	600	-	650
2002-03	630	725	650	750
2003-04	670	700	650	795
2004-05	-	721	-	758
2005-06	690	728	690	760
2006-07	830	730	750	1,051

*Average wholesale prices during post-harvest in major producing area markets.

Sources: All Pakistan Solvent Extractor Association (APSEA).

Table-20: Average Market Prices of Fertilizer: 1983-84 to 2006-07

(Rs per 50 kg bag)

Year	Urea	DAP	SSP	NP	SOP
1983-84	128	133	40	110	40
1984-85	128	133	40	110	40
1985-86	128	146	40	110	50
1986-87	130	146	46	110	50
1987-88	135	161	53	119	60
1988-89	165	185	58	137	72
1989-90	185	217	68	150	107
1990-91	195	249	93	173	150
1991-92	195	272	93	173	150
1992-93	205	264	93	196	195
1993-94	210	269	96	203	195
1994-95	235	379	150	250	195
1995-96	267	479	183	320	331
1996-97	340	553	211	384	532
1997-98	341	565	200	397	540
1998-99	346	665	234	457	541
1999-00	327	649	298	464	543
2000-01	363	670	253	468	682
2001-02	394	710	280	519	765
2002-03	411	765	287	539	780
2003-04	420	913	329	622	809
2004-05	468	1001	373	704	996
2005-06	509	1079	407	710	1170
2006-07	527	957	329	650	998

Source:
1. Federal Bureau of Statistics.
2. National Fertilizer Development Centre, Islamabad.

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1. Manuscripts of articles, comments and reviews should be in English only and sent in triplicate preferably accompanied with 1.44 MB diskette in MS Words to the Chief Editor, Pakistan Journal of Agricultural Economics. Comments and Reviews should be submitted alongwith two copies of relevant book or paper.

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