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INFLUENCE OF AVERAGE MARKET PRICE OF FERTILIZERS AND AGRICULTURAL CREDITS ON THE ACREAGE RESPONSE OF SUGARCANE IN NWFP

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ABSTRACT

The study makes an effort to measure economic influence of market retail sale price of fertilizers as well as the term-wise agricultural credits on the sugarcane acreage in NWFP. In this regard, the time-series data have been used over a period of 17 years from 1991-92 to 2007-08. The statistical analysis has been done through Nerlovian Adjustment Model and Augmented Dickey Fuller Test. The results reveal that area under sugarcane crop have been tremendously expanded due to favourable market retail Price of fertilizers in proportional significance ratios [DAP ($P<0.05$), SSP ($P<0.10$), NP ($P<0.05$)] as well as the adequate provision of agricultural credits [short-term credits (SC) ($P<0.05$) and medium-term credits (MC) ($P<0.01$)]. Results revealed that sugarcane growers were successful in bringing the long run equilibrium output. Such development has resulted in meeting not only domestic consumption adequately in NWFP as well as in Punjab and Sindh provinces of the country, but more specifically it helped in reducing the burden of sugar import in the country.

Key words: Acreage, price of fertilizer, agricultural credits, Nerlovian Adjustment Model, sugarcane.

INTRODUCTION

Sugarcane being major cash crop grown widely for sugar and gur production in three provinces of Pakistan; Punjab, Sindh and North West Frontier Province (NWFP). In accordance to NWFP Bureau of Statistics, area under sugarcane production in NWFP during 2007-08 was recorded as103.27 000hectares, and its yield as 46005 kg per hectare. Sugarcane crop is planted in the month of spring and harvested after 8-10 months. In NWFP, sugar beet is also processed in the months of May and June after the sugarcane crop. The comparative advantage of sugarcane production in NWFP over other provinces can be judged from the official rates of sugarcane in NWFP province, Rs. 65 per 40 kg as compared to Rs. 63 in Sindh and Rs.60 in Punjab (Chaudhry, 1995). It is painful reality that poor sugarcane growers are not getting fair return of their bumper produce in kharif season. Sugarcane supply to sugar mills in NWFP is reported hardly 30 percent as growers are supplying a substantial quantity of sugarcane to gur producers in the province. However, sugar mills in Dera Ismail Khan are continuously making utmost efforts but sugar recovery level in the NWFP is reported as 1.5 to 2 percent - severely reduced due to frost. Many researchers have intensively and extensively conducted studies on estimating the acreage response of major crops including sugarcane (Banger *et al*., 1991; Abd *et al*., 1992; Kanwar, 2004).

Majority of sugarcane growers in NWFP are subsistence farmers and are not in a position to use high quality seed, chemical fertilizers, improved farm implements, and other modern farm inputs right from seed bed preparation to the disposal of produce. Lack of finances is one of the main reasons relatively low sugarcane productivity. Small (2.5 to 5 acres) and medium size (5 to 10 acres) farmers require liquid capital (agricultural credits), certified seed, chemical fertilizer, insecticide, timely and regular flow of irrigation for efficient agronomic practices on the farm.

The present study is focused on designing unique sugarcane area model for major contributing sugarcane producing province (NWFP) in Pakistan. The past studies have indicated that sugarcane growers in Pakistan are responsive to price changes and they adjust their productive resources accordingly for growing sugarcane crop (Kanwar, 2004). The objective of the present study was to enhance our conceptual level of the estimation of sugarcane acreage response and to suggest policy guideline for implementation.

MATERIALS AND METHODS

Model specification and data: The scientific analysis of this study is conducted through Nerlovian Adjustment Model and Augmented Dickey Fuller Test (Koc, 1999). In this regard, the sample of time series data that cover 1991-92 through 2007-08 have been utilized to measure the influence of average market retail sale price of fertilizers and term-agricultural credits on sugarcane acreage in NWFP.

Sugarcane acreage equation can be symbolically expressed in simple form as;

Sugarcane acreage = f (Average market retail price of fertilizers as price factors and term-wise agricultural credits as non-price factors, lagged area planted to sugarcane crop).

Since sugarcane is annually grown cash crop, once it is planted, then other crop may be planted for at least 2-3 years later on the same piece of land because of rationing. The data on sugarcane acreage was obtained from Agricultural Statistics of Pakistan, (Anonymous, 2007-08).

Norlovian Adjustment Model in single variant linear relationship form as:

$A^*_t = bo + bP_{t-1} + U_t$ ----------(i)

U_t is the stochastic error term, while A^*_t is the sugarcane acreage; the growers may plant in period of time t, if there is no hurdle of making adjustment. Anyhow equation (i) cannot be estimated as A^*_t is unobservable. There is one possibility to convert into observable equation for estimation, if it is assumed that sugarcane acreage actually grown in period of time t equals to t-1, plus a term that is proportional to the difference between the acreage, growers may grow at time t and the acreage, where farmers planted actually in the last period. Thus hypothesis can be drawn in the following manner:

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

The institutional and technological factors prevent the desired sugarcane acreage from being realized during a period of time and β is called as sugarcane adjustment coefficient.

The adjustment coefficient β is derived by deducting 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 basic estimating equation of sugarcane acreage in responses of price {Average market retail sale price of fertilizers (Rs. per bag of 50 kg) lagged by one year} and non-price {Term-wise agricultural credit advanced by ADBP (Rs. in million)} factors applied are:

$A_t = b_o + b_1 UP_{t-1} + b_2 DP_{t-1} + b_3 SSP_{t-1} + b_4 NPI_{t-1} + b_4 SOP_{t-1} + b_5 SC_t + b_6 SM_t + b_7 A_{t-1} + V_t$ ------- (iii)

Where

A_t = Acreage (hectares) under sugarcane crop in year t.

UP_{t-1} = Urea price (Rs. per bag of 50 Kg) lagged by one year.

DP_{t-1} = DAP price (Rs. per bag of 50 Kg) lagged by one year.

SSP_{t-1} =SSP price (Rs. per bag of 50 Kg) lagged by one year.

NP_{t-1} = NP price (Rs. per bag of 50 Kg) lagged by one year.

SOP_{t-1} = SOP price (Rs. per bag of 50 Kg) lagged by one year.

SC_t = Short-term agricultural credits (Rs. in Million) in year t.

MC_t = Medium-term agricultural credits (Rs. in Million) in year t.

A_{t-1} = Area lagged one year V_t = Error term in year t

Logarithmic linear versions are applied on both sides of equation (iii) as follows:

$\text{Log}A_t = \text{Log}\, b_o + b_1 \text{Log}\, UP_{t-1} + b_2 \text{Log}\, DP_{t-1} + b_3 \text{Log}\, SSP_{t-1} + \text{Log}\, NP_{t-1} + b_4 \text{Log}\, SOP_{t-1} + b_5 \text{Log}\, SC_t + b_6 \text{Log}\, SM_t + b_7 \text{Log}\, A_{t-1} + \text{Log}\, V_t$ ----iv

RESULTS AND DISCUSSION

Unit Root Tests for Residuals: Augmented Dickey-Fuller Test for Unit Root has been applied for the purpose of determining the order of integration. It has been observed that Augmented Dickey-Fuller Unit Root Test rejects the null hypothesis of non-stationarity of all variables, when 1st, 2nd and 4th difference variables are applied, which clearly confirm that respective variables are stationary of order 1, 2 and 4 i.e 1(1), 1(2) and 1(4) as reflected in Table 1.

Table 1: Unit Root Test

Variables	ADF (Levels) (Non-Stationarity)		ADF in Differences (Stationarity)		Order of Integration through differencing 1( )
	Without Trend	With Trend	Without Trend	With Trend	
A_t	-3.0274	-2.8947	-4.6354	-4.5374	1(1)
UP_{t-1}	-0.86699	-1.8105	-4.9229	-4.7321	1(2)
DP_{t-1}	-1.3519	-1.1740	-3.9094	-4.1089	1(2)
SSP_{t-1}	-1.6656	-1.3439	-4.8023	-4.8435	1(2)
NP_{t-1}	-2.2910	-0.64274	-4.3081	-4.5030	1(2)
SOP_{t-1}	-1.6726	-1.5340	-4.6133	-4.3805	1(4)
SC_t	-1.7858	-3.2920	-4.6690	-4.9656	1(1)
MC_t	-2.9846	-3.7998	-4.3778	-3.9574	1(1)
A_{t-1}	-2.7520	-2.6370	-5.0916	-5.2295	1(1)

Note: All variables are measured in natural logarithms; 95% critical values = -3.0819 (without trend); and 95% critical values = -3.7612 (with trend)

The data derived from Agricultural Statistics of Pakistan, (Anonymous 2007-08) the regression was run on the log linear version of model (iv) by applying the Ordinary Least Squares (OLS) measures of estimation. The results shown in Tables 2, 3 and 4; provide useful data about factors (Lagged average market retail sale price of fertilizers, term-wise agricultural credits and its own lagged value) for bringing about change in sugarcane acreage as dependent variable of the model. Among average market retail sale price of fertilizers,

DAP_{t-1}, $SSP_{t-1,}$ and NP_{t-1} have shown significant and positive relationship with sugarcane acreage at P<0.05, P<0.10 and P<0.05 respectively (Abd *et al.,* 1992; Huang and Uri, 1992; Sampietro and Vattuone, 2006a), while among term-wise agricultural credits, SC_t and MC_t has shown significant influence on sugarcane acreage at P<0.05 and P<0.01 respectively. Hence, the farmer's agronomic practices for sowing sugarcane crop have become to have extensive bearing on its cultivation. These results are in agreement with the previous studies (Wang *et al*; 1994; Singh *et al*. 2003). Since the adjustment coefficient (β) is relatively large (0.92), it means there are less technological and institutional constraints to prevent the farmers from realizing the desired sugarcane equilibrium acreage level in NWFP, (Banger *et al*. 1991). A high rate of adjustment is observed (β= 0.92), indicating that sugarcane acreage is influenced less by technological and institutional inflexibilities (de Carvalho *et al*., 1996).

Table 2: Log-linear response functions for sugarcane acreage and explanatory variables over a period of time (1995-96 to 2007-08) in NWFP

Dependent variable is A_t with order of integration 1(1) 13 observations used for estimation from 1995-96 to 2007-08			
Regresser	Coefficient	Standard Error	T-Ratio [Prob]1( )
A	0.013	0.007	1.855[0.137]^{ns}
UP_{t-1}	-0.053	0.073	-0.721[0.510]^{ns}1(2)
DP_{t-1}	0.389	0.102	3.819[0.019]** 1(2)
SSP_{t-1}	0.090	0.041	2.193[0.093]* 1(2)
NP_{t-1}	-0.345	0.125	-2.768[0.050]**1(2)
SOP_{t-1}	-0.032	0.023	-1.406[0.232]^{ns}1(4)
SC_t	-0.078	0.023	-2.999[0.040]**1(1)
MC_t	0.119	0.019	6.171[0.004]*** 1(1)
A_{t-1}	-0.084	0.163	-0.518[0.632]^{ns}1(1)
R^2 = 0.94468 Adjusted R^2 = 0.83405 S.E. of Regression = 0.015413			F(8,4)= 8.5389[0.027]*** DW= 1.1738

***Significant at 1% **Significant at 5% *Significant at 10% ns = Non-Significant

Table 3: Adjustment Coefficient and Short and Long-run Price Elasticities for Log Linear Response Function

Dependent Variable	Adjustment Coefficient (ß)	Price Elasticities {Average market retail sale price of fertilizers (Rs. per bag of 50 kg) (Price response)}									
		Urea		DAP		SSP		NP		SOP	
		Short Term	Long Term	Short Term	Long Term	Short Term	Long Term	Short Term	Long Term	Short Term	Long Term
A	0.92	-0.053	-0.058	0.389	0.423	0.090	0.098	-0.345	-0.375	-0.032	-0.035

Table 4. Adjustment Coefficient and Short and Long-run Non-Price Elasticities for Log Linear Response Function

Dependent Variable	Aadjustment Coefficient (ß)	Non-Price Elasticities {Term-wise agricultural credit advanced by ADBP (Rs. in million) (Non-Price response)}			
		Short Term Loan		Medium Term Loan	
		Short Term	Long term	Short Term	Long term
A	0.92	-0.078	-0.085	0.119	0.129

Coefficients of multiple regression in Table 2, indicate a strong relationship (R^2 = 0.94) between the dependent variable with the respective independent variables i.e., 94 % change in the sugarcane acreage occurs due to lagged average market retail sale price of fertilizers, term-wise agricultural credits and its own lagged value (Chaudhry, 1995). While the value of adjusted R^2 is 0.83, which is the measure of the effect due to the variables selected in the model. Since the value of Durbin Watson is 1.2, which indicates that there is slight autocorrelation, which could not have strength to break the model. It means that t–ratio and F distributions are applicable and model is quite efficient. Among average lagged retail price of fertilizers, short term and long trem price elasticities in respect of Urea have been worked out as -0.053 and -0.058, in respect of DAP as 0.389 and 0.423, in respect of SSP as 0.090 and 0.098, in respect of NP as -0.345 and -0.375 and in respect of SOP as -0.032 and -0.035, respectively (Wang *et al*., 1984). While among term-wise agriculture credits, the short and long run elasticities have been worked out as -0.078 and -0.085 and in respect of medium term credit as 0.119 and 0.129 respectively. Hence overall performance of the nerlovian adjustment model in explaining possible variations on sugarcane acreage are quite good.

Technological and institutional development is quite necessary to raise sugarcane acreage considerably. Similar findings have already been reported (Sampietro and Vattuone, 2006b; Singh *et al*. 2003).

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DATA APPENDIX

Showing sugarcane acreage, average market retail sale price of fertilizers lagged by one year, term-wise agricultural credits and wheat acreage lagged by one year in NWFP over a period of time (1991-92 to 2007-08)

Year	Sugar-cane Acreage (Hec.)	Average market retail sale price of fertilizers (Rs. per bag of 50 kg) lagged by one year (Price Response)					Term-wise agricultural credit advanced by ADBP (Rs. in million) (Non-Price Response)		Sugarcane Acreage (Hectares) lagged by one year
		Urea	DAP	SSP	NP	SOP	Short-term	Medium-term	
1991-92	103951	195	249	93	173	150	39.87	127.80	104380
1992-93	99876	195	272	93	173	150	29.33	95.54	103951
1993-94	100333	205	264	93	196	195	31.11	204.69	99876
1994-95	102102	210	269	96	203	195	306.55	279.55	100333
1995-96	102523	235	379	150	250	195	243.42	118.75	102102
1996-97	108442	267	479	183	320	331	169.33	250.04	102523
1997-98	108574	340	553	211	384	532	491.12	437.60	108442
1998-99	103328	341	565	200	397	540	714.82	368.62	108574
1999-00	106272	346	665	234	457	541	553.89	351.38	103328
2000-01	105891	327	649	298	464	543	699.09	390.19	106272
2001-02	101518	363	670	253	468	682	830.19	380.35	105891
2002-03	104874	394	710	280	519	765	939.00	429.03	101518
2003-04	104833	411	765	287	539	780	1247.45	407.39	104874
2004-05	106445	420	913	329	622	809	2107.66	487.32	104833
2005-06	98601	468	1001	373	704	996	2558.68	335.09	106445
2006-07	101806	509	1079	407	710	1170	3381.32	279.12	98601
2007-08	104830	527	957	329	650	998	3767.91	623.09	101806

Source: 1.Agricultural Statistics of Pakistan, 2007-08 2. Federal Bureau of Statistics. 3. National Fertilizer Development Centre, Islamabad.