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ESTIMATION OF YIELD RESPONSE FUNCTIONS OF SUGARCANE IN PUNJAB PROVINCE

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After cotton and rice, sugarcane is the most important cash crop of Pakistan. In this study the sugarcane yield response was estimated in three ecological zones, i.e. Faislabad, Gujranwala and Multan, representing mixed, rice based and cotton based cropping regions of the Punjab province respectively. In addition, factors affecting the yield of sugarcane in these zones were also estimated. Water availability at the farm gate came out to be the most important factor which influenced the yield of sugarcane in these zones of Punjab province during the period 1966 to 1986.

INTRODUCTION

Agriculture is the most important sector of Pakistan's economy. It continues to play a pivotal role in the economy of Pakistan. It supports three-fourth of country's population for its 26.5% of GDP, contributes about 80% of foreign exchange earnings (Economic Survey, 1988-89), and provides raw material for major industries like cotton textiles, sugar and several other medium and small scale agro-based industries. In Pakistan, after cotton and rice, sugarcane is the most important cash crop. Being the chief source of sugar production, it plays a remarkable role in balancing the agricultural economy of the country. Molasses, a by-product of sugar manufacturing industry, is an important export item of Pakistan.

The available statistical evidence shows that despite all efforts towards increasig its porduction, the average cane yield per hectare in Pakistan is still far below the level of major cane producing countries of the world. Low yield of sugarcane is the result of poor crop management practices especially inappropriate planting method, indequate water application at critical stages of growth and unbalanced use of fertilizers, etc. The preser study was planned to develop yield response functions of sugarcane in the punjab province with a view to indentify the variables which have an influence on crop yields.

MATERIALS AND METHODS

For the purpose of study, the irrigated Punjab was divided into three ecological zones, i.e. Faisalabad, Gujranwala and Multan. One representative district was selected from each of these zones for further detailed investigation. Hence Faisalabad, Gujranwala and Multan districts represent three different zones of the Punjab province. Each of the zones identified above represents more or less homogeneous agrarian conditions such as source of irrigation, cropping pattern, physiography, climate, soil, etc.

It was assumed that perhectare yield of sugarcane depended physically on a large number of factors which were both quantitative and qualitative in nature. However, highly related and quantifiable factors like fertilizer crop price ratio, farm gate water availability, rainfall received during the per-sowing, vegetative growth and maturing periods and tractor horse power were included in the study.

Keeping in view the important variables which were expected to have an im-

pact on the yield of sugarcane, a generalized yield response function was expressed as:

$$Y_t = f\left(\frac{PF_{t-1}}{PS_{t-1}}, RP_t, RV, RM_t, WI_t, HP_t, e_t\right)$$

Where,

Y_t = Yield of sugarcane per hectare (kg) in year t,

PF_t-1 = Fertilizer price per kg in a year t–1,

PS_t-1 = Sugarcane price per kg in a year t-1

RP_t = Rainfall (mm) per hectare during the pre-sowing period of crop in year t,

RV_t = Rainfall (mm) per hectare during the vegtative growth period of crop in year t,

RM = Rainfall (mm) per hectare during the maturing period of crop in year t,

WI = Farm gate water availability in inches per hectare in year t,

HP_t = Availability of tractor horse power per hectare in year t and.

e_t = Random disturbance term.

Data for each selected district were analyzed with the help of indirect least squares tecnique to see the effect of different variables on sugarcane yield. The results are presented in the Table 1. For observing the yield trend of sugarcane crop from 1966 to 1986 for three districts representing three zones i.e. Faisalabad, Gujranwala and Multan and for Punjab province as a whole, the function chosen was an exponential function of the form:

$$\log Y = a + bt$$

Where,

a = Intercept,

b = Rate of change, when multiplied with100, gives percentage growth rate and,

t = Time.

RESULTS AND DISCUSSION

On average, the yield of sugarcane in Multan increased by 0.26% and in Gujranwala by 1.68% per annum during the period of study. The overall increasing yield trend in Multan and Gujranwala might be attributed to the fact that rainfall at vegetative growth period has had a significant positive effect on crop yield over the period of study. The yield of sugarcane in the Faisalabad zone and the Punjab province decreased by 0.93% and 0.18% per annum respectively during this period. Exponential growth rates for three different districts and Punjab Province are given in the folowing table:

District/ province	Regression coefficients	Percentage growth rate
Faisalabad	– 0.0093	– 0.93
Gujranwala	0.0168	1.68
Multan	0.0026	0.26
Punjab	–0.0018	– 0.18

The result of the estimated equation for Faisalabad district showed that water availability at the farm gate was the most important variable in explaining the sugarcane yield. The elasticity coefficient of sugarcane with respect to farm gate water availability was 2.2437. Other important variables that influenced the sugarcane yield were unfavour

Table 1. Structural Coefficients & their significance & the value of R^2 for three districts

		Regression coefficients									
	D.V.	Constant	FCPR	RP_t	RV_t	RM_t	WI_t	HP_t	R^2	"F"	"D"
Faisalabad	Y_t	1.91	–0.406	– 0.058	0.0867	– 0.179	– 2.2437	0.04	0.98	107.4	2.21
			(0.151)	(0.042)	(0.051)	(0.025)	(0.159)	(0.066)			
Gujranwala	Y_t	11.48	– 0.053	– 0.159	0.145	–0.071	– 0.175	0.11	0.90	18.8	1.88
			(0.029)	(0.053)	(0.042)	(0.028)	(0.248)	(0.056)			
Multan	Y_t	8.26	– 0.164	0.0092	0.082	– 0.004	0.6776	0.13	0.87	12.96	2.20
			(0.088)	(0.028)	(0.024)	(0.021)	(0.182)	(0.029)			

D.V. = Department variable; "D" = D.W. value; "F" = F – Ratio.

Figures in parentheses are standard errors.

able fertilizer crop price ratio and rainfall at the maturing and vegetative growth periods. The elasticity coefficient of fertilizer crop price ratio was 0.4061 with a negative sign while elasticity coefficients of rainfall at maturing and vegetative growth periods were 0.179 and 0.0867 with a negative and positive sign respectively.

In Gujranwala the most important variables in explaining the yield of sugarcane were water availability at the farm gate, rainfall availability with the elasticity coefficients as -0.175, - 0.159, 0.145 and 0.112 respectively. In case of Multan, water availability at the farm gate, fertilizer crop price ratio and horse power avilability were the most important variables in explaining the changes in the yield of sugarcane over the period of study. It was also observed that the increase in sugarcane yield has been negatively influenced by and unfavourable increase in the fetilizer crop price ratio. Rainfall during vegetative growth period was another important variable in explaining changes in the yield of sugarcane.

POLICY RECOMMENDATIONS

The path to the rapid increase in agriculture in future lies in extended availability and use of fertilizer, better water management and a viable agriculture extension service.

In this study it has been found that alongwith other factors, the ratio of lagged fertilizer price to output price has significantly affected the yield of sugarcane. It becomes, therefor, necessary to boost the use of fertilizer on sugarcane crop which can only be done with lower chemical fertiliizer prices and high cane prices. Alongwith the prices of fertilizers and crop, following steps should be taken:

a) Information should be made available to the extension workers on different aspects of fertilizer prices.
b) Improved flow of credit should be ensured to take account of increase in fertilizer prices.
c) Marketing infrastructure should be improved to sell fertilizer in balanced proportions especially in currently remote and inaccessible areas.

The areas where farm gate water availableity showed a water logging problem need to be attended to on priority basis. While in the areas where water availability at the farm gate had a very high positive response (as in Faisalabad and Multan districts), there is need for increased water availability. Where the underground water is useable for irrigation, tube wells must be installed. It will help realize the full potential of the crop. With increase in mechanization, the farmers would be in a better position to prepare land in time and to irrigate in time at required interval which in turn will increase the timely use of fertilizers by the farmers. Therefore farmers, especially the small farmerss, must have an easy access to the credit to buy or at least to hire tractor services.

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