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Crop Weather Analysis for Preharvest Forecasting of Groundnut Yield in Surat and Bulsar Districts of Gujarat State

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ABSTRACT

The regression analysis was applied to past historic data of crop estimation surveys and rainfall data for making preharvest forecasting of groundnut yield in the district and to help in planning irrigation research. The data of 2082 crop cutting experiments and the rainfall data for the past 24 years from 1953-54 to 1977-78 were used in the regression analysis. Prediction model obtained through stepwise regression analysis are discussed in the paper.

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INTRODUCTION

The groundnut (*Arachis hypogaea* Linn) in Surat and Bulsar districts is grown in 37 thousand hectares, constituting only 2% of the total area under the crop in the State. However, an attempt has been made to apply regression analysis to the past historic data of crop estimation surveys and the rainfall data with the following objectives:

1. To investigate the possibilities of making preharvest forecast more objective through the use of multiple linear regression equation combining eye estimate and selected rainfall variables, which enter into regression equation through stepwise regression analysis.
2. To help in scheduling irrigation treatments which will maximise the yield.

The growing plant is a very efficient "integrator" of the many sequences of the contemporary weather that it has experienced upto a particular stage of its growth (Ramdas, 1970). Sanderson (1942) used the condition reports (very similar to eye estimate) and weather data in forecasting the yield of wheat in the United States. The regression technique was utilized by Panse *et al.* (1951) to get improved estimate of yield of cotton, using *anna* valuation (eye estimate) only. Bali (1970) also used eye estimate to provide preharvest estimate of sugarcane yield in Uttar Pradesh.

MATERIALS AND METHODS

The actual crop cutting yields (CCY) and the corresponding eye estimates (EEY) were collected for 2082 crop cutting experiments conducted in old Surat district, at present compris-

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ing Surat and Bulsar districts, for the past 24 years from 1953-54 to 1977-78, under crop estimation surveys. The daily rainfall data of the observatory at Surat over a period of 24 years were collected from the Directorate of Agriculture, Gujarat State, Ahmedabad.

The data were processed to build up the estimates of average EEY at taluka and district levels and to work out weekly totals of rainfall for the meteorological standard weeks during the groundnut growing season covering the period from 22nd week to 43rd week. A comparative examination of EEY and the corresponding CCY was carried out to detect outliers using the procedure outlined by Anscombe (1960). The outliers were then replaced by the corresponding second forecast values.

The analysis comprised of formulation of an appropriate model for forecasting groundnut yield for the Surat district. Technological trend was examined in the time series data of yield per hectare of 24 years using graphical method. The time trend was absent and therefore time variable has not been taken as one of the independent variable. The presence of auto-correlation in regression analysis was examined using Durbin-Watson Statistics -'d' (Durbin and Watson, 1950-1) and indicated absence of auto-correlation. Stepwise regression analysis (Efromyson, 1962) was carried out utilizing CCY as dependent and EEY with 22 rainfall variables during the crop growing season as independent variables for the purpose of formulation of yield prediction model. To select the appropriate model, the following different regression equations were worked out.

(I) with eyes estimate alone.

(II) eye estimate and rainfall variables up to 9th September, by which time the eye estimate figures are normally available.

(III) eye estimate and all selected rainfall variables.

(IV) selected rainfall variables alone.

Finally, the prediction model was tested for its utility by predicting the district yield and comparing with CCY for the year not included in the development of the prediction model.

RESULTS AND DISCUSSION

The comparative results of the different regression equations are presented in Table 1.

The first regression equation with only eye estimate accounted for 41% of the total variation in yield. Thus the correlation coefficient between the actual crop cutting yield (CCY) and eye estimate yield (EEY) is 0.6433. Eye estimate with all the selected rainfall variables in stepwise regression analysis accounted for the largest variation to the tune of 68% of the total variation in yield. Since the regression equation with eye estimate and rainfall variables upto 9th September accounted for only 44% of the total variation in yield, the prediction equation with eye estimate and all the selected rainfall variables which accounted for 68% of the total variation in yield was considered appropriate. The drawback with this model is that it includes X_{23} over the prediction as on 9th September and thus the prediction is delayed upto the end of October. The appropriate prediction equation with error of forecast 2.85% was as under :

TABLE 1

Estimate of regression coefficients, their standard errors, R^2 and error of forecast for selected variables in stepwise regression analysis of groundnut yield data of Surat district.

Selected variables	*EEY alone*		*EEY and rainfall variables upto 9th Sept.*		*EEY and all selected variables*		*Selected rainfall variables alone*	
	Regression coefficient	*S. E.*	*Regression coefficient*	*S. E.*	*Regression coefficient*	*S. E.*	*Regression coefficient*	*S. E.*
X_1	0.7967**	0.2019	0.8128**	0.2028	0.9472**	0.1608		
X_5							1.7382**	0.5007
X_6							-0.9746**	0.3109
X_{10}							-1.5871**	0.4626
X_{13}			0.3028	0.3018	0.4174	0.2355	0.6216	0.3162
X_{15}							0.8997	0.5407
X_{19}							-1.0358*	0.4706
X_{23}					63.6845**	16.4228	44.3725*	20.9853
R^2	0.4138**		0.4406**		0.6807**		0.6363	
Error of forecast	4.20%		4.11%		2.85%		3.31%	

* and ** indicate (significance) at 5% and 1% levels respectively.

$$\hat{Y} = 57.6959 + 0.9472\,X_1 + 0.4174\,X_{13} + 63.6845\,X_{23}.$$

The results revealed that the major contribution was by the first variable – EEY (eye estimate) and the contribution of the rest of the two rainfall variables was 27%. The regression equation with selected rainfall variables alone also accounted for 64% of the total variation in yield. The contributions of the selected rainfall variables through stepwise regression analysis can also be viewed as guidelines in scheduling irrigation treatments in irrigation research on the groundnut crop in Surat and Bulsar districts.

The variable X_{13} corresponds to the rainfall during full pegging and pod development stage, since the rains received during this critical period of growth have beneficial effect on yield. Seshadri (1962) reported that the hair on the peg and pod of groundnut help in taking up little moisture thus protecting the pod from excessive drying up and helping in its proper development. The physiology of water absorption in groundnut indirectly justifies that rains during full pegging to initial pod development stage have positive effect on yield. Drizzling rains during this stage help in the proper development of pod and hence higher yields are obtained. These results are in conformity with the results obtained by Joshi and Kabaria (1972) at Amreli as well as by Singh *et al.* (1971) at Hissar. Joshi and Raddar (1975) observed that very low yield during 1967 at Dharwar was mainly due to reduction in the total amount of precipitation and long break of rains in the month of September, which

coincided with the peak period of pod development. This also indirectly support the positive effect of rainfall during pod development on the yield of groundnut. These results, therefore, indicated the need for irrigation from full pegging to pod development stage.

The variable X_{23} which corresponds to rainfall during late maturity has also affected the yield. Surat and Bulsar districts have heavy black cotton soils which become very hard on drying and it become very difficult and practically impossible to get the complete harvest of groundnut. Rains around the harvesting stage of the crop help in taking out the complete yield of groundnut. Thus it has indirect positive effect on yield. This result, therefore, indicated the need for light irrigation treatment during harvesting of the crop in Surat and Bulsar districts and other similar areas with such soils.

The validity of the prediction equation may be judged by putting the value of the variables observed during the year 1978-79 (the year not included in the study), which gave a predicted value of 847.6 kg/ha as against the actual crop cutting yield of 778.6 kg/ha with a percentage difference of – 8.9, which is well within the limit of the difference observed in the data under the study. Thus groundnut yield of the district can be predicted by the end of October with an error of forecast of 2.85 per cent. The State Department of Agriculture issues final forecast of groundnut crop by 10th February and hence the utility.

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