SHORT COMMUNICATION

A STUDY ON PRE-HARVEST FORECAST OF RICE YIELD USING CLIMATIC VARIABLES

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Abstract: A suitable statistical model has been developed for forecasting the yield of the rice in Raipur district (1981-2013) using the data and weekly weather variable viz., average maximum and minimum temperature, relative humidity morning evening sunshine hours and total weekly rainfall. The forecast model was developed using generate weather variables as regression in model. The generated weather variables were developed using weighted accumulated of weekly data on weather variable, weights being the correlation coefficient of the weather variables, in respective weekly with yield. The data for a period of (1981-13) was used to develop the forecast model. The validation of the model was done using the data from (2011-13).

The results revealed that the forecast model developed was able to explain 57% of variation in the rice yield. And it is possible to forecast rice yield successfully two month before harvest.

Keywords: Generate weather variables, Regression weekly data, Correlation Coefficient, Forecast model

INTRODUCTION

Rice is one of the important food crops in the world and ranks, second in terms of area and production .It is the staple food for about 50 per cent of the population in Asia, where 90 per cent of the world's rice is grown and consumed. Asia's food security depends largely on the irrigated rice fields, which account for more than 75 per cent of the total rice production.(Virk et al. 2004) Rice is a proliferate user of water, consuming half of all fresh water resources. In Asia, 17 million ha of irrigated rice area may experience "physical water scarcity'' and 22 million ha may have "economic water scarcity"by 2025 (Tuong and Bauman, 2001). Water has become a scarce resource in the world as well as in India. Water needs of rice are two to four times more than that of the other crops of the same duration because of water loss by percolation, seepage, field preparation etc under submerged conditions.

In Asia, India has the largest area under rice occupying 29.4 per cent of the global area, but India has the lowest yield. The conventional paddy growing tracts are in worst crisis due to special, biological and technical setbacks. Well acclaimed rice bowls in several parts of the nation are facing a decline in area, production and productivity.

In India, there is growing demand for rice due to ever burgeoning population. It is estimated that rice demand by the year 2011 will be of 100 million tonnes. To assure food security in the rice-consumingcountries of the world, rice production would have to be increased by 50 per cent in these countries by 2025 and, this additional yield will have to be produced on less land with less usage of water, labour and chemicals (Zeng et al., 2004)

In Chhattisgarh State, rice is the staple food and it is grown in an area of 3.48 million hectare with a production of 6.15 million tonnes and productivity of 1517 kg per hectare during 2010-11 and area, production and productivity reduced in the subsequent year.

A number of statistical techniques such as multiple regressions, principal component analysis, Markov chain analysis (Ram Subramanian and Jain, 1999), Discriminant function (Rai, 1999) and agro-meteorological models (Baweja, 2002, Bazgeer et al. 2008, Ravi Kiran and Bains, 2007, Muralidhara and Rajegowda, 2002) have been used to quantify the response of crops to weather. Individual effects on weather factors on rice yield were studied by Jain et al. (1980) and Agrawal et al. (1986). Agrawal et al. (1983) studied the joint effect of weather variables on rice yield. In the above models generated weather variables were used. Weather indices and principal components of weather variables were used in the models developed by Agrawal et al. (1980). Composite models, combining biometrical characters and weather variables were developed by Mehta et al. (2000). Yield forecast models were developed for wheat and rice using weather variables and agricultural inputs on agro-climatic zone basis by Agrawal et al. (2001).Four different approaches, two on original weather variables and two on generated weather variables were used by Khistaria et al. (2004) and Varmola et al. (2004). By coupling technology trend with weather variables, models were developed by Mallick et al. (2007). The present study provides yield forecast models for rice production of Raipurdistrict using weather variables.

MATERIAL AND METHOD

The yield figures of rice for a period of (1981-2013) collected data from season and crop report, issued by the state government of Chhattisgarh and department of agriculture has been used for the present study. The daily data on weather parameters such as temperature (maxi & mini.), relative humidity (morning & evening), and amount of rainfall for 28 years period has been collected from weather station located at college of agriculture university, Raipur

Data and variables used in the study

Weekly data on weather variables have been for the study namely, X_1-Max. Temp. (^oC), X_2- Mini. temp.(^oC) X_3-Rel. hum. Morning(%), X_4-Rel. Hum. Evening (%), X_5-Rainfall (mm), X_6-Sunshine (hours). The forecast models were developed using the partial crop season data. *i.e*. the data on weather variables during the active vegetative phase has been used for our study. The data the period (1981-2010) has been used in developing the forecast model and the remaining three years data from (2011-2013) has been used for the validation of the models.

Yield forecast model

The yield forecast model is given by

where,

Here Y is the rice yield (kg/ha.)

Xiw is the value of the i-th weather variable in the w-th week.

Riwrii'w is correlation coefficient of Y with i-th weather variable/ product of I-th and I'-th weather variable in w-th week

'm' is the week of weather variable =6

I = I' = 1,2 =6 correspond respectively to maximum and minimum temperature, relative humidity at 7 hr , 14 hr and rainfall.

a, b and c are constants

T is year number included to correct for the long term upward or downward trend in yield and 'e' is the error term.

For each weather variables, two variables were generated- one as simple accumulation of weather variable and the other one as weighted accumulation of weekly data on weather variable, weighted being the correlation coefficients of the weather variables, in respective weeks with yield. Similarly, for effect of weather variables, weekly interaction variables were generated using weekly products of weather variables taking 2 at time.

Stepwise regression was used to select significant generated variables Zij and Z ii'j further analysis was carried out including significant generated variables only.

In order to study the consistency of forecast, predicted values of subsequent years (not included in the forecast equation) were worked out. Yield of subsequent years were forecast two months before harvest. For forecasting, observed weather was used up to the time of forecast and normal values of weather variables for the remaining period up to harvest.

RESULT AND DISCUSSION

The results of ANOVA are present in table 1. The results of F-test show that the regression equation is significant.

Table 1: The results of ANOVA for the regression equation

Model	df	SS	MS	F	Significance
Regression	1	242794.4	242794.4	3.112*	0.089
Residual	28	2184773	78027.6		
Total	29	2427567			

*- significant at 1% level

The result of t-test shows that the generated weather variables Z131 and Z161 are significant at 5% and 1% level. The result of t-test along with the value of partial regression coefficients is presented in table 2.

Table 2: The results of t-test partial regression coefficients

Variables	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	1822.958	351.039	5.193	.000
Z131	2.241	.692	3.237**	.003
Z161	7.438E-02	.025	2.918*	.007

*- significant at 5% level

**- significant at 1% level

Yield forecast model

The yield forecast equation has been developed using the significant generated weather variables based on equation 1. The final yield forecast function using important important weather variables along with its R2 value has been presented below.

Y = 1822.958 + 2.241 (Z161) + 0.07438 (Z131)

$R^2 = 0.574$

R2 value which is measure of goodness of fit indicates that generated weather variables are able to explain 57 % of variation in the rice yield.

The performance of the rice yield forecast equation has been tested by comparing the predicted values (which were not included in the forecast equation) with the observed values for a period of three year from (2011-2013) which are presented in table 4. The predicted values of rice yield were deviation (3.8 %) values for the year 2011.

Table 3: Performance of the rice yield model

year	Actual yield (kg/ha.)	Predicted yield (kg/ha.)	% of Deviation
2011	1270.0	1318.2	3.8
2012	1244.0	1401.1	12.6
2013	-	1667.5	-

Table 4: Actual and Predicted yield in Raipur district. (1981-2013)

Year	Act.Yield	Pre. Yield	% deviation
1981	989.9	1160.3	17.2
1982	772.3	775.4	0.4
1983	1229.6	1247.5	1.5
1984	1156.2	1170.3	1.2
1985	1483.6	1650.9	11.3
1986	1015.1	1004.2	-1.1
1987	1145.9	1264.3	10.3
1988	812.6	1093.9	34.6
1989	1247.6	1208.0	-3.2
1990	1340.5	1406.4	4.9
1991	1400.6	1131.6	-19.2
1992	1579.8	1168.4	-26.0
1993	1564.2	1346.3	-13.9
1994	1411.1	1504.8	6.6
1995	1406.0	1180.7	-16.0
1996	1193.5	1128.4	-5.4
1997	1057.2	1344.7	27.2
1998	1091.0	1145.4	5.0
1999	1471.0	1345.8	-8.5
2000	405.0	863.7	113.3
2001	1191.0	1314.5	10.4
2002	748.0	789.1	5.5
2003	1367.0	1533.2	12.2
2004	1201.0	1119.1	-6.8
2005	1545.0	1620.0	4.9
2006	1543.0	1365.5	-11.5
2007	1577.0	1293.9	-17.9

2008	1369.0	1163.8	-15.0
2009	1534.0	1493.0	-2.7
2010	1470.0	1490.1	1.4

SUMMARY AND CONCLUSION

Using the forecast model, pre-harvest estimates of rice yield for Raipur district could be computed successfully very much in advance before the actual harvest. As the data used for developing this model is of high degree of accuracy, its reliability is also high. Further, this model will produce more accurate result depending on the accuracy of input data provided.

The district government authorities also can make use of the forecast model developed using weather indices, this study, for obtaining accurate pre-harvest estimates of rice crop.

Till the final production of crops becomes known, decision have to be made on the basis of inform predictions or scientific forecasts. The main beneficial are farmers trader, exporters and importers (for planning their logistics, inventories and contracts). The processing companies can also plan in advance about the capacity, manpower and marketing strategy.

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