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Development of pre harvesting forecast model on rice for Chhattisgarh plain zone

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Abstract

The present study deals with the weather variable based forecasting model for rice on Chhattisgarh Plain Zone in which total nine districts and the seven weather variable are taken for under the study. The variable Z_{i0} (individual unweighted), Z_{i1} (individual weighted), $Q_{ii'0}$ (interaction unweighted), $Q_{ii'1}$ (interaction weighted) generated the data on weather variable with the raw data of weather variable. The data on weather variable procured from the Meteorological Observatory of Department of Agricultural Meteorology, IGKV, COA, Raipur, C.G. from 1990-2014 yield data for the same years collected from the published booklets and official website (http://agridept.cg.gov.in/index.htm) of the Directorate of Agricultural, Govt. of Chhattisgarh. The step-wise regression analysis (SRA) use for selection of most intract and significant generated weather variable from the total 57 (7 unweighted individual + 7 weighted individual + 21 unweighted interaction + 21 weighted interaction +T) variables run through step-wise regression analysis (SRA) and finally variable inter in the model. The determination of robust and best fitted model has been done by R^2 and percent error. The validation of the model has been done through percent error the R^2 for proposer model found 79%.

Keywords: Rice, wheat, coefficient of determination (R^2), yield forecasting

Introduction

Forecasting technique is an essential component of research in agriculture and allied science. It is though forecasts the policy makers, agricultural scientists, farmers are able to plan their operations and forecasts can be expressed by suitable models.

Reliable forecasting of crop production before the harvest constitutes a problem of topical interest such forecasts are needed by the Government, agro-based industries, traders and agriculturists alike. The Government needs them for use as a basis for its policy decisions in regard to procurement, distribution, buffer-stocking, import-export, price fixation and marketing of agricultural commodities while agro-based industries, traders and the agriculturists need them for property planning their operations.

Weather variable effects the crop differently during different stages of development. These effects is manifested through plant characteristic; like height, number of tillers, number of leaf area and number of ear heads etc. which ultimately effect the yield. Further, weather may also create condition which may be favorable or unfavorable for growth of disease and pest there by, affecting the crop yield.

A number of Statistical Techniques such as Multiple Regression, 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) [3]. Agrawal *et al*. (1983) [2] 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) [1]. 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 inputson agro-climatic zone basis by Agrawal *et al*. (2001) [5]. 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 yield of Bilaspur district using weather variables.

Material and Methods

The sixteen districts (Raipur, Durg, Rajnandgaon, Bilaspur, Dhamtari, Mahasamund, Korba, Kawardha, Janjgeer, Kanker, Balodabazar, Gariyaband, Bemetara, Mungeli, Balod and Raigarh) out of 27 are chosen basically for the Chhattisgarh plains Zone. Out of these seventeen districts only 9 districts (Raipur, Durg, Rajnandgaon, Bilaspur, Dhamtari, Mahasamund, Korba, Kawardha and Janjgeer) are taken for the study. Which is situated between Korba (22.5472° N, 82.6483° E) to Dhamtari (20.6118° N, 81.7787°E) and Kawardha (22.0991° N, 81.2519° E) to Mahasamund (21.1091° N, 82.0979° E) with average annual rainfall of about 1050 mm. Five Districts of CPZ namely Balodabazar, Gariyaband, Bemetara, Mungeli and Balod are added afterward in 2012. Two districts Kanker and Raigarh are not added in the study because only few parts of these two districts are covered under CPZ.

Time series data on yield for rice crop for 25 years (1990-91 to 2014-15) for Raipur, Durg, Rajnadgaon, Bilaspur and Raigarh Districts. Seventeen year (1998-99 to 2014-15) for Dhamtari, Mahasamund, Korba, Kawardha and Janjgir have been procured from the published booklets and official website (http://agridept.cg.gov.in/index.htm) of the Directorate of Agricultural, Govt. of Chhattisgarh and the District wise weekly meteorological data (1990-91 to 2014-15) procured from the department of Agro meteorology, Indira Gandhi Agriculture University, Raipur (CG.) for the same years. The data have been collected up to the 19 weeks of the rice crop cultivation which include 23rd SMW to 42nd SMW. The data on seven weather variables *viz*. Maximum Temperature (Tmax) °C, Minimum Temperature (Tmin) °C, Morning Relative Humidity (RH-I) %, Afternoon Relative Humidity (RH-II) %, Bright Sunshine hours (SS) hours/day, Rainfall (mm) and Wind Velocity (WV) have been used in the study.

Statistical Methodology

The individual effect of weather variable and joint effect of pair of weather variables, the procedures laid down Agrawal *et al.* 1986 [3] have been applied. They expressed the effect of change in weather variables on yield in wth week as a linear function of respective correlation coefficients between yield and weather variables. As trend effect on yield is generally expected to be considerable one, its effect need to be removed from yield while calculating correlation coefficients of yield with weather variables to be used as weights.

Generated weather variables (Individual)

In order to study the effect of individual weather variable, two new variables from each weather variable are generated as follows:

Let X_{iw} be the value of ith (i = 1,2,…p) weather variable at wth weeks (w = 1,2,…..n) in this study n is 19 for rice.

Let r_{iw} be the simple correlation coefficient between weather variable X_i at W-th week and crop yield over a period of K years. The generated variables are then given by

$$Z_{ij} = \sum_{w=1}^{n} r_{iw}^{j} x_{iw} \Big/ \sum_{w=1}^{n} r_{iw}^{j} \text{ ; j = 0,1}$$

For j = 0, we have un weighted generated variable

$$Z_{i0} = \sum_{w=1}^{n} X_{iw} \Big/ n$$

and weighted generated variables

$$Z_{i1} = \sum_{w=1}^{n} r_{iw} X_{iw} \Big/ \sum_{w=1}^{n} r_{iw}$$

Generated weather variables (interaction):-

For studying the joint effect of two weather variables on crop-yield, the model in interaction terms are as follows:

$$Q_{ii',j} = \sum_{w=1}^{n} r_{ii',w}^{j} X_{iw} X_{i'w} \Big/ \sum_{w=1}^{n} r_{ii',w}^{j} \text{ ;j = 0,1}$$

Where, $r_{ii',w}$ is the correlation coefficient between crop yield Y and product of weather variables X_{iw} and $X_{i'w}$. Clearly, we have two generated variables (interaction term)

$$Q_{ii',0} = \sum_{w=1}^{n} X_{iw} X_{i'w} \Big/ n ,$$

Where n is the number of weeks

unweighted, and

$$Q_{ii',1} = \sum_{w=1}^{n} r_{ii',w}^{j} X_{iw} X_{i'w} \Big/ \sum_{w=1}^{n} r_{ii',w}$$

the weighted one.

Including these two interaction terms, the effect of joint weather variables are as

$$Y = a + \sum_{i=1}^{2} \sum_{j=0}^{1} b_{ij} Z_{ij} + \sum_{j=0}^{1} b_{ii',j} Q_{ii'j} + cT + \varepsilon$$

Where b_{ij} and $b_{ii',j}$ are parameters (regression coefficients) of the model, and other terms have already been explained previous model. The above model is fitted using multiple regression method for each weather variable. The study consist CPZ.

Forecast Model based on weather variables through Step wise Regression Analysis (SRA)

Let m denotes the week (w = 1, 2,..…m) at which pre-harvest forecast of crop-yield need to be released. Using the weekly data on m weeks of p weather variables (p = 7 here), new weather variables and interaction components have been generated with respect to each weather variable. Forecast model has been developed considering all generated variables simultaneously including time trend (T). The model used is similar to one described in Generated weather variables (Interaction), which can be written as

Model – I

$$Y = a + \sum_{i=1}^{p} \sum_{j=0}^{2} b_{ij} z'_{ij} + \sum_{i \neq i'=1}^{p} \sum_{j=0}^{2} b_{ii'j} Q_{ii'j} + CT + \in$$

Where

$$Z_{ij} = \sum_{w=1}^{m} r_{iw}^{j} X_{iw} \Big/ \sum_{w=1}^{m} r_{iw}^{j}$$

$$\text{And } Q'_{ii',j} = \sum_{w=1}^{m} r_{ii',w}^{j} X_{iw} X_{i'w} \Big/ \sum_{w=1}^{m} r_{ii',w}^{j}$$

X_{iw} is the value of the i^{th} weather variable in w^{th} week, $r_{iw}/r_{ii'w}$ is correlation coefficient of yield adjusted for trend effect with i^{th} weather variable/product of i^{th} and i'^{th} weather variable in w^{th} week.

Measures for validation and comparison of the models

Two procedures have been used for the comparison and the validation of the developed models. These procedures are given bellow.

Coefficient of determination (R^2) and (R^2_{adj})

The models were validated on the basis of (R^2) and (R^2_{adj}) which can be computed from the formula given by Drapper and Smith (1988).

It is in general used for checking the adequacy of the model. R^2 is given by the following formula

$$R^2 = 1 - \frac{ss_{res}}{ss_t}$$

Where ss_{res} and ss_t are the residual sum of square and the total sum of square respectively.

R^2 never decreases when a regressed is added to the model, regardless of the value of the contribution of the variable in the model. Therefore, it is difficult to judge whether an increase in R^2 is really important. So it is preferable to use Adjusted R^2 when models to be compared are based on different number of regressed.

Adjusted R^2 is given by the following formula

$$R^2_{adj} = 1 - \frac{ss_{res}/(n-p)}{ss_t/(n-1)}$$

Where, $ss_{res}/(n\text{-}p)$ is the residual mean square and $ss_t/(n\text{-}1)$ is the total mean square. The total mean square is constant regardless of how many variables are in the model. On adding a regressed in the model Adjusted R^2 increases only if the addition of the regressed reduces residual mean square. It also penalizes for adding terms that are not helpful, so it is very important in evaluating and comparing the regression models.

Percent Deviation:-

The formulae for computation of Percent Deviation of forecast yield from actual yield are given by Mohd. Azfar *et al.* (2015) this measures the deviation (in percentage) of forecast from the actual yield data. The formula for calculating the percent deviation of forecast is given below:

$$\text{Percentage deviation} = \frac{\text{(Actual yield- Forecasted yield)}}{\text{(Actual yield)}} \times 100$$

Result and Discussion

Model Development through SRA for Plain zone on Rice

Total 57 variables (7 unweighted individual + 7 weighted individual + 21 unweighted interaction + 21 weighted interaction +T) run in Stepwise regression analysis (SRA) for the selection of most important variables. Out of 57 variables three regressed variables have been entered in the model finally, which is given below:

$$Y= 930.22-0.73Q_{151}+1.04Q_{561} +0.08\ Q_{460}$$

Where

Q_{151}= weighted interaction between maximum temperature and sun shine hours

Q_{561} = weighted interaction between sun shine hours and rainfall

Q_{460}= Unweighted interaction between relative humidity-II and rainfall

Table 1: Weather variable based Yield Forecast Model through SRA for Plain zone on Rice

Variables	Coefficient	Standard error	P-Value	Significance (R^2)	R^2 (Adj)
Intercept	930.22***	165.69	0.0001	0.0001	0.79***
Q_{151}	-0.73**	0.27	0.01		
Q_{561}	1.04***	0.27	0.0009		
Q_{460}	0.08*	0.03	0.02		

***P< 0.001, **P< 0.01, *P< 0.05, +P< 0.1

The results given in table-1: are out of 56 variables only three variables entered into the model. The coefficient of determination (R^2) has been found to be 79% which is significant at 0.1% level of significance. Variables Q_{151}, Q_{561} and Q_{460} have been found to be significant at 0.01, 0.001 and 0.05 respectively, probability level of significance.

Table 2: Validation of the model for Plain zone on Rice

Year	Actual rice yield(q/ha)	Predicted rice yield(q/ha)	Percent deviation
2010	1772	1677	5.36
2011	1687	1604	4.94
2012	1960	1831	6.54
2013	1695	1926	-13.59
2014	1966	1811	7.87

**P< 0.01, *P< 0.05, +P< 0.1

It can be observed from the results of the percent deviation found very less that's indicates that the predicted model is robust and best fit and it has high power to pre-harvest forecast of rice yield (Table -2). Fig:-1 shows the comparison between actual and predicted yield on the basis of 5 year data, almost same indication in result as well as graph.

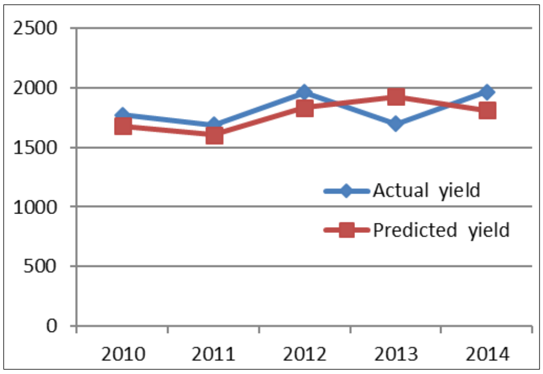
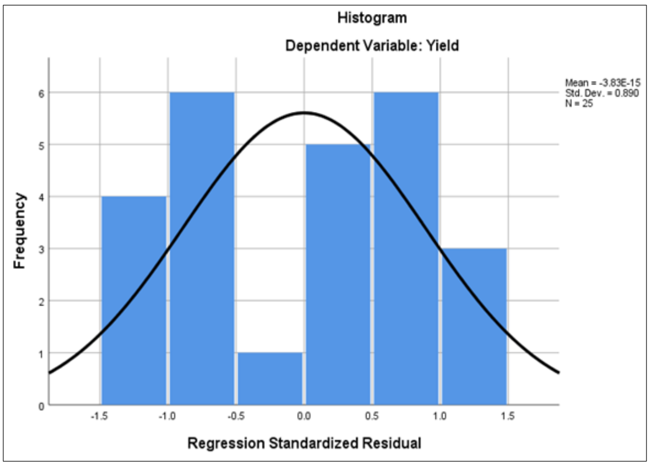
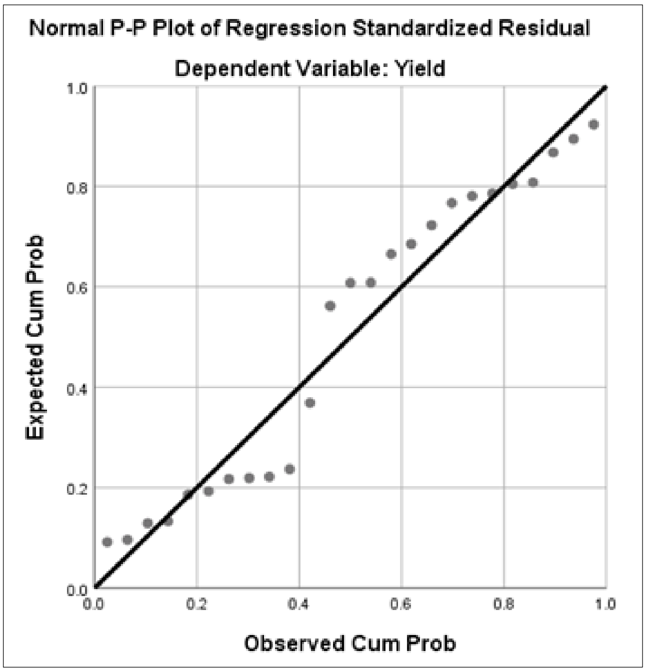


Fig 1: Comparison between actual and predicted yield on Rice



Graph 1: Histogram of the data on rice (model – I)



Graph 2: Normal distribution fitted on rice (model – I)

References

1. Agrawal R, Jain RC, Jha MP, Singh D. Forecasting of rice yield using climatic variables. Ind. J Agri. Sci. 1980;50(9):680-684.
2. Agrawal R, Jain RC, Jha MP. Joint effects of weather variables on rice yield. Mausam. 1983;32(2):189-194.
3. Agrawal R, Jain RC, Jha MP. Models for studying rice crop weather relationship. Mausam. 1986;37(1):67-70.
4. Draper NR, Smith H. Applied Regression Analysis. 3rd edn, John Wiley & Sons Inc, 1998, 1-15.
5. Agrawal R, Jain RC, Mehta SC. Yield forecast based on weather variables and agricultural inputs on agro climatic zone basis. Ind. J Agri. Sci. 2001;71(7):487-490.
6. Pandey KK, Rai VN, Sisodia BVS, Bharti AK, Gairola KC. Pre-harvest forecast models based on weather variables and weather indices for eastern UP. Advance in Bioresearch, 2013, 118-122.
7. Kumar N, Pisal RR, Shukla SP, Pandey KK. Crop yield forecasting of paddy, sugarcane and wheat through linear regression technique for South Gujarat. Mausam, 2014, 361-364.
8. Pandey KK, Rai VN, Sisodia BVS, Singh SK. Effect of weather variables on rice crop in Eastern Uttar Pradesh, India. Plant archives, 2015, 575-579.
9. Kumar N, Pisal RR, Shukla SP, Pandey KK. Crop yield forecasting of paddy and sugarcane through modified hendrick and scholl technique for South Gujarat. Mausam, 2016, 405-410.
10. Pandey KK, Rai VN, Sisodia BVS, Pandey R, Pandey V. Development of forecasting Model on weather parameters for eastern U.P. Environ Life sci. rel. sci., 2016, 1370-1372.
11. Gaind lal, Pandey KK. Development of pre harvest forecasting model of Chhattisgarh plain zone on Pigeonpea by Principal Component Analysis. Int. J Environ Sci. Nat Res. 2017;5(4):78-80.