

IMPACT OF RAINFALL PARAMETERS ON YIELD RATES OF SELECTED KHARIF CROPS IN AURANGABAD DISTRICT MAHARASHTRA STATE

AMBADAS S. JADHAV, Kolhapur

ABSTRACT : The scope for bringing area under the plough is very much limited in India. Increasing food production by increasing the productivity seems to be the most suitable strategy to solve the food problem and to keep the pace with the ever increasing population of the country. Today in India about 77 per cent of the cultivable land depends on rain fed farming which produces about 42 per cent of the total national agricultural production.

Rainfall parameters and their uneven distribution pose risk on the yield of rain fed crops. The present article attempts to analyse rainfall parameters and their influence on the yield of rain fed crops. Major five rain fed crops (Jowar, Bajra, Tur, Groundnut and Cotton) and five rainfall parameter (Annual rainfall, Seasonal rainfall, Rainy days, Dry spell and Wet spell) are selected for the present study. Correlation matrix and regression analysis are worked out to find the impact of rainfall parameters on the variation in yield of the rain fed crops over 25 years in Aurangabad district of the Maharashtra state.

INTRODUCTION

The unpredicted and extremely variable rainfall pattern during growing season is the biggest risk to crop production. So far, unfavorable weather conditions have imposed serious limitations on crop planning in India. For the better adjustment to the adverse impact of unfavourable weather condition on agriculture, various parameters of the weather have to be studied thoroughly. The soils of Aurangabad district are medium black and very little differences in soils from place to place are found and extremes of temperatures are uncommon so that rainfall assumes great importance in the case of Kharif crops. It was, therefore, considered necessary to examine the effect of rainfall during the growth period,

on the yield of Jowar, bajara, tur, cotton and ground nut. Successful crop production depends not only on mean annual rainfall and seasonal rainfall but also on the proper distribution of rainfall during the crop season. Prolonged or short wet spell and dry spells, particularly at critical stages of the crop growths cause widespread damage. Keeping this in view wet spell, dry spell, seasonal rainfall and rainy days are also included in the analysis to examine their influence on yield.

OBJECTIVES

- 1) To know the influence of various parameters of rainfall on the yield rate of major Kharif crops in Aurangabad district, and
- 2) To identify the possible causes behind the variation in the yield.

HYPOTHESIS

The yield of various crops in a district is a function of various parameters of rainfall, e.g. mean annual rainfall, rainy days, seasonal rainfall, frequency of wet spell and dry spell.

METHODOLOGY

The rainfall parameters are identified and correlation matrix and stepwise regression analysis is worked out.

Rainfall parameters identified for analysis are as under :

- 1) mean annual rainfall
- 2) rainy days (rainy day is defined as a day receiving 0.1" or 2.5 mm or more rainfall)
- 3) seasonal rainfall (Agriculturally, a year in Aurangabad district is divided into three crop seasons viz. 1) Kharif season: mid June (June 11 th) to mid October (Oct. 14 th), 2) Rabi season: mid of October (Oct. 15 th) to mid of April (April 15 th), and 3) Zaid season: mid of April (April 16 th) to mid June (June 10 th)
- 4) Wet spell (A wet spell is considered to be a wet day or days, which are preceded and followed by at least a day or more dry days).
- 5) Frequency of dry spell (Dry spell is defined as a period of at least five consecutive days of dry days. Wet day is defined as a day with 2.5 mm or more rainfall and dry day is defined as a day with less than 2.5 mm rainfall).

Correlation matrix has been worked out to examine the degree of relationship between dependent and independent variables.

A stepwise regression analysis has been attempted to identify the important variables

responsible for explaining the variations in the yield over 15 years period in Aurangabad districts.

In the correlation matrix and stepwise regression analysis the following variables are used:

A) Dependent Variables:

- 1) Y_1 =Yield of Jowar
- 2) Y_2 =Yield of Bajara
- 3) Y_3 =Yield of Tur
- 4) Y_4 =Yield of Cotton
- 5) Y_5 =Yield of Groundnut

A) Independent Variables:

- 1) X_1 =Mean annual rainfall
- 2) X_2 =Rainy days
- 3) X_3 =Seasonal Rainfall
- 4) X_4 =Frequency of Wet Spell
- 5) X_5 =Frequency of Dry Spell

CORRELATION MATRIX

Correlation matrix for Jowar shows that mean annual rainfall ($r=0.534$) has a positive correlation with the yield of jowar while dry spell has a weak negative correlation with r value of -0.313 . The seasonal rainfall, rainy days and frequency of wet spell have weak positive correlation with the yield of Jowar.

It can be said that all the parameters of rainfall are correlated with yield of jowar and correlation matrix could not convey any trend because all the coefficients of Correlation have loss significance level except mean annual rainfall, which is significant at 5 per cent level of significance.

Correlation matrix for bajra shows that mean rainfall ($r=0.733$), rainy days ($r=0.836$), seasonal rainfall ($r=0.740$) and frequency of wet spell ($r=0.759$) have strong positive

Table 1
Correlation Matrix

| Crops | Yield | Mean annual rainfall | No. of rainy days | Seasonal rainfall | Frequency of wet spell | Frequency of dry spell |
|------------------|------------|----------------------|-------------------|-------------------|------------------------|------------------------|
| Jowar | 1.000 | | | | | |
| | 0.534 *** | 1.000 | | | | |
| | 0.442 | 0.804 | 1.000 | | | |
| | 0.376 | 0.885 | 0.879 | 1.000 | | |
| | 0.328 | 0.559 | -0.853 | 0.681 | 1.000 | |
| | -0.313 | -0.377 | -0.423 | -0.371 | -0.286 | 1.000 |
| Bajra | 1.000 | | | | | |
| | 0.733 * | 1.000 | | | | |
| | 0.836 | 0.804 | 1.000 | | | |
| | 0.740 * | -0.885 | 0.879 | 1.000 | | |
| | 0.759 * | 0.559 | 0.853 | 0.681 | 1.000 | |
| | -0.302 | -0.377 | -0.413 | -0.371 | -0.286 | 1.000 |
| Tur | 1.000 | | | | | |
| | 0.212 | 1.000 | | | | |
| | 0.281 | 0.804 | 1.000 | | | |
| | 0.154 | 0.885 | 0.879 | 1.000 | | |
| | 0.158 | 0.559 | 0.853 | 0.681 | 1.000 | |
| | -0.288 | -0.377 | -0.413 | -0.371 | -0.226 | 1.000 |
| Cotton | 1.000 | | | | | |
| | 0.013 | 1.000 | | | | |
| | 0.163 | 0.804 | 1.000 | | | |
| | 0.036 | 0.885 | 0.879 | 1.000 | | |
| | 0.213 | 0.559 | 0.853 | 0.681 | 1.000 | |
| | 0.112 | -0.377 | -0.413 | -0.371 | -0.226 | 1.000 |
| Groundnut | 1.000 | | | | | |
| | 0.489 **** | 1.000 | | | | |
| | 0.753 * | 0.804 | 1.000 | | | |
| | 0.520 *** | 0.885 | 0.879 | 1.000 | | |
| | 0.712 * | 0.559 | 0.853 | 0.681 | 1.000 | |
| | 0.095 | -0.377 | -0.413 | -0.371 | -0.286 | 1.000 |

* 1 Per cent level of significance

** 2 Per cent level of significance

*** 5 Per cent level of significance

**** 10 Per cent level of significance

correlation with yield of bajra and r values are significant at 1 per cent level of significance whereas the frequency of dry spell ($r=0.302$) has weak inverse correlation.

The correlation matrix for tur shows that all the parameters of rainfall have very weak relationship with the yield of tur and in no case r value has been more than 0.283 and in no case r value is significant at any level.

It can be said that tur is a less water requiring and so the yield is not being affected by the fluctuations in rainfall parameters.

The correlation matrix for cotton exhibits that all the variables of rainfall are weakly correlated with yield of the cotton. The frequency of wet spell has positive correlation with a r value of

0.231 and all the remaining variables have a r value of less than this. In the correlation matrix no value of correlation of coefficient is significant.

The correlation matrix for ground nut displays that the seasonal rainfall and frequency of wet spell are positively correlated with the r value of 0.753 and 0.712 significant at 1 per cent level of significance respectively with the yield of ground nut. The remaining variables have weak positive correlation with its yield.

STEPWISE REGRESSION ANALYSIS

It is found that the mean annual rainfall is an important variable, explaining variation in the yield, which has a correlation coefficient of 0.534. The mean annual rainfall explains about

Table 2

Regression Analysis

| Yield | Step | Variable entered | R | R ² x100 | Increase in R ² x100 | T value | Regression co-efficient | F value | Standard error |
|--------------|------|------------------|-------|---------------------|---------------------------------|-----------|-------------------------|---------|----------------|
| Jowar Yield | I | X ₁ | 0.534 | 28.51 | | 2.361 *** | 0.683 | 5.576 | 160.861 |
| | II | X ₁ | | | | 1.895 | 1.183 | | |
| | | X ₃ | 0.572 | 32.71 | 4.2 | -0.905 | -0.633 | 3.163 | 161.909 |
| Bajra Yield | I | X ₂ | 0.836 | 69.88 | | 5.691 * | 13.686 | 32.385 | 57.201 |
| | II | X ₂ | | | | 2.765 ** | 11.396 | | |
| | | X ₁ | 0.842 | 70.89 | 1.01 | 0.691 | 0.122 | 15.828 | 58.298 |
| Tur Yield | I | X ₅ | 0.288 | 8.29 | | -1.124 | -47.495 | 1.263 | 111.323 |
| | II | X ₅ | | | | -0.722 | -34.142 | | |
| | | X ₂ | 0.338 | 11.42 | 3.13 | 0.683 | 3.580 | 0.841 | 113.505 |
| Cotton Yield | I | X ₄ | 0.213 | 4.53 | | 0.816 | 2.273 | 0.666 | 29.003 |
| | II | X ₄ | | | | 0.916 | 2.679 | | |
| | | X ₅ | 0.296 | 7.23 | 2.7 | 0.616 | 7.119 | 0.508 | 29.668 |

* 1 Per cent level of significance

** 2 per cent level of significance

*** 5 per cent level of significance

X₁ Mean annual rainfall

X₂ No. of rainy days

X₃ Seasonal Rainfall

X₄ Frequency of wet spell

X₅ Frequency of Dry spell

28.51 per cent of the variations in the yield but it is significant only at 5 per cent level of significance. The seasonal rainfall is entered in the second step. These two variables explained 32.71 per cent of the variations in the yield over the duration of 16 years in Aurangabad district but it has no significance.

It can be said that parameters of rainfall played very minor role in explaining the variations in the yield of jowar as no single exercise proved to be significant except mean annual rainfall, which shows some relationship. The weak relationship indicates that there are other more important factors than the parameters of rainfall which have generally failed to offer any consistent explanation for the variations in the yield of jowar.

The rainy days alone seems to be very effective in explaining the variation in the yield of bajra. It explains 69.88 per cent of the variations, which is significant at 1 per cent of the level of significance. The mean annual rainfall entered into the equation after it but could not add much to explanatory power. These two variables put together explained 70.89 per cent of the variation in the yield of bajra but it lost the significance.

The frequency of dry spell entered first was able to explain on 8.29 per cent of the variation in the yield of tur. The rainy days added with frequency of dry spells are able to explain 15.44 per cent of the variations in the yield of tur but the exercise remained insignificant and inconsequential.

Tur, as sown in the district, being an annual crop is very hardy and tolerates long dry spells. Too much of rainfall enhances the chances of diseases and pest, which results in low yield. Hence the frequent dry spells seem to be more beneficial to its yield.

Only two variables were entered in the equation and were able to explain on 7.23 per cent of variation in the yield of cotton. The first variable introduced was frequency of wet spell which explained 4.53 per cent of the variations followed by the frequency of dry spell which explained only 2.70 per cent of the variation in the yield of cotton but exercise remained insignificant and inconsequential.

It is found that in yield of cotton, the rainfall parameters failed to explain any variations. No single exercise proved to be significant in Aurangabad district.

SUMMARY

It is observed that all the parameters of rainfall weakly correlated with yield of five major crops of the district with a few exceptions. Correlation of coefficients is not significant.

The step wise regression analysis has been attempted to explain variation in the yield of five major crops in the district. It has been found that the rainfall parameters do not show a regular pattern in all the crops. Though these parameters are important in explaining the variations in the yield of Kharif crops but enough remains to be explained and these parameters have been able to offer only partial explanation. It is found that yield rates changed due to the fluctuations in rainfall parameters. It has been found that the frequency of dry spell and wet spell are some of the main causes behind the fluctuations in the yield of Kharif crops. The mean annual rainfall stands next to these variables which also plays dominant role in explaining variations in yield rates. However, the study underlines the fact that total annual rainfall and total seasonal values are not the indicators of yield rates variation but it is the proper distribution of rainfall which is significant and methodology should be developed to capture the influence exerted by it.

REFERENCES

- Abhyankar, V.P. (1972) Nature of Frequency Distribution of Indian Rainfall, Monsoon and Annual, *Indian J. Met. Geophys. Hydrol.*, 23: 507
- Baier, W. (1973) Crop Weather Analysis Models : Review and Model Development, *Journal of Applied Meteorology*, 12; (1-8), 937-47.
- Banerjee, J.R. (1960) Preliminary Studies on Crop Weather Relationship, Cotton; *Indian J. Met. Geophys. Hydrol.*, 1; 337
- Biswas, B.C. (1978) Characteristics of Short Period Rainfall in Gujrath, *Indian J. of Met. Geophys. Hydrol.*, 29; 521.
- Gangopadhyay, M. and R.P. Sirkar (1964) Effects of Weather on Growth of Sugar cane, *Indian J. Met. Geophys. Hydrol.*, 15; 215
- Gupta, B.P.D. (1966) Frequency of Wet Spells and Dry Spells at Five Stations in Rajasthan, *Indian J. Met. Geophys. Hydrol.*, 17; 451.
- Malik, A. K. (1958) Crop Yield with Reference to Rainfall, *Indian J. Met. Geophys. Hydrol.*, 9; 1
- Malik, A. K. (1958) An Examination of Crop Yields at crop Weather Station with Special Reference to Rainfall, *Indian J. Met. Geophys. Hydrol.*, 4 (4): 337-82
- Ramdayal, (1973) Impact of Rainfall of Crop Yield and Acreage, *Indian Journal of Agricultural Economics*, 20.

ADDRESS OF THE AUTHOR

Dr. A. S. Jadhav

Department of Geography

Shivaji University,

Kolhapur-416 004