# Crop planning based on monthly variation of rainfall and rainy days in Kawardha District of Chhattisgarh state


## ABSTRACT

An attempt has been made to study the impact of Monthly rainfall variability and trend on crop production and productivity of different crops at Kawardha districts of Chhattisgarh state by using long term rainfall (1963-2015). Mean monthly rainfall was more in the month of August (283 mm) where as it was least in December (4 mm) in Kawardha district. The coefficient of variation was highest in the month of December (245 %) and lowest in August (33 %). The CV during July and August is less than 40 % where as it is more than 50 % but less than 60 % in June and September months. The CV is more than 100 percent in rest of the months. The CV in June month is more than 50 percent but less than 60 percent indicates that the crop operations like sowing of crops is uncertain in the month of June. July and August months have lower CV in indicating that the rainfall is stable in the months of July and August but again the CV increased in the month of September and it is around 48 percent in Kawardha districts. Low CV indicates that the rainfall variability is less during monsoon months where as other months show relatively a high value of CV i.e. more than 100 percent. About approximate 80 per cent of the total average annual rainfall concentrated in the south west monsoon and received during a short span of two to three months between June to September. Despite advance technology, still monsoonal rains influence the food grain production to a considerable extent. Kharif food grain production is adversely affected due to monsoon break or failure. This rainfall variability studies can help to plan conservation of excess water and its utilization during their peak requirement. For the purpose of crop planning the rainy days are taken into account and it also plays an important role strategic crop planning.



**Keywords:** Monthly Rainfall variability, Variability of rainy days, Crop planning


## INTRODUCTION

One of the most interesting aspects of weather is rainfall and its variance from one place to another. The amount of rainfall received over an area is an important factor in assessing the amount of water available to meet the various demands of agriculture, industry, irrigation, hydroelectric power generation and other human activities. Therefore, distribution

of rainfall in time and space is an important factor in determining the economic status of a region or a state or a nation. Except the south-eastern part of the peninsula and Jammu and Kashmir, the south west monsoon (June – Sept.) is the principle source of rain in the entire country. During monsoonal period more than 75% of annual rainfall is received over a major portion of the country. The shortage of water results from uneven distribution of rains, significant gaps between rain events and field water losses rather than from low seasonal or annual rainfall totals. Although water in form of precipitation is available freely and right at the site where it is to be used, yet so tenuous and delicate is the balance between the demand for water by crops and its supply by precipitation that even short term deficit periods often reduce the production significantly (Gupta *et al*. 1990).

Chhattisgarh state located in central India covers total area of about 13.5 million hectares. The region has a great variety and diversity of weather conditions. Three agro-climatic zones have been demarcated in the state viz., Chhattisgarh plains zone, Bastar plateau zone and Northern hills zone region. Chhattisgarh is located in the middle-eastern part of India. That is why the state has a Tropical Monsoon climate or Dry Sub-Humid climate, similar to the rest of the country. The Tropic of Cancer line passes through the northern part of Chhattisgarh (Surguja-Koriya districts), that is why the summer is very hot, while the winter is quite cold. Due to its location in the middle-eastern part of India, the impact of the sea doesn't reach Chhattisgarh, because of which it receives lesser rainfall as compared to the coastal regions. The nature of the rainfall here is of the monsoon type. Most of the rainfall occurs in the state from June to September, and December and January witness some rainy cyclones.

Rainfall analysis is important in view of crop planning for any region. Rainfall studies, particularly its variability and analysis of number of rainy days can give more information for rainfed region crop planning. The knowledge of total rainfall and its distribution throughout the year is extremely useful and important for better planning of cropping pattern, developing irrigation and drainage plans for an area.

## Materials and Methods

### Study area and Data base

The present study is confined to Chhattisgarh, a newly created state which came in to existence on November 1, 2000 as a result of bifurcation from the state of Madhya Pradesh. C.G. state situated in eastern India which is located between 170 41' N and 240 45' N

latitudes and 790 30’ E and 840 15’ E longitudes. It is surrounded in the west by M.P. and Maharashtra, in the north by M.P., in the east by Odisha and Jharkhand (the new state separated from Bihar) and in the south by Andhra Pradesh. Much of the information about the rainfall climatology of any region is mostly based on weekly, monthly, seasonal and annual rainfall data that are derived from daily rainfall recorded at individual stations. The analysis was carried out under Kawardha district by using weather cock software available in department of Agrometeorology. Station wise daily rainfall data was obtained from the Department of Agricultural Meteorology, IGKV, Raipur. Efforts had been made to investigate the basic statistics and variability of rainfall in Kawardha district of Chhattisgarh by analysing long term data of rainfall. This study was conducted at Department of Agrometeorology by using weather cock software developed by CRIDA, Hyderabad (Rao et al., 2011).

## RESULTS AND DISCUSSION

### Mean monthly rainfall variation

Mean monthly rainfall was more in the month of August (283 mm) where as it was least in December (4 mm) in Kawardha district. The coefficient of variation was highest in the month of December (245 %) and lowest in August (33 %). The CV during July and August is less than 40 % where as it is more than 50 % but less than 60 % in June and September months. The CV is more than 100 percent in rest of the months. It can be very well observed than as assured monsoonal month starts, CV value comes down. This showed that there is uncertainty of rainfall in most of the months except monsoonal months. When we compared the mean monthly rainfall variability of different months, it is always found that the mean monthly rainfall is highest during the month of July and August. The CV in June month is more than 50 percent but less than 60 percent indicates that the crop operations like sowing of crops is uncertain in the month of June. July and August months have lower CV in these two districts indicating that the rainfall is stable in the months of July and August but again the CV increased in the month of September and it is around 48 percent in Kawardha districts. In rest of the months CV is more than 100 percent which indicates that there is more variation and uncertainty of rainfall found during these months. There are also some amount of rainfall is occurred during October due to north-east monsoon period. Low CV indicates that the rainfall variability is less during monsoon months where as other months show relatively a high value of CV i.e. more than 100 percent.

**Table 1: Mean monthly rainfall, its S.D and C.V for Kawardha districts**

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean (mm)** | 11 | 17 | 15 | 8 | 11 | 129 | 274 | 283 | 169 | 52 | 12 | 4 | **984** |
| **S.D. (mm)** | 19 | 21 | 22 | 16 | 17 | 73 | 98 | 94 | 81 | 48 | 21 | 9 | **526** |
| **C.V. (%)** | 173 | 125 | 146 | 198 | 155 | 56 | 36 | 33 | 48 | 105 | 177 | 245 | **1497** |

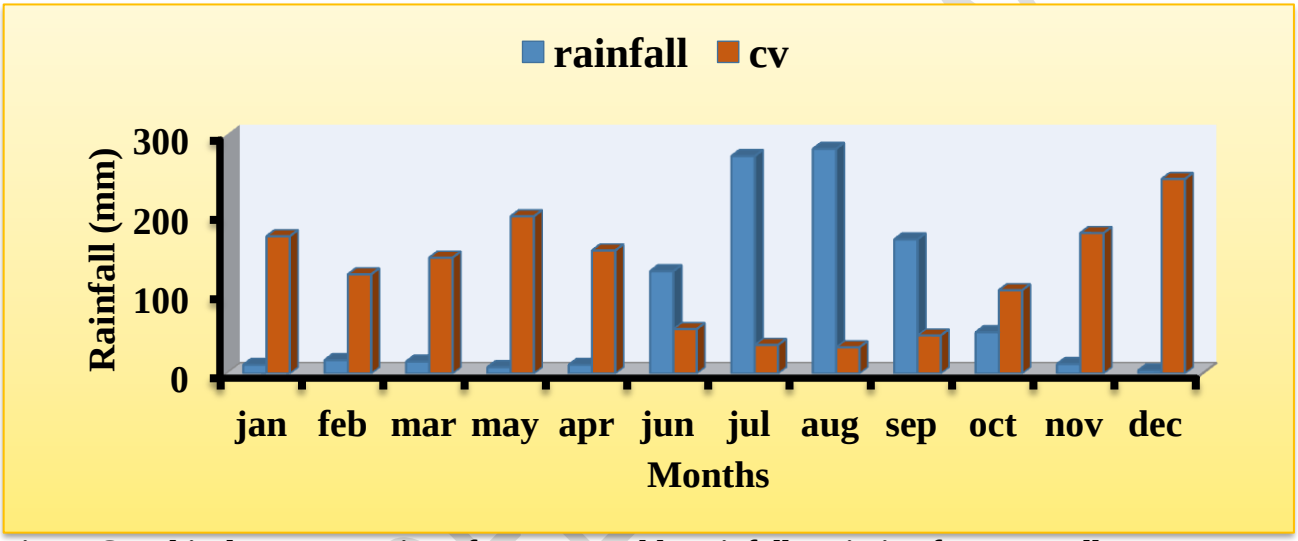


**Fig. 1: Graphical representation of mean monthly rainfall variation for Kawardha district**

**Mean monthly variation of rainy days**

Chaudhary and Sastri (1999) studied the temporal variations of rainfall and rainy days for different districts of Chhattisgarh state from the beginning of this century. The results showed alarmingly decreasing trends of rainfall in some pockets in this region. Not only the quantum of rainfall, but also the number of rainy days was in decreasing trend during the cropping season. The decreasing trend of annual rainfall was observed in Raipur, Durg, Bilaspur, Balaghat and Rajnandgaon districts. As regards the number of annual rainy days, which determine the length of growing season, decreasing trend over the decades could be seen at Durg, Balaght, Raigarh and Bilaspur districts.

In Kawardha district, highest mean monthly rainy days of 15 was recorded during July and August followed by 9 and 7 in September and June respectively and 3 in October but it was less than 3 mm in rest of months. The lowest coefficient of variation of 27 percent was recorded under August followed by 30 percent in the month of July. The CV was less than 100 % during June, July, August and September where as it was more than 100 % in rest

of the months. Low CV value of assured rainy days can lead to assured kharif crops production in these monsoonal months. The highest CV value was found in the month of December (228 %).

**Table 2: Mean, S.D and CV of monthly rainy days for Kawardha districts**

| | **Kawardha** | | |
|---|---|---|---|
| **Months** | **Mean (days)** | **S.D. (days)** | **C.V. (%)** |
| **Jan** | 1 | 1 | 162 |
| **Feb** | 1 | 2 | 129 |
| **Mar** | 1 | 2 | 139 |
| **Apr** | 1 | 1 | 180 |
| **May** | 1 | 1 | 130 |
| **Jun** | 7 | 3 | 41 |
| **Jul** | 15 | 5 | 30 |
| **Aug** | 15 | 4 | 27 |
| **Sep** | 9 | 4 | 43 |
| **Oct** | 3 | 3 | 81 |
| **Nov** | 1 | 1 | 166 |
| **Dec** | 0 | 0 | 0 |

## Rainfall based crop planning

Chaudhary (1999) studied the variations of rainfall, rainy days etc. for understanding and adopting the suitable cropping system and scope for application of modern techniques for increased cropping intensity and crop productivity. Cropping system of any area can be decided by several climatic parameters. Here, we are mainly concerned with the rainfall characteristics among all the parameters. There is comparatively less amount of rainfall found in Kawardha districts than other districts as this is under rainshadow area of Chhattisgarh. Rice is one of the most important cereals of Chhattisgarh and occupies a large part of its area than other crops. Mostly farmers follow mono-cropping of rice but now a days inter-cropping, multiple cropping and double cropping have a great importance in agriculture for sustainable crop development. Inclusion of legumes in the cropping system is beneficial in many ways like legumes fix atmospheric nitrogen in root nodules and thus improve the nitrogen status of the soil. It saves upto 25 % of recommended level of nitrogen application to the associated cereals when grown as inter-crop. The crop residues and root nodules of legumes release nitrogen during decomposition for the use of the succeeding crop. The total geographical area and area under crops in two selected districts are given below in Table 3. The total irrigated area of the district is very less as compared to net sown area. This means

that the area under irrigation is very less than that of rainfed area that indicates the agriculture in these districts is mainly dependant on monsoon rainfall. In recent years, the total irrigated area has shown an increasing pattern due to improved technology and proper water harvesting system. Srivastava and Chaudhary (1998) in Chhattisgarh region found that inadequate and poor distribution of rainfall has reduced rice yields. Rice is grown in this region in about 4 million hectares. Rainfall data for the period 1901-90 are presented, and strategies for harvesting water are discussed.

**Table 3: Area under crops in Kawardha districts for 2014-15 (hectare)**

| **Districts** | **Total geographical area** | **Total cropped area** | **Area sown more than once** | **Net area sown** |
|---|---|---|---|---|
| Kawardha | 444705 | 267711 | 81529 | 186182 |

(Source: Directorate of Economics and Statistics)

Jajoria *et al.* (2015) determined the cropping pattern of an area and the type of crop to be cultivated by using an index called rainfall. Therefore, the present study deals the rainfall characteristics of the Udaipur District of Rajasthan, India. The daily rainfall data for last 39 years (1973–2011) were analyzed to study its variability and probability. Rains during June, July, August and September are more helpful to indicate the suitability crop growing period for profitable crop production. The study indicated that the mean annual rainfall was found 630.20 mm and monthly mean rainfall was observed to be 14.20, 74.29, 178.52, 212.59, 100.98, 20.51 mm for May, June, July, August, September and October, respectively.

Crops require soil moisture during the growth and development phase. The only source for soil moisture is rainfall under rainfed conditions. Since, crops depend on rainfall, they must be adjusted to a particular period during which rainfall is assured. Plenty of rainfall is noticed during the south-west monsoon in all parts of country with the exception of Tamil Nadu in the south and Jammu and Kashmir in the north, where considerable amount of rainfall is seen during the north-east monsoon. The distribution of rainfall in both the seasons is erratic and unpredictable. The whole year is divided into four seasons viz. south-west monsoon, post-monsoon, winter and summer or pre-monsoon which is coinciding with the agricultural seasons i.e. kharif, rabi and summer. The kharif season is nothing but the south-west monsoon or autumn while rabi coincides with post monsoon and winter seasons. In

summer, the cultivable land under seasonal crops is kept fallow in many regions of Chhattisgarh state. Almost all the field crops are sown or planted based on the onset of monsoon. The crops are never in shortage of water during the first crop season if monsoon is normal otherwise crops are grown under soil moisture stress even in kharif because the number of rainy days and the amount of rainfall received are less than that of the average rainfall and rainy days of a particular district. In rabi season, few rains are received as a result of which almost all the crops suffer due to soil moisture stress if irrigation facilities are not available during rabi. Hence, irrigation facilities are pre-requisite to raise successful crop during rabi as well as summer. Gates (1988) experienced that the world is sufficient to convince people that even a temporary change of climate can have profound impact on agricultural production and on the use of energy and water resources. knowledge of total rainfall and its distribution throughout the year is extremely useful and important for better planning of cropping pattern, developing irrigation and drainage plans for an area. Further, a precise understanding of agro -climatic conditions is a pre-requisite for efficient crop planning in any given region and this type of understanding is of more relevance in rainfed area where crop productions depend on vagaries of monsoon and other climatic parameters.

Like rainfall, rainy days also plays an important role in crop planning. A day is called as rainy day if the rainfall of that day is at least 2.5 mm. A week during which the weekly rainfall is less than 35 mm with less than 4 rainy days is called dry spell. The interval between the onset of effective rains and the commencement of the first dry spell is known as wet spell (the effective rain may be a rainfall spell of more than 35 mm spread over a period of 7 days with at least four rainy days to begin with). As known, rice (*Oryza sativa*) is a water loving plant widely grown during the monsoonal season. Traditionally, rice is grown under continuous flooded condition and requires 1500-2000 mm water (Kandaih, 1985**).** Moreover, rainfall distribution pattern is a major determinant of crop yield in rainfed areas. Most of the farmers construct huge bunds in the rice fields and they impound this water for rice cultivation to avoid the uncertainty factor of monsoonal rainfall. This practice of making huge bunds often becomes adverse for rice crop seedlings as higher bunds submerge the rice seedlings and hence growing of tall, long duration, photo-sensitive varieties which can sustain higher water levels has become a traditional practice of rice cultivation in this area. Farmers in this region grow long duration varieties under *Broadcast Biasi* system. These varieties mature by mid-November whereas the south western monsoon withdraws in mid-September. Therefore, terminal drought at the reproductive stage of the rice crop is a

recurring feature and moreover, water stresses are a common feature during growth cycle of crops. Under this *broadcast biasi* system, rice seeds are broadcast in a ploughed field immediately after onset of the monsoon around mid-June. After about 30 to 35 days of onset of monsoon when sufficient water is impounded in the fields, the fields are ploughed in the standing crop. This is called *biasi* or *bushening*. The uprooted seedlings are transplanted approximately at the same site (*in situ* transplanting) after biasi and this operation is called *chalai* in local language. The biasi operation is done mainly to control weeds, to create semi-puddled conditions, to arrest percolation losses, to decrease the initial high population and to slightly adjust the plant population through *chalai*.

## Existing & suggested cropping pattern for Kawardha District

**Existing & suggested cropping pattern for rainfed condition**

| Existing cropping pattern | Suggested cropping pattern |
|---|---|
| Rice-Fallow | Rice-Wheat |
| Rice-Lathyrus | Rice-Gram |
| Rice-Gram/Wheat | Maize-Gram |
| Soybean + Arhar | Rice-Rapeseed/Mustard |
| Maize-Mustard | Soybean + Arhar |

**Existing & suggested cropping pattern for irrigated condition**

| Existing cropping pattern | Suggested cropping pattern |
|---|---|
| Rice-Wheat/Gram/Sunflower | Rice-Gram-Maize |
| Maize-Urd | Maize-Rice-Wheat/Gram |
| Vegetable-Vegetable | Maize-Gram |
| Sugarcane | Soybean-Wheat/Gram |
| Rice-Rice/Maize | Rice-Vegetables |
| Soybean + Arhar | Maize-Vegetables |
| | Soybean-Vegetables |
| | Maize+Arhar |
| | Sugarcane+Urd/Moong/Leafy vegetables |

## CONCLUSIONS

In west central part of the Chhattisgarh state, mainly Kabirdham or Kawardha district which is considered as rainshadow due to presence of Maikal mountain, receives low seasonal rainfall with high inter-annual variability. In this district, rice is cultivated in 80% of area posing high risk of crop failure. During rabi season, large area in the state is under fallow after kharif rice cultivation and has potential to grow low water demand crops like pulses and oilseeds with excess rainfall conserved in ponds and reservoirs. High rainfall variability indicates chances of instability in the crop productivity. Low CV value indicated that the rainfall was stable in the months of July and August but again the CV increased in the month of September which creates water stress condition during reproductive and maturity stages of crops due to intermittent dry spells. About approximate 80 per cent of the total average annual rainfall concentrated in the south-west monsoon and received during a short span between June to September. Despite advance technology, still monsoonal rains influence the food grain production to a considerable extent. Kharif food grain production is adversely affected due to monsoon break or failure. If there is well distributed rainfall in sufficient quantity then this stored water can be utilized to grow second crop in *rabi* season. This rainfall variability studies can help to plan conservation of excess water and its utilization during their peak requirement. Looking into the challenges in rainfed crop cultivation in Kawardha (rainshadow districts of Chhattisgarh) that our future agricultural planning must be taken into account of this rainfall. Short duration but high yielding varieties need to be developed in this region. Soybean + Pigeon pea intercropping is also found promising which can be used as a sustainable tool for crop production. Increased production of sugarcane crop mainly due to introduction of high yielding varieties, improved agronomic practices and state government policy support.



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