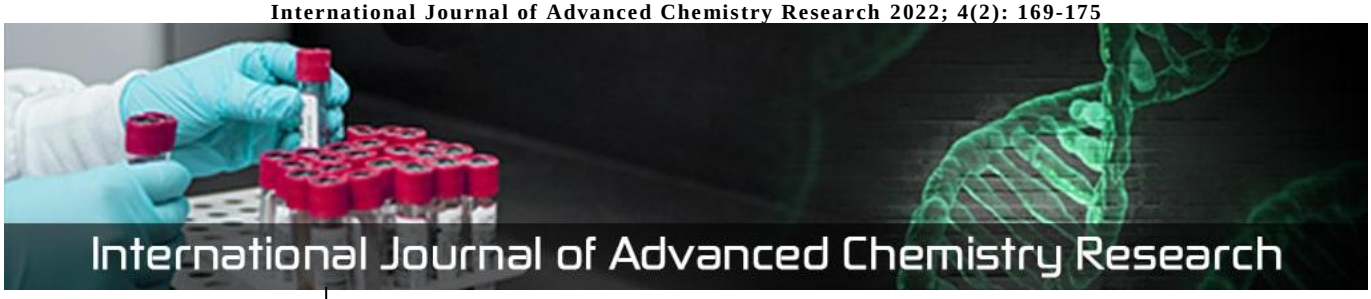

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To analysis the trend of area production and productivity of Chickpea, Soybean and Tomato crops in different districts of Chhattisgarh

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Abstract
"Weather variable based yield forecasting of Chick pea, Soybean and Tomato crops for different districts of Chhattisgarh'' was carried out for the purpose of area, production, and productivity data for the period of 15 years (2004-2019) of Chick pea, Soybean and Tomato crops for different districts of Chhattisgarh were obtained from Directorate of Land Records Government of Chhattisgarh. Software were used for Trend analysis. Based on the trend analysis, results revealed that most of districts showed significantly increasing trend in area, production and productivity of chickpea crop at Rajnandgaon, Kabirdham and Kanker, were found to be suitable for agricultural yield, Similarly Rajnandgaon, Kabirdham and Mungeli showed significantly increasing trend in area of Soybean crop. However Tomato showed significant increasing trend in area, production and productivity at 8 districts namely Mahasamund, Rajnandgaon, Bilaspur, Janjgir-Champa, Korba, Koria, Raigarh, and Jashpur districts.

Keywords: Trend analysis, crop weather relationship, yield prediction, Chickpea, soybean and tomato

Introduction
Gram (*Cicer arietinum*), Family (Leguminosae) commonly known as chickpea or Bengal gram. It is the most important winter (Rabi) pulse crop in India. In the world, India ranks 1st in area and production of chickpea, followed by Australia, Myanmar and Pakistan. The highest productivity of 1969 kg/ha is observed in Ethiopia followed by Mexico, Myanmar and USA. India's average chickpea productivity was 974 kg/ha. The total area and production of chickpea was 89.45 lakh hectares and 84.25 lakh tonnes, respectively. In India, Madhya Pradesh ranked first in total area and production of 34.39% and 40.32% lakh ha. In Chhattisgarh, total production of 345472 tonnes in an area of 330912 ha. Maharashtra rank 2nd for area of 15.48 lakh ha (17.30%) and third in the production of about 12.12 lakh tones (14.43%). The highest productivity was recorded in the state of Telangana (1474 kg/ha) followed by Gujarat (1178 kg/ha) and West Bengal (1148 kg/ha). The lowest productivity was recorded in Karnataka (619 kg/ha) (Annon. 2019) [3]. The highest area and yield of chickpea was recorded in the district of Rajnandgaon area 758380 ha production 684983 Mt followed by Durg 792794 ha area with production of 723254 Mt, Raipur 96599 ha area with production of 92280 Mt and Bilaspur 177089 ha area and production 147309 Mt, whereas the lowest production were recorded in Sarguja in an area of 33668 ha and production 25777 Mt (Annon. 2019) [4].

Soybean (*Glycine max* L.) is an important food legume which plays an important role in human consumption. It has two cropping seasons of *kharif* and spring. In case of *kharif* season most common time of sowing is onset of monsoon or last week of June to first week of July while spring sowing is done between from third week of February third week of March (Agarwal *et al*. 2013) [1]. Global production of Soybean continues to increase and it recorded as the world production of 336.56 million tonnes from an area of 127.19 million hectares. In India, total area under soybean cultivation was 113.988 lakh hectares and production of 1258 kg/hectare with the production of 137.86 lakh Mt. The area under Madhya Pradesh, Maharashtra and Rajasthan contribute about 92-93% of area and production of Soybean (Annon. a or b 2019) [3, 4]. In Chhattisgarh total area under soybean cultivation was 0.742 lakh hectares with the productivity of 726 kg /hectare and production of 0.539 lakh Mt.

The highest area under soybean was in Kabirdham 419980 ha with production of 439574 Mt, followed by Rajnandgaon 319707 ha with production of 304562 Mt and Durg 231698 ha with production of 194689 Mt (Annon. a or b 2019) [3, 4].

Tomato (*Lycopercium esculentum*), is one of the most important crop in the world. Tomatoes are nutritious and low in calories. Sowing must be done in June-July for autumn winter crop and in November for spring summer crop (Sreedhar, 2019) [8]. In the world, the major growing countries of tomato are China, USA, Italy, Turkey, India and Egypt. Total Production of tomato was 150513813 tonnes in an area of 4582438 thousand ha with the productivity of 32.8 tons/ha. China is leading for tomato production 59,626,900 tons in the world. In India total production estimated to be 193.97 lakh tonnes. The major producing states in the country are Andhra Pradesh, Karnataka, Gujarat, Odisha West Bengal and Chhattisgarh. Andhra Pradesh was highly producing state in an area of 64250 hectare and production 81420515 Mt (Annon. a or b 2019) [3, 4]. In Chhattisgarh, the highest area under tomato was recorded in the Durg district in an area of 96266 ha with production of 1907892 Mt, followed by Raipur with an area of 71507 ha and production of 789182 Mt, Jashpur with an area of 63470 ha with production of 884925 Mt, and Raigarh 51083 ha area with production of 734288 Mt (Annon. a or b 2019) [3, 4].

Crop production involves a complex interaction between climate and crop genotype, soil, the aerial environment and crop management practice. Weather plays an important role in growth and development for all crops and decides the year to year variability in different crops yield. Fluctuation in the total seasonal rainfall and its intra-seasonal distribution has strongly influence on crop productivity. Moisture stress due to prolonged dry spells and thermal stress due to heat wave conditions significantly affect the critical stage of crops. Lack of our understanding on the links between the climate variability and crop productivity could seriously endanger to sustainable agricultural production in the coming decades.

Crop models are generally, quantitative modules which show the interaction in between the crop and environment with the help of weather data, soil data and other data regarding the environment of the crop. These models are used to simulate crop growth and development, yield, water and nutrient uptake. The input data which is to be fed into the crop models include daily weather data, such as maximum and minimum temperatures, rainfall and solar radiation; soil data like soil texture and characteristics, initial soil conditions; cultivar characteristics *i.e*., genotypic and phenotypic parameters of the crop and crop management practices. Crop models are mathematical algorithms that capture the quantitative information of agronomy and physiology experiments in a way that can explain and predict crop growth and development. Crop models provide results as early as possible. It can be used to simulate crop growth under many treatments, seasons, locations and scenarios. Crop models can be helpful to agriculture in many ways. They help in assessing the relationship in between the atmospheric variables, the crop characteristics and the soil parameters which in turn alter the crop agronomy, pest management, breeding, and natural resource management, and assess the impact of climate change (Asseng *et al*. 2014) [6].

Material and Methods

This chapter deals with the description of materials used and technique adopted during the course of investigation entitled "Weather variable based yield forecasting of Chickpea, Soybean and Tomato crop for different districts of Chhattisgarh" which provide the necessary data base for this study and to highlight the important analytical tools and techniques employed in the analysis. The methodology used in the present investigation was conducted at Department of Agro-meteorology College of Agriculture, Research, IGKV, Raipur, Chhattisgarh under the following headings:

Description of the study area

Chhattisgarh state came into existence on 1 November, 2000, as result of bifurcation of the state of Madhya Pradesh. Chhattisgarh state is situated in the eastern India. It is located between the latitudes of 17°46' N to 24°5' N and longitudes of 80°15' E to 84°20' E. It is surrounded by Madhya Pradesh and Maharashtra in the west, in the north by Madhya Pradesh, in the east by Orissa and Jharkhand and in the south by Telangana. The climate of Chhattisgarh is tropical. It is hot and humid because of its proximity to the Tropic of Cancer and its dependence on the monsoons for rains. From April to June summer is started, winter starts from November to January and monsoon starts from late June to October. Average annual temperature varies between 20 to 35°c and average annual rainfall 120 to 125 (cm).

Selection of the study area

For present study different districts of Chattisgarh has been selected *i.e*. Raipur, Durg, Mahasamund, Rajnandgaon, Kawardha, Dhamtari, Kanker, Janjgir-Champa, Korba, Raigarh, Bilaspur, Jashpur, Koria, Narayanpur, Bijapur, Bastar, Dantewada and Sarguja. The details are given below table no. 1.1.

Table 1: Geographical location of selected districts of Chhattisgarh.

S. No.	Districts	Latitude	Longitude
1	Raipur	21.15 °N	81.41 °E
2	Durg	21.11 °N	81.21 °E
3	Mahasamund	21.31 °N	83.15 °E
4	Rajnandgaon	21.05 °N	81.05 °E
5	Kabirdham	22.00 °N	81.17 °E
6	Dhamtari	20.42 °N	81.34 °E
7	Kanker	20.15 °N	81.32 °E
8	Janjgir-champa	22.02 °N	82.43 °E
9	Korba	22.20 °N	82.42 °E
10	Raigarh	21.54 °N	83.24 °E
11	Bilaspur	22.05 °N	82.13 °E
12	Jashpur	22.78 °N	83.84°E
13	Koria	23.15°N	82.33°E
14	Narayanpur	20.28°N	81.11°E
15	Bijapur	19.82°N	81.03°E
16	Baster	19.34°N	81.41°E
17	Dantewada	18.89°N	81.34°E
18	Sarguja	22.94°N	83.16°E

Source of Data

Crop Data

The long term (2004-05 to 2018-19)secondary crop data of area, production and productivity of Chickpea, Soybean and Tomato crop has been collected from Department of

Agriculture and Economics, Ministry of Agriculture, Government of Chhattisgarh and www.revenue.cg.nic.in.

Statistical analysis
Mann-Kendall test
Mann-Kendall equation

$$S = \sum_{i<j} a_{ij}\, b_{ij}$$

Where,

$$a_{ij} = sgn(xj - xi) = \begin{cases} 1\ xi < xj \\ 0\ xi = xj \\ -1\ xi > xj \end{cases}$$

b_{ij}, is similarly defined for the observation in Y.

Trend V1.0.2 software
Trend software was used to conduct trend analysis in this research. The Mann-Kendall test is used to calculate the trend in this application. TREND is an application that allows you to test for trend, change, and unpredictability in hydrological and other time series data statistically. Trend software includes 12 statistical tests based on WMO/UNESCO Expert (Workshop on trend/change detection) and joint research centre for catchment Hydrology publication Hydrology. There are 12 statistical tests available in the Mann-Kendall test. TREND software various steps are shown some figures:
In the output file of trend analysis the first column lists the statistical tests, the second column gives the test statistics for each test, the next three columns gives the critical values of the statistics for significance levels of α = 0.1 or 10%, α = 0.05 or 5%, and α = 0.01 or 1% (from standard statistical table), and the last column gives the test result (NS means not significant at α =0.1; S means statistical significant, with the significance level shown in brackets).

Results and discussion
To analysis the trend of area, production and productivity of Chickpea, Soybean and Tomato crops in different districts of Chhattisgarh. The present study was undertaken to analyze the trends of area, production and productivity of chickpea, soybean and tomato crops in different districts of Chhattisgarh. The study was based on secondary time series data which collected from the year 2005-2019.

Trend analysis of area, production and productivity of chickpea
Trend analysis of area of chickpea
Table 1.2 revealed that out of 16 districts Kanker showed significantly increasing trend at 10% level of significance while two districts namely Rajnandgaon and Kabirdham showed significantly increasing trend at 1% level of significance. Whereas 10 districts namely *i.e.* Raipur, Mahasamund, Durg, Baster, Bilaspur, Janjgir, Korba, Koria, Raigarh and Jashpur showed significantly decreasing trend at 1% level of significance. However, Dhamtari, Koria and Narayanpur had non- significant decreasing trend in area of chickpea.
While in the case of linear trend analysis out of 16 districts one district Kanker showed significantly increasing trend at 10% level of significance while two districts *i.e.* Rajnandgaon and Kabirdham showed significantly increasing trend at 5% level of significance. Whereas, 9 districts namely Raipur, Mahasamund, Durg, Baster, Bilaspur, Korba, Sarguja, Raigarh and Janjgir-Champa showed decreasing trend at 1% level of significance. The remaining district Dhamtari showed non-significantly increasing trend while Janjgir-Champa, Koria and Narayanpur showed non-significantly decreasing trend in area of chickpea crop.

Trend analysis of production of chickpea
Table 1.2 revealed that Mahasamund and Bilaspur districts showed significantly decreasing trend at 10% significance level while Raipur, Durg, Baster and Sarguja districts showed significantly decreasing trend at 1% level of significance. However, Rajnandgaon, Kabirdham and Kanker districts showed significantly increasing trend at 1% significance level, while Jashpur and Koria districts were found significant increasing trend at 5% level of significance. Non-significantly increasing trend were found in Dhamtari, Narayanpur and Raigarh districts while Janjgir-Champa and Korba showed non-significantly decreasing trend.
In linear analysis at 1% level of significantly increasing trend was found in Rajnandgaon and Kabirdham districts while Sarguja and Durg showed significantly decreasing trend at 1% significance level. However Raipur and Baster districts showed significantly decreasing trend at 5% level of significance while Kanker showed significantly increasing trend at 5% level of significance. Non significance increasing trend were found in Dhamtari, Janjgir- Champa, Koria, Raigarh, Jahpur, and Narayanpur districts while Mahasamund, Bilaspur and Korba showed non-significantly decreasing trend.

Trend analysis of productivity of chickpea
Table 1.2 Out of 16, 14 districts namely Raipur, Mahasamund, Dhamatari, Rajnandgaon, Baster, Kabirdham, Bilaspur, Janjgir-Champa, Korba, Sarguja, Koria, Raigarh, Jashpur and Narayanpur showed significantly increasing trend at 1% level of significance and only two districts Durg and Kanker showed significantly increasing trend at 5% level of significance level under Mann-kendall.
In linear analysis, productivity of chickpea showed significantly increasing trend in Durg district at 10% level of significance. However out of 16 districts, 9 districts *i.e.* Raipur, Mahasamund, Dhamatari, Rajnandgaon, Bilaspur, Janjgir-Champa, Korba, Raigarh and Jashpur showed significantly increasing trend at 1% significance level while 4 districts namely Kabirdham, Baster, Sarguja and Narayanpur showed significantly increasing trend at 5% level of significance. Only two districts Kanker and Koria showed non-significance increasing trend in productivity of chickpea.
Arunchalam and Balakrishnan (2012) [5] studied the trends area, production and productivity of wheat crop grown during the period 1950-1951 to 2009-2010 in India. Different non-linear models were employed to study the trends in area, production and productivity. When none of the non-linear models were found suitable to fit the trends nonparametric regression model was employed. None of the non-linear model was found suitable to fit the trends in area data. The Sinusoidal model was found suitable to fit the trends in production as well as productivity of wheat crop grown in India. The results indicated that area, production

and productivity of wheat crop grown in India, had been shown in the increasing trend. The area of cultivation had played a major role in increasing the trend in production.

Table 2: Trend analysis of area, production and productivity of chickpea in 16 districts of Chhattisgarh

S.N.	Districts	Area (Ha)		Production (Mt)		Productivity (Kg/ha)	
		Man-Kendall	Linear trend	Man-Kendall	Linear trend	Man-Kendall	Linear trend
1	Raipur	S*(Dec)	S*(Dec)	S* Dec	S** (Dec)	S* (Inc)	S*(Inc)
2	Mahasamund	S*(Dec)	S* (Dec)	S***(Dec)	NS (Dec)	S*(Inc)	S*(Inc)
3	Dhamtari	NS (Dec)	NS (Inc)	NS (Inc)	NS (Inc)	S*(Inc	S*(Inc)
4	Durg	S*(Dec)	S*(Dec)	S*(Dec)	S*(Dec)	S**(Inc)	S***(Inc)
5	Rajnandgaon	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)
6	Kabirdham	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc	S**(Inc)
7	Baster	S*(Dec)	S*(Dec)	S*(Dec)	S**(Dec)	S*(Inc)	S**(Inc)
8	Kanker	S***(Inc)	S***(Inc)	S*(Inc)	S*(Inc)	S**(Inc)	NS (Inc)
9	Bilaspur	S*(Dec)	S*(Dec)	S***(Dec)	NS (Dec)	S*(Inc)	S*(Inc)
10	Janjgir-Champa	S*(Dec)	NS (Dec)	NS (Dec)	NS (Inc)	S*(Inc)	S*(Inc)
11	Korba	S*(Dec)	S*(Dec)	NS(Dec)	NS (Dec)	S*(Inc)	S*(Inc)
12	Sarguja	S*(Dec)	S*(Dec)	S*(Dec)	S*(Dec)	S*(Inc)	S**(Inc)
13	Koria	NS (Dec)	NS (Dec)	S**(Inc)	NS (Inc)	S*(Inc)	NS (Inc)
14	Raigarh	S*(Dec)	S*(Dec)	NS (Inc)	NS (Inc)	S*(Inc)	S*(Inc)
15	Jashpur	S*(Dec)	S*(Dec)	S**(Inc)	NS (Inc)	S*(Inc)	S*(Inc)
16	Narayanpur	NS (Dec)	NS (Dec)	NS (Inc)	NS (Inc)	S*(Inc)	S** (Inc)

*** = (10% level of significance), ** = (5% level of significance), * = (1% level of significance), S = (Significance), NS =(non-significance), Dec. =(Decreasing), Inc. = (Increasing)

Trend analysis of area, production and productivity of soybean for 7 districts of Chhattisgarh

Trend analysis of area of Soybean

In Mann-Kendall analysis, out of 7 districts, 4 districts *i.e.* showed significantly decreasing trend at 1% significance level while 3 districts namely Rajnandgaon, Kabirdham and Mungeli showed significantly increasing trend at 5% significance level.

In linear analysis, Raipur and Bemetara districts showed significantly decreasing trend while Rajnandgaon and Kabirdham showed significantly increasing trend at 1% level of significance. Whereas, Bilaspur and Durg districts showed significantly decreasing trend at 5% significance level. Non-significantly increasing trend was found in Mungeli district in table no 1.3

Trend analysis of production of soybean

Table 1.3 revealed that five districts namely Raipur, Bilaspur, Bemetara, Mungeli and Durg showed significantly decreasing trend in production of soybean while Rajnandgaon district showed significantly increasing trend at 1% significance level. Only one district Kabirdham showed non-significantly increasing trend in production of Soybean. The linear analysis two districts *i.e.* Raipur and Durg showed significantly decreasing trend in production of soybean. While Rajnandgaon showed significantly increasing trend at 1% significance level while Bilaspur showed significantly decreasing trend at 5% level significance level. Non-significantly increasing trend was found in Kabirdham district and Mungeli & Bemetara showed non-significantly decreasing trend in production of soybean.

Trend analysis of productivity of Soybean

In Mann-Kendall analysis, Raipur and Durg districts showed significantly decreasing trend while Bemetara and Mungeli showed significantly increasing trend at 5% level of significance in productivity of soybean. However, Bilaspur showed significantly decreasing trend at 1% level of significance. Whereas, two districts *i.e.* Rajnandgaon and Kabirdham showed non-significantly decreasing trend in productivity of soybean.

Bilaspur district showed significantly decreasing trend at 1% significance level while Durg showed significantly decreasing trend at 5% significance level. Whereas, three districts namely Raipur, Rajnandgaon and Kabirdham showed non-significantly decreasing trend while Bemetara and Mungeli showed non-significantly increasing trend in productivity of soybean under linear analysis.

Agashe *et.al.* (2018) [2] reported that the area of linseed crop was decreasing at an alarming rate in all the major linseed growing districts including Raipur 1812/yr; R = 0.85**, Rajnandgaon 849/yr; R = 0.72**, Bilaspur 824/yr; R = 0.78**, and Durg 348/yr; R = 0.32, however decreasing area in Durg was not statistically significant. The reason being that in Chhattisgarh linseed crop was cultivated under utera cultivation under rice based rainfed cropping. The area in Raigarh R = 0.87** and Surguja R = 0.83** districts was increasing but these districts are not important as far as linseed area was concerned. The under Bastar district showed no sign of change. The production of linseed positively increased in Raigarh R=0.80**, Bastar R = 0.52** and Surguja R = 0.44* districts due to increased area in these districts. Whereas, there was decreasing trend in Raipur (R = 0.38*) and Bilaspur R = 0.05. The districts of Durg R = 0.27 and Rajnandgaon (R= 0.14) also show increasing production trend, which was non-significant. The productivity of linseed was significantly increasing in all districts due to introduction of high yielding varieties and agricultural mechanization in recent years.

Table 3: Trend analysis of area, production and productivity of soybean in 7 districts of Chhattisgarh

S.N.	Districts	Area (Ha)		Production (Mt)		Productivity (Kg/ha)	
		Mann-Kendall	Linear trend	Mann-Kendall	Linear trend	Mann-Kendall	Linear trend
1	Raipur	S*(Dec)	S*(Dec)	S* (Dec)	S*(Dec)	S**(Dec)	NS(Dec)
2	Bilaspur	S*(Dec)	S**(Dec)	S*(Dec)	S**(Dec)	S*(Dec)	S*(Dec)
3	Rajnandgaon	S**(Inc)	S*(Inc)	S* (Inc)	S* (Inc)	NS(Dec)	NS(Dec)
4	Kabirdham	S**(Inc)	S***(Inc)	NS(Inc)	NS (Inc)	NS (Dec)	NS(Dec)
5	Durg	S*(Dec)	S**(Dec)	S*(Dec)	S*(Dec)	S**(Dec)	S**(Dec)
6	Bemetara	S*(Dec)	S*(Dec)	S*(Dec)	NS(Dec)	S**(Inc)	NS(Inc)
7	Mungeli	S**(Inc)	NS(Inc)	S*(Dec)	NS(Dec)	S**(Inc)	NS(Inc)

*** = (10% level of significance), ** = (5% level of significance), * = (1% level of significance), S = (Significance), NS= (non-significance), Dec. =(Decreasing), Inc. = (Increasing)

Trend analysis of area, production and productivity of tomato in 18 districts of Chhattisgarh

Trend analysis of area of tomato crop

Table 1.4 revealed that out of 18 districts,11 districts namely showed significantly increasing trend at 1% significance level while only one district Baster showed significance increasing trend at 10% level of significance in tomato crop under Mann-Kendall analysis. However, 4 districts *i.e.* Raipur, Durg, Sarguja and Narayanpur districts showed non-significantly increasing trend while Bijapur and Dantewada districts showed non-significantly decreasing trend in area of tomato.

In linear analysis, 10 districts *i.e*. Mahasamund, Dhamtari, Rajnandgaon, Kabirdham, Kanker, Janjgir-champa, Korba, Koria, Raigarh and Jashpur showed significantly increasing while one district showed decreasing trend at 1% level of significance. However, Bilaspur showed significantly increasing trend while Dantewada showed significantly decreasing trend at 5% significance level. Whereas Raipur, Durg, and Baster showed non-significance increasing trend and Sarguja and Bijapur showed non-significantly decreasing trend in area of tomato crop.

Trend analysis of production of tomato

In Mann-Kendall analysis, significantly decreasing trend in production of tomato at 10% level of significance was found in Dantewada district. While11 districts namely *i.e.* Raipur, Mahasamund, Dhamtari, Rajnandgaon, Kabirdham, Bilaspur, Janjgir-champa, Korba, Koria, Raigarh and Jashpur showed significantly increasing trend at 1% level of significance While two districts Sarguja and Durg showed significantly increasing trend at 5% significance level in production of tomato crop. Baster, Kanker and Narayanpur showed significantly increasing trend while only one district Bijapur showed non-significantly decreasing trend in production of tomato crop.

Table 1.4 showed that out of 18 districts, 10 districts namely *i.e.* Raipur, Mahasamund, Dhamtari, Rajnandgaon, Kabirdham, Bilaspur, Janjgir-champa, Korba, Koria and Jashpur showed significantly increasing trend at 1% level of significance. However, Narayanpur District showed significantly decreasing trend at 5% level of significance. Four districts namely Raigarh, Sarguja, Kanker and Durg showed non-significantly increasing trend while Bijapur and Baster districts showed non significance decreasing trend.

Trend analysis of productivity of tomato

In productivity of tomato found Mahasamund district showed significantly increasing trend at 10% level of significance. However, 10 districts namely Raipur, Rajnandgaon, Bilaspur, Jashpur, Korba, Sarguja, Koria, Jashpur and Narayanpur showed significantly increasing trend at 5% significance level while one district Dhamtari showed significantly decreasing trend at 5% significance level. Whereas 4 districts *i.e*. Dantewada, Kanker, Baster and Kabirdham showed non-significantly decreasing trend while one district Durg showed non-significance increasing trend in productivity of tomato crop.

In linear trend analysis 9 districts namely Raipur, Rajnandgaon, Janjgir-Champa, Korba, Sarguja, Koria, Narayanpur and Bijapur showed significantly increasing trend at 1% significance level while Dhamtari district showed significantly decreasing trend at 1% significance level. Another district Baster showed significantly decreasing trend but Mahasamund showed significantly increasing at10% level of significance. However, Bilaspur and Jashpur showed significantly increasing trend while Kanker and Dantewada showed significantly decreasing trend at 5% significance level. Non-significantly increasing trend were found in Durg and Raigarh districts while Kabirdham showed non-significantly decreasing trend in productivity of tomato.

Bagri (2012) [7] examined the trend and growth rates cost, return and constraints in tomato production in Satna district of Madhya pradesh, Secondary data on area, production and productivity of Tomato for Satna district of M.P. state were collected from the year 2000-2001 to 2010-2011.linear equation was used for estimation of trend and growth rates area, production and productivity of tomato crop. The study revealed that the trend value of area and total production were in increasing order while the trend value of productivity of tomato crop. Satna district was positive and non-significant during the study.

Table 4: Trend analysis of area, production and productivity of tomato in 18 districts of Chhattisgarh

S.N.	Districts	Area(Ha)		Production(Mt)		Productivity(Kg/ha)	
		Man-Kendall	Linear trend	Man-Kendall	Linear trend	Man-Kendall	Linear trend
1	Raipur	NS(Inc)	NS(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)
2	Mahasamund	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S***(Inc)	S***(Inc)
3	Dhamtari	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Dec)	S*(Dec)
4	Durg	NS(Inc)	NS(Inc)	S**(Inc)	NS(Inc)	NS(Inc)	NS(Inc)
5	Rajnandgaon	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)
6	Kabirdham	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	NS(Dec)	NS(Dec)
7	Baster	S***(Inc)	NS(Inc)	NS(Inc)	NS(Dec)	NS(Dec)	S***(Dec)
8	Kanker	S*(Inc)	S*(Inc)	NS(Inc)	NS(Inc)	NS(Dec)	S**(Dec)
9	Bilaspur	S*(Inc)	S**(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S**(Inc)
10	JanjgirChampa	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)
11	Korba	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)
12	Sarguja	NS(Inc)	NS(Dec)	S**(Inc)	NS(Inc)	S*(Inc)	S*(Inc)
13	Koria	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)
14	Raigarh	S*(Inc)	S*(Inc)	S*(Inc)	NS(Inc)	S*(Inc)	NS(Inc)
15	Jashpur	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S*(Inc)	S**(Inc)
16	Narayanpur	NS (Inc)	S*(Dec)	NS(Inc)	S**(Dic)	S*(Inc)	S*(Inc)
17	Bijapur	NS(Dec)	NS(Dec)	NS(Dec)	NS(Dec)	S**(Inc)	S*(Inc)
18	Dantewada	NS(Dec)	S**(Dec)	S***(Dec)	S*(Dec)	NS(Dec)	S**(Dec)

*** = (10% level of significance), ** = (5% level of significance), * = (1% level of significance), S = (Significance), NS =(non-significance), Dec. =(Decreasing), Inc. = (Increasing)

Chickpea is the most important pulse crop in Chhattisgarh. It is grown during Rabi season. The most serious problems in chickpea are observed when rice cultivation is subject to the extent of monsoon rains, and most of the existing rice varieties are of long duration (about 130 to 150 days) there remains a very short growing period for chickpea production. If the harvest of rice is delayed, chickpea sowing also gets delayed. The recommended sowing time for chickpea is mid-October to mid-November but it is often sown up to last week of December or well into the first fortnight of January. This leads to reduced seed germination and a poor crop stand. Since the chickpea is gown on residual soil moisture after the harvest of rice, farmers perceive that better germination of chickpea occurs if sowing is done immediately after the harvest of rice. Perhaps the soil moisture, temperature and micro-environment in the field after the harvest of rice favor chickpea. Unfortunately, the sowing of chickpea is further delayed due to threshing and preparation of the field for rabi sowing. Most of the cultivated chickpea varieties are of long duration. These varieties often suffer the worst form of terminal drought or even witness massive failures if there is no rainfall.

In Chhattisgarh, soybean is one of the most widely grown oil seed crop in *kharif* season. In Chhattisgarh under the plane region highly growing and producing districts as compare than to other regions of Chhattisgarh. Lower productivity and low yield potential, under oil seed crop compared to cereals besides allocation of poor, marginal land and improper nutrition were seen. The second factor of low production of oilseed crops was absence of critical irrigation as compared to other districts of Chhattisgarh. Also some other factors were included especially in ignorance, high yield variety, marketing price and government scheme while in others regions of Chhattisgarh, lack of transportation, farmer recognition decreasing of area and production of soybean crop unavailability of quality seeds, poor accessibility to markets, practice of cultivating long-duration rice varieties and lack of short-duration soybean varieties, lack of extension system, drought-like situation at the time of crop maturity in uncertain rainfall and decreasing area in soybean production these are the some major constraints to soybean production in Chhattisgarh region.

Tomato one of the highly consumed vegetables crop in Chhattisgarh while Mostly of the districts highly cultivation of Tomato crop. The major factor of depending upon the decreasing trend of production of tomato the type of soils and availability of irrigation, farmers decide their crop plan. A very high proportion of the farmers perceived the problem of soil cracking as one of the most serious constraints. Deep vertisol soils become hard and compact after puddling. Under prolonged moisture stress conditions these soils develop cracks that facilitate rapid escape of available moisture from the field and proves fatal for the standing rabi crops. Apart from this some other factors notably lack of transportation, lack of recognition of farmers and non-availability of quality seeds in tomato crop production, poor access to markets, practice of cultivation of long duration rice varieties and short duration. Tomato varieties were lacking. The expansion system, drought-like conditions at the time of crop maturity in erratic rainfall and decreasing area in tomato production are some of the major constraints for tomato production in Chhattisgarh region.

References

1. Agarwal DK, Billore SD, Sharma AN, Dupare BU, Shrivastava SK. Soybean: introduction, improvement, and utilization in India-problems and prospects. Agricultural Research. 2013;2(4):293-300.
2. Agashe DR, Sastri ASRAS, Bobade P, Agashe R. Trends of Area, Production and Productivity of Linseed in Different Districts of Chhattisgarh, International Journal of Current Microbiology and Applied Science. 2018;7(7):711-718.
3. Anonymous. Ministry of Agriculture and Farmer Welfare, Govt. of India, Annual Report, 2019, 1-79.
4. Anonymous. Revenue Department, Govt. of Chhattisgarh, Annual Agricultural Report, 2019, 32-68.
5. Arunachalam R, Balakrishnan V. Statistical modeling for wheat (*Triticum Aestivum*) crop production.

International Journal of Statistics and Applications. 2012;2(4):40-46.
6. Asseng S, Zhu Y, Basso B, Wilson T, Cammarano D. Simulation Modeling: Applications in Cropping Systems. Encyclopedia of Agriculture and Food System spp, 2014, 102-112.
7. Bagri KB. Growth Rates and Economic Analysis of Tomato Production in Satna District of Madhya Pradesh. M.Sc. (Ag.) Thesis, Jawaharlal Nehru Krishi Vishwavidyalaya, 2012, 1-67.
8. Sreedhar M. Studies on the pest complex of tomato (*Lycopersicon esculentum* L.) and their natural enemies in western region of Uttar Pradesh, India. Journal of Entomology and Zoology Studies. 2019;7(6):1010-1014.