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Growth and instability in area, production and productivity of Red gram in Vidarbha region of Maharashtra

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Abstract

The present study has been conducted to analyse the growth and instability in area, production and productivity of Red gram in Vidarbha region of Maharashtra. The time series data of area, production and productivity of Red gram of all the districts of Vidarbha were collected from various government publications, reports and related websites. For analysing the performance of Red gram, the statistical tools like Absolute change and Relative change, Compound growth rate, Coefficient of Variation and Coppock's Instability Index were worked out. The results concluded that the significant increase in the growth rate of area of Red gram was noticed in Gadchiroli district followed by Bhandara and Chandrapur district at the rate of 7.22, 3.82 and 2.88 percent per annum respectively. Additionally, the districts of Chandrapur, Gadchiroli, and Nagpur had the fastest increase rates in red gram production, with annual growth rates of 9.69, 7.87, and 4.06 percent, respectively. However, Chandrapur district was the only one to record notable increases in Red Gram productivity, with annual growth rates of 6.62%. The growth rates of area and production of Red gram were found positive and significant for Nagpur division as a whole whereas non-significant for Amravati division. It is observed that, the highest variation and instability of Red gram was observed in Akola district whereas the highest instability is observed in Gadchiroli and Chandrapur districts.

Keywords: Red gram, area, production, productivity, compound growth rate, instability

1. Introduction

An important crop in India is Red gram. It is also known as Pigeon pea, Arhar and Tur. Red gram is mainly cultivated and consumed in developing countries of the world. This crop is widely grown in India. India is largest producer and consumer of Red gram in the world. Red gram is primarily eaten as split pulse, or Dal, which is a necessary addition to a diet high in cereals. The staples of the typical Indian diet are combinations of Dal-Chawal or Dal-Roti. Due to the complementary link between the essential amino acids, combining red gram with wheat or rice significantly boosts the biological value. It is especially high in iron, niacin, thiamine, riboflavin, and lysine.

Red gram is a valuable source of food for humans and animals, but it also maintains soil fertility by enhancing the physical characteristics of the soil and fixing nitrogen from the atmosphere. It is mostly used as an intercrop with other crops and is suited for dryland farming because to its resistance to drought. Red gram is farmed on 63.57 lakh hectares worldwide, yielding 54.75 lakh tonnes of output and 861.25 kg/ha of productivity. With 43.4 lakh tonnes grown under 49.8 lakh hectares and a productivity of 871 kg/ha in 2021–2022, India leads the world in Red gram production. With respective areas of 12.98 and 12.40 lakh hectares, Maharashtra and Andhra Pradesh were the two most productive states in India.

From 1990–1991 to 2021–2022, the area under Red gram rose from 10.08 lakh hectares to 12.98 lakh hectares, mainly in Maharashtra. Maharashtra was found to be the most productive state in India in terms of Red gram production in 2021–2022. This paper aims to study the performance in area, production and productivity of Red gram in Vidarbha region of Maharashtra.

2. Materials and Methods

The nature of the present study is mainly based on secondary data. In order to attain objectives of study, relevant secondary data pertains for 20 years from 2001-02 to 2020-21 was utilized for this study.

2.1 Selection of study area

The Vidarbha region of Maharashtra state comprising of eleven districts viz: Akola, Buldhana, Washim, Amravati, Yavatmal, Wardha, Nagpur, Bhandara, Gondia, Chandrapur and Gadchiroli were considered for the present study.

2.2 Collection of data

The time series data of area, production and productivity of Red gram of all the districts of Vidarbha were collected from various government publications, reports and related websites.

2.3 Analytical tools

2.2.1 Performance of selected crops

For analysing the performance of Red gram, the statistical tools like Absolute change and Relative change, Compound growth rate, Coefficient of Variation and Coppock's Instability Index were worked out.

2.2.1.1 Absolute change and Relative change

The absolute change and relative change in area, production and productivity of Red gram during study period were measured by using formula given below.

Absolute change = Current year – Base year

Where,

Current Year = Area/production/productivity of Red gram at current year (2020-21)

Base Year = Area/production/productivity of Red gram at base year (2001-02)

$$\text{Relative change} = \frac{\text{Current year} - \text{Base year}}{\text{Base year}} \times 100$$

Where,

Current Year = Area/production/productivity of Red gram at current year (2020-21)

Base Year = Area/ production/productivity of Red gram at base year (2001-02)

2.2.1.2 Compound growth rate

Compound growth rates of area, production and productivity of Red gram were worked out by fitting an exponential function as given below.

$$Y = ab^t$$

Where,

Y = Area/Production/Productivity of Red gram

a = Intercept

b = Regression coefficient

t = Time period (Years)

From the coefficient values, the compound growth rates were worked out by using the formula,

$$\text{CGR} = [\text{Antilog}(\log b) - 1] \times 100$$

2.2.1.3 Coefficient of Variation

The coefficient of variation (CV) was calculated by using the formula,

$$\text{C. V. (\%)} = \frac{\text{SD}}{\bar{X}} \times 100$$

Where,

SD = Standard Deviation

$$\text{SD} = \sqrt{\frac{\sum(X - \bar{X})^2}{n}}$$

Where,

\bar{X} = Arithmetic mean

X = Variable

n = Number of observations

2.2.1.4 Coppock's Instability Index

To measure the instability in area, production & productivity of Red gram, the Coppock's index of instability were used.

$$V \log = \frac{\sum\{[\log(X_{t+1})/(X_t)] - m\}^2}{N}$$

$$\text{Coppock's Instability Index (C. I. I.)} = [\text{Antilog}(\sqrt{V \log}) - 1] \times 100$$

Where,

X_t = Area/ Production/ Productivity of Red gram in the year 't'

V Log = Logarithmic variance of the series

m = Arithmetic mean of difference between the logs of X_{t+1} ,

X_t etc.

N= Number of Years

3. Results and Discussion

District wise performance of Red gram in Vidarbha region were analysed and presented below.

Table 1: District wise Absolute and Relative Change in area, production and productivity of Red gram in Amravati division of Vidarbha

Districts	Area	Production	Productivity
Buldhana			
Absolute Change	15626	47700	503
Relative change (%)	26.80	121.68	74.74
Akola			
Absolute Change	2936	17500	300
Relative change (%)	6.27	42.07	33.75
Washim			
Absolute Change	10621	12000	71
Relative change (%)	26.49	37.85	8.99
Amravati			
Absolute Change	10635	16500	68
Relative change (%)	11.14	19.76	7.78
Yavatmal			
Absolute Change	-15265	-82700	-587
Relative change (%)	-12.41	-53.01	-46.29
Amravati Division			
Absolute Change	24553	11100	-33
Relative change (%)	6.75	3.15	-3.41

(Current year = 2020-21 & Base year = 2001-02), (Area in ha, Production in Tonnes, Productivity in kg/ha)

The results revealed that, the absolute and relative change in

area under Red gram is found to be decreased by 15265 ha and 12.41 percent only in Yavatmal district respectively. While the absolute & relative change in production of Red gram is found to be decreased in Yavatmal district by 82700 Tonnes and 53.01 percent respectively. In case of productivity of Red gram, the absolute and relative change is found to be decreased in Yavatmal district by 587 kg/ha and 46.29 percent respectively.

For Amravati division as a whole, the absolute & relative change in area under Red gram is found to be increased by 24553 ha and 6.75 percent respectively. While in case of production of Red gram for Amravati division, the absolute & relative change is found to be increased by 11100 Tonnes and 3.15 percent respectively. However, the absolute change & relative change in productivity of Red gram is found to be decreased by 33 kg/ha and 3.41 percent for Amravati division respectively.

From above table, it could be seen that area and production of for this division is increasing whereas productivity is decreasing. This is because of uncertain rainfall occurred during the tur growing period resulting in losses in productivity.

Table 2: District wise Absolute and Relative Change in area, production and productivity of Red gram in Nagpur division of Vidarbha

Districts	Area	Production	Productivity
Wardha			
Absolute Change	-299	34800	632
Relative change (%)	-0.53	52.89	53.93
Nagpur			
Absolute Change	498	18600	354
Relative change (%)	0.98	33.04	31.83
Bhandara			
Absolute Change	6854	-1900	-735
Relative change (%)	120.25	-31.15	-68.56
Gondia			
Absolute Change	995	-800	-362
Relative change (%)	24.88	-18.61	-33.77
Chandrapur			
Absolute Change	5320	4900	-122
Relative change (%)	354.67	306.25	-11.38
Gadchiroli			
Absolute Change	3138	27000	803
Relative change (%)	11.45	124.42	101.39
Nagpur Division			
Absolute Change	16506	82700	402
Relative change (%)	11.36	53.08	37.50

(Current year = 2020-21 & Base year = 2001-02), (Area in ha, Production in Tonnes, Productivity in kg/ha)

The results revealed that, the absolute and relative change in area under Red gram is found to be decreased in Wardha district. While the absolute & relative change in production of Red gram is found to be decreased in Bhandara and Gondia district. In case of productivity of Red gram, the absolute and relative change is found to be decreased in Bhandara, Gondia and Chandrapur district.

For Nagpur division as a whole, the absolute & relative change in area under Red gram is found to be increased by 16506 ha and 11.36 percent respectively. While in case of production of Red gram for Nagpur division, the absolute & relative change is found to be increased by 82700 Tonnes and 53.08 percent respectively. However, the absolute change & relative change in productivity of Red gram is found to be increased by 402 kg/ha and 37.50 percent for Nagpur division respectively.

From this table, it is observed that area, production and productivity of Red gram goes on increasing in Nagpur division.

Table 3: District wise annual compound growth rates for area, production and productivity of Red gram in Vidarbha region

Districts	Area	Production	Productivity
Buldhana	1.66	1.85	0.18
Akola	0.57	3.34	2.75
Washim	1.37***	-1.74	-3.07
Amravati	1.22***	1.32	0.10
Yavatmal	0.26	-1.99	-2.24
Amravati Division	0.96	0.71	-0.25
Wardha	1.99***	2.17	0.17
Nagpur	1.27***	4.06**	2.76
Bhandara	3.82***	2.16	-7.55
Gondia	2.02***	1.89	-0.08
Chandrapur	2.88***	9.69***	6.62***
Gadchiroli	7.22***	7.87***	4.01
Nagpur Division	2.13***	4.00**	1.84

(Note: *, ** and *** significant at 10%, 5% and 1% level of significance respectively)

(Area in ha, Production in Tonnes, Productivity in kg/ha)

The results revealed that the significant increase in the growth rate of area of Red gram was noticed in Gadchiroli district followed by Bhandara and Chandrapur district at the rate of 7.22, 3.82 and 2.88 percent per annum respectively. Also, the highest growth rate of production of Red gram was observed in Chandrapur district followed by Gadchiroli and Nagpur district at the rate of 9.69, 7.87 and 4.06 percent per annum respectively. However, significant growth rates in productivity of Red gram was observed in Chandrapur district only at the rate of 6.62 percent per annum. The growth rates of area and production of Red gram were found positive and significant for Nagpur division as a whole whereas non-significant for Amravati division.

Table 4: District wise Coefficient of Variation and Coppock's Instability Index for area, production and productivity of Red gram in Amravati division of Vidarbha

Districts	Area	Production	Productivity
Buldhana			
CV (%)	22.59	48.59	37.65
CII	42.01	45.42	43.56
Akola			
CV (%)	10.33	57.60	54.59
CII	38.77	47.07	46.52
Washim			
CV (%)	11.35	29.76	31.45
CII	38.68	42.47	42.79
Amravati			
CV (%)	11.74	29.83	26.63
CII	38.69	42.39	42.11
Yavatmal			
CV (%)	13.36	44.36	35.17
CII	38.83	45.39	44.54
Amravati Division			
CV (%)	9.90	29.99	25.67
CII	38.38	42.54	42.11

(Area in ha, Production in Tonnes, Productivity in kg/ha)

It was observed from the table that the highest coefficient of variation and instability for area under Red gram was observed in Buldhana district i.e. 22.59 and 42.01 percent respectively. The lowest degree of variation in area was found in Akola district i.e. 10.33 percent while lowest instability in area was observed in Washim district i.e. 38.68 percent. The coefficient of variation and instability index for production of Red gram

was observed to be high in Akola district i.e. 57.60 and 47.07 percent respectively. The lowest coefficient of variation for production of Red gram was noticed in Washim district i.e. 29.76 percent while lowest instability was observed in Amravati district i.e. 42.39 percent.

In case of productivity of Red gram, the highest coefficient of variation and instability index was noticed in Akola district i.e. 54.59 and 46.52 percent respectively. However, the lowest degree of variation and instability was observed in Amravati district i.e. 26.63 and 42.11 percent respectively. It is observed from this table that, the highest variation and instability of Red gram was observed in Akola district as there is decrease in area, production and productivity of tur in this district.

Table 5: District wise Coefficient of Variation and Coppock's Instability Index for area, production and productivity of Red gram in Nagpur division of Vidarbha

Districts	Area	Production	Productivity
Wardha			
CV (%)	16.22	45.02	42.15
CII	39.46	46.32	46.35
Nagpur			
CV (%)	10.49	66.36	58.21
CII	38.48	45.65	45.22
Bhandara			
CV (%)	23.22	58.74	44.24
CII	40.76	44.65	44.24
Gondia			
CV (%)	14.87	49.51	39.89
CII	39.35	43.57	43.19
Chandrapur			
CV (%)	20.87	61.59	49.66
CII	40.30	49.46	46.17
Gadchiroli			
CV (%)	42.08	62.93	46.06
CII	45.64	48.88	54.61
Nagpur Division			
CV (%)	14.96	50.77	40.75
CII	39.27	44.79	43.88

(Area in ha, Production in Tonnes, Productivity in kg/ha)

It was observed from the table that the highest coefficient of variation and instability for area under Red gram was observed in Gadchiroli district i.e. 42.08 and 45.64 percent respectively. The lowest degree of variation and instability in area was observed in Nagpur district i.e. 10.49 and 38.48 percent respectively. The coefficient of variation for production of Red gram was observed to be high in Nagpur district i.e. 66.36 percent while highest instability in production was found in Chandrapur district i.e. 49.46 percent. The lowest coefficient of variation for production of Red gram was noticed in Wardha district i.e. 45.02 percent while lowest instability was observed in Gondia district i.e. 43.57 percent.

In case of productivity of Red gram, the highest coefficient of variation was noticed in Nagpur district i.e. 58.21 percent while highest instability in productivity was observed in Gadchiroli district i.e. 54.61 percent. However, the lowest degree of variation and instability was observed in Gondia district i.e. 39.89 and 43.19 percent respectively. From above table, it is observed that, the highest instability is observed in Gadchiroli and Chandrapur districts because there is increase in area, production and productivity of Red gram in these districts during recent years.

4. Conclusion

The results concluded that the significant increase in the growth rate of area of Red gram was noticed in Gadchiroli district followed by Bhandara and Chandrapur district at the rate of 7.22, 3.82 and 2.88 percent per annum respectively. Additionally, the districts of Chandrapur, Gadchiroli, and Nagpur had the fastest increase rates in red gram production, with annual growth rates of 9.69, 7.87, and 4.06 percent, respectively. However, Chandrapur district was the only one to record notable increases in Red Gram productivity, with annual growth rates of 6.62 percent.

The growth rates of area and production of Red gram were found positive and significant for Nagpur division as a whole whereas non-significant for Amravati division. It is observed that, the highest variation and instability of Red gram was observed in Akola district as there is decrease in area, production and productivity of tur in this district whereas the highest instability is observed in Gadchiroli and Chandrapur districts because there is increase in area, production and productivity of Red gram in these districts during recent years.

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