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# Growth and instability in area, production and productivity of chickpea in Marathwada region of Maharashtra

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## Abstract

Pulses are the important sources of proteins, vitamins and minerals and are popularly known as “Poor man’s meat” and “rich man’s vegetable”, contribute significantly to the nutritional security of the country. The main objective of the study is to estimate growth and instability in area, production and productivity of chickpea. The growth and instability in area, production and productivity of chickpea was achieved by estimating growth rates. The linear and compound growth rates of chickpea were worked out for the period of 2001-02 to 2015-16 by using time series data. The compound growth rates of area, production and productivity of chickpea was worked out by using exponential function. To measure the instability in area, production and productivity, an index of instability was used as a measure of variability. Coppock’s instability index was used to measure the coefficient of instability. The instability index developed by Cuddy and Della was also used for estimating instability index.

The growth of area under chickpea showed mixed trend in the period of study i.e. from 2002 – 2016. It clearly observed from the study that deviation in area from year to year was observed and it might be due to the climatic factors and dry spells in the region. At an overall period of study, the least instability was observed in Parbhani district, while highest instability was observed in Hingoli. It is concluded from the above discussion that all districts of Marathwada region was failed to achieve the stability in production of chickpea. In case of productivity, at an overall period of study, the least instability was observed in Parbhani district while highest instability was observed in Hingoli. Thus, from the above discussion it is concluded that all districts of Marathwada region was failed to achieve the stability in productivity of chickpea.

**Keywords:** Growth and instability, chickpea, proteins, vitamins and minerals

## Introduction

Pulses are the important sources of proteins, vitamins and minerals and are popularly known as “Poor man’s meat” and “rich man’s vegetable”, contribute significantly to the nutritional security of the country. Currently, we are in the mid-way of self-sustaining in pulses production as we are world leader in production, consumption and import as well. India accounts for about 29 per cent of the world area and 19 per cent of the world’s production with 25.26 million hectares’ area and production of 16.47 million tonnes.

According to Indian Institute of Pulses Research’s Vision document, India’s population is expected to touch 1.68 billion by 2030 and the pulse requirement for the year 2030 is projected at 32 million tons with anticipated required annual growth rate of 4.2%. The average productivity of pulses in the country is 781 kg/ha, which is much below the world’s productivity of 871 kg/ha. Thus, the productivity and production of pulses has remained more or less stagnant for last four decades. Slight increase is observed during last five years showing the impact of National Food Security Mission.

## Objective

The main objective of the study is to estimate growth and instability in area, production and productivity of chickpea.

## Methodology

### Estimation of growth rates

The growth and instability in area, production and productivity of chickpea was achieved by estimating growth rates. The linear and compound growth rates of chickpea were worked out for the period of 2001-02 to 2015-16 by using time series data. The compound growth rates of area, production and productivity of chickpea was worked out by using exponential function. To measure the instability in area, production and productivity, an index of instability was used as a measure of variability. Coppock’s instability index was used to measure the

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coefficient of instability. The instability index developed by Cuddy and Della was also used for estimating instability index.

### Performance of chickpea crop in Marathwada region

The performance of chickpea crop was estimated with respect to area under crop, production and productivity of crop for fifteen years (2001-02 to 2015-16). The period of study was divided into four periods i.e. Period-I (2001-02 to 2005-06), Period-II (2006-07 to 2010-11), Period-III (2011-12 to 2015-16) and Overall period (2001-02 to 2015-16).

### Growth in area, production and productivity of chickpea

Agricultural growth of the Marathwada region can be ascertained through studying the growth in area, production and productivity of chickpea crop. The growth rates were estimated for mentioned period of the study. Results of the study are presented in following section.

### Results and Discussion

#### Growth in area of chickpea crop in Marathwada region of Maharashtra state

Compound growth rates of area under chickpea in Marathwada region was analyzed and is presented in Table 1. The results revealed that inconsistent growth in area under chickpea. In Aurangabad district growth shown negative trend in area to the tune of -1.76 per cent during Period-I while in Period-II and Period-III it was positive and significant with 4.33 per cent and 6.36 per cent respectively. At Overall the growth of area was positive but showed the decline trend which tuned to 0.51 per cent. In Jalna district the area under chickpea in all the periods shown positive trend with 1.84, 11.65, 9.14, 5.31 per cent respectively, which indicated that the area increased in period -II over period -I again declined in period-III and overall period but positive and significant at 1 per cent level. In Beed district it is observed that area under chickpea was positive in all the periods' i.e 10.10, 11.87, 17.76 and 8.00 per cent respectively. Trend shows that area was significant in Period-III and overall period at 5 per cent and 1 per cent respectively with increase in period II, III but declined at overall level. The growth rates of Latur district were observed to be 10.24, 9.45, 3.11, and 5.92 during period-I to overall period. Area of chickpea in Latur district showed positive but declining trend in comparison with period-I. Area was significant at 5 per cent level and 1 per cent level in period -I and at overall level respectively. Osmanabad district showed positive but inconsistent growth trend i.e. during Period-I to overall period the area was observed to the tune of 0.47, 2.30, 12.45, 2.51 respectively which means that area under chickpea in Hingoli district was increased during period- II to overall level but showed declining trend at overall period in compare to period-II and III. Nanded district showed positive and significant growth at 1 per cent level during Period-I while in period-II and III it is negative and declining to the tune of -0.87 and -3.72 respectively. At overall period it was positive and significant at 1 per cent level to the tune of 3.89 per cent. It means that the growth rate of area during the period of study under chickpea in Nanded district was showed inconsistent trend. In Hingoli district the area under chickpea positive trend in all the periods, decreased in period-II, increased in period-III and declined at overall period. From the table it is observed that in whole Marathwada region the growth of area under chickpea was positive and increased in Period-III. At overall level it is positive and significant at 1 per cent level to the tune of 4.39.

**Table 1:** Growth Rates of Chickpea Area in Marathwada region

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	-1.76	4.33*	6.36	0.51
Jalna	1.84	11.65	9.14	5.31**
Beed	10.10	11.87	17.76*	8.00**
Latur	10.24*	9.45	3.11	5.92**
Osmanabad	0.47	2.30	12.45	2.51
Nanded	17.37**	-0.87	-3.72	3.89**
Parbhani	4.32	-0.33	-5.31	1.46
Hingoli	9.81*	0.80	16.56	8.81**
Marathwada	5.95	4.29	7.01	4.39**

\* Significant at 5 %,

\*\* Significant at 1 %

#### Growth in chickpea production in Marathwada region of Maharashtra state

Compound growth rates of production of chickpea in Marathwada region was analyzed and is presented in Table 2. The results revealed that in Aurangabad district growth of production was positive to the tune of 6.55, 4.80 respectively but declined in period-II than Period-I. During period III and overall it was negative and significantly declined to the tune of -4.52 and -1.12 respectively. Jalna district showed negative growth trend of chickpea production except in period -II which was to the tune of 11.58 per cent, which means the production of chickpea during study period was inconsistent and declining. During Period-I and period-II production of Beed, Latur, Osmanabad and Nanded was observed positive and mixed trend as 19.73, 9.59, 13.65 and 14.16, 10.10, 7.96 respectively. Production of Latur declined in period-II, Osmanabad showed increased trend and Nanded showed decreasing trend in Period-II. In case of period -III Beed, Latur, Osmanabad, Nanded showed negative and declining trend to the tune of -3.33, -28.79, -8.58, -25.76, -25.01 respectively. Growth rates of production of chickpea in Hingoli district was positive in Period-I, negative in period-II and positive in period-III and overall period to the tune of 11.05, -4.01, 12.09 and 13.08 respectively. This means that the production was decreased in period-II, increased in period in period-III and significantly increased during overall period at 1 per cent level. As regards whole Marathwada region the growth of production of chickpea was non-significantly increased during first two periods, significantly decreased in period-III to the tune of -17.31 per cent. At overall period it was positive to the tune of 3.0.

**Table 2:** Growth Rates of Chickpea Production in Marathwada region

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	6.55	4.80	-4.52	-1.12
Jalna	-0.80	11.58	-2.05	-0.14
Beed	15.89	11.42	-3.33	7.57*
Latur	19.73	14.16	-28.79	7.10
Osmanabad	9.59	10.10	-8.58	3.08
Nanded	13.65	7.96	-25.76	4.05
Parbhani	-1.28	-3.01	-25.01	0.88
Hingoli	11.05	-4.01	12.09	13.08**
Marathwada	4.01	1.46	-17.31	3.00

\* Significant at 5 %, \*\* Significant at 1 %

#### Growth in productivity of chickpea in Marathwada region of Maharashtra State

Compound growth rates of productivity of chickpea in Marathwada region was analyzed and is presented in Table 3. The results revealed that in Aurangabad district growth of productivity was positive during Period-I and Period-II while

it was negative during period-II and overall period to the tune of 8.48, 0.49, -10.39, -1.63 respectively, which indicated that the productivity was increased in period -I, declined but positive in period-II and negatively declined and non-significant during period-III and overall period. In Jalna district productivity of chickpea was showed negatively declining trend during all periods of study to the tune of -2.62, -0.06, -10.08, and 5.18 respectively. Beed showed negative and declining trend during Period-II to overall period except in Period-I. It is observed from the table that productivity of chickpea in Latur and Osmanabad district was positive and increased during Period-I and II to the tune of 8.6, 79.07, 4.30, 7.61 respectively. In case of period -III it was negative and significantly declining to the tune of -30.77 and -18.70. Whereas at overall period productivity was declined but positive. Nanded district showed inconsistent trend of productivity of chickpea during study period. In Period-I and II it was negative and decreasing, during period-II it was positive and increasing and in overall period it was declining but positive. It is evident from the table that growth rates of productivity of Parbhani district were negative in all periods of the study. Hingoli showed positive growth during period-I (1.08), negative and decreasing in period-II (-4.83) and III (-3.87), whereas positive and increasing trend during overall period (3.92).

As regards to whole Marathwada region the table revealed that inconsistent growth in productivity of chickpea resulted in increasing productivity during Period-I, decreasing but positive in period-II to the tune of 2.41 and 1.63 respectively. During period-III, productivity was negative and significantly declined to the tune of -15.67 per cent. At overall level productivity was declined in comparison with Period-I and period-II but increased in comparison with period-III which was to the tune of 0.64.

**Table 3:** Growth Rates of Chickpea Productivity in Marathwada region

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	8.48	0.49	-10.39	-1.63
Jalna	-2.62	-0.06	-10.08	-5.18
Beed	5.24	-0.38	-17.92	-0.41
Latur	8.67	4.30	-30.77	1.11
Osmanabad	9.07	7.61	-18.70	0.56
Nanded	-3.18	8.64	-22.83	0.17
Parbhani	-5.40	-2.61	-20.73	-0.56
Hingoli	1.08	-4.83	-3.87	3.92
Marathwada	2.41	1.63	-15.67	0.64

\* Significant at 5 %,

\*\* Significant at 1 %

#### Instability in area, production and productivity of Chickpea in Marathwada

Performance of chickpea crop during given time period was measured not only in terms of growth in area, production and productivity but also on the extent of fluctuations observed in area, production and productivity of same crop. In view to estimate the extent of variability in area, production and productivity of chickpea in the region coefficient of variation was worked out which helps to measures variability of data in absolute form.

#### Coefficient of variation of area under Chickpea in Marathwada region

The coefficient of variation of area under chickpea in Marathwada region was calculated and is presented in Table

4. It was observed from the table that during Period-I the highest coefficient of variation of area under chickpea was recorded in Nanded district i.e. 25.66 per cent followed by Beed (19.91per cent), Latur (17.38per cent) Hingoli (16.32per cent) and Jalna (12.50). While the lowest degree of variation was recorded for Aurangabad district i.e. 4.85 per cent followed by Osmanabad (7.94 per cent) and Parbhani (9.24 per cent). As regards to whole Marathwada region the coefficient of variation was 11.04 per cent. During Period-II the variability was increased in Aurangabad, Jalna, Beed, Osmanabad and Parbhani i.e. 7.66, 25.70, 21.71, 21.49 and 15.72, whereas variability in area was more or less constant in Latur and Hingoli and steeply declined in Nanded. During this period the degree of variation of Jalna district was 25.70 per cent which was highest degree of variation in that period followed by Parbhani district (15.72 per cent) and Nanded (13.41 per cent). Lowest degree of variation was recorded in Hingoli i.e. 16.34 per cent followed by Latur (17.18 per cent), and Aurangabad (7.66 per cent). In this period degree of variation of whole Marathwada region was decreased to 8.78 per cent from 11.04 per cent. During Period-III the variability in Hingoli district was 35.04 per cent which was highest variability throughout study period and lowest variability was recorded in Nanded (12.65 per cent). The coefficient of variation of area under chickpea was increased in Beed, Osmanabad, Parbhani and Hingoli district to 26.47 per cent, 32.53 and 35.04 per cent respectively. In Aurangabad, Jalna, Latur and Nanded the coefficient of variation was 14.01 per cent, 16.40 per cent, 12.86 per cent, 12.65 per cent respectively. As regards whole Marathwada region the variability was decreased to 16.56 per cent from 11.04 per cent in period -I and 8.78 per cent in period-II. At an overall period, the highest degree of variation was recorded in Hingoli i.e. 50.67 followed by Beed district i.e. 37.36 per cent. Hingoli (20.07 per cent) and Latur (19.91 per cent). While lowest variation was recorded in Parbhani district i.e. 17.32 per cent followed by Aurangabad (18.02 per cent). As regards whole Marathwada region the degree of variation was 21.47 per cent. The variation of area in all districts was higher than the variation of whole in Marathwada region. It is concluded from above discussion that the area under chickpea crop in all districts of Marathwada region was unstable during the period of study.

**Table 4:** Coefficient of Variation of Chickpea Area in Marathwada region

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	4.85	7.66	14.01	18.02
Jalna	12.50	25.70	16.40	27.75
Beed	19.91	21.71	26.47	37.36
Latur	17.38	17.18	12.86	26.72
Osmanabad	7.94	21.49	32.53	25.74
Nanded	25.66	13.41	12.65	21.61
Parbhani	9.24	15.72	19.77	17.32
Hingoli	16.32	16.34	35.04	50.67
Marathwada	11.04	8.78	16.56	21.47

#### Coefficient of variation of Chickpea production in Marathwada region

The coefficient of variation of production of chickpea in Marathwada region was calculated and is presented in Table 5. It was observed from the table that during Period-I the highest coefficient of variation of production of chickpea was recorded in Beed district (61.46 per cent) followed by Osmanabad (44.70 per cent) and Latur (43.05 per cent). While

lowest degree of variation was recorded in Aurangabad (22.32 per cent) followed by Jalna (25.32 per cent), Nanded (25.45 per cent), Parbhani (25.31 per cent) and Hingoli (28.20 per cent). As regards to whole Marathwada region the degree of variation was 26.26 per cent. The variation in production of Beed, Latur, Osmanabad and Hingoli districts was higher than the variation recorded of Marathwada region and lower than other districts of Marathwada. During Period-II the degree of variation in production recorded in all districts except Jalna was decreased than the Period-I. The variability of whole Marathwada region was decreased to 13.83 per cent. During this period the highest variation was recorded in Jalna district (33.15 per cent) while lowest was recorded in Aurangabad district (10.06 per cent). The degree of variation recorded in all districts as well as at Marathwada level during Period-III was higher than Period-I and Period-II. During Period-III the variation percentage observed was highest in Hingoli district i.e. 96.33 per cent which was highest during the period of study followed by all other districts Latur, Jalna, Osmanabad, Nanded, Aurangabad, Parbhani and Beed. As regards to whole Marathwada region the variability in production was increased to 44.10 per cent. During overall period the highest degree of variation was recorded again in Hingoli (126.61 per cent) followed by Latur (72.85 per cent), Osmanabad (48.81 per cent), Beed (48.44), Jalna (47.86), Aurangabad (47.01), Nanded (44.40) and Parbhani (36.59). As regards to whole Marathwada region the coefficient of variation was 44.10 per cent. It is concluded from above discussion that production of chickpea in all districts of Marathwada region was unstable during the period of study.

**Table 5:** Coefficient of Variation of Chickpea Production in Marathwada region

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	22.32	10.06	48.61	47.01
Jalna	25.32	33.15	71.44	47.86
Beed	61.46	19.75	43.74	48.44
Latur	43.05	28.56	78.19	72.85
Osmanabad	44.70	22.11	61.18	48.81
Nanded	25.45	22.99	51.50	44.40
Parbhani	25.31	21.08	46.63	36.59
Hingoli	28.20	22.35	96.33	126.61
Marathwada	26.16	13.83	44.10	44.10

### Coefficient of variation of Chickpea productivity in Marathwada region

The degree of variation of productivity of chickpea in Marathwada region was calculated and is presented in Table 6. It is revealed from the table that during Period-I the highest degree of variation of productivity in chickpea was found to be in Osmanabad district i.e. 40.58 per cent followed by Latur (23.59 per cent), Aurangabad (21.40) and Parbhani (21.26 per cent). While the lowest variability was recorded in Hingoli (15.87 per cent) followed by Jalna (16.04 per cent) and Beed (17.15 per cent). The variability of whole Marathwada region was 12.90 per cent. During Period-II the coefficient of variation was found to be decreased in Aurangabad (5.71 per cent), Jalna (14.01 per cent), Beed (7.39 per cent), Latur (11.21 per cent), Osmanabad (12.83 per cent), Parbhani (7.89 per cent) and Hingoli (13.72 per cent). Only in case of Nanded district the variability was increased to 22.99 per cent. During the same period the highest variability was found in Nanded i.e. 22.99 per cent and lowest was found in Aurangabad district i.e. 5.71 per cent. The variability of whole Marathwada region was decreased to 7.52 per cent.

During Period-III the variability recorded in all districts was showed the percentage of variation was found to be increased. In this period highest variation was recorded in Hingoli district (80.68 per cent) and lowest were recorded in Nanded district. As regards of whole Marathwada region the percentage of variation was 36.61 per cent which showed increased variation. As compared to Marathwada region all districts showed higher variability. At an overall period, the percentage of variation recorded in Jalna district was highest and in other districts it was more or less variable. As regards of whole Marathwada region the variability was 24.81 per cent. It is concluded from the above discussion that productivity of chickpea in all districts of Marathwada region was unstable during the period of study.

**Table 6:** Coefficient of Variation of Chickpea Productivity in Marathwada region

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	21.40	5.71	46.10	33.68
Jalna	16.04	14.01	68.60	37.49
Beed	17.15	7.39	38.18	26.67
Latur	23.59	11.21	67.03	46.91
Osmanabad	40.58	12.83	51.34	38.20
Nanded	12.29	22.99	46.03	31.40
Parbhani	21.26	7.89	36.33	24.91
Hingoli	15.87	13.72	80.68	68.93
Marathwada	14.15	7.52	36.31	24.81

### Coppock's Instability Index of area, production and productivity of chickpea in Marathwada region

The instability index of area, production and productivity of chickpea is computed by using Coppock's instability index and the results are presented in the following sections. Coefficient of instability is another measure of instability besides coefficient of variation. The coefficient of instability also known as instability index measures the variation around the trend. It is a close approximation of the average year to year percentage variation adjusted for trend. Thus variations around the trend are more pronounced than the absolute variation.

### Coppock's Instability Index of area under chickpea

The instability of area under chickpea in Marathwada region was calculated by Coppock's instability index and is presented in Table 7. It is revealed from the table that during Period-I the highest instability in area was observed in Jalna district (16.91 per cent) followed by Beed (16.60 per cent), Osmanabad (14.55 per cent), Hingoli (12.34 per cent), and Parbhani (10.59 per cent), while lowest instability was observed in Aurangabad (5.90 per cent) followed by Nanded (7.71 per cent) and Latur (7.78 per cent). In case of Whole Marathwada region the instability of area was 7.85 per cent. During this period the instability of area was comparatively low which means there was stability in area under chickpea. The increased instability was observed during Period-II and Period-III over Period-I. During Period-II highest instability was observed in Osmanabad district (42.62 per cent) followed by Jalna (26.92 per cent), Beed (22.88), Hingoli (22.87 per cent) and Parbhani (20.49 per cent) and lowest instability was recorded in Aurangabad (5.22 per cent). Except in Aurangabad district (5.22 per cent) the instability was increased in all other districts of Marathwada which tuned to 26.92 per cent, 22.87 per cent, 13.73 per cent, 42.62 per cent, 18.86 per cent, 20.49 per cent, 22.88 per cent respectively. As regards to whole Marathwada region the instability of area

was slightly decreased to 7.84 per cent from 7.85 during Period-I. During Period-III the instability in area under chickpea was increased in Aurangabad, Latur, Osmanabad, Parbhani and Hingoli district to the tune of 21.70 per cent, 20.83 per cent, 42.52 per cent, 25.37 per cent and 44.61 per cent respectively. While it was decreased in Jalna (19.69), Beed (20.54) and Nanded (16.50). During this period the highest instability of area was observed in Hingoli district i.e. 44.61 per cent. As regards to whole Marathwada region the instability was increased to 19.84 per cent. During overall period of study (Overall) the highest instability observed in Osmanabad district (34.09 per cent) followed by Hingoli (27.38 per cent), Beed (23.68 per cent) and Parbhani (20.81) while lowest instability found to be in Nanded district (17.30 per cent). As regards to whole Marathwada region the instability was 14.47 per cent. It was concluded from the above discussion that there was no stability of area under chickpea in Marathwada region.

**Table 7:** Instability in Area of chickpea by Coppock's Instability Index

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	5.90	5.22	21.70	19.47
Jalna	16.91	26.92	19.69	20.68
Beed	16.60	22.87	20.54	23.68
Latur	7.78	13.73	20.83	16.77
Osmanabad	14.55	42.62	42.52	34.09
Nanded	7.71	18.86	16.50	17.30
Parbhani	10.59	20.49	25.37	20.81
Hingoli	12.34	22.88	44.61	27.38
Marathwada	7.85	7.84	19.84	14.47

#### Coppock's Instability Index of chickpea production

Coppock's instability index was employed to calculate the instability in production of chickpea in Marathwada region and is presented in Table 8. It is revealed from the table that during Period-I the highest instability in production was observed in Osmanabad district (81.02 per cent) followed by Parbhani (61.57 per cent), Jalna (45.99 per cent) Aurangabad (39.96 per cent), Hingoli (38.84 per cent), Beed (34.84 per cent) and Latur (31.05 per cent) while lowest instability was observed in Nanded (29.93 per cent). In regards to whole Marathwada region the instability was 27.80 per cent which mean that all the districts of Marathwada region did not show the stability in chickpea production during Period-I. During Period-II the instability of production in Jalna district was 55.12 per cent which was highest instability for the period. The instability in Hingoli, Osmanabad, Parbhani, Nanded, Latur and Beed was Aurangabad and Jalna was 43.14 per cent, 31.14 per cent, 30.02 per cent, 27.81 per cent, 25.39 per cent and 21.91 per cent respectively. Lowest instability was found to be in Aurangabad district (8.32 per cent). In case of whole Marathwada region the instability was decreased to 10.89 per cent. During Period-III it is observed that the instability in production of chickpea was found higher in all districts of Marathwada over the previous two periods. The highest instability was recorded in Jalna (307.0) followed by Hingoli, Aurangabad, Latur and Osmanabad to the tune of 245.62 per cent, 167.77 per cent, 163.15 per cent and 157.51 per cent

respectively. While lowest instability was recorded in Nanded district (61.25 per cent) followed by Beed (76.68 per cent) and Parbhani (79.32 per cent). The instability of whole Marathwada region was increased to 92.03 per cent. During overall period of study, the highest instability was observed in Jalna district (127.97 per cent) followed by Hingoli district (106.22 per cent) followed by Aurangabad (82.22 per cent), Osmanabad (90.04 per cent), Latur (80.47 per cent) and Parbhani (61.48 per cent) while lowest instability was recorded in Nanded (44.81 per cent) followed by Beed (50.08 per cent). The instability recorded for whole Marathwada region was 50.28 per cent.

Thus, the above discussion was concluded that there was no stability in production of chickpea in Marathwada region throughout the studied period.

**Table 8:** Instability in Production of chickpea by Coppock's Instability Index

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	39.96	8.32	167.77	82.22
Jalna	45.99	55.12	307.02	127.97
Beed	34.84	21.91	76.68	50.08
Latur	31.05	25.39	163.15	80.47
Osmanabad	81.02	31.14	157.51	90.04
Nanded	29.93	27.81	61.25	44.81
Parbhani	61.57	30.02	79.32	61.48
Hingoli	38.84	43.14	245.62	106.22
Marathwada	27.80	10.89	92.03	50.28

#### Coppock's Instability Index of chickpea productivity

The coefficient of instability in productivity of chickpea in Marathwada region was calculated by Coppock's instability index and is presented in Table 9. It is observed from the table that during Period-I the highest coefficient of instability was observed in Osmanabad district followed by Parbhani, Beed and Aurangabad to the tune of 86.31 per cent, 46.53 per cent, 32.84 per cent and 32.01 per cent respectively. While least instability was observed in Nanded district (21.23 per cent) followed by Latur (23.29 per cent), Jalna (26.93 per cent) and Hingoli (26.84 per cent). In case whole Marathwada region the instability was 20.65 per cent. During Period-II the coefficient of instability of Nanded was 35.72 per cent which was highest in this period followed by Jalna (27.54 per cent) and Hingoli (23.59). The instability during period-II was low in Aurangabad followed by Parbhani, Osmanabad and Beed. The instability of whole Marathwada region was decreased to 12.35 per cent. During Period-III the instability of Jalna district was 244.61 per cent which was highest instability throughout the studied period followed by Hingoli (204.91 per cent), Latur (119.14 per cent) and Aurangabad (120.41 per cent). The lowest instability was recorded in Nanded district (47.95 per cent) followed by Beed, Parbhani and Osmanabad. The instability of whole Marathwada region was increased to 61.84 per cent. The coefficient of instability in productivity of chickpea during overall period of study of Jalna was highest in the tune of 100.61 per cent. As regards to whole Marathwada region the instability was 36.33 per cent.

Thus, above discussion was concluded that there was no stability in productivity of chickpea in Marathwada region.

**Table 9:** Instability in Productivity of chickpea by Coppock's Instability Index

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	32.01	9.17	120.41	59.65
Jalna	26.93	27.54	244.61	100.61
Beed	32.84	12.07	48.58	34.61
Latur	23.29	14.85	119.14	60.91
Osmanabad	86.31	11.84	99.84	69.55
Nanded	21.23	35.72	47.95	37.88
Parbhani	46.53	10.65	61.60	44.53
Hingoli	26.84	23.59	204.91	89.27
Marathwada	20.65	12.35	61.84	36.33

#### Instability in area, production and productivity of chickpea in Marathwada region by Cuddy Della Vella Index

Cuddy and Della Vella measure variability after eliminating trends hence this measure of variability is trend free. Therefore, numeric value of variability measures of Cuddy and Della Vella index is relative smaller than coefficient of variation. However, magnitude of these two measures carries similar meanings. In order to examine the extent of variability in area, production and productivity Cuddy and Della Vella index was worked out.

#### Instability in area under chickpea by Cuddy and Della Vella Index

The instability of area under chickpea in Marathwada region was calculated by Cuddy and Della Vella index and presented in Table 10. It is revealed from the table that during Period-I the least variability was observed in Aurangabad district (4.58 per cent) followed by Nanded (5.39 per cent), Latur (7.12 per cent), Parbhani (7.17 per cent), Hingoli (8.28 per cent) and Osmanabad (9.13 per cent) while highest variability was observed in Jalna (14.03 per cent) followed by Beed (13.98 per cent). During Period-II the instability in all districts was increased except Aurangabad. During Period-II highest instability was observed in Osmanabad district (24.42 per cent) followed by Jalna (21.66 per cent), Hingoli (18.81), Parbhani (18.14), Nanded (15.40 per cent) and Beed (13.54 per cent). While least variability was observed in Aurangabad (4.21 per cent) followed by Latur (10.02 per cent). In regards to whole Marathwada instability in period-II increased to 6.51. During period-III the instability was highest in Osmanabad (30.07 per cent) and lowest in Jalna district (11.23 per cent). In case of whole Marathwada instability increased to 14.63 per cent. During overall period of study, the least variability was observed in Latur district (10.87 per cent). While highest instability was observed in Hingoli district (25.76 per cent). As regards to whole Marathwada region the instability was 10.21 per cent.

The above results can be concluded as in Marathwada region was instable in area under chickpea.

**Table 10:** Instability in Area under chickpea by Cuddy Della Valle Index

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	4.58	4.21	12.22	18.55
Jalna	14.03	21.66	11.23	15.42
Beed	13.98	13.54	12.03	19.07
Latur	7.12	10.02	13.69	10.87
Osmanabad	9.13	24.42	30.07	23.46
Nanded	5.39	15.40	12.77	15.60
Parbhani	7.17	18.14	20.40	16.55
Hingoli	8.28	18.81	30.02	25.76
Marathwada	6.23	6.51	14.63	10.21

#### Instability in production of chickpea by Cuddy and Della Vella Index

The coefficient of instability in production of chickpea in Marathwada region was calculated by Cuddy and Della Vella index and is presented in Table 11. It is revealed from the table that during Period-I highest instability was observed in Osmanabad (49.33 per cent) followed by Beed (48.57 per cent). While least variability was found in Nanded district (18.36 per cent). In case of whole Marathwada the instability in production was 24.00 per cent. During Period-II highest instability was observed in Jalna (33.37 per cent) followed by Hingoli (24.95 per cent) whereas least variability was found in Aurangabad district (7.52 per cent) followed by Beed district (11.93 per cent). During Period-III the highest instability was observed in Hingoli district (108.92 per cent) followed by Jalna (82.41 per cent). Least variability was found to be in Nanded district (37.70 per cent). At an overall period of study, the least instability was observed in Parbhani district (37.83 per cent) while highest instability was observed in Hingoli (91.04 per cent). The instability in production of whole Marathwada region was 37.37 per cent. Thus, it is concluded from the above discussion that all districts of Marathwada region was failed to achieve the stability in production of chickpea.

**Table 11:** Instability in Production of chickpea by Cuddy Della Valle Index

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	23.43	7.52	55.63	48.57
Jalna	29.20	33.37	82.41	49.67
Beed	48.57	11.93	49.98	39.29
Latur	29.93	19.25	68.83	65.77
Osmanabad	49.33	18.46	68.96	49.15
Nanded	18.36	21.79	37.70	42.26
Parbhani	29.16	23.75	38.84	37.83
Hingoli	25.58	24.95	108.92	91.04
Marathwada	24.00	9.94	37.37	37.37

#### Instability in productivity of chickpea by Cuddy and Della Vella Index

The instability of productivity of chickpea in Marathwada region was calculated by Cuddy and Della Vella index and is presented in Table 12. It is revealed from the table that during Period-I the least instability was observed in Nanded district i.e. 13.01 per cent while highest instability was observed in Osmanabad district (44.95 per cent). As regards to whole Marathwada region the instability was 15.74 per cent. During Period-II the instability was decreased except Nanded district while in Period-III it was increased. The instability in productivity of whole Marathwada was 33.51 per cent in Period-III. During Period-III the least instability was observed in Beed (28.64 per cent) followed by while highest instability was observed in Hingoli district (92.81 per cent) which was

highest throughout the studied period. At an overall period of study the least instability was observed in Parbhani district (25.78 per cent) while highest instability was observed in Hingoli (66.06 per cent). Thus, from the above discussion it is concluded that all districts of Marathwada region was failed to achieve the stability in productivity of chickpea.

**Table 12:** Instability in Productivity of chickpea by Cuddy Della Valle Index

Name of District	Period-I	Period-II	Period-III	Overall
Aurangabad	20.04	6.53	49.46	34.32
Jalna	17.88	16.18	76.84	34.41
Beed	17.79	8.51	28.64	27.63
Latur	21.21	10.17	51.78	48.40
Osmanabad	44.95	7.23	47.29	39.59
Nanded	13.01	21.64	31.74	32.58
Parbhani	22.99	7.75	29.33	25.78
Hingoli	18.22	13.11	92.81	66.06
Marathwada	15.74	8.18	33.51	25.62

### Socio-economic characteristics of chickpea growers

The socio-economic characteristics of chickpea growers include age, educational level, family size, occupational level, operational land holding, bullock pair and livestock

### Socio-economic characteristics of chickpea growers

Socio-economic characteristics of chickpea growers were estimated and are presented in Table 13. It was observed from the table that the middle age farmers ( $>40$  to  $\leq 55$ ) was 40.00 per cent, the young ( $>25$  to  $\leq 40$ ) which was 12.50 per cent and old group farmers ( $>55$  to  $\leq 70$ ) was 47 per cent. With respect to educational level secondary level was dominating with 39.17 per cent followed by primary level education with 32.50. per cent. Higher secondary and college level education contributing same i.e. 10.83 per cent while illiteracy per cent was negligible accounting 6.67 per cent. The family size of the farmers was divided into three categories on the basis of members in family as small, medium and large. About 52.50 per cent of growers belonged to medium family size which was ranging from 5 to 7 members in a family followed by 33.33 per cent growers belonged to small family ranging from 2 to 4 members. About 14.17 per cent growers belonged to large family ranging from 8 to 10 members in a family. In respect of occupational level of chickpea growers, most of farmers belonged to agriculture that was 97.50 per cent followed by services 1.67 and business very negligible having 0.83 per cent. In case of operational land holding medium group ranging from more than two hectares to four hectares ( $>2$  to  $\leq 4$  ha) was found to be maximum having 47.50 per cent, 35.83 per cent farmers have less than less than two hectares of land and 16.67 per cent farmers comes under large holding category having more than 4 hectares' land. Fragmentation of land was dominating with one fragment in which 65.83 per cent were distributed for chickpea farm. In case of distance of farm from village, it is observed that 59.17 per cent farms 2 to 4 kilometres away from the village, 24.17 per cent are more than ( $> 4$  to  $\leq 6$ ) away and only 16.67 per cent are near the village. With respect of bullock pair 51.67 per cent farmers have one bullock pair, 18.33 per cent farmers having two bullock pairs while 30 per cent farmers having no bullock pair. Regarding the livestock 45.83 per cent farmers rearing one livestock, 29.17 per cent farmers rearing two livestock and 25 per cent farmers having one livestock.

### Conclusions

The discussion made above can be concluded as the growth of area under chickpea showed mixed trend in the period of study i.e. from 2002 – 2016. It clearly observed from the study that deviation in area from year to year was observed and it might be due to the climatic factors and dry spells in the region. At an overall period of study, the least instability was observed in Parbhani district, while highest instability was observed in Hingoli. It is concluded from the above discussion that all districts of Marathwada region was failed to achieve the stability in production of chickpea.

In case of productivity, at an overall period of study, the least instability was observed in Parbhani district while highest instability was observed in Hingoli. Thus, from the above discussion it is concluded that all districts of Marathwada region was failed to achieve the stability in productivity of chickpea.

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