**A statistical evaluation of growth and decomposition analysis of pulses crops in Chhatarpur District, Madhya Pradesh**

**Abstract**

**Research has been conducted on the growth and decomposition analysis of major pulse crops in Chhatarpur district of Madhya Pradesh for 2011-12- 2022-23. The compound growth rate for that period was analyzed by applying the exponential function. It is observed from the study that the CAGR of the Black gram crop for area, production, and productivity increased at the compound growth rates of 34.08 %, 58.80%, and 18.84% respectively. In the case of the Gram crop area, production, and productivity increased by 1.92%, 20.35%, and 7.78% respectively. While CAGR of Pigeon pea crop in area and production decrease at the compound growth rate of -32.81 percent and -19.89 percent respectively, while productivity increases at the rate of 17.82 percent. After analysis of decomposition, it is observed that the productivity effect was the dominant factor in influencing the production of Gram and pigeon pea crops while growth in the production of Black gram was majorly influenced by the interaction effect**.

**Keywords- CAGR, Decomposition analysis, Black gram, gram, and Pigeon pea.**

1. **Introduction**

The pulses are the most important crops grown in India because it is a major source of protein for human beings. Pulses crops provided protein 20-25 gram per hundred gram of dried pulses that why pulses are called powerhouse of nutrition [4] The total production of pulsed in India is 247.85 Lakh Million tones in which Madhya Pradesh has the highest contribution approximately 54.82 Lakh Million tones. The major pulses crop in India is Arhar Gram, Urad, Pea, Moong Lobia Kulthi, Moth, Lentil and Rajma [2] .Out of these crops in the Chhatarpur district Urad, Gram and Arhar crops are dominantly grown on 184.57, 86.90, and 2.94 million ha respectively with the production of 149.50, 165.11, 2.19 million metric tons respectively. (Urad, Gram and Arhar) [3]

1. **Research methodology**

Compound growth rates of area, production and productivity of pulses crops were worked out for Chhatarpur district of Madhya Pradesh during the period of 2011-12 to 2022-23. Compound growth rate was worked out by fitting exponential function as given below: [5]

 Yt= abt

Where,

 Yt = Dependent variable on area, production and productivity in the year ‘t’

 a = Constant

 b = Regression coefficient

 t = Time element which takes the value 1, 2, 3…….12

After transforming the model into a linear form by taking logarithms, we get

log Yt = log a + t log b

 By putting log Yt = y

 Log a = A

 Log b = B

The model becomes linear between y and t, as y=A +Bt, the compound growth rate (r) in per cent was obtained by the following formula.

 r = (b-1) x100 = (antilog B-1) X100

The significance of growth rate was tested by applying student’s’ test statistic

 t= r /S.E.(r)

 Where

 S.E. (r) = 100 x b x S.E.

 r = CAGR

Which follows distribution with (n-2) degree of freedom and n is the number of years considered under study.

**Coefficient of variation**

 The standard deviation as a percentage of mean is called coefficient of variation. Crop wise variation has been calculated for area, production and productivity separately.

 **CV =** x100

 Where,

CV = Co-efficient of variation

SD = Standard deviation of variables

 = Mean of the variable

**Decomposition analysis**

Decomposition analysis was performed to assess the area effect, productivity effect (yield), and interaction effect in the total production of pulses crop. The following additive techniques of decomposition analysis were used.

 P = A0 (Yn- Y0) + Y0 (An - A0) +∆A ∆Y

 = [(Y ∆A)/P] + [(A ∆Y)/ P] + [(∆A ∆Y)/ P] x100

Where,

 P = Change in production

 A0 = Area in the base year

An = Area in the last year

 Y0 = Yield in the base year

Yn = Yield in the last year

 ∆A = Change in the area (An-A0),

 ∆Y = Change in the yield (Yn- Y0).

3. Result and Discussion

Compound annual growth rate of area, production and productivity of Black Gram

The compound annual growth rate of area, production, and productivity of Black gram in the Chhatarpur district was for the 12-year period from 2011-12 to 2022-23 to examine the growth performance of Black gram crop and the results are presented in table1.The results reveal that during 2011-12 to 2022-23 the area of Black gram crop increased from 63.00 thousand hectares to 184.57 thousand hectares, with a significant compound growth rate of 34.08 per cent per annum. The growth in area was found to positive due to farmers have more interest in the cultivation of Black gram crop due to its profitability. The maximum area was observed in the year 2019-20 (265.55 thousand hectare) followed by 2018-19 (254.45 thousand hectare), 2020-21 (225.30 thousand hectare), and in 2022-23(184.57.00 thousand hectare) as compared to other years. [1] During the period 2011-12 to 2022-23 the production increased from 8.00 thousand metric tons to 149.50 thousand metric tons with a significant compound annual growth rate of 58.80 per cent. The production of increased due to increase in the yield of Black Gram crop due to introduction of high yield variety. The maximum production was found to be in the year 2018-19 (185.49 thousand metric ton) followed by 2022-23 (149.50 thousand metric ton), 2022-23 (20872.20 thousand metric ton), and in 2021-22 (121.07 thousand metric ton) as compared to other year. During the study period the productivity increased from 124 Kg/ha to 810 kg/ha with 18.84 per cent compound annual growth. The productivity increases due to use of high yield varieties by the farmers. Maximum productivity found to be in the year 2017-18 (1052.00 kg /ha), followed by 2016-17 (1031.00 Kg/ha), 2015- 16 (789.00 Kg/ha) as compared to other year.

**Table 1: CAGR of area, production and productivity of Black Gram**

|  |  |  |  |
| --- | --- | --- | --- |
|  **Year** |  **Area****(Thousand ha)** | **Production****(Thousand MT)** | **Productivity****(Kg/ha)** |
| 2011-12 | 63.00 | 8.00 | 124.00 |
| 2012-13 | 73.00 | 24.00 | 325.00 |
| 2013-14 | 78.00 | 32.00 | 405.00 |
| 2014-15 | 79.00 | 55.00 | 700.00 |
| 2015-16 | 95.00 | 75.00 | 789.00 |
| 2016-17 | 108.00 | 111.00 | 1031.00 |
| 2017-18 | 123.30 | 129.71 | 1052.00 |
| 2018-19 | 254.45 | 185.49 | 729.00 |
| 2019-20 | 265.55 | 53.75 | 202.00 |
| 2020-21 | 225.30 | 99.13 | 440.00 |
| 2021-22 | 178.04 | 121.07 | 680.00 |
| 2022-23 | 184.57 | 149.50 | 810.00 |
| **a** | 4.02 | 2.88 | 5.76 |
| **b** | 0.13 | 0.20 | 0.07 |
| **R2** | 0.78 | 0.63 | 0.17 |
| **CAGR** | **34.08\*\*\*** | **58.80\*\*\*** | **18.84NS** |

Note **-\*\*\*, \*\*** and **\*** indicated significant at 1 per cent ,5 per cent and 10 percent level of significance.

 **Compound annual growth rate of area, production and productivity of Gram**

The compound annual growth rate of area, production, and productivity of Gram in the Chhatarpur district was analyzed for the period of 12-year from 2011-12 to 2022-23 to examine the growth performance of Gram and the results are presented in table 2. The results reveal that during 2011-12 to 2022-23 the area of Gram increased from 88.00 thousand hectares to 86.90 thousand hectares, with a significant compound growth rate of 1.92 per cent per annum. The growth in area was found to positive due to farmers have more interest in the cultivation of Gram crop and also its profitability [8]. The maximum area was observed in the year 2020-21 (92.85 thousand hectare) followed by 2012-13 (92.00 thousand hectare), 2013-14(89.00 thousand hectare), and in 2016-17(88.00 thousand hectare) as compared to other years. During the period 2011-12 to 2022-23 the production increased from 133 thousand metric tons to 165.11 thousand metric tons with a significant compound annual growth rate of 20.35 per cent. The production increased due to increase in the yield of Gram crop due to introduction of high yield variety. The maximum production was found to be in the year 2020-21 (175.49 thousand metric ton) followed by 2022-23 (165.11 thousand metric ton), 2021-22 (134.11 thousand metric ton), and in 2016-17 (132.00 thousand metric ton) as compared to other year. During same period the productivity increased from 1509 Kg/ha to 1900 kg/ha with 17.78 per cent compound annual growth. The productivity increases due to use of high yield varieties by the farmers. Maximum productivity found to be in the year 2022-23 (1900 kg/ha), followed by 2020-21 (1890.00 Kg/ha), and 2018- 19 (1658.00 Kg/ha) as compared to other year.

**Table 2: CAGR of area, production and productivity of Gram**

|  |  |  |  |
| --- | --- | --- | --- |
|  **Year** |  **Area****(Thousand ha)** | **Production****(Thousand MT)** | **Productivity****(Kg/ha)** |
| 2011-12 | 88.00 | 133.00 | 1509.00 |
| 2012-13 | 92.00 | 117.00 | 1271.00 |
| 2013-14 | 89.00 | 45.00 | 499.00 |
| 2014-15 | 46.00 | 28.00 | 609.00 |
| 2015-16 | 49.00 | 42.00 | 858.00 |
| 2016-17 | 88.00 | 132.00 | 1510.00 |
| 2017-18 | 49.99 | 60.39 | 1208.00 |
| 2018-19 | 69.64 | 115.46 | 1658.00 |
| 2019-20 | 78.35 | 128.42 | 1511.00 |
| 2020-21 | 92.85 | 175.49 | 1890.00 |
| 2021-22 | 82.85 | 134.14 | 1619.00 |
| 2022-23 | 86.90 | 165.11 | 1900.00 |
| **a** | 4.25 | 4.00 | 6.66 |
| **b** | 0.01 | 0.08 | 0.07 |
| **R2** | 0.01 | 0.23 | 0.34 |
| **CAGR** | **1.92\*\*** | **20.35\*\*** | **17.78\*\*** |

Note **-\*\*\*, \*\*** and **\*** indicated significant at 1 per cent ,5 per cent and 10 percent level of significance

 **Compound annual growth rate of area, production and productivity of Pigeon pea.**

 The compound annual growth rate of area, production, and productivity of Pigeon pea crop in the Chhatarpur district was analyzed for the period of 12-year from 2011-12 to 2022-23 to examine the growth performance of Pigeon pea and the results are presented in table 3. The results reveal that during 2011-12 to 2022-23 the area of Pigeon pea decreased from 15.00 thousand hectares to 2.94 thousand hectares, with a significant rate of -32.81 per cent per annum. The negative growth rate in area was found due to increase area of other competitive pulses crop in the study area. The minimum area was observed in the year 2018-19 (1.98 thousand hectare) followed by 2020-21(2.49.00 thousand hectare), 2022-23 (2.94.00 thousand hectare), and in 2021-22 (2.86.00 thousand hectare) as compared to other years. During the period 2011-12 to 2022-23 the production decreased from 4.00 thousand metric tons to 2.19 thousand metric tons with a compound annual negative growth rate of 19.89 per cent [6&7].The production decreased due to decreased in the area of Pigeon pea. The minimum production was found to be in the year 2018-19 (1.17 thousand metric ton) followed by 2021-22 (1.40 thousand metric ton), 2020-21 (1.99 thousand metric ton), and in 2022-23 (2.19.00 thousand metric ton) as compared to other year. During same period the productivity increased from 276 Kg/ha to 745 kg/ha with a significant compound annual growth rate of 17.82 per cent. The productivity increases due to use of high yield varieties by the farmers. Maximum productivity found to be in the year 2014-15 (1444.00 kg/ha), followed by 2016-17 (1120.00 Kg/ha), and 2020- 19 (1658.00 Kg/ha) as compared to other year.

**Table 3: CAGR of area, production and productivity of Pigeon pea**

|  |  |  |  |
| --- | --- | --- | --- |
|  **Year** |  **Area****(Thousand ha)** | **Production****(Thousand MT)** | **Productivity****(Kg/ha)** |
| 2011-12 | 15.00 | 4.00 | 276.00 |
| 2012-13 | 10.00 | 2.00 | 201.00 |
| 2013-14 | 12.00 | 3.00 | 287.00 |
| 2014-15 | 9.00 | 13.00 | 1444.00 |
| 2015-16 | 9.00 | 6.00 | 642.00 |
| 2016-17 | 10.00 | 11.00 | 1120.00 |
| 2017-18 | 8.00 | 5.40 | 675.00 |
| 2018-19 | 1.98 | 1.17 | 590.00 |
| 2019-20 | 3.73 | 2.07 | 534.00 |
| 2020-21 | 2.49 | 1.99 | 800.00 |
| 2021-22 | 2.86 | 1.40 | 489.00 |
| 2022-23 | 2.94 | 2.19 | 745.00 |
| **a** | 2.90 | 1.82 | 5.87 |
| **b** | -0.17 | -0.10 | 0.07 |
| **R2** | 0.77 | 0.20 | 0.20 |
| **CAGR** | **-32.81\*\*\*** | **-19.89 NS**  | **17.82\*\*** |

Note **-\*\*\*, \*\*** and **\*** indicated significant at 1 per cent ,5 per cent and 10 percent level of significance

**Fig 1: Trend in area of Black gram, Gram and Pigeon pea crop**

**Fig 2: Trend in area of Black gram, Gram and Pigeon pea crop**

**Fig 3: Trend in area of Black gram, Gram and Pigeon pea crop**

**Relative contribution of area and yield in the production of pulses crop**.

The compound annual growth rate techniques help us to know the pattern of growth and direction of changes in the area, production, and productivity. But it does not measure the contribution of area, productivity, and interaction effect in the production. Therefore, it is a major need to examine the sources of increase the production of pulses during study period. Decomposition analysis was used to measure the area, productivity, and interaction effect in the production growth of major pulses crops in the Chhatarpur district for the period of 2011-12 to 2022-23 and the result is presented in table 4. It was observed from the table that, interaction effect was one of the most important factors that affect the growth of production of Black Gram and Gram crop, while interaction effect was observed dominant in the growth of production of pigeon pea in study area. The area, productivity, and interaction effect of Black Gram was seen 10.24 per cent, 22.84 per cent, and 66.92 per cent respectively. In case of Gram area, it was observed 28.30 per cent, 36.08 per cent, and 35.63 per cent respectively. In the pigeon crop area effect was observed 5.72 per cent, productivity effect 78.83 per cent and interaction effect 15.45 per cent. Overall, it can be concluded that the productivity effect was dominated factor in influencing the growth of Gram and pigeon pea crop while growth in production of Black Gram majorly influenced by interaction effect.

**Table 4 : Area, productivity and interaction effect of major pulses crop**

|  |  |
| --- | --- |
| **Particular** | **Period- 2011-12 to 2022-23** |
| **Area****Effect (%)** | **Productivity****Effect (%)** | **Interaction****Effect (%)** | **Total****( %)** |
| **Black Gram**  | 10.24 | 22.84 | 66.92 | 100 |
| **Gram** | 28.30 | 36.08 | 35.63 | 100 |
| **Pigeon pea**  | 5.72 | 78.83 | 15.45 | 100 |

**Instability of pulses crop in the Chhatarpur of district Madhya Pradesh.**

The instability in area, production, and productivity of pulses crop was analyzed in the Chhatarpur district of Madhya Pradesh for the period of 2011-12 to 2022-23 and the results is presented in table 5. It was noted during study period the highest variation under black gram, was observed in production (18.13 per cent) followed productivity (14.52 per cent) and in area (14.90 per cent). In case of Gram crop highest variation was observed in production (13.50) per cent followed by productivity (10.04 per cent) and in area (6.78 per cent). In case of pigeon pea crop highest variation was also observed in production (25.18 per cent) followed by area (17.20 per cent) and productivity (15.84 per cent). It is concluded from the above discussion that highest variation under major three pulses crop (black gram, Gram, and pigeon pea) in the Chhatarpur district was observed in the production. The highest variation in the production due to famers adopted different type of technologies and inputs in the district.

**Table 5: Instability in area, production and productivity of major pulses in the Chhatarpur**

|  |  |  |
| --- | --- | --- |
| **Particular** | **Variables** | **Period- 2011-12 to 2022-23** |
| **SD** | **MEAN** | **CV**  |
| **Black Gram** | Area | 143.93 | 21.44 | 14.90 |
| Production | 86.97 | 15.77 | 18.13 |
| Productivity | 607.25 | 88.19 | 14.52 |
| **Gram** | Area | 76.05 | 5.16 | 6.78 |
| Production | 106.33 | 14.36 | 13.50 |
| Productivity | 1336.83 | 134.21 | 10.04 |
| **Pigeon pea** | Area | 7.25 | 1.25 | 17.20 |
| Production | 4.43 | 1.12 | 25.18 |
| Productivity | 650.25 | 102.98 | 15.84 |

**Source:** Author’s computation based on secondary data  **Note\*-** SD represent standard deviation.

**Fig 4: Area, productivity and interaction effect in production of pulses**

**Fig 5: Crop wise Variation in area, production and productivity**

**Conclusion-**

**It is concluded from the study as mentioned earlier that the CAGR of Black gram crop in respect to area, production and productivity increased at compound growth rate of 34.08 %, 58.80%, and 18.84% respectively. In case of Gram crop area, production and productivity increased 1.92%, 20.35%, and 7.78% respectively. While CAGR of Pigeon pea crop in area and production decrease at the compound growth rate of -32.81 per cent and -19.89 per cent respectively, while productivity increase at the rate of 17.82 per cent. After analysis of decomposition, it is observed that productivity effect was dominated factor in influencing the production of Gram and pigeon pea crop while growth in production of Black gram majorly influenced.**

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