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Growth rates in area, production and productivity of soybean in Marathwada region of Maharashtra state

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Abstract

Soybean, (*Glycine max*), also called soja bean or soya bean, annual legume of the pea family Fabaceae (Leguminosae). The “king of beans” is mostly crushed into soy oil and meal and is found in hundreds of edible and non-edible products, ranging from cooking oil, animal grains, milk and vegan food to biodiesel and industrial applications. Investigation was carried out for the period from 2000-01 to 2019-20 in order to estimate the “Growth rates in area, production and productivity of soybean in Marathwada region of Maharashtra state”. The growth in the area, production and productivity of soybean was estimated by using the compound growth function of the linear trend equation. The study analyzed growth rate over initial for area, production and productivity of soybean in Marathwada region of Maharashtra and observed an increased during the study period i.e 90.59 per cent 94.19 per cent and 0.20 per cent for overall period, respectively per annum. The CDVI for area, production and productivity of soybean of Maharashtra was 14.22, 45.87 and 35.70, for overall period respectively.

The increase in production of soybean in Marathwada region of Maharashtra was due to the increase acreages under soybean crop and little due to increase in productivity of soybean. It was revealed that, farmers in Marathwada region are gradually switching over to soybean from cotton, jowar, tur and other traditional crops due to higher yield, easy crop husbandry and remunerative price for soybean due to high demand for oil, animal feed and industrial products. Efforts should be made to improve the productivity of soybean in order to increase soybean production in Maharashtra state.

Keywords: soybean, production, compound growth rate, Maharashtra, cuddly and Della instability index (CDVI)

Introduction

Soybean has an important place in world's oilseed cultivation scenario, due to its high productivity, profitability and vital contribution towards maintaining soil fertility. Soybean contributes 25 per cent to the global vegetable oil production, about two third of the world's protein concentrate for livestock feeding and is a valuable ingredient in formulated feeds for poultry and fish. About 85 per cent of the world's soybeans are processed annually into soybean meal and oil. The origins of the soybean plant are obscure. Soybean has been cultivated in China for more than 4,000 years. United States systematic breeding in the 1940s and 1950s, transformed soybean from an inefficient fodder type crop to a highly productive erect plant type. Brazil overtook the United States of America as the soybean producing country with 123.0 million metric tonnes production in 2019-20. Brazil stood first with 123.0 million metric tonnes in 2019-20 followed by United States of America (96.61 million metric tonnes), Argentina (53.00 million metric tonnes), China (17.100 million metric tonnes) and India (9.00 million metric tonnes). Among the states, Madhya Pradesh stood first with 55.16 lakh ha followed by Maharashtra (40.11 lakh ha), Rajasthan (10.60 ha), Karnataka (3.30 lakh ha) and Telangana (1.77 lakh ha). The area under Soybean crop in Maharashtra state in 2020 was 40.398 lakh hectare with production of 45.446 lakh MT and productivity of 1125 kilograms per hectare. In Marathwada region soybean was cultivated on 19.85 lakh ha with production of 22.33 lakh tonnes and productivity of 1122.5 Kg /ha in *kharif* season.

Methodology

The Times series secondary data for area, production and productivity for the period from 2000-01 to 2019-20 and latest census data was collected from publications and online data service websites of Directorate of Economics and statistics at a glance and Bureau of Economics and statistics of Maharashtra state.

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Specification of time period

To facilitate proper understanding of impact *kharif* Soybean cultivation on Maharashtra with regard to percentage increase in area, production and productivity, the overall period of 20 years i.e. from 2000-01 to 2019-20 considered as one period.

Linear trend equation

$$Y = a + bt$$

The semi log trend equation

$Y = a \cdot b^t$
 Y = Estimated area / production / productivity
 a = Intercept
 b = Estimate of growth parameter

Linear growth rate

$$\text{Over initial year} = \frac{b}{x} \times 100 \quad \dots(1)$$

Where,
 b = Estimate of growth parameter
 \bar{x} = Base year area / production / yield

Linear growth rate

$$\text{Over average} = \frac{b}{x} \times 100 \quad \dots(2)$$

Where,
 b = Estimate of growth parameter
 x = Arithmetic mean of area / production / yield
 From Equation (2) i. e. CGR from semi log trend equation.
 Compound growth rate = Antilog (b-1) x 100

Compound growth rate

The significance of the linear and compound growth rate was tested with the help of correlation coefficient (r) by using 't' test.

$$t = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}}$$

Where,
 n = Number of observations
 The linear or semi log trend was better fit according to the significance of r and significance of b.

Coefficient of variation (CV)

Standard deviation is an absolute measure of dispersion, given by formula.

$$\sigma = \sqrt{\frac{1}{\sum (X - \bar{X})^2}}$$

$$\bar{x} = \frac{1}{n} \sum x = \text{Mean sample observation}$$

n = Numbers of observation
 CV is percentage variation in mean whereas, standard deviation considered as total variation in the mean.

$$\text{Coefficient of variation} = \frac{\sigma}{\bar{x}} \times 100$$

Where,
 σ = Standard deviation
 \bar{x} = Mean

Cuddy and Della instability index (CDVi)

$$CV_t = CV \sqrt{1 - r^2}$$

Where,
 CV = Coefficient of variation
 r^2 = Coefficient of determination of trend

Results and Discussion

Growth and instability in soybean area of Marathwada region of Maharashtra state during overall period (2000-01 to 2019-20)

The highest increasing trend in area was recorded in Latur district i.e. 2391.10 hectares followed by Nanded district i.e. 1927.10 hectares. The average area of soybean in the Marathwada region was 10021.72 hectares and in case of Maharashtra state, it was 28820.05 hectares. The compound growth rate of Jalna, Beed, Latur, Nanded, Parbhani and Hingoli districts were found to be significant at 1 per cent for overall period. Aurangabad and Osmanabad at 5 per cent. It indicated that, Hingoli district was consistent in the case of area for the overall period and Osmanabad district was inconsistent compared to rest of districts of Marathwada region. Latur district showed a positive compound growth rate (9.12) with minimum instability index (9.95), whereas Osmanabad district showed a positive compound growth rate (13.99) with maximum instability index (52.70) in soybean area for Marathwada region.

Table 1: Growth and instability in soybean area of Marathwada region of Maharashtra state during overall period (2000-01 to 2019-20)

| Parameter | Aurangabad | Jalna | Beed | Latur | Osmanabad | Nanded | Parbhani | Hingoli | Marthwada | M.S |
|------------------------------|------------|---------|----------|----------|-----------|----------|----------|---------|-----------|-----------|
| | L | L | L | L | L | L | L | L | L | L |
| a | 5.95 | -222.29 | -371.70 | -7.52 | -486.47 | 48.45 | -157.65 | 433.68 | -757.53 | 11538.05 |
| b | 9.58* | 79.73** | 119.54** | 218.06** | 126.33* | 170.79** | 125.96** | 88.53** | 938.52** | 1571.09** |
| R ² | 0.61 | 0.93 | 0.90 | 0.97 | 0.73 | 0.94 | 0.95 | 0.81 | 0.96 | 0.95 |
| Initial base year (%) | 29.67 | 63.33 | 89.00 | 142.33 | 34.67 | 237.00 | 181.33 | 258.67 | 1036.00 | 11673.00 |
| Growth rate over initial (%) | 32.28 | 125.89 | 134.31 | 153.20 | 364.38 | 72.06 | 69.46 | 34.22 | 90.59 | 13.46 |
| Growth rate over average (%) | 8.60 | 12.18 | 12.67 | 9.12 | 13.99 | 8.86 | 10.26 | 6.29 | 0.09 | 5.45 |
| Area | 111.38 | 654.71 | 943.19 | 2391.10 | 903.19 | 1927.10 | 1228.00 | 1407.52 | 10021.72 | 28820.05 |
| CV (%) | 68.63 | 78.52 | 82.68 | 57.45 | 101.43 | 56.86 | 65.22 | 43.38 | 71.10 | 34.78 |
| CDVI | 42.86 | 20.77 | 26.14 | 9.95 | 52.70 | 13.93 | 14.58 | 18.91 | 14.22 | 8.52 |

Growth and instability in soybean production of Marathwada region of Maharashtra state overall period (2000-01 to 2019-20).

The highest increasing trend in production was recorded in

Latur district i.e. 2961.19 qtls. followed by Nanded district i.e. 1897.67 qtls. The average production of soybean in the Marathwada region was 12413.71 qtls and in the case of Maharashtra state, it was 31593.10 qtl.

Table 2: Growth and instability in soybean production of Marathwada region of Maharashtra state overall period (2000-01 to 2019-20)

| Parameter | Aurangabad | Jalna | Beed | Latur | Osmanabad | Nanded | Parbhani | Hingoli | Mart | M.s |
|------------------------------|------------|---------|---------|---------|-----------|---------|----------|---------|----------|----------|
| | L | L | L | L | L | L | L | L | L | L |
| a | 39.05 | -358.90 | -384.61 | -226.32 | -634.10 | -107.38 | -43.15 | 434.47 | 74.13 | 12328.15 |
| b | 5.95 | 100.78* | 112.26 | 289.77 | 144.88 | 182.28* | 113.95* | 115.38 | 1121.78* | 1751.36* |
| R ² | 0.32 | 0.65 | 0.44 | 0.46 | 0.38 | 0.52 | 0.63 | 0.42 | 0.60 | 0.56 |
| Initial base year (%) | 31.00 | 54.67 | 114.33 | 117.33 | 25.33 | 327.00 | 262.67 | 279.00 | 1191.00 | 13024.00 |
| Growth rate over initial (%) | 19.19 | 184.35 | 98.19 | 246.97 | 571.89 | 55.74 | 43.38 | 41.35 | 94.19 | 13.45 |
| Growth rate over average (%) | 5.69 | 13.44 | 13.20 | 9.78 | 15.09 | 9.60 | 9.41 | 6.77 | 9.03 | 5.54 |
| Area | 104.52 | 749.71 | 850.29 | 2961.19 | 959.52 | 1897.67 | 1210.33 | 1703.67 | 12413.71 | 31593.10 |
| CV (%) | 62.85 | 103.27 | 124.19 | 89.39 | 151.73 | 82.33 | 73.72 | 64.49 | 72.53 | 46.13 |
| CDVI | 51.82 | 61.09 | 92.93 | 65.68 | 119.47 | 57.03 | 44.84 | 49.11 | 45.87 | 30.59 |

Aurangabad district was consistent in the case of production for the overall period and Osmanabad district was inconsistent compared to rest of districts of Marathwada region. The production increased due to increase in productivity in Hingoli and Latur districts. Also, the production shows increased trend due increase in area in Latur, Nanded and Marathwada region. The highest increasing trend in productivity was recorded in

Hingoli district i.e. 1209.00 kg per hectares, followed by Latur district i.e. 1136.10 kg per hectares. The average productivity of soybean in the Marathwada region was 1040.56 kg per hectares and in the case of Maharashtra state, it was 1120.90 kg per hectares. The compound growth rate for the soybean productivity in the Marathwada region was -0.05 per cent and in the case of Maharashtra state, it was -0.08 per cent.

Table 3: Growth and instability in soybean production of Marathwada region of Maharashtra state overall period (2000-01 to 2019-20)

| Parameter | Aurangabad | Jalna | Beed | Latur | Osmanabad | Nanded | Parbhani | Hingoli | Mart | M.s |
|------------------------------|------------|---------|---------|---------|-----------|---------|----------|---------|---------|---------|
| | L | L | L | L | L | L | L | L | L | L |
| A | 1341.84 | 960.03 | 1057.89 | 951.38 | 769.14 | 1118.52 | 1264.87 | 1253.7 | 1018.76 | 1168.71 |
| B | -24.86 | 15.47 | -9.28 | 16.79 | 11.20 | -9.10 | -16.61 | -4.06 | 1.98 | -4.34 |
| R ² | 0.12 | 0.04 | 0.01 | 0.02 | 0.01 | 0.01 | 0.07 | 0.003 | 0.001 | 0.007 |
| Initial base year (%) | 1105.67 | 970.00 | 1251.33 | 1025.67 | 711.00 | 1296.00 | 1348.33 | 1370.67 | 987.75 | 1206.00 |
| Growth rate over initial (%) | -2.25 | 1.59 | -0.74 | 1.64 | 1.58 | -0.70 | -1.23 | -0.30 | 0.20 | -0.36 |
| Growth rate over average (%) | -2.32 | 1.36 | -0.97 | 1.47 | 1.25 | -0.89 | -1.53 | -0.33 | 0.19 | -0.38 |
| Productivity | 1068.33 | 1130.24 | 955.81 | 1136.10 | 892.43 | 1018.38 | 1082.14 | 1209.00 | 1040.56 | 1120.90 |
| CV (%) | 40.80 | 41.95 | 55.83 | 53.55 | 61.27 | 41.75 | 34.93 | 37.45 | 35.72 | 28.57 |
| CDVI | 38.27 | 41.10 | 55.55 | 53.01 | 60.96 | 41.54 | 33.68 | 37.39 | 35.70 | 28.46 |

Osmanabad district showed a positive compound growth rate (1.25) with maximum instability index (60.96) in soybean area for Marathwada region. In Hingoli and Latur districts, the productivity was increased due to both increased in area as well as production in overall period. The Cuddy Della Vella instability index in soybean productivity of Marathwada region. Parbhani district showed a negative compound growth rate (-1.53) with minimum instability index (33.68), whereas Osmanabad district showed a positive compound growth rate (1.25) with maximum instability index (60.96) in soybean area for Marathwada region.

Conclusion

1. The area under soybean had increased in the Marathwada region and in Maharashtra state. The area, production and productivity of soybean were positively significant at the rate of 90.59, 94.19 and 0.20 per cent and 13.46, 13.45 and negative productivity i.e.- 0.36 per cent per annum, respectively.
2. The study has concluded that, area under soybean in Marathwada region and in all districts and states as whole have been increased, during overall period. The performance of soybean in area and production was quite satisfactory mainly due to the area expansion and little productivity improvement.
3. The revolution launched in 1986- 1987 to increase the

production of edible oil, was Yellow revolution, which targeted nine crops including Soybean. Developed new varieties of soybean were introduced for commercial usage in India in 1970's. Remarkable increase in the area as well as production of this crop. Today 'miracle bean' or "King of bean" is globally traded commodity in both temperate and tropical regions. In the world, India and Maharashtra, area under cultivation of this crop is growing continuously.

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