### ****Original research article****

### ****DYNAMICS OF SOYBEAN PRODUCTION IN BULDHANA DISTRICT OF MAHARASHTRA, INDIA****

### ****ABSTRACT****

### **S**oybean is a major oilseed crop in the state of Maharashtra and Buldhana is considered as the largest producer district of Soybean crop in Maharashtra. Buldhana district contributes to a major share in the total area under Soybean cultivation as well as total Soybean production in Maharashtra which is among the largest producers of Soybean in India. The research was aimed to study the dynamics of change in production of Soybean crop. The study was used **to analyse the effect of area and yield over the production of Soybean. The research was carried out in Buldhana district of Maharashtra for it contributed to the total share** of 9.66 per cent in area and 13.65 per cent in the production of Soybean. **The study was carried out for the period of 15 years from 2007-08 to 2021-22. The study was based on the time series data collected from authorized government sources on area, production and Yield of Soybean in Buldhana district for the duration of 15 years. Buldhana district in 2022-23, had the area under Soybean cultivation of 445955 hectare and the production of 792435 tonnes. The research used additive decomposition model as the research tool to determine the impact of area and yield over the increase or decrease in Soybean production. In, the area effect and yield effect were calculated to determine the change in production of Soybean. The study also revealed the contribution of each effect over the change in production to determine the drivers behind the increase or decrease in production of Soybean in Buldhana district of Maharashtra. The area effect and yield effect were calculated for individual year. The present research reveals that, the yield effect contributed 84.88 percent to the change in production of Soybean in Buldhana district of Maharashtra while the remaining 15.12 percent was due to the area effect.** **Hence, the yield effect was the driving factor behind the increase or decrease in production of Soybean in Buldhana district of Maharashtra over the study period.** It was concluded that, with the average annual growth of 29 per cent and the contribution of 84.88 percent, yield effect contributed a major share to the growth in production of 34.17 per cent in Buldhana district of Maharashtra. It was concluded that, though the yield of Soybean was observed to be increasing, it is not consistent and hence, it has become necessary to stabilize the yield of Soybean in Buldhana district as well as Maharashtra as a whole.

### Keywords: Decomposition, area effect, yield effect, growth, Soybean production

**1. INTRODUCTION**

Soybean is an important oilseed crop in Maharashtra as it was ranked 2nd in area under cultivation at 4595.03 thousand hectares and 1st in production of Soybean at 5500.25 thousand tonnes in year 2021-22 (Department of Agriculture and farmers welfare, 2024). **Buldhana district** plays a key role in the state's Soybean production as it ranks 2nd in area under Soybean cultivation and 1st in Soybean production. In the year **2022-23**, Buldhana cultivated the area of **445955 hectares** of soybean yielding the production of **792435 tonnes** with a productivity of **1.69 ton per hectare**. This positions Buldhana as the largest contributor to Maharashtra's soybean production, making it an important region to understand the production dynamics of Soybean crop. In year 2021-22, Buldhana district alone contributed to the 9.66 percent of the total area under Soybean cultivation and 13.65 percent of the total Soybean production in the state of Maharashtra. Soybean is a major oilseed grown for its use in human and animal feed for its edible protein and oil content as well as in industrial use. The present study aims to study the change in production of Soybean in Buldhana district of Maharashtra. It was carried out to identify the determinants as well as share of each determinant in the production change whether increased or decreased. Hence, the present research determines the drivers behind the increase or decrease in production of Soybean so as to suggest the policies to be implemented for the succeeding years based on the results.

**2. MATERIAL AND METHODS**

 The study was based on the time series secondary data on area, production and yield of Soybean crop in Buldhana District of Maharashtra. The data was collected for 15 years from 2007-08 to 2021-22. The studies Datarkar *et al.* (2016), Sharma (2016), Pathrikar *et al.* (2022), and Tiwari *et al.* (2022) used growth rate analysis to determine whether the area or the yield showed more growth and thus determining the pattern of change in production viz., increase or decrease in production of Soybean over the study period. However, some studies viz., Tayade *et al.* (2013), Hazari (2015), Datarkar *et al.* (2017) and Ninawe *et al.* (2020) used the decomposition analysis to determine the effect of area and yield as well as their interaction on the production of Soybean in Maharashtra. The present research was aimed to study the dynamics change in production of Soybean crop. The decomposition analysis was used to work out the change in production of Soybean in Buldhana district of Maharashtra.

 Since decomposition analysis deals with highlighting the share of individual components responsible for the increase or decrease in production/output of the crop, it is also called as component analysis. In the present research, the decomposition analysis was worked out using the additive decomposition model by Minhas and Vaidyanathan (1965) in the book by Vani et al. (2019). The original additive decomposition model consists of the area effect, yield effect and the interaction effect between the area and yield. However, the results from the model were not considered to be absolute since, the model possesses the residual effects caused by the interaction effect. Hence, the results cannot absolutely define whether the area effect or the yield effect is the driver behind the production change. However, in the present research this residual effect has been removed by reconstructing the additive decomposition model. The original additive decomposition model was written as

$$∆Q\_{t}=∆A\_{t}Y\_{t-1}+∆Y\_{t}A\_{t-1}+∆A\_{t}∆Y\_{t}$$

Where,

Δ Qt represents the change in production,

Δ At and Δ Yt represent the changes in area and yield, respectively.

The present research aims to determine the drivers behind the change in production of Soybean in Buldhana district of Maharashtra. Here, to remove the residual effects, the interaction effect was divided in two equal halves also called partial interaction effect and added to both area effect and yield effect. Hence, the change is production is called as absolute change since the error term has been removed. The reconstructed model is written as

∆ Qt = (∆ AtYt-1 +0.5 ∆ At ∆Yt) + (∆ YtAt-1 +0.5 ∆ At ∆Yt)

This equation was further be decomposed as

∆ Qt = [(At - At-1) Yt-1+ 0.5(At - At-1) (Yt - Yt-1)] + [(Yt - Yt-1) At-1+ 0.5(At - At-1) (Yt - Yt-1)]

Thus, the expression explains that, the absolute change in production is equal to the sum of area effect and yield effect. The area effect and yield effect found can be explained as-

**Area effect:** It is the effect of change in area on production keeping yield constant at previous year values plus partial interaction effect.

Area Effect = ∆ AtYt-1 +0.5 ∆ At ∆Yt = (At - At-1) Yt-1+ 0.5(At - At-1)(Yt - Yt-1)

**Yield effect:** It is the effect of change in yield of a crop/crops upon production or aggregate production while keeping area under crop constant at previous year values plus partial interaction effect.

Yield Effect= ∆ YtAt-1 +0.5 ∆ At ∆Yt = (Yt - Yt-1) At-1+ 0.5(At - At-1)(Yt - Yt-1)

The present study also calculated the average annual growth rate for the area, yield and production directly from the decomposition model to get the better understanding of how each of these components affect the Soybean production in Buldhana district as well as the drivers contributing to the change in Production of the crop.

**3. RESULT AND DISCUSSION:**

The research reveals the factors driving the change in production of Soybean in Buldhana district of Maharashtra as well as how the area effect and yield effect affected the production of Soybean in the district. The results of the study revealed that, over the period of study the area under Soybean cultivation increased steadily from 190500 hectare in 2007-08 to 443849 hectare in 2021-22. Similarly, the production of Soybean also increased from 382400 tonnes in 2007-08 to 750581 tonnes in 2021-22. However, the yield of Soybean crop was always inconsistent throughout the study period and it can be observed from the scenario that suggested the yield decreased from 2.01 in 2007-08 to 1.78 ton per hectare in 2021-22. The yield in initial years decreased to 0.29 ton/hectare in 2008-09 which in next two year increased to 1.85 ton/hectare in 2010-11. Later, with consistent decrease and then increase caused the yield to be 1.93 ton/hectare in 2016-17. From 2018-19 to 2021-22, the yield consistently increased from 1.11 ton/hectare to 1.69 ton/hectare. This suggests that, though the yield has been inconsistent in the recent years the yield of Soybean has been increasing steadily.

**Table.1. Area and yield effect on change in production of Soybean in Buldhana**

|  |  |  |
| --- | --- | --- |
| Parameters | Average | Effect |
| Area (Hectare) | 322044.27(25.31) | 24639.87101.53 |
| Yield (Ton/Ha.) | 1.28(43.07) | -94.47-236741.51 |
| Production (Tonnes) | 415323.27(49.86) | 24545.40882.93 |

 *Note: Figures in parentheses are the coefficient of variation in percentage*

From table 1, it was observed that over the period of 15 years from 2007-08 to 2021-22, the Soybean was cultivated under the average area of 322044.27 hectare with the average yield of 1.28 ton per hectare. The average production of Soybean during the period of 2007-08 to 2021-22 was 415323.27. The fluctuations were found to be more prominent in the yield at 43.07 percent which also affected the production as the C.V. of production was observed to be 49.86 percent. The average area effect on the change in production was observed to be positive and significant at 24639.87. The area effect was observed to be negative in years 2009-10, 2015-16 and 2019-20 negatively affecting the change in production. During year 2015-16, though area effect was negative; the yield effect was also found negative with a large margin and negatively affected the production. The area effect was found maximum in year 2013-14 with the area effect of 66022 during which the yield effect was found negative and significantly affected the production. However, the change in production of Soybean in Buldhana during year 2013-14 was more due to the area effect [Appendix table 1.].

 The average yield effect during the study period was observed to be -94.47 in Buldhana district of Maharashtra. It was observed that, out of seven times when the yield effect was found negative, five times the change in production was observed to be negative viz., every time the change in production was negative it was due to the negative area effect [Appendix table 1]. When the yield effect was positive, it was found more than area effect except in the years 2012-13, 2013-14 and 2018-19 where the area effect was found more dominant. The same can be observed in figure 1 as well as appendix table 1. The change in production was found to be maximum during the year 2016-17 at 543200 during which the yield effect was also found to be maximum at 528177.

**Table 2. Growth and contribution of area effect and yield effect**

|  |  |  |
| --- | --- | --- |
| Parameters | % Growth | % Contribution |
| Area | 5.17(171.67) | 15.12(830.76) |
| Yield | 29.00(367.64) | 84.88(148.68) |
| Production | 34.17(307.79) | 100 |

 *Note: Figures in parentheses are the coefficient of variation in percentage*

 The average annual growth in area was observed to be 5.17 percent while average annual growth in yield was 29.0 percent. Both together were responsible for the average annual growth in production of 34.17 percent. From table 2 it was observed that the yield effect contributed more to the change in production than the area effect at 84.88 percent. The appendix table 1. states that, though the yield effect affected the change in production more the area effect was also found dominant in years 2012-13, 2013-14 and 2018-19 during which area contributed more to the change in production of Soybean in Buldhana district of Maharashtra. It was also concluded that though yield effect was found to be the driving factor in the increase or decrease in the change in production of Soybean in Buldhana the yield is not consistent.

 Datarkar *et.al.* (2017) also revealed similar results though in the Latur and Amaravati districts of Maharashtra which stated that with the contribution of 25.78 percent the yield affected the production of Soybean more in the selected areas viz., Latur, Amaravati and Ahmednagar districts of Maharashtra. Tiwari *et al.* (2022) were also of the view that, over the years in the major Soybean producing district, the yield was observed to be increasing over the last few years and it was essential to stabilize this increasing yield through various conventional as well as non-conventional means. The other research studies viz., Hazari (2015), Ninawe *et al.* (2020) and were of the contradictory view that, the area effect contributed a major role in increasing the production of Soybean in Maharashtra during their respective study periods. Datarkar et al. (2016), Sharma (2016) stated that the Soybean production in the major Soybean producing states was observed increasing from the growth rate of 18.3 percent in Rajasthan, 10 per cent in Madhya Pradesh and 7.9 per cent in Gujarat during the period of 1980 to 2012. The area and production in India had the growth rate of 9.6 percent and 11.5 percent respectively. Pathrikar *et al.* (2022) also revealed similar results with the growth in area resulting in the increased growth in production of Soybean during the study period.

**Policy implication:**

From the average yield effect of -94.47 and the contribution of yield being 84.88 percent in the production of Soybean, it can be implied that, the yield over the period of study was found to be the driving factor behind the change in Soybean Production in Buldhana district. The average area effect was found significant and positive at 24639.87 whereas, average yield effect of -94.47 was found negative along with positive change in production. It was concluded that, there is a scope to increase the yield levels of Soybean crop in Buldhana district of Maharashtra. Thus, it was suggested that more area to be allocated for the Soybean cultivation. While the fluctuating yield effect as well as growth in the yield also depicts that, the yield levels were not stable during the study period. Thus, it was suggested that the government should lay more emphasis in stabilizing the yield level and promote high yielding varieties as well as yield improving technological innovations in the Soybean cultivation practices in Buldhana district of Maharashtra.

**Conclusion:**

 The area and yield showed the growth of 5.17 percent and 29 percent respectively. The area effect contributed 15.12 percent whereas, yield effect contributed 84.88 percent to the production of Soybean in Buldhana district. Thus it can be concluded that, the yield effect was found to be the driver behind the change in production of Soybean in Buldhana district of Maharashtra. It was also concluded that the yield though dominant factor was found inconsistent. Thus, it was suggested that, the government should employ technologies and innovations that promote yield as well as incorporation of high yielding varieties of Soybean in Buldhana as well as the state of Maharashtra. The government should also lay emphasis on improving the yield stability.

**Disclaimer:**

I, Rode Payal Sewakram, hereby declare that no generative AI technologies such as Large Language Models viz., ChatGPT, COPILOT, etc. and text-to-image generators have been used during the writing or editing of this manuscript.

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**Appendix:**

**Table A1: Change in production/output of Soybean in Buldhana district of Maharashtra**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Area effect** | **Yield effect** | **Change in output** | **Growth in area** | **Growth in Yield** | **Growth in output** | **% Share of area** | **% Share of Yield** |
| 2007-08 | **0** | **0** | **0** | 0.0 | 0.0 | 0.0 | 0 | 0 |
| 2008-09 | 56767 | -370467 | -313700 | 14.845 | -96.88 | -82.04 | -18.10 | 118.10 |
| 2009-10 | -13895 | 101695 | 87800 | -20.225 | 148.03 | 127.80 | -15.83 | 115.83 |
| 2010-11 | 16387 | 243213 | 259600 | 10.471 | 155.41 | 165.88 | 6.31 | 93.69 |
| 2011-12 | 54797 | -96697 | -41900 | 13.169 | -23.24 | -10.07 | -130.78 | 230.78 |
| 2012-13 | 30899 | 25201 | 56100 | 8.257 | 6.74 | 14.99 | 55.08 | 44.92 |
| 2013-14 | 66022 | -17322 | 48700 | 15.343 | -4.03 | 11.32 | 135.57 | -35.57 |
| 2014-15 | 29571 | -319471 | -289900 | 6.174 | -66.69 | -60.52 | -10.20 | 110.20 |
| 2015-16 | -50 | -28650 | -28700 | -0.026 | -15.15 | -15.18 | 0.17 | 99.83 |
| 2016-17 | 15023 | 528177 | 543200 | 9.366 | 329.29 | 338.65 | 2.77 | 97.23 |
| 2017-18 | 8223 | -272223 | -264000 | 1.169 | -38.69 | -37.52 | -3.11 | 103.11 |
| 2018-19 | 38949 | -30120 | 8829 | 8.860 | -6.85 | 2.01 | 441.15 | -341.15 |
| 2019-20 | -9593 | 97008 | 87415 | -2.139 | 21.633 | 19.494 | -10.97 | 110.97 |
| 2020-21 | 29150 | 130101 | 159251 | 5.440 | 24.280 | 29.720 | 18.30 | 81.70 |
| 2021-22 | 47347 | 8139 | 55486 | 6.812 | 1.171 | 7.983 | 85.33 | 14.67 |
| Average | 24640 | -94 | 24545 | 5.17 | 29.00 | 34.17 | 15.12 | 84.88 |
| S.D. | 25017 | 223654 | 216718 | 8.87 | 106.62 | 105.17 | 126 | 126 |
| C.V. (%) | 101.53 | -236741.5 | 882.93 | 171.67 | 367.64 | 307.79 | 830.76 | 148.68 |