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An Analysis of Growth Pattern and Volatility in Area, Production and Yield of Soybean in Major Producing States of India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Agriculture is one of the important sector of our Indian economy. Among agriculture various agricultural crops, oilseeds plays a major role by placing India at the 4th largest producer of oilseed in the world. Cultivation of oilseeds is done under 15-20 per cent of total area at global level (Kumar and Tiwari, 2020). Oilseeds group also considered to be one of the great sources of oil (soybean, groundnut, mustard, etc.) and protein (soybean). This study tried to analyse the trend in the area, production and productivity of soybean crop by fitting the exponential growth function. Further examination of instability in the crop was also done using Cuddy Della Valle index. The present study research period was taken from 1970-71 to 2017-18 which is further divided as follows: Pre

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Technology Mission on Oilseeds (Pre TMO) Period from 1970-71 to 1985-86, Technology Mission on Oilseeds Phase one Period from 1986-87 to 2001-02, Technology Mission on Oilseeds Phase two Period from 2002-03 to 2017-18, Overall Period of Technology Mission on Oilseeds from 1986-87 to 2017-18, Overall Period from 1970-71 to 1985-86. The Pre TMO period and Post TMO period criteria has been considered to estimate whether TMO had any impact on area, production , productivity, import and export of oilseeds. The study showed that during Pre TMO period, positive growth rate in the area of soybean was found positive in all the states except in Gujarat where area declined at the rate of 5.26 per cent per annum. Maximum rate of growth in the area was found in Rajasthan at the rate of 21.00 per cent per annum. During this period, production increased in all the states and country as a whole wherein, maximum rate of production registered in Rajasthan at the rate of 20.52 per cent per annum, production had shown negative growth in Gujarat at the rate of 0.08 per cent per annum. Productivity had shown increasing trend in all the states except in Rajasthan where negative growth is found at the rate of 0.40 per cent per annum. Maximum increase in the productivity was registered in Maharashtra at the rate of 7.78 per cent per annum. While the instability analysis revealed that fluctuations in the area of soybean was observed only in the state of Gujarat, whereas, Gujarat, Karnataka, Madhya Pradesh and Rajasthan production of soybean was comparatively less stable as compared to the other major states.

Keywords: Oilseeds; exponential function; pre TMO period; post TMO period.

1. INTRODUCTION

Agriculture is one of the important sector of our Indian economy. Percentage share of this sector in GVA of country was around 17.60 per cent during 2018-19, 18.40 per cent in 2019-20 and 20.20 per cent during 2020-21 (NSO, Ministry of Statistics and Program Implementation, 2021). It has shown a considerable progress throughout the years. Among agriculture various agricultural crops, oilseeds plays a major role by placing India at the 4th largest producer of oilseed in the world. Cultivation of oilseeds is done under 15-20 per cent of total area at global level (Kumar and Tiwari, 2020). Oilseeds group also considered to be one of the great sources of oil (soybean, groundnut, mustard, etc.) and protein (soybean) [1-5]. During the financial year 2022 37 million metric tons around of oilseeds were produces in the Southern parts of country and Soybean was highest produced oilseed among the group (13 million metric tons) (Minhas, 2023). Apart from all of this the challenging aspect in oilseed sector is their productivity which is still very low due to their dependence on the dry land farming situation [6-9]. For rectifying this situation government of India had launched various programs dedicated exclusively to oilseeds namely, Technology Mission on Oilseeds (1986), National Mission on Oilseeds and oil Palm (2012) to achieve good productivity levels. After cereals, oilseeds group are the second most important crop for our economy [10-14]. The major oilseeds grown in India include; Soybean, groundnut, rapeseed, mustard, sunflower, safflower, sesame, niger, etc [15,16]. These are considered as the edible group of oilseeds while castor and linseed comes under inedible oilseed group. From these oilseeds, groundnut, rapeseed and mustard, soybean, sesame and sunflower are classified as major oilseeds accounting for 89 per cent of the total area and 93 per cent of the total production in oilseeds in the country [17-19]. As we have discussed above, oilseeds are considered as the second largest crop group grown after the food grains in the country [20-25]. However, when it comes to trade, India is a net importer of oilseeds. While talking about export value of oilseeds from India during financial year 2022 it was around 83.10 billion Indian rupees, whereas it was 91.56 billion rupees during 2021 which had shown a decrease in the value of exports [26-28]. Domestic production of the oilseeds is not according to the increasing demand for oil in the country. This research paper majorly focussed on one of the important oilseed Soybean. It contributes almost 25 per cent of global edible oil, and about 2/3rd of the concentrate feed for livestock population. It also contributes 40 to 25 per cent of total edible oil production of the country. (Agarwal, et al. 2013). It contains 20 per cent of oil and 40 per cent protein. It has many health benefits and also a very cheaper source of protein of high quality.

2. OBJECTIVE OF THE STUDY

The major objective covered under this paper was to analyse the growth in area, production and productivity of soybean and their instability in major producing states.

3. LITERATURE REVIEWED

Samal et al. [29] estimated growth rate and instability in oilseed production in Odisha from 1995 to 2015, based on district level analysis with special emphasis on groundnut. The study was divided into two time periods 1995-96 to 2001-05 and 2005-06 to 2014-15. The compound annual growth rate analysis was done to study the growth pattern. The study showed that the overall negative growth of groundnut and the total oilseed production was recorded during the period from 1995-96 to 2004-05, whereas, in the period from 2005-06 to 2014-15 improvement in the growth of groundnut and the total oilseed production was found.

Bharadi and Kurubetta [30] analysed growth rate performance of oilseed crops in Karnataka state using exponential growth rate analysis method during the period from 2000-01 to 2014-15 and found that out of the nine oilseed crops grown in the state soybean was the only crop that showed positive growth rate in area and productivity to the extent of 10.50 and 12.36 per cent, respectively, whereas rest of the crops showed negative growth. The highest negative growth with respect to area and production was observed in niger crop at -7.83 per cent and -3.22 per cent per annum, respectively, whereas, highest negative growth in productivity was observed in linseed at -7.00 per cent per annum.
Kumar et al. [31] studied growth and instability in area, production and productivity of soybean in India from 1996-97 to 2015-16. The whole period was divided into four sub periods viz. I Period (1996-97 to 2000.-01), II Period (2001-02 to 2005-06), III Period (2006-07 to 2010-11), IV Period 9 (2011-12 to 2015-16). They observed that, the relative changes in the area, production and productivity was not uniform as compared to the base year (1996-97). Maximum increase in the area of soybean was found to the tune of 15.51 per cent in the year 2004-05 of II period whereas maximum decrease of 6.88 per cent was found in the same year of II period. In case of production and productivity, maximum increase was found at 67.98 and 56.56 per cent, respectively in the year 2003-04 of II period, whereas maximum decrease was found at 25.42 and 27.68 per cent, respectively, in the year 2000-01 of I period. They further reported that the overall Compound Annual Growth Rate in area was significant and positive at 1 per cent level of significance, whereas, yield was positive but not significant during the period from 1996-97 to 2015-16.

Kumar et al. [31] studied growth and instability in area, production and productivity of soybean in India for the period from 1996-97 to 2015-16 using Cuddy Della Velle index. The study revealed that instability was low in case of area under soybean as compared to the production and the productivity from 1996-97 to 2015-16. They further reported that the area effect was found 100.75 per cent, whereas yield and interaction effect were (-) 0.41 and (-) 0.34 per cent, respectively, during the study period. The degree of relationship they studied during the period between area and production of soybean crop was found 0.83 which was significant at 1 per cent significance level.

Dash and Hansdah [32] conducted an analytical study of growth and instability of rabi oilseeds production in Odisha during the study from 1993-94 to 2016-17. They reported that the growth rate of oilseed yield in Odisha for rabi oilseeds was positive and significant (1.59 per cent) due to which the compound growth rate of production of rabi oilseeds was also significant positive at 1.09per cent despite of significantly negative compound growth rate in area at -0.49per cent under of rabi oilseeds.

4. MATERIALS AND METHODS

Soybean crop was taken in the study. Major states were selected for the study in which respective Soybean is majorly grown. Madhya Pradesh (included Chhattisgarh) which was not carved up earlier and included in the former state was also taken in the research study. The time period of the study was taken from 1970-71 to 2017-18. The time period was further divided into phases which are mentioned below: Pre Technology Mission on Oilseeds (Pre TMO) Period from 1970-71 to 1985-86. Technology Mission on Oilseeds Phase one Period from 1986-87 to 2001-02. Technology Mission on Oilseeds Phase two Period from 2002-03 to 2017-18. Overall Period of Technology Mission on Oilseeds from 1986-87 to 2017-18. Overall Period from 1970-71 to 1985-86.

The Pre and Post TMO criteria had been considered to estimate whether TMO had any impact on area, production, productivity, of soybean crop.

To accomplish the research objective, estimation of growth rates of area, production and productivity of soybean was done using exponential growth function. Growth is estimated

to examine the tendency of variable to increase, decrease or constant over the years. It also indicates the rate of change in the values of a particular variable taken under consideration per unit of time.

The simple growth rate showing the absolute change in growth per unit of time can be written, mathematically as:

$dY_t/dt.$

Compound Annual Growth Rate can be mathematically written as

$CAGR = [(1/Y_t).(dY_t / dt)] = [(Y_{t+1} – Y_t) / Y_t]$.

It is rate of change of Y_t per unit of change in time't' expressed as a fraction of the magnitude of Y_t itself. The CAGR had been estimated using the exponential function of the following form:

$Y_t = Ae^{bt}$

The log transformation of this function is as follows:

$Log_e Y_t = Log_e A + bt$

Through regression analysis the values of 'A' and 'b' had been found. The log form of function represents a constant growth rate over time. The formula for calculating CAGR from the log liner can be derived as follows:

Let 'Y_O' be the value of the variables under study in the base period 'Y_t' be the value of the variable in the time't' and 'r' be the value of CGR (compound growth rate).

Using compounding formula we get,

$Y_t = Y_O (1 + r)^t$

Log transformation of the above is

Log Yt = log Y_o + t log (1+ r)

Assuming log Y_O = log A and log (1+ r) = b, the same expression can be put as :

Log Y_t = log A + bt

The estimate of 'b' here is in log-linear form. Therefore, to convert it into original form of Y_t , following transformation is done,

Since b = log (1+ r)

Antilog (b) = 1 + r

Therefore: CAGR (r) **= (Antilog b) -1**

CAGR in percentage = [(Antilog b)-1] * 100

Further to examine the instability in the area, production and productivity of soybean crop, instability index was used. Instability index is used as an analytical tool to find the fluctuations in any given time series data. Cuddy – Della Valle instability **(Cuddy and Della Valle, 1978)** method is used to measure the instability in the time series data. In general Coefficient of Variation is used to find the instability and it is one of the most used procedures in finding instability. But in case of time series data which has linear or non-linear trends, CV over estimates the value of instability index. Therefore, Cuddy Della Valle method was used as it corrects the coefficient of variation, if data are scattered around the negative or positive trend lines, hence, over estimation can be eliminated. The Cuddy index is constructed as follows,

Cuddy – Della Valle Instability index (per cent) = C.V $\sqrt{(1 - \bar{R}^2)}$

Where,

$\bar{R}^2$ = Adjusted Coefficient of Multiple Determination

CV (per cent) = Coefficient of Variation $\left(\frac{\sigma}{\bar{x}}\right) * 100$

σ = Standard deviation

The present study divides the Cuddy Della Valle Index value into three categories, which represent the different range of instability (Sihmar, 2014). Low instability = up to 15, Medium instability = greater than 15 to 30 and High instability = greater than 30.

5. RESULTS AND DISCUSSION

5.1 Compound Annual Growth of Soybean Area during Different Periods

Table 1 represent compound annual growth rate of soybean area in major soybean producing states during the given periods. The table reveals that Maharashtra, Karnataka, Madhya Pradesh (undivided), Rajasthan and country as a whole witnessed with positive growth in the area during Pre TMO period with highest increase in

Rajasthan at the rate of 21.01 per cent per annum except Gujarat which registered, decline in area at the rate of 5.26 per cent per annum. During first phase of TMO, all these major soybean producing states have shown increase in the area of soybean along with country as a whole except in Gujarat where area declined at the rate of 8.19 per cent per annum. During this period, highest increase in the rate of growth has shown by Maharashtra to the tune of 23.64 per cent per annum. During second phase of TMO period, all the major soybean producing states along with India have shown positive growth in the area wherein highest growth is recorded in the state of Karnataka at the rate of 8.78 per cent per annum. During TMO period as a whole positive growth with highest in Maharashtra at the rate of 13.60 per cent per annum has been recorded in all the major states along with country as a whole. Similarly entire study period is also recorded with positive growth in the area of soybean in all the major producing states along with country as a whole. Maximum rate of growth in the area is recorded in Maharashtra at the rate of 13.39 per cent per annum during this entire study period.

5.1.1 Compound annual growth of soybean production during different periods

Table 2 shows compound annual growth rate of soybean production in major producing states during the given periods. The table depicts that Rajasthan has shown highest positive growth in the production of soybean among all the major states during Pre TMO period at the rate of 20.52 per cent per annum, whereas, in Gujarat production is found almost stagnant but in

Table 1. Compound annual growth rate in area of soybean for different periods (000'ha)

States / Country	Time period	Constant	Trend coefficient	R^2	CAGR (%)
Maharashtra	Pre TMO	3.23	0.049***	0.68	5.12
	TMO (I)	4.12	0.212***	0.96	23.64
	TMO (II)	7.40	0.060***	0.82	6.20
	TMO Total	4.81	0.127***	0.89	13.60
	Overall Period	2.64	0.130***	0.95	13.39
Karnataka	Pre TMO	2.17	0.011**	0.45	1.20
	TMO (I)	2.43	0.126***	0.79	13.50
	TMO (II)	4.38	0.084***	0.82	8.78
	TMO Total	2.63	0.101***	0.92	10.63
	Overall Period	1.50	0.086***	0.93	9.06
Gujarat	Pre TMO	2.75	-0.054*	0.39	-5.26
	TMO (I)	3.20	-0.085**	0.59	-8.19
	TMO (II)	3.02	0.111**	0.63	11.80
	TMO Total	1.80	0.045***	0.44	4.64
	Overall Period	2.02	0.073***	0.50	7.57
Rajasthan	Pre TMO	5.13	0.190***	0.94	21.01
	TMO (I)	8.30	0.047***	0.90	4.90
	TMO (II)	8.36	0.024***	0.80	2.42
	TMO Total	8.38	0.038***	0.94	3.91
	Overall Period	6.27	0.081***	0.84	8.43
Madhya Pradesh + Chhattisgarh	Pre TMO	3.62	0.091***	0.69	9.52
	TMO (I)	4.22	0.088***	0.78	9.91
	TMO (II)	5.96	0.056***	0.83	5.75
	TMO Total	4.69	0.077***	0.74	8.00
	Overall Period	4.98	0.071***	0.96	7.35
India	Pre TMO	7.26	0.053***	0.93	5.44
	TMO (I)	7.02	0.073***	0.70	7.57
	TMO (II)	7.66	0.086***	0.79	8.98
	TMO Total	7.10	0.090***	0.86	9.41
	Overall Period	7.99	0.097***	0.94	10.18

**** shows significant at 1 per cent level of probability*
*** shows significant at 5 per cent level of probability*
** shows significant at 10 per cent level of probability*

Table 2. Compound annual growth rate in production of soybean for different periods (000' tons)

States /country	Time period	Constant	Trend coefficient	R^2	CAGR (%)
Maharashtra	Pre TMO	1.56	0.075***	0.94	7.88
	TMO (I)	3.37	0.288***	0.89	33.41
	TMO (II)	7.63	0.042**	0.31	4.37
	TMO Total	4.45	0.143***	0.78	15.42
	Overall Period	1.03	0.175***	0.92	19.24
Karnataka	Pre TMO	1.63	-0.042**	0.25	-4.13
	TMO (I)	1.48	0.182***	0.76	19.96
	TMO (II)	3.88	0.106***	0.85	11.23
	TMO Total	1.95	0.118***	0.86	12.56
	Overall Period	0.41	0.106***	0.87	11.26
Gujarat	Pre TMO	1.23	-0.0008	0.0004	-0.087
	TMO (I)	2.48	-0.045	0.15	-4.44
	TMO (II)	2.52	0.128***	0.71	13.68
	TMO Total	0.61	0.069***	0.68	7.18
	Overall Period	1.50	0.081***	0.58	8.52
Rajasthan	Pre TMO	4.90	0.186***	0.95	20.52
	TMO (I)	8.25	0.054***	0.68	5.55
	TMO (II)	9.17	0.004*	0.67	0.42
	TMO Total	8.42	0.036***	0.75	3.76
	Overall Period	6.01	0.088***	0.83	9.24
Madhya Pradesh + Chhattisgarh	Pre TMO	4.56	0.007***	0.78	0.70
	TMO (I)	4.29	0.096***	0.83	10.07
	TMO (II)	8.39	0.074***	0.74	7.68
	TMO Total	8.99	0.085***	0.83	8.87
	Overall Period	8.76	0.094***	0.96	9.85
India	Pre TMO	8.43	0.086***	0.82	8.98
	TMO (I)	8.08	0.074***	0.75	7.68
	TMO (II)	6.96	0.080***	0.74	8.32
	TMO Total	9.09	0.092***	0.89	9.63
	Overall Period	9.72	0.091***	0.94	9.52

**** shows significant at 1 per cent level of probability, **shows significant at 5 per cent level of probability*
**shows significant at 10 per cent level of probability*

Karnataka it declined at 4.13 per cent per annum. During the first phase of TMO, all the states along with country as a whole has shown positive growth in the area of soybean wherein highest rate of growth in area is shown in Maharashtra at 33.41 per cent per annum except Gujarat where production remained stable during this period also. During the second phase of TMO, Gujarat which had shown no growth in the production has shown positive and highest growth rate in this period among all other states at 13.68 per cent per annum. During the entire TMO period, Maharashtra has shown highest rate of positive growth among all the other states at 15.42 per cent per annum. Maharashtra remained at highest in the overall study period in the positive growth rate in the production of soybean at 19.24 per cent per annum. Maharashtra, Karnataka and Madhya Pradesh (undivided) performed better than the country average during the overall period of study.

5.1.2 Compound annual growth of soybean productivity during different periods

Compound annual growth rates in the productivity of soybean for different periods are presented in the Table 3. The table reveals that among the major soybean producing states, except Rajasthan in which productivity declined at the rate of 0.40 per cent per annum, all the other major states have shown positive growth in the productivity of soybean during Pre TMO period wherein highest rate of compound growth of productivity is found in Gujarat at the rate of 5.90 per cent per annum. During first phase of TMO, all the states along with the country as a

whole has shown positive growth in which Maharashtra has registered highest increase at the rate of 7.90 per cent per annum. During TMO second phase, Maharashtra which had shown highest as well as positive growth rate in productivity in the previous period is now observed with negative growth which indicates that productivity of soybean decreased at the rate of 1.72 per cent per annum. Rest all the other states along with the country have shown positive growth in which highest growth rate is recorded in Madhya Pradesh (undivided) at the rate of 6.07 per cent per annum. For the entire TMO period, all the states along with the country have shown increase in the productivity with the highest growth rate recorded in Madhya Pradesh at the rate of 6.50 per cent per annum. During overall period of the study, all the states recorded with positive growth in which Madhya Pradesh remained on top at the rate of 7.14 per cent per annum.

5.2 Instability in Soybean Area

Instability in the soybean area, production and productivity in India and major soybean producing states is given in Tables 4, 5 and 6.

Instability indices in area of soybean for major states during different periods are presented in the Table 4. The table indicates that during the Pre TMO period, soybean area in Madhya Pradesh (undivided) (31.28) along with the country as a whole (35.83) observed higher instability. Gujarat showed higher instability in the area in all the specified periods ranging from 31.55 to 66.44 except in Pre TMO period, wherein Gujarat showed instability of 25.39 per cent in the area of soybean. For the entire period of study, Madhya Pradesh (undivided) also witnessed higher instability of 32.20 per cent in the area of soybean.

Table 3. Compound annual growth in productivity of soybean for different periods (kg/ha)

States / country	Time period	Constant	Trend coefficient	R^2	CAGR (%)
Maharashtra	Pre TMO	5.45	0.036**	0.55	7.78
	TMO (I)	6.15	0.076**	0.66	7.90
	TMO (II)	7.13	-0.017*	0.67	-1.72
	TMO Total	6.63	0.015**	0.44	1.59
	Overall Period	5.60	0.037***	0.67	3.80
Karnataka	Pre TMO	5.55	0.018**	042	1.86
	TMO (I)	5.96	0.055**	0.40	5.69
	TMO (II)	6.40	0.022*	0.33	2.24
	TMO Total	6.22	0.017**	0.43	1.74
	Overall Period	5.55	0.028***	0.65	2.84
Gujarat	Pre TMO	5.31	0.057**	0.33	5.90
	TMO (I)	6.17	0.040**	0.26	4.08
	TMO (II)	6.40	0.016*	0.32	1.68
	TMO Total	5.67	0.024***	0.48	2.52
	Overall Period	6.39	0.008	0.73	0.86
Rajasthan	Pre TMO	6.67	-0.004*	0.36	-0.40
	TMO (I)	6.85	0.006*	0.63	0.61
	TMO (II)	6.93	0.013*	0.32	1.36
	TMO Total	6.83	0.008**	0.42	0.87
	Overall Period	6.57	0.011***	0.47	1.18
Madhya Pradesh + Chhattisgarh	Pre TMO	4.59	0.045***	0.75	4.60
	TMO (I)	5.69	0.039***	0.72	3.97
	TMO (II)	6.23	0.059***	0.69	6.07
	TMO Total	6.86	0.063***	0.78	6.50
	Overall Period	6.92	0.069***	0.90	7.14
India	Pre TMO	7.86	0.063***	0.94	6.50
	TMO (I)	7.36	0.075***	0.82	7.78
	TMO (II)	8.06	0.058***	0.86	5.97
	TMO Total	7.98	0.073***	0.89	7.57
	Overall Period	8.34	0.085***	0.96	8.87

**** shows significant at 1 per cent level of probability, ** shows significant at 5 per cent level of probability*
** shows significant at 10 per cent level of probability*

Table 4. Instability indices in area of soybean in major soybean producing states and India

Particulars	Period				
	Pre Technology Mission on Oilseeds (Pre TMO) Period – (1970-71 to 1985-86)	**Period of Technology Mission on Oilseeds (Phase one) Period – (1986-87 to 2002-03)**	**Period of Technology Mission on Oilseeds (Phase two) Period – (2002-03 to 2017-18)**	**Overall Period of Technology Mission on Oilseeds – (1986-87 to 2017-18).**	**Overall Period – (1970-71 to 1985-86)**
Lower instability	Karnataka (6.09)	Rajasthan (12.68)	Rajasthan (7.58) Maharashtra (11.94) Madhya Pradesh + Chhattisgarh (8.28) India (11.04)		
Medium instability	Gujarat (25.39) Maharashtra (15.61) Rajasthan (29.99)	Karnataka (24.53) Maharashtra (19.33) Madhya Pradesh + Chhattisgarh (20.12) India (23.04)	Karnataka (17.27)	Karnataka (28.17) Rajasthan (17.28) Maharashtra (26.74) Madhya Pradesh + Chhattisgarh (21.26) India (25.05)	Karnataka (29.02) Maharashtra (28.35) India (21.04)
Higher instability	Madhya Pradesh + Chhattisgarh (31.28) India (35.83)	Gujarat (31.55)	Gujarat (35.75)	Gujarat (82.59)	Madhya Pradesh (32.20) Rajasthan (33.63) Gujarat (66.64)

Figures in parentheses indicate instability indices

Table 5. Instability indices in production of soybean in major soybean producing states and India

Particulars	Period				
	Pre Technology Mission on Oilseeds (Pre TMO) Period – (1970-71 to 1985-86)	**Period of Technology Mission on Oilseeds (Phase one) Period – (1986-87 to 2002-03)**	**Period of Technology Mission on Oilseeds (Phase two) Period – (2002-03 to 2017-18)**	**Overall Period of Technology Mission on Oilseeds – (1986-87 to 2017-18).**	**Overall Period – (1970-71 to 1985-86)**
Lower instability	Maharashtra (10.20)				
Medium instability	Madhya Pradesh + Chhattisgarh (28.41)	Maharashtra (29.71)	Karnataka (22.72) Maharashtra (29.93) Madhya Pradesh + Chhattisgarh (18.44) Rajasthan (19.89) India (21.31)	Madhya Pradesh + Chhattisgarh (29.05)	
Higher instability	Gujarat (52.17) Karnataka (31.68) Rajasthan (62.96) India (37.06)	Gujarat (50.52) Karnataka (36.11) Madhya Pradesh + Chhattisgarh (31.24) Rajasthan (54.23) India (32.15)	Gujarat (34.64)	Gujarat (72.00) Karnataka (33.50) Maharashtra (38.80) Rajasthan (56.27) India (30.17)	Gujarat (65.12) Karnataka (46.22) Maharashtra (34.50) Madhya Pradesh + Chhattisgarh (33.00) Rajasthan (32.57) India (37.15)

Figures in parentheses indicate instability indices

Table 6. Instability indices in productivity of soybean in major soybean producing states and India

Particulars	Period				
	Pre Technology Mission on Oilseeds (Pre TMO) Period – (1970-71 to 1985-86)	**Period of Technology Mission on Oilseeds (Phase one) Period – (1986-87 to 2002-03)**	**Period of Technology Mission on Oilseeds (Phase two) Period – (2002-03 to 2017-18)**	**Overall Period of Technology Mission on Oilseeds – (1986-87 to 2017-18).**	**Overall Period – (1970-71 to 1985-86)**
Lower instability	Karnataka (10.53) Maharashtra (14.54) Madhya Pradesh + Chhattisgarh (14.22) Rajasthan (6.81) India (11.05)	Madhya Pradesh + Chhattisgarh (14.54)	Gujarat (11.74) Rajasthan (5.33)	Rajasthan (5.61)	
Medium instability		Madhya Pradesh (16.33) Gujarat (25.46) Maharashtra (21.00) Rajasthan (15.89) India (15.15)	Madhya Pradesh + Chhattisgarh (16.52) Karnataka (27.04) Maharashtra (27.49) India (26.14)	Madhya Pradesh + Chhattisgarh (16.52) Gujarat (28.80) Karnataka (29.76) Maharashtra (29.44) India (23.66)	Madhya Pradesh + Chhattisgarh (16.97) Gujarat (23.93) Karnataka (28.25) Rajasthan (16.67) India (23.15)
Higher instability	Gujarat (37.67)	Karnataka (30.14)			Maharashtra (31.66)

Figures in parentheses indicate instability indices

5.2.1 Instability in the production of soybean

Instability indices in the production of soybean in major states and India during different periods are presented in Table 5.

The table depicts infers that during Pre TMO period, higher instability observed in the production of soybean in the states of Gujarat (52.17), Karnataka (31.68), Rajasthan (62.96) and country as a whole (37.06). Similarly during TMO I, all the major states except Maharashtra (29.71) showed higher instability in the soybean production from 31.94 to 54.23 per cent. During TMO II higher instability in the soybean production observed only in Gujarat (34.64 per cent). During the entire TMO period all the states and the country as a whole except Madhya Pradesh (undivided) (29.05) recorded with higher instability ranging from 30.17 to 72.00 per cent in the soybean production. For the entire study period higher extent of variability observed in the production of soybean in all the major states from 32.57 to 65.12 per cent.

5.2.2 Instability in soybean productivity

Instability indices in the productivity of soybean are shown in Table 6. The table depicts that during Pre TMO period; only Gujarat (37.67) showed higher instability in the productivity of soybean.

During TMO I, instability in the productivity of soybean in Gujarat decreased to 16.33 per cent from 37.67 per cent in the Pre TMO period. Only Karnataka (30.14) during this period registered higher instability in the productivity of soybean. During TMO II all the major states witnessed instability in the soybean productivity in the range of 16.52 to 27.49 per cent. Only Gujarat (11.74) and Rajasthan (5.33) experienced lower fluctuations in soybean productivity. During the entire TMO period, except Rajasthan (5.61) all the other major states and the country as well registered instability in the range of 16.52 to 29.76 per cent. For the entire study period only Maharashtra (31.68) has shown higher instability in the productivity of soybean.

6. CONCLUSION

During Pre TMO period, positive growth rate in the area of soybean is found positive in all the states except in Gujarat where area declined at the rate of 5.26 per cent per annum. Maximum rate of growth in the area is found in Rajasthan at the rate of 21.00 per cent per annum. During this period, production increased in all the states and country as a whole wherein, maximum rate of production registered in Rajasthan at the rate of 20.52 per cent per annum, production has shown negative growth in Gujarat at the rate of 0.08 per cent per annum. Productivity has shown increasing trend in all the states except in Rajasthan where negative growth is found at the rate of 0.40 per cent per annum. Maximum increase in the productivity is registered in Maharashtra at the rate of 7.78 per cent per annum. During TMO period as a whole, area of soybean increased for all the states and country as a whole where area increased at the maximum rate of 13.60 per cent per annum in Maharashtra. Production has also shown positive growth in all the states and country as a whole, wherein, maximum increase in the production is registered in Maharashtra at the rate of 15.42 per cent per annum. Productivity of soybean increase in the all the major producing states and country as a whole with maximum increase in the rate of productivity registered in India at the rate of 7.57 per cent per annum followed by the state of Madhya Pradesh (undivided) (6.50 per cent per annum). During the whole study period, area grew for all the states and country as a whole, wherein, maximum rate of increase in the area is found in Maharashtra at the rate of 13.39 per cent per annum. Production also increased in all the states and country as well with maximum increase in the rate of production shown in Maharashtra (19.24 per cent per annum). The major soybean producing states along with the country as a whole have shown increase in the productivity with maximum rate of increase witnessed in India at the rate of 8.87 per cent per annum followed by the state of Madhya Pradesh (undivided) (7.14 per cent per annum).

During the Pre TMO period, instability in the area of soybean is found higher in the state of Madhya Pradesh (undivided) (35.83) and country as a whole (35.83). Gujarat shared higher instability in the area in all the specified periods except in Pre TMO period, in which Gujarat showed instability of 25.39 per cent in the area of soybean was higher as compared to the other states. During Pre TMO, instability in the production of soybean was higher in the states of Gujarat (52.17), Karnataka (31.68), Rajasthan (62.96) and country as a whole (37.06). During second phase of TMO, higher fluctuations were recorded only in the state of Gujarat (34.64 per cent) with respect to the production of soybean. For the entire study period higher extent of instability observed in the

production of soybean in all the major states ranging from 32.57 to 65.12 per cent. Soybean productivity flexibility during Pre TMO period was explained only in Gujarat (37.67 per cent). During TMO II, all the major states experienced instability in the productivity in the range of 16.52 to 27.49 per cent. During the entire TMO period, only Rajasthan (5.33) was stable in the productivity of soybean among all the other states.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bansal RK, Gondaliya VK, Shaikh AS. A review of the status of the groundnut production and export of India. Indian Journal of Economics and Development. 2017;13(2):369-374.
2. Bansal S, Singh L. An analysis of growth and variability in area production and yield of groundnut in Punjab. International Journal of Farm Sciences. 2020;10(1):61-65.
3. Bharti AK, Sharma MK, Sharma HL, Sisodia BVS, Dube LK. Pattern of growth and technological impact on oilseeds production in Uttar Pradesh. Journal of Crop and Weed. 2011; 8(2):1-6.
4. Bhattacharyya K, Mitra A. Instability in groundnut production in eastern regions-a relook. Economic Affairs. 2016;61(1):159-162.
5. Brown JKM, Beeby R, Penfield S. Yield instability of winter oilseed rape modulated by early winter temperature. Scientific Reports. 2019;9(1):1-9.
6. Chowdhary MAB, Uddin MT, Uddin MJ. Oil Seeds Area and Production Variability in Bangladesh. Journal of Applied Quantitative Methods. 2014;51.
7. Hedge, Gurupad S. Status of oilseeds in India M Sc (Ag.) Thesis (unpub.) Punjab Agricultural University Ludhiana; 2017.
8. Joseph JV. Growth and Instability in area production and productivity of oilseed in India. Editorial Board. 2020;9(4):43.
9. Kachroo J, Kachroo D, Sharma RK. Growth and instability of major oilseeds in India. Agricultural Situation in India. 2010;66(10):589-600.
10. Kour MA, Sekhon MK, Kour M. Growth and instability of oilseeds production in Punjab. Journal of Agriculture Development and Policy. 2014;23(2):68-78.
11. Kulshrestha SK, Rathore JS, Singh J. Economic growth and oilseed production in Rajasthan: An econometric analysis; 2015.
12. Kumar P, Kumar D, Gupta JK. An analysis of trends growth and B: C ratio in Bhind district of Madhya Pradesh with special reference to mustard crop. Journal of Pharmacognosy and Phytochemistry. 2020;9(4):152-156.
13. Laxmi S, Sahu RM. Scenerio of major oilseeds crop in agro climatric zones of Madhya Pradesh India. Plant Archives. 2020;20(1):1543-1549.
14. Naidu VB, Sankar AS, Leelavathi C. Trends in area production and productivity of selected oil seed crops in Andhra Pradesh. International Journal of Multidisciplinary Research and Development. 2014;1(7):366-369.
15. Sharma BK, Singh G, Kumar P. Growth and instability in area production and productivity of groundnut in Rajasthan: A district level analysis. Journal of Community Mobilization and Sustainable Development. 2014;9(1):37-43.
16. Sharma P. Dynamics of growth of soybean in India: role of income and risk. Agricultural Situation in India. 2016;73(6):37-46.
17. Sonnad J.S, Raveendran N, Ajaan N, Selvaraj KN. Growth analysis of oilseed crops in India during pre and post – WTO periods. Karnataka Journal of Agricultural Sciences. 2011;24(2): 184-187.
18. Teja IK, Rao SR, D Vishnu Sankar RAO, Reddy BR. Performance of oilseeds in India-a temporal analysis; 2017.
19. VR R, Jha GK. Oilseeds sector in India: A trade policy perspective. Indian Journal of Agricultural Sciences. 2019; 89(1):73-8.
20. Narayan P. Recent demand – supply and growth of oilseeds and edible oil in India: an Analytical approach. International Journal of Advanced Engineering Research and Science. 2016;4(1):32-46.
21. Pervin S, Chowdhury AR, Islam MM, Ahmed MB, Ara R. Present status and problem confrontation of oilseed cultivation in southwest region of Bangladesh. Journal of the Bangladesh Agricultural University. 2018;16(2):198-207.
22. Reddy K, Vishwanatha, Kingsly I. Area production and yield trends and pattern of

oilseeds growth in India. Economic Affairs. 2017;62(2):327-334.
23. Reddy VK, Immanuelraj KT. Area production yield trends and pattern of oilseeds growth in India. Economic Affairs. 2017;62(2) 327.
24. Rondanini DP, Gomez NV, Agosti MB, Miralles DJ. Global trends of rapeseed grain yield stability and rapeseed-to-wheat yield ratio in the last four decades. European Journal of Agronomy. 2012;37(1):56-65.
25. Sharma A. Current trends in oilseed crops production: An overview. International Journal of Agriculture Sciences. 2018;10(3):5104-5114.
26. Singh AK, Choudhary AK, Kumar A, Kumar R. Towards self-sufficiency in India: present status and way forward. Journal of Agriculture Research. 2017;4(2):80-84.
27. Singh AK, Manibhushan Bhatt BP, Singh KM, Upaadhaya A. An analysis of oilseeds and pulses scenario in Eastern India during 2050-51. Journal of Agricultural Science. 2013;5(1):241-249.
28. Singh L, Bansal S. Status of rapeseed and mustard crop in India: Trend and decomposition analysis. Editor'Message. 2020;279.
29. Samal SB, Patra R, Das MK, Nanda B. Growth and instability in oilseeds production in Odisha: A district level analysis. International Journal of Humanities and Social Science Invention. 2017;6 (11):39-45.
30. Bharadi HH, Kurubetta S. An analysis of growth rate performance of oilseed crops in Karnataka state. International Journal of Farm Sciences. 2018;8(1):110-113.
31. Kumar S, Singh PK, Rathi D, Nahatkar SB, Choudhary VK, Parey SK. Growth and instability in area production and productivity of Soybean in India. International Journal of Science Environment and Technology. 2019;8(2):278-288.
32. Dash A, Hansdah R. Analytical study of growth and instability of rabi oilseed production in Odisha. Journal of Pharmacognosy and Phytochemistry. 2020;9(2):2145-2149.

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