



ISSN (E): 2277- 7695
 ISSN (P): 2349-8242
 NAAS Rating: 5.23
 TPI 2022; SP-11(4): 771-777
 © 2022 TPI
www.thepharmajournal.com
 Received: 16-02-2022
 Accepted: 18-03-2022

Lekha Kalra
 Department of Agricultural
 Economics, College of
 Agriculture, GBPUAT,
 Pantnagar, Uttarakhand, India

SK Srivastava
 Department of Agricultural
 Economics, College of
 Agriculture, GBPUAT,
 Pantnagar, Uttarakhand, India

Analysis of growth in area, production and productivity of groundnut in major producing states of India

Lekha Kalra and SK Srivastava

Abstract

Oilseed sector plays an important role in the Indian agricultural sector covering an area of about 24507.90 thousand hectares, with total production of over 31459.30 thousand tons during 2017-18. The study tried to analyse the growth of groundnut in its major producing states. Exponential growth function had been fitted for estimating compound annual growth rates in area, production and productivity of groundnut in major states during the period from 1970-71 to 2017-18 which was further divided on the basis of Technology Mission of Oilseeds as Pre TMO period from 1970-71 to 1985-86, TMO I from 1986-87 to 2001-02, TMO II from 2002-03 to 2017-18, overall TMO from 1986-87 to 2017-18 and overall period of study 1970-71 to 2017-18.

Keywords: Oilseeds, exponential function, pre TMO period, post TMO period

Introduction

Agriculture sector of Indian economy contributing around 16.50 per cent (NSSO, 2019-20) of the country's GDP and livelihood for more than one third population of the country. Indian agriculture has made considerable progress, particularly in respect of food crops such as wheat and rice in irrigated areas; however, performance has not been so good in case of her crops particularly oilseeds, pulses, and coarse cereals. Therefore, after achieving self-sufficiency in food grains the government is focusing attention on other agricultural commodities. Oilseeds play an important role in the economy after food grains. As well as Indian climate is also suitable for wide variety of oilseeds that is grown in India. Groundnut is one of the important oilseeds among the group and a good source of oil as well as protein. Groundnut is known as the poor man's nut. It is the sixth most important oilseed crop in the world. India's rank in production of groundnut is second. In India, the availability of groundnut is throughout the year because it has two crop cycle harvested in March & October. It is also considered as an important forage crop also. Groundnut plays an important role both as oil or food crop. Groundnut is very nutritious food. It contains 48-50% oil, 26-28% protein and a rich source of dietary fiber, minerals and vitamins. It also helps in preparing products other than food products such as soaps, medicines, cosmetics and lubricants. Availability per capita of Groundnut in India is around 10 kilograms for domestic consumption purpose. Groundnut is an annual herbaceous plant growing 30 to 50 cm tall. World's leading producer of Groundnut are India & China. About 60 percent of Groundnut production produced by India & China. Major groundnut producing states were selected (according to 2018 production data) for the study based on their cumulative contribution of at least 95 per cent of total production. The state of Uttar Pradesh (included Uttarakhand), which were not carved up earlier and included in the former states was also taken in the study.

Table 1: Production of groundnut in different states during 2018-19

Serial No	Name of States	Production (MT)	% share	Cumulative%
1	West Bengal	2.2	34.49	34.48
2	Rajasthan	1.38	21.64	56.11
3	Tamil Nadu	0.88	13.79	69.90
4	Gujarat	0.48	7.53	77.42
5	Karnataka	0.47	7.36	84.79
6	Uttar Pradesh(Uttarakhand)	0.37	5.79	90.59
7	Maharashtra	0.21	3.29	93.88
8	Kerala	0.18	2.82	96.70
9	Others	0.21	3.29	100
10	All India	6.38	100	-

Source: Crop Production Volume II, Rajendra Prasad (2018)

Corresponding Author
Lekha Kalra
 Department of Agricultural
 Economics, College of
 Agriculture, GBPUAT,
 Pantnagar, Uttarakhand, India

Literature Review

Sonnad *et al.* (2011) ^[2] conducted a study on growth analysis of oilseed crops in India for a period of 37 years from 1970-71 to 2006-07. The study was divided into Pre Technology Mission on Oilseeds (Pre TMO) Period – (1970-71 to 1985-86), Period of TMO or Pre World Trade Organisation Period – (1986-87 to 1994-95) and Post WTO period – (1995-96 to 2006-07). The study reported that the area under rapeseed and mustard, soybean, sunflower and castor increased with an overall annual compound growth rate of 2.13, 17.61, 9.51 and 1.85, respectively in Post WTO period. They further reported that increase in the productivity from the period of Pre WTO to Post WTO for all the nine oilseed crops, was 140 kg per hectare. The overall growth of yield was positive in all the oilseeds except sunflower. The production of all the nine oilseeds when put together increased from 9.99 million tonnes during Pre TMO period to 17.68 million tonnes in Pre WTO period and to 22.33 million tonnes in the Post WTO period. Bharti *et al.* (2011) ^[1] examined Pattern of Growth and Technological Impact on Oilseed Production in Uttar Pradesh during the period 1970-71 to 2005-06. The study revealed that the production gains in the oilseeds were largely due to the expansion in the area during the first period of 1970-71 (before the launch of the Technological Mission on Oilseeds) rather than the productivity. The observed absence in the growth of productivity was a result insufficient technological advancement and the adoption of poor yield enhancing technologies. The study further revealed that the favorable price situation created through the Technological Mission on Oilseeds resulted in the expansion of the oilseed area, and causes a decline in average yield developing location specific technologies that enhance oilseeds productivity. Chowdhury *et al.* (2014) ^[3] studied Oilseeds Area and Production Variability in Bangladesh from the year 1987 to 2010. The study revealed that the production and yield of oil seeds were increased significantly though the areas were decreased. The growth rate in production and yield of oil seeds were satisfactory over the study period although they were not stable. The study further revealed that, the results showed was not sufficient to fulfill the present demand of vegetable oil in Bangladesh. Sharma *et al.* (2014) studied on Growth and Instability in Area, Production and Productivity of Groundnut in Rajasthan: A District Level Analysis. The study period was taken from 1980-81 to 2010-11. A district wise analysis was done regarding growth rate and instability in Rajasthan for groundnut crop which revealed that compound annual growth rate in area and production was highest during 2001-2010, and in relation to productivity it was highest during 1981-1990. The change in production was mostly affected by change in area as compared to the change in the yield. Sharma (2014) conducted a study on Development Programmes and Performance of Oilseeds in India during the period (1970-71 to 2012-13). The time was divided into different periods as Pre-TMO (1970-71 to 1985-86), Post-TMO or Pre WTO (1986-87 to 1994-95), Post WTO (1995-96 TO 2003-04), and Post ISOPOM (2004-05 TO 2012-13). The study showed that the compound annual growth rate of 2% was witnessed in India during the study time period. The study further revealed that the growth rate in area, production and yield of oilseeds, except for linseed and safflower, increased during Post WTO period which results in the decline in the edible oil imports to almost negligible (2% of total consumption) during the period of 1992. During Post

WTO period most of the oilseeds witnessed a negative growth in area and production mainly due to lower real process and edible oil import surge. During Post ISOPOM, the production of soybean, sesame and castor increased positively, while the growth of other oilseeds continued to decline.

Kulshrestha *et al.* (2015) ^[4] conducted a study on Economic Growth and Oilseed Production in Rajasthan from 1980-81 to 2008-09. The study reported that Rajasthan witnessed highest growth in rapeseed and mustard in term of area and production as 6.17 and 7.96 per cent per annum respectively which impact not only economic growth but also oilseed production in the state. Rajasthan was largest oilseed producer next to Gujarat. It had first place in term of rape seeds production while Gujarat in term of castor production. Time series data of last five decades of the state showed that there was bidirectional and long run relationship between economic growth and oilseed production. Further study revealed that the production of oilseeds in Rajasthan had significant changes over last five decades.

Narayan (2016) estimated growth of oilseeds and edible oil in India from 1951-52 to 2013-14, entire period was divided into two periods i.e., before launching of TMO 1951-52 to 1985-86 and after launching of TMO 1986-87 to 2013-14. The study reported that the compound annual growth rate of oilseeds in area, production and productivity was 0.31, 3.35 and 3.03 per cent, respectively during the recent year (2006-07 to 2013-14), however higher growth of 3.70, 6.97 and 3.15 per cent in area, production and productivity, respectively, was recorded during early years of (1986-87 to 1995-96) when Technology Mission on Oilseeds was launched. The study further revealed that negligible growth was recorded in area, production and productivity at 0.01, 1.08 and 1.07 per cent, respectively during the middle period of (1996-97 to 2005-06) due to the peter out effect of the oilseeds mission.

Sharma (2016) conducted a study on Dynamics of Growth of Soybean in India: Role of Income and Risk during the year (1980-891 to 2011-12). The study showed that Rajasthan state has witnessed highest growth in the production of soybean (18.3% annual) followed by Madhya Pradesh (10%) and Gujarat (7.9%) during the period 1980-2012.

Reddy *et al.* (2017) ^[5] conducted a study on area, production, yield trends and pattern of oilseed growth in India from 1980-81 to 2011-12. They reported that the increase in the growth rates of production and yield was mainly in Kharif season during 1980-90. They further reported that in India, area under oilseeds was increased from 18 Mha during 1982 to 27 Mha during 2012 due to initiatives taken in Technology Mission on Oilseeds and other oilseeds development programmes.

Samal *et al.* (2017) ^[6] 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 study showed that the overall negative growth of groundnut and the total oilseed production was recorded in the period from 1995-96 to 2004-05 whereas in period from 2005-06 to 2014-15 improvement in the growth of groundnut and the total oilseed production was found.

Jakhar and Srivastava (2018) studied growth rate in area, production and productivity of sugarcane in Western region of Uttar Pradesh from 1995-96 to 2014-15. The time period was further divided into two sub periods i.e. 1995-96 to 2004-05, 2005-06 to 2014-15. The study revealed that the area,

production and productivity of sugarcane in western region was increased during the entire study period, whereas area under sugarcane was declined during II sub period i.e. 2005-06 to 2014-15. The study further revealed that yield was also decreased during I sub period i.e. 1995-96 to 2004-05.

Bharadi and Savakka (2018) [7] conducted a study on an Analysis on the Growth Rate Performance of Oilseed crops in Karnataka state during the period 200-01 to 2014-15. The study concluded 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% respectively whereas all rest of the crops showed negative growth. The highest negative growth rate was observed in niger crop (-7.83%) and highest negative growth rate of productivity in linseed (-7.00%) and the highest negative growth rate of production in case of niger crop (-3.22%).

Objective of the study

The major objective of the study was to analyse the growth in area, production and productivity of groundnut in major producing states.

Material and Methods

The time series data on area, production, productivity of groundnut in country was collected from various published and unpublished sources such as journals, official government records, department of agriculture, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers' Welfare, commodities.cmie.com, etc. Period of the study had been taken from 1970-71 to 2017-18. The phases of the period of the proposed study were specified as follows. 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 and Overall Period from 1970-71 to 2017-18. The Pre and Post TMO criteria had been considered to estimate whether TMO had any impact on area, production, productivity of groundnut. Growth was 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. To achieve this objective, the growth of time series data on area, production and productivity of groundnut in the country estimated for the different periods.

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 has been estimated using the exponential function of the following form:

$$Y_t = Ae^{bt}$$

The log transformation of this function is as follows:

$$\text{Log}_e Y_t = \text{Log}_e A + bt$$

Through regression analysis the values of 'A' and 'b' were 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_0 ' 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,

$$Y_t = Y_0(1+r)^t$$

Log transformation of the above is

$$\text{Log } Y_t = \text{log } Y_0 + t \text{ log } (1+r)$$

Assuming $\text{log } Y_0 = \text{log } A$ and $\text{log } (1+r) = b$, the same expression can be put as

$$\text{Log } Y_t = \text{log } A + bt$$

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

following transformation is done,

$$\text{Since } b = \text{log } (1+r)$$

$$\text{Antilog } (b) = 1 + r$$

Therefore:

$$CAGR (r) = (\text{Antilog } b) - 1$$

$$CAGR \text{ in percentage} = [(\text{Antilog } b) - 1] * 100$$

Results and Discussion

Compound annual growth of groundnut area during different periods Compound annual growth rates in area of groundnut for different periods were shown in the table 2. The table depicts that during Pre TMO period area of groundnut grew significantly in the states of West Bengal, Gujarat and Rajasthan at 14.66, 1.66 and 0.03 per cent per annum, respectively, in which West Bengal had shown maximum rate of increase in the area of groundnut in this period. Rest of the states as well as the country as a whole had shown decline in the area except in Karnataka, where the area was found almost stagnant, and while, highest rate of decline had been shown in Uttar Pradesh (undivided) at the rate of 5.14 per cent per annum. During phase I of TMO period, only West Bengal and Gujarat had shown increase in area at the compound annual growth rate of 6.09 and 1.05 per cent per annum, respectively, whereas, Rajasthan which had increasing trend in Pre TMO period had shown decrease in area at the rate of -1.19 per cent per annum. Groundnut area in country as a whole grew at the rate of 1.98 per cent per annum. Only West Bengal and Gujarat during first phase of TMO had performed better than that of the country as a whole, and rest other states had shown decrease in the area of groundnut with maximum rate of decline in the area of groundnut registered in Kerala at the rate of 6.89 per cent per annum during this TMO I. During II phase of TMO period, only West Bengal recorded growth in area, whereas, Gujarat along with other major states and India had shown decline in the groundnut area. Kerala registered maximum decline in the

area at the rate of 14.18 per cent per annum. During TMO period as a whole, area under groundnut decreased in all the major states except in West Bengal (5.90 per cent per annum) and country as a whole (0.90 per cent per annum) wherein area under groundnut increased. Maximum decline in the area during this period had been registered in Kerala at the rate of 12.02 per cent per annum. During overall study period, except in West Bengal all the states along with India had shown

negative growth in which maximum decline in the area had been shown in the state of Kerala at the rate of 7.35 per cent per annum.

Technology Mission on Oilseeds had not shown any consistent increase in the area of groundnut in any of the major producing states except West Bengal which had performed better in all the time periods among all the other major states.

Table 2: Compound annual growth rate groundnut area in major states as well as India during different periods (Area 000³ha)

States / Country	Time periods	Initial year observation	Final year observation	Constant	Trend coefficient	Standard error	R ²	CAGR (%)
Gujarat	Pre TMO	1758.30	1793.50	7.40	0.016**	0.004	0.44	1.66
	TMO (I)	1824.50	1887.70	7.41	0.010	0.008	0.10	1.05
	TMO (II)	2029.40	1679.00	7.63	-0.019**	0.005	0.46	-1.93
	TMO Total	1824.50	1679.00	7.53	-0.002**	0.002	0.34	-0.29
	Overall Period	1758.30	1679.00	7.54	-0.001**	0.001	0.39	-0.17
Maharashtra	Pre TMO	952.70	662.50	6.72	-0.006*	0.005	0.52	-0.67
	TMO (I)	653.80	429.40	6.76	-0.038**	0.007	0.67	-3.74
	TMO (II)	419.00	291.00	6.07	-0.025**	0.005	0.56	-2.51
	TMO Total	653.80	291.00	6.72	-0.034**	0.002	0.88	-3.42
	Overall Period	952.70	291.00	6.93	-0.024**	0.001	0.84	-2.46
West Bengal	Pre TMO	4.56#	8.90	-0.67	0.136***	0.026	0.66	14.66
	TMO (I)	12.10	36.90	2.66	0.059***	0.006	0.84	6.09
	TMO (II)	31.00	70.50	3.72	0.045***	0.008	0.69	4.67
	TMO Total	12.10	70.50	2.69	0.057***	0.002	0.93	5.90
	Overall Period	4.56#	70.50	-0.09	0.109***	0.005	0.88	11.56
Karnataka	Pre TMO	837.10	810.50	6.79	-0.005	0.007	0.03	-0.53
	TMO (I)	1033.90	854.80	7.12	-0.007*	0.006	0.60	-0.79
	TMO (II)	843.90	564.00	6.90	-0.033***	0.005	0.68	-3.26
	TMO Total	1033.90	564.00	5.44	-0.011***	0.004	0.35	-1.09
	Overall Period	837.10	564.00	6.93	-0.005***	0.002	0.89	-0.52
Tamil Nadu	Pre TMO	1000.40	932.00	6.95	-0.009**	0.004	0.25	-0.92
	TMO (I)	897.00	663.00	7.07	-0.025**	0.006	0.51	-2.53
	TMO (II)	502.10	327.40	6.74	-0.049***	0.005	0.85	-4.84
	TMO Total	897.00	327.40	7.22	-0.047***	0.002	0.91	-4.59
	Overall Period	1000.40	327.40	7.23	-0.026***	0.002	0.72	-2.57
Uttar Pradesh + Uttarakhand	Pre TMO	341.10	124.30	6.09	-0.053***	0.012	0.57	-5.14
	TMO (I)	122.80	107.50	4.92	-0.006	0.005	0.08	-0.68
	TMO (II)	81.70	88.00	4.52	0.001	0.003	0.01	0.17
	TMO Total	122.80	88.00	4.96	-0.016***	0.002	0.63	-1.60
	Overall Period	341.80	88.00	5.82	-0.03***	0.002	0.81	-3.23
Kerala	Pre TMO	14.70	11.00	2.88	-0.033***	0.007	0.61	-3.34
	TMO (I)	11.10	2.40	2.29	-0.071***	0.022	0.41	-6.89
	TMO (II)	2.10	0.30	1.49	-0.152***	0.018	0.82	-14.18
	TMO Total	11.10	0.30	3.37	-0.128***	0.008	0.89	-12.02
	Overall Period	14.70	0.30	3.57	-0.076***	0.006	0.76	-7.35
Rajasthan	Pre TMO	7326.20	7923.80	8.87	0.003*	0.001	0.45	0.03
	TMO (I)	6982.10	6238.10	9.03	-0.012**	0.004	0.29	-1.19
	TMO (II)	5935.50	4887.70	8.79	-0.019**	0.004	0.62	-1.97
	TMO Total	6982.10	4887.70	9.39	-0.018**	0.001	0.87	-1.78
	Overall Period	7326.20	4887.70	9.01	-0.008**	0.001	0.50	-0.82
India	Pre TMO	115263.00	106359.00	6.35	-0.015***	0.004	0.46	-1.48
	TMO (I)	103625.00	106875.00	5.69	0.019***	0.006	0.55	1.98
	TMO (II)	126896.00	105978.00	7.65	-0.035***	0.003	0.74	-3.43
	TMO Total	103625.00	105978.00	4.36	0.009***	0.002	0.59	0.90
	Overall Period	115263.00	105978.00	4.89	-0.046***	0.004	0.69	-4.49

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

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

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

the area of groundnut in West Bengal is from the year 1980-81 as data was not available for the previous time period.

Compound annual growth in production of groundnut during different periods.

Compound annual growth rates of groundnut production for different periods were presented in the table 3. The table depicts that during Pre TMO period production of groundnut increased significantly in the states of West Bengal, and Karnataka at 12.44 and 1.29 per cent per annum, respectively, in which West Bengal had shown maximum rate of increase in the production of groundnut during this period. Other states during this period as well as the country as a whole had shown decline in the production, highest rate of decline had been shown in Kerala at the rate of 6.09 per cent per annum. During phase I of TMO period, only West Bengal, Gujarat and Maharashtra had shown increase in production at the compound annual growth rate of 7.09, 4.78 and 1.20 per cent per annum, respectively, whereas, Karnataka which had increasing trend of production in Pre TMO period had shown decrease in production at the rate of 0.48 per cent per annum. Groundnut production in country as a whole grew at the rate of 4.60 per cent per annum. Only West Bengal and Gujarat during first phase of TMO had performed better than that of the country as a whole, while rest of other states had shown decrease in the production of groundnut with maximum rate of decline

registered in Kerala at the rate of 5.61 per cent per annum during this TMO I. During II phase of TMO period, West Bengal, Gujarat, Tamil Nadu, Uttar Pradesh (undivided) and Rajasthan recorded growth in production in which maximum increase in the production had been registered in West Bengal at the rate of 8.03 per cent per annum, whereas, other major states namely Maharashtra, Karnataka and Kerala had shown decline in the groundnut production. Kerala registered maximum decline in the production at the rate of 9.23 per cent per annum. During TMO period as a whole, production of groundnut increased in the states of West Bengal, Gujarat, Tamil Nadu and Rajasthan with highest CAGR in West Bengal at the tune of 8.47 per cent per annum while in Maharashtra, Karnataka, Uttar Pradesh (undivided) and Kerala production of groundnut decreased. Maximum decline in the production during this period had been registered in Kerala at the rate of 9.78 per cent per annum. During overall study period, West Bengal, Gujarat, Tamil Nadu and Rajasthan along with India had shown positive growth in which maximum increase had been found in the state of West Bengal at the rate of 14.22 per cent per annum. Technology Mission on Oilseeds had shown positive impact in the production of groundnut in the states of West Bengal, Gujarat, Rajasthan and Tamil Nadu.

Table 3: Compound annual growth of groundnut production for different periods (production, 000' tons)

States /Country	Time period	Initial year observation	Final year observation	Constant	Trend coefficient	Standard error	R ²	CAGR (%)
Gujarat	Pre TMO	1835.90	448.2	7.08	-0.010**	0.03	0.70	-0.99
	TMO (I)	1291.70	2646.60	6.75	0.046*	0.04	0.76	4.78
	TMO (II)	1094.50	3937.10	7.59	0.026*	0.02	0.59	2.67
	TMO Total	1291.70	3937.10	6.81	0.040**	0.01	0.25	4.12
	Overall Period	1835.90	3937.10	6.87	0.020**	0.006	0.69	2.10
Maharashtra	Pre TMO	616.60	468.70	6.06	-0.028*	0.01	0.38	-2.76
	TMO (I)	435.20	492.20	6.67	0.012	0.01	0.16	1.20
	TMO (II)	450.00	344.30	6.12	-0.017**	0.006	0.32	-1.76
	TMO Total	435.20	344.30	6.70	-0.028**	0.003	0.65	-2.83
	Overall Period	616.60	344.30	6.49	-0.009**	0.003	0.27	-0.96
West Bengal	Pre TMO	1.23	10.20	-0.66	0.117***	0.040	0.37	12.44
	TMO (I)	14.30	55.70	2.84	0.068***	0.009	0.77	7.09
	TMO (II)	47.30	165.20	4.11	0.077***	0.010	0.80	8.03
	TMO Total	14.30	165.20	2.75	0.081***	0.003	0.94	8.47
	Overall Period	1.23	165.20	-0.41	0.132***	0.006	0.89	14.22
Karnataka	Pre TMO	613.10	707.10	6.29	0.012*	0.012	0.70	1.29
	TMO (I)	738.10	585.80	6.89	-0.004*	0.012	0.65	-0.48
	TMO (II)	539.00	552.60	6.37	-0.014	0.012	0.08	-1.40
	TMO Total	738.10	552.60	5.88	-0.019*	0.020	0.60	-1.93
	Overall Period	613.10	552.60	6.61	-0.004*	0.003	0.35	-0.42
Tamil Nadu	Pre TMO	916.70	1176.00	6.95	-0.004*	0.009	0.53	-0.40
	TMO (I)	1092.60	1250.00	7.17	-0.00001	0.020	0.0000005	-0.001
	TMO (II)	717.40	1007.50	6.88	0.027*	0.008	0.38	2.73
	TMO Total	192.60	1007.50	7.28	0.017**	0.005	0.25	1.71
	Overall Period	916.70	1007.50	7.05	0.013*	0.002	0.45	1.30
Uttar Pradesh + Uttarakhand	Pre TMO	221.70	105.30	5.76	-0.060***	0.017	0.45	-5.86
	TMO (I)	110.60	90.20	4.77	-0.010*	0.010	0.70	-1.04
	TMO (II)	50.05	89.10	4.10	0.024***	0.008	0.35	2.45
	TMO Total	110.60	89.10	4.75	-0.015***	0.004	0.30	-1.56
	Overall Period	221.70	89.10	5.43	-0.028***	0.003	0.65	-2.76
Kerala	Pre TMO	16.10	6.00	3.10	-0.062***	0.011	0.68	-6.09
	TMO (I)	6.10	1.80	2.47	-0.057*	0.027	0.33	-5.61
	TMO (II)	1.10	0.40	1.02	-0.096***	0.022	0.57	-9.23
	TMO Total	6.10	0.40	2.78	-0.102***	0.009	0.80	-9.78
	Overall Period	16.10	0.40	3.39	-0.074***	0.005	0.82	-7.13
Rajasthan	Pre TMO	6111.10	5119.50	8.61	-0.006*	0.008	0.39	-0.59
	TMO (I)	5875.40	7027.50	8.92	0.030*	0.009	0.65	-3.04
	TMO (II)	4121.10	9252.60	8.69	0.017*	0.013	0.61	1.79
	TMO Total	5875.40	9252.60	8.88	0.074*	0.004	0.59	7.68

	Overall Period	6111.10	9252.60	8.66	0.005***	0.002	0.45	0.57
India	Pre TMO	105698.00	95863.00	3.23	-0.030***	0.006	0.63	-2.95
	TMO (I)	105369.00	115698.00	2.63	0.045***	0.004	0.86	4.60
	TMO (II)	116987.00	126378.00	1.99	0.016***	0.003	0.75	1.61
	TMO Total	105369.00	126378.00	4.56	0.039***	0.002	0.69	3.97
	Overall Period	105698.00	126378.00	3.96	0.036***	0.004	0.67	3.66

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

** shows significant at 5 per cent level of probability

* shows significant at 10 per cent level of probability

the production of groundnut in West Bengal is from 1980-81 as data was not available for the previous time period.

Compound annual growth of groundnut productivity during different periods

Compound annual growth rates in productivity of groundnut for different periods had shown in the table no 4 The table depicts that during Pre TMO period, productivity increased significantly for all the major producing states except for Kerala and Gujarat wherein productivity decreased, maximum decline observed in Kerala at the rate of 2.84 per cent per annum. During this period highest increase in the productivity had shown by West Bengal at the rate of 1.85 per cent per annum. During this period no state had performed better than the country's growth (4.60 per cent per annum) regarding productivity of groundnut. During TMO first phase, all the states had shown increase in the productivity of groundnut along with country as a whole, in which highest rate in the productivity is recorded by Gujarat (3.69 per cent per annum) except in Karnataka and Uttar Pradesh (undivided) wherein productivity had declined at the rate of 2.60 and 0.35 per cent per annum, respectively. During the second phase of TMO, all the major producing states and country as a whole recorded

increase in the productivity of groundnut with highest increase in Kerala at the rate of 5.98 per cent per annum. All the states along with India as a whole in the overall TMO period registered positive growth in the productivity. During this period, Gujarat had shown highest increase in the productivity at the rate of 4.43 per cent per annum. The overall study period, productivity grew significantly for all the states and country as a whole. West Bengal recorded with highest rate of growth in productivity of groundnut at 16.77 per cent per annum during the overall study period.

Technology Mission on Oilseeds had shown positive impact in the productivity of groundnut in all the major groundnut producing states, but decline in area under this oilseed mainly forced the production to decline in almost all the major producing states except West Bengal. This calls for detailed study of cropping pattern over time in such states to find the trade-off among groundnut and its competing crop(s) area under which expanded at the cost of groundnut area, to encourage the farmers to increase area under groundnut crop after resolving constraint therein, if any.

Table 4: Compound annual growth rate of groundnut productivity for different periods (productivity kg/ha)

States / Country	Time period	Initial year observation	Final year observation	Constant	Trend coefficient	Standard error	R ²	CAGR (%)
Gujarat	Pre TMO	1044.10	249.9	6.59	-0.005	0.03	0.002	-0.55
	TMO (I)	708	1402.00	6.24	0.036*	0.03	0.60	3.69
	TMO (II)	593.3	2344.90	6.86	0.045*	0.02	0.39	4.70
	TMO Total	708	2344.90	6.18	0.043**	0.01	0.34	4.43
	Overall Period	1044.10	2344.90	6.23	0.022**	0.006	0.22	2.28
Maharashtra	Pre TMO	647.20	707.70	6.25	0.03**	0.01	0.30	3.54
	TMO (I)	665.60	1146.30	6.81	0.015***	0.009	0.18	1.60
	TMO (II)	1074.00	1183.00	6.95	0.007	0.004	0.15	0.77
	TMO Total	665.60	1183.00	6.88	0.006**	0.002	0.15	0.60
	Overall Period	647.60	1183.00	6.46	0.015**	0.002	0.53	1.54
West Bengal	Pre TMO	946	1146.10	-2.40	0.620***	0.092	0.76	1.85
	TMO (I)	1181.80	1509.50	7.08	0.009***	0.004	0.26	0.94
	TMO (II)	1525.80	2343.30	7.30	0.031***	0.005	0.73	3.21
	TMO Total	1181.80	2343.30	6.97	0.023***	0.001	0.83	2.42
	Overall Period	946	2343.30	2.06	0.155***	0.019	0.56	16.77
Karnataka	Pre TMO	732.40	698.40	6.40	-0.018*	0.013	0.35	-1.78
	TMO (I)	713.90	685.30	6.68	-0.003*	0.007	0.42	-0.29
	TMO (II)	638.70	979.80	6.38	0.019***	0.008	0.24	1.92
	TMO Total	713.90	979.80	5.55	0.002*	0.002	0.65	0.26
	Overall Period	732.40	979.80	6.58	0.09*	0.002	0.76	0.09
Tamil Nadu	Pre TMO	916.30	1261.80	6.90	0.005*	0.006	0.65	0.52
	TMO (I)	1218.10	1885.40	7.00	0.025*	0.018	0.39	2.60
	TMO (II)	1428.80	3077.80	7.31	0.041***	0.005	0.78	4.26
	TMO Total	1218.10	3077.80	6.96	0.029***	0.004	0.54	2.97
	Overall Period	916.30	3077.80	6.72	0.022***	0.002	0.66	2.28
Uttar Pradesh + Uttarakhand	Pre TMO	650.00	847.10	6.57	0.007*	0.013	0.76	0.70
	TMO (I)	900.00	839.10	6.75	-0.003	0.008	0.012	-0.35
	TMO (II)	618.10	1013.00	6.48	0.022***	0.008	0.32	2.27
	TMO Total	900.00	1013.00	6.69	0.0003*	0.003	0.63	0.03
	Overall Period	650.00	1013.00	6.51	0.005***	0.002	0.70	0.50
Kerala	Pre TMO	1095.20	545.50	7.12	-0.028***	0.007	0.51	-2.84
	TMO (I)	550.00	750.00	6.44	0.013*	0.009	0.63	1.33

	TMO (II)	523.80	1349.00	6.42	0.058***	0.008	0.75	5.98
	TMO Total	550.00	1349.00	6.31	0.023***	0.003	0.59	2.59
	Overall Period	1095.20	1349.00	6.72	0.002*	0.002	0.36	0.25
Rajasthan	Pre TMO	834.10	850.60	6.64	0.005	0.007	0.04	0.57
	TMO (I)	841.50	1126.50	6.80	0.009*	0.006	0.61	0.90
	TMO (II)	694.30	1893.00	6.82	0.037**	0.011	0.45	3.80
	TMO Total	841.50	1893.00	6.71	0.017***	0.003	0.46	1.76
	Overall Period	834.10	1893.00	6.55	0.013***	0.001	0.58	1.40
India	Pre TMO	8965.00	9645.00	6.96	0.045***	0.005	0.65	4.60
	TMO (I)	9967.00	10367.23	4.65	0.034***	0.003	0.71	3.45
	TMO (II)	10643.43	15679.74	7.65	0.062***	0.004	0.69	6.39
	TMO Total	9967.00	15679.74	5.99	0.074***	0.005	0.77	7.68
	Overall Period	8965.00	15679.74	6.78	0.088***	0.004	0.86	9.19

*** 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

the productivity of groundnut in West Bengal is from 1980-81 as data was not available for the previous time period

References

1. 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.
2. Sonnad JS, 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.
3. Chowdhary MAB, Uddin MT, Uddin MJ. Oil Seeds Area and Production Variability in Bangladesh. *Journal of applied quantitative methods*, 2014, 51.
4. Kulshrestha SK, Rathore JS, Singh J. Economic Growth and Oilseed Production in Rajasthan: An Econometric Analysis, 2015.
5. Reddy K Vishwanatha, Kingsly I. Area, Production and Yield trends and pattern of oilseeds growth in India. *Economic Affairs*. 2017;62(2):327-334.
6. 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.
7. 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.