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Growth Performance and Interrupted Time Series Approach to Estimate Immediate and Sustained Effects of Oilseeds Mission on Groundnut in India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Oilseeds are mostly grown in marginal lands with inadequate irrigation facilities (only 10% is irrigated) as a result yields tend to be low leading to a widening gap between domestic production of vegetable oil and demand. Production growth in the early eighties was slow due to insufficient technologies and the turning point was the year 1985-86. Since then, oilseeds production in the

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country has increased due to implementation of technology mission. The present study was attempted to examine the growth performance of groundnut in the major states of India and assess the immediate and sustained effects of oilseeds mission on groundnut production in order to identify the potentials for future expansion of area and scaling -up the yield of groundnut-based production system. Growth and quasi experimental time series analyses were employed to assess the growth performance and intervention's effects (oilseeds mission) using time series data. Increase in groundnut production has been contributed mainly by increase in productivity. Though the maximum productivity growth was 6.24% per annum in India, overall growth rate in yield was 2.28 % per annum due to yearly aberrations indicating the high instability. Groundnut yield grew by 3.84, 3.06 and 2.16 % per annum respectively in Rajasthan, Madya Pradesh and Tamil Nadu for the overall period (1992-93 and 2020-21). However, these states witnessed production shortfalls and production fell by 0.94, 6.42 and 2.05 % per annum, respectively. Except Gujarat the other major states also exhibited negative growth in production and the rate of drop was higher in the Uttara Pradesh (7.91%) followed by Madhya Pradesh (6.42%), Maharashtra (4.94%), Andhra Pradesh (3.69%) and Karnataka (3.03%). Groundnut production in India also fell by 2.13 % per annum mainly due to fall in area and marginal growth in yield. The estimated yield increase was 450 kg/ha in India, which is higher by 48 % after the intervention. The estimated positive and significant coefficient of interrupted time series for India (50.36) reveal that the oilseeds mission has created sustained effects as a result there was a yield improvement. Sustained effects of intervention are noticed in most of the states. Sustaining the productivity in those states with high yield potential and improving the productivity in other major states by prioritizing and disseminating the seeds of suitable varieties and production technologies are vital as there is lackluster response from the farmers in adoption of varieties and technologies.

Keywords: Growth performance; interrupted time series; immediate and sustained effects; oilseeds mission; growth rate.

1. INTRODUCTION

Failure to achieve higher yields in oilseeds particularly in groundnut is one of the reasons for the widening gap between domestic production of vegetable oils and demand. This is due to insufficient technological improvements, especially high yielding seed material and plant protection technologies. In the case of oilseeds more than 300 modern varieties and hybrids have been released to the farmers [1] but their adoption rates are poor due their cultivation on rainfed areas, which are endowed with poor resources. In the case of groundnut 74% of the total produce is harvested from rainy season crops, while only 26% from irrigated post rainy season crop [2]. In rainfed area, farmers were reluctant to adopt the improved technology due to spatial variability of rainfall and soil (Kadaliya, et al. 2021) which results in low yield and income. The average productivity during the post rainy season is as at two times more than the rainy season [2]. A study on adoption of various technology components worked out for select oilseed crops reported that 56% of the farmers adopted full complement of technologies; 37 % did adopt partially and 8 % drew blank in the case of groundnut [3]. There is a diversion of major oilseeds namely groundnut, rapeseed and mustard from irrigated condition to dry situation. Lack of quality seeds, poor irrigation facilities, price variability, storage losses due to rodent attack and shortage of labour were the major abiotic constraints as a result groundnut cultivation has almost disappeared from the irrigated areas of the Punjab state over the years [4]. Only 10 per cent of the area under oilseeds is irrigated and as a result yields tend to be low [5]. Variability in irrigated area is also high as compared to area variability envisaging that oilseeds are grown on marginal land holdings under natural climate and low fertility conditions [5].

Evidences also show that area variability in oilseeds is high [6]; (Jhala, 1997) which lead to production variability and results in surplus in one year and deficit in the subsequent year. However, oilseed yield almost doubled over the last four decades. The share of oilseeds in total cropped area increased only marginally over the last three decades. In the early eighties the growth in oilseeds production was slow and the turning point was the year 1985-86 since then oilseeds production in the country has increased due to implementation of technology mission on oilseeds and increase can be attributed to productivity growth resulting from improved

technologies. In order to identify the potentials for future expansion of area under groundnut in the major states and scaling -up the productivity of groundnut-based production, the present was attempted to examine the growth pattern of groundnut in major states of India and assess the immediate and sustained effects of oilseeds mission on groundnut production.

2. MATERIALS AND METHODS

(i) Growth Performance

Time series data on area, production, and productivity of groundnut for the major states and India were collected from various online publications (www.dacnet.nic.in) for the period between 1992-93 and 2020-21. Compound growth rates were estimated for overall period using the formula [(Ending period (2020-21)/Initial value (1992-93)^(1/23)-1)*100]. To identify feasibility for expansion of area, production and productivity, maximum decline and increase in area/ production and productivity in the various states and India in terms of compound growth rates were also estimated using the formula [(Min value/Max value)^(1/No. of years)-1*100].The growth rates were estimated in excel worksheet and the states were classified based on compound growth rates.

(ii) Intervention's Effects of Oilseeds Mission on Groundnut Production: Application of Quasi experimental time series analysis

India is one of the largest producers of oilseeds in the world. The government of India implemented technology mission on oilseed and oil palm (TMOP) during the period 1985-2003 (7^{th} to 9^{th} plan), integrated scheme on oilseed, pulses, oil palm and maize (ISPOM) during 2004-2013 (10^{th} to 11^{th} plan) and national mission on oilseed and oil palm (NMOOP) during the period 2014-2017 (12^{th} plan) in order to increase oilseed production since a substantial portion of edible oil requirement is met through imports. Since 1985-86 oilseeds production in the country has increased and increase was attributed to improvement in yield resulting from adoption of improved technologies.

In time series it is important to understand the counterfactual and the actuals. Thus, interrupted time series enable to investigate no impact, immediate impact, sustained or long-term impact and both immediate and sustained impacts of oilseed mission on area, production, and productivity of groundnut in various states and India. The time coefficient β_1 indicates the trends in area, production, and productivity of groundnut in before intervention. The positive and significant coefficients indicate that area, production, and productivity increase over the period or vice versa. The β_2 normally indicates the immediate effect of oilseed mission and the immediate effect is expected to be positive and significance. Time since intervention impact co-efficient β_3 indicates that trend has changed after the intervention i.e., the sustained effect of intervention. Following interrupted time series segmented regression is employed.

$$y = \alpha + \beta_1 T + \beta_2 X + \beta_3 XT + \varepsilon.$$

Where;

T refers to time period, X indicates the study phase and XT represents time after interruption. β_1 coefficient indicate pre-trend, β_2 shows the post level change, β_3 is the post trend change and ($\beta_1 + \beta_3$) is the post-trend.

3. RESULTS AND DISCUSSION

(i) Growth Performance

Peanuts or groundnuts accounted for nearly 349 billion Indian rupees in the Indian economy in fiscal year 2020 (www.statista.com) and contributed to over 29 percent of the sector's gross value of output (GVO) during the same year (Fig. 1). Groundnut is the major oilseed accounting for more than 40 per cent of the area under oilseeds, but its share has declined over the years due to increases in soybeans and sunflower. Rapeseed and mustard are the next most important oilseeds in terms of acreage, accounting for 30 per cent of the oilseeds produced in India. Peanuts or groundnuts accounted for nearly 349 billion Indian rupees in the Indian economy in fiscal year 2020 and contributed to over 29 percent of the sector's gross value added in oilseeds. The largest oilseed-producing states in India include Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal. Out of these states, Rajasthan, Gujarat, Madhya Pradesh and Maharashtra are the top producers.

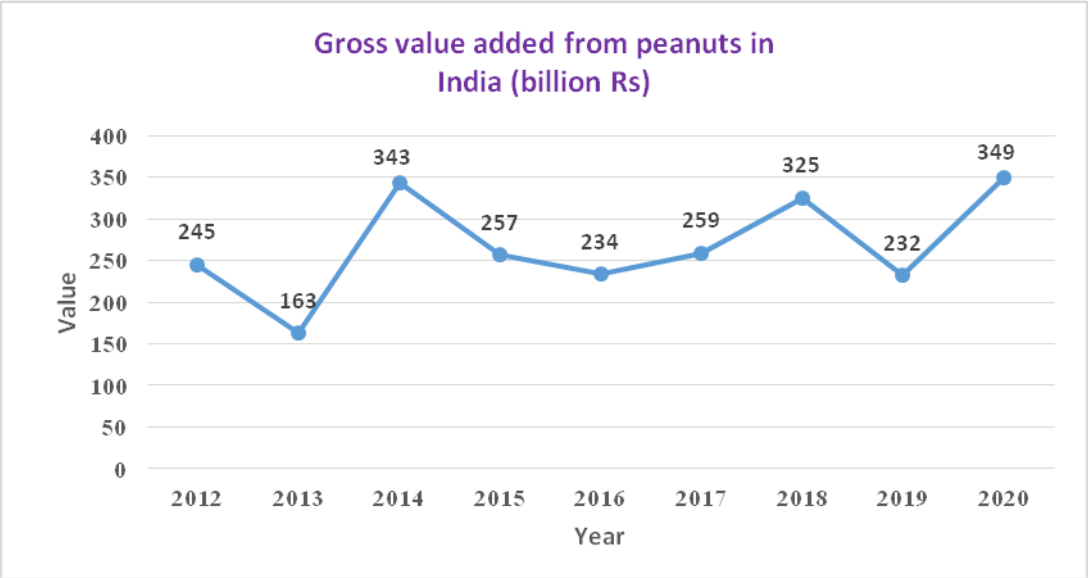

Fig. 1. Gross value added from peanuts
Source: www.statista.com

Area under groundnut is declining in major growing states and India with a maximum fall of 9.20% per annum found in Madhya Pradesh, this state accounts for on an average 23% of the total groundnut cultivated area in the country. Similarly, the other major groundnut growing states such as Gujarat, Andhra Pradesh, Maharashtra, Madhya Pradesh, Karnataka, Rajasthan also exhibited negative growth in area under groundnut cultivation recording a rate of 1.03%, 4.33%,7.06%,9.20%, 4.50% and 4.6% per annum for the period between 1992-93 and 2020-21 respectively (Table 1). The state of Gujarat, which constituted a maximum of 33% of the total cultivated under groundnut in the country in the early years, lost its share to 9% and the average share 13 % of the total groundnut area in the country due to a maximum rate of decline by 7% per annum. Similar pattern is also noticed in the states namely Andhra Pradesh (share declined from 13 to 10%), Madhya Pradesh (28% to 23%), Karnataka (12% to8%) and Rajasthan (20% to 16%). Overall, the area under groundnut in the country declined at the rate 4.51 % annum.

The productivity of groundnut was 2168 kg per hectare in irrigated areas compared to 1414 kg per hectare in rainfed areas with a gap of 754 kg, which is almost 50 per cent of the irrigated area yield [5]. Though the maximum productivity growth was 6.24% per annum in India, overall growth rate in yield was 2.28 % per annum due to yearly aberrations indicating the instability particularly in the rainfed production environments. Among the states, Rajasthan, Madya Pradesh and Tamil Nadu recorded higher growth rates in yield and yields grew at the rate of 3.84, 3.06 and 2.16% per annum respectively during the overall period (1992-93 and 2020-21), which are above than the national average rate of growth. Though the productivity growth were found higher in these states, there were production shortfalls and growth in groundnut productions fell by 0.94, 6.42 and 2.05% per annum, respectively (Table 2). Except Gujarat the other major states also exhibited negative growth in production and the rate of drop was higher in Uttara Pradesh (7.91%) followed by Madhya Pradesh (6.42%), Maharashtra (4.94%), Andhra Pradesh (3.69%) and Karnataka (3.03%). Groundnut production in India also fell by 2.13 % per annum mainly due to fall in area and marginal growth in productivity.

The average oilseeds yield of the country during 1995-96 to 1999-2000 were around 0.68 tonnes per ha far below the world average of 1.43 tonnes per ha and average of 1.63 tonnes per ha achieved in China during the same period [7]. There existed a realizable yield gap of about 7.5 quintal per hectare, which accounts for 94.58 per cent of the existing national average [3] due to poor adoption of modern technologies. It is found that the projected climate change will impact groundnut yields by 34 to 43 % across India. However, adaptation synergies showed promising in adverse climate conditions

(Kadialya et al 2021). Shortage of improved quality seeds, high cost of oilseeds, and the low priority accorded to oilseeds research and development resulted in a lackluster response from the farmers. If attempts are made to increase the yield of 10 traditional oilseeds, and those with high oil-recovery, by 20 per cent, the resultant increase in edible oil supplies will be at least 15 lakh tonnes. This increase will be sufficient to meet the growing demand.

The country imports about 15 to 18 lakh tonnes of edible oil each year to make up for the shortfall in the country [8]. Vegetable oil imports may touch 8 million tonnes in the oil year - Nov 2008-Oct 2009. During 1998-99 and 2006 -07 edible oil import have risen to more than $1.8 billion. This has raised Indian's dependence on import for edible oil close to 40% [9] and is causing adverse impact on domestic oilseed growers [10]. Liberalization of oilseed sector in 1994 and subsequent move of bringing the import of oilseeds under Open General License proved to have negative effect on the domestic oilseed economy [11]. The country's oilseeds output is expected to rise from 26.71 million tonnes in 2009-10 to around 27.53 million tonnes in 2011-2012, an increase of around 3 per cent. However, demand for oilseeds during the same period is expected to rise from 49.35 million tonnes in 2009-10 to around 53.39 million tonnes in 2011-2012, an increase of around 8 per cent. The gap between demand and supply of oilseeds is projected to increase from 12.64 million tonnes in 2009-10 to around 25.86 million tonnes in 2011-2012. Demand for edible oil in India is seen rising to 13.9 mt in 2004-2005 from 10.2 mt consumed in 1999-2000. This demand would go up to 19 mt by 2009-2010 [8].

3.1 The above estimates evidently reveal that every year the gap between the demand and supply of oilseeds is widening and signifies the importance of improving the productivity and production in the country

Productivity growth in the States of Tamil Nadu and Rajasthan and Madhya Pradesh were higher (Tables 3 through 5) compared to other states, while the areas were declining at faster rates leads to production fall. State of Rajasthan and Madhya Pradesh together shares more 40% of the country's production. Sustaining the productivity in these two states and improving the productivity in other major states by prioritizing and disseminating the seeds of suitable varieties and production technologies are vital as there is lackluster response from the farmers in adoption of varieties and technologies due to adaptability factor. The maximum productivity realized kg/ ha in Gujarat, Andhra Pradesh, Maharashtra, Madya Pradesh, Karnataka and Rajasthan were 2749, 1426, 1394, 1849 , 1180 2259 and the average productivity kg/ha in these states are 1400, 789, 953, 1049, 671 and 1170 signifying possibilities of reducing the yield gaps in these states for attaining higher production in the country. Studies show that there exists a tremendous potential for enhancing the yield of oilseed crops by adopting the technologies already available (Chowdary et al. 2017); [12]; (www.icrisat.org) and reduce the yield gap [13-16]. This contention is based on the results of 23,118 frontline demonstrations (FLDs) (2010-2015) conducted on nine oilseeds crops under real farm situations in different agro-ecological conditions of India over a period of five years. The productivity (yield) gap between improved technology and farmers' practices ranged from 21% in sesame to 149% in sunflower. Bridging yield gap across oilseeds can increase oilseeds production significantly that would concomitantly reduce the dependence on imports of vegetable oil besides realizing higher profitability to oilseed farmers (www.nfsm.gov.in).

(ii) Intervention's Effects – Oilseeds Mission

In the Budget 2022-23, the Government of India allocated a total of Rs. 1,500 crore (US$ 197 million) towards developing the oilseed industry. Out of this, Rs. 900 crore (US$ 118 million) have been allocated towards the edible oil palm programme and the rest Rs. 600 crore (US$ 79 million) have been allocated to the oilseed programme. During the last couple of years 2019-20 and 2020-21, the Government of India undertook several initiatives like Targeted Rice Fallow Area (TRFA) oilseeds, National Food Security Mission (NFSM) oilseeds and cluster demonstrations of improved technology to increase the oilseed production. The above initiatives resulted in highest oilseed production in the country. State-wise potential area and coverage of oilseeds under Oilseeds Mission up to March 2020 are set out in Table 6.

Table 1. Growth of area of ground nut in major states of India during the period between 1992-93 and 2021-22

State	Area – Average Share (%)	Area – share – Max (%)	Area – Share – Min (%)	CGR (%) – Area (ha)	Max decline/increase in area- CGR (%)
Gujarat	12.58	32.75	9.26	-1.03	-6.58
Andhra Pradesh	9.55	13.17	3.51	-4.33	-5.72
Maharashtra	12.23	16.57	4.68	-7.06	-49.28
Madhya Pradesh	22.78	28.45	3.82	-9.20	-36.07
Karnataka	8.16	11.62	4.88	-4.50	-6.36
Rajasthan	15.92	20.16	11.40	-4.60	-18.16
Tamil Nadu	3.07	6.31	1.46	-4.12	-4.83
West Bengal	2.42	3.04	1.29	-5.58	-38.29
Uttar Pradesh	4.95	6.76	1.38	-9.61	-11.16
Haryana	2.79	10.83	1.84	-0.22	-3.13
Orissa	1.40	3.94	0.73	-2.82	-4.53
India	100.00	-	-	-4.51	-16.53

Source: Authors estimation based on the data sourced at www.dacnet.nic.in

Table 2. Growth of production and yield of peanuts in major states of India during the period between 1997-98 and 2019-20

District	Production Share (Average %)	Production share (Max %)	Production Share (Min %)	CGR (%) -Production (tonnes)	Max decline/increase –Production CGR (%)	CGR (%) - Yield (t/ha)
Gujarat	15.87	38.41	7.31	0.90	-7.99	1.95
Andhra Pradesh	7.81	14.77	2.17	-3.69	-7.81	0.67
Maharashtra	11.75	16.44	3.78	-4.94	-40.30	0.84
Madhya Pradesh	22.86	30.69	4.86	-6.42	-42.89	3.06
Karnataka	5.25	8.79	2.41	-3.03	-3.38	1.45
Rajasthan	17.35	23.29	11.04	-0.94	-8.26	3.84
Tamil Nadu	5.04	9.51	1.89	-2.05	-30.40	2.16
West Bengal	2.35	3.39	0.56	-4.41	-29.79	1.58
Uttar Pradesh	4.20	6.62	1.02	-7.91	-10.01	1.87
Haryana	3.41	8.21	1.99	1.41	-35.10	0.20
Orissa	0.73	1.37	0.43	-1.77	-10.81	1.07
India	100.00	-	-	-2.13	-2.11	2.28 (6.24)

(Figures in parenthesis indicate max increase in CGR - %)

Source: Authors estimation based on the data sourced at www.dacnet.nic.in

Table 3. Classification of states based on the rate of growth of Area

Rate of growth (%)	No state	Name of the State
- < 1 to - 2	2	Gujarat, Haryana
-2 to -4	5	Orissa, Andhra Pradesh, Karnataka, Rajasthan, Tamil Nadu
-5 to -8	2	West Bengal, Maharashtra
-9 to -10	2	Uttar Pradesh, Madhya Pradesh
Total	**11**	**-**

Source: Authors estimation based on the data sourced classification from Table 1

Table 4. Classification of states based on the rate of growth of production

Rate of growth (%)	No of districts	Name of the State
- < 1 to - 2	2	Orissa, Rajasthan
-3 to -4	4	TN, AP, Maharashtra, Karnataka
- 4 to -6	2	Madhya Pradesh, West Bengal
- 7 to -8	1	Uttar Pradesh
< 1 to 2	2	Gujarat, Haryana
Total	**11**	**-**

Source: Authors estimation based on the data sourced classification from Table 2

Table 5. Classification of state based on the rate of growth of yield

Rate of growth (%)	No of state	Name of the State
< 1-1	3	AP, Maharashtra, Haryana
< 1-2	5	Gujarat, Karnataka, WB, UP, Orissa
2-4	2	TN, Rajasthan, MP
Total	**11**	**-**

Source: Authors estimation based on the data sourced classification from Table 2

Aims of National Mission on Edible Oils is to reduce our dependence on imported edible oil to 30-40 % consumption by 2026 from the current level of 65% by increasing the domestic production. Despite commendable performance of domestic oilseeds crops, it could not match with the galloping rate of per capita demand due to enhanced per capita consumption driven by increase in population and enhanced per capita income. Considering the growing domestic demand for edible oils, the staggering deficiency and the cost to the exchequer on account of imports, the urgency of scaling up the oilseeds production does not need over-emphasis. National Mission on Oilseeds and Oil palm (NMOOP) for Oilseeds & Oil palm development programme in this country was started in 2014-15 and continued up to 2017-18 and oil seeds was merged under revamped NFSM from the year 2018-19. The intervention comprises of three major components namely seed, production of inputs and transfer of technology. It aims to augment the availability of vegetable oils and to reduce the import of edible oils by increasing the production and productivity of oilseeds from an average production of 29.79 million tonnes and productivity of 1122 kg/ha during 12th plan period to 36.10 million tonnes and 1290 kg/ha, respectively by end of 2019-20.

Nearly 72% of the oilseeds area is restricted to rainfed farming done by small farmers which led to poor productivity. However, a breakthrough was realized in oilseed production through introducing latest crop production technologies. Consequently, the oilseed production grew to 365.65 tonnes in 2020-21 from 108.3 lakh tonnes in 1985-86. Average productivity of groundnut was 1396 kg/ha after the intervention (period between 2014-15 and 2020-21) and it was 946 kg /ha before intervention (period between 1992-93 and 2013-14). The estimated yield increase was 450 kg/ha, which higher by 48% after the intervention. The launch of Technology Mission on Oilseeds (TMO) showed an impressive growth in area, production and productivity of all oilseeds by 4.23%, 8.28% and 3.89%, respectively (Shraddha and Singh, 2017). The interrupted time series model furnished in the Table 7 and Fig. 2 reveal that the intervention (oilseeds mission) has a long-term impact and the estimated coefficient (50.36) was positive and significant at one per cent level of

Table 6. State-wise potential area and coverage of oilseeds under oilseeds mission up to March 2020

State	Area	No of Districts
Andhra Pradesh	531379	10
Gujarat	62361	14
Karnataka	72642	15
Odisha	34291	17
Tamil Nadu	95719	17
Madhya Pradesh	118079	29
Maharashtra	162210	28
Uttar Pradesh	48663	9
West Bengal	45463	9
Total	**1170807**	**148**

Source: National Mission on Edible Oils - Oil Palm operational guidelines report.

Table 7. Impact of oilseeds mission: Interrupted time series model results for India

	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
		β Coefficient	
Before Intervention (β_1)	54.18 (0.22)	392.92 (1.56) *	13.37* (1.69)
Immediate Effect (β_2)	6607.22** (1.94)	6458.20* (1.78)	-112.57 (-0.99)
Sustained Effect (β_3)	-1503.67 (-3.46) ***	-1080.52** (-2.33)	50.36*** (3.47)
Constant (β_0)	24968.62*** (10.00)	19349.84*** (7.29)	772.95*** (9.26)

*(Figures in parentheses are t ratios). * = P< 0.10, ** = P< 0.50 and *** = P< 0.01*
Source: Authors estimation based on the data sourced at www.dacnet.nic.in

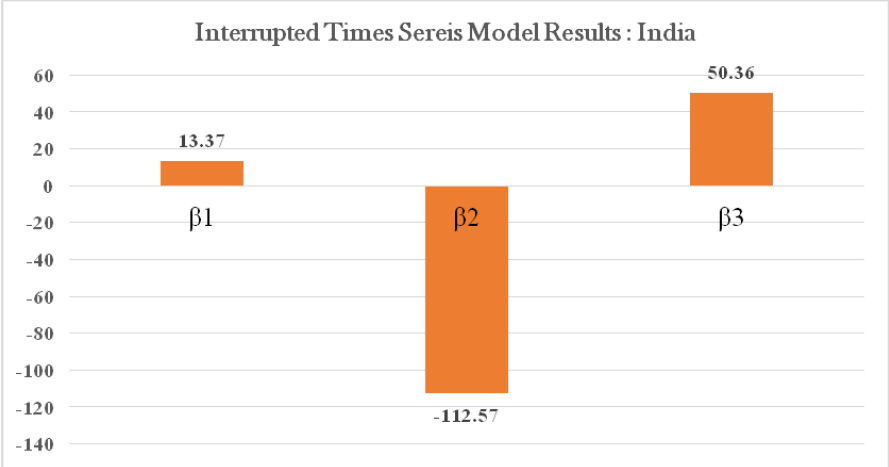

Fig. 2. Intervention's effects: Oilseeds mission in India

probability. The estimated coefficient value indicates that after the intervention the incremental productivity was 50 kg/ha.

The Gujarat is one of the largest producers of groundnut in the country and groundnuts are mainly grown in the districts of Amreli, Junagadh, Rajkot, Jamnagar, Bhavnagar and Sabarkantha, etc. The oilseed mission was implemented in all the districts. From the results of interrupted time series coefficients provided in the Table 8, it evident that though the intervention has not created short term effect in terms of improvement in yield of groundnut but in the long run the effect

Table 8. Impact of oilseeds mission: Interrupted time series model results for Gujarat

	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
	β Coefficient		
Before Intervention (β_1)	-0.64 (-0.04)	98.52 (1.25)	33.08 (1.48)
Immediate Effect (β_2)	166.40 (0.88)	-67.47 (-0.13)	-59.28 (-0.18)
Sustained Effect (β_3)	-63.27** (-2.63)	48.59 (0.58)	43.18 (1.05)
Constant (β_0)	2919.07*** (21.16)	2334.33** (2.82)	802.93** (3.41)

*(Figures in parentheses are t ratios). ** = P< 0.50 and *** = P< 0.01*
Source: Authors estimation based on the data sourced at www.dacnet.nic.in

is recognized. The estimated coefficient (β2) is negative, while β_3 is positive though not significant at the expected probability level signifying the long term impact of the mission on productivity improvement.

In Andhra Pradesh productivity of oilseeds particularly in case of groundnut is lesser than national average. Implementation of oilseeds mission in all the districts has aided the state to improve the productivity in the long run though there is no short run impact. The model results demonstrate that higher productivity growth was obtained in the long run and yield was increased by 38 kg per ha annually (Table 9). The long-term effect of intervention was observed in other major groundnut growing states like Maharashtra, Madhya Pradesh, Karnataka, Rajasthan and Tamil Nadu (Tables 10 through 14). The production of oilseeds in these states has been growing for the last five years. From the years 2015-16 to 2020-21, the compound annual growth rate (CAGR) of production higher in all these states though there are overall declining trends in production. This was achieved due to implementation of various programs like special programmes on during Rabi and cluster demonstrations of improved technology.

Table 9. Impact of oilseeds mission: Interrupted time series model results for Andhra Pradesh

	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
	β Coefficient		
Before Intervention (β_1)	-39.03 (-1.18)	-23.10 (-0.45)	2.91 (0.23)
Immediate Effect (β_2)	-670.52 (-1.41)	-1161.97* (-1.58)	-230.07 (-1.30)
Sustained Effect (β_3)	16.75 (0.27)	141.12 (1.50)	37.63* (1.66)
Constant (β_0)	3100.08*** (8.92)	2338.55*** (4.34)	739.58*** (5.69)

*(Figures in parentheses are t ratios). * = P< 0.10 and *** = P< 0.01*
Source: Authors estimation based on the data sourced at www.dacnet.nic.in

Table 10. Impact of oilseeds mission: Interrupted time series model results for Maharashtra

	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
	β Coefficient		
Before Intervention (β_1)	88.17 (1.95)	135.46** (2.62)	18.08 (1.59)
Immediate Effect (β_2)	1249.74* (1.93)	1341.95* (1.81)	93.28 (0.57)
Sustained Effect (β_3)	-329.73*** (-3.98)	-363.52*** (-3.83)	-29.63 (-1.42)
Constant (β_0)	2138.03*** (4.49)	1411.34** (2.59)	725.34*** (6.06)

*(Figures in parentheses are t ratios). * = P< 0.10, ** = P < 0.05 and *** = P< 0.01*
Source: Authors estimation based on the data sourced at www.dacnet.nic.in

Table 11. Impact of oilseeds mission: Interrupted Time series model results for Madhya Pradesh

	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
		β Coefficient	
Before Intervention (β_1)	38.20 (0.49)	98.47 (1.30)	10.71 (1.08)
Immediate Effect (β_2)	3131.49** (2.81)	3375.88*** (3.12)	-128.494 (-0.90)
Sustained Effect (β_3)	-525.63*** (-3.69)	-464.57*** (-3.36)	56.15*** (3.10)
Constant (β_0)	5398.43*** (6.60)	4248.50*** (5.35)	792.86*** (7.61)

*(Figures in parentheses are t ratios). ** = P < 0.05 and *** = P< 0.01*
Source: Authors estimation based on the data sourced at www.dacnet.nic.in

Table 12. Impact of oilseeds mission: Interrupted time series model results for Karnataka

	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
		β Coefficient	
Before Intervention (β_1)	-23.66 (-1.24)	-28.31** (-2.20)	-5.82 (-0.89)
Immediate Effect (β_2)	-339.93 (-1.24)	-100.51 (-0.54)	-24.72 (-0.26)
Sustained Effect (β_3)	-49.86 (-1.42)	4.38 (0.18)	41.78*** (3.51)
Constant (β_0)	2585.67*** (12.87)	1690.54*** (12.44)	657.29*** (9.61)

*(Figures in parentheses are t ratios). ** = P < 0.05 and *** = P< 0.01*
Source: Authors estimation based on the data sourced at www.dacnet.nic.in

Table 13. Impact of oilseeds mission: Interrupted time series model results for Rajasthan

	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
		β Coefficient	
Before Intervention β_1)	58.32 (1.04)	172.13** (2.79)	27.99** (2.92)
Immediate Effect (β_2)	1629.90** (2.03)	1288.38 (1.45)	-357.50** (-2.59)
Sustained Effect (β_3)	-338.83*** (-3.30)	-280.65** (-2.47)	82.88*** (4.70)
Constant (β_0)	3324.35*** (5.64)	2072.22*** (3.18)	673.85*** (6.65)

*(Figures in parentheses are t ratios) ** = P < 0.05 and *** = P< 0.01*
Source: Authors estimation based on the data sourced at www.dacnet.nic.in

Table 14. Impact of oilseeds mission: Interrupted time series model results for Tamil Nadu

	Area (000 ha)	Production (000 tonnes)	Yield (kg/ha)
		β Coefficient	
Before Intervention (β_1)	-48.80*** (-12.94)	-46.01*** (-3.17)	31.80** (2.15)
Immediate Effect (β_2)	-45.64 (-0.84)	7.45 (0.03)	235.07 (1.11)
Sustained Effect (β_3)	41.93*** (6.05)	48.77* (1.83)	37.27 (1.37)
Constant (β_0)	1336.21*** (33.55)	1715.68*** (11.21)	1193.07*** (7.67)

*(Figures in parentheses are t ratios) * = P< 0.10, ** = P < 0.05 and *** = P< 0.01*
Source: Authors estimation based on the data sourced at www.dacnet.nic.in

4. CONCLUSION AND IMPLICATIONS

The increase in production of oilseeds has been contributed mainly by increase in productivity of oilseeds. Though the maximum productivity growth was 6.24% per annum in India, overall growth rate in yield was 2.28 % per annum due to yearly aberrations indicating the instability particularly in the rainfed production environments. Among the states, Rajasthan, Madya Pradesh and Tamil Nadu recorded higher growth rates in yield and yields grew at the rate of 3.84, 3.06 and 2.16 % per annum respectively during the overall period (1992-93 and 2020-21), which are above than the national average rate of growth. Though the productivity growth were found higher in these states, there were production shortfalls and growth in groundnut productions fell by 0.94, 6.42 and 2.05 % per annum, respectively. Except Gujarat the other major states also exhibited negative growth in production and the rate of drop was higher in the Uttara Pradesh (7.91%) followed by Madhya Pradesh (6.42%), Maharashtra (4.94%), Andhra Pradesh (3.69%) and Karnataka (3.03%). Groundnut production in India also fell by 2.13 % per annum mainly due to fall in area and marginal growth in productivity. Productivity growth in the States of Tamil Nadu and Rajasthan and Madhya Pradesh were higher compared to other states, while the areas were declining at faster rates leads to production fall and these state together shares close to 50% of the country's production.

The estimated yield increase was 450 kg/ha, which higher by 48 % after the intervention in India. The interrupted time series model for India reveal that the intervention (oilseeds mission) has a long-term impact. It is evident that though the intervention has not created short term effect in terms of improvement in yield of groundnut but in the long run the effect is recognized in most of the states. In the case of oilseeds more than 300 modern varieties and hybrids crops have been released to the farmers but their adoption rates are poor due their cultivation on rainfed areas, which are endowed with poor resources. Sustaining and improving the productivity in the major states by identifying the production and marketing constraints and prioritizing and disseminating the seeds of suitable varieties and production technologies are vital as there is lackluster response from the farmers in adoption of varieties and technologies due to adaptability factor. The failure to achieve higher yields in oilseeds cultivation is one of the most obvious reasons for the widening gap between domestic production of vegetable oils and demand. If attempts are made to increase the yield the resultant increase in edible oil supplies will be more. The production of oilseeds in the country has, therefore, to be increased to enable reduction in import of vegetable oils.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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