Performance of oilseeds in India - a temporal analysis

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ABSTRACT

The present paper explores the performance of total oilseeds in India, using times series data, collected from 1949-50 to 2014-15. Nine annual oilseeds, which include seven edible oilseeds, *viz.,* groundnut, rapeseed-mustard, soybean, sunflower, sesame, safflower and niger along with two non-edible crops, *viz.,* castor and linseed are grown in the country, constitutes total oilseeds in the study. The total period from 1949-50 to 2014-15 was divided into four sub-periods i.e. period I, II, III and IV. An attempt was made to analyze the trends, Compound Annual Growth Rate (CAGR), decomposition analysis, instability analysis in the area, production, yield of total oilseeds. After analysis of the performance of oilseeds, it was concluded that there was a noteworthy performance in yield aspect of total oilseeds at the national level. Though there was an upward and significant growth in terms of the area, production and yield of total oilseeds over the study period, it was sluggish. There exists a gap between domestic demand and supply of oilseeds, which obligates us to import edible oils. The government has to implicate technological breakthroughs and enhance the productivity of oilseeds to offset the gap between production and consumption of oilseeds.

Keywords: CAGR, Decomposition analysis, Instability analysis, Oilseeds, Trends

India occupies a prominent place in global oilseeds scenario with 12-15 per cent of the area, 6-7 per cent of vegetable oil production and 9-10 per cent of the total edible oil consumption and 13.6 per cent of vegetable oil imports (FAO, 2014). Nine annual oilseeds, which include seven edible oilseeds *viz.,* groundnut, rapeseed-mustard, soybean, sunflower, sesame, safflower and niger along with two non-edible crops *viz*., castor and linseed are grown in the country, constitutes total oilseeds. In the case of major oilseeds, India ranks first in the production of groundnut, third in rapeseed-mustard and fifth in soybean (Sarada *et al.,* 2015). The country has achieved self-sufficiency in food grains production, in fact, it has become surplus in rice and wheat with mounting food stocks, but it is facing serious shortages of oilseeds (Govindaraj *et al.,* 2016). Although India is the 4th largest edible oil economy in the world and contributes about 10 per cent of the world oilseeds production, 6-7 per cent of the global production of vegetable oil and nearly 7 per cent of protein meal, India is one of the largest importers of edible oils in the world. Despite having the largest area under oilseeds in the world, India currently imports about 58 per cent of total oil requirement (12 million tonnes) at an exchequer of ₹ 68,000 crores (2014-15) (SEAI, 2016). Several studies were conducted in India quoting the performance of oilseeds. Swain (2007) studied the trends and variability in the growth of oilseeds production in Rajasthan. The study concluded that production of most of the oilseeds has increased mainly due to the area expansion. Thus he suggested that the level of oilseeds production can be increased in future only by increasing the yield rather than the area under oilseeds in Rajasthan. Rao *et al.* (2012) studied the performance of safflower in India using trend analysis, compound annual growth rates, instability analysis and decomposition analysis. They divided the study period into three based on inception of AICRP on safflower, TMO and trade liberalization and portrayed the scenario of safflower during these periods. Rambabu *et al*. (2014) examined the trends in the area, production, productivity of groundnut in Andhra Pradesh over a period of 1995-96 to 2010-2011. The specific objectives of the present study are to study the trends, Compound Annual Growth Rates (CAGR) in area, production and productivity of total oilseeds in India, to examine the effect of area, productivity and interaction on total oilseeds production and to estimate the instability analysis of total oilseeds.

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MATERIALS AND METHODS

The present study utilizes the time series data on area, production and productivity of total oilseeds, that was collected from various publications, *viz*., Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, Agricultural Statistics at a glance and Bureau of Economics and Statistics of Andhra Pradesh state. The total period from 1949-50 to 2014-15 was divided into four sub-periods.

Period-I	Before inception of AICRP on Oilseeds	1949-50 to 1965-66
Period-II	Establishment of AICRP on Oilseeds to the Genesis of Technology Mission on Oilseeds (TMO)	1966-67 to 1985-86
Period-III	TMO initiation to liberalization	1986-87 to 1999-2000
Period-IV	Post liberalization	2000-01 to 2014-15

Estimation of Compound Growth Rates (CGR): In order to estimate the CGR, the exponential time trend equation of the form:

$Y=a\ b^t$ ----------(1)
was used
It becomes linear when converted to log form, i.e.,
$\text{Ln } Y=\text{Ln } a + t \text{ Ln } b_1$ where---------- (2)
Y: Variable whose growth rate is being computed
t: Time trend (1, 2…n)
a and b are regression coefficients to be estimated.

This form implies a constant growth rate over time. There will be a constant deceleration if $b < 0$. A value of $b=0$ indicates absence of any trend and a positive value for b indicates a constantly accelerating growth.

Using the compounding formula,

$Y_t=Y_0 (1+r)^t$ ---------- (3a)
or
$\text{Ln } Y_t=\text{Ln } Y_0 + t \text{ Ln } (1+r)$ ---------- (3b)
or
$\text{Ln } Y_t=A + tb$ where ---------- (3c)
$A = \text{Ln } Y_0$ and $B = \text{Ln } (1+r)$---------- (4)

This equation is the log linear form of the exponential function and gives CGR when differentiated with respect to t as follows:

$1/Y_t.dY_t/dt = \text{Ln}(1+r)$ ---------- (5)
$e^B = 1 + r$ ---------- (6)
$r = e^B - 1$ ---------- (7)

Thus the CGR (per cent) is given by $(e^B - 1) \times 100$
In this study, Y represents the area or production or productivity of the crops.

Estimating the effect of area, productivity and interaction on total oilseeds production: The following procedure was adopted to estimate the effect of area, productivity and their interaction on the production of total oilseeds:

$P_o= A_o* Y_o$
$P_n= Y_o* Y_n$
$P= P_n - P_o$ (Change in production)
A_o=Area in the base year
A_n=Area in the current year
Y_o=Yield in the base year
Y_n=Yield in the current year
ΔA=Change in Area (A_n-A_o)
ΔY=Change in Yield (Y_n-Y_o)

Finally,

$$P = P_n - P_o = \underbrace{A_o*\Delta Y}_{\text{Yield effect}} + \underbrace{Y_o*\Delta A}_{\text{Area effect}} + \underbrace{\Delta A*\Delta Y}_{\text{Interaction effect}}$$

The change in production when more pronounced through yield effect indicates that the productivity has contributed to the production.

In the present study, the estimation of the effect of area, productivity and their interaction on the production of total oilseeds was worked for the four respective periods as mentioned earlier. The triennium averages of the respective base and current years were considered for the estimation to minimize and/or eliminate the biases since the majority of total oilseeds is chiefly confined to cultivation under rainfed situations.

Instability analysis: Linear trend was fitted to the original data of the area, production and productivity of total oilseeds, for the study period. The trend coefficients were tested for their significance. Whenever the trend of series found to be significant; the variation around the trend rather than the variation around mean was used as an index of instability. The formula suggested by Cuddy and Della (1978) was used to compute the degree of variation around the trend. That is Co-efficient of variation was multiplied by the square root of the difference between the unity and coefficient of multiple determinations (R^2) in the cases where R^2 was significant to obtain the Instability Index.

RESULTS AND DISCUSSION

Trends in the area, production and yield of total oilseeds: Area, production and yield details of total oilseeds from the period I to period IV were furnished in Tables 1 to 4.

From the Table 1, it was observed that, there was an increasing trend in both area and production with minor fluctuations, while, the trend of yield component was increasing with lower fluctuations, in period I.

In period II, as portrayed in Table 2, area, production and yield of total oilseeds registered similar increasing trend with greater fluctuations in production component when compared to the period I.

In period III, area, production and yield of total oilseeds recorded an increasing trend with slight decreasing

fluctuations in 1989-99 and 1999-2000 (Table 3). In period IV, all the three components recorded a highly fluctuating upward trend (Table 4).

Table 1 Trend in area, production and yield of total oilseeds in India over the Period-I (from 1949-50 to 1965-66)

Years	Area ('000 ha)	Production ('000 tonnes)	Yield (kg/ha)
Period-I			
1949-50	10070	5260	522
1950-51	10730	5130	478
1951-52	11690	5030	430
1952-53	11180	4730	423
1953-54	10990	5370	489
1954-55	12520	6400	511
1955-56	12020	5650	470
1956-57	12490	6360	509
1957-58	12660	6350	502
1958-59	13000	7300	562
1959-60	13950	6560	470
1960-61	13770	6980	507
1961-62	14770	7280	493
1962-63	15340	7390	482
1963-64	14820	7130	481
1964-65	15260	8560	561
1965-66	15910	6510	409

Table 2 Trend in area, production and yield of total oilseeds in India over the Period-II (from 1966-67 to 1985-86)

Years	Area ('000 ha)	Production ('000 tonnes)	Yield (kg/ha)
Period-II			
1966-67	15000	6430	429
1967-68	15670	8300	530
1968-69	14470	6850	473
1969-70	14810	7330	495
1970-71	16640	9630	579
1971-72	17270	9080	526
1972-73	15790	7140	452
1973-74	16900	9390	556
1974-75	17310	9150	529
1975-76	16920	10610	627
1976-77	16470	8430	512
1977-78	17170	9660	563
1978-79	17710	10100	570
1979-80	16940	8740	516
1980-81	17600	9370	532
1981-82	18910	12080	639
1982-83	17760	10000	563
1983-84	18690	12690	679
1984-85	18920	12950	684
1985-86	19020	10830	569

Compound Annual Growth Rates (CAGR) of area, production and yield of total oilseeds: The CAGR of the area, production and yield of total oilseeds in period I to period IV were worked out and presented in Table 5.

Table 3 Trend in area, production and yield of total oilseeds in India over the Period-III (from 1986-87 to 1999-2000)

Years	Area ('000 ha)	Production ('000 tonnes)	Yield (kg/ha)
Period-III			
1986-87	18630	11270	605
1987-88	20130	12650	628
1988-89	21900	18030	823
1989-90	22800	16920	742
1990-91	24150	18610	771
1991-92	25890	18600	718
1992-93	25240	20110	797
1993-94	26900	21600	803
1994-95	25300	21420	847
1995-96	25960	22110	852
1996-97	26340	24390	926
1997-98	26120	21320	816
1998-99	26230	24750	944
1999-00	24280	20720	853

Table 4 Trend in area, production and yield of total oilseeds in India over the Period-IV (from 2000-01 to 2014-15)

Years	Area ('000 ha)	Production ('000 tonnes)	Yield (kg/ha)
Period-IV			
2000-01	22770	18400	808
2001-02	22640	20660	913
2002-03	21150	14840	702
2003-04	23670	25190	1064
2004-05	27520	24350	885
2005-06	27860	27980	1004
2006-07	26510	24290	916
2007-08	26690	29760	1115
2008-09	27600	27700	1006
2009-10	25959	24882	958
2010-11	27224	32479	1193
2011-12	26308	29799	1133
2012-13	26484	30940	1168
2013-14	28051	32749	1168
2014-15	25596.2	27510.8	1075

Table 5 Comparison of Compound Annual Growth Rates (CAGR) of area, production and yield of total oilseeds in India over the Period-I to Period-IV

Particulars	CAGR (%)		
	Area	Production	Yield
Period-I	2.71	2.86	0.14^{NS}
Period-II	1.22	2.68	1.44
Period-III	2.06	4.66	2.54
Period-IV	1.26	3.89	2.59

Note: All are significant at 1 per cent, except the yield in period-I

In the period I, production recorded the highest growth rate of 2.86 per cent, followed by area (2.71 %) and yield (0.14 %). The growth rate of yield was to be non-significant. In period II, production registered the highest growth rate of 2.68 per cent, followed by yield (1.44 %) and area (1.22 %). When compared to the period I, it was observed that growth rates of both production and area have declined, while the growth rate in yield was increased. In period III, highest growth rates were observed in production (4.66 %), followed by yield (2.54 %) and area (2.06 %). When compared to period II, growth rates of all the three components was increased. In period IV, production registered the highest growth rate of 3.89 per cent, while it was followed by growth rates of yield (2.59 %) and area (1.26 %). It was conspicuous that there was significant raise CAGR of yield component from 0.148 per cent in period I to 2.59 per cent in period IV. The results of the growth rates inferred that government policies and programmes like AICRP on Oilseeds, Technology Mission on Oilseeds, liberalization showed a positive and significant impact on the productivity of total oilseeds.

Effect of the area, productivity and interaction on total oilseeds production: The contribution of area and productivity to the total production of total oilseeds were analyzed using decomposition analysis and presented in Table 6.

It was evident from the result that, the production of oilseeds was influenced by the yield effect, which was 58.69, 50.41 and 44.74 per cent in period IV, period II and period III, respectively. Contrary to that, in period I, production of oilseeds was influenced by the area effect, with 95.24 per cent.

In the period I, production was chiefly contributed by area effect. However, a meager contribution of 3.37 per cent is only contributed by yield effect. This inferred that the production of total oilseeds was stunted due to the restriction of total oil oilseeds cultivation to marginal lands coupled with poor management practices and incidence of pests and diseases. Lower contribution of yield effect concluded that the technology has not made any positive impact on the total oilseeds production during this period. In period II, total oilseeds production was contributed majorly (50.41 %) by yield effect, while 36.75 per cent of contribution was made by area effect. This inferred that AICRP on Oilseeds enhanced total oilseeds production through technology implications. In period III, the production of total oilseeds was influenced majorly (44.74%) by yield effect, while the area effect also contributed to 43.48 per cent. This scenario gives a clear indication that due to trade liberalization there was the almost equal contribution of both area and yield effect. In period IV, it was observed that yield effect was more pronounced than area effect in contribution to total oilseeds production, which reflected a positive impact of technologies and trade liberalization on total oilseeds production.

Instability in the area, production and yield of total oilseeds: The details pertaining to the instability of total oilseeds was estimated for area, production and yield components and were presented in Table 7.

A perusal of Table 7, showed that in period I, the area was stable, when compared to production and yield components. High level of instability was observed in yield component, with an instability index of 1.00. Period II also registered similar instability scenario, with the stable area, followed by relatively unstable production and highly unstable yield, with an instability index of 0.72. It was also noticed that, though instability in the area, production components was increased from the period I to period IV, there was a decline in instability from the period I to period II with respective to yield component. In period III, production component was stable, when compared to area and yield components. Highest instability was noticed in the area (instability index of 0.64), which is followed by yield (instability index of 0.57). It was also observed that there was an increase of instability in area and production, a decline of instability in yield component when compared to period II. In period IV, area registered highest instability (instability index of 0.77), followed by yield and production, with instability indices of 0.65 and 0.63, when compared to period III, there was an increase of instability in all the three components *viz*., area, production, and yield. At a glance, over the study period from the period I to IV, it was noticed that, though there were fluctuations in instability of all three components, there was a continuous increasing trend in instability of area, while it was in declining in yield component.

Table 6 Decomposition analysis of area, production and yield of total oilseeds in India over the Period I to Period IV

	Yield effect	Area effect	Interaction effect
Period-I	3.37	95.24	1.40
Period-II	50.41	36.75	12.83
Period-III	44.74	43.48	11.78
Period-IV	58.69	29.35	11.97

Table 7 Instability analysis of area, production and yield of total oilseeds in India over the Period-I to Period-IV

Particulars	Area	Production	Yield
Period-I			
Mean	13010.00	6352.35	488.18
Standard Deviation	1791.70	1039.96	41.96
Coefficient of Variation	13.77	16.37	8.60
R^2	0.95	0.75	0.01
Instability Index	0.22	0.50	1.00
Period-II			
Mean	16998.50	9438.00	551.15
Standard Deviation	1352.80	1814.10	68.03
Coefficient of Variation	7.96	19.22	12.34
R^2	0.79	0.65	0.47
Instability Index	0.45	0.59	0.72
Period-III			
Mean	24276.43	19464.29	794.64
Standard Deviation	2522.04	3888.97	97.38
Coefficient of Variation	10.39	19.98	12.25
R^2	0.60	0.71	0.67
Instability Index	0.64	0.54	0.57
Period-IV			
Mean	25735.48	26101.99	1007.19
Standard Deviation	2152.89	5125.64	143.64
Coefficient of Variation	8.37	19.64	14.26
R^2	0.41	0.60	0.58
Instability Index	0.77	0.63	0.65

Conclusions and policy implications: In period I, before the inception of AICRP on oilseeds, the performance of total oilseeds at the national level was satisfactory, except in the yield component. There was a scope of enhancing the yield of total oilseeds, which emphasized the inception of AICRP on Oilseeds. In period II, after the inception of AICRP on Oilseeds, the growth rates of yield component of total oilseeds at national level enhanced, which inferred a positive impact of oilseeds at the national level. In period III, Genesis of TMO had almost doubled the growth rates of production component and a significant rise in yield performance was also noticed. This scenario explained the appreciable impact of TMO on the overall performance of total oilseeds. In period IV, post liberalization period brought a decline in performance of area and production components. However, yield performance was increased, when compared to previous periods.

After analysis of the performance of oilseeds, it was concluded that there was a noteworthy performance in yield aspect of total oilseeds at the national level. Though there was an upward and significant growth in terms of area, production and yield of total oilseeds in India, it was sluggish. There exist a gap between domestic demand and supply of oilseeds (Jha *et al.,* 2012), which obligates us to

import edible oils. It can be suggested that government has to intervene and enhance the productivity of oilseeds to offset the gap between production and consumption of oilseeds by adopting proper strategies, technological breakthroughs should be implicated in order to improve the yield of total oilseeds on par with total food grains, socio-economic impact assessment studies, supply chain management studies, value chain analysis studies should be conducted from agricultural economics perspective, oilseeds farming and appropriate measures should be adopted to aid in coordinated researches and care should be taken on value addition which enhances the revenue from oilseeds.

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