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Research Paper

Trends in Production of Pulses and Oilseeds Over Last Two Decades in Eastern India

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ABSTRACT

India is a major producer and consumer of a wide variety of pulses and oilseeds but still struggles to achieve self-sufficiency due to the growing disparity between demand and supply. The present study has made an attempt to compare and disseminate trends in acreage, production, and productivity of pulses and oilseeds over the last two decades (1999-2000 to 2018-2019). Regarding the computation of growth and instability, a modified exponential production function is fitted, and to judge the overall change in production, a decomposition of the trend in area and yield over two decades has been performed. Bihar and West Bengal stand out as the primary producers of pulses, while rapeseed and mustard take the lead among oilseed crops, followed by sesame. Odisha uniquely contributes to groundnut production, while linseed has become integral to West Bengal's overall oilseeds output. To enhance production in these states, implementing HYV seeds, proper land preparation techniques, and adopting *paira* cropping in rice-fallow situations can significantly boost the current status of pulses and oilseeds in the eastern India.

HIGHLIGHTS

- Growth rates in production were unsatisfactory up to previous decade although a notable improvement has been observed in the subsequent decade.
- The change in mean production was primarily influenced by acreage for pulses and yield for oilseeds in all major states of eastern India except Odisha.

Keywords: Trend, growth rate, instability, decomposition, pulses and oilseeds

Pulses and oilseeds hold immense significance in Indian agriculture due to their nutritional content, which is essential for the human diet. Pulses serve as a primary protein source, yet they lack certain essential amino acids like methionine, tryptophan and cystine (Tiwari & Singh, 2012). Besides, oilseeds are an abundant energy source (9 KCL/g) offering double the energy content of carbohydrate or protein (4 KCL/g). India, contributing 25% of the world's pulses output with per capita availability (55.9 gram/day) surpassing the ICMR recommendation (52 gram/day) (Anonymous, 2021). Moreover, India is the largest global producer of oilseeds accounting for over 20% of the world's area and 10% of its production (IBEF, 2023). Despite being a prominent producer of oilseeds and pulses globally, India has grappled with a supply-demand disparity for both edible oils and pulses since the mid-seventies due to the persistent increase in the population. The projections indicate a shortfall of 114.50 lakh tonnes of Gram and 365.60 lakh tonnes of Tur during 2030 (Jadhav *et al*. 2018). Subsequently, India is heavily dependent on imports to meet its edible oil

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requirements and is the largest importer of vegetable oils in the world (15% share) (Anonymous, 2018).

The Government of India has taken proactive measures in recent years to boost pulses and oilseeds production, aiming to reduce the reliance on imports (Anonymous, 2023). Initiatives like the National Food Security Mission (NFSM) have yielded a positive and significant impact by providing nutritional security to the nation (Patel *et al.* 2020). To fulfil the National interest, the National Mission on Edible Oils - Oil Palm (NMEO-OP) directed to enhance edible oilseeds production and availability in the country.

Eastern India occupies 22.5% of the country's geographical area and accommodates 33.64% of the total population (Singh *et al*. 2012). This densely populated area comprises rural communities and about 69% of farmers are categorized as marginal (Chand, 2009) due to small and fragmented landholdings which hampers the adoption of advanced technology as well. Despite its natural resource abundance, the region primarily focuses on food grain production and literally leaves minimal space for non-food crops. Pulses and oilseeds hold considerable importance in the daily diet of Eastern India's residents, serving as affordable sources of proteins and unsaturated fats. Incorporating pulses and oilseeds into the rice-based cropping system prevalent in this region could contribute to enhancing soil fertility and overall crop productivity as well.

In view of the above, an in-depth study has been conducted on production of major pulses and oilseeds for the last two decades in order to examine the overall status of these crops across the eastern states of India. Accordingly, an effort has been made to compute the decadal growth and instability in area, production and productivity of major pulses from 1999-00 to 2018-19 in order to evaluate the causes of production change through area-yield decomposition method.

MATERIALS AND METHODS

The major pulses and oilseeds were taken into consideration for each state of eastern India subject to availability of data. The crops selected for the entire study has been illustrated in Table 1.

The study has been segregated into three specific objectives. The first objective involves determining the exponential growth rate which is calculated using the exponential functional form with following identity.

$$Y = ae^{bt}$$

Where the dependent Y-value is a function of the independent time t and b is the slope and a is the intercept.

The growth rate is computed with the following formula:

$$Growth\ rate\ (\%) = (antilog\ (b) - 1) \times 100$$

Similarly, Coefficient of Variation (C.V.) is deflected by the following expression to measure instability and compare it between trended and de-trended variables as used by Cuddy and Della Valle.

$$I_x = CV\left(\sqrt{1-\overline{R^2}}\right)$$

Where I_x refers to the instability measures CV determines coefficient of variation and $\sqrt{\left(1-\overline{R}^2\right)}$ = the unexplained proportion of the trend line serving as weights.

Table 1: Selection of major pulses and oilseeds from four major states of Eastern India

States	Pulses	Oilseeds
Assam	Urad, Peas and Beans, Moong, Lentil, Arhar, Gram	Rapeseeds and Mustard, Sesame, Linseeds
Bihar	Gram, Urad, Moong, Arhar, Lentil, Horse gram, Peas and Beans	Rapeseeds and Mustard, Sesame, Linseeds, Groundnut, Sunflower
Odisha	Urad, Moong, Horse gram	Rapeseeds and Mustard, Sesame, Groundnut
West Bengal	Urad, Gram, Moong, Arhar, Lentil, Horse gram, Peas and Beans	Rapeseeds and Mustard, Sesame, Linseeds, Soyabean, Groundnut, Sunflower, Safflower

where $\bar{R}^2$ = Adjusted R-square = $1-\left(1-R^2\right)\frac{n-1}{n-k}$

R^2 is Multiple coefficients of determination, n is total number of observations and k is number of parameters.

Focusing on the second objective i.e.; components of change in average production are made by using the Decomposition Method of analysis as used by Peter B.R. Hazell. Accordingly, average production E(Q) is expressed as:

$$E(Q) = \hat{A}.\hat{Y} + Cov(A,Y) \quad \ldots(1)$$

where Q denotes production and $\hat{A}$ & $\hat{Y}$ denote mean areas and yields.

Average production is affected by changes in covariance between area & mean yield and by changes in mean area and mean yield.

The objective of the decomposition analysis is to partition the changes in E(Q) into constituent parts, which can be attributed separately to change in the means and co-variances of areas and yields.

Using equation (1), average production in the first period is:

$$E(Q_1) = \hat{A}_1.\hat{Y}_1 + Cov(A_1,Y_1) \quad \ldots(2) \text{ and}$$

In the second period, it is:

$$E(Q_{11}) = \hat{A}_{11}.\hat{Y}_{11} + Cov(A_{11},Y_{11}) \quad \ldots(3)$$

Each variable in the second period can be expressed as its counter parts in the first plus the change in the variable between the two.

Therefore,

$$E(Q_{11}) = (\hat{A}_1 + \Delta\hat{A})(\hat{Y}_{11} + \Delta\hat{Y}) + Cov(A_1, Y_1) + \Delta Cov(A, Y)$$

$$\Delta E(Q) = E(Q_{11}) - E(Q_1) = \hat{A}_1.\Delta\hat{Y} + \hat{Y}_1.\Delta\hat{A} + \Delta\hat{A}.\Delta\hat{Y} + \Delta Cov(A, Y)$$

Thus, total change in average production between the two periods is partitioned into four components. Table 2 portrays the components of change in average production.

Table 2: Components of change in average production

Source of Change		
Description	**Symbols**	**Components of Change**
Change in Mean Yield	$\Delta\hat{Y}$	$\hat{A}_1.\Delta\hat{Y}$
Change in Mean Area	$\Delta\hat{A}$	$\hat{Y}_1.\Delta\hat{A}$
Interaction between changes in Mean Area & Mean Yield	$\Delta\hat{A}, \Delta\hat{Y}$	$\Delta\hat{A}.\Delta\hat{Y}$
Change in Area-Yield Covariance	Δ Cov (A, Y)	ΔCov (A, Y)

RESULTS AND DISCUSSION

The contemporary scenario of pulses and oilseeds grown in eastern India has been examined by evaluating the change (%) and exponential growth rate in mean acreage, production and yield over the last two decades. The first decade (1999-00 to 2008-09) and the second decade (2009-10 to 2018-19) have been considered as period I and period II respectively. It is found that the four major eastern states of India cumulatively share only 7.24% acreage under total pulses. Assam is emerging as a significant contributor to *urad* followed by Peas and beans. Bihar and West Bengal are recognized as the major pulse belts in the region where lentil has emerged as the primary pulse in both states. Bihar showcases a consistent trend of acreage and production reduction, despite productivity gains. Odisha, although less prominent in pulse production, notably focuses on *moong* and *urad* cultivation. Regarding oilseeds, eastern states only contribute 5.45% to the overall oilseed acreage. Among all the oilseeds grown in the east, Rapeseed and mustard hold the majority share, followed by sesame. Rapeseed and Mustard dominate oilseed cultivation in West Bengal, Assam and Bihar while Odisha takes the lead in groundnut production. A notable observation lies in the increasing acreage under linseed in West Bengal. The results depicted in Table 3 reveal a diverse and varied scenario in pulses and oilseeds cultivation strategies and outcomes across the eastern region of India.

In the context of exponential growth rates as well as instability of major pulses and oilseeds grown in India for the last two decades, a significant growth with stability has been recorded for total pulses while there is a fluctuation in acreage under oilseeds with a steady significant change in production and

productivity. Regarding the status of total pulses, Assam, Bihar and Odisha have shown significant change in acreage, production and yield with more than 80% stability.

Table 3: State-wise decadal change (%) in mean area production and yield of pulses and oilseeds in Eastern India

State	Crops	Mean Area (%)	Mean Production (%)	Mean Productivity (%)
Assam	Total Pulses	25.38	53.32	21.06
	Total Oilseeds	4.59	28.09	21.88
Bihar	Total Pulses	-22.05	-9.07	17.56
	Total Oilseeds	-17.78	3.27	25.41
Odisha	Total Pulses	11.79	41.24	27.95
	Total Oilseeds	-30.19	-10.45	29.52
West Bengal	Total Pulses	21.94	44.21	17.70
	Total Oilseeds	21.54	53.53	26.06
Eastern States	Total Pulses	0.90	17.17	16.14
	Total Oilseeds	2.25	33.43	30.45
INDIA	Total Pulses	17.25	43.32	21.85
	Total Oilseeds	4.07	27.33	23.28

However, West Bengal has shown fluctuations in acreage under pulses with significant change in production and productivity, as well as moderate stability. Coming to the scenario under oilseeds, West Bengal has only shown a steady significant change in area production and yield. Acreage fluctuations have been recorded in Assam. Fluctuations in production of oilseeds have been registered in Bihar and Odisha with a steady significant change in productivity.

In order to compare the change in growth rates of pulses and oilseeds between two decades (1999-00 to 2008-09 and 2009-10 to 2018-19), a positive change in area production and yield of total pulses over the previous decade was observed in India, whereas in the case of oilseeds, a retarding growth was observed in between the decade for oilseeds in India. West Bengal has shown a significantly drastic fall in area and production for the first decade (-4.38% and -4.74% respectively) whereas a galloping jump in acreage and production in the second decade (11.30% and 12.62% respectively) has led to a spectacular increase in total scenario of pulses over the decade. Barring Odisha, Assam and Bihar, both states have registered positive change in growth rates of area, production and productivity between the decades. In regard to the change in growth rates for oilseeds, Assam and West Bengal have shown acceleration in acreage, production and yield as well in between the decades, but unfortunately, it is retarding for Bihar and Odisha. Much retardation in growth rates of acreage production and productivity of pulses and oilseeds have been registered for Odisha. It is very alarming for the pulses and oilseeds growers in eastern India as they go for short-duration cash crops like vegetables for betterment of their livelihood (Table 4). The scenario of pulses and oilseeds acreage cover over the last two decades is illustrated in Fig. 1.

Looking at the all-India results of total pulses, there is a massive change (43.32%) in production, and it is due to the simultaneous impact of change in yield (50.34%) and acreage (39.74%). The interaction effect between acreage and yield was found to be very small (8.68%) with a covariance of 1.24%. However, the results exhibit a dismal picture for the eastern states as well, where change in production is mainly responsible for acreage expansion in Assam, Bihar and West Bengal (47.59%, 242.00% and 49.52% respectively). Bihar has shown a significantly huge negative impact (-192.69%) of yield on production change which is well surpassed by acreage expansion. So, there is ample scope and opportunity to expand and convert rice-fallow land into pulse cultivation.

As per the oilseed production in India, a similar scenario was observed where change in production (27.33%) over two decades is fully governed by the yield component (84.61%) and not by acreage expansion (14.80%) (Singh *et al*. 2018). The interaction effect has shown a very little impact (3.45%) on production with a covariance of -2.86%. Barring Odisha, a similar trend was observed for all the eastern states where the yield component dominates over acreage expansion for

Table 4: State-wise growth in area, production and yield of major pulses and oilseeds in eastern India (1999-00 to 2018-19)

State	Crops	Entire Period			Period I			Period II		
		Area Growth (%)	Production Growth (%)	Yield Growth (%)	Area Growth (%)	Production Growth (%)	Yield Growth (%)	Area Growth (%)	Production Growth (%)	Yield Growth (%)
Assam	Total Pulses	1.98**	3.94**	1.92**	-0.59 NS	-0.45 NS	0.14 NS	2.96**	7.30**	4.21**
		(10.13)	(22.00)	(14.21)	(4.47)	(5.48)	(1.97)	(10.48)	(22.70)	(14.08)
	Total Oilseeds	0.24NS	2.11**	1.87**	-2.70**	-1.95NS	0.77NS	1.88**	4.20*	2.28**
		(5.78)	(13.70)	(12.56)	(8.75)	(9.49)	(5.67)	(6.93)	(14.68)	(8.92)
Bihar	Total Pulses	-2.52**	-1.43**	1.12**	-3.49**	-4.57**	-1.12NS	-2.11*	-1.73NS	0.38NS
		(12.01)	(11.48)	(11.32)	(11.82)	(17.53)	(7.09)	(9.12)	(8.79)	(8.85)
	Total Oilseeds	-2.16**	0.19NS	2.40**	-2.20*	1.22NS	3.50**	-3.48**	-1.79**	1.75**
		(10.73)	(6.52)	(14.67)	(11.20)	(9.82)	(12.19)	(11.39)	(7.05)	(7.15)
Odisha	Total Pulses	1.16*	3.71**	2.53**	3.39*	6.36**	2.87**	-1.18NS	1.02NS	2.22**
		(8.63)	(17.96)	(15.31)	(13.25)	(22.89)	(10.94)	(8.04)	(9.28)	(7.70)
	Total Oilseeds	-3.85**	-1.26NS	2.69**	0.25NS	4.86NS	4.60*	-8.12**	-7.65**	0.51NS
		(17.11)	(17.49)	(17.84)	(7.41)	(20.82)	(18.16)	(26.13)	(24.94)	(7.56)
West Bengal	Total Pulses	1.91NS	3.25**	1.31**	-4.38**	-4.74**	-0.37NS	11.30**	12.62**	1.19NS
		(22.42)	(30.00)	(12.23)	(13.13)	(16.87)	(7.21)	(39.38)	(41.83)	(10.83)
	Total Oilseeds	2.35**	4.52**	2.12**	3.26**	4.20*	0.92NS	3.83**	5.82**	1.92**
		(10.92)	(21.82)	(13.99)	(10.26)	(16.00)	(8.39)	(13.05)	(19.52)	(7.31)
India	Total Pulses	1.63**	3.49**	1.84**	1.19*	2.12NS	0.92NS	2.42*	4.37*	1.90NS
		(8.91)	(14.01)	(6.71)	(4.70)	(10.14)	(3.56)	(7.35)	(8.62)	(4.08)
	Total Oilseeds	0.53NS	2.72**	2.18**	2.44*	5.38*	2.87NS	-0.79NS	0.83NS	1.63NS
		(5.63)	(11.07)	(8.05)	(8.42)	(19.92)	(7.53)	(2.91)	(4.77)	(4.33)

Note: *Figures in the parentheses represents respective Standard Deviation of Mean Area Production and Productivity; * means significant at 5% level ** means significant at 1% level NS means Non-significant.*

oilseeds. As per the result depicted in Table 5, a spectacular decline (-547.35%) in acreage under oilseeds has been observed in Bihar, which has been complimented by the mammoth productivity gain (782.45%) over a decade.

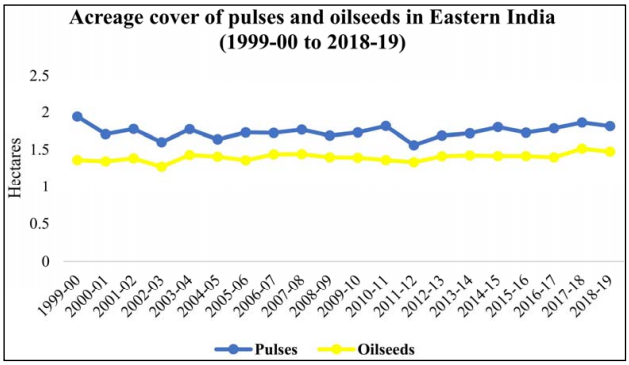

Fig. 1: Area coverage of pulses and oilseeds in Eastern India over last two decades (1999-00 to 2018-19)

The eastern states of India can cater to a more prosperous position all over India in terms of pulses and oilseeds production to enrich the nutritional security of the farm-family and enhancement of their livelihood. Development of short duration varieties of various pulses is an essential aspect for enhancing productivity of pulses as a whole in eastern states of India. Super early maturing (<100 days) pigeon pea varieties (ICPL 20340, ICPL 20338, ICPL 20325, ICPL 20326) along with early maturing chickpea variety JG 14 (ICCV 92944) are already becoming popular in eastern India. Introduction of lentil varieties like L-4717 in the rice-fallow situation and inclusion of summer mungbean as an intercrop (Singh *et al*. 2012) with rice-wheat and rice-rice cropping system will ensure long term sustainability in the context of pulse production. Abiotic stress tolerance variety (heat tolerant variety of chickpea JG 14) followed by biotic stress (Dry Root Rot, Fusarium wilt, Pod borer) tolerance will confirm an assured future of pulse production. An effort should also be made for proper use of molecular engineering

Table 5: Components of changes in average production of pulses and oilseeds (in percent) in eastern India

State	Crops	% $\hat{A}_1$. $\Delta \hat{Y}$	% $\hat{Y}_1$. $\Delta \hat{A}$	% $\Delta \hat{A}$. $\Delta \hat{Y}$	% ΔCov (A, Y)	Total
		(A)	(B)	(C)	(D)	(A+B+C+D)
Assam	Total Pulses	39.49	47.59	10.02	2.89	100.00
	Total Oilseeds	77.94	16.36	3.58	2.12	100.00
Bihar	Total Pulses	-192.69	242.00	42.50	8.20	100.00
	Total Oilseeds	782.45	-547.35	-139.10	4.00	100.00
Odisha	Total Pulses	67.02	28.28	7.90	-3.20	100.00
	Total Oilseeds	-280.73	287.13	84.76	8.85	100.00
West Bengal	Total Pulses	39.96	49.52	8.77	1.76	100.00
	Total Oilseeds	48.46	40.06	10.44	1.04	100.00
India	Total Pulses	50.34	39.74	8.68	1.24	100.00
	Total Oilseeds	84.61	14.80	3.45	-2.86	100.00

and development of transgenic crops that will give a thrust in the current pulse productivity as well.

Eastern India has a huge need for further expansion of acreage for oilseeds production. Adoption of low-cost and eco-friendly technology will have a high impact on productivity by enhancing the input use efficiency. Increasing seed production along with distribution of newly released varieties will ensure more acceptances of oilseeds among farmers. Keeping in mind the day-to-day increase in demand for oilseeds, improvement in quality as well as value addition will open an opportunity for entrepreneurial development.

The entire study depicts that there is an ample scope and opportunity to enhance pulses and oilseeds cultivation in eastern India through technology transfer and acreage expansion by utilization of vested land. The finding is as similar as the study of Ahmed *et al.* (2018) that acreage and production of pulses have been gaining in eastern India for the last two decades. Technology plays a major role in disseminating improved package of practice for pulses and oilseeds growers in India during the last decade (Sharma *et al*. 2013). Before the onset of the National Food Security Mission (NFSM) to enhance overall food-grain production of the country, the growth rates of pulses were not satisfactory in the previous decade (2000-01 to 2010-11) whereas a significant, gaining in productivity occurred for the next decade (2011-12 to 2018-19) with fluctuations in acreage and production (Bisht *et al*. 2018). With a close look into the status of pulses and oilseeds for the eastern states, each state differs in respect in choice and preferences of crops. Assam occupies the highest acreage and production under urad the highest productivity gaining was registered for Arhar. Lentil became the major contributing pulse for the state of Bihar (Kumari *et al.* 2021) and West Bengal, where West Bengal has shown spectacular increases in acreage over decades, while Bihar has shown contraction in acreage despite increases maintaining a steady yield level due to technology. Proper research and extension have to be incorporated regarding pulses and oilseeds production in the state (Singh *et al*. 2016). Odisha features less importance in terms of pulses as pulses have been marginalized by highly remunerative competing cash crops (Devegowda *et al*. 2018).

As per the overall scenario of oilseeds production in eastern India, rapeseeds and mustard are the major oilseeds grown, followed by sesame. Almost all the eastern states have featured dominancy in the production of rapeseeds and mustard due to positive change in productivity over decades. Linseed has become a part of the total oilseeds of West Bengal in the last decade, with a spectacular change in acreage and production as well over the previous decade. Paddy followed by linseed as a paira crop will produce a better yield (Jana *et al*. 2018). Cultivation of sunflowers and safflowers became lesser and lesser in West Bengal as it follows a systematic weather risk (Lakshman *et al*. 2021). Odisha became the sole contributor of groundnuts among eastern states, occupying two-thirds of acreage under total pulses (Behura *et al*. 2020) where productivity is gaining in spite of shrinkage in acreage. Chances of instability occur while measuring growth rates of oilseeds for eastern states due to unscientific cultivation practices by the growers, which need to be rectified through

site-specific scientific package of practices (Kolar *et al*. 2020).

CONCLUSION

In fine, it can be clinched that Bihar and West Bengal stand out as primary producers of pulses, while rapeseed and mustard take the lead among oilseed crops, followed by sesame. Odisha uniquely contributes to groundnut production. Oilseeds have become integral to overall oilseeds output in West Bengal. Therefore, the scope for introduction of pulse crops in rice-fallows (mostly un-irrigated) needs to be exploited with supplemental irrigation. There is a vast area of fallow land in Bihar, Odisha and West Bengal which is most suitable for pulse cultivation. In order to enhance production in these states, implementing HYV seeds, adopting scientific land preparation techniques and paira cropping in rice-fallow situations can significantly boost the current area and production of pulses and oilseeds in eastern India.

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