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Article *in* Journal of AgriSearch · February 2018

DOI: 10.21921/jas.v5i01.11137

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Journal of AgriSearch **5**(1):00-00
An Open Access International Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)

Growth and Instability in Pulses : A Spatiotemporal Analysis in Eastern India

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ARTICLE INFO

Received on	:	03/11/2017
Accepted on	:	14/02/2018
Published online	:	27/02/2018

ABSTRACT

Pulses are not only vital ingredient of human diet but they are equally important to the health of humans and agricultural soils as well. The study revealed that the share of area and production of pulses in total food grains production has gone up. The area under total pulses in TE-2003 was worked out to be 7.52% of the total area under food grains in the region, which became almost, double, i.e. 14.48% in TE-2016.Production of pulses went up from 2.99% in TE-2003 to 6.22% in TE-2016 and productivity of pulses has also improved (635.01 Kg/ha to 910.68 Kg/ha) during study period. The Compound growth rates of area and production were found positive in all the states. Though there is a wide gap between consumption and production, on account of low productivity of pulses, they are not able to compete with profitability of cereal crops, thus resulting in decreased area.

Keywords: Pulse crops, Instability, Nutritional security, Consumption, Production

INTRODUCTION

Pulses are a vital gift of nature as they nourish mankind with highly nutritive food and provide ample quantity of proteins, vitamins and minerals. Pulses are traditionally important constituents of our cropping system. Being leguminous in nature, these improve soil fertility by fixing nitrogen and making soil more porous due to tap root system. Pulses play an important role as nitrogen fixing mini-factories. Pulses are an integral part of sustainable crop production system as these have ability of biological nitrogen fixation, low water requirement and capacity to withstand abnormal weather conditions. Pulses are an important ingredient of Indian diet especially for vegetarian population of the country. Supplemented with cereals, pulses provide a perfect mix of vegetarian protein of high biological value. The results from household consumption survey revealed decline in the consumption of pulses, leading to increase in malnutrition and decline in protein intake (Shalendra *et al.*, 2013). India is still a home of about 24% of undernourished people in the world (Sharma *et al.*, 2016 and Ahlawat *et al.*, 2016). According to FAO estimates, in 'The State of Food Security and Nutrition in the World, 2017" 190.7 million people are undernourished in India. By this measure 14.5% of the population is undernourished in India. On account of these virtues, pulses crops remained an integral part of sustainable agriculture production system. Realizing its importance for human health, the United Nation declared 2016 as International Year of Pulses.

India has the distinction of being one of the major pulse producers, importers and consumers countries contributing about 25% to the global pulse production and consumer of 27% of total pulses of the world. Pulses are also an important part of Indian agricultural economy next to the food grains and oilseeds in term of acreage, production and economic value (Singh *et al.*, 2016). The production of pulses is about 16.47 million tonnes with a very low average productivity of 625 kg/ha. Currently the area is about 25.26 million hectares under pulses (Anonymous, 2016).

The eastern region of India comprising the states of Bihar, Jharkhand, Odisha, Assam and West Bengal is one of the most backward regions(consisting of 32.10% below poverty line population) and accounting for maximum number of economically most backward districts (69 out of 150 at national level) of the nation. This region occupies about 21.85% of geographical area and supports 34% of the population of the country. The population density is 1.91 fold higher in eastern states to national average. Agriculture is the mainstay of economy in this region. The region produces about 11.94% of India's total pulses production in around 9.14% of total pulses area of the nation. The state-wise production percentage was observed to be 2.60% in Bihar, 3.32% in Jharkhand, 3.37% in Odisha, 0.65% in Assam and 2.00% inWest Bengal of total national production during 2015-16.

A large proportion of malnourished population resides in the region. Protein-energy malnutrition as well as micro nutrient deficiencies can be combated by increasing the consumption of pulses which are a rich source of proteins, minerals, iron and fibre. After accounting for seed, feed and wastage, the per capita availability of pulses in 2014 was around 38 grams per day which is progressively declined from 65 gram a day in 1961 and is less than the recommended daily requirement of

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40 grams per day. After considering the imports of 3.5 million tonnes, the net availability reached a level of 44 grams, which is above the recommended daily requirement. For a country that faces persistent protein inflation and has preference for vegetarian diet, pulses will help address the scourge of pervasive malnutrition caused by protein deficiency among the large sections of Indian population (Kumar and Singh, 2016).

Despite rich natural resource availability, the recurring gap between supply and demand of the pulses has been an issue of concern leading to spike in prices, further resulting in good source of protein which is generally inaccessible to the poor. The sluggish performance of pulses production in the region and at the national level has resulted in increasing deficit, on the one hand and depletion of foreign currency reserves by soaring import bills, unpredictable price rise and lower net profit compared to competing crops, on the other hand (Joshi and Saxena, 2002, Srivastava *et al.*, 2010). The production of pulses in the region has been caught in vicious circle of low and uncertain productivity, low per hectare returns resulting in farmers' least preference to grow pulses on irrigated and fertile parcel of land (farmers preferred to grow pulses on marginal land with no use of production input), thereby, leading to unstable and low yields (Singh *et al.*, 2018 and Lingareddy, 2015). The technological progress in these crops is slow as compared to cereals and other cash crops due to hosts of factors. The crops have to compete with the superior cereals and cash crops for natural and research resources, and infrastructure (Ramasamy and Selvraj, 2002; Singh *et al.*, 2015 andJain *et al.*, 2016).Pulses are considered secondary to cereal crops and relegated to marginal soils as they are perceived to be low yielding and less remunerative crops. Under these backdrops the present study tried to focus on growth and instability in area, production and productivity of major pulses in different states of the eastern region as well as region as a whole.

MATERIALS AND METHODS

The state wise time series data on area, production and productivity of major pulses crops were taken from different statistical publications of the respective states and from Directorate of Economics and Statistics, Government of India website, for the period 2000-01 to 2015-16.

India is home to the highest number of malnourished children under 5 years of age. Thirty-eight per cent of the children were stunted and 21 per cent wasted in 2014-15 according to the fourth round of the National Health and Family Survey. The eastern region of India comprising the states of Bihar, Jharkhand, Odisha, Assam and West Bengal is one of the most backward regions consisting of 32.10% population below poverty line. Agriculture is the mainstay of livelihood in the region. The region produces about 11.94% of India's total pulses production in around 9.14% of total pulses area of the nation. Still a large proportion of malnourished population resides in the region. Protein-energy malnutrition as well as micro nutrient deficiencies can be combated by increasing the consumption of pulses. The eastern region is also focused as the origin of second green revolution in the country. Hence, the proposed study was undertaken to draw the attention of the policy makers in this direction.

The compound growth rates (CGRs) of area, production and productivity of major pulses were computed both state wise and for eastern India as a whole, using the following formula:

$$CGR = (\text{Anti log of } b - 1) \times 100$$

Where, b is the regression coefficient.

Instability is the deviation from trend and many of the researchers have used the coefficient of variation (CV %) as a tool of instability. An index of instability was computed for examining the nature and degree of instability in area, production and yield of the pulses crops at state and regional level. Simple CV does not explain properly the trend component inherent in the time series data so the instability index was calculated using better measure of variability suggested by Cuddy- Della Valle index (Cuddy and Della, 1978).

$$\text{Instability Index} = CV * \sqrt{1 - R^2}$$

$$CV = \frac{\text{Standard deviation of the variable}}{\text{Mean of the variable}} \times 100$$

Where, CV is Coefficient of Variation and R^2 is the Coefficient of Determination from a time series trend regression adjusted by the number of degrees of freedom.

RESULTS AND DISCUSSION

Share of Pulses in total food grains

The share of pulses in total food grains in eastern India over the periods has been given in Table 1. The area and production of pulses in the region have been recorded rising trend. The area under total pulses in TE-2003 was worked out to be 7.52% of the total area under food grains in the region, which became almost, double, i.e. 14.48% in TE-2016. Similar trend was observed in case of production i.e. it went up from 2.99% in TE-2003 to 6.22 in TE-2016. After green revolution, due to lack of breakthrough in production technology of the pulses in comparison to other commodities, a very slow increase was observed in area, production and productivity of the pulses. The widening gap between demand and supply and spike in the prices of pulses, the government prompted the Ministry of

Table 1: Percentage share of pulses in total food grains in Eastern India

(Area: 000 ha, production: 000 tonnes, Yield Kg/ha)

Period	Particulars	Total Food grains	Total Pulses	Percent share
	Area	24017.49	1807.07	7.52
TE-2003	Production	38337.77	1147.50	2.99
	Area	24002.77	1988.47	8.28
TE-2006	Production	38399.61	1178.20	3.07
	Area	24196.83	2112.83	8.73
TE-2009	Production	42700.30	1328.07	3.11
	Area	22324.76	2103.00	9.42
TE-2012	Production	41331.44	1438.97	3.48
	Area	16092.48	2329.53	14.48
TE-2016	Production	34121.24	2121.47	6.22

Agriculture and farmers' Welfare to vigorously pursue the National Food Security Mission (NFSM-Pulses) during the Eleventh Plan (2007-08 to 2011-12) and further continued during Twelfth Plan (2012-13 to 2015-16). This uphill task has to be undertaken under more critical production constraints like erratic climatic changes, spread of new pests and diseases and decreasing soil micro nutrients (Ali *et al.*, 2012; Reddy, 2009 and Singh and Singh, 2008). Under NFSM government distributed quality seeds on subsidized prices and raised MSP of the pulses enhanced the production of the pulses.

Trends in area, production and yield of pulses

State wise as well as eastern region as a whole, average area, production and yield of pulses crops like gram, arhar, urd, mung, lentil, peas, lathyrus (khesari) and kulthi (Horse gram) and their annual growth rates and instability indices are presented in Table 2 to Table 8.

Pulses crops: The area under pulses has increased in the eastern region and the states under study except in Bihar (Table 2). The area under pulses was estimated 703.07 thousand ha in Bihar and the states under study such as Jharkhand (113.70 thousand ha), Odisha (622.23 thousand ha), Assam (113.43 thousand ha), West Bengal (254.63 thousand ha) and in the eastern region (1807.07 thousand ha) in TE-2003. However, area declined to 521.57 thousand ha in Bihar but in other states under study the area showed and increasing trend like in Jharkhand (590.53 thousand ha), Odisha (793.27 thousand ha), Assam (136.50 thousand ha), West Bengal (298.67 thousand ha) and in the eastern region (2329.53 thousand ha) during the TE-2016. Similar trend was observed in case of production. It was further observed that the overall productivity of the region registered increasing trend i.e. 635.01 Kg/ha to 910.68 Kg/ha during the study period, and state wise productivity also recorded a rising trend.

Table 2: Area, production and productivity of different pulse crops grown in the states of Eastern India

Area: '000 ha, Production: '000 tonnes, Yield: Kg/ha

Period	Particulars	Bihar	Jharkhand	Odisha	Assam	West Bengal	**Eastern India**
TE-2003	Area	703.07	113.70	622.23	113.43	254.63	1807.07
	Production	576.20	90.93	230.43	62.67	187.27	1147.50
	Productivity	819.55	799.77	370.33	552.45	735.44	635.01
TE-2006	Area	648.70	276.70	722.17	107.70	233.20	1988.47
	Production	492.10	155.77	286.17	59.80	184.37	1178.20
	Productivity	758.59	562.94	396.26	555.25	790.59	592.52
TE-2009	Area	600.10	387.60	818.30	110.90	195.93	2112.83
	Production	468.13	280.20	374.20	62.17	143.37	1328.07
	Productivity	780.09	722.91	457.29	560.57	731.71	628.57
TE-2012	Area	567.17	402.43	825.20	120.47	187.73	2103.00
	Production	507.20	321.77	389.93	67.77	152.30	1438.97
	Productivity	894.27	799.55	472.53	562.53	811.26	684.24
TE-2016	Area	521.57	590.53	793.27	136.50	287.67	2329.53
	Production	486.97	569.23	645.07	121.87	298.33	2121.47
	Productivity	933.66	963.93	813.18	892.80	1037.08	910.68

Compound growth rate of pulses crops

The CGRs of area and production of pulses crops were computed and found positive in all the states (Table 3). The compound growth rates of area under total pulses were accounted for 5.28 in Jharkhand, 0.79 in Odisha, 0.66 in Assam, 0.001 in West Bengal it was only in Bihar where there was a negative growth i.e. -1.03%, while the eastern region as a whole recorded and CGR of 0.75 during the period under study.

Table 3: Compound growth rate of pulses crops

State	**Pulse crops**		
	Area	Production	Productivity
Bihar	-1.03	-0.37	0.66
Jharkhand	5.28	6.52	1.18
Odisha	0.79	3.01	2.21
Assam	0.66	1.94	1.28
West Bengal	0.001	0.99	0.98
Eastern India	**0.75**	**1.97**	**1.21**

The productivity recorded positive growth trend. i.e. 1.21 in eastern India as a whole and for the states under study it was estimated as Bihar (0.66%), Jharkhand (1.18%), Odisha (2.21%), Assam (1.28%) and West Bengal (0.98%).

Instability indices of pulses crops

The results of instability indices (Table 4) in area (4.10), production (12.56) and productivity (11.22) of total pulses were recorded lower, indicating that these were comparatively stable in the region under study. When compared among states, it was found that the instability in area, production and yield of the total pulses was recorded relatively lower in Bihar i.e. 4.73, 9.54 and 9.31.

A shift in crop preferences by the farmers has been seen during the period of investigation. The cultivators of Bihar (Gangetic belt farmers), who grew pulses earlier, have increasingly shifting to wheat production where yield ranges from 3,000 to 4,000 kg per hectare as compared to only about

800 kg in case of pulses. This may be the probable reason for negative growth in area and production of pulses. The positive trend in area, production and productivity is possible by way of harnessing this yield gap by growing pulses in new niches, precision farming, quality inputs, soil test based Integrated Nutrient Management (INM) and mechanized method of pulse cultivation, complimented with generous Governmental policies and appropriate funding support to implementing states/stake holders (Agrawal, 2012).

Table 4: Instability indices of pulses crops

State	Area	Production	Productivity
Bihar	4.73	9.54	9.31
Jharkhand	22.44	23.32	15.65
Odisha	10.06	24.83	23.71
Assam	9.83	22.66	17.68
West Bengal	18.19	28.92	14.18
Eastern India	4.10	12.56	11.22

Some of the major pulse crops of the eastern India have been discussed in detail in the following sections:

Gram *(Chickpea)*: Overall acreage, production and yield under gram in eastern region increased during the study period. These were estimated 159.04 thousand hectares, 133.48 thousand tonnes and 839.31 Kg/ha in TE-2003 and these went up to 300.86 thousand hectares, 308.54 thousand tonnes and 1025.53 Kg/ha, respectively in case of area, production and productivity. The state wise area and production were recorded fluctuating but the productivity registered increasing trend in almost all the states of the region.

The CGR of area was recorded negative in case of Bihar (-0.71%) also in Assam (-0.55%) and West Bengal (-2.33%). The production showed negative growth in the states of Assam (-0.18%) and West Bengal (-1.33%). But, the growth in productivity was estimated positive in all the constituent states of the eastern India.

Table 5: Area, production and productivity of different *kharif* pulses grown in the states of eastern India

Area: '000 ha, Production: '000 tonnes, Yield: Kg/ha

Period	Particulars	Bihar	Jharkhand	Odisha	Assam	West Bengal	Eastern India
				Pigeon Pea			
TE-2003	Area	40.90	28.27	129.90	7.10	5.30	21147
	Production	49.87	37.33	76.70	5.07	4.00	172.97
	Productivity	1219.23	1320.75	590.45	713.62	754.72	817.94
TE-2006	Area	36.00	83.07	132.93	6.73	2.23	260.97
	Production	45.10	48.97	94.37	4.77	2.03	195.23
	Productivity	1252.78	589.49	709.88	707.92	91045	748.12
TE-2009	Area	32.77	104.60	136.17	6.13	1.23	280.90
	Production	34.43	72.50	112.30	4.27	0.93	224.43
	Productivity	1050.86	693.12	824.72	695.65	756.76	798.98
TE-2012	Area	29.73	92.97	136.80	6.33	1.23	267.07
	Production	48.40	75.83	117.07	4.53	1.10	246.93
	Productivity	1627.80	815.70	855.75	715.79	891.89	924.61
TE-2016	Area	23.700	195.43	138.37	6.03	2.13	365.67
	Production	39.267	192.77	123.57	5.23	3.08	363.92
	Productivity	1656.821	986.36	893.04	867.40	1445.31	995.21
				Urad (Urad Bean)			
TE-2003	Area	29.70	45.30	125.07	39.63	65.03	304.73
	Production	20.13	28.87	33.00	21.40	41.17	144.57
	Productivity	677.89	637.23	263.86	539.95	633.01	474.40
TE-2006	Area	24.47	71.63	131.30	37.57	60.77	325.73
	Production	18.43	37.00	34.53	19.80	41.20	150.97
	Productivity	753.41	516.52	263.01	527.06	678.00	463.47
TE-2009	Area	23.73	91.90	134.70	38.23	56.77	345.33
	Production	19.07	55.43	40.13	20.70	40.10	175.43
	Productivity	803.37	603.19	297.95	541.41	706.40	508.01
TE-2012	Area	18.40	76.97	125.27	45.13	50.50	316.27
	Production	15.97	54.13	36.37	25.97	34.03	166.47
	Productivity	867.75	703.33	290.31	575.33	673.93	526.35
TE-2016	Area	14.98	91.83	64.73	47.00	80.23	298.78
	Production	13.35	85.10	29.84	42.43	64.27	234.99
	Productivity	890.99	926.68	460.92	902.84	801.00	786.48

Kulthi (Horse gram)							
TE-2003	Area	14.97	20.87	81.00	0.00	4.57	121.40
	Production	11.80	14.63	19.00	0.00	2.70	48.13
	Productivity	788.42	701.28	234.57	0.00	591.24	396.49
TE-2006	Area	13.90	17.63	82.47	0.00	3.23	117.23
	Production	11.07	7.03	22.23	0.00	1.43	41.77
	Productivity	796.16	398.87	269.60	0.00	443.30	356.27
TE-2009	Area	13.13	15.53	68.17	0.00	2.17	99.00
	Production	11.70	6.43	19.43	0.00	1.03	38.60
	Productivity	890.86	414.16	285.09	0.00	476.92	389.90
TE-2012	Area	9.70	17.03	59.43	0.00	2.25	87.60
	Production	9.37	11.03	17.73	0.00	1.12	38.83
	Productivity	965.64	647.75	298.37	0.00	496.30	443.30
TE-2016	Area	8.09	29.15	44.78	0.00	3.03	85.05
	Production	7.67	19.63	15.20	0.00	1.47	43.97
	Productivity	948.47	673.53	33941	0.00	483.52	516.97
Mung (Mung Bean)							
TE-2003	Area	187.80	3.63	176.07	7.53	10.63	385.67
	Production	111.43	1.90	39.57	3.37	5.87	162.13
	Productivity	593.36	522.94	224.73	446.90	551.72	420.40
TE-2006	Area	184.97	12.10	236.63	7.67	11.43	452.80
	Production	98.30	5.57	56.63	3.73	4.60	168.83
	Productivity	531.45	460.06	239.33	486.96	402.33	372.87
TE-2009	Area	173.97	16.27	245.20	6.87	9.70	452.00
	Production	108.53	10.43	60.33	3.20	4.60	187.10
	Productivity	623.87	641.39	246.06	466.02	474.23	413.94
TE-2012	Area	166.60	25.20	264.00	7.77	17.53	481.10
	Production	70.03	13.60	75.10	3.57	11.03	173.33
	Productivity	420.37	539.68	284.47	459.23	629.28	360.29
TE-2016	Area	162.81	20.11	235.80	10.43	30.43	459.58
	Production	99.65	14.63	134.03	10.27	42.00	30058
	Productivity	612.08	727.21	568.42	984.65	1380.07	654.03

Table 6: Area, production and productivity of different *rabi* pulses grown in the states of eastern India

Area: '000 ha, Production: '000 tonnes, Yield: Kg/ha

Period	Particulars	Bihar	Jharkhand	Odisha	Assam	West Bengal	Eastern India
Gram (Chickpea)							
TE-2003	Area	71.93	10.04	23.83	2.23	51.00	159.04
	Production	72.03	8.68	14.07	1.10	43.50	133.48
	Productivity	1001.39	864.21	590.21	49254	852.94	839.31
TE-2006	Area	71.53	20.71	32.23	2.03	41.17	167.68
	Production	64.97	16.78	20.13	1.03	41.03	143.94
	Productivity	908.20	809.95	624.61	508.20	996.76	858.44
TE-2009	Area	62.23	80.30	37.80	1.83	26.00	208.17
	Production	56.63	73.40	24.87	0.97	24.47	180.33
	Productivity	910.02	914.07	657.85	527.27	941.03	866.29
TE-2012	Area	59.53	86.80	41.97	1.80	22.40	212.50
	Production	66.30	89.03	32.07	0.90	24.10	212.40
	Productivity	1113.66	1025.73	764.10	500.00	1075.89	999.53
TE-2016	Area	60.17	16742	43.73	1.97	27.57	300.86
	Production	67.467	172.93	34.40	1.14	32.60	308.54
	Productivity	1121.330	1032.91	786.59	577.97	1182.59	1025.53

Lentil							
TE-2003	Area	174.80	6.23	0.00	20.53	72.03	273.60
	Production	154.47	3.90	0.00	10.97	49.73	219.07
	Productivity	883.68	625.67	0.00	534.09	690.42	800.68
TE-2006	Area	170.73	20.23	0.00	20.37	64.53	275.87
	Production	133.77	13.83	0.00	11.13	46.03	204.77
	Productivity	783.48	683.69	0.00	546.64	713.33	742.27
TE-2009	Area	164.23	20.70	0.00	21.23	57.53	263.70
	Production	124.97	15.97	0.00	11.33	39.97	192.23
	Productivity	760.91	771.34	0.00	533.75	694.67	728.98
TE-2012	Area	192.73	30.85	0.00	22.77	56.13	302.48
	Production	178.93	23.64	0.00	11.37	47.23	261.18
	Productivity	928.40	766.37	0.00	499.27	841.45	863.44
TE-2016	Area	152.96	42.57	0.00	29.23	65.67	290.43
	Production	177.58	36.37	0.00	22.21	63.07	299.22
	Productivity	1160.93	854.35	0.00	759.64	960.41	1030.27
Pea							
TE-2003	Area	24.27	2.28	25.73	24.13	8.97	85.38
	Production	23.00	1.77	16.03	14.27	6.80	61.87
	Productivity	947.80	776.64	623.06	591.16	758.36	724.65
TE-2006	Area	23.53	9.30	0.00	22.07	14.00	68.90
	Production	21.27	7.63	0.00	13.57	12.70	55.17
	Productivity	903.68	820.79	0.00	614.80	907.14	800.68
TE-2009	Area	23.63	15.17	0.00	20.97	10.40	70.17
	Production	22.57	17.50	0.00	13.00	7.43	60.50
	Productivity	954.87	1153.85	0.00	620.03	714.74	862.23
TE-2012	Area	20.30	39.30	0.00	21.70	11.03	92.33
	Production	20.87	37.67	0.00	13.30	11.80	83.63
	Productivity	1027.91	958.44	0.00	612.90	1069.49	905.78
TE-2016	Area	18.81	32.82	135.30	30.47	13.70	140.90
	Production	18.18	39.40	80.40	27.15	16.17	127.70
	Productivity	966.34	1200.61	594.24	891.14	1180.05	906.31
Khesari (Lathyrus)							
TE-2003	Area	151.90	0.00	0.00	0.00	35.97	187.87
	Production	129.37	0.00	0.00	0.00	32.80	162.17
	Productivity	851.66	0.00	0.00	0.00	911.96	863.20
TE-2006	Area	114.47	0.00	0.00	0.00	34.67	149.13
	Production	93.70	0.00	0.00	0.00	34.87	128.57
	Productivity	818.58	0.00	0.00	0.00	1005.77	862.09
TE-2009	Area	100.73	0.00	0.00	0.00	31.13	131.87
	Production	86.23	0.00	0.00	0.00	24.93	111.17
	Productivity	856.06	0.00	0.00	0.00	800.86	843.02
TE-2012	Area	77.90	0.00	0.00	0.00	26.57	104.47
	Production	82.67	0.00	0.00	0.00	21.77	104.43
	Productivity	1061.19	0.00	0.00	0.00	81932	999.68
TE-2016	Area	60.34	0.00	0.00	0.00	31.97	92.30
	Production	64.07	0.00	0.00	0.00	39.80	103.87
	Productivity	1061.88	0.00	0.00	0.00	1245.05	1125.31

The instability indices were estimated to be 8.59, 11.83 and 7.59 for area, production and yield, respectively, in eastern India. Among the states, Bihar recorded the lowest instability index in area (7.81), as compared to Assam (10.32), whereas in production, it was the lowest in Assam (13.80) with respect to Odisha (14.93) and Bihar (15.66). But, in productivity the highest stability was observed in Odisha and lowest in Bihar as evidenced by instability indices being 5.68 (Odisha) and 11.69 (Bihar).

The fluctuating trend and negative growth may perhaps be due to differential impact of technology and relative profitability of pulses and other crops. Initially, it started with high yielding varieties of wheat which raised productivity and profitability relative to gram and pushed the latter out of cultivation in almost all the regions where wheat could spread.

The different programmes, like distribution of good quality

seeds, large scale full package technology demonstrations, were also organized by Indian Council of Agricultural Research through its *Krishi Vigyan Kendras* for the major pulses crops. Besides this, minimum Support Price of pulses has been significantly increased in 2010-11 with an increase of about 50% over that of the previous year. Along with the increase in MSP, additional agencies for procurement of pulses have been notified to boost the production of pulses.

Table 7: Compound growth rates of area, production and productivity of major pulses from 2000-01 to 2015-16

State	Gram(Chickpea)			Pigeon pea		
	Area	Production	Productivity	Area	Production	Productivity
Bihar	-0.71	0.02	0.74	-1.89	-0.53	1.39
Jharkhand	9.92	10.83	0.83	5.93	6.07	0.13
Odisha	1.89	3.06	1.15	0.20	1.57	1.36
Assam	-0.55	-0.18	0.38	-0.57	-0.01	0.57
West Bengal	-2.33	-1.33	1.02	-2.91	-1.33	1.63
Eastern India	**2.10**	**2.93**	**0.70**	**1.60**	**2.52**	**0.91**
	Urd (Urd Bean)			**Mung (Mung Bean)**		
	Area	Production	Productivity	Area	Production	Productivity
Bihar	-2.37	-1.46	0.93	-0.54	-0.84	-0.30
Jharkhand	2.09	3.60	1.48	6.06	7.19	1.06
Odisha	-2.18	-0.34	1.88	0.80	3.41	2.59
Assam	0.65	2.08	1.43	0.87	2.97	2.08
West Bengal	0.11	0.92	0.81	2.43	5.66	3.15
Eastern India	**-0.20**	**1.44**	**1.64**	**0.47**	**1.64**	**1.16**
	Lentil			**Pea**		
	Area	Production	Productivity	Area	Production	Productivity
Bihar	-0.27	0.74	1.01	-0.96	-0.71	0.26
Jharkhand	5.74	6.99	1.18	9.53	11.53	1.62
Odisha	-	-	-	-	-	-
Assam	1.18	2.02	0.84	0.75	1.81	1.06
West Bengal	-0.39	0.78	1.17	0.88	2.31	1.41
Eastern India	**0.27**	**1.22**	**0.94**	**1.38**	**2.48**	**1.09**
	Khesari (Lathyrus)			**Kulthi (Horse gram)**		
	Area	Production	Productivity	Area	Production	Productivity
Bihar	-2.97	-2.01	0.99	-2.27	-1.53	0.76
Jharkhand	-	-	-	0.86	1.78	0.92
Odisha	-	-	-	-2.13	-0.92	1.23
Assam	-	-	-	-	-	-
West Bengal	-0.69	-0.06	0.63	-1.38	-1.71	-0.33
Eastern India	**-2.37**	**-1.41**	**0.99**	**-1.51**	**-0.48**	**1.04**

***Arhar (Pigeon pea)*:** Area, production and productivity of arhar in eastern region registered increasing trend. As such the area, production and productivity were estimated 211.47 thousand hectares, 172.97 thousand tonnes and 817.94 Kg/hain TE-2003, which escalated to 365.67 thousand hectares, 363.92 thousand tonnes and 995.21 Kg/ha in TE-2016, respectively. In case of states, Jharkhand registered largest push up in area (195.43 thousand hectares) and production (192.77 thousand tonnes) in TE-2016 as compared to area (28.27 thousand hectares) and production (37.33thousand tonnes) in TE-2003, however, the productivity was found decelerated from 1320.75 Kg/ha in TE-2003 to 986.36 Kg/ha.

Remaining states of the region depicted fluctuating trend in area and production however it was observed upward trend in productivity. Annual compound growth rates of area were estimated negative in case of area for Bihar (-1.89%), Assam (-0.57%) and West Bengal (-2.91%) and the same trend was observed in case of production in the respective states. Over all rate of growth in area, production and productivity in the study region was computed 1.60%,2.52% and 0.91%, respectively. Productivity of the crop during the study period registered positive growth in all the states as well as in eastern India during the investigation period. Stability in area and production was asserted highest in Odisha, followed by Assam and Bihar, but in case of productivity it

(stability) was emphasized most in Assam followed by West Bengal.

The fluctuating trend in area and production may be due to erratic climatic conditions and the crop generally grown with wide row spacing, hence a lot of inter row spaces remain vacant and get infested by weeds. Weeds poses serious problem during rainy season by robbing the crop's precious nutrients and moisture and also give shelter to various insects and pests. The major constraints in arhar production are Fusarium wilt and sterility mosaic disease and in recent times, phytophthora blight is emerging as potential threat due to climate change to arhar production causing huge yield losses. The government has taken care of providing disease resistant high yielding seeds of the crop, hence, the acceleration in productivity has been observed.

Urd (Urd Bean):The declining trend in area of urd crop was observed in eastern region of India. The area of the crop declined from 304.73 thousand hectare in TE-2003 to 298.78 thousand hectare in TE-2016.The annual compound growth was computed to be -0.20%. The CGR of area in Bihar and Odisha were observed to be -2.37% and -2.18%. Similar trend was noticed in case of production in the above states. The productivity of the crop was found increasing as in all the states under study and eastern region as whole registered positive annual growth rates. The stability in area, production and yield has been observed comparatively higher in Bihar. The stability in area, production and productivity of the crop in eastern region as whole was observed to be moderate.

The crop is of short duration and photo insensitive, fits well in different cropping situations, especially intensive crop rotations, the pulse legume, used as a green manuring after picking the pods and with its characteristics to fix the atmospheric nitrogen. The plant with deep tap roots binds soil particles and helps in conservation of soil. Still the area and production were reflected going downwards; this may probably be due to competitive profitability with cereal crops especially paddy and wheat.

Table 8: Instability Index of area, production and productivity of major pulses from 2000-01to 2015-16

State	**Gram(Chi ckpea)**			**Pigeon pea**		
	Area	Production	Productivity	Area	Production	Productivity
Bihar	7.81	15.66	11.69	9.89	16.79	16.94
Jharkhand	24.09	26.30	8.73	28.45	34.54	31.00
Odisha	13.15	14.93	5.68	5.40	7.46	7.18
Assam	10.32	13.80	9.82	6.53	10.20	6.69
West Benga l	21.01	22.22	8.93	72.71	65.95	31.06
Eastern India	**8.59**	**11.83**	**7.59**	**10.03**	**11.76**	**8.00**
	Urd (Urd Bean)			**Mung (Mung Bean)**		
	Area	Production	Productivity	Area	Production	Productivity
Bihar	10.02	10.12	3.89	3.84	23.64	24.39
Jharkhand	17.49	20.08	16.96	47.17	39.66	25.70
Odisha	13.00	17.48	16.39	17.22	37.60	28.04
Assam	12.58	26.18	23.70	18.17	44.34	31.49
West Bengal	24.63	23.41	16.53	53.83	93.93	37.23
Eastern India	**11.26**	**14.24**	**14.93**	**9.98**	**23.15**	**23.60**
	Lentil			Pea		
	Area	Production	Productivity	Area	Production	Productivity
Bihar	11.31	17.82	16.34	7.03	5.88	6.84
Jharkhand	26.68	31.18	12.78	34.45	33.27	20.57
Odisha	-	-	-	-	-	-
Assam	9.02	21.40	13.09	15.27	25.32	11.41
West Bengal	10.04	20.51	14.55	17.26	26.62	19.07
Eastern India	**6.55**	**15.81**	**12.48**	**37.57**	**27.69**	**9.76**
	Khesari (Lathyrus)			**Kulthi (Horse gram)**		
	Area	Production	Productivity	Area	Production	Productivity
Bihar	6.60	14.49	12.25	9.70	9.75	4.23
Jharkhand	-	-	-	38.07	65.56	26.93
Odisha	-	-	-	10.41	22.70	12.87
Assam	-	-	-	-	-	-
West Bengal	9.73	27.37	22.54	28.71	35.93	19.27
Eastern India	6.14	13.75	10.77	**10.62**	**18.55**	**10.86**

***Mung (Mung Bean)*:** Green gram is an excellent source of high quality protein with easy digestibility, consumed as whole grains, dal and sprouted in variety of ways. This crop showed increase in area, production and productivity in the study region and all the constituent states except Bihar. Overall area increased from 385.67 thousand hectares to 459.58 thousand hectares and production 162.13 thousand tonnes to 300.58 thousand tonnes and productivity from 420.40 Kg/ha to 654.03 kg/ha during the period from TE-2003 to TE-2016. The CGRs of area, production and productivity of the crop were estimated 0.47%, 1.64% and 1.16%, respectively, during the period of investigation in the eastern region of the country. The stability in area, production and yield of this crop was calculated comparatively high in Bihar.

In Bihar, mung is grown in two season viz., summer and winter. Due to uncertain climatic conditions, farmers did not take risks of crop failure. Summer mung requires irrigation and thus, irrigation by pumping sets becomes costly and therefore, they did not prefer to cultivate the crop. No doubt, the availability of quality seeds on subsidized prices was made available to farmers, resulting in boostup in the productivity of the crops. Further, the area expansion of the crop needs attention and farmers may be encouraged to utilize the rice fallow areas for growing this crop.

***Masoor (Lentil)* :** India ranked first in the area (43.0%) and second in the production with 37% of world area and production of lentil crop. Bihar ranked third in area (11.29%) and production (17.35%),however, stood first in productivity (1209 kg/ha) during Twelfth Plan. The area under crop depicted increase in area from only 273.60 thousand ha to 290.43 thousand ha and in production from 219.07 thousand tonnes to 299.22 thousand tonnes in TE-2003 to TE-2016, respectively.

Across the states of eastern India, fluctuating trend was observed in area as well as in its production, but productivity was noticed in upward direction in all the states as well as in the region as whole. The CGRs of area, production and yield were recorded 0.27%, 1.22% and 0.94% per annum, respectively, for the study region. Bihar and West Bengal showed negative growth trend in area i.e. -0.27% and -0.39%, respectively. In case of production and productivity, all the states revealed positive growth. Area, production and productivity of the crop were observed almost stable in the region.

The pulses development programmes of the government augmented the production and productivity of the crop. But, the area under crop was almost stagnant, this may be due to low income fetching enterprise as compared to other competing cereals crops during the seasons as vast technological changes has been observed in production of cereal crops like wheat and rabi maize during and after green revolution period.

***Matar (Pea)* :** The land under cultivation, production and productivity of pea crop showed shooting trend in the region. The area (85.38 thousand hectares), production (61.87 thousand tonnes) and productivity (724.65 kg/ha) in TE-2003 stepped up to area (140.90 thousand hectares), production (127.70 thousand tonnes) and productivity (906.31 Kg/ha). Among states under study only Bihar recorded declining growth trend in both area (-0.96%) and production(-0.71%) during the study period. Growth trend of productivity was found to be positive in almost all the states and further, it was calculated 1.09% per annum for the region as a whole. Stability in area, production and productivity was found high in Bihar as compared to the rest of the states in the region.

The slight increase of 1.09% per annum in productivity was found probably due to the larger growth in area (1.38%) of the crop. It may be due to the impact of government policies of encouragement in pulses production, which encouraged the cultivators to put larger area under the crop.

***Khesari (Lathyrus)* :** The acreage and production of Khesari were found to be declining in almost all the states of the region. The area under this crop was 187.87 thousand ha in TE-2003 which came down to 92.30 thousand ha in TE-2016. Compound growth rates of area (-2.37%) and production (-1.41%) of the crop also conformed downward trends whereas, the productivity growth (0.99%) revealed increasing trend. Stability in area, production and productivity of the crop was found larger and consistent in Bihar only. The shrinkage in area and production of this crop may be attributed to low preference by consumers and low income to the cultivators.

***Kulthi (Horsegram)*:** Actually horse gram (Kulthi) is an important crop of south India. Its grain is used for human consumption as 'dal' as well as in preparation of so called 'rasam' and also as a concentrated feed for cattle. In eastern India, it is grown when the cultivator is unable to sow any other crop for want of timely rains and also grown in vacant space of low fertile lands. Like khesari, area and production under kulthi were also declined during the period under study. The CGRs of area and production of the crop were obtained negative i.e. -1.51% and 0.48% per annum respectively during investigation in the region. Stability in area, production and productivity was observed comparatively larger in Bihar as compared to other states as well as the region as whole. It is pertinent to mention here that the demand of this crop is very limited and fetches very low profitability. Hence, cultivators did not prefer to cultivate it commercially, rather only cultivated for their own uses and selling very little surplus in the market.

CONCLUSION

From the ongoing discussion it was observed that share of area and production of pulses in total food grains production has gone up during the study period in eastern region.

On account of low productivity of pulses, susceptible to disease and pest attack as well as animal damages and debilitating market infrastructure, the pulses crops are not able to compete with profitability of cereal crops like paddy

and wheat. Despite, incredible features, the majority of research investments in agriculture is focused on mere handful of cereal crops, with pulses lagging far behind in terms of research support.

To bridge the wide gap between consumption and production Indian Agriculture Research System has to come up with a time bound program backed by adequate scientific, financial resources, improved marketing infrastructure along with enhanced productivity, reducing post- harvest losses and price policy linking to trade policy.

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Citation:

Ahmad N, Sinha DK and Singh KM. 2018**.** Growth and Instability in Pulses: A Spatio-Temporal Analysis in Eastern India. *Journal of AgriSearch* **5** (1):