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Research Paper

Growth Rate of Pulses in Eastern Uttar Pradesh a Zone-wise Analysis

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ABSTRACT

Attempts are made in this paper to investigate the trend of pulses in Eastern Uttar Pradesh, as well as their instability and non-linear model. This time series data on pulses pertains to the period 1980-1981 to 2014-15 and includes information on the area, production, and productivity of pulses. Pulses have had negative growth in terms of area, production, and productivity in all three zones of Eastern Uttar Pradesh, namely, the North Eastern plain zone, the Eastern plain zone, and the Vindhyan zone. Since 1980-81, there has been a rise in the area and output of pulses in the Vindhyan zone, as seen by the percentage change. The Eastern plain zone has the most stable pulse crop in terms of instability.

Highlights

- Zone wise study of growth rates of pulses crops helps in agricultural planning and determining agricultural operation at the state level to meet rising food and nutritional security.

Keywords: Growth, trend, linear growth rate (LGR), Instability index, non- linear regression

Pulses belong to the Fabaceae or Leguminos as family and are the third largest flowering clusters in the world. Since the dawn of the farming of the principal plants in the globe, people have grown pulses to be domesticated. Pulses are a vital constituent of the super molecule in the diet of an overwhelming majority of the poor and eating in Asia (Devi *et al*. 2021). In addition to grains, pulses offer a great blend of eater super high biological value molecules. Asian countries continue to be home to the precious gold of the world's ill-fed people. Asian countries are the largest producers, businessmen and buyers of pulses, representing twenty fifths of world production in thirty-fifths of the world's space Vishwajith *et al*. (2014). About 15.2 percent of people in Asian squares are poorly fed. This shows the importance of food and nutrition pulses for Indians (Vani and Mishra, 2019). Pulses are produced mostly in Asian countries, particularly in the Indian subcontinent. Various pulse crops are large measured in the Asiatic country in a wide variety of agro-climatic circumstances therefore it is a major global pulse participant. Pulses do not encompass crops which square measure

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unrecovered (e.g. green peas, unrecognized beans) are categorized as vegetable crops. The assembly of pulses in Asia has been caught in the vicious circle of low and unsafe yields, which is less likely to produce pulses on irrigated and fertile land, leading to unstable and low returns. These crops must be supplemented with superior cereals and financial crops for resources, analysis and infrastructure.

MATERIALS AND STRATEGIES

The statistic knowledge concerning the amount from 1980-81 to 2014-15 on space, production and productivity of various crops are wont to study the expansion trends. These statistic knowledge are procured from the Bulletins of board of directors of Agricultural Statistics and Crop-Insurance, Krishi Bhawan, Lucknow, Government of state. Loads of efforts are created by Government of India to enhance the state of affairs of various crops production within the country within the past. Therefore, the statistic knowledge has been classified into 3 decade to review the decadal growth pattern of the world, production and productivity of pulses.

Applied math Methodologies

The applied math methodologies used for the analysis of your time series knowledge to satisfy the objectives of the thesis are delineate within the following sub-sections.

Growth Models

The trend and growth rates in space, production and productivity completely different of various} cereal crops have been figured out by fitting the subsequent 5 different functions (Mishra *et al*. 2021):

1. Simple linear operate

   $Y_t = a + bt + \mu t$

2. Compound operate

   $Y_t = at\ (1 + r)\ t\ \mu t$

Where,

Y_t: statistic knowledge on area/production/productivity of various cereal crops at time *t*, *a* & *b* are parameters of the operate to be calculable.

t: Time index (t= 1,2,…..,*n*)

r: Average compound rate every year

t: error term at t and is assumed to follow severally distributed.

However, before fitting the higher than functions, the statistic knowledge on space and production were smoothened by 3 years moving-average methodology.

Computation of rate

1. For linear operate

Once fitting the linear trend operate by least-square methodology, we tend to get the estimate of b denoted by (say). Then, annual linear rate is computed as follows (Dhekale *et al.* 2014).

$$r = \frac{\hat{b}}{\overline{Y}} \times 100$$

Where, $\overline{Y}$ is mean value of *Yt*.

2. Compound rate

To get annual compound rate, the third operate was initial linearised by taking natural go online each aspect, i.e.

$$Log\ Y_t = log\ a + t\ log\ (1 + r)$$

or $Y_t^* = a + bt$

Where, $Y_t^* = \log Y_t$, $a^* = \log a$ and $b = \log (1 + r)$

The higher than linear operate was fitted by least sq. methodology and estimate of b as $\hat{b}$ was obtained.

The annual compound rate is then computed as,

$$r = (\text{antilog of } \hat{b} - 1) \times \text{a hundred}$$

All growth rates are expressed in share. The most effective fitted operate was judged on the idea of R^2 (coefficient of determinations).

Measure of instability in crop production

High growth and low instability in crop production and agricultural property performance conditions. Vital issue is that the technological modification in the development of crops has increased the variability to one in all the food safety hazards. Given the scale of agricultural growth and instability for policy makers, the level of instability in space, crop production and productivity will be an adequate mathematical mistreatment calculable. The constant of variation is typically used to live the degree of instability. The straight forward coefficients of variation (C.V.) typically contain the trend element and therefore over estimate the amount of instability in statistic information characterized by future trend. To beat this drawback, a live of instability is calculable by mistreatment cook-house Della Valle Index that corrects the constant of variations and it's given by

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

Where, R^2 is that the constant of determination from a time trend regression adjusted by the amount of degree of freedom. Curve knowledgeable skilled is employed for fitting sixty seven linear and non-linear functions like rational model, Weibull model, provision power etc.

RESULTS AND DISCUSSION

Trends in space, production and productivity of total pulses

The average triennium space (in 1000 hectares), production (1000 tones), and productivity (kg/hectare) and their percent change over many decadal periods are measured by the total pulses square in Table 1 to 3 (Mishra *et al*. 2014). The average area of the triennium and its percentage changes in the three eastern Uttar Pradesh zones over a decadal period of total pulses. The area of total pulses has dropped in all three regions, save in the vindhyan zone.

Vindhyan zone has increased by 17.67% due to favorable weather conditions and adequate irrigation facilities. The triennium average of production and its percentage change has increased in the Vindhyan zone, but decreased in the North Eastern plain zone from 1980-81 to 1990-91. Because of the efficient use of fertilizer, production in the eastern plain zone is high. In all three productivity zones, the triennium average of total pulses has decreased. Although the area has grown, productivity has decreased dramatically due to unfavorable weather and inadequate irrigation facilities (Vani and Mishra 2019).

The area under total pulses has nominal downfall at the rate of 1.68 per cent during the entire period under study. The positive growth rate is found 1.19 per cent in first period. However, the second and

Table 1: Triennium averages ending at year shown of space (in '000' ha.), production (in '000' tones) and productivity (in kg/ha) of total pulses and its dynamic pattern in North Eastern Plain Zone

Crops	% change in 1990-91 over 1980-81	% change in 2000-01 over 1990-91	% change in 2010-11 over 2000-01	% change in 2014-15 over 2010-11	% change in 2014-15 over 1980-81
Area	25.32	-14.08	-30.98	-2.42	-27.48
Production	44.52	-12.99	-30.33	-22.58	-32.18
Productivity	15.31	1.26	0.94	-20.65	-6.47

Table 2: Triennium averages ending at year shown of space (in '000' ha.), production (in '000' tones) and productivity (in kg/ha) of total pulses and its dynamic pattern in Eastern Plain Zone

Crops	% change in 1990-91 over 1980-81	% change in 2000-01 over 1990-91	% change in 2010-11 over 2000-01	% change in 2014-15 over 2010-11	% change in 2014-15 over 1980-81
Area	-25.51	-9.98	-24.17	-5.46	-51.94
Production	-3.46	-18.29	-25.33	-23.54	-54.97
Productivity	29.60	-9.22	-1.53	-19.12	-6.31

Table 3: Triennium averages ending at year shown of space (in '000' ha.), production (in'000' tones) and productivity (in kg/ha) of total pulses and its dynamic pattern in Vindhyan Zone

Crops	% change in 1990-91 over 1980-81	% change in 2000-01 over 1990-91	% change in 2010-11 over 2000-01	% change in 2014-15 over 2010-11	% change in 2014-15 over 1980-81
Area	10.82	21.57	-11.19	-1.66	17.67
Production	0.64	25.71	-11.09	1.96	14.69
Productivity	-9.18	3.40	0.11	3.69	-2.52

third period witnessed the negative growth rate of 4.07 and 1.84 per cent, respectively (Table 4).

Table 4: Annual average simple and compound growth rate of the area, production and productivity of total pulses during a different period in the North Eastern Plain Zone

Period		Area	Production	Productivity
1980-81 to 1994-95	SGR	1.15	2.75	1.65
	CGR	1.19	2.88	1.66
1995-96 to 2004-05	SGR	-4.08	-5.17	-1.14
	CGR	-4.07	-5.21	-1.15
2005-06 to 2014-15	SGR	-1.86	-2.22	-0.31
	CGR	-1.84	-2.23	-0.35
1980-81 to 2014-15	SGR	-1.58	-1.02	0.61
	CGR	-1.68	-1.06	0.62

Similar is the case of production it has declined considerably at the rate of 1.06 per cent annually since 1980-81 onwards. The second period has experienced more downfalls at the rate of 5.21 per cent per annum as compared to negative growth rate of 2.23 per cent during third period. The productivity of total pulses has been found 0.62 per cent since 1980-81 onwards. The growth rate has been found to be more in first period i.e. 1.66 per cent. The negative growth rate is found 1.15 per cent during second period (Table 5).

Table 5: Annual average simple and compound growth rate of area, production and productivity of total pulses during a different period in the Eastern Plain Zone

Period		Area	Production	Productivity
1980-81 to 1994-95	SGR	-2.05	-0.76	1.34
	CGR	-2.06	-0.77	1.37
1995-96 to 2004-05	SGR	-1.74	-0.90	0.69
	CGR	-1.73	-0.96	0.73
2005-06 to 2014-15	SGR	-2.34	-2.15	0.05
	CGR	-2.29	-2.23	0.00
1980-81 to 2014-15	SGR	-2.29	-2.29	-0.03
	CGR	-2.30	-2.32	-0.02

The total pulses has registered tremendous downfall in its area at the rate of 2.30 per cent annually since 1980-81 to 2014-15. It can also be seen from the above table that this decline is more prominent during third period 2.29 per cent as against 2.06 and 1.73 per cent during the first and second period, respectively. The production of total pulses has declined by the rate of 2.32 per cent during the entire period of study. The negative growth rate has been found during all periods. The overall period has registered a nominal downfall in the growth of productivity, i.e. by 0.02 per cent per annum. The maximum growth of productivity is 1.37 per cent during first period (Table 6).

Table 6: Annual average of the simple and compound growth rate of the area, production and productivity of total pulses during different periods in the Vindhyan Zone

Period		Area	Production	Productivity
1980-81 to 1994-95	SGR	0.65	0.35	-0.33
	CGR	0.65	0.32	-0.32
1995-96 to 2004-05	SGR	1.50	2.86	1.29
	CGR	1.49	2.87	1.31
2005-06 to 2014-15	SGR	-0.62	2.81	3.43
	CGR	-0.62	2.85	3.49
1980-81 to 2014-15	SGR	0.66	0.51	-0.16
	CGR	0.67	0.52	-0.16

The area under total pulses has increased at the rate of about 0.67 per cent annually since 1980-81 to 2014-15. The increased in growth rate is prominent during the second period 1.49 per cent. However, the third period has witnessed negative growth rate of about 0.62 per cent. The production of total pulses has increased at the rate of 0.52 per cent annually. The maximum growth rate is obtained 2.87 per cent during third period as against 2.85 per cent during second period The productivity of total pulses has declined at the rate of 0.16 per cent annually. The maximum growth rate is obtained 3.49 per cent during third period (Table 6).

Table 7: Instability index (in %) of Total Pulses during 1980-81 to 2014-15

Zone	Area	Production	Productivity
North Eastern Plain Zone	9.85	13.60	5.63
Eastern Plain Zone	2.31	7.31	6.76
Vindhyan Zone	22.87	23.24	22.69

In the table 7 high instability of total pulses has been found in case of area, production and productivity in Vindhyan Zone and low instability has been found in Eastern Plain Zone this shows that pulse crop is most stable in Eastern Plain Zone (Sahu

Table 8: Linear and Non- Linear regression models for total pulses in North Eastern Plain Zone, Eastern Plain Zone and Vindhyan Zone

Crops	Zone	Model	A	B	C	d	S.E	R^2	Equation
Total pulses	North Eastern Plain	Sinusoidal	2.057	4.877	1.669	-2.243	2.684	6.485	a+b*cos(c*x+d)
		Exponential Plus linear	3.669	-2.309	-6.474		2.735	6.352	a+b*r^x+c*x
	Eastern Plain Zone	Weibull model	3.298	2.217	1.392	-1.712	2.752	8.38	a-b*exp(-c*x^d)
		Hoerl	3.205	9.665	1.316		2.758	8.32	a*b^x*x^c
	Vindhyan Zone	MMF	6.234	2.461	7.217	1.140	9.678	1.83	(a*b+c*x^d)/(b+x^d)
		Weibull model	7.198	9.799	4.980	6.638	9.725	1.75	a-b*exp(-c*x^d)

and Mishra, 2014). From the table 8 of non-linear regression model shows the top two results of the zones of Eastern Uttar Pradesh.

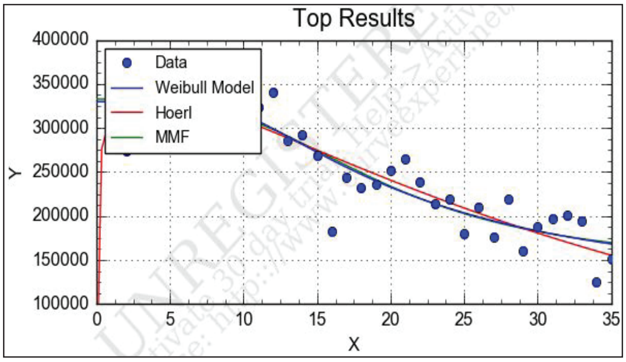

Fig. 1: Non-linear graph of North Eastern Plain Zone for different crops

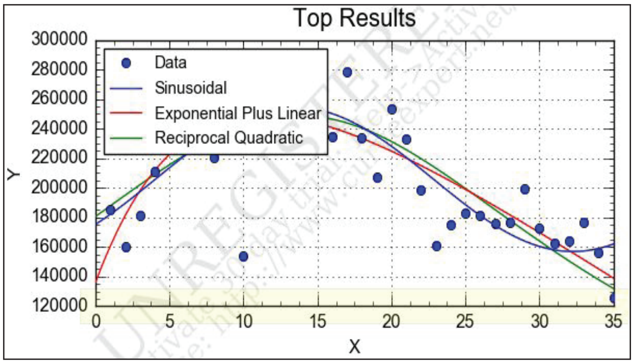

Fig. 2: Non-linear graph of Eastern Plain Zone for different crops

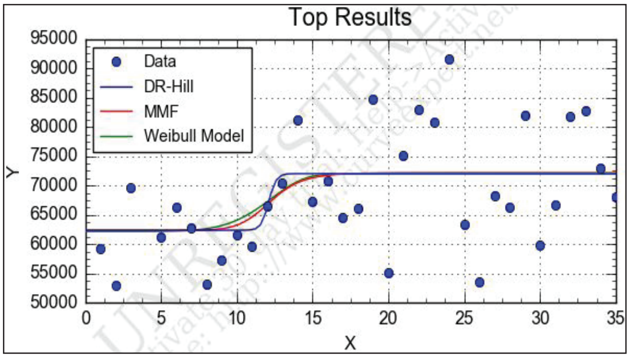

Fig. 3: Non-linear graph of Vindhyan Zone

Eastern plain zone shows best result of R^2 *i.e.* 8.38 in Weibull model, -6.48 Sinusoidal model in North Eastern plain zone and 1.83 MMF model in Vindhyan zone (Table 8). This shows that the value of R^2 for total pulses in Eastern Uttar Pradesh shows beneficial results in all the three zone (Fig. 1 to 3).

CONCLUSION

The data indicate that pulse productivity has increased annually in the North Eastern Plain Zone. Additionally, the Vindhyan Zone has the highest level of instability. As a result, officials at the state and national levels must initiate another mission-mode approach to boost pulse generation. Additionally, farmers must be provided with facilities and incentives for cereal production in general, and pulse production in particular. To supplement the supply of pulses in the current context, a public distribution system will not only provide pulses to the needy and improve nutritional security, but will also help stabilize prices and boost farmer incomes through secured procurement. Government procurement would give growers with enough marketing support. Alternative marketing structures such as contract farming and farmer producer cooperatives should be developed.

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