



# REGIONAL GROWTH ANALYSIS OF PULSES PRODUCTION IN UTTAR PRADESH, INDIA

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## Abstract

The study was conducted in the state Uttar Pradesh, which was selected purposively for the present study. Keeping in mind, the agro climatic conditions of the state was divided into nine agro-climatic zones. The methodology used was based on dynamicity of time and regionalization of area, production and yield of major pulses crops grown in the state. The study reveals that there was positive growth of area, production and productivity of urd bean, pea and moong bean whereas rest crops showed mixed trend. Variability of pulses was on higher side for production and productivity. There was decrease in production of pulses though increase in productivity was noticed due to reduction in area under pulses cropping. The future projection shows that we are lagging behind the production of pulses crops as it decreasing every year which forced to malnutrition for majority of the population in the state.

**Key words :** Pulses, growth rate, variability, decomposition analysis, future projection, demand and supply.

## Introduction

Pulses play a fundamental role as a low fat, high fiber source of protein and carbohydrates, the essential components of traditional food basket. Pulses contributing about 10 per cent in daily protein intake and 5 per cent in energy intake are of particular importance for food security in low income countries, where the major source of protein are non animal products. Pulses also contains thiamin, niacin, calcium, phosphorus, iron etc are also found in sufficient quantity and essential for human per day minimum nutrient requirement. During 1951 the area under pulses cultivation in India was 19.09 million hectares, which increased to 26.47 million hectares in 2015-16. The production of pulses increased from 8.41 million tonnes to 18.45 million tonnes. The production increased by 119.38 per cent where as the population increased by 252.12 per cent, showing more rapid growth for the same period. Due to population explosion, the per capita availability of pulses has declined from 60.72 g/day to 46.78 g/day against the requirement of 80 g/day.

The productivity of pulses has increased from 4.41 q/ha in 1951 to 8.03 q/ha in 2015-16. This shows that there was no significant increase in productivity of pulses as compared to the cereals. The main reason behind it

was that the pulses have been regarded as “The crop of the marginal area and crop of poor farmers”. Due to this reason very little promotional efforts by the farmers, government and other agencies has been taken. Other reason for low productivity and adaptability of pulse crops are highly susceptible to insects, pests and diseases as compared to pulses and other crops, insufficient availability of HYV seeds, poor and slow technological dissemination, improper marketing infrastructure. In this context, the minimum research attention towards pulses contributed more gap between its requirement and supply. Growth, variation and forecasting in agriculture production have become a matter of great concern from the view point of long term food security of the country. It is always desirable to maintain high and regular growth in farm production with minimum variability to achieve sustained economic growth.

Keeping in mind, the importance of pulses and estimation of its demand and supply and projection, a critical examination of growth, variation, decomposition analysis and constraints related to production, post harvest management and marketing infrastructure among various agro-climatic zones on one hand and the growth of population on other would have paramount importance.

An econometric study of the facts during thirty years (1981-82 to 2011-12) will help to determine the future strategies and desirable actions to meet the forth coming challenges in pulse production.

### Materials and Methods

Uttar Pradesh was purposively selected for study area as it rank first in production of cereals. As per National Agricultural Research Project (NARP) classification, the state has been classified into nine agro climatic zones (Ghosh, 1991) *viz.* Western Plain Zone, South Western Semi Arid Zone, Mid Western Plain Zone, Bhabhar and Tarai Zone, Central Zone, Bundelkhand Zone, Eastern Plain Zone, Vindhyan Zone and North Eastern Plain Zone have been taken into account for purpose of present investigation. A period of thirty years from 1981-82 to 2011-12 was taken into account by dividing it into three phases, *i.e.* Phase I (1981-82 to 1990-91), Phase II (1991-92 to 2000-2001) and Phase III (2001-02 to 2011-12) to find out the variation and decomposition analysis.

For the present study, major pulses crops grown in Uttar Pradesh are gram, pea, pigeon pea, lentil, mung bean and urd bean. Secondary information was collected on various aspects like area, production and productivity of major pulses and was utilized for estimation of growth in area, production and productivity of cereals, variability, decomposition analysis and forecasting through Directorate of Agriculture, Statistics Division, Lucknow, U.P. The collected data were categorized, classified and tabulated as per need and then suitable statistical tools were employed to analyze them.

#### Compound growth rate

The compound growth rate technique was used for explaining its growth patterns (Saravanadurai and Kalaivani, 2010).

$$Y = a b^t$$

Where, Y = area, production or yield.

t = time

a = intercept term.

b = 1 + r (constant)

r = compound growth rate

#### Decomposition analysis

An analysis of growth rate of area, production and productivity of crops indicate the general pattern of growth in production, although this does not evaluate the exact contribution of area and yield to production (Paul *et al.*, 2012).

$$\Delta P = A_0 \Delta Y + Y_0 \Delta A + \Delta A \Delta Y$$

Where,

$A_0$  = Total area under crops in base period

$Y_0$  = Total yield under crops in base period

$\Delta P$  = Average difference in total production during two periods.

$\Delta Y$  = Average difference in total yield during two periods.

$\Delta A$  = Average difference in total area during two periods.

#### Variability of area, production and productivity

The variability in area, production and productivity of pulses crops of the entire state and across different regions in different phases was worked out by using following technique (Paul *et al.*, 2012).

$$\text{Variability} = C. V. \times \sqrt{1} \times R^2$$

Where,

$R^2$  is coefficient of multiple determinations.

**Projection of the population :** The growth in population of the state was computed by using the following formula (NCAER, 1970).

$$P_t = P_0 \left( 1 + \frac{r}{100} \right)^t$$

Where,  $P_t$  = Population in t years

$P_0$  = Population in base year

r = annual compound growth rate

t = time (years)

**Projection of supply of cereals :** The production of pulses in the state was projected by log linear function. (Saravanadurai and Kalaivani, 2010).

$$Y = a b^t$$

Where, Y = production.

t = time

a = intercept term.

b = 1 + r (constant)

r = compound growth rate

**Projection of the demand :** The demand projection of pulses depends upon population of the state and was measured through :

Requirement = Population  $\times$  Minimum Requirement / Day  $\times$  No. of days in year.

**Projection of demand and supply gap :** Demand and supply gap depend upon the demand against the supply of pulses. It was calculated by the following formula :

Demand Supply Gap = Total demand  $\pm$  Total supply.

## Results and Discussion

Growth rate in area, production and yield in urd bean in Uttar Pradesh and across different zones have been presented in table 1. Overall growth rate in area was positive and significant in Zone I (4.05 per cent), III (3.85 per cent), V (1.24 per cent), VI (8.43 per cent) at 0.1 per cent level of significance. In Zone II and IX indicated negative and significant growth by 1.94 and 3.03 per cent. In Uttar Pradesh, it was 3.90 per cent and significant at 0.1 per cent level of significance. The overall production growth to the state (6.28 per cent) and to Zone I (5.88 per cent), III (8.62 per cent), IV (6.05 per cent), V (3.47 per cent), VI (10.72 per cent) and VI (3.22 per cent) was positive and significant at 0.1 per cent level of significance. In the state, overall growth in yield was positive and significant (2.29 per cent) at 1 per cent level of significance. Across the zones, positive and significant growth observed in all the zones at various levels of significance.

Table 1 shows the compound growth rate with respect to area, production and yield of moong bean. It indicates overall growth in area of Uttar Pradesh was positive 2.38 per cent and significant at 0.1 per cent level of significance. Across the zone overall growth was observed positive and significant in Zone I (4.06 per cent), Zone II (6.56 per cent) and Zone VI (5.87 per cent) at 0.1 per cent level of significance. But in Zone IV, VIII and IX it was found to be negative and significant. The overall growth in production of moong bean in the state was positive and significant. Across the zones it was positive in Zone I (5.84 per cent), Zone II (8.73 per cent) and in Zone VI (8.70 per cent) and significant at 0.1 per cent level of significance and Zone IV, VII, VIII and IX indicated negative and significant growth. Regarding the growth in yield in the state, it was found to be positive in the state as a whole.

Table 1 presents growth rate in area, production and yield of pigeon pea in the state and among the zones.

**Table 1 :** Compound growth rate of area, production and productivity of pulses in different regions of Uttar Pradesh.

Regions/Zones	Urd Bean(1981-82 to 2011-12)			Moong bean(1981-82 to 2011-12)			Pigeon Pea (1981-82 to 2011-12)		
	Area	Prod <sup>n</sup>	Yield	Area	Prod <sup>n</sup>	Yield	Area	Prod <sup>n</sup>	Yield
Zone I	4.05***	5.88***	1.75**	4.06***	5.84***	1.71*	3.06	0.06	-2.92
Zone II	-1.94**	0.31	2.29**	6.56***	8.73***	2.03*	-1.22	-3.51	-2.28
Zone III	3.85***	8.62***	4.59***	-0.75	1.38	2.15*	-9.60	-11.07	-4.43
Zone IV	0.11	6.05***	5.93***	-8.81***	-8.08***	0.85	-10.82	-10.11	-3.19
Zone V	1.24***	3.47***	2.20***	-0.41	1.05	1.47*	-2.86	-3.24	0.34
Zone VI	8.43***	10.72***	2.10*	5.87***	8.70***	2.67***	0.46	-1.66	-1.18
Zone VII	0.64	3.22***	2.56***	-5.3***	-5.55***	0.16	-2.21	-1.27	0.93
Zone VIII	-0.28	1.14	1.43**	-4.48***	-4.79***	-0.32	0.09	-0.79	-0.89
Zone IX	-3.03***	0.52	3.63***	-9.05***	-7.83***	1.34	-0.50	-1.15	-0.65
State	3.90***	6.28***	2.29***	2.83***	4.12***	1.25*	-1.83	-2.62	0.78

**Note :** Zone I- Western Plain Zone, Zone II- South Western Semi Arid Zone, Zone III- Mid Western Plain Zone, Zone IV- Bhabhar and Tarai Zone, Zone V- Cental Zone, Zone VI- Bundelkhand Zone, Zone VII- Eastern Plain Zone, Zone VIII- Vindhyan Zone, Zone IX- North Eastern Plain Zone, \* Significant at 5 per cent, \*\* Significant at 1 per cent and \*\*\*Significant at 0.1 per cent.

**Table 2 :** Compound growth rate of area, production and productivity of pulses in different regions of Uttar Pradesh.

Regions/Zones	Lentil (1981-82 to 2011-12)			Pea (1981-82 to 2011-12)			Gram (1981-82 to 2011-12)		
	Area	Prod <sup>n</sup>	Yield	Area	Prod <sup>n</sup>	Yield	Area	Prod <sup>n</sup>	Yield
Zone I	-5.49	-5.20	0.29	-10.59***	-10.85***	-0.28	-17.16***	-17.33**	-0.21
Zone II	-0.06	2.90	2.96	-12.37***	-11.88***	0.55	-11.44***	-10.90**	0.61
Zone III	0.03	1.80	1.76	-6.79***	-5.38***	1.51**	-20.53***	-19.87**	0.46
Zone IV	-3.95	-1.56	2.39	-1.72	-0.17	1.57***	-18.11***	-16.54**	1.91***
Zone V	6.13	7.42	1.28	-3.47***	3.24***	0.25	-3.69***	-2.78***	0.94***
Zone VI	2.48	-1.23	-3.71	13.17***	13.29***	0.10	-1.29***	-0.82	0.47
Zone VII	3.51	3.02	-0.48	-0.01	1.07***	1.08***	-7.39***	-7.10***	0.30
Zone VIII	3.45	4.96	1.50	5.40***	5.86***	0.43	-1.36***	-1.26**	0.10
Zone IX	2.28	4.46	2.18	-2.09***	0.30	1.83***	-12.97***	-12.25**	0.83
State	2.06	1.59	-0.46	1.13**	1.62**	0.47*	-3.47***	-3.06***	0.42

From the table, overall growth rate in area and production was negative in the state. Across zones overall growth was found to be negative in Zone II (1.20 per cent), III (9.60 per cent), IV (10.82 per cent), V (2.86 per cent), VII (2.21 per cent) and Zone IX (0.50 per cent) and other indicated positive growth. Zone wise overall growth was estimated to be negative except Zone V and VII.

Growth in area, production and yield of lentil is presented in table 2. It indicates overall growth of area in the state was 2.06 per cent. Zone wise overall growth was found to be positive in all the zones except in Zone I, II and IV. Table also indicates the overall growth rate in production with respect to lentil in the state. All the zones were observed to be positive but Zone I, IV and VI indicate negative growth. Regarding the overall growth in yield in the state was negative. Growth rate of the state was estimated to be negative but Zone II, III, V and IX indicates positive where as other zones have negative growth.

Growth rate in area, production and yield of area, production and yield of pea in the state and among the different zones is presented in table 2. The overall growth in area among the Zones was negative and significant, only Zone VI and VIII indicate positive growth by 13.17 and 5.40 per cent significant at 0.1 per cent level of significance. Overall growth in the state was also observed to be positive and significant. Regarding overall growth in production with respect to pea in the state was positive (1.82 per cent) and significant at 0.1 per cent level of significance. Table also indicate the overall as well as phase wise growth in yield of pea was observed to be positive in the state and in most of the zones.

Table 2 presents growth rate in area, production and yield of gram in the state and across the zones. Table indicates the overall growth in area of the state was positive and significant (1.13 per cent). Across the zones overall growth in area under grams was observed negative and significant but Zone VI and VIII showed positive and significant growth. Table also indicates growth in production of gram, overall growth was positive and significant (1.62 per cent) at 1 per cent level of significance. Across the zone, overall growth was worked out to be positive and significant in Zone V, VI, VII and VIII and negative and significant in Zone I, II, III and IV. In most of the zones, overall growth was observed to be positive but significant growth was only in IV and V zone. Negative growth was reported in Zone I.

The table 3 contains zone wise and overall variability in area, production and yield of pulse crops. From the table it is observed that in state, overall variation in area under pulse crops was 2.32 percent. Across the zone, overall variation was highest 12.54 per cent in Vindhyan

**Table 3 :** Variability of area, production and productivity of pulses in different zones of Uttar Pradesh (Percentage).

Regions/ Zones	Area (1981-82 to 2011-12)	Production (1981-82 to 2011-12)	Productivity (1981-82 to 2011-12)
Zone I	11.30	7.88	14.99
Zone II	5.14	21.72	18.75
Zone III	6.62	23.28	16.80
Zone IV	5.76	18.55	15.06
Zone V	2.97	19.54	19.26
Zone VI	8.99	20.09	14.17
Zone VII	3.29	18.29	17.90
Zone VIII	12.54	34.05	24.28
Zone IX	1.51	22.08	20.68
State	2.32	19.29	18.19

Zone followed by Western Plain Zone (11.30 per cent), Bundelkhand Zone (8.99 per cent), Mid Western Plain Zone (6.62 per cent), Bhabhar and Tarai Zone (5.76 per cent), South Western Semi Arid Zone (5.14 per cent), Eastern Plain Zone (3.29 per cent), Central Zone (2.97 per cent) and in North Eastern Plain Zone (1.51 per cent) in order of merit. The variability in production table shows that in the state as a whole, overall variability was estimated to be 19.29 per cent. The overall variability in yield of pulse crops in the state was 18.19 per cent. The overall variability in yield across the zones was highest (24.28 per cent) in Vindhaya Zone followed by that in North Eastern Plain Zone (20.68 per cent), Central Zone (19.26 per cent), South Western Semi Arid Zone (18.75 per cent), Eastern Plain Zone (17.90 per cent), Mid Western Plain Zone (16.80 per cent), Bhabhar and Tarai Zone (15.60 per cent), Western Plain Zone (14.99 per cent) and lowest in Bundelkhand Zone (14.17 per cent).

The overall situation in table 4 showed that decrease in production because of decrease in area to the extent of 200.34 per cent and minutely positive change in yield effect (179.78 per cent). Among the zones it was estimated that the production decreased in all the zones except Bundelkhand Zone and Vindhayan Zone. In Bundelkhand Zone, the area effect and yield effect was positive 127.42 per cent and yield effect 76.03 per cent while in Vindhyan Zone increment in area and yield was estimated 4.10 and 6.18 per cent, respectively. The zones with decrease in production due to more decrease in area than marginally less decrease in yield were Western Plain Zone (-10.52 per cent and + 1.14 per cent), South Western Semi-Arid Zone (79.89 per cent and +3.22 per cent), Mid-Western Plain Zone (-23.60 per cent and +12.01 per cent), Bhabhar and Tarai Zone (-18.61 per cent and +2.54 per cent), Central Zone (-91.32 per cent and +16.92 per cent), Eastern Plain Zone (-59.90 per cent and +24.52 per cent) and North Eastern Plain Zone

**Table 4 :** Decomposition Analysis of total pulses production with respect to area, yield and interaction effect in different zones of Uttar Pradesh (in percentage).

Regions	Effects	Phase I	Phase II	Phase III	Over all
<b>Zone 1</b>	<b>Area</b>	+0.42	-22.68	-8.62	-10.52
	<b>Yield</b>	+21.90	-9.91	-2.75	+1.14
	<b>Interaction</b>	+0.13	+0.73	+0.09	-0.05
	<b>Change in production</b>	Positive	Negative	Negative	Negative
<b>Zone 2</b>	<b>Area</b>	-70.01	-48.83	-31.01	-79.89
	<b>Yield</b>	+44.71	-25.89	+11.55	+3.22
	<b>Interaction</b>	-12.98	+1.26	-0.61	-0.44
	<b>Change in production</b>	Negative	Negative	Negative	Negative
<b>Zone 3</b>	<b>Area</b>	-40.22	-43.87	+4.26	-23.60
	<b>Yield</b>	+6.77	+2.11	+24.52	+12.01
	<b>Interaction</b>	-0.27	-0.15	+0.96	-0.24
	<b>Change in production</b>	Negative	Negative	Positive	Negative
<b>Zone 4</b>	<b>Area</b>	-12.95	-12.49	-9.18	-18.61
	<b>Yield</b>	+2.94	+5.25	+3.28	+2.54
	<b>Interaction</b>	-0.18	-0.38	-0.22	-0.35
	<b>Change in production</b>	Negative	Negative	Negative	Negative
<b>Zone 5</b>	<b>Area</b>	-42.49	-144.85	-71.14	-91.32
	<b>Yield</b>	+144.03	+33.83	-8.13	+16.92
	<b>Interaction</b>	-0.87	-0.85	+0.14	-0.39
	<b>Change in production</b>	Positive	Negative	Negative	Negative
<b>Zone 6</b>	<b>Area</b>	+177.48	+158.98	-14.32	+127.42
	<b>Yield</b>	+64.18	-155.48	+254.07	+76.03
	<b>Interaction</b>	+1.27	-3.29	-0.29	+0.79
	<b>Change in production</b>	Positive	Positive	Positive	Positive
<b>Zone 7</b>	<b>Area</b>	-54.38	-71.70	-48.51	-59.90
	<b>Yield</b>	+106.39	-10.51	+34.02	+24.52
	<b>Interaction</b>	-1.58	+0.25	-0.67	-0.59
	<b>Change in production</b>	Positive	Negative	Negative	Negative
<b>Zone 8</b>	<b>Area</b>	+2.78	+14.71	-12.15	+4.10
	<b>Yield</b>	+4.16	-7.57	+11.45	+6.18
	<b>Interaction</b>	+0.19	-0.14	-0.17	+0.30
	<b>Change in production</b>	Positive	Positive	Negative	Positive
<b>Zone 9</b>	<b>Area</b>	+19.44	-40.21	-54.08	-36.47
	<b>Yield</b>	+95.46	+16.64	+42.52	+21.24
	<b>Interaction</b>	+0.62	-0.26	-1.25	-0.42
	<b>Change in production</b>	Positive	Negative	Negative	Negative
<b>State</b>	<b>Area</b>	-14.59	-116.78	-254.87	-200.34
	<b>Yield</b>	+50.54	-206.07	+369.65	+179.78
	<b>Interaction</b>	-0.26	+1.13	-4.03	-1.54
	<b>Change in production</b>	Positive	Negative	Positive	Negative

**Table 5 :** Projection of population and population density of Uttar Pradesh.

Year	Population (crores)	Population density
1981	10.60	440
1991	13.20	548
2001	16.61	689
2011	19.98	828
2012	20.34*	843*
2013	20.71*	859*
2014	21.09*	875*
2015	21.47*	891*
2016	21.86*	907*
2017	22.26*	924*
2018	22.66*	941*
2019	23.08*	959*
2020	23.50*	977*
2021	23.92*	995*
2022	24.42*	1016*

Note : \* stands for Estimated value.

(-36.47 per cent and +21.24 per cent).

The data presented in table 5 depicts that the population of the state in 1981 was 10.60 crores with population density of 440 person/km<sup>2</sup> which increased to 13.20 crores with population density of 548 person/km<sup>2</sup> in 1991. It became 16.61 crores (2001) and it recorded 19.98 crores in 2011. The estimated population of Uttar Pradesh during 2012 to 2022 was calculated by annual compound growth rate of 1.82 per cent would be constant for projection period. The population in 2012 was estimated to be 20.34 crores with population density of 843 person/km<sup>2</sup>, which increased to 24.42 crores in 2022.

The perusal of table 6 reveals that the production of pulses in 1981, 1991, 2001 and 2011 was 2.25, 2.49, 2.37 and 2.33 million tonnes against the demand of 3.09, 3.85, 4.85 and 5.83 million tonnes during the respective years. The demand and supply gap of pulses reveals a supply deficit of 0.84, 1.36, 2.48 and 3.50 million tonnes. The demand and supply was also estimated for the period of 2012 to 2022. The result shows that the supply of pulses was declining from 2.01 (2012) to 1.63 million tonnes (2022) against the increased demand from 5.93 to 7.12 million tonnes, which indicates deficit in supply of pulses increased from 4.02 to 5.49 million tonnes during 2012-2022. The increase in demand and supply gap lead us to nutritional insecurity and compelled us for import to meet the growing demand.

### Conclusion

Urd bean holds good performances in absolute terms among the other pulse crops while the compound growth

**Table 6 :** Pulses demand and supply in Uttar Pradesh as per minimum recommendation of WHO (80 gm/ day).

Year	Supply (million tonnes)	Demand (million tonnes)	Demand supply gab (million tonnes)
1981	2.25	3.09	-0.84
1991	2.49	3.85	-1.36
2001	2.37	4.85	-2.48
2011	2.33	5.83	-3.50
2012	2.01*	5.93*	-4.02*
2013	1.88*	6.04*	-4.16*
2014	1.85*	6.15*	-4.3*
2015	1.82*	6.26*	-4.44*
2016	1.79*	6.38*	-4.59*
2017	1.77*	6.49*	-4.72*
2018	1.74*	6.61*	-4.87*
2019	1.71*	6.73*	-5.02*
2020	1.68*	6.86*	-5.18*
2021	1.66*	6.98*	-5.32*
2022	1.63*	7.12*	-5.49*

Note : \* stands for Estimated value.

rate revealed that the moong bean was found to be positive and recorded second highest growth rate among other pulse crops in terms of area of cultivation, production and yield in Uttar Pradesh over the study period. Eventhough, the fact that urd bean, moong bean and pea were found to obtain positive growth performance in production and yield among other pulse crops. The future projection shows that we are lagging behind the production of pulses crops as it decreasing every year which forced to malnutrition for majority of the population in the state.

### Competing interests

The authors have declared that no competing interest exists. This manuscript is neither published nor submitted for publication in some other journal or book.

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