



Research Article

PULSES ARE OUT OF REACH: A REGIONAL STUDY OF UTTAR PRADESH

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Abstract- Pulses are known as cheapest and easier source of protein for the rural population. Including Uttar Pradesh, there are 17 major pulses producing States in India. Uttar Pradesh has 9% area and 11% share in production in India, which stands fifth and fourth ranks in India. The study based on Uttar Pradesh and its four economic zones viz. Western, Central, Bundelkhand, and Eastern. The Government of India launched the project in just beginning of the nineties for self-sufficiency in pulses production. The impact of the project on production was quite good and it has recorded 12% as compared to 7% as in pre-period. Data were collected from data bulletins of Government of Uttar Pradesh and India. Analyses have been attempted on time series data on pulses crops like Arhar, Gram, Lentil, Pea and Total Pulses for four economic regions from 1970-71 to 2009-10. It is observed that the Arhar and Lentil crop is more prominent in Eastern region for area and production than other regions. Bundelkhand region has a leading position in terms of area and production of Gram. It is found that the only Bundelkhand region staying alone with valuable contribution of area and production of the State.

Keywords- Area, Production, Yield, Pulse crop, Economic Zone

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Introduction

Pulses are the edible dry seeds of leguminous plants. These are of special nutritional and economic importance due to their contribution to the diets of millions of people worldwide. The main importance of pulses lies primarily in their high protein content (two to three times higher than most cereals) with a valuable source of energy. The use of pulses as food is concentrated in developing countries accounting for about 90% of global human pulse consumption. In meager income countries, pulses contribute about 10 % of the daily protein and almost 5 % of energy intakes in the diets of people.

Uttar Pradesh is the second largest producer of the pulse in India, both in quantity and variety. Pulses are the primary source of protein for the poor and the vegetarians who constitute the majority of the Indian population in the State and the country. While the traditional cropping pattern almost always included a pulse crop either as a mixed crop or in the rotation, the commercialization of agriculture has encouraged the practices of sole cropping. However, Uttar Pradesh accounts for about 13.17 % of total national production, based on advanced estimates. It is well known that pulses are rich and a major source of protein in national and State food composition as the majority of Indians are vegetarian. Pulses are used to serve low-cost food to get the protein requirement of a larger section of people in India. But the pulses are becoming beyond the reach for the common people of the country because of its continue shoring prices.

Keeping all above attempts taken by Government of India in the frame of different technology programme launched with major crops (other than food grain) inclusively, with concerning on scenario of the area, production and yield from last decade government has to focus on a regional level or area under classified in certain criteria in the country. It has the mounting demand to carried out a study on which should be based on economic regions. The present study based on four

economic zones *i.e.*, Western Region, Bundelkhand Region, Central Region and Eastern Region of Uttar Pradesh. In this regards the data of the area, production and yield of major pulse crops grown in State have been used for the study to know how technology mission on pulse production could change the scenario of the area, production and yield in Uttar Pradesh since 1970-71 to onwards. To describe the regional status of major pulse crops an attempt has been carried out and presented in following sections [1,2].

Materials and Methods

The data is procured from the region wise statistical bulletin, published by Directorate of Agricultural Statistics and Crop Incurrence, Govt. of Uttar Pradesh and collected also from Statistical Abstract of Uttar Pradesh, Directorate of Economics and Statistics, Ministry of Agriculture. Data are collected from 1970-71 to 2009-10 in respect of the area, production and yield of major pulse crops *i.e.*, Arhar, Gram, Lentil and Pea with total pulses. All data are collected in the manner of administrative regions of Uttar Pradesh *i.e.*, Western, Central, Bundelkhand and Eastern Region covering 40.00%, 13.33%, 9.33% and 37.33% district of Uttar Pradesh, respectively [18,19].

The entire period 1970-71 to 2009-10 has been divided into two parts, *i.e.*, period I: 1970-71 to 1989-90 (before the launch of the project) and period II: 1990-91 to 2009-10 (after the launch of the project) to highlight the impact of the launch of National Pulse Development Project (NPDP).

Overview about Major Pulses Growing States

It is necessary to know before describing the regional pattern the rank of Uttar Pradesh among major pulse crops growing States in terms of area, production

and yield. The present status of major pulse growing States is presented in [Table-1] in terms of their ranking in the area, production and yield of total pulses [3,6,14,15].

Table-1 Ranking (first five) of major pulse crops growing States of area, production and Yield of total pulses during 2012-13 (based on fourth advanced estimate)

Ranks	State	Area	State	Production	State	Yield
Arhar						
I	Maharashtra	1.08	Maharashtra	0.91	Bihar	16.67
II	Karnataka	0.67	Madhya Pradesh	0.4	Uttar Pradesh	11.94
III	Madhya Pradesh	0.53	Karnataka	0.37	Gujarat	11.74
IV	Andhra Pradesh	0.48	Uttar Pradesh	0.37	Jharkhand	10.53
V	Uttar Pradesh	0.31	Gujarat	0.27	Odisha	9.29
Gram						
I	Madhya Pradesh	3.13	Madhya Pradesh	3.55	Karnataka	21.66
II	Rajasthan	1.25	Rajasthan	1.27	Bihar	15.00
III	Maharashtra	1.25	Maharashtra	1.06	Uttar Pradesh	12.17
IV	Andhra Pradesh	0.68	Andhra Pradesh	0.76	Gujarat	11.76
V	Uttar Pradesh	0.6	Uttar Pradesh	0.73	Madhya Pradesh	11.34
Lentil						
I	Madhya Pradesh	0.62	Uttar Pradesh	0.51	Rajasthan	13.33
II	Uttar Pradesh	0.57	Madhya Pradesh	0.23	Bihar	10.00
III	Bihar	0.17	Bihar	0.17	Uttar Pradesh	8.95
IV	West Bengal	0.06	West Bengal	0.04	West Bengal	6.67
V	Rajasthan	0.03	Rajasthan	0.04	Assam	5.00
Pea						
I	Uttar Pradesh	0.32	Uttar Pradesh	0.46	Haryana	20.00
II	Madhya Pradesh	0.28	Madhya Pradesh	0.19	Himachal Pradesh	17.47
III	Jharkhand	0.04	Jharkhand	0.04	Rajasthan	17.41
IV	Maharashtra	0.03	Bihar	0.02	Uttar Pradesh	14.33
V	Assam	0.02	HP	0.02	Manipur	12.22
Total pulses						
I	Madhya Pradesh	5.31	Madhya Pradesh	4.98	Jharkhand	10.73
II	Maharashtra	3.28	Uttar Pradesh	2.43	Uttar Pradesh	10.30
III	Rajasthan	3.25	Maharashtra	2.41	Bihar	10.19
IV	Uttar Pradesh	2.36	Rajasthan	1.95	West Bengal	9.55
V	Karnataka	2.33	Andhra Pradesh	1.56	Madhya Pradesh	9.38

Note: Area in million hectares, Production in million tonnes and yield in q/hectare

Source: Agricultural Statistics at a Glance, MOAFW, GOI

Major Arhar (*Cajanus cajan*) growing States are presented in [Table-1] shows the status of their ranking in the area, production and yield. It is very obvious from the table that Madhya Pradesh is on top in terms of area, while, U.P. is on the fourth position. In the case of production, Madhya Pradesh is again on top followed by U.P. However, U.P. is on top in terms of its Yield followed by Madhya Pradesh.

Ranks of all States in the production of Gram (*Cicer arietinum*) are followed the areas ranked States. It is showing that there is a high correlation between area and production of Gram. It is evidently observed from the table, the Madhya Pradesh is on top in area and production followed by Rajasthan, Maharashtra, A.P, and finally Uttar Pradesh on fifth place, respectively. It is very surprising evidence obtained in the case of Karnataka where the yield of Gram was found very high as abnormal due to high favorable climatic condition or adoption of high yielding variety during the period. Uttar Pradesh is standing on the third rank in case of yield. Bihar, Gujrat and Madhya Pradesh are standing on the second, fourth and fifth position in case of yield.

Madhya Pradesh is the largest area in the country for Lentil (*Lens culinaris*) cultivation and having the second rank in production. While in yield ranking, there is no significant place due to low productivity. Uttar Pradesh is still in the second rank in the cultivated area under Lentil crop and covering the first rank in production in the country along with the third rank in yield. In the case of yield Rajasthan having the first rank while stands on the fifth rank in both area and production. West Bengal is standing on the fourth rank in case of area, production and yield. Rajasthan is still on the fifth rank of ranking in area and production while due to high yield potential varieties it is first in yield [10-12].

Predominantly Pea (*Pisum sativum*) is a highly consumable item in Uttar Pradesh the fact is shown in [Table-1]. In this regard, Uttar Pradesh is registered first ranking in cultivation area of Pea and in production too. In the case of the second rank, Madhya Pradesh maintained their pace in cultivation of Pea in area and production both. UP and MP together has covered almost 77% and 76% of area and production of Pea in the country, respectively. The Other States like Jharkhand, Maharastra, Assam, Bihar and Himachal Pradesh producing Pea only

for survival which has only 23% and 24% of the area of cultivation and output of Pea. In the case of yield, it is registered the highest in Haryana due to the cultivation of high-yield varieties in quite a low area of cultivation. Himachal Pradesh and Rajasthan producing high yield due to their climatic conduction. Uttar Pradesh shows low yield efficiency than other due to the different climatic condition. Manipur is observed very low yielding State of Pea production due to its quite low area of cultivation.

It is observed from the table regarding the rank of major pulse growing States; Madhya Pradesh mounted in the area as well as production in the country, while it is standing on lowest rank in yield due to unavailability of high yielding varieties or it's belonging to the drought-affected area of the country. Maharashtra State is standing on the second position along with the third position in production. It is observed that Maharashtra has not come in yield ranking due to very low yield (7.34 q/ha). Rajasthan stands the third rank in the area and the fourth rank in production, while no rank found in yield rating. The rank of Uttar Pradesh still found at fourth in the area under cultivation of pulse crops, although it has maintained his position as second in case of production and yield, respectively. Karnataka has an about 10 % area under pulse cultivation with the fifth rank but contributing only 7 % in production which does not come in view of present ranking. Andhra Pradesh stands the fifth rank in production.

Percent share of area and production of Uttar Pradesh in India

Percent share of Uttar Pradesh in the Country has computed in the present section. This is computed in terms of area and production over the decade and displayed in [Table-2]. To obtain reliable figure is computation taken with triennium average of the State and Country. The percent share of the area of pulse crop of Uttar Pradesh in India depicted in [Table-2]. The table shows that the percentage share of State various from 21.71% to 9.35% with declining trend in 1973 and 2010 in the case of Arhar. The same trend has been observed in the case of Gram and Pea from 26.16% to 7.63% and 80.66% to 43.04%, respectively, during the same period. An increasing trend has shown in-

the case of Lentil as 22.46% to 37.85% over the period of time. It is obvious from the above result that the total pulses showing the also declining trend as 16.22% to 10.35% over the period. However, it is also considerable point the middle

decades *i.e.*, 1983 to 2003 showing the stagnant percentage of area Uttar Pradesh in the country.

Table-2 Decadal status of percent shares of area and production of Uttar Pradesh in India

Crops	Triennium average year									
	1973	1983	1993	2003	2010	1973	1983	1993	2003	2010
	Area					Production				
Arhar	21.71	16.90	14.07	11.23	9.35	39.07	31.41	24.54	19.82	10.43
Gram	26.16	20.88	17.60	14.43	7.63	30.70	26.21	21.66	16.84	7.65
Lentil	22.46	32.74	44.17	42.67	37.85	29.58	37.59	49.25	47.58	46.24
Pea	80.66	55.72	59.73	50.78	43.04	89.80	75.47	78.76	66.85	60.17
Total Pulses	16.22	12.73	12.57	12.75	10.35	26.96	21.47	19.83	18.88	12.77

The table shows that the percentage share of State various from 39.07% to 10.43% with declining trend in 1973 and 2010 in the case of Arhar. The same trend has been observed in the case of Gram and Pea from 30.70% to 7.65% and 89.80% to 60.17%, respectively, during the same period. An increasing trend has shown in the case of Lentil as 29.58% to 46.24% over the period of time. It is obvious from the above result the total pulses showing the also declining trend as 26.96% to 12.77% over the period. However, it is also considerable point the middle decades *i.e.*, 1983 to 2003 showing a declining trend of production Uttar Pradesh in the country.

Cropping Pattern in Uttar Pradesh:

The decadal cropping patterns since 1970-71 onwards have been worked out and are displayed in [Table-3]. It is obvious from the table that technological changes in crop production, particularly in rice, wheat, and oilseeds have marginalized the production of other cereal crops and pulse crops as well. The area under total cereals had increased steadily over last fifty years, and presently it constitutes about 69 per cent of the gross cropped area as compared to that of about 68 per cent in 1970-71. This increase in area under total cereals can evidently be attributed to increase in the area under rice and wheat, which together is now about 61 per cent as against about 45 per cent in 1970-71.

The scenario of total pulses production during last fifty years had been very gloomy. The area under total pulses had steadily decreased over every decade since 1970-71 onwards, and it is reduced to half, *i.e.*, about 10% at present from about 16% in 1970-71. Among the pulse crops, a drastic reduction in the area had been found under Arhar (2.51% to 1.30%), Pea (3.12% to 1.19%) and Gram (8.75 to 2.30%) over last fifty years. In contrast to these pulse crops, Lentil has gained its area from 0.72% in 1970-71 to 2.29% in 2010-11. This has been probably due to the development of rust-resistance varieties of Lentil which grasped the area of Pea which is more sensitive to environmental variation and rust and wilt diseases. The other pulse crops, which mostly constitute the Urd and Moong, had been experienced increasing trend in its area since 1970-71 onwards (from 0.75% to 2.48%). Traditionally the Urd and Moong were grown during Kharif season. But, due to the development of short duration varieties of Urd and Moong and its suitability is summer seasons the farmers started growing Urd and Moong in the summer season, and consequently, the area under these crops had started increasing since the late seventies onwards.

The area under total oilseeds was increased from 2.97% in 1970-71 to about 3.40% in 2000-01 and onwards and gone higher as 4.17 per cent. This increase in total oilseeds is found due to increase in the area under mustard and rapeseed which was witnessed increasing trends, *i.e.*, from 0.91% in 1970-71 to about 2.32% in 2010-11. Til was also experienced upward trend and had registered steady growth from 0.30 per cent to 1.34 per cent during last fifty years. However, the area under groundnut and linseed declined over the same period.

Two cash crops, *viz.*, Potato (*Solanum tuberosum*) and Sugarcane (*Saccharum officinarum*) had also shown increasing trend in its area since 1970-71 onwards. The potato registered a continuous growth in its area (from 0.70% to 2.07%), and the same case is with sugarcane (from 5.80% to 8.04%) over last fifty years.

It can be visualized from the table that the most of the area under total pulses has shifted to wheat (*Triticum aestivum*), mustard & rapeseeds (*Brassica nigra*) and

potato as these are competing for crops to pulse crops. The change is also found in other crops, which was registered about in 1970-71 (6.88%) with a quite low increase in 2010-11 (7.04%) its area during the period under study. This is probably because of diversification of agriculture in recent years and farmers have shifted the area towards more remunerative crops like a vegetable, medicinal and aromatic plants, and fruit crops [17].

Table-3 Cropping pattern (in % of gross cropped area) in Uttar Pradesh

S. No.	Crop	1970-71	1980-81	1990-91	2000-01	2010-11
1.	Total Cereals	67.8	71.66	67.05	69.62	69.13
(i)	Rice	19.04	21.53	22.04	23.34	22.69
(ii)	Wheat	25.45	33.01	33.63	36.51	38.26
(iii)	Maize	6.50	4.98	4.3	3.64	3.03
(iv)	Barley	5.71	3.17	1.67	1.13	0.64
(v)	Other	11.10	8.97	5.41	4.99	4.50
2.	Total Pulses	15.85	11.64	11.93	10.64	9.56
(i)	Arhar	2.51	2.13	1.84	1.61	1.30
(ii)	Pea	3.12	0.91	1.38	1.32	1.19
(iii)	Lentil	0.72	1.12	2.12	1.32	2.29
(iv)	Gram	8.75	6.09	5	3.29	2.30
(v)	Other	0.75	1.39	1.59	3.10	2.48
3.	Total Oilseeds	2.97	2.90	4.01	3.40	4.17
(i)	Mustard & rapeseed	0.91	1.66	2.72	2.2	2.32
(ii)	Groundnut	1.47	0.78	0.60	0.46	0.34
(iii)	Linseed	0.29	0.26	0.37	0.22	0.11
(iv)	Til	0.30	0.19	0.31	0.43	1.34
(v)	Other	0.00	0.01	0.01	0.10	0.06
4.	Potato	0.70	1.08	1.35	1.56	2.07
5.	Sugarcane	5.80	5.50	7.28	7.66	8.04
6.	Others	6.88	7.22	8.38	7.13	7.04
Gross cropped area (lacs ha)		217.30	232.07	245.74	253.04	256.15

Source: Statistical Abstract, U.P., Agricultural Statistics at a Glance, MOA, GOI

Changing pattern between two periods

To study the change in an area, production and yield of pulse crops during the two periods, *i.e.*, before and after the launch of Pulse Technology Mission, the triennium averages of the area, production and Yield ending at 1989-90 and 2009-10 had been computed along with % change between the two periods.

Changing pattern in the area between two periods along with their percentage is illustrated in [Table-4.1]. The story of Arhar in all four regions have shown negative change with the highest downfall in Central (-50.06%) followed by Western (-44.20%), Eastern (-28.88%) and Central regions (-14.07%). It has also noted that the same pattern follows the Gram with highly changing in central (-90.93%) followed by Eastern (-72.39%), Central (-55.81%) and Bundelkhand (-34.41%). In the case of Lentil, all regions show positive change except the Western region (-32.82%). Highest gain has been found central *i.e.*, 71.47% followed by Eastern (33.57%) and Bundelkhand (14.01%). The pattern of change in Pea has found quite high in Bundelkhand region *i.e.*, 425% whereas, other suffering negative change *i.e.*, -88.04%, -49.42% and -15.92% for the Western, Central and Eastern region, respectively. Overall total pulses are shown positive changing in only Bundelkhand region *i.e.*, 21.14% while rest of regions showed struggling with negative change *i.e.*, -58.24, -26.54% and -30.96 for Western, Central and Eastern regions between two periods of time.

Table-4.1 Change in area of Pulse crops between two periods

Crops	Regions	Area (000ha)		Change in area (000ha)	Percent change in area
		Triennium average ending 1989-90	Triennium average ending 2009-10		
Arhar	Western	101.05	56.39	-44.66	-44.20
	Central	113.94	56.90	-57.04	-50.06
	Bundelkhand	75.35	64.75	-10.60	-14.07
	Eastern	211.61	151.76	-59.85	-28.28
Gram	Western	170.24	15.45	-154.80	-90.93
	Central	233.14	103.03	-130.11	-55.81
	Bundelkhand	589.91	386.90	-203.01	-34.41
	Eastern	344.84	95.22	-249.62	-72.39
Lentil	Western	79.62	53.49	-26.13	-32.82
	Central	44.82	76.85	32.03	71.47
	Bundelkhand	172.70	196.89	24.20	14.01
	Eastern	148.93	198.93	50.00	33.57
Pea	Western	85.92	10.28	-75.64	-88.04
	Central	36.81	18.62	-18.19	-49.42
	Bundelkhand	35.51	186.53	151.02	425.24
	Eastern	103.81	87.28	-16.53	-15.92
Total pulse	Western	578.68	241.67	-337.01	-58.24
	Central	534.82	392.90	-141.92	-26.54
	Bundelkhand	945.36	1145.22	199.86	21.14
	Eastern	869.56	600.38	-269.18	-30.96

Source: Authors Calculation

Table-4.2 Change in production of Pulse crops between two periods

Crops	Regions	Production (000tonnes)		Change in production (000tonnes)	Per cent change in production
		Triennium average ending 1985-86	Triennium average ending 2009-10		
Arhar	Western	114.91	49.87	-65.03	-56.60
	Central	152.35	57.08	-95.27	-62.53
	Bundelkhand	113.39	45.29	-68.10	-60.06
	Eastern	236.77	119.26	-117.51	-49.63
Gram	Western	167.28	19.04	-148.24	-88.62
	Central	208.10	116.38	-91.72	-44.07
	Bundelkhand	399.24	292.01	-107.23	-26.86
	Eastern	287.75	89.96	-197.79	-68.74
Lentil	Western	42.11	45.56	3.45	8.20
	Central	23.72	62.52	38.79	163.52
	Bundelkhand	152.97	148.11	-4.86	-3.18
	Eastern	100.92	173.85	72.93	72.27
Pea	Western	117.71	13.38	-104.32	-88.63
	Central	43.28	24.76	-18.53	-42.80
	Bundelkhand	51.88	222.17	170.29	328.26
	Eastern	100.38	102.69	2.32	2.31
Total pulse	Western	505.68	205.19	-300.48	-59.42
	Central	462.45	328.50	-133.95	-28.97
	Bundelkhand	734.95	813.11	78.16	10.63
	Eastern	757.94	525.70	-232.24	-30.64

Source: Authors Calculation

Changing pattern between two periods of production of major pulse crop and their % change computed through triennium average ending and illustrated in [Table-4.2]. In the case of Arhar, all regions have registered with the negative change due to their reduction of area *i.e.*, -56.60% in Western, -62.53% in Central, -60.06% in Bundelkhand and -49.63% in Eastern regions. As perception about a reduction in area in case of Gram, all the regions have found negative change *i.e.*, -88.62%, -44.07%, -26.86% and -68.74% for Western, Central, Bundelkhand and Eastern regions, respectively. In the case of Lentil only, Bundelkhand region shows negative changing in their production between two periods due to a reduction in yield. All other regions due to high yield showed the positive changing pattern *i.e.*, 8.20% in Western, 163.52% in Central and 72.27% in Eastern region. Bundelkhand region has quite high positive change *i.e.*, 328.26% between two periods due to high increment in cultivated area in case of Pea. The performance of Pea in Eastern region is suffering from quite low positive change due to their high yield. Others regions have suffered due to negative changing pattern either their reduction of area or yield *i.e.*, -88.63% in Western and -42.80% in the

Central region. The positive performance of the overall production of the total pulse between two periods has shown only in Bundelkhand region due to the expansion of area which was found 10.63% and rest of them found with negative change as 59.42%, 28.97% and 30.65% for Western, central and eastern regions, respectively. Percent change in yield of major pulse crops along with total pulses in four regions is calculated between two spans of time *i.e.*, before and after the launch of Technology mission on Pulse Production and it is presented in [Table-4.3].

Table-4.3 Change in yield of Pulse crops between two periods, before and after launch of TMPP

Crops	Zones	Yield (q/ha)		Percent change
		1989-90	2009-10	
Arhar	Western	11.37	8.84	-22.22
	Central	13.37	10.03	-24.97
	Bundelkhand	15.05	6.99	-53.52
	Eastern	11.19	7.86	-29.77
Gram	Western	9.83	12.33	25.45
	Central	8.93	11.30	26.55
	Bundelkhand	6.77	7.55	11.52
	Eastern	8.34	9.45	13.22
Lentil	Western	5.29	8.52	61.06
	Central	5.29	8.13	53.68
	Bundelkhand	8.86	7.52	-15.08
	Eastern	6.78	8.74	28.97
Pea	Western	13.70	13.02	-4.93
	Central	11.76	13.30	13.08
	Bundelkhand	14.61	11.91	-18.46
	Eastern	9.67	11.77	21.68
Total pulse	Western	8.74	8.49	-2.84
	Central	8.65	8.36	-3.31
	Bundelkhand	7.77	7.10	-8.67
	Eastern	8.72	8.76	0.46

Source: Authors Calculation

The performance of yield for Arhar crop has shown negative in all the regions *i.e.*, -41.08%, -37.51%, -55.55% and -39.32% for Western, Central, Bundelkhand and Eastern region, respectively. Gram has shown positively high changing % in the Western region (23.72%) followed by Central (11.72%) and Bundelkhand (1.67%), however, it has registered with a negative change in Eastern region with quite a low percentage *i.e.*, -1.20% between two periods. Changing the pattern of the yield of Lentil crop showed only negative in Bundelkhand region (-8.08%) and rest of them has registered positive change *i.e.*, 57.17%, 70.97% and 49.34% for the Western, Central and Eastern region, respectively. In the case of the yield of Pea crop showed a positive change in regions *i.e.*, Central (17.90%) and Eastern region (28.77%), while it is registered negative in Western (-1.86%) and Bundelkhand region (-5.49%) between two periods. The changing pattern of yield between two periods for total pulse is registered with negative change *i.e.*, -7.84%, -13.71%, -13.76% and -6.53% for western, Central, Bundelkhand and Eastern regions, respectively.

Overview of availability of pulses:

Per person per capita availability of per day of the pulse in India and Uttar Pradesh is given in [Table-5]. It may be seen from the table that over the period from 1971 to 2011, the net per capita per day availability of pulses was fallen from 106 gms to 26.67 gms in Uttar Pradesh. On the contrary, the daily per capita availability of pulses is registered and also decrease from 51.20 gms to 43.01 gms during the same period. In this regard, the region-wise scenario is also shown a decrease from 99.82 gms to 7.57 gms, 112.59 gms to 25.02 gms, 326.23 gms to 230.10 gms and 80.70 gms to 18.03 gms for Western, Central, Bundelkhand and Eastern Region, respectively, during the same period. Per day per capita availability of Arhar was gone down during 1971 to 2011 in all the regions as well as in the State. The Western, Central, Bundelkhand and Eastern regions had been registered from 17.15 to 1.84 gms, 24.48 to 4.35 gms, 53.96 to 12.82 gms and 18.27 to 4.09gms during the last five decades. The State had been registered about 83% downfall *i.e.*, 21.58 gms to 3.72gms during last fifty years. In the case of chickpea, the availability has also gone down as Arhar in all regions

along within the State. Per day per capita availability was varied from 46.88 to 0.70 gms for Western, from 64.66 to 8.86 gms for Central, from 249.49 to 82.63 gms for Bundelkhand and from 29.71 to 3.09 gms for Eastern Region. The State had been registered 87 % downfall i.e., varied from 53.76 to 7.09 gms during 1971 to 2011.

The story of per day per capita availability of Lentil is satisfactory but not sufficient. The Western region had registered downfall in terms of availability i.e., 2.49 to 1.68 gms during the last five decades. The availability was varied for the Central region, Bundelkhand and Eastern regions from 1.67 to 4.76 gms, from 14.40 to

41.91 gms and from 2.96 to 5.96 gms, respectively during the same period. The State was registered positively as 88% availability of Lentil during the five decades which varied from 3.13 to 5.90 gms due to increasing the production.

Availability of Pea per day per capita has maximum varied in Bundelkhand i.e., from 6.69 to 62.87 gms followed by from 32.21 to 0.49 gms for Western, from 13.05 to 1.89 gms for Central and from 28.6 to 3.52 gms for Eastern region. The State had registered in per day per capita availability of Pea i.e., from 28.86 to 4.98 which is 81 % of downfall during the last five decades. [7,20].

Table-5 Region-wise per day per capita (in Gram) availability of major pulse crops during different decades

Major pulse Crops	Regions/State	Decades				
		1971	1981	1991	2001	2011
Arhar	Western Region	17.15	9.08	6.5	3.26	1.84
	Central Region	28.48	27.56	17.49	11.4	4.35
	Bundelkhand Region	53.96	62.8	46.16	29.11	12.82
	Eastern Region	18.27	16.86	12.23	9.08	4.09
	Uttar Pradesh	21.58	17.69	12.81	8.35	3.72
ChickPea	Western Region	46.88	16.71	9.46	2.79	0.7
	Central Region	64.66	39.97	23.89	12.7	8.86
	Bundelkhand Region	249.49	172.64	162.53	129.5	82.63
	Eastern Region	29.71	19.41	14.86	7.15	3.09
	Uttar Pradesh	53.76	28.56	22.04	12.61	7.09
Lentil	Western Region	2.49	1.84	2.38	1.96	1.68
	Central Region	1.67	1.35	2.72	4.74	4.76
	Bundelkhand Region	14.4	30.5	62.28	51.57	41.91
	Eastern Region	2.96	1.56	5.21	6.36	5.96
	Uttar Pradesh	3.13	2.92	6.63	6.69	5.9
Pea	Western Region	32.21	9.55	6.66	3.45	0.49
	Central Region	13.05	3.39	4.97	3.95	1.89
	Bundelkhand Region	5.69	1.67	21.12	91.56	62.87
	Eastern Region	28.6	5.77	5.18	5.07	3.52
	Uttar Pradesh	25.86	6.64	6.5	8.56	4.98
Total Pulses	Western Region	99.82	39.00	28.61	14.01	7.57
	Central Region	112.59	76.30	53.09	36.80	25.02
	Bundelkhand Region	326.23	269.78	299.20	317.78	230.10
	Eastern Region	80.70	44.49	39.15	29.09	18.03
	Uttar Pradesh	106.21	57.63	51.06	39.24	25.67
	India	51.20	37.40	40.30	33.40	43.01

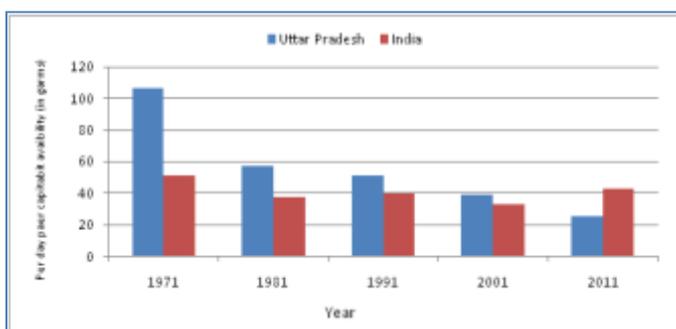


Fig-1 Distribution of per day per capita availability (Gram) of total pulse in State and Country

Per day per capita availability of total pulse had been registered as quite low in all the regions. The table shows about Western, Central, Bundelkhand and Eastern regions that the availability varied from 99.82 to 5.57 gms, from 112.59 to 25.02 gms, from 326.23 to 230.10 gms during last five decades. The State suffering continues downfall in per day per capita availability of total pulse during 1971 to 2010 from 106.21 to 25.67 gms which were counted as 76% reduction in aforesaid period. It is also notable that the Country also suffers a decline of availability of total pulse during the five-decade which is registered as 16 per decline and varied from 51.20 to 43.01 gms.

Volatility in the area, production and yield of pulse crops in various regions of U.P.

To measure volatility in the area, production and yield of different administrative regions are computed by the coefficient of variation. The coefficient of variation

has been computed for pre and post period of the launch of Technology Mission on Pulse production along with total period which is described in the present section. One thing is remarkable in this measurement that coefficient of variation varies with the pulse crops and the period under study.

In the case of Arhar, the most fluctuating regions in pre-phase of TMPP are Western and Bundelkhand regions with CV of 13.15%, 12.03%, respectively, and in the case of Central and Eastern regions are computationally stable i.e., 8.13% and 5.95%. In the case of Gram Western and Central region have become most fluctuating with CV of 33.08% and 23.82% and in which other regions are comparable with stable in pre-phase. The pre-phase of Lentil showed the highest fluctuation in Bundelkhand region with CV of 73.89% followed by an Eastern region with CV of 40.12%, Central with CV of 39.69% and Western Region with CV of 22.98%. In the case of Pea tremendous fluctuation is found in Bundelkhand region with CV of 92.52% and others are following with CV of 41.59%, 34.96% and 54.20% for Western, Central and Eastern regions, respectively. However, in the case of total pulses, it has shown high fluctuation in Western region with CV of 15.56% followed by 12.35%, 7.85% and 9.84 % for Central, Bundelkhand and Eastern regions, respectively.

In post-phase scenarios, the rate of fluctuation has become more strong than pre-phase for every region and every pulse crops the only exception in Lentil and three regions of Pea i.e., Central, Bundelkhand and Eastern regions which coefficient of variation in post-phase lower than pre-period. The table shows that in the total period only Central and Eastern regions shows moderate fluctuation as compared to post-phase for Arhar crop. In the case of Gram, Lentil, Pea and Total pulses showing strong fluctuation in the total period as compared to their post-phase of TMPP.

In the case of production level, the highest variation found in a Western region with CV of 33.12 followed by Bundelkhand, Central and Eastern regions i.e., CV

are 29.24%, 22.90%, and 14.5%, respectively in pre-phase in the case of Arhar Crop. However, in post-phase, it had fluctuation with CV of 24.53%, 33.03%, 29.16% and 23.60% in Western, Central, Bundelkhand and Eastern regions, respectively. The total period has been found strong fluctuation as compared to pre-phase. In the case of Gram highest variation has been found in Western Region (27.82%) followed by Central (26.49%), Bundelkhand (21.60%) and Eastern Region (16.40%) during pre-phase. In post-phase, there were remarkable variable counted in the Western region (65.93%) and Eastern Region (44.77%) and other had a weak variation as compared to pre-phase. However, in a total period, all regions had a strong variation as compared to the post-phase the only exception of Eastern region. The coefficient of variation was found stronger in pre-phase of Lentil crop as post-phase. While the total period has been also counted with strong fluctuation as compared to post phase of Lentil crop. It was found quite a high variation in pre-phase of Bundelkhand region (129.41%), while, other have had CV of 34.42%, 35.38% and 52.61% for the Western, Central and Eastern region in case of Pea. The post-phase has shown low fluctuation in all regions except in Western region which had a strong variation as compared to pre-phase.

Table-6.1 Coefficient of variation of area under pulse crops in different region during two phases

Crops	Period	Western region	Central region	Bundelkhand region	Eastern region
Arhar	Pre	13.15	8.13	12.03	5.95
	Post	18.87	28.43	15.78	14.05
	Total	19.82	23.00	23.32	10.89
Gram	Pre	33.08	23.82	6.17	9.36
	Post	69.18	25.69	13.09	42.60
	Total	79.60	47.65	13.63	43.95
Lentil	Pre	22.98	39.69	43.89	40.12
	Post	16.52	21.18	22.96	9.18
	Total	19.76	55.47	42.14	42.92
Pea	Pre	41.59	34.96	92.52	54.20
	Post	70.56	23.49	31.41	8.29
	Total	75.74	39.29	99.64	57.61
Total pulse	Pre	15.56	12.35	7.85	9.84
	Post	28.43	17.53	12.33	13.42
	Total	37.91	18.88	18.94	16.56

Source: Authors Calculation

Table-6.2 Coefficient of variation of production of pulse crops in different region during two phases

Crops	Period	Western region	Central region	Bundelkhand region	Eastern region
Arhar	Pre	33.12	22.90	29.24	14.51
	Post	24.53	33.03	29.16	23.60
	Total	45.29	33.39	35.31	22.90
Gram	Pre	27.82	26.49	21.60	16.40
	Post	65.93	23.35	20.83	44.77
	Total	69.89	40.27	20.95	41.29
Lentil	Pre	40.68	51.29	56.83	57.73
	Post	10.35	30.21	27.45	11.59
	Total	32.41	73.37	48.56	56.62
Pea	Pre	34.42	35.38	129.41	52.61
	Post	70.60	27.29	36.39	10.17
	Total	61.04	32.02	102.79	40.73
Total pulse	Pre	21.70	19.22	24.86	12.13
	Post	32.51	13.78	19.32	16.60
	Total	40.79	21.10	30.54	16.13

Source: Authors Calculation

In a total period of Pea showing quite a low variation in all regions as compared to the only exception of the Western region. In case of Total pulse, the pre-phase showing variation with CV of 21.70%, 19.22%, 24.86% and 12.13 for Western, Central, Bundelkhand and Eastern region, respectively, however, the post phase showed maximum variation in Western region with CV of 32.51% followed by Bundelkhand (19.30%), Eastern (16.60%) and Central region (13.75%). In a total period of total pulses shows high fluctuation in the Western region (40.79%), while other have CV of 21.10%, 30.54% and 16.13% for Central, Bundelkhand and Eastern region respectively.

Table-6.3 Coefficient of variation of yield of pulse crops in different region during two phases

Crops	Period	Western region	Central region	Bundelkhand region	Eastern region
Arhar	Pre	31.74	21.88	31.38	12.94
	Post	11.75	21.12	30.15	15.27
	Total	34.17	22.35	30.38	17.75
Gram	Pre	19.84	18.51	21.69	17.53
	Post	9.63	11.84	13.48	10.61
	Total	19.35	18.58	19.85	15.87
Lentil	Pre	22.26	17.04	21.14	21.77
	Post	13.90	13.56	22.94	8.02
	Total	29.19	26.24	22.23	23.92
Pea	Pre	21.11	24.30	33.92	25.10
	Post	11.37	9.73	18.21	7.57
	Total	22.38	22.94	27.17	25.49
Total pulse	Pre	16.03	16.30	20.89	12.87
	Post	6.80	13.05	14.01	6.23
	Total	12.17	14.57	18.47	10.48

Source: Authors Calculation

The coefficient of variation of yield in four regions for major pulse crops during the pre-phase, post-phase and total period under study is indicated in [Table-6.3]. The fluctuation in yield for Arhar crop was found more in pre-phase than the post-phase the only exception in Eastern region, however, total period is registered with strong variation as compared to post-phase. In the case of Gram, pre-phase has counted with strong fluctuation as compared to post-phase and it is remarkable that the total period performed as similar as pre-phase with quite a low variation. Pre-phase had strong variation in Lentil crop as compared to post-phase with the only exception in Bundelkhand region, however, the total period shows having more fluctuation as compared pre-phase. In the case of Pea, the pre-phase and total period had the behavior of the same type of variation with little bit dispersion to each other, while, both of the periods having strong fluctuation as compared to post-phase of TMPP. The coefficient of variation in total pulses is very wide in pre-phase as compared to total period, however, the post-period remained stable in each region. [4,9]

Constraints:

It was seen in last few decades, pulses production and productivity have been stagnant. It is due to the low-yield low-input nature, pulses are grown as alternative crops on marginal lands after taking care of food grain needs from high yield-high input crops like paddy and wheat by most farmers in Uttar Pradesh. It has also observed that farmers are shifting from cereal crops to vegetable crop for instant credit. The Bundelkhand region comes under the rainfed crops regions with little or no modern yield enhancing inputs. It is well-known that pulses like Urd, Moong, Lentil etc. were widely grown in this region due to the suitability of soil and climatic condition. The low priority accorded to pulse crops may be related to their relatively low status in the cropping system is mostly found in Eastern Region of Uttar Pradesh, might be area shifted in vegetable production for instant income. As a crop of secondary importance, in many of these systems, pulse crops do not attract much of the farmer's crop management attention. In addition to this, these crops are adversely affected by a number of biotic and abiotic stresses, which are responsible for a large extent of the instability and low yields. Formation of grain is mainly depending upon the temperature. Winter is an abiotic stress, affecting the yield of pulse crops. All summer season pulse crops are very sensitive to low temperature. Cool season crop (Gram) is often subjected to low temperature. There has been a high degree of risk in pulses production. More than 52% of the area under pulses is presently rainfed which comes under Bundelkhand region. Irrigated area under pulses virtually remains stagnant at 13% of the total area. Availability of adequate soil moisture for crop growth depends on rainfall, water holding capacity and depth of soil in rainfed areas. Another major problem is salinity and alkalinity of soils. Salinity and alkalinity are high both in semi-arid tropics and in the Indo-Gangetic plains in irrigated areas, which is a cause for concern, as most pulses are susceptible to salinity and alkalinity. Poor drainage stagnation during the rainy season causes heavy losses to Arhar on account of a low plant stand and increased the incidence of Phytophthora

blight (*Phytophthora infestans*) disease. More than 250 insect species are reported to affect pulses in the country. Among them, pod borer (*Maruca vitrata*) causes the most harm, followed by pod fly (*Melanagromyza obtusa*), wilt (*Fusarium wilt*), and root rot mainly in Uttar Pradesh. Among important diseases, wilt in gram, sterility mosaic virus in Arhar, yellow mosaic virus (YMV) and powdery mildew (PM) are common and more damaging.

By nature, pulse crop is attacked by more than one disease and pest at a time; causing low productivity of pulse crops. Post-harvest losses account for 9.5% of total pulses production. Among post-harvest operations, storage is responsible for the maximum loss (7.5%). Processing, threshing and transport cause 1%, 0.5% and 0.5% losses, respectively.

In any crop, generally, an increase in the production and productivity is brought about by the wider availability and adoption of improved varieties of seeds. The wide gap between the requirement of certified/quality seeds and its distribution in India as well as various regions of Uttar Pradesh State is a matter of great concern.

Cash is a key element for enabling small farmers to shift from low input-low output to high input-high output agriculture. But access to credit by these farmers is low because of their low asset base and low risk-bearing ability. Further, credit facilities for pulse crops both from formal and informal sources are limited due to unstable returns.

Markets for legumes crops are heavily channeled and fragmented due to scattered production and consumption across States. Farmers/village traders sell their marketed surplus immediately after harvest, while some large traders/wholesalers trade between major markets and hoard pulses to take advantage of speculative gains in the off-season.

It is very unfortunate that health professionals do not report that the pulses are richest and easiest sources of protein. During the discussion, they argued that the animal protein is also easily available and not claimed that the essential amino acids do not occur in animal protein. Insufficient consumption of pulses is also the cause of malnutrition. It is observed that only a few documents available for linkage in nutrition and pulse production. It should be recognized by now that the protein gap. The protein-gap is the lack of calories or rather than lack of sufficient food which is the major issue. It is quite possible that the declining trend in pulse production is affecting diets detrimentally. Another one thing has increased attention, the steady rise in prices of the pulse has put pulses are out of reach of a progressively larger number of people.

Conclusions

The status of Uttar Pradesh has a leading position in only Pea crop of major pulses, however, in production; it is mounted in the output of Lentil and Pea crop. None of the crops is found at leading position in yield of major pulse crops.

In the case of percent share in the area of the country it is registered high contribution for only Lentil crop in 2010 compared to 1973, however, in other crops have been contributing at present and about half from the beginning. The percent share of production it is observed as like area, while others are contributed at present and about one-fourth to half except Pea, from beginning.

The percent area of total cereals to the gross cropped area was marginally increased to about 69 % in 2010-11 from about 68 % in 1970-71. This increment was found due to increase in cropped area of rice and wheat. The % area of total pulses to the gross cropped area was declined to about 10 % in 2010-11 from about 16 % in 1970-71. However, the percent area of Lentil and others (mostly Urd) to the gross cropped area was increased from 0.72 to 2.29% and 0.75 to 2.48%, respectively during 1970-71 to 2010-11. Two cash crops, viz. Potato and Sugarcane had also been shown increasing trend in its area since 1970-71 onwards. Potato registered a continuous growth in its area (from 0.70% to 2.07%), and the same case was with sugarcane (from 5.80% to 8.04%) over last fifty years.

Percent change in the area of pulse crop between two periods has been positively the highest in Pea for Bundelkhand region, however in the case of Lentil crop Central region showed the highest and positive change followed by Eastern and Bundelkhand region and others are found negative change. It is notable that only Bundelkhand region has shown the positive change between two periods among

all has counted in case of Total pulses. In the production change between two periods is registered highly positive in Bundelkhand region followed by quite low in Eastern region for Pea. Another positive change in production in Lentil, whereas Central region registered with high change followed by Western region. In the case of Total Pulses only Bundelkhand region shows positive change like in the area. In the case of yield potential between two periods, it is found positive in Gram crop for all regions. In Lentil crop, Western and Central region performed the positive change, while in the case of change of yield has observed a positive change in the Central and Eastern region. The story of the Total pulse in terms of change in yield that only Eastern region counted positive change with below one percent that can be said that it was found constant.

Availability of major pulse crop with a total pulse is found very uncertain decline from 1971 to 2011. Of the all major pulse crop per day per capita availability is found quite high for only crops for Lentil and Pea in the only region of Bundelkhand region. It is a remarkable point that availability of total pulse has been found in only Bundelkhand region with upward increasing from the eighties to the entire period. Availability of per day per capita in Uttar Pradesh decline has been as one-fourth from the seventies to entire period, however, it is found in marginal change in case of Country.

It is found variability in area and yield obtained are quite high except some of the cases in all pulses crops, which affects the volume and variability of production. There is a need to evolve such varieties of pulse crops, which would be drought, pest, and disease resistant and suited to the climatic condition of various regions of the State. It is necessary to concentrate on yield portion and should research with new efforts on it. The routine research work is not a way to achieve the target but innovative ideas should be implemented. Area specific policies should be introduced and implemented for the enhancing the pulse producing. It is due to that nine agro climatic zones are existing in Uttar Pradesh and each agro climatic zone having their specific climatic condition. It has been observed that many stakeholders working on self-sufficiency of pulse production on their specific level from village to global level. It should be assembling at one platform and work together.

Application of Research: The present paper will help for policy formulation for the planning of pulse production in four economic zones of Uttar Pradesh.

Research Category: Pulses, leguminous plants

Abbreviations:

NPDP- National Pulse Development Project
MOAFW- Ministry of Agriculture and Farmers' Welfare
GOI- Government of India
TMPP- Technology Mission on Pulse Production
CV- Coefficient of Variation
gms- gram

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