

CULTIVATION OF VEGETABLES IN MID WESTERN PLAIN ZONE OF UP: GROWTH AND VARIATIONS

K. Srinivasa Rao*

*Associate Professor, Giri Institute of Development Studies, Lucknow, Uttar Pradesh.

In Uttar Pradesh there are 22 vegetable crops has been cultivating by the farmers. UP has 9 agro-climatic zones. Vegetable cultivation has occupied first position in Uttar Pradesh. Out of which Mid Western Plain Zone (MWPZ) is one of the vegetable producer in this state. In this ACZ 7% of area under vegetable cultivation. The main objectives of the present paper is to examine the trends of vegetable crops growth during 2013-18 and variations between 22 crops and 5 districts of this MWPZ in respect of vegetable cropped area, production and yield levels during 2015–18, and also to find out the significance of its variations between the area under vegetable crops grown in this zone, production levels and crops yield levels during 2015-18. To achieve the above objectives we have collected the data related to vegetable cropped area, production levels and yield levels during 2013-18 in respect of 22 crops in each of 5 districts in this zone during 2015-18. We found that the vegetable crops cultivation growth among 5 districts are positive, variations between each crop in each district are also different in respect of area, production and yield levels and finally there are significant variations are existing between each crop in each district with respect to cropped area, production and yields levels during the study period. Still there is a large scope in enhancing the vegetable cropped area; production and yield levels of each crop in each district of this agro-climatic zone of Uttar Pradesh.

Introduction

Vegetables are essential in human diet. India is the second largest producer of vegetables in the world, next to China. Vegetables are an important food crops playing a greater role in food trade in India. India has diverse climatic conditions to ensure the availability of all types of varieties of vegetables for consumption throughout the year. The contribution of vegetables remains highest (59 – 61%) in horticulture crop productions over the last five years (2013-18). Apart from nutritional benefits, the production of vegetables improves the economy of a country as these are very good source of income and employment. Thakur et al. (1996) efforts to increase vegetable acreage, provision of irrigation, adoption of improved and hybrid seeds, seed treatment and improved package practices were recommended for boosting vegetable production in the area. Vegetables are mostly grown by small and marginal farmers to increase the income of farmers. The area under vegetable cultivation in India during 2017-18 shows that 10259 ('000ha) and the production of vegetables has increased from 101.2 Million Tonnes to 184.40 Million Tonnes since 2004-05 to 2017-18. The productivity of vegetables in India shows that 17.97 (MT/ha) during the above mentioned period (Horticulture Statistics at a Glance, 2018). As per vision 2050 document of Indian Institute of Vegetable Research, Varanasi, India will require 375 million t of quality vegetables by 2050 which would need nearly 15 million ha area with an average productivity of 25 t/ha (IIVR vision, 2050, 2015). The output variation leads to fluctuation in its price making it more risky for vegetable growers.

However, by 2050 a gap of 5 million hectares of land and around 191 million tonnes of quality vegetables production is lower as on 2017-18. For this period the total vegetable production was highest in case of Uttar Pradesh (28.32 million tonnes) followed by 27.70 million tonnes in West Bengal. The per capita consumption of vegetables in India is only 257 grams per capita per day against minimum 300 grams per capita per day recommended by the dieticians. It clearly shows that we the people of India are not able to consume sufficient quantity of qualitative vegetables, because scarcity of vegetables and productivity levels are also very much low

in majority of the states. However, UP is producing relatively higher vegetables as compared to the other states of India.

In Uttar Pradesh the vegetable cultivated area has grown at the rate of 4.14 per cent of CAGR during the period of 2013–18. During this period Uttar Pradesh has occupied the first place in India as compared to all the other states. Especially, during 2014-15 the vegetable cultivated area has grown tremendously at the rate of 10.86 per cent. Subsequently, during 2016-17 also it has grown at the rate of 6.68 per cent respectively. These two levels of growth rates have contributed to reach Uttar Pradesh to a first place in vegetable cultivation. Earlier West Bengal used to be the first place, now it has second place in area under vegetable cultivation. However, sustainability of first place is most important for Uttar Pradesh. As seen from the data, Mid-Western Plain zone has recorded moderate vegetable production in this state. It means that this ACZ has five districts which are producing reasonable quantity of vegetables during this period. In view of this, the present paper wants to explain the trends in vegetable area, production and productivity of the five districts in this ACZ during 2013-18, whereas each vegetable crop-wise trends and variations during 2015-18 shows the number of crops grown and its variations among the crops grown in this zone as compared with these districts.

Objectives of the study: The specific objectives of the study are:

- To find out the vegetables cultivation growth trends in respect of Area, Production and Yield among the districts of Mid-Western Plain zone of UP during 2013-18;
- To analyse the vegetable crop wise variations in Area, Production and Yield among the districts of MWP zone of UP during 2015-18; and
- To calculate the significance of variations in Area, Production and Yield of vegetable crops among the districts of MWP zone of UP During 2015-18.

Data and Methodology: The secondary data on area, production and yield of all vegetables growing in MWP zone districts are collected during 2013-18. Specifically, vegetable wise area, production and yield levels of different crops data collected for this Agro-climatic zone districts during 2015-18. On the basis of the above data to achieve the first objective we have computed CAGR (Compound Annual Growth Rate) for Area, Production and Yield during 2013-18 for MWP zone districts. Secondly, to see the variations among various crops and districts, in each district what is the position of vegetable rank especially first place and finally to compute the variation of crops and districts significance levels in MWP Zone, Two way Anova with replication has run for the crop-wise area, production and yield panel data during 2015-2018.

Trends of Vegetable cultivated Area, Production and Yield during 2013-18 among Mid-Western Plain (MWP) zone Districts:

During 2013-18, CAGR recorded the vegetables cultivation area was 3.74 per cent on an average in this zone.

Table 1: Vegetables cultivated area for Mid-Western Plain zone districts during 2013-18 (CAGR and AGR (%))

Year/District	Badaun	Bareilly	Moradabad	Shahjahanpur	Sambhal	Zone Total
2013-18 (CAGR)	2.80	3.53	7.89	3.34	4.10	3.74
2015-14(AGR)	7.57	5.46	9.62	7.38	8.86	7.58
2016-15(AGR)	1.45	3.72	6.98	2.11	0.20	2.27
2017-16(AGR)	5.10	8.54	24.57	6.58	11.94	8.89
2018-17(AGR)	0.10	0.18	0.09	0.84	0.14	0.31

Source: Annual Reports of Department of Horticulture, Directorate of Horticulture, GoUP.

In this MWP zone area under vegetable cultivation of crops point of view Badaun has occupied first place (Large area under vegetables) among the districts of this zone, successively, Shahjahanpur, Sambhal, Bareilly and Moradabad respectively. According to CAGR growth rate during 2013-18 Moradabad has recorded highest growth followed by Sambhal which are above the average of ACZ and the remaining districts are below the zonal average like Bareilly, Shahjahanpur and Badaun respectively. The year-wise growth rates reveals that during 2013-15 and 2016-17 shows that all the five districts has grown more than 5%.

Table 2: CAGR (%) of Vegetable crops Production for MWP zone districts during 2013-18

Year/District	Badaun	Bareilly	Moradabad	Shahjahanpur	Sambhal	Zone Total
2013-18 (CAGR)	6.46	3.34	7.41	-0.10	10.22	4.56
2015-14(AGR)	14.17	5.86	17.94	11.89	13.42	12.43
2016-15(AGR)	3.37	3.83	8.42	4.77	4.09	4.50
2017-16(AGR)	15.73	7.00	11.67	-15.28	37.61	6.25
2018-17(AGR)	0.11	0.18	0.12	0.16	0.13	0.14

Source: same as table 1.

During 2013-18, CAGR recorded the vegetables cultivation Production was 4.56 per cent on an average in this zone. In this MWP zone Production under vegetable cultivation of crops point of view Badaun has occupied first place (Highest Production under vegetables) among the districts of this zone, successively, Shahjahanpur, Sambhal, Bareilly and Moradabad respectively. According to CAGR growth rate during 2013-18 Sambhal has recorded highest growth followed by Moradabad, Badaun which are above the average of ACZ and the remaining districts are below the zonal average like Bareilly. Whereas Shahjahanpur has recorded negative CAGR during this period. The year-wise growth rates reveals that during 2013-15 data shows that all the five districts has grown more than 5%. The important point to note is Shahjahanpur has recorded high negative growth during 2016-17.

Table 3: CAGR (%) of Vegetable cultivated Yield for MWP zone districts during 2013-18

Year/District	Badaun	Bareilly	Moradabad	Shahjahanpur	Sambhal	Zone Total
2013-18 (CAGR)	3.56	(0.19)	(0.45)	(3.33)	5.88	0.79
2015-14(AGR)	1.21	0.08	1.83	1.23	0.75	4.51
2016-15(AGR)	0.40	0.02	0.35	0.80	0.73	2.18
2017-16(AGR)	2.16	(0.32)	(2.73)	(6.43)	4.46	(2.42)
2018-17(AGR)	0.00	0.00	0.01	(0.17)	(0.00)	(0.17)

Source: same as table 1.

Finally, during 2013-18, CAGR recorded the vegetables cultivation yield was 0.79 per cent only on an average in this zone. In this MWP zone yield under vegetable cultivation of crops point of view Moradabad has occupied first place (Highest yield under vegetables) among the districts of this zone, successively, Bareilly, Shajahanpur, Sambhal, and Badaun respectively. According to CAGR growth rate during 2013-18 Sambhal has recorded highest growth followed by Badaun, Shajahanpur which are above the average of ACZ and the remaining districts are below the zonal average like Moradabad and Bareilly. The year-wise growth rates reveals that during 2013-15 data shows that all the five districts has grown marginally. The important point to note is Bareilly has recorded lowest growth during 2013-18.

Area under vegetable cultivation by crop-wise variations among the districts of MWP zone

The area under vegetable crops cultivation point of view, Bareilly has recorded first place in 6 crops like Ash gourd, Bottle gourd, Cauliflower, Onion, Peas (green) and Pointed gourd; followed by Shajahanpur in 5 crops like Beans, Okra/Lady Fingers, Pointed Gourd, Raddish and Tomato ; Badaun in 4 crops like Kaddu, Potato, Sweet Potato and Other vegetables; Sambhal in 4 crops like Ridge/sponge gourd (torai), Carrot, Bitter gourd, and Arbi; and Moradabad in 3 crops i.e. Brinjal, Green chilly, and Turnip respectively. Cabbage crop is not grown in this ACZ.

Production of Vegetable crops and its variations among the districts of ACZ by crop-wise:

The production of vegetable crops point of view, except small changes, more or less same results like area under vegetable cultivation have recorded for the districts and crops again. It means same number of crops have recorded first place in 6 crops in Bareilly; Shajahanpur also in 6 crops, i.e Potato added to this district; Sambhal in 4 crops; Moradabad in 3 crops; and Badaun in 3 crops respectively. As compared to area under vegetable cultivation, the production of potato is high in Shajahanpur, but area under potato is high in Badaun district, other wise all the remaining crops Production is same in all the other districts as seen in Area under vegetable cultivation.

The Yield levels of Vegetable crops and its variations among the districts of ACZ by crop-wise:

The yield of vegetable crops point of view, Shajahanpur has recorded first place in 8 crops like Ridge/Torai, Pointed Gourd, Peas (Green), Okra/LF, Carrot, Brinjal, Bottle gourd, and Bitter gourd; followed by Bareilly in 7 crops like Sweet Potato, Potato, Pointed gourd, Onion, Beans, Ash gourd, and Arbi; Badaun in 3 crops like Cauliflower, Tomato and Turnip; Moradabad in 2 crops like Raddish and other vegetables; and Sambhal in 2 crops like Green chilly and Kaddu respectively. The above trends reveals that there are large variations between area, production as compared to yield among the districts.

Significance of variations in Area, Production and Productivity of vegetable crops among the districts of MWP zone:

As seen from the above, trends and variations between 22 crops grown in 5 districts are presented. But, to determine the variations among various crops grown in various districts are significant or not been explained so far. In view of this the following analysis has been computed to measure the significance levels of the crops grown in MWP zone districts with respect to vegetable cropped area, production and yield levels. The following analysis computes the variations are significant or not among the districts by crop-wise during the study period (2015-18). To achieve the above we have adopted two way anova with replication for two factors(crops and districts) related to area, production and yield variations among 22 crops and 5 districts for three years data (panel data) significance levels.

Two way Anova with replication Results:

The two way anova determines whether the mean differences between these groups are statistically significant or not. Additionally, two-way ANOVA determines whether the interaction effect between the two factors (Crops, districts) is statistically significant. Replication in this context refers to collecting multiple observations in each group.

Here the dependent variable is vegetable cropped area and the independent variables are different crops and different districts. We want to test the vegetable cropped area in each crop and in each district are same or different. If it is same there will be no problem of scarcity of each vegetable in any of the districts of this MWP zone during 2015-18, otherwise vice versa...

Table 4: Two-way ANOVA with replication results for Area under vegetable cultivation for crops (22) and districts (5) during 2015-18 (panel data)

ANOVA	Source of Variation	Df	P-value
	Sample(crops)	21	0
	Columns(districts)	4	0
	Interaction (crops vs. districts)	84	0
	Within	220	
	Total	329	

Source: as table 1.

Ho = there are no variations in cropped area between different crops, between different districts and between different crops and districts

H1 = there are variations in cropped area between different crops, between different districts and between different crops and districts

According to the above results, the p-value is <0.05 , which means the crop area for various crops (22) is not the same. So null hypothesis is rejected and alternative hypothesis reveals that the vegetable cropped area is different from crop to crop among 22 crops. Secondly, the cropped area between each district is not the same, p-value is <0.05 , which means the cropped area between the districts are different from one to one among 5 districts. Finally, the interaction effect of crops vs. districts, cropped area between these two are also different, p-value is <0.05 , which means the cropped area is significantly different between crops and districts (each crop as well as in each district). Hence, there are significant differences exist between each crop and each district in case of cropped area in MWP zone of Uttar Pradesh.

Table 5: Two-way ANOVA with replication results for Production under vegetable cultivation for crops (22) and districts (5) during 2015-18 (panel data)

	Source of Variation	Df	P-value
	Sample(crops)	21	0
	Columns(districts)	4	0
	Interaction (crops vs. districts)	84	0
	Within	220	
	Total	329	

Source: as table 1.

Ho = there are no variations in production between different crops, between different districts and between different crops and districts

H1 = there are variations in production between different crops, between different districts and between different crops and districts.

According to the above results, the p-value is <0.05 , which means the production for various crops (22) is not the same. So null hypothesis is rejected and alternative hypothesis reveals that the vegetable production is

different from crop to crop among 22 crops. Secondly, the vegetable production between each district is not the same, p-value is <0.05 , which means the production between the districts are different from one to one among 5 districts. Finally, the interaction effect of crops vs. districts, production between these two are also different, p-value is <0.05 , which means the vegetable production is significantly different between crops and districts (each crop as well as in each district). Hence, there are significant differences exist between each crop and each district in case of vegetable production in MWP zone of Uttar Pradesh.

Table 6: Two-way ANOVA with replication results for Yield under vegetable cultivation for crops (22) and districts (5) during 2015-18 (panel data)			
	Source of Variation	Df	P-value
	Sample(crops)	21	0
	Columns(districts)	4	0.00
	Interaction (crops vs. districts)	84	0.00
	Within	220	
	Total	329	

Source: as table 1.

H_0 = there are no variations in yield levels between different crops, between different districts and between different crops and districts;

H_1 = there are variations in yield levels between different crops, between different districts and between different crops and districts

According to the above results, the p-value is <0.05 , which means the yield levels for various crops (22) is not the same. So null hypothesis is rejected and alternative hypothesis reveals that the vegetable yield levels are different from crop to crop among 22 crops. Secondly, the yield levels between each district is not the same, p-value is <0.05 , which means the yield levels between the districts are different from one to one among 5 districts. Finally, the interaction effect of crops vs. districts, yield levels between these two are also different, p-value is <0.05 , which means the yield levels are significantly different between crops and districts (each crop as well as in each district). Hence, there are significant differences exist between each crop and each district in case of vegetable yield levels in MWP zone of Uttar Pradesh.

Hence, we conclude that the vegetable cropped area, vegetable production levels and vegetable crop yield levels are significantly different at 5% level between each crop (22) and in each district (5) of MWP zone in Uttar Pradesh. The interaction effect of both the vegetable crops and districts are also significantly different between these two factors. It clearly reveals that the dependent variables like vegetable cropped area, production and yield levels are significantly different from each vegetable crop between each district of MWP zone of Uttar Pradesh.

Conclusions: Uttar Pradesh has reached first place in vegetable cultivation in India. According to IIVR document revealed that there is a gap of 5 million ha, of vegetable cropped area will be required for India by 2050 to meet the additional demand of vegetable production of 191 million tonnes. As seen from the data, MWP zone has 5 districts and 22 crops which are growing continuously. First of all, according to the above data, the trends

in area under vegetable cultivation, production of vegetables and yield levels of vegetable crops in this ACZ are as follows: In this MWP zone area under vegetable cultivation of crops point of view Badaun occupied first place among the districts of this zone, successively, Shajahanpur, Sambhal, Bareilly and Moradabad respectively during this period. Secondly, the production of vegetable crops trend reveals that Badaun has recorded first position followed by Shajahanpur, Sambhal, Bareilly and Moradabad respectively. Finally, the yield levels of vegetable crops, Moradabad, Bareilly, Shajahanpur, Sambhal and Badaun respectively. It seems that the absolute values point of view Badaun has recorded first place as compared to the remaining districts of this zone in respect of area and production under vegetable cultivation of crops. Whereas, the yield data shows that Moradabad has recorded high as compared to other districts of this ACZ during 2013-18. This ACZ is an example for reverse large variations, which means small area and production under vegetable cultivation yield levels are higher in Moradabad, whereas large area and production under vegetable cultivation yield levels are smaller in Badaun district respectively.

Secondly, The district wise data (5) and the crop wise (22) data reveals that there are large variations have taken place during 2015-18 (average) in respect of area under vegetable cultivation, production and the yield levels in this ACZ. The area under vegetable cultivation reveals that, Bareilly has recorded first place in 6 crops; followed by Shajahanpur in 5 crops; Badaun and Sambhal in 4 crops each and Moradabad in 3 crops respectively. The production of vegetable crops point of view, same number of crops have recorded first place in 6 crops in Bareilly and Shajahanpur, i.e Potato (additional) followed by same crops as in area under cultivation; followed by Sambhal (4) and Badaun and Moradabad (3 each) respectively. The yield of vegetable crops point of view, Shajahanpur has recorded first place in 8 crops; followed by Bareilly in 7 crops, Badaun in 3 crops and Sambhal and Moradabad in 2 crops each respectively. The area under vegetable cultivation and production shows similar positional variations, whereas yield under vegetable cultivation shows entirely different variations among the positions of districts and crops. It clearly reveals that there are large variations exists in area under vegetable cultivation and yield levels among the districts.

Finally, whether the above mentioned variations are significant or not is tested by Two Way ANOVA with replication for Area under vegetable cultivation, Production and Yield levels of 22 crops growing in 5 districts of MWP zone during 2015-18 panel data. All the above three dimensions data clearly reveals that the variations among crops and districts are highly significant from area under vegetable cultivation, production and yield levels at 5% level. Hence, the level of variations among crops and districts are highly significant.

Suggestions

1. First of all in Bareilly district area and production is occupied first place in 6 crops, whereas in yield levels reveal that 7 crops has occupied first place in this district. It is a model for this ACZ indicates that other districts in this zone should learn from Bareilly. Next, Shajahanpur district also performs well like 5 crops

first place in area, 6 crops first place in production and 8 crops first place in yield which is also a another model in this ACZ.

2. Secondly, Moradabad district has recorded vegetable crop yield levels in first place and it has large scope of expansion of area under vegetable crops in this district. Whereas this district has recorded high yield levels in respect of 2 crops namely, Raddish and Other vegetables. It means there is a possibility to enhance the area under cultivation of the above 3 crops in this district.
3. Finally, the remaining districts in this ACZ have lot of scope in enhancement of area, production and yield level under vegetable cultivation in coming future.

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