

Original Research Article

Inter Year Yield Instability of Major Crops in Rajasthan Agriculture

Jitendra Suman^{1*}, Hari Singh², Devendra Kumar Verma² and Pradeep Patil²

¹Department of Agricultural Economics, S.K.N. College of agriculture, Jobner. S.K.N. Agriculture University Jobner-303329, Rajasthan, India

²Department of Agricultural Economic & Management RCA, MPUAT Udaipur (Raj.) – 313001, India

**Corresponding author*

ABSTRACT

The study was based on secondary data on productivity of past twenty years from 1995-96 to 2014-15 were collected from various published sources. The rabi cereals were more stable, the detrended yield instability was found lower i.e. 7.59 per cent for barley and 7.76 per cent for wheat crops than kharif season crops. The kharif cereals, bajra (33.60%) and jowar (37.39%) emerged with high CV values in yield. In case of pulses moth, urad, moong and arhar were found to have very instable yield with very high CV values. As far as oilseeds are concerned, the CV values of yield ranged between 10.18 per cent for rapeseed and mustard to 46.22 per cent for sesame. The CV value with respect cash crops was highest for guar (56.48%) and lowest for sugarcane (14.16%). Spices the CV values for the yield varied between 11.23 per cent for fenugreek to 25.37 per cent for cumin during the study period from 1995-96 to 2014-15. The crops bajra, jowar, moth, urad, moong, sesame, cotton and guar falls in the category of high growth and high instability. The pulse arhar under the category of low growth and high yield instability. Paddy, gram, soybean, cumin and chili were found under the category of low growth and low instability in yield. Crops like maize, wheat, barley groundnut, rapeseed & mustard, linseed, castor, sugarcane and garlic were found high growth and low instability in yield which is desirable. The crops coriander and Fenugreek comes under the category negative growth and low instability in yield. Both area and yield of these crops declined drastically over the years.

Keywords

Yield, crops, instability, productivity and Growth

Introduction

Agricultural development in India has undergone many changes over the years. The changes especially in the last two decades are attributable to multiplicity of factors. Investment in agriculture sector through institutional and other sources has not been on the desired rate, though a number of policy decisions were taken to give high priority to agriculture. Consequently, the share of agricultural GDP has been reduced from over 55% in 1950-51

to 13.9% in 2013-14 indicating that the growth in agriculture sector has not been comparable to that of other sectors. Indian economy has been passing through different phases during the past years. However, there was a sea change in the character of the economy from mid-1991. The economy has now been channelized by pursuing a policy of liberalization with a view to globalizing the Indian economy and to integrate it with the world development process. While

setting the future strategy for agricultural production one has to look in to the past performance more critically, as without studying the past performance and trend, the strategic needs of the future cannot be framed meaningfully.

Rajasthan is the largest state in India. It has a geographical area of 34.2 million hectares. The total cultivated area of the state is 20 million hectares. Net cropped area of the state is 18.3 million hectares, rained area 11.68 million hectares and irrigated area 6.66 million hectares in the year 2014-15. Agriculture sector in Rajasthan is prone to high risk and uncertainties which in turn make it necessary to assess the magnitude of growth as well as instability. The measurement of magnitude of instability helps policy makers, as it plays a crucial role in policy issues like feasibility of crop insurance planning schemes, level of buffer stocks, pattern of marketing, storage export and so on. It also helps to assess the causes and estimate the level of investment in various crop enterprises. The magnitude and source of instability are guiding factors for the farmers in streamlining the policy package benefiting to different agro-climatic situations.

Despite progress in irrigation and technology, the agriculture production and income are subject

To large year-to-year fluctuations, playing havoc with farmers' livelihood and adversely affecting their decisions to invest in farming. These fluctuations also undermine the viability of agriculture sector and its potential to contribute to economic growth as well as food and nutritional security. Most of the studies on Indian agriculture have looked at the instability in agricultural production at aggregate level and have focused only on production.

Research Methodology

The study was based on secondary data on productivity of past twenty years from 1995-96 to 2014-15 were collected from various published sources.

The data were analysis instability of selected major crops in Rajasthan i.e. 1995-96 to 2014-15. Further it was divided in two periods i. e. first period 1995-96 to 2004-05 and second period 2005-06 to 2014-15.

The instability of yield of selected crops was worked out by following formula:

$$\text{Instability Index 1 (I}_1\text{)} = \frac{SD}{AM} \times 100$$

Where,

I = Instability index

SD = Standard deviation of yield of the crop for specified period.

AM = Arithmetic mean of yield of the crop for specified period.

$$\text{Instability Index 2 (I}_2\text{)} = \frac{SD^*}{AM^*} \times 100$$

Where,

I= Instability index

SD*= Standard deviation of detrended yield of crop for specified period.

AM*= Arithmetic mean of detrended yield of crop for specified period.

Detrend values were worked out:

$$\text{Detrended value} = \frac{TSCR}{T} \text{ (Trend, Seasonal, Cyclical, Irregular random variation)}$$

Results and Discussion

Cereals

The detrended yield instability for cereals in Rajasthan state recorded 9.34 per cent during the period of 1995-96 to 2014-15. Rabi cereals were more stable where the detrended yield instability was found lower i.e. 7.59 per cent for barley and 7.76 per cent for wheat crop than kharif season crops. In the state, the kharif cereals like jowar, bajra, maize and paddy were highly instable crops in which detrended yield instability were recorded highest in jowar crops i.e. 37.39 per cent followed by bajra (33.60%), maize (19.72%) and paddy (17.17%). Thus, it can be concluded that in rabi season, the yield instability was lower due to the technology change or crops wheat and barley are grown mostly under irrigated condition which impart lot of stability to the production but the the kharif season crops mainly depended on rainfall which is untimely irregular in the state. Paddy was grown in the irrigated condition but there is the limit factor of suitable climate condition.

First period (1995-96 to 2004-05)

The yield instability in the state for cereals recorded 11.05 per cent during the first period 1995-96 to 2004-05. The instability of the first period for various cereal crops varied from as low as 8.32 per cent to 43.16 per cent. Barley recorded the lowest instability (8.32%) closely followed by wheat (9.80%) and paddy (18.79%). Jowar recorded the highest instability (43.16%) closely followed by bajra (38.22%) and maize (20.39%) this is due to lack of irrigation facilities and erratic rainfall.

Second period (2004-05 to 2014-15)

The yield instability in the state for cereals recorded 7.54 per cent during the second

period 2005-06 to 2014-15. The yield instability of the second period for various cereal crops varied from as low as 6.30 per cent to 31.86 per cent. Wheat recorded the lowest instability (6.30%) closely followed by barley (6.78%) and paddy (12.57%). Jowar recorded the highest instability (31.86%) closely followed by bajra (25.78%) and maize (19.57%). It can be concluded that in the whole period i.e. 1995-96 to 2014-15 cereals like jowar recorded the highest instability crop followed by bajra and maize.

Pulses

The yield instability in the state for pulses recorded 24.21 per cent during the study period 1995-96 to 2014-15. The instability for various pulse crops varied from as low as 16.38 per cent to as high as 58.74 per cent. Rabi crop Gram was found more stable crop in which detrended yield instability was 16.38 per cent than the kharif pulses. In conclusion kharif pulses were found highly instable crops in which the detrended yield instability were 58.74 for moth followed by moong (54.46%), arhar (35.82%) and urd (31.73%). Thus, it can be concluded that in the post reform period, the pulses were highly instable because of erratic rainfall situation, fluctuation in market prices shifting of area in substitute crops etc. Gram is rabi season crop grown in irrigated conditions, technology effect are not seen due to decrease in area and not availability of high yielding varieties that it is moderate stable crops.

First period (1995-96 to 2004 -05)

The yield instability in the state for pulses recorded 26.24 per cent during the first period 1995-96 to 2004-05. The instability of the first period for various pulse crops varied from as low as 10.75 per cent to as high as 69.91 per cent. Gram recorded the

lowest instability (10.75%) followed by urd (27.71%). Moth recorded the highest instability (69.91%) closely followed by moong (63.11%) and arhar (46.30%).

Second period (2004-05 to 2014-15)

The yield instability in the state for pulses observed 22.57 per cent during the second period 2005-06 to 2014-15. The instability of the second period for various pulse crops varied from as low as 19.94 per cent to as high as 47.22 per cent. Gram recorded the lowest instability (19.94%) closely followed by arhar (22.50%) and urad (33.38%). Moong recorded the highest instability (47.22%) closely followed by moth (44.07%). It can be concluded erratic rainfall over the time moong and moth were showed high instability.

Oilseeds

The yield instability in the state for oilseeds recorded 13.77 per cent during the study period 1995-96 to 2014-15. The instability for various oilseed crops varied from as low as 10.18 per cent to as high as 46.22 per cent. Rapeseed & mustard was recorded more stable crop. In rabi season oilseed like groundnut (17.90%), linseed (22.12%) and soybean(23.03%) showed moderate instable while Sesame with 46.22 per cent coefficient of variation adjusted for trend (CVT) was estimated to be the highest unstable oilseed crop in the state and castor seed (29.63%) also observed as high instability. This moderately instability in soybean and groundnut due to the slow increment in area while sesame showed high instability due to incidence of pest and disease over the year in the state.

First period (1995-96 to 2004-05)

The yield instability of the first period in the state for oilseeds registered 18.57 per cent

during the period 1995-96 to 2014-15. In the first period for various oilseed crops varied from as low as 7.05 per cent to as high as 54.62 per cent. Linseed recorded the lowest instability (7.05%) closely followed by rapeseed & mustard (10.95%) and groundnut (21.13%). Sesame recorded highest instability (54.62%) closely followed by castor seed (36.13%) and soybean (27.53%).

Second period (2005-06 to 2014-15)

The yield instability in the state for oilseeds recorded 7.49 per cent during the second period 2005-06 to 2014-15. The instability of the second period for various oilseed crops varied from as low as 8.48 per cent to as high as 31.92 per cent. Rapeseed & mustard recorded the lowest instability (8.48%) closely followed by groundnut (15.15%) and soybean (18.90%). Sesame recorded the highest instability (31.92%) closely followed by linseed (30.17%) and castor (19.15%). That higher instability in the overtime in the oilseeds crops like sesame, linseed and castor due to high incidence of pest and disease during the season.

Cash Crops

The coefficients of variation of original and detrended yield during the period 1995-96 to 2014-15 all cash crops observed 14.23 per cent instability. The yield instability in the state for various cash crops varied from as low as 14.16 per cent to as high as 56.48 per cent.

Sugarcane recorded the lowest instability (14.16%). guar with 56.48 per cent coefficient of variation adjusted for trend (CVT) was estimated to be the highest unstable cash crop in the state. Cotton recorded intermediate instability (34.17%) between cotton and guar.

Table.1 Inter year yield instability of cereals in Rajasthan

Crops	Yield instability					
	Original yield			Detrended yield		
	Mean (kg/ha)	SD (kg/ha)	CV (%)	Mean (kg/ha)	SD (kg/ha)	CV (%)
Overall Period (1995-96 to 2014-15)						
Cereals	9724.4	1747.38	17.96	0.99	0.09	9.34
Bajra	691.8	320.14	46.27	1.00	0.33	33.60
Maize	1362.95	358.54	26.30	1.00	0.19	19.72
Jowar	466.6	205.79	44.10	1.00	0.37	37.39
Paddy	1888.9	348.51	18.45	0.99	0.17	17.17
Wheat	2858.85	439.59	15.37	0.99	0.07	7.76
Barley	2455.3	431.69	17.58	1.00	0.07	7.59
First Period (1995-96 to 2004-05)						
Cereals	8506.2	1348.40	15.85	1.00	0.11	11.05
Bajra	525.7	268.95	51.16	1.00	0.38	38.22
Maize	1184	294.77	24.89	1.00	0.20	20.39
Jowar	369.8	171.66	46.42	1.00	0.43	43.16
Paddy	1772.4	160.42	9.05	1.00	0.18	18.79
Wheat	2530.9	317.66	12.55	1.00	0.09	9.80
Barley	2123.4	242.27	11.4	1.00	0.08	8.32
Second Period (2005-06 to 2014-15)						
Cereals	10942.6	1153.22	10.53	0.99	0.07	7.54
Bajra	857.9	287.62	33.52	0.99	0.25	25.78
Maize	1541.9	336.65	21.83	0.99	0.19	19.57
Jowar	563.4	197.78	35.1	0.99	0.31	31.86
Paddy	2005.4	256.58	12.79	1.00	0.12	12.57
Wheat	3186.8	260.86	8.18	0.99	0.06	6.30
Barley	2787.2	299.89	10.75	0.99	0.06	6.78

Table.2 Inter year yield instability of pulses in Rajasthan

Crops	Yield instability					
	Original yield			Detrended yield		
	Mean (kg/ha)	SD (kg/ha)	CV (%)	Mean (kg/ha)	SD (kg/ha)	CV (%)
Overall Period (1995-96 to 2014-15)						
Pulses	2372.9	624.19	26.30	1.00	0.24	24.21
Moth	228.2	140.86	61.72	1.00	0.59	58.74
Urad	396.35	139.54	35.20	1.00	0.31	31.73
Moong	341.65	205.07	60.02	1.00	0.54	54.46
Gram	735.7	126.65	17.20	1.00	0.16	16.38
Arhar	671	237.61	35.41	1.00	0.35	35.82
First Period (1995-96 to 2004-05)						
Pulses	2164.9	569.00	26.28	1.00	0.26	26.24
Moth	188.6	144.16	76.43	1.00	0.70	69.91
Urad	355.5	97.3	27.37	1.00	0.27	27.71
Moong	249.2	167.33	67.14	1.00	0.63	63.11
Gram	716.1	77.61	10.83	1.00	0.10	10.75
Arhar	655.5	307.03	46.84	0.99	0.46	46.30
Second Period (2005-06 to 2014-15)						
Pulses	2580.9	634.53	24.585	0.99	0.22	22.57
Moth	267.8	132.75	49.57	0.99	0.43	44.07
Urad	437.2	167.13	38.22	0.99	0.33	33.38
Moong	434.1	204.43	47.09	0.99	0.47	47.22
Gram	755.3	164.27	21.75	0.99	0.19	19.94
Arhar	686.5	156.17	22.74	0.99	0.22	22.50

Table.3 Inter year yield instability of oilseeds in Rajasthan

Crops	Yield instability					
	Original yield			Detrended yield		
	Mean (kg/ha)	SD (kg/ha)	CV (%)	Mean (kg/ha)	SD (kg/ha)	CV (%)
Overall Period (1995-96 to 2014-15)						
Oilseeds	6008.45	1293.18	21.52	1.00	0.13	13.77
Groundnut	1389.15	416.22	29.96	1.00	0.17	17.90
Soybean	1147.4	271.75	23.68	0.99	0.23	23.03
Sesame	243.65	122.28	50.18	0.99	0.45	46.22
Rapeseed & Mustard	1147.2	198.66	17.31	0.99	0.10	10.18
Linseed	912.05	385.43	42.25	1.00	0.22	22.12
Castor	1170.6	351.07	30.00	1.00	0.29	29.63
First Period (1995-96 to 2004-05)						
Oilseeds	5091	1072.82	21.07	1.0	0.18	18.57
Groundnut	1100	292.57	26.59	1.00	0.21	21.13
Soybean	1082.1	307.11	28.38	1.00	0.27	27.53
Sesame	196.4	134.56	68.51	1.02	0.56	54.62
Rapeseed & Mustard	1003.8	158.85	15.82	1.00	0.10	10.95
Linseed	640.9	116.58	18.19	0.99	0.07	7.05
Castor	1067.8	386.93	36.23	1.00	0.36	36.13
Second Period (2005-06 to 2014-15)						
Oilseeds	6925.9	713.48	10.30	0.99	0.07	7.49
Groundnut	1678.3	307.13	18.3	1.00	0.15	15.15
Soybean	1212.7	228.27	18.83	0.99	0.18	18.90
Sesame	290.9	92.19	31.69	0.99	0.31	31.92
Rapeseed & Mustard	1290.6	111.29	8.62	0.99	0.08	8.48
Linseed	1183.2	369.65	31.24	0.99	0.30	30.17
Castor	1273.4	294.94	23.16	0.99	0.19	19.15

Table.4 Inter year yield instability of cash crops in Rajasthan

Crops	Yield instability					
	Original yield			Detrended yield		
	Mean (kg/ha)	SD (kg/ha)	CV (%)	Mean (kg/ha)	SD (kg/ha)	CV (%)
Overall Period (1995-96 to 2014-15)						
Cash crops	55252.73	12499.81	22.62	1.00	0.14	14.23
Cotton	351.19	132.91	37.85	1.01	0.34	34.17
Sugarcane	54609.13	12255.75	22.44	1.00	0.14	14.16
Guar	292.59	177.18	60.57	1.07	0.60	56.48
First Period (1995-96 to 2004-05)						
Cash crops	45151.16	7404.67	16.39	1.0	0.16	16.36
Cotton	259	99.45	38.38	1.00	0.39	39.52
Sugarcane	44716	7366.44	16.47	1.00	0.16	16.43
Guar	176.1	83.05	47.16	1.00	0.47	47.54
Second Period (2005-06 to 2014-15)						
Cash crops	65354.3	6947.06	10.62	1.0	0.05	5.52
Cotton	443.2	92.55	20.88	1.00	0.09	9.84
Sugarcane	64502.2	6733.16	10.43	1.00	0.05	5.47
Guar	408.9	172.46	42.17	1.00	0.32	32.02

Table.5 Inter year yield instability of spices in Rajasthan

Crops	Yield instability					
	Original yield			Detrended yield		
	Mean (kg/ha)	SD (kg/ha)	CV (%)	Mean (kg/ha)	SD (kg/ha)	CV (%)
Overall Period (1995-96 to 2014-15)						
Spices	7691.65	1047.32	13.616	0.99	0.11	11.74
Coriander	1037.5	169.95	16.38	0.99	0.16	16.35
Fenugreek	1155.6	135.84	11.75	0.99	0.11	11.23
Cumin	343.7	87.94	25.58	0.99	0.25	25.37
Garlic	4007.45	1035.15	25.83	0.99	0.20	20.55
Chilli	1225.4	239.16	19.51	1.00	0.19	19.47
First Period (1995-96 to 2004-05)						
Spices	7224.1	958.27	13.26	1.0	0.09	9.26
Coriander	1046.3	128.54	12.28	0.99	0.05	5.82
Fenugreek	1195.5	170.62	14.27	1.00	0.14	14.20
Cumin	353.9	90.18	25.48	1.00	0.21	21.08
Garlic	3425.8	871.5	25.43	1.00	0.19	19.54
Chilli	1202.6	269.75	22.43	0.99	0.22	22.03
Second Period (2005-06 to 2014-15)						
Spices	8159.2	954.78	11.70	0.99	0.1	10.73
Coriander	1028.7	210.43	20.45	0.99	0.19	19.78
Fenugreek	1115.7	79.42	7.11	0.99	0.07	7.06
Cumin	333.5	89.23	26.75	0.99	0.25	25.75
Garlic	4589.1	866.5	18.88	0.99	0.18	18.00
Chilli	1248.2	216.4	17.33	0.99	0.15	15.44

Table.6 Classification of crops in terms of growth and instability in productivity of major crops in Rajasthan (1995-96 to 2014-15)

Instability	Yield growth		
	+ve High ($\geq 1.96\%$)	+ve Low ($< 1.96\%$)	Negative
High ($\geq 30\%$)	Bajra, Jowar, Moth, Urad, Moong, Sesame, Linseed, Castor, Cotton, Guar	Arhar	
Low ($< 30\%$)	Maize, Wheat, Barley, Groundnut, Rapeseed & Musturd, Sugarcane, Garlic	Paddy, Gram, Soybean, Cumin, Chili	Coriander, Fenugreek

Table.7 Classification of crops in terms of growth and instability in (detrended) productivity of major crops in Rajasthan (1995-96 to 2014-15)

Instability	Yield growth		
	+ve High ($\geq 1.96\%$)	+ve Low ($< 1.96\%$)	Negative
High ($\geq 30\%$)	Bajra, Jowar, Moth, Urad, Moong, Sesame, Cotton, Guar	Arhar	
Low ($< 30\%$)	Maize, Wheat, Barley, Groundnut, Rapeseed & Mustard, Linseed, Castor, Sugarcane, Garlic,	Paddy, Gram, Soybean, Cumin, Chili	Coriander, Fenugreek

The instability in these crops like cotton and guar were recorded as highly instable crop due to the technological factors effect cotton and erratic rainfall effect guar.

There are the yield was increased in cotton due to showing improved and bt cotton varieties in the state. Sugarcane was recorded as stable crop due to increase in area and yield proportionately beside this sugarcane crop grown only some certain part of the state in every year.

First period (1995-96 to 2004-2005)

The yield instability of the first period in the state for cash crops registered 16.36 per cent during the period 1995-96 to 2014-15. The instability of the first period for various cash crops varied from as low as 16.43 per cent to as high as 47.54 per cent. Sugarcane recorded the lowest instability (16.43%).

Cotton recorded the intermediate instability (39.52%). guar recorded highest instability (47.54%).

Second period (2005-06 to 2014-15)

The instability in cash crops during second period observed very low 5.52 per cent. The range of instability various for different cash crops from as low as 5.47 per cent to as high as 32.02 per cent. Sugarcane recorded the lowest instability (5.47%) closely followed by cotton (9.84%). guar recorded the highest instability (32.02%).

Spices

During the period 1995-96 to 2014-15 all spices recorded 11.74 per cent instability. The instability in the state for various spice crops varied from as low as 11.23 per cent to as high as 25.37 per cent. Fenugreek

recorded the lowest instability (11.23%) closely followed by coriander (16.35%). cumin with 25.37 per cent coefficient of variation adjusted for trend (CVT) was estimated to be the highest unstable spice crops in the state followed by garlic (20.55%) and chili (19.47%). The spices crops were showed stable yield except cumin crops, cumin crop was highly effected by environmental factors disease and pest incidence recorded as over the years.

First period (1995-96 to 2004-05)

The yield instability in the state for spices recorded 9.26 per cent during the first period 1995-96 to 2004-05. The instability of the first period for various spice crops varied from as low as 5.82 per cent to as high as 22.03 per cent. Coriander recorded lowest instability (5.82%) followed by fenugreek (14.20%). chili recorded highest instability (22.03%) closely related to cumin (21.08%) and garlic (19.54%).

Second period (2005-06 to 2014-15)

The yield instability in the state for spices recorded 10.73 per cent during the second period 2005-06 to 2014-15. In the spices varied instability from as low as 7.06 per cent to as high as 25.75 per cent. Fenugreek recorded lowest instability (7.06%) followed by chili (15.44%). Cumin recorded highest instability (25.75%) closely followed by coriander (19.78%), and garlic (18.00%).

Indentification of crops according to pattern of yield growth and instability in Rajasthan

The description of instability would help to assess the past performance productivity of crops. Generally the CV value more than 30 is considered as high in agriculture. The

growth rate in productivity of crops must be more than the population growth so as to meet the requirement of increased population. Therefore, the growth of yield of crops more than 1.96 was considered as high, which is the population growth rate of the state (2000-01 to 2010-11).

The yield of crops bajra, jowar, moth, urad, moong, sesame, linseed, castor, cotton and guar were found to have high growth coupled with high instability in yield. For the raw yield data it is desirable because high growth rate of crops due to technology and policy support causes high instability also. Arhar was having low growth and high instability in yield. Maize, wheat, barley, groundnut, rapeseed & mustard, sugarcane and garlic were found in the category of high growth and low instability. The area and productivity of these crops increased and market support and policy implications were also favorable for these crops. The crops paddy, gram, soybean, cumin and chili were found to have low growth and low instability. Absence of growth leads to less fluctuations in the productivity of crops. The crops coriander and fenugreek comes under the category negative growth and low instability in yield. Both area and yield of above crops declined drastically over the years.

In terms of detrended yield bajra, jowar, moth, urad, moong, sesame, cotton and guar falls in the category of high growth and high instability. The technological thrust for this category must aim to reduce the inter year fluctuations in productivity without hampering the high yield growth potential of these crops in the state.

The pulse arhar under the category of low growth and high yield instability as the productivity of these crops declined drastically over the years. These crops

require strategy for upgrading productivity level as well as ensuring high inter year stability in production. Paddy, gram, soybean, cumin and chili were found under the category of low growth and low instability in yield of these crops. Crops like maize, wheat, barley groundnut, rapeseed & mustard, linseed, castor, sugarcane and garlic were found to have high growth and low instability in yield which is desirable. The crops coriander and fenugreek comes under the category negative growth and low instability in yield. Both area and yield of above crops declined drastically over the years.

The crops maize, wheat barley, groundnut, rapeseed & mustard, linseed, castor, sugarcane and garlic were found to have the ideal pattern of growth and instability as these crops emerged with high growth in productivity and low rate of instability. The crops with the low growth rates in yield such as paddy, gram, soybean, cumin and chili. require adequate technological support to push up the growth in productivity of these crops indicating that the available technology are not adequate to push up the yield of these crops.

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