



RESEARCH ARTICLE

DOI: 10.15740/HAS/IJFCI/9.2/37-43

Trends in growth and instability of major *Kharif* crops in Western Maharashtra

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ABSTRACT : The present investigation emphasizes trends in growth and instability of pearl millet and paddy crop in Western Maharashtra. Traditionally, pearl millet has been important millet and the main component of the food basket of the poor people and dry farming system in India. The district wise compound growth rates of area, production and productivity of pearl millet for each district as well as Western Maharashtra as a whole for 53 years of study period viz., 1960-61 to 2012-13 using log-linear production function were worked out for the entire period the area has continuously declined for all districts of Western Maharashtra except Ahmednagar district. The production of pearl millet was increased mainly due to the productivity improvement. The production and productivity of paddy has been increased in Nasik, Pune, Kolhapur, Satara, Sangli and Nandurbar districts while, it is declined in Dhule, Jalgaon, Ahmednagar and Solapur districts. For the entire period (1960-61 to 2012-13) productivity was highly increased in Nandurbar district with 6.66 per cent per annum.

KEY WORDS : Growth, Area, Production, Productivity, Instability, Pearl millet, Paddy

HOW TO CITE THIS ARTICLE : Kulkarni, A.R., Pokharkar, V.G and Nimbalkar, C.A. (2018). Trends in growth and instability of major *Kharif* crops in Western Maharashtra. *Internat. J. Forestry & Crop Improv.*, 9 (2) : 37-43, DOI: 10.15740/HAS/IJFCI/9.2/37-43. Copyright@ 2018: Hind Agri-Horticultural Society.

ARTICLE CHRONICAL : Received : 26.10.2018; Revised : 02.11.2018; Accepted : 19.11.2018

INTRODUCTION

Pearl millet is a major warm season coarse grain. India leads the world in millet production, followed by

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the African countries of Nigeria and Niger. India is one of the largest producers of pearl millet in the world with around 7 millions ha area under cultivation. Major pearl millet production states in India are: Rajasthan, Maharashtra, Haryana, Uttar Pradesh and Gujarat. pearl millet can also be used as valuable animal fodder. It is one of the major crops of China, India, South Eastern Asia, Sudan, Pakistan, Arabia, Russia and Nigeria. In India, the highest pearl millet producing state is Rajasthan followed by Maharashtra, Haryana, Gujarat and Uttar Pradesh.

Government of India has approved 2018 as National Year of Millets to boost production of the nutrient-rich

millets. Pearl millet is known for its high nutritive value because of its high iron and zinc content. Maharashtra has second rank in millet production after Rajasthan (Rao, 1989). Growing capacity in poorest soil, nil or very low demand of fertilizers leads Maharashtra to be a major millet producing region in our country. The present study aims at examining the growth in area, production and productivity of Pearl millet in Western Maharashtra.

India is one of the leading producers of paddy, it is the basic food crop and being a tropical plant, it flourishes comfortably in hot and humid climate. Rice is mainly grown in rain fed areas that receive heavy annual rainfall. That is why it is fundamentally a *Kharif* crop in India.

Paddy is one of the most important food crops of India and is second in importance through-out the world. It feeds more than 50 per cent of the world's population. It is the staple food of most of the people in South-East Asia. Asia accounts for about 90 per cent of the world's paddy cultivation and production. Among the paddy growing countries, India has the largest area under cultivation, though in terms of volume of output, it is second to China. Productivity in India is much lower than in Egypt, Japan, China, Vietnam, USA and Indonesia and even below the world's average. It makes up 42 per cent of India's total food grain production and 45 per cent of the total cereal produced in the country. Each part of the plant has various uses. It is also used in medicine. Paddy bran oil is used for its medicinal properties and is also used as cooking oil.

Objective:

- To examine the trends in growth and instability of Pearl millet and paddy in Western Maharashtra.
- The present study aims at examining the growth in area, production and productivity of major crops in the state.

EXPERIMENTAL METHODS

Nature and sources of data:

The time series data required to fulfill the objectives, such data was collected from secondary sources *i.e.*, different published records of the state government, cooperative institutions *viz.*, Season and crop reports, Departments of Agriculture, Government of Maharashtra, Pune, Statistical Abstract of Maharashtra State, Directorate of Economics and Statistics, Government of

Maharashtra, Mumbai, Epitomes of Agriculture in Maharashtra, Part-II, Socio-economic Review and District Statistical Abstracts of all districts in Maharashtra, Directorate of Economics and Statistics, Government of Maharashtra, Mumbai and Census report *viz.*, agricultural census.

Crops covered:

The important millet crop of Western Maharashtra *viz.*, Pearl millet and paddy were selected for the study.

Period of study:

To examine growth in the region, the period was considered from 1960-61 to 2012-13.

Analytical techniques:

Compound growth rates:

The compound growth rates were computed based on time series data on area, production and productivity of pearl millet crop for each district as well as Western Maharashtra as a whole for 53 years of study period *viz.*, 1960-61 to 2012-13 using log-linear production function. Compound growth rates were estimated to study the percentage increase or decrease in the selected parameter. The following exponential growth function was used.

$$Y = ab^t e$$

where,

Y = Dependent variable for which growth was estimated (*i.e.* area, production and productivity etc.).

a = Intercept or constant

b = Regression/trend co-efficient

t = Periods in years (1, 2, 3...n)

e = Error terms with zero mean and constant variance.

EXPERIMENTAL RESULTS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads :

Growth in area, production and productivity of pearl millet:

An attempt has been made to examine the changes in area, production and productivity of pearl millet in Western Maharashtra. The district wise growth rates in

area, production and productivity of pearl millet were studied by estimating compound growth rates for sub periods as period I (1960-61 to 1969-70), period II (1970-71 to 1979-80), period III (1980-81 to 1989-90), period IV (1990-91 to 1999-00), period V (2000-01 to 2012-13) and overall period (1960-61 to 2012-13). The annual percentage growth rates of area (A), production (P) and productivity (Y) of pearl millet are

presented in Table 1 for all ten districts of Western Maharashtra and Western Maharashtra as a whole, respectively.

The growth rates of production and productivity of pearl millet for Western Maharashtra (Table 1) as a whole were observed to be positive and highly significant at 1 per cent level for the entire period of 53 years. The production and productivity of pearl millet increased at

Particulars		Nashik	Dhule	Jalgaon	Pune	Ahmednagar	Solapur	Kolhapur	Satara	Sangli	Nandurbar	Western Maharashtra
Period-I	A	2.42**	3.52***	3.2**	0.11	4.86***	3.55*	-4.82***	-0.03	1.13***	--	2.02***
(1960-61 to	P	3	1.12	3.09	2.28	4.41	17.92***	-7.42*	2.37	-2.19	--	3.06*
1969-70)	Y	0.57	-2.32	-0.11	2.18	-0.43	13.92**	-2.68	2.39	-3.3	--	1.01
Period-II	A	-0.63	-2.98***	-1.73	-0.81	0.72	-4.39	-3.45	-0.32	2.08	--	-2.38**
(1970-71 to	P	6.74	4.01	7.58*	0.7	2.2	5.04	1.02	-0.7	6.69	--	2.62
1979-80)	Y	7.41	7.22	9.47**	1.53	1.46	9.8***	4.88	-0.4	4.52**	--	5.13**
Period III	A	0.66	3.16***	3.15***	5.62*	1.69	-5.73**	--	1.01	-0.62	--	0.51
(1980-81 to	P	2.13	4.09	9.25**	10.72**	1.61	-2.79	--	8.81	0.55	--	4.01
1989-90)	Y	1.46	0.9	5.91	4.83*	-0.08	3.14	--	7.73	1.15	--	3.49
Period IV	A	0.52	4.24	-6.7***	-6.33	-1.16	1.19	--	-2.3**	1.73	--	-1.2
(1990-91 to	P	3.89	3.33	-4.33	-4.72	0.52	-0.07	--	6.32*	9.95***	--	1.05
1999-00)	Y	3.36	-0.88	2.54	1.71	1.7	-1.27	--	8.83***	8.09***	--	2.28
Period V	A	-4.12*	-1.41	-10.32***	-11.15***	-3.42**	-9.78*	--	-9.1	-5.53	-1.78**	-5.22***
(2000-01 to	P	-2.41	2.68	-6.22**	-11.29***	-0.55	-16.74**	--	-7.01	-1.57	5.53**	-2.66
2012-13)	Y	1.78	4.15	4.57***	-0.15	2.97	-7.73	--	2.3	4.23	7.44***	2.7*
Overall	A	-1.05***	-0.47	-1.54***	-1.95***	1.2*	-4.4***	-4.27***	-2.43***	-2.1***	-1.78**	-0.96***
(1960-2012)	P	1.51***	1.36***	1.49***	0.07	5.05***	-1.93***	-3.17*	-0.56	-0.25	5.53**	1.52***
	Y	2.59***	1.84***	3.08***	2.06***	3.81***	2.58***	0.1	1.91***	1.89***	7.44***	2.51***

*, ** and *** indicate significance of values at P=0.01, 0.05 and 0.1, respectively

Particulars	Area		Production		Productivity	
	CV	CDV	CV	CDV	CV	CDV
Nashik	21.84	17.41	45.6	39.85	51.92	35.42
Dhule	18.89	18.46	44.82	41.40	42.60	33.49
Jalgaon	34.59	29.37	57.99	53.39	48.23	25.00
Pune	33.02	26.14	44.32	44.31	38.10	21.06
Ahmednagar	78.63	76.54	137.58	104.50	65.78	37.92
Solapur	70.35	39.74	56.66	52.89	52.44	42.11
Kolhapur	73.43	36.10	53.67	41.79	90.24	49.79
Satara	33.90	25.67	47.96	47.51	47.91	36.61
Sangli	4.42	2.71	28.48	27.68	28.47	26.52
Nandurbar	12.50	10.05	39.23	33.05	39.15	27.73
Western Maharashtra	18.38	12.56	37.14	28.41	43.25	21.06

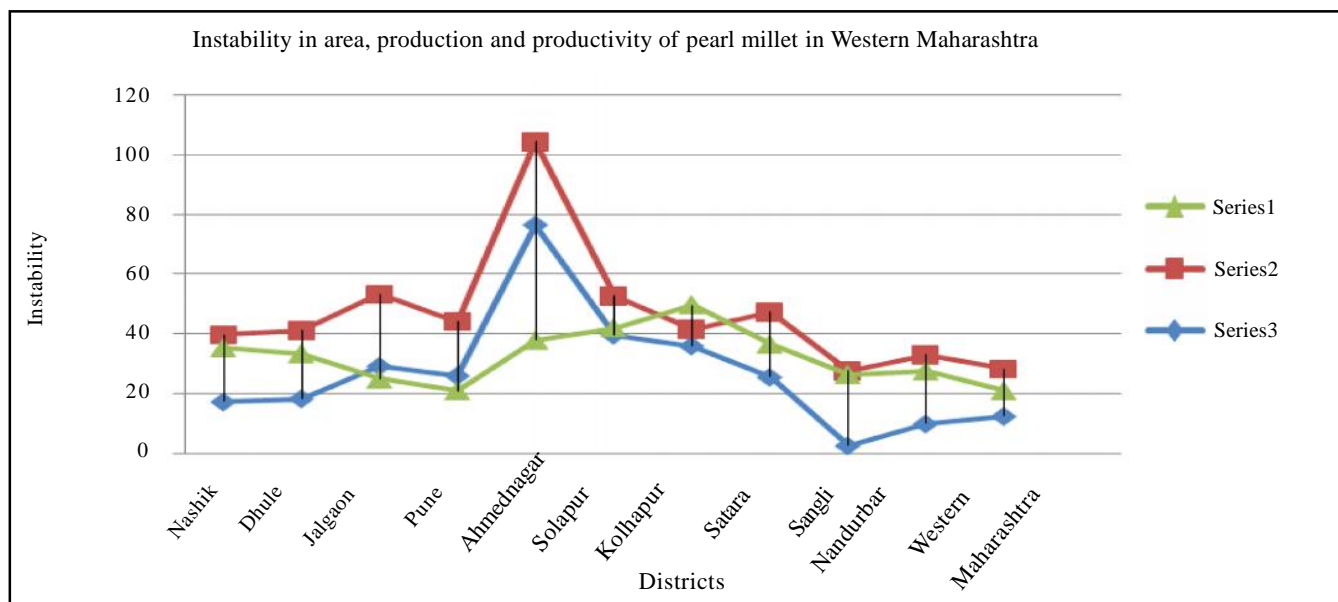


Fig. 1: Instability in area, production and productivity of pearl millet crop in Western Maharashtra

the rate of 1.52 per cent and 2.51 per cent per annum, respectively, during the entire period. However, the area of pearl millet has declined by 0.96 per cent per annum.

It indicates that, the production of pearl millet was increased only due to the productivity improvement. It may be due to new hybrid varieties released by private companies and Agril. Universities over a period of time. For the entire period (1960-61 to 2012-13), the growth rates of production and productivity was positive and significant for few district *viz.*, Nasik, Dhule, Jalgaon, Pune, Ahmednagar and Nandurbar district, while production declined in Solapur, Kolhapur, Satara and Sangli district. For the entire period (1960-61 to 2012-13) the area has continuously declined for all districts of Western Maharashtra *viz.*, Nasik, Dhule, Jalgaon, Pune, Solapur, Kolhapur, Satara, Sangli and Nandurbar district except Ahmednagar district. The decline in area under Pearl millet may be due to crop diversification. The area under cash crops, pulses, oilseeds and fruits has increased over a period of time. In general, the production of Pearl millet was increased mainly due to the productivity improvement for Nasik, Dhule, Jalgaon, Pune, Ahmednagar and Nandurbar districts of Western Maharashtra region (Acharya *et al.*, 2012; Kumar and Jain, 2004; Rao, 1986 and Singh and Chandra, 2001).

Co-efficient of variation and instability in area, production and productivity of pearl millet in Western Maharashtra (overall period 1960-61 to 2012-13):

The perusal of Table 2 revealed that at overall period there is less variation in area *i.e.* 18.38 per cent and instability 12.56 in the pearl millet crop of Western Maharashtra. Highest instability was found in the Ahmednagar district 76.54 per cent this may be influenced by degree of availability of water resources in Ahmednagar district. Lowest instability was found in Sangli district 2.71 per cent.

At overall period there is high variation and instability was found in production of pearl millet crop it was 37.14 per cent and 28.41 per cent, respectively in Western Maharashtra. Highest instability in the production of Ahmednagar district 104.50 per cent is due to high instability in area under pearl millet crop, it might be due to Pearl millet grown rainfed conditions and instability in grain yield and prices of pearl millet results in shifting of farmers towards other competing crops.

In case of productivity of the pearl millet crop in Western Maharashtra the co-efficient of variation was 43.25 per cent and instability was 21.06 per cent it clearly indicates that pearl millet productivity in Western Maharashtra is unstable for overall period. The productivity of Kolhapur district showed high

variation *i.e.*, 90.24 per cent and instability 49.79 per cent this indicates that productivity of pearl millet in Kolhapur is stable. The high instability in production of Kolhapur district was due to instable area under pearl millet crop (Alexander, 2007 and Kumar and Mittal, 2006).

Growth rates of the area, production and productivity of paddy:

The district wise annual percentage growth rates of area, production and productivity of paddy are presented in Table 3 the growth rates of area and production of paddy for Western Maharashtra as a whole were observed to be positive and highly significant at 1 per cent level for the entire period of 53 years. Production of paddy crop has been increased significantly in Nashik, Pune, Solapur, Satara and Sangli district this increase in production is mainly because of both increase in area and productivity of the paddy crop in Western Maharashtra. Where as in Dhule, Jalgaon, Ahmednagar and solapur districts of Western Maharashtra the growth in the production is found negative and significant this mainly because of decline in area of the paddy in these districts. In Western Maharashtra as whole in period I

compound growth rate in area production and productivity of paddy was found to be -1.29, -4.57 and -3.33 per cent, respectively. This clearly indicates because of less productivity of the paddy crop in Western Maharashtra leads to declining the area with decline in production of the paddy crop.

In the period II it is found that there is significant increase in production by 12.64 per cent per annum in paddy crop. This is mainly because of the significant increase in productivity by 10.09 per cent per annum and increase in area 2.32 per cent per annum in Western Maharashtra. In the period III, IV and V the actual increase in the production of the paddy crop in Western Maharashtra is due to increase in productivity as well as area expansion. At overall time period the Increase in production 1.66 per cent is mainly because of increase in area 1.97 per cent and not due to increase in productivity. After introduction of Green Revolution (1965) the high yielding varieties of the paddy crop leads to increases the productivity, which ultimately helps in increasing the production as well as area increase in Western Maharashtra from the year 1970-71 to 2012-13.

Table 3 : District wise compound growth rates of the area, production and productivity of paddy

Particulars		Nashik	Dhule	Jalgaon	Pune	Ahmednagar	Solapur	Kolhapur	Satara	Sangli	Nandurbar	Western Maharashtra
Period-I	A	-1.76***	-5.58***	--	-1.32**	-2.78**	-4.29***	-1.18*	0.35	1.68***	--	-1.29**
(1960-61 to	P	-4.19	-8.53**	--	-6.02*	-7.62*	-9.49**	-5.29**	-0.99	-0.19	--	-4.57*
1969-70)	Y	-2.47	-3.14	--	-4.77	-5.04	-5.43	-4.15*	-1.32	-1.82	--	-3.33
Period-II	A	1.71***	3.73***	--	1.62***	4.87*	6.77	1.53*	2.68***	2.88**	--	2.32***
(1970-71 to	P	13.93*	14.29***	--	16.9**	18.42*	21.92	9.81***	12.87*	15.93**	--	12.64**
1979-80)	Y	12.03	10.18**	--	15.02**	12.92	14.19*	8.17**	9.91	12.69*	--	10.09**
Period III	A	-0.76**	0.34	--	1.42*	-2.95***	-4.62	0.12	1.39***	-0.67*	--	0.4
(1980-81 to	P	-4.38	-0.14	--	-1.58	-5.08*	-11.83	0.41	3.77*	0.86	--	-0.08
1989-90)	Y	-3.65	-0.47	--	-2.96	-2.19	-7.57	0.29	2.34	1.54	--	-0.48
Period IV	A	1.33*	-0.56	--	-0.26	-2.18	-7.35**	0.52***	-0.0022	-0.26	--	0.66
(1990-91 to	P	4.67*	-2.74	--	1.14	2.4	-2.46	0.78	1.17	6.5*	--	1.66
1999-00)	Y	3.28	-2.21	--	1.4	4.67*	5.49***	0.26	1.17	6.78**	--	0.99
Period V	A	-3.18	2.7**	-22.38***	0.85	1.44	-7.97	0.25	1.52***	0.43	-0.41	0.51
(2000-01 to	P	-7.27	2.96	-22.02***	-1.01	5.52	-17.32**	1.69**	2.27	-0.4	10.46***	1.09
2012-13)	Y	-4.2	0.26	0.46	-1.85	4.1	-10.16**	1.44**	0.74	-0.82	10.92***	0.58
Overall	A	0.43*	-3.03***	-22.38***	0.65***	-0.52***	-6.61***	0.31***	1.42***	0.45***	-0.41	1.97***
(1960-2012)	P	0.64	-1.68***	-22.02***	1.23***	-0.91*	-7.62***	2.35***	3.1***	2.66***	10.46***	1.66***
	Y	0.21	1.39***	0.46	0.57*	-0.38	-1.1*	2.03***	1.66***	2.19***	10.91***	-0.1

*, ** and *** indicate significance of values at P=0.01, 0.05 and 0.1, respectively

Co-efficient of variation and instability of paddy crop in Western Maharashtra:

The perusal of Table 4 revealed that at overall period there is more variation in area *i.e.* 32.89 per cent and instability 21.85 in the paddy crop of Western Maharashtra. Highest instability was found in the Jalgaon district 43.95 per cent. Lowest instability was found in Kolhapur district 5.92 per cent. At overall period there is high variation and instability was found in production of paddy crop *i.e.*, 30.77 per cent and 24.18 per cent, respectively in Western Maharashtra. Highest instability

in the production of Solapur district 62.16 per cent is due to uneven distribution of rainfall affects the area under paddy crop (Basavaraj *et al.*, 2010; Bhagavatula *et al.*, 2013; Bhatia, 1981 and Chatterjee *et al.*, 2014).

In case of productivity of the paddy crop in Western Maharashtra the co-efficient of variation was 97.23 per cent and instability was 97.14 per cent it clearly indicates that paddy productivity in Western Maharashtra is instable for overall period. The productivity of Solapur district showed high variation *i.e.*, 57.27 per cent and instability 55.39 per cent this indicates that productivity of pearl

Particulars	Area		Production		Productivity	
	CV	CDV	CV	CDV	CV	CDV
Nashik	19.74	19.13	37.18	36.52	30.56	30.47
Dhule	44.95	32.67	57.75	53.71	39.95	34.50
Jalgaon	98.29	43.95	102.60	49.29	28.58	28.53
Pune	12.6	7.71	30.22	26.61	29.88	28.95
A.nagar	21.17	19.4	46.99	45.35	39.32	39.04
Solapur	73.32	39.91	90.92	62.16	57.27	55.39
Kolhapur	7.55	5.92	34.93	18.31	31.04	17.80
Satara	21.92	6.09	43.99	26.25	30.77	24.18
Sangli	10.42	7.81	41.68	27.82	37.56	26.66
Nandurbar	6.48	6.24	46.52	30.37	47.80	30.54
Western Maharashtra	32.89	21.85	30.77	24.18	97.23	97.14

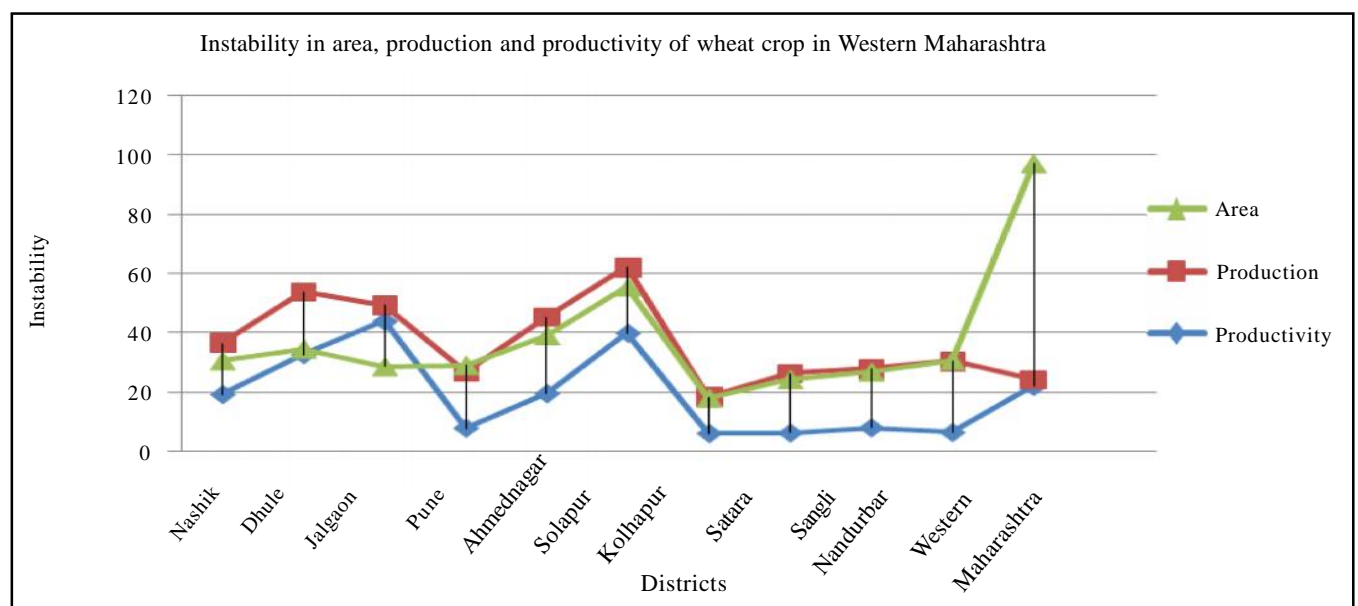


Fig. 2: Instability in area, production and productivity of wheat crop in Western Maharashtra

millet in Solapur is unstable. The high instability in production of Solapur district was due to instable area under paddy crop.

Conclusion:

The production of pearl millet in Maharashtra at overall period is increased due productivity enhancement not due to area increase.

The production of paddy in Maharashtra at overall period is increased because of increase in area not due to increase in productivity. Dhule, Kolhapur, Satara and Sangli district contributes in area increase of paddy crop. There is more instability in area, production and productivity of paddy in Western Maharashtra.

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