

Analysis of Growth and Instability in Area, Production, Yield and Price of Rice in India

Ankur Jain*

Abstract

Agricultural growth with stability has been a matter of concern in India. This paper analyses 41 years data (1970-71 to 2011-12) on area, production and yield under paddy to understand the question of instability in rice production in India. The analysis shows that at all India level compound annual growth rate of area, production and yield of rice were positive but it had been declining gradually over the periods. In the recent decade (2000-01 to 2011-12) there is increase in instability at all India level in area, production and yield of rice. The possible reasons for increase in instability were low percentage of irrigated area to total cropped area, decline in use of seeds and manure and other inputs necessary for agriculture. In the post reform period (1990-91 to 2016-17) the instability has increased in case of wholesale price of paddy across various states while instability has declined in case of farm harvest price of paddy.

1. Introduction

Growth with stability is considered important for development of agriculture. There is considerable literature on growth and instability of yield and production of crops both from theoretical and empirical perspectives. An analysis of instability in crop output, apart from growth, is important for understanding the nature of food security and income stability. The variations in crop output not only affect prices and bring about sharp fluctuation in them but also result in wide variations in disposable income of the farmers. The magnitude of fluctuations depends on the nature of crop production technology, its sensitivity to weather, economic environment, availability of material inputs and many other factors. The estimates of Dev and Pandey (2012) showed that there is a continuous decline in trend growth rate in the value of output of all cereals. The growth rate in value of the output of cereals in India declined from 2.76 per cent in 1980s to 2.02 per cent in 1990s and it further declined to 1.25 per cent during 2000s. In the case of paddy the trend growth rate in the value of output declined from 3.31 per cent during 1980s to 1.80 per cent in 1990s and it declined further to 1.13 per cent

* Ankur Jain (ankurjain869@gmail.com) is research scholar at CSRD, JNU, New Delhi.

(Dev and Pandey 2012). This shows that situation of farmers in India has been worsening as value of output had declined. The need for maintaining stability of income of the farmers and is also important from food security perspective.

A number of studies on growth and instability in agricultural production, in general and food grain production in particular observed that substantial gain in area, production and productivity of wheat has been achieved in all the states during post green revolution period. Rice cultivation also recorded an increase in area, production and productivity, particularly in states which adopted rice cultivation during post-green-revolution period. Hazell (1982) assigned much importance to the growth for increasing instability, but Ray (1983), Dev (1987) and Rao (1988) identified rainfall, irrigation and agro-physical situations as important factors influencing instability in food grain production during post green revolution period. The application of new technology (Seed-fertilizer) has also been found responsible for variability in food grain production during post green revolution period (Mehra, 1981, Mehra 1981; Hazell 1982; Ray 1983; Parthasarthy 1984; Mitra 1990 and Wasim 1999).

Despite improvement in technology, increase in input subsidies, and improvement in access to these services, farm prices and farm income across states have diverse variation. These year to year fluctuations in prices and farmers income affect farmer's decision for investment in agriculture. While the need for increasing agricultural production is obvious, the increase in instability in agricultural production has several adverse affect-it raises the risk involved in farm production and affects farmers' income and decisions to adopt high paying technologies it affects price stability and increases vulnerability of low income households. Instability in agricultural and food production is also important for food management and macroeconomic stability (Chand and Raju, 2009).

A number of studies have tried to look into the factors leading to instability. Paltasingh and Goyari (2013) calculated instability in subsistence agriculture of Odisha by taking 41 years data from 1970 to 2010 and dividing the period into pre- reform and post reform period. They observed that there is no positive relation between growth and instability and found that weather variability was the only important factor responsible for higher instability. As irrigation coverage is low in Odisha and cultivation continues to be rain fed, variation in weather variability was one of the primary determinants of instability in agricultural production. In areas of green revolution too, even though there had been increase in productivity and production of all the crops, instability in agricultural production did not decline (Sihmar: 2014). Instability affects both production and productivity per hectare. There are studies which emphasize that instability is a consequence of growth which means growth and instability are positively related.

2. Data Source and methodology

2.1 Focus of the paper

While instability in agricultural sector has been widely studied, this paper makes an

attempt to look into the question of instability in rice production in India. Paddy rice make up more than 10 percent of the total output value of India's agriculture. Globally, China is the largest producer of paddy, and India ranks second. Around 60 per cent of people in India consume rice and it is cultivated by the farmers in more than 16 states. The paper tries to understand the growth rates of area, production and yield of paddy and to measure the instability in area, production and yield of paddy across states. The paper also analyzes the instability in farm harvest prices and wholesale prices of paddy across states. The time period used under the study is 1970-71 to 2011-12 divided into four quarters-. Period I covers 1970-71 to 1979-1980; period II starts from 1980-81 to 1989-90; period III covers 1990-91 to 1999-00 and period IV starts from 2000-01 to 2011-12. The time period has been chosen to understand the post green revolution period impact on rice production, and the post reform period in India.

2.2 Data and Methodology

Data on important variables like area, production and yield of rice for the period 1970-71 to 2011-12 and cost of cultivation data were compiled from Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi. Other relevant data used in this analysis were compiled from secondary sources such as Agricultural Statistics at a Glance, Land Use Statistics, Agriculture Prices in India, State wise value of Output of Agriculture and allied activities by Ministry of Statistics and Program Implementation (MOSPI), and Agmark Portal maintained by Directorate of Marketing and Inspection (Ministry of Agriculture).

The compound annual growth rate of area, production and yield of paddy has been calculated using semi log model. For calculating instability index the methodology used by Chand and Raju (2008) has been used. The instability index is given by:

Instability Index = Standard deviation of the natural logarithm (X_{t+1}/X_t)

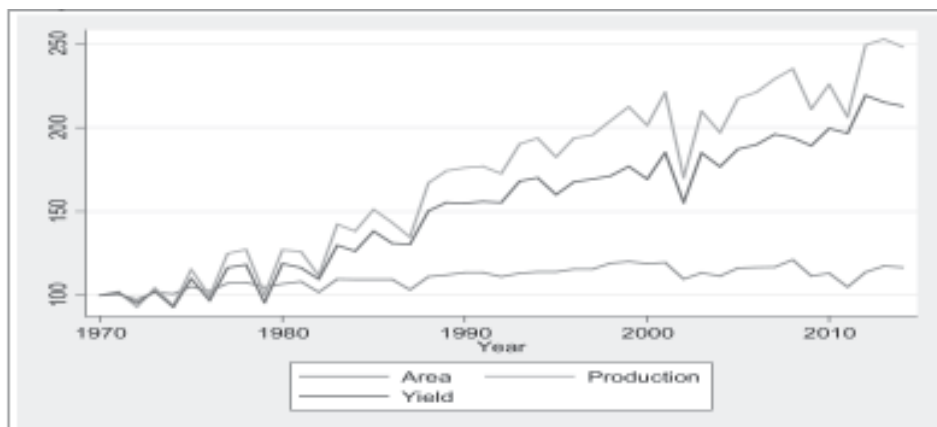
Here X_t refers to Area (A), Production (P), Yield (Y) and Farm Harvest Price (FHP) in the year "t"; and X_{t+1} denote the same for subsequent year. This index is unit free and robust and measures deviations from underlying trend (log linear in this case). When there are no deviations from the trend, the ratio of X_{t+1} and X_t remains the same and their standard deviation is zero. The findings are discussed in the subsequent sections of the paper.

3. Trends in Production and Yield

India has close to 199 million hectares of gross cropped area, and more than 21 per cent, i.e., 42.9 million hectares, is under paddy. Close to 60 percent of the area under rice in 2011-12 was under irrigation. The area, production and yield of rice in India have increased over the years. Taking 1970-71 as the base year, the figure shows that till the 1990s there was continuous fluctuation in all three key variables namely area, production and yield of rice. There has not been much increase in area under rice but there has been significant increase in production which reflects India's self sufficiency in rice production and the potential to export rice to other countries. Even though the

yield of rice increased over the period but it was lower compared to two major rice producing countries in Asia viz. Thailand and China.

Figure 1: Variation in All India Area, Production & Yield of Rice from 1970-71 to 2011-12



Source: Computed from Government of India various issues

Table 1: Share in State Wise Value of Output of Paddy at 2004-05 Prices (Per Cent)

States	TE 1992-1993	TE 2002-2003	TE 2010-2011	TE 2013-2014
Andhra Pradesh	13.97	13.56	14.3	6.57
Assam	4.35	4.77	4.49	3.76
Bihar	6.42	6.04	4.05	5.88
Gujarat	1.69	1.38	1.56	1.52
Haryana	4.66	5.33	4.98	4.94
Himachal Pradesh	0.16	0.16	0.16	0.17
Jammu & Kashmir	0.95	0.67	0.73	0.74
Karnataka	2.82	2.85	4.6	3.65
Kerala	1.67	1.03	0.64	0.53
Madhya Pradesh	7.7	1.61	1.74	2.71
Maharashtra	3.31	2.79	2.7	3.47
Manipur	0.49	0.54	0.53	0.37
Odisha	7.1	5.51	6.54	6.45
Punjab	9.13	10.62	11.4	10.79
Rajasthan	0.26	0.21	0.42	0.32
Tamil Nadu	7.58	6.18	5.17	5.08
Tripura	0.95	1.03	0.95	0.62
Uttar Pradesh	13.48	14.08	12.59	13.77
West Bengal	14.2	15.82	13.82	13.13

Source: Author's Calculation

Note: Value for TE 2013-14 are in 2011-12 Prices

The share of state wise value of output of paddy during different time periods show that there were large variation across states. Uttar Pradesh, West Bengal and Punjab

were the top three rice producing states during T.E. 2013-14 at 2011-12 prices. Andhra Pradesh had a higher share before Telangana was formed. During T.E. 2010-11 Andhra Pradesh, West Bengal, Uttar Pradesh and Punjab became the major producers at 2004-05 prices. Punjab is the only state where there has been a continuous increase in the percentage share in the state wise value of output of paddy from 1992-93 to 2010-11. Changes in cropping pattern across the states that had started in the eighties in response to more, skewed domestic demand, have accelerated in the post-reform period with opening up of trade in agricultural products and thrust towards agro-exports. The area under rice production declined markedly in favour of export crops.

4. Growth Rate for Rice at All India level

Table 2: Compound Annual Growth Rate in Area, Production and Yield of Rice (Per Cent)

Period	Area	Production	Yield
1970-71 to 1979-80	0.88***	1.9	1.01
1980-81 to 1989-90	0.41	3.62***	3.19***
1990-91 to 1999-00	0.67***	2.02***	1.34***
2000-01 to 2011-12	-0.003	1.82	1.82***

Source : Author's Calculation

*Note: *** means significant at 1per cent level, ** means significant at 5per cent level and * means significant at 10 per cent level.*

The main rice growing season in the country is kharif, in which the crop is sown during the Indian monsoon season, June-July, and harvested in November–December. About 84 percent of the annual crop of the country is grown in this season. Four states, West Bengal, Uttar Pradesh, Andhra Pradesh, and Punjab, are the biggest producers in paddy in the country. The all India compound annual growth rate (CAGR) of area, production and yield of rice from 1970-71 to 2011-12 shows that there has been a steady decline for area under cultivation largely because of changes in cropping pattern. The CAGR of production was 3.62 per cent per annum during 1980-81 to 1989-90. The CAGR of yield was 3.19 per cent during 1980-81 to 1989-90 which declined to 1.82 per cent during 2011-12. This implies that growth rate over the period under study though positive but was declining gradually.

5. Growth rate of area, production and yield of rice: State wise variation

State wise estimation on rice production, shows large variation in the growth rates of area under rice (Table: 3). During 1970s, Punjab, Rajasthan and Haryana were the top three states with high CAGR in area under rice cultivation propelled mainly by HYV. During the decade of 80s, all India CAGR of rice decreased from 0.89 per cent in 70s to 0.41 per cent in 80s. During 1990s, there had been marginal improvement in all India CAGR of area of rice from 0.41 per cent to 0.67 per cent. However at state level there are mixed results as in some states there has been a decrease in CAGR of rice

while in many other states there is increase in CAGR of rice. Haryana recorded substantial increase in area under rice production during 1990-91 to 1999-2000 when the CAGR of area of rice increased from 2.40 per cent in 1980-81 —1989-90 to 6.10 per cent in period in 1990-91—1999-2000. However in case of Punjab there is continuous decline in CAGR of area of paddy. During 2000-01 to 2011-12, there has been a decline in CAGR of area of rice in many states except Andhra Pradesh, Gujarat and Manipur. Consequently, there had been a decrease during the same decade for the All-India level. Although the CAGR of area under rice cultivation has been positive, but there has been a declining trend over the years.

Table 3: State Wise Compound Annual Growth Rate in Area of Rice from 1970-71 to 2011-12

States	Period I 1970-71 to 1979-80	Period II 1980-81 to 1989-90	Period III 1990-91 to 1999-2000	Period IV 2000-01 to 2011-12
Andhra Pradesh	1.91*	0.54	0.55	2
Assam	1.49***	0.51	0.1	-0.25
Bihar	0.51	0.25	0.11	-0.79
Gujarat	0.26	0.41	0.5	2.37**
Haryana	6.64***	2.40*	6.10***	2.29***
Himachal Pradesh	-1.08*	-1.45**	-0.23	-0.66***
Jammu and Kashmir	2.54***	-0.03	-0.46	0.68***
Karnataka	-0.09	0.38	1.72***	1.37
Kerala	-1.07**	-4.13***	-5.58***	-4.48***
Madhya Pradesh	0.88***	0.36**	0.74***	-0.40**
Maharashtra	1.69***	-0.09	-0.69***	0.03
Manipur	1.94*	-0.67	0.35	2.68***
Odisha	-0.91**	0.41	0.16	-0.56**
Punjab	12.46***	5.39***	2.48***	1.02***
Rajasthan	5.87***	-3.15	4.07***	1.07
Tamil Nadu	0.23	-2.02*	1.06	0.39
Tripura	0.29	-1.42***	-0.78	0.52
Uttar Pradesh	1.53**	0.03	0.95**	0.06
West Bengal	-0.05	1.12**	0.55**	-0.73
All India	0.89	0.41	0.67***	0.003

Source: Author's Calculation

Notes: *** means significant at 1 per cent level, ** means significant at 5 per cent level and * means significant at 10 per cent level.

Rice is a water-intensive crop and states of Punjab and Haryana, has contributed to over-exploitation of ground water in these states. Thus policy makers and economists alike today feel the need to undertake a “second green revolution,” wherein the rice production base is shifted away from the states of Punjab and Haryana (which face threats due to plummeting groundwater tables) to the more water-abundant eastern states of Bihar, Uttar Pradesh, and Odisha (Saini and Gualti:2017). Further with the opening up of the economy, expectations of export opportunities and higher prices at international markets led many farmers to switch from traditional rice growing to cash

crops and high value agricultural products like oil seeds, ground nut and cotton. The states in eastern India except for Tripura had a negative growth in area under rice cultivation which indicates that farmers were shifting away from rice cultivation.

Table 4: State Wise Compound Annual Growth Rate in Production of Rice from 1970-71 to 2011-12

States	Period I 1970-71 to 1979-80	Period II 1980-81 to 1989-90	Period III 1990-91 to 1999-2000	Period IV 2000-01 to 2011-12
Andhra Pradesh	4.2**	2.5	1.7	3.0*
Assam	0.6	1.1	1.1*	1.4
Bihar	0.3	4.1	3.1	0.3
Gujarat	4.2	-0.2	3.7***	9.0***
Haryana	11.3***	2.2	4.4***	9.0***
Himachal Pradesh	-0.9	-1.8	1.6***	0.5
Jammu & Kashmir	3.5**	-0.7	-1.8	2.4***
Karnataka	1.4	0.2	3.6***	2.6
Kerala	-0.5	-2.9***	-7.1	-2.5***
Madhya Pradesh	-3.1	2	-0.1	4.9**
Maharashtra	6.9*	-0.7	1.4**	1.9
Manipur	6.4**	0.3	2.8	2.6*
Odisha	-1.4	4	-1.3	2.8
Punjab	18.5***	6.7***	2.5***	2.8***
Rajasthan	5	-1.9	6.0**	7.6**
Tamil Nadu	0.5	3.9**	-0.1	1.7
Tripura	4.3*	2.2**	-0.2	2.6***
Uttar Pradesh	1.6	5.7***	3.2***	1
West Bengal	0.8	6.8***	2.5***	0.2
All India	1.9	3.6***	2.0***	1.82**

Source: Author's Calculation

Notes: *** means significant at 1 per cent level, ** means significant at 5 per cent level and * means significant at 10 per cent level.

There has also been large variation in the growth rates of production of rice across states (Table: 4). During the 70's under the impact of green revolution, states like Punjab, Haryana, Maharashtra, Andhra Pradesh, Manipur, Rajasthan, recorded high growth rates in production of rice. Punjab and Haryana the two largest beneficiaries of green revolution had the highest growth rates. At the same time states like Himachal Pradesh, Kerala, Madhya Pradesh and Odisha where impetus of green revolution remained absent recorded negative growth rate during the period. As state support to agriculture increased during the 1970s and 1980s some improvement in growth rate during the decade of 80s was observed in states such as Assam, Madhya Pradesh, Odisha, Tamil Nadu, Uttar Pradesh and West Bengal. In West Bengal CAGR of production of rice increased from 0.8 per cent in 70's to 6.8 per cent in 80s. The all India CAGR of production of rice also increased from 1.9 per cent during 70s to 3.6 per cent during the 80s.

During 1990s the all India level of CAGR of production of rice declined over the previous decade. In major rice producing states there was steep decline in CAGR of production of rice e.g. in Andhra Pradesh growth rate declined from 2.5 per cent during 80s to 1.7 per cent in 1990s, in case of Punjab growth rate declined from 6.7 per cent in 80s to 2.5 per cent during 1990s; in case of Uttar Pradesh growth rate declined from 5.7 per cent in 1980s to 3.2 per cent in 1990s and in case of West Bengal growth rate declined from 6.8 per cent in 1980s to 2.5 per cent in 1990s. During the last decade, at all India level there was further decline in CAGR of production of rice to 1.82 per cent. However at state level there was some improvement in states except Uttar Pradesh, Bihar and West Bengal.

Table 5: State Wise Compound Annual Growth Rate in Yield of Rice from 1970-71 to 2011-12

States	Period (I) 1970-71 to 1979-1980	Period (II) 1980-81 to 1989-1990	Period (III) 1990-91 to 1999-2000	Period (IV) 2000-01 to 2011-12
Andhra Pradesh	2.2**	2.0**	1.1*	1.0*
Assam	-0.9	0.6	1.0***	1.7**
Bihar	-0.2	3.9*	2.9	1.1
Gujarat	3.9	-0.6	2	0.7
Haryana	4.4*	-0.1	-1.6	1.2*
Himachal Pradesh	0.1	-0.4	1.9***	1.2
Jammu & Kashmir	1	-0.7	-1.3	1.7**
Karnataka	1.5	-0.1	1.9***	1.2
Kerala	0.6	1.2*	10.2**	-7.1***
Madhya Pradesh	-3.9	1.7	-0.8	5.3**
Maharashtra	5.2	-0.6	2.1***	1.9
Manipur	4.4*	1	2.4	-0.1
Odisha	-0.5	3.6	-1.4	3.4*
Punjab	5.4*	1.3	5.6	1.0**
Rajasthan	-0.8	1.3	-5.4	6.5***
Tamil Nadu	0.2	6.0***	-1.2	1.3
Tripura	4.0*	5.1	0.5	2.0***
Uttar Pradesh	0.1	5.6***	2.2***	0.9
West Bengal	0.8	5.6***	1.9***	0.9***
All India	1	3.2***	1.3***	1.82***

Source: Author's Calculation

Notes: *** means significant at 1 per cent level, ** means significant at 5 per cent level and * means significant at 10 per cent level.

The growth rate in yield of rice during 1970-71 to 2011-12 across various states shows large variation (Table: 5). During the decade of 70's the CAGR in yield of rice was positive and high in most of the states like Punjab, Maharashtra, Haryana, Manipur, Tripura and Gujarat which recorded a marginal increase during 1980s. During 90's there was decline in all India CAGR in yield of rice and in some major rice producing states like Andhra Pradesh, Uttar Pradesh, Haryana, Odisha and West Bengal. The CAGR in yield of rice during the last decade was found to be positive in all the states except Kerala and Manipur. But in some important states such as Punjab, Uttar Pradesh and West Bengal there was decline in CAGR in yield of rice. Even though Uttar Pradesh has the highest area under rice production in the country, its yield rate is same with West Bengal.

6. Instability Index for rice cultivation: All India scenario

Table 6: Instability in Area, Production and Yield of Rice in Different Periods at All India level.

Variables	Period I 1970-71 to 1979-80	Period II 1980-81 to 1989-90	Period III 1990-91 to 1999-00	Period IV 2000-01 to 2011-12
Area	3.1	4.8	1.4	5
Production	16.2	12.6	4.7	12.2
Yield	13.3	8.5	3.8	8.2

Source: Author's Calculation

The instability index in area, production and yield of rice at all India level (Table: 6) shows that instability in area under rice cultivation increased from 3.1 in 70's to 4.8 during 80's, with a decline in the 90's and finally again an increase in 2000. The instability index for area under rice cultivation has been the highest during 2000 which shows that there is large scale fluctuation in area under rice cultivation. During the last decade the instability index for rice production increased which also highlights the distress in India's major cereal production. A similar situation is observed in respect of instability index for yield in rice production largely due to fluctuation in area under cultivation

7. Instability Index for Rice Cultivation: Variations across States

The instability index for area under rice cultivation (Table: 7) shows large variation. States which had high instability index for area under rice cultivation were Andhra Pradesh, Gujarat, Karnataka, Rajasthan and Tamil Nadu, Haryana and Rajasthan. Instability index for area under rice cultivation increased for Uttar Pradesh only during the last decade. However, in states like Haryana, Maharashtra, Odisha, Punjab and Tripura the instability index for area under rice cultivation declined during the last decade compared when compared to the decade of 70's.

Table 7: State Wise Instability in Area of Rice from 1970-71 to 2011-12

States	Period (I) 1970-71 to 1979-80	Period (II) 1980-81 to 1989-90	Period (III) 1990-91 to 1999-00	Period (IV) 2000-01 to 2011-12
Andhra Pradesh	10.5	12.9	10.9	19.1
Assam	3.9	4	3.5	5
Bihar	7	7.7	5.2	13.6
Gujarat	12.6	22.1	7.3	8.1
Haryana	7.9	14.9	6.2	6.6
Himachal Pradesh	6.3	7.1	2.8	1.5
Jammu	3.5	2.2	3.6	4.2
Karnataka	11	8.8	4.5	11
Kerala	2	3.4	3.9	4.9
Madhya Pradesh	1.4	1.6	1.3	2.8
Maharashtra	4.2	5.9	1.5	2.2
Manipur	7.3	4.6	5.8	9
Odisha	5	4.5	2.3	3
Punjab	7.6	4.9	4.3	2.5
Rajasthan	9.9	25.4	9.5	20.2
Tamil Nadu	12	14.6	8.2	14.6
Tripura	6.2	5.9	7.1	4.1
Uttar Pradesh	5.3	7.4	2.7	9.6
West Bengal	5.4	5	2.5	6.6
All India	3.1	4.8	1.4	5

Source: Author's Calculation

The instability index for production of rice during the period 1970-71 to 2011-12 varied widely across states in India (Table: 8). Instability index for production of rice was higher in most of the states as compared to instability index for area under paddy cultivation during the period under study. Most of the states had high instability index of production compared to all India level. States such as Gujarat, Rajasthan, Maharashtra, Madhya Pradesh and Uttar Pradesh had high instability index during 70's. During 1980's there was a decline at all India level for instability index for production compared to the earlier decade. States where instability index was found to be higher were Rajasthan, Gujarat, Odisha, Bihar and Himachal Pradesh. Overall there was a decrease in instability index for rice production across the states in India in 1980s with few exceptions like Assam, Bihar, Kerala, Odisha, Rajasthan and West Bengal where there was worsening of the situation. During 1990s, there was an improvement at the all India level when the instability index declined from 12.6 in 1980s to 4.7 during 1990s. During the last decade, instability index for rice production increased from 4.7 in previous decade to 12.2 at all India level. Also, there was an increase in the instability index for most of the states particularly Rajasthan, Bihar, Gujarat, Madhya Pradesh and Odisha.

Table 8: State Wise Instability in Production of Rice from 1970-71 to 2011-12

States	Period (I) 1970-71 to 1979-80	Period (II) 1980-81 to 1989-90	Period (III) 1990-91 to 1999-2000	Period (IV) 2000-01 to 2011-12
Andhra Pradesh	18.9	18.7	16.4	22.5
Assam	10	13.1	6.2	11.1
Bihar	19.4	27.3	43.5	42.9
Gujarat	81.6	53.7	11.6	41.3
Haryana	26.4	18.5	12.7	7.6
Himachal Pradesh	25.2	24.6	6.3	20.4
Jammu and Kashmir	19.8	16.8	19.1	7.9
Karnataka	24.2	16.6	6.6	27.5
Kerala	5.4	5.8	70.8	11.4
Madhya Pradesh	38.7	22.1	14.9	39.7
Maharashtra	40.5	23.3	7	25.8
Manipur	18.2	17.5	22.8	19
Odisha	28.4	30.9	22.1	37
Punjab	13.2	12.4	6.9	4.4
Rajasthan	50.6	73.4	26.8	44.4
Tamil Nadu	24.5	22.2	60.1	28.3
Tripura	29.4	9.5	33.2	7.6
Uttar Pradesh	32.7	15.6	7.8	19.1
West Bengal	13.2	20.2	5.3	8.3
All India	16.2	12.6	4.7	12.2

Source: Author's Calculation

The instability index in yield of rice (Table: 9) from 1970-71 to 2011-12 shows that during the decade of 70s, the index was higher in states such as Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, Tripura, Odisha and Haryana. However, during 1980's, there was an improvement in the situation when the index value was found to decrease from 13.3 to 8.5. This was also reflected for most of the state level estimates. During 1990s, there was further decline in instability index at all India level from 8.5 in 1980s to 3.8 in 1990s. Despite an overall improvement observed in most of the states, few states like Bihar, Haryana, Jammu and Kashmir, Kerala, Manipur, Rajasthan and Tamil Nadu showed an increase in the instability index value. The instability index increased during the decade of 2000 showing the high vulnerability of rice production and the concomitant distressed situation for farmers.

Table 9: State Wise Instability in Yield of Rice from 1970-71 to 2011-12

States	Period I 1970-71 to 1979-80	Period II 1980-81 to 1989-90	Period III 1990-91 to 1999-00	Period IV 2000-01 to 2011-12
Andhra Pradesh	11.9	10	7.1	8
Assam	7.4	9.8	3.4	6.5
Bihar	15.9	21.2	41.5	36.7
Gujarat	69.8	35.9	17.9	8.3
Haryana	23.1	8.9	15.6	8.8
Himachal Pradesh	20.9	21.6	5.6	21.5
Jammu	19.9	16.6	17.6	6.2
Karnataka	14.9	8.4	3.9	20.1
Kerala	4.9	3	43.4	25.1
Madhya Pradesh	38	21.5	15.2	38.1
Maharashtra	37.3	20	7.3	25
Manipur	12.8	15.8	19.9	11.6
Odisha	25	26.7	20.8	34.4
Punjab	11.9	10.2	60.7	3.4
Rajasthan	44.4	50.3	73.1	30.9
Tamil Nadu	13.6	11.4	60.6	18.5
Tripura	27.1	41.9	36.1	5.3
Uttar Pradesh	29.2	9.8	7.6	11.2
West Bengal	11.4	16.7	6.4	3.4
All India	13.3	8.5	3.8	8.9

Source: Author's Calculation

It was found that in some major rice producing states such as Andhra Pradesh, Haryana, Punjab, Uttar Pradesh and West Bengal the value of instability index was lower compared to other states during the decade of 2000.

8. Cropped Area and Input use in Rice Cultivation across states in India

The percentage of gross cropped area across states shows that while in some states there has been an increase in percentage of gross cropped area, in others there was decline in gross cropped area under rice (Table:10). In states such as Bihar, Kerala, Madhya Pradesh, Manipur and West Bengal there has been decline in percentage of gross cropped area of rice from TE 1992-93 to TE 2011-12 while states such as Andhra Pradesh, Haryana, Odisha, Punjab, Tamil Nadu and Tripura shows an increase in percentage of gross cropped area under rice. In Tripura, Assam and Manipur the percentage of gross cropped area is high during 2011-12 largely due to national Food Security Mission programme.

Table 10: State Wise Percentage of Gross Cropped Area of Rice (in Thousand Hectares)

States	TE1992-93	TE 2004-05	TE 2011-12
Andhra Pradesh	29.58	24.38	30.09
Assam	65.52	63.01	61.15
Bihar	50.04	41.08	42.33
Gujarat	5.31	4.09	6.38
Haryana	11.56	15.65	19.05
Himachal Pradesh	8.51	8.61	8.19
Jammu and Kashmir	25.51	22.73	22.74
Karnataka	10.28	9.88	11.69
Kerala	18.03	9.95	8.21
Madhya Pradesh	21.77	8.65	7.14
Maharashtra	7.44	6.83	6.68
Manipur	80.54	71.66	63.95
Odisha	46.47	52.55	79.2
Punjab	27.3	32.92	35.71
Rajasthan	0.7	0.51	0.58
Tamil Nadu	29.78	29.19	32.85
Tripura	57.11	80.42	78.6
Uttar Pradesh	21.6	21.93	21.81
West Bengal	66.59	61.04	57.76
All India	-	22.59	22.12

Source: Land Use Statistics (Ministry of Agriculture, Government of India)

Rice is water intensive and requires adequate irrigation facilities. Punjab, Haryana, Uttar Pradesh and West Bengal are the states with highest percentage of irrigated area to total cropped area. In Andhra Pradesh the share of irrigated area to total cropped area of rice has increased over the years. Percentage of irrigated area to total cropped area in states such as Bihar and Tamil Nadu also increased over the years largely supported by government programmes. In case of Bihar it increased from 57.94 per cent in 2003-04 to 68.94 per cent in 2012-13 and in Tamil Nadu it increased from 46.62 per cent in 2003-04 to 58.20 per cent in 2012-13. In case of Maharashtra share of irrigated area to total cropped area was just 18.48 per cent in 2012-13 which was much below the national average of 47.62 per cent. In north eastern states the percentage of irrigated area to total cropped area was very low and there was a decline in states such as Manipur, Mizoram, Nagaland and Tripura. At all India level proportion of irrigated area to total cropped area increased from 41.15 per cent in 2003-04 to 47.62 per cent in 2012-13. At state level except north eastern states there was increase in percentage of irrigated area to total cropped area (Table: 11).

Table 11: State Wise Percentage of Irrigated Area to Total Cropped Area of Rice

States	2003 -04	2004 -05	2005 -06	2006 -07	2007 -08	2008 -09	2009 -10	2010 -11	2011 -12	2012 -13
Andhra Pradesh	38.66	39.83	44.88	47.38	46.32	48.74	45.89	49.29	49.31	45.92
Assam	4.38	4.39	3.59	3.77	3.7	7.29	5.49	4.09	3.91	3.82
Bihar	57.94	56.72	58.47	60.19	60.85	61.16	60.76	61.83	67.45	68.49
Chattisgarh	20.66	22.96	23.94	25.92	26.48	27.05	26.74	28.29	29.09	30.31
Goa	23.74	23.73	22.23	21.9	23.19	21.99	23.47	22.75	24.99	22.37
Gujarat	36	38.02	41.45	44.71	45.95	45.57	44.37	45.82	48.18	46.93
Haryana	83.64	84.58	83.74	85.4	85.99	85.25	87.31	85.22	87.53	88.96
Himachal Pradesh	18.84	19.21	19.67	19.78	20.19	20.29	19.76	20.56	20.59	20.62
Jammu and Kashmir	40.46	41.11	41.62	40.73	40.85	41.45	41.91	42.02	41.34	41.95
Jharkhand	10.28	9.93	9.37	8.71	9.39	9.69	11.07	12	11.33	14.16
Karnataka	23.6	25.98	27.88	28.96	29.39	31.87	31.82	32.76	34.3	34.11
Kerala	14.38	15.2	15.41	16.8	16.49	17	17.06	17.65	20.49	17.67
Madhya Pradesh	29.19	30.65	29.98	32.53	32.17	32.5	33.45	33.66	36.54	38.76
Maharashtra	18.42	17.84	17.93	18.77	19.26	19.27	19.25	19.4	18.92	18.48
Manipur	18.39	22.73	22.72	22.72	21.7	21.9	22.3	20.98	18.83	15.7
Meghalaya	30.26	27.93	24.93	29.23	25.75	21.5	21.94	21.98	23.59	36.75
Mizoram	18.36	19.23	19.28	12.47	9.99	11.79	8.43	10.05	13.52	12.62
Nagaland	28.06	27.48	27.44	26.2	29.11	20.46	17.57	20.24	19.4	18.92
Odisha	29.16	30.86	33.56	35.77	36.7	35.03	29.29	28.35	28.95	29.51
Punjab	97.66	97.12	97.61	97.52	97.71	97.63	97.95	97.99	98.31	98.39
Rajasthan	29.51	33.68	36.03	36.96	36.42	34.74	33.61	32	36.33	39.47
Sikkim	9.41	9.24	15.12	15.12	14.64	15.4	13.66	13.22	13.7	13.55
Tamil Nadu	46.62	52.42	56.3	56.64	55.92	58.26	58.12	58.19	59.75	58.2
Tripura	38.18	38.22	36.03	36.22	36.47	36.64	36.62	35.02	34.9	34.88
Uttarakhand	44.76	44.5	45.32	45.79	46.7	47.75	48.58	48.02	49.02	49.26
Uttar Pradesh	72.86	74.2	74.96	75.62	75.6	77	76.08	76.62	76.72	78.2
West Bengal	55.76	56.06	57.7	57.93	58.14	57.66	57.97	58.81	58.13	63.08
All India	41.15	42.43	43.73	45.09	45.11	45.51	45.02	44.99	46.89	47.62

Source: Computed from Government of India various issues

Over the years, rice production India has witnessed a continuous decline in using seeds (Kg) and manure (quintals) in most of the states and an increase in fertilizer (Kg nutrients) use. However there is large variation in input use across states. There is also large variation in fertilizer use across states e.g. in Assam, Himachal Pradesh and Jharkhand the use of fertilizer was below 50 Kg nutrients during 2013-14; the use of manure was below 20 Kg in most of the states during 2013-14. Although India's average input application is not high, the imbalance in application of inputs like fertilizers is very high. There is sizeable intensification (rice and wheat in Punjab) while in others there is none (Table: 12).

Table 12: State Wise Input Use in Paddy Cultivation in India (Per Hectare)

State/Year	Seeds (Kg)			Fertilizer (Kg Nutrients)			Manure (Qtls.)		
	2000 -01	2005 -06	2013 -14	2000 -01	2005 -06	2013 -14	2000 -01	2005 -06	2013 -14
Andhra Pradesh	86.1	77.2	73.9	189.46	201.35	239.24	35.58	16.69	15.77
Assam	64.81	65.05	58.02	12.03	9.78	16.66	4.5	3.77	5.17
Bihar	63.22	53.47	46.31	75.36	84.84	98.92	1.29	1.22	0
Chhatisgarh	-	103.6	84.46	-	85.39	122.5	-	7.78	8.46
Gujarat	-	14.94	10.55	-	143.4	153.6	-	19.22	16.83
Haryana	0	0	0	197.7	229.4	207.8	3.07	3.62	0.07
Himachal Pradesh	-	98.4	91.6	-	43.0	19.7	-	25.7	6.0
Jharkhand	-	55.29	50.84	-	39.51	50	-	0.95	6.07
Karnataka	88.8	74.8	65.5	222.1	263.6	260.6	20.37	13.53	12.3
Kerala	0	0	0	106.5	127.2	176.2	28.33	17.76	10.16
Madhya Pradesh	98.4	91.95	66.84	50.71	50.2	105.6	20.24	17.04	7.54
Maharashtra	-	88.45	57.64	-	117.6	143.4	-	22.86	10.19
Odisha	104.9	91.86	89.13	81.18	83.88	78.59	25.2	25.41	21.13
Punjab	0	0	0	171.3	191.6	209.1	19.62	35.26	24.08
Tamil Nadu	-	0	0	220.2	224.2	240.1	32.76	30.24	37.15
Uttar Pradesh	0	0	0	110.0	129.6	156.8	9.46	8.42	0.91
Uttarakhand	-	0	0	-	79.35	115.6	-	67.03	10.86
West Bengal	71.59	71.27	63.36	95.81	94.03	132.3	30.91	23.36	25.1

Source: Computed from Government of India (Cost of Cultivation Data various issues)

9. Instability index for whole sale prices for rice

Owing to the differences in consumption pattern of rice, holding size and production per farm, the quantity of production sold or marketed by the farmers varies from one state to the other. The marketed surplus (MS)-output ratio varies from 29 percent to 99 percent for paddy/rice in India (Acharya et.al: 2012). In other words total production does not enter the market and a portion is retained by the cultivator for his self-consumption and also for making various payments towards cost of cultivation in kind.

Despite large number of rural markets, post-harvest distress sales, absence of grading and packaging at the farm level and inter-locking credit and commodity markets continue to be common place. A study on paddy sales by the Karnataka State Agriculture Prices Commission in 2002 found that only 29% of the sample farmers sold their produce through the regulated markets. The vast majority (71%) did not because of distance, no knowledge of regulated market, payment delays, no provision for paddy sale, harassment by coolies, good price at the local market, small quantity, and advance taken (Chatterjee and Kapur:2016).

Since agriculture is a state subject, the regulation on wholesale agriculture markets is governed by various states' specific Acts which empower the states to notify the commodities and designate the markets for regulated trades. Together with this, the minimum support price (MSP) is provided for procurement to cover the cost of production

by the farmers. The MSP linked to procurement had served the country well in the past three decades. However, in recent years it has started encountering problems mainly because of surpluses of several agricultural commodities and excessive built up of stocks with FCI. Even deficit states like Bihar, Assam, Eastern U.P. have started generating surpluses of certain cereals (GoI:2010). Consequently there are large variations in wholesale price of paddy across states (Table:13). During 1990s instability in wholesale prices was higher in states such as Haryana, Punjab, Tripura, Madhya Pradesh, and Kerala. Instability in wholesale prices increased during 2000s as compared to 1990s in most of the states except Assam, Bihar and Haryana. During 2000s in states such as Punjab, Andhra Pradesh, Haryana, Madhya Pradesh, Kerala, Gujarat, Himachal Pradesh and Tripura instability in wholesale prices was considerably high.

Table 13: Instability in Wholesale Prices of Paddy from 1990-91 to 2016-17

States	1990-91 to 1999-00	2000-01 to 2016-17
Andhra Pradesh	7.9	33.4
Assam	13.7	10.3
Bihar	9.3	8.6
Gujarat	19	25
Haryana	42.1	31.8
Himachal Pradesh	13.2	24.8
Karnataka	13	19
Kerala	20.6	28.1
Madhya Pradesh	21.2	31.2
Maharashtra	8.1	22.1
Manipur	5.1	22.8
Odisha	6.8	14.2
Punjab	24	46.6
Tamil Nadu	9.3	22.8
Tripura	21.4	24.8
Uttar Pradesh	6.9	16.9
West Bengal	7.5	19.2

Source: Author's Calculation (Directorate of Marketing and Inspection)

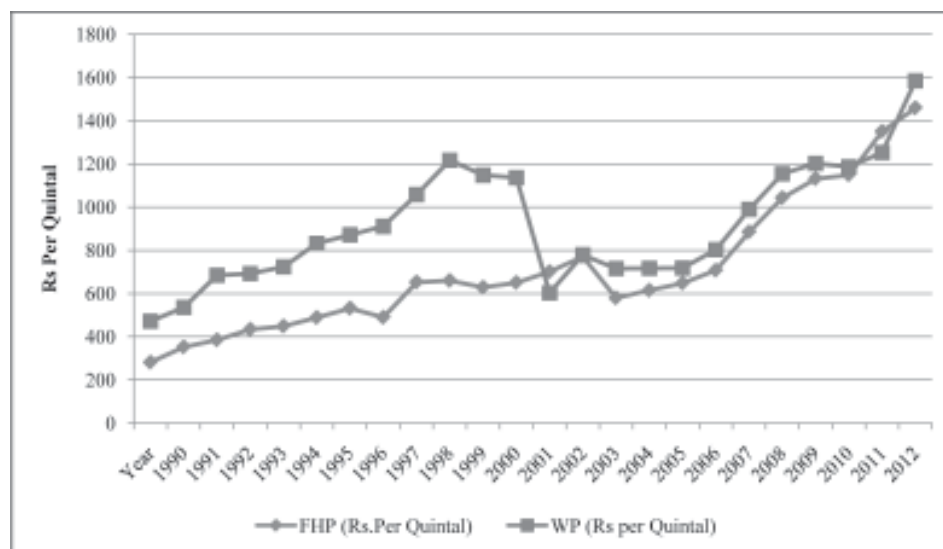
Also there are large fluctuations in farm harvest prices of paddy at state level (Table:14). The state with high instability in farm harvest prices during 1990s were Haryana, Tripura, Rajasthan, Madhya Pradesh and West Bengal. The instability index for farm harvest prices during 2000s increased by large margins during the last decade in most of the states as compared to 1990s. Karnataka, Haryana, Punjab, Rajasthan and Madhya Pradesh continued to be highly unstable in respect of farm harvest prices.

Table 14: State wise Instability in Farm Harvest Prices of Paddy from 1990-91 to 2011-12

States	1990-91 to 1999-00	2000-01 to 2011-12
Andhra Pradesh	7.6	11.3
Assam	12.3	5.2
Bihar	9.6	7.4
Gujarat	17.8	7.7
Haryana	51.9	39.7
Himachal Pradesh	14.5	9.1
Jammu and Kashmir	13.3	3.9
Karnataka	8.9	50.6
Kerala	10.3	10.7
Madhya Pradesh	19.9	18.4
Maharashtra	10.7	10.9
Manipur	11.2	14.2
Odisha	11	9.9
Punjab	14.6	27.5
Rajasthan	21.4	24.5
Tamil Nadu	11.4	11.7
Tripura	21.6	11.3
Uttar Pradesh	11.4	10.6
West Bengal	18.4	14.6

Source: Author's Calculation (Farm Harvest Price taken from Agriculture Prices in India)

Figure 2: Farm Harvest Price and Wholesale Prices of Paddy at All India Level (Current Price)



Source: Computed from Government of India various Issues

Figure 2 shows the Farm Harvest Prices and Wholesale Prices of paddy at all India level from 1990 to 2012. In most of the years wholesale prices were higher than the farm harvest price which shows that farmers were not able to get remunerative prices for paddy and they were selling at distress. From early 1990s to 2000 the gap between whole prices and farm harvest prices increased which also reflects the uncertainty for Indian farmers to recover their basic cost of cultivation.

During the 1970s and 1980s, MSP for rice moved downward in real terms. MSP policy yet afforded adequate producer incentives because of steady yield gains. Beginning in the early 1990s, however, devaluation of the rupee pushed up the costs of traded inputs and led to an upward trend in MSP for rice. Devaluation of the rupee in the early 1990s helped increase the cost of inputs traded. Linking MSPs on production costs disconnected from market conditions as India transitioned from deficits to surpluses. During the late 1990s, the MSP for rice in India was higher than the domestic and world market conditions. This trend benefited the relatively small share of producers in surplus areas who received the MSPs, but higher market prices had adverse impacts. Since 2001, following the accumulation of large surplus stocks, there have been relatively small nominal annual increases in MSPs for wheat and rice. As a consequence, there has been slower growth in rice output, including both area and yield, slowed growth in government procurement of rice in price support operations.

Table 15: Ratio of Farm Harvest Prices to Wholesale Prices of Paddy in Different Years

State	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	-91	-92	-93	-94	-95	-96	-97	-98	-99	-00
Andhra Pradesh	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5
Assam	0.7	0.9	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.6
Bihar	0.5	0.6	0.5	0.5	0.6	0.5	0.5	0.5	0.6	0.5
Gujarat	0.6	0.9	0.7	0.6	0.6	0.7	0.7	0.8	0.7	0.5
Haryana	1.4	1.6	1.8	2.6	1.5	0.7	1	1.2	3	0.9
Himachal Pradesh	0.6	0.7	0.6	0.8	0.7	0.6	0.6	0.6	0.6	0.6
Karnataka	0.5	0.6	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.4
Kerala	0.7	0.8	0.8	0.6	1	0.8	0.9	0.8	0.7	0.6
Madhya Pradesh	0.5	0.6	0.4	0.5	0.4	0.4	0.7	0.5	0.6	0.5
Maharashtra	0.6	0.8	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.5
Manipur	0.5	0.6	-	-	0.5	0.5	0.5	0.4	0.6	0.6
Odisha	-	-	-	-	-	-	-	-	0.5	0.5
Punjab	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Tamil Nadu	0.6	0.5	0.6	0.7	0.6	0.5	0.5	0.5	0.5	0.4
Tripura	1.3	1.1	1	1.1	1.1	1	1.1	0.9	0.5	0.9
Uttar Pradesh	0.5	0.6	0.5	0.6	0.5	0.5	0.5	0.5	0.6	0.5
West Bengal	0.6	0.6	0.5	0.6	0.5	0.6	0.6	0.5	0.7	0.5

States	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	-01	-02	-03	-04	-05	-06	-07	-08	-09	-10	-11	-12	-13	-14
Andhra Pradesh	0.5	0.5	-	0.9	0.4	0.9	0.9	1.1	1.2	1.2	1	1	1.2	1.1
Assam	0.5	0.5	-	0.9	1.1	0.9	-	0.9	0.9	0.9	0.9	1	1	0.8
Bihar	0.4	0.5	-	0.8	0.9	0.8	0.9	0.9	0.9	-	-	-	0.8	0.8
Gujarat	0.5	0.5	1.2	1.1	1	0.9	1	1.1	1	1	1	1	1.1	1
Haryana	0.9	1.5	1.6	0.8	0.9	0.9	-	-	-	-	1.2	0.8	1.5	1.3
Himachal Pradesh	0.7	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Karnataka	0.4	0.5	1	2.6	0.7	0.7	0.8	0.9	0.9	0.8	0.9	0.9	1	0.7
Kerala	0.5	0.5	-	0.4	0.5	-	0.9	0.6	1.1	1.1	1	1	1.1	0.9
Madhya Pradesh	0.6	0.5	1.5	1.2	0.9	0.9	0.9	1.1	0.9	1.1	0.9	1.1	1.2	0.9
Maharashtra	0.6	0.6	0.9	0.7	0.9	-	-	-	0.8	0.8	0.9	1.3	1	0.8
Manipur	0.4	0.4	0.9	0.7	0.9	0.8	0.7	0.8	-	-	0.7	0.6	0.7	0.9
Odisha	0.4	0.5	0.8	0.8	0.9	0.9	0.8	1.1	1	1	1	1	1	1
Punjab	0.2	0.3	1.6	1.4	-	1.3	1.3	0.7	0.8	1.1	0.7	0.7	0.8	0.5
Tamil Nadu	0.4	0.4	0.9	0.8	0.8	0.7	0.8	1	1	0.9	0.9	1	1.1	1
Tripura	-	1.1	-	1.4	-	0.7	0.7	1	-	-	0.8	1	1.3	1.1
Uttar Pradesh	0.5	0.5	0.9	0.9	0.9	1	1	0.9	1	1.1	0.8	1	1	0.8
West Bengal	0.5	0.5	0.8	0.9	0.9	0.9	0.9	0.7	0.9	1.1	0.9	0.9	1.1	1.1

Source: Computed from Government of India various Issues

Table 15 shows the ratio of farm harvest Prices to wholesale prices of paddy across states¹. During 1990s in all the states except Haryana and Tripura the ratio of farm harvest Prices to wholesale prices was less than one. In case of Punjab the value of this ratio is 0.1 and 0.2 during 1990s which explains the reasons for distressed sale of rice by farmers in Punjab during 1990s. A similar situation arose in Andhra Pradesh, Uttar Pradesh, West Bengal where there was distress sale by the farmers in these states during 1990s.

During 2000s the ratio of farm harvest price to wholesale price has improved. However, in states like Assam, Bihar, Karnataka and Manipur though there has been an improvement in the ratio but paddy cultivation is still not profitable as the ratio continues to be less than one (0.7 and 0.9). Before liberalization, even low yields fetched relatively higher prices, but with opening up of the economy and linking to international markets have made prices depend on global demand and supply rather than local and low yield is made worse by low price. This combination of low yield and low price adds further to distress of cultivators (Menon:2006)

¹ When the value of this ratio is less than one implies there is distress sale by the farmers as farm harvest prices are the prices received by the farmer at the village site and when this ratio attains the value greater than 1 one it means the cultivation of paddy is profitable to the farmers.

10. Conclusion

Over the years the compound annual growth rate of area, production and yield of rice in India though continues to be positive had been declining gradually. The rate of decline was faster in the post reforms period. The instability index in respect of production and yield at all India level decreased during the decade of 80s and 90s but increased during the last decade. As growth rate declined in area under production of rice, total production of rice and yield of paddy cultivation during the last decade, instability index for all the three indicators increased at the same time. The increase in instability in wholesale prices of paddy across various states from 1990-91 to 2016-17 shows the distressed situation of paddy farmers. The ratio of farm harvest price to wholesale price has improved in many states after 2005 in many states. The instability in area, production and yield of rice can be reduced through adequate institutional support and input supply to the farmers including marginal and small farmers.

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