

Statistical Methods for Instability in Production of Major Crops in National Capital Region (NCR) of Haryana

Madhu Ahlawat and Pooja Kumari*

Department of Economics, Baba Mastnath University,
AsthalBohar, Rohtak-124021, Haryana, India

*Corresponding author: drpoojakumari108@gmail.com

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Abstract

The instability in agriculture production of major crops of NCR-districts of Haryana state is studied using Cuddy Della Valle Index method (CDVI). The study includes 13 National Capital Region (NCR) district like Bhiwani, Mahendergarh, Jind, Rewari, Gurugram, Faridabad, Jhajjar, Rohtak, Sonipat, Panipat, Karnal, Mewat and Palwal except the newly established district Charkhi Dadari. For the study a period of last fifteen years, that is, from 2004-05 to 2018-19 is taken for the analysis which is divided in to three equal sub-intervals: period-I (2004-05 to 2008-09), period-II (2009-10 to 2013-14) and period-III (2014-15 to 2018-19). The secondary data is collected from the various issues of the Economical Survey of Haryana and the Statistical Abstract of Haryana for the period of 15 years, that is, from 2004-05 to 2018-19.

Keyword: Crops, Cuddy Della Valle Index method, Instability, NCR-Districts, Production.

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INTRODUCTION

It is true that the agriculture production and small industries of Haryana state plays a vital role in the growth of total Economy of India. In Haryana, the major crops are Wheat, Rice, Jowar, Bajra, Gram, Sugarcane, Cotton, Oilseeds, Mustard, Potato, and Barely. The income of the 70% population of Haryana depends on the agriculture production. It is examined that due to the modern technology of irrigation in agriculture the variability in instability and growth production have removed. Also, it is observed that the 75% agriculture land is irrigated using tubewells and Canals thorough modern technology of irrigation system. Further, the Asia's largest agriculture University Chaudhary Charan Singh University is situated in Hisar district of Haryana. The Green Revolution technology has affected the agriculture production in Haryana; therefore, the Haryana state has become self-dependent in Foodgrain sector. Moreover, there are so many research who examined the growth and instability in major crops of various states of India such as Saravanadurai and Kalaivani (2010), Krishan and Chanchal (2014), Vyas, V. S. (1996), Vaidyanathan A. (2000), etc.

The instability in area, production and yield in the major crops such as Rice, Groundnut and Cotton before the period 1981-93 and after the period 1993-04 was estimated at district and state level of Andhra Pradesh by Chand and Raju(2008). Further, it was observed that the unpredictability in prices of major crops may affect the instability in total return. It is observed that the net effect of variation in prices of the crops and production has described that the instabilities in area, yield, production and prices do not deny each other. In 2014, Sihmar (2014) studied the instabilization in the agriculture production of major crops of various district of Haryana. He shown that the agriculture reforms such as minimum support price, new economic reforms, green revolution and land reforms have directly affected the agriculture production in all the states of India. It is also analyzed that all the reforms are considered favorable in term of productivity and production of the crops but they have partially affected in terms of crops stability. The few major crops such as Rice and Wheat are assumed more stable but the pulses and cereals gets highest instability in production and area in Haryana state. In 2012, Acharya et al. (2012) studied the growth in production, area and productivity of major crops of Karnataka using compound annual growth rate (CAGR) function for 1982-1983 to 2007-2008. A major growth was determined in growth of area of the major crops such as vegetables, pulses, spices and fruits and also described a negative trend in the growth of major cereals of Karnataka state. In 2013, Paltasingh and Goyari (2013) determined the performance analysis of major crops of Odisha state in terms of area, yield and production. During the study many causes for the low growth rate was observed. They determined that the price risk and weather fluctuation are the major parameters of instability and found that the weather plays a major role then price fluctuation in augmenting risk. Therefore, they suggested some agriculture policies to improve the agriculture production in future. In 2016, Patil et al. (2006) examined the growth and instability of major crops in area, productivity and production in urban division of Bengaluru through Compound Annual Growth Rate (CAGR) method. They determined that the Bengaluru urban division has the highest CAGR value 24.26 percent in productivity and the Bengaluru rural division has the highest CAGR value 22.26 percent productivity. Further, in 2015, Savita and Kunal (2015) using the secondary data for the period 1998-1999 to 2012-13 studied the growth in the production of various major crops of Karnataka using CAGR method. In the next year, the growth in production, area and productivity in Bengaluru urban division was determined using CAGR method. Moreover, for further study one may refer to Senapati et al. (2018), Singh et al. (2018), Sood et al. (2019).

The article deals with the instability analysis of agriculture production of various major crops such as Wheat, Rice, Bajra, Barley, Jowar, Maize, Gram, Moong, Massar, Ground Nut, Sesamum, Mustard, Cotton, Sugarcane, Potato, etc. of NCR districts of Haryana state. The Cuddy Della Valle Index (CDVI) method is used to examine the instability in percentage. By using the different issues of Economic Survey of Haryana and the Statistical Abstract the Haryana the secondary data of the major crops for the last 15 years, that is, from 2004-05 to 2018-19 is collected. In Section 1, a brief literature review of the growth and instability of major crops of various states of India is discussed. Section 2 deals with the research methodology and data collection used in the paper. Section 3 contains the main instability results of 13 NCR district of the Haryana state. Finally, paper is concluded in section 4.

MATERIALS AND METHODS

Haryana is the major crops growing state in India. Therefore, the seventy percent population of Haryana depends on the agriculture income. In this analysis, we take the major crops of NCR-district of Haryana to examine the instability in production of major crops. The secondary data of major crops is collected from the Economical Survey of Haryana and the Statistical Abstract of Haryana for the period of 15 years, that is, from 2004-05 to 2018-19. The 13 NCR districts are Bhiwani, Mahendergarh, Jind, Rewari, Gurugram, Faridabad, Jhajjar, Rohtak, Sonapat, Panipat, Karnal, Mewat, and Palwal. The analysis is divided into three periods that is, 2004-05 to 2008-09 (period-I), 2009-10 to 2013-14 (period-II), 2014-15 to 2018-19 (period-III).

To measure the agriculture production instability various methods are used such as Coefficient of variation, method of dispersion, Cuddy Della Valle Index method, etc. Therefore, in the present analysis, to find the instability in agriculture production of major crops, the Cuddy Della Valle Index Method (CDVI) is used. It presents a detrend approach against the Coefficient of variation by using coefficient determination parameter R^2 . Thus, it is considered a more effective and efficient method to measure the annual instability production. The parameter value of this method is divided into three categories: low, medium and high instability. The low index value indicates low instability in production of crops, medium index value denotes the medium instability in production and high index value means high instability in crop production. Thus, to examine the instability the following form of the Cuddy Della Valle Index method is used.

$$\text{Cuddy Della Valle Index (CDVI)} = I = CV \times \sqrt{1 - \text{Ad } R^2},$$

where I = Instability Index (in percent), CV = Coefficient of Variations and $\text{Ad } R^2$ = Adjusted R^2

The range of Cuddy Della Valle Index are given as follows:

- (a) **Low Instability:** between 0 and 15
- (b) **Medium Instability:** greater than 15 and lower than 30
- (c) **High Instability:** greater than 30

RESULTS AND DISCUSSION

Throughout, this section the instability in agriculture production of major crops of NCR district of Haryana is examined for the last fifteen years, that is, for the period-I, period-II, and period-III.

Instability in Agriculture Production of Major Crops in Bhiwani District

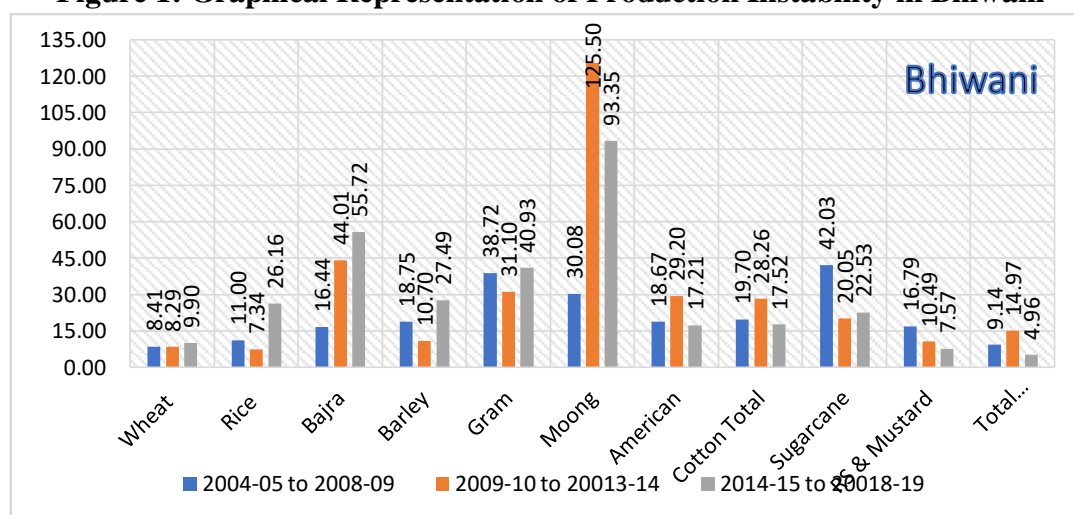
We take the nine major crops such as Wheat, Rice, Bajra, Barely, American Cotton, RS & Mustard, Gram, Moong and Sugarcane in Bhiwani district and examine their instability using Cuddy Della Valle Index (CDVI) method. The instability is divided into three categories, Low, Medium and High instability as shown in Table 1. In period-I(2004-05 to 2008-09), Wheat and Rice are registered in low instability range followed by Bajra, Barley, American Cotton and RS & Mustard which remains in medium instability range and Gram, Moong and Sugarcane which attains high instability range. The crops Wheat, Rice, Barley and Mustard with a sharp decline trend are registered in low instability range in period-II (2009-10 to 2013-14) followed by American Cotton and Sugarcane which admits medium

instability. Further, it is noticed that the Sugarcane with a sharp decline gets medium instability from high instability of period-I and the crops Gram and Moong still take place high instability in period-II also. In period-III (2014-15 to 2018-19) Rice and Barley is shown in the medium instability range. From the Figure 1, it is noticed that the instability in Bajra increases continuously from period-I to period-III, Moong shows highest instability in period-II and period-III as compared to period-I and Rice shows low instability in period-I and period-II but increases drastically in period-3 and attains medium instability. Further, the Figure 1 shows that the Wheat and total Foodgrain always remains in low instability range in all the periods. The crops Mustard continuously decreases and is registered in low instability in period-II and III.

Table 1: Production Instability among major crops in Bhiwani district (in %)

Years	LOW INSTABILITY (0 to ≤ 15)		MEDIUM INSTABILITY (>15 to ≤ 30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Wheat	8.41	Bajra	16.44	Gram	38.72
	Rice	11	Barley	18.75	Moong	30.08
	Total Foodgrain	9.14	American Cotton	18.67	Sugarcane	42.03
			Mustard	16.79		
2009-10 To 2013-14	Wheat	8.29	American Cotton	29.20	Bajra	44.01
	Rice	7.34	Sugarcane	20.05	Gram	31.10
	Barley	10.70			Moong	125.50
	Mustard	10.49				
	Total Foodgrain	14.97				
2014-15 To 2018-19	Wheat	9.90	Rice	26.16	Bajra	55.72
	Mustard	7.57	Barley	27.49	Gram	40.93
	Total Foodgrain	4.96	American Cotton	17.21	Moong	93.35
			Sugarcane	22.53		

Figure 1: Graphical Representation of Production Instability in Bhiwani



Instability in Agriculture Production of Major Crops in Mahendergarh District

In Mahendergarh district, we take the five major crops such as Wheat, Bajra, American Cotton, RS & Mustard, and Gram and examine their instability. Table 2 and Figure 2 gives a brief analysis of these crops for low, medium and high instability for the period-I, II and III. Therefore, from the Table 2 it is observed that the Bajra is the only crop in period-I (2004-05 to 2008-9), which attains low instability followed by RS & Mustard in medium instability and Wheat, Gram and American Cotton in high instability. In period-II (2009-10 to 2013-14), Wheat and American Cotton with a major decline are registered in low and medium instability, respectively. While the crop Gram is registered in high instability range in period-II and III. In period-III (2014-15 to 2018-19), Wheat and American Cotton with a major decline are registered in low and medium instability, respectively. While the crop Gram is registered in high instability range in period-II and III.

Table 2: Production Instability among major crops in Mahendergarh district (in %)

Years	LOW INSTABILITY (0 to ≤ 15)		MEDIUM INSTABILITY (>15 to ≤ 30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Bajra	8.54	Mustard	23.93	Wheat	44.16
	Total Foodgrain	4.36			Gram	39.57
					American Cotton	54.44
2009-10 To 2013-14	Wheat	9.64	American Cotton	16.91	Gram	38.44
	Bajra	14.08	Mustard	29.10		
	Total Foodgrain	8.16				
2014-15 To 2018-19	Wheat	6.43	Bajra	24.01	Gram	65.29
	Mustard	9.19	American Cotton	11.35		
			Total Foodgrain	16.42		

Figure 2: Graphical Representation of Production Instability in Mahendergarh

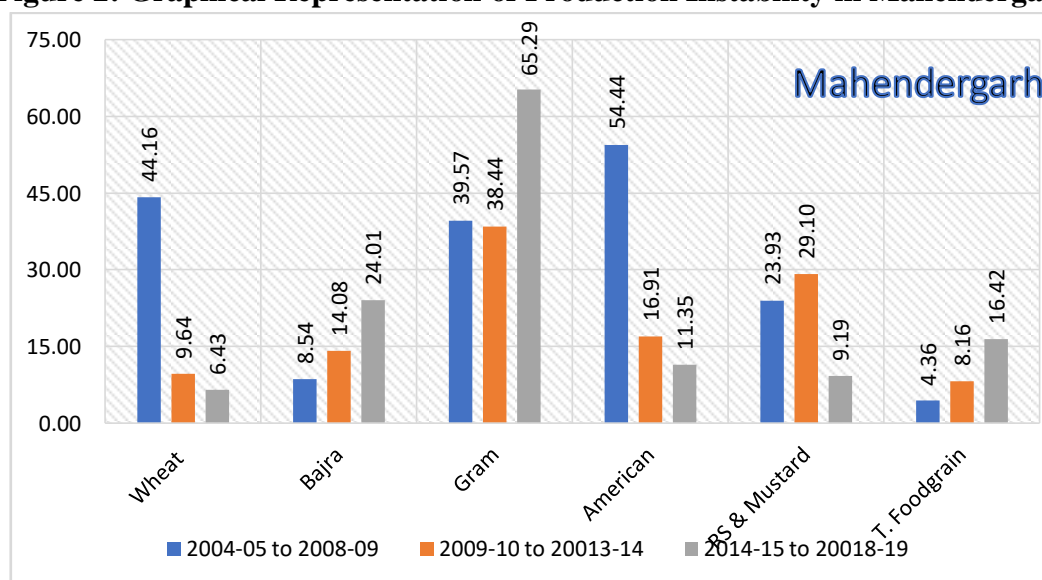


Figure 2, shows a continues declining trend in Wheat and American Cotton from period-I to period-III and shows a major increase in Bajra and total Foodgrain from low instability to high instability from period-I to period-III. Also, Figure 2 represents that the Mustard has recorded a sharp decline in period-III and attains low instability range.

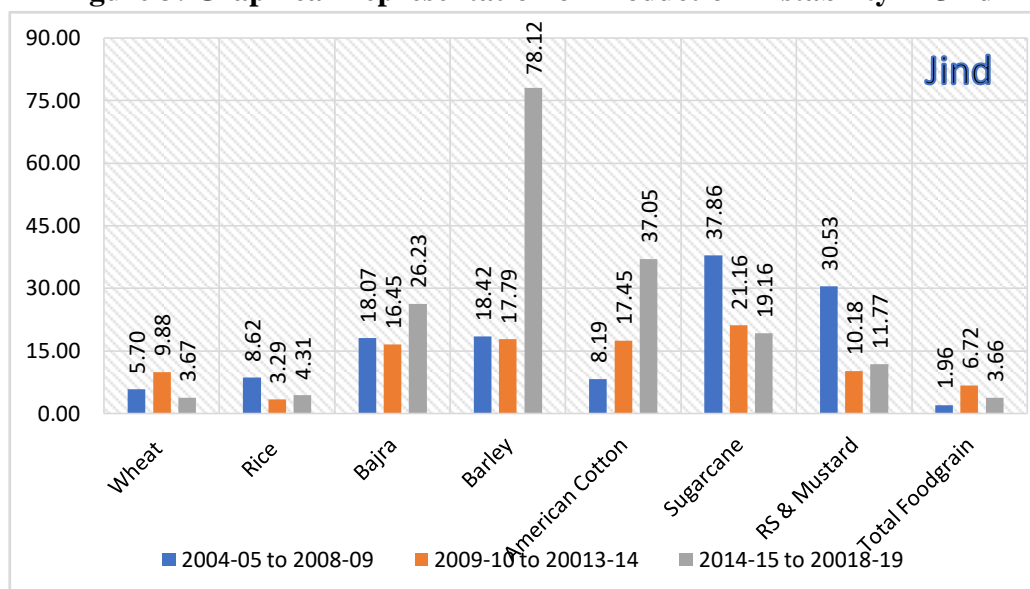
Instability in Agriculture Production of Major Crops in Jind District

In Jind district, we take seven major crops such as Wheat, Rice, Bajra, Barley, American Cotton, RS & Mustard, and Sugarcane and examine their instability. Table 3 and Figure 3 gives a brief analysis of these crops for low, medium and high instability for the period-I (2004-05 to 2008-09), period-II(2009-10 to 2013-14) and period-III (2014-15 to 2018-19). In Table 3 the study finds that the instability in production of Wheat, Rice, and American Cotton remains low during the first period followed by the medium instability crops Bajra and Barley. Although, the instability in the production of Sugarcane and RS & Mustard is registered high in period-I. In period-II, the crop RS & Mustard achieves low instability category with a large decline from high instability category and Sugarcane also gets medium instability production category from high instability production category. Therefore, the study finds that there are no crops in high instability production category in period-II. Further, in period-III, the production in Barley and American Cotton gets high instability, Wheat, Rice and RS & Mustard attains low instability and Bajra and Sugarcane remains in medium instability category.

Table 3: Production Instability among major crops in Jind district (in %)

Years	LOW INSTABILITY (0 to ≤15)		MEDIUM INSTABILITY (>15 to ≤30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Wheat	5.70	Bajra	18.07	Sugarcane	37.86
	Rice	8.62	Barley	18.42	Mustard	30.53
	American Cotton	8.19				
	Total Foodgrain	1.96				
2009-10 To 2013-14	Wheat	9.88	Bajra	16.45	NIL	
	Rice	3.29	Barley	17.79		
	Mustard	10.18	American Cotton	17.45		
	Total Foodgrain	6.72	Sugarcane	21.16		
2014-15 To 2018-19	Wheat	3.67	Bajra	26.23	Barley	78.12
	Rice	4.31	Sugarcane	19.16	American Cotton	37.05
	Mustard	11.77				
	Total Foodgrain	3.66				

Figure 3 represents a comparative analysis of instability production of all the seven crops versus period-I, II, and III. It shows that the production in Wheat, Rice and Total Foodgrain acquires low instability throughout the period-I, II, and III. While the production in Bajra remains stable in medium instability range from period-I to III. Also, the production in Barley shows high instability in period-III, the instability in American Cotton increases continuously and the instability in the crops Sugarcane and RS & Mustard decreases sharply from period-I to III.

Figure 3: Graphical Representation of Production Instability in Jind

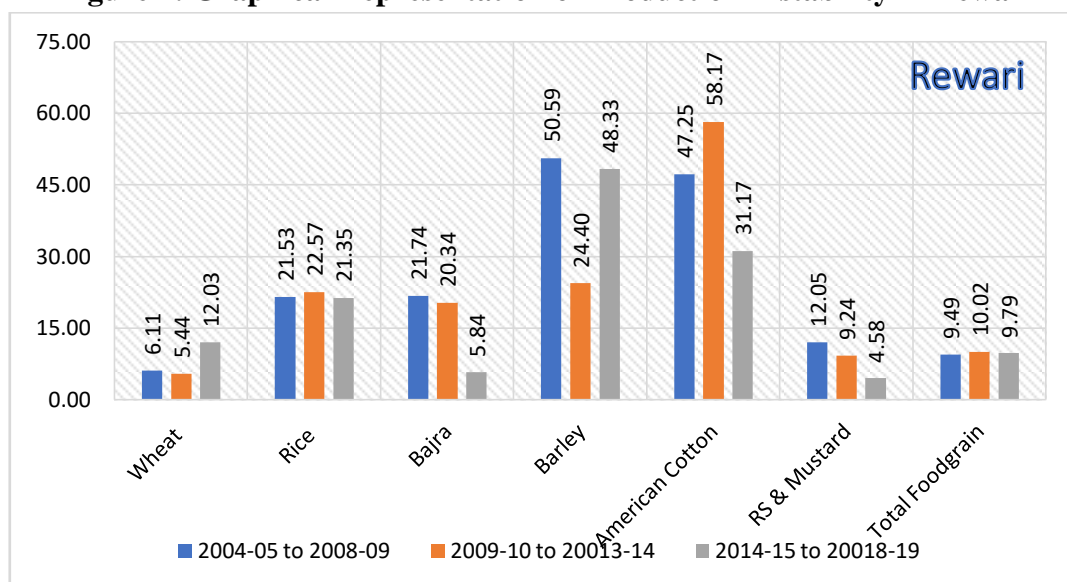
Instability in Agriculture Production of Major Crops in Rewari District

In Rewari district, six major crops, Wheat, Rice, Bajra, Barley, American Cotton and RS & Mustard are considered to examine the instability in production for the last fifteen years, that is, from 2004-05 to 2018-19. The total period is divided into three categories, period-I (2004-05 to 2008-09), period-II (2009-10 to 2013-14) and period-III (2014-15 to 2018-19). Table 4 contains the production instability values which are determined by using Cuddy Della Valle Index (CDVI) method. The production of Wheat and Mustard is registered in low instability category in all the three periods, Rice and Bajra is determined in medium instability category in all the periods, and American Cotton is admitted in high instability category. Further, the production in Barely varies from high to medium and medium to high instability category, from period-I to period-III.

Figure 4, shows that the crops such as Wheat, Mustard and total Foodgrain always remains in low instability range (0 to 15), Barley and American Cotton attains high instability range (greater than 30) and Rice gets medium instability range (15 to 30).

Table 4: Production Instability among major crops in Rewari district (in %)

Years	LOW INSTABILITY (0 to ≤15)		MEDIUM INSTABILITY (>15 to ≤30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Wheat	6.11	Rice	21.53	Barley	50.59
	Mustard	12.05	Bajra	21.74	American Cotton	47.25
	Total Foodgrain	9.49				
2009-10 To 2013-14	Wheat	5.44	Rice	22.57	American Cotton	58.17
	Mustard	9.24	Bajra	20.34		
	Total Foodgrain	10.02	Barley	24.40		
2014-15 To 2018-19	Wheat	12.03	Rice	21.35	Barley	48.33
	Mustard	4.58	Bajra	5.84	American Cotton	31.17
	Total Foodgrain	9.79				

Figure 4: Graphical Representation of Production Instability in Rewari

Instability in Agriculture Production of Major Crops in Gurugram District

The Wheat, Rice, Bajra, Barley, Sesamum and RS & Mustard are the major crops in Gurugram district. Table 4 contains the instability production measure of these crops which is determined using Cuddy Della Valle Index method. In period-I (2004-05 to 2008-09), almost all the crops show high instability in production except Bajra which attains medium instability. Therefore, there is no crops in low instability production category in period-I. Further, in period-II (2009-10 to 2013-14), the instability production in Wheat, Rice and Bajra is low followed by the Barley and Mustard in medium and Sesamum in high. In period-III (2014-15 to 2018-19) the instability production in Wheat, Rice and Bajra is again in low range. But the sesamum with a sharp decline enters in medium instability and hence there is no crops in high instability range. It is amazing to see that in period-I, almost all the crops were registered in the high instability category but in period-III there is no crops in high instability category. It shows a great improvement in the production of major crops in the last fifteen years.

Table 5: Production Instability among major crops in Gurugram district (in %)

Years	LOW INSTABILITY (0 to ≤ 15)		MEDIUM INSTABILITY (>15 to ≤ 30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	NIL		Bajra	25.09	Wheat	37.04
					Rice	51.61
					Barley	34.79
					Sesamum	60.47
					Mustard	47.99
					Total Foodgrain	34.44
2009-10 To 2013-14	Wheat	9.42	Barley	27.65	Sesamum	52.79
	Rice	8.30	Mustard	13.11		
	Bajra	4.80				
	Total Foodgrain	7.01				

2014-15 To 2018-19	Wheat	11.93	Barley	18.29	NIL
	Rice	5	Sesamum	24.38	
	Bajra	7.28	Mustard	17.19	
	Total Foodgrain	9.18			

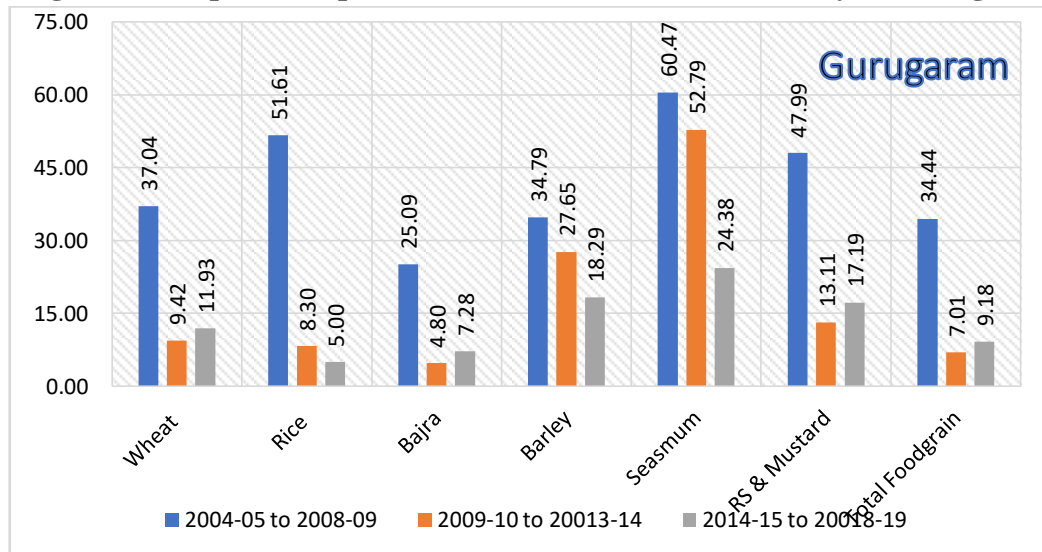
Figure 5: Graphical Representation of Production Instability in Gurugram

Figure 5, shows that due to the major production in Wheat, Rice and Bajra the instability production decreases continuously from period-I to period-III. The overall total Foodgrain also continuously decreases. Further, it is noticed that the instability production in Barley also decrease from high instability to medium instability but does not achieve low instability. Similarly, the crop Sesamum decreases from high instability to medium instability but does not achieve low instability. Mustard enters in all the three categories of instability production.

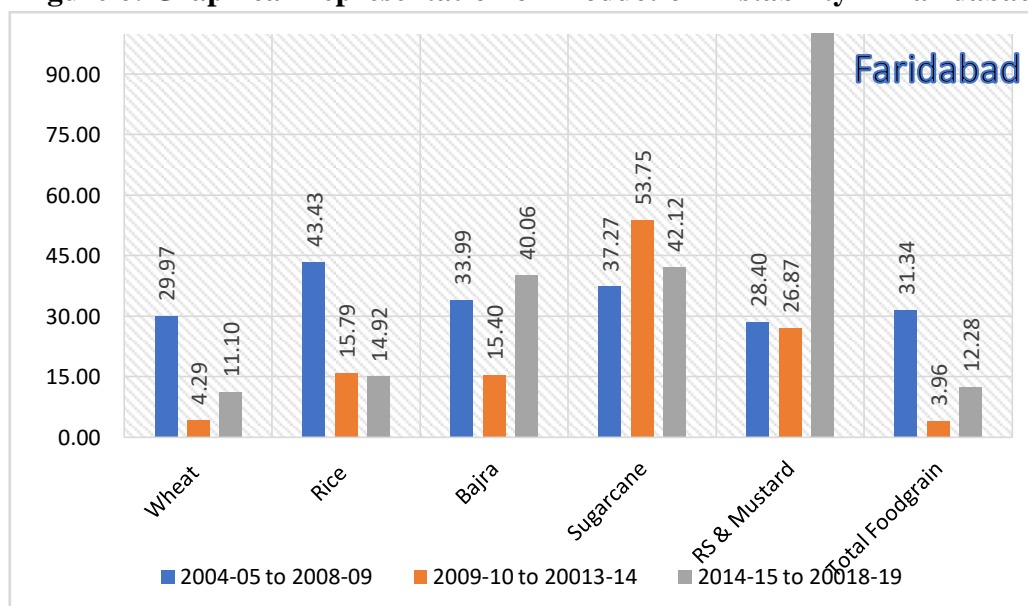
Instability in Agriculture Production of Major Crops in Faridabad District

In Faridabad district, Wheat, Rice, Bajra, Sugarcane and Mustard are considered as the major crops. Table 4 shows that in period-I the crops Wheat and Mustard remains in medium instability production category and Rice, Bajra and Sugarcane stay in high instability production category. While there is no crop in low instability category for the period-I. Further, it is observed that the total Foodgrain is also highly instable in period-I. In period-II, the instability in production of the crop Wheat is low, Rice, Bajra and Mustard is medium and Sugarcane is high. Also, the production in Wheat and Total Foodgrain with a large decline is registered in low instability category from high instability category. In period-III, the Rice with a continuous declining trend achieves low instability production range. While the Bajra, Mustard and Sugarcane gets high instability.

Table 6: Production Instability among major crops in Faridabad district (in %)

Years	LOW INSTABILITY (0 to ≤15)	MEDIUM INSTABILITY (>15 to ≤30)	HIGH INSTABILITY (>30)
2004-05 To 2008-09	NIL	Wheat 29.97 Mustard 28.40	Rice 43.43 Bajra 33.99 Sugarcane 37.27 Total Foodgrain 31.34
2009-10 To 2013-14	Wheat 4.29 Total Foodgrain 3.96	Rice 15.79 Bajra 15.40 Mustard 26.87	Sugarcane 53.75
2014-15 To 2018-19	Wheat 11.10 Rice 14.92 Total Foodgrain 12.28	NIL	Bajra 40.06 Sugarcane 42.12 Mustard 231.17

Figure 6, shows a comparative analysis of instability in production of major crops versus period-I to III. The crops Wheat and Rice continuously decline and achieve medium and low instability production in period-II and period-III. While Mustard shows a major increase in the instability in period-III and is registered in high instability production. The Sugarcane remains in high instability category for all the periods. But the Total Foodgrain production is shown in low instability in period-II and period-III.

Figure 6: Graphical Representation of Production Instability in Faridabad

Instability in Agriculture Production of Major Crops in Jhajjar District

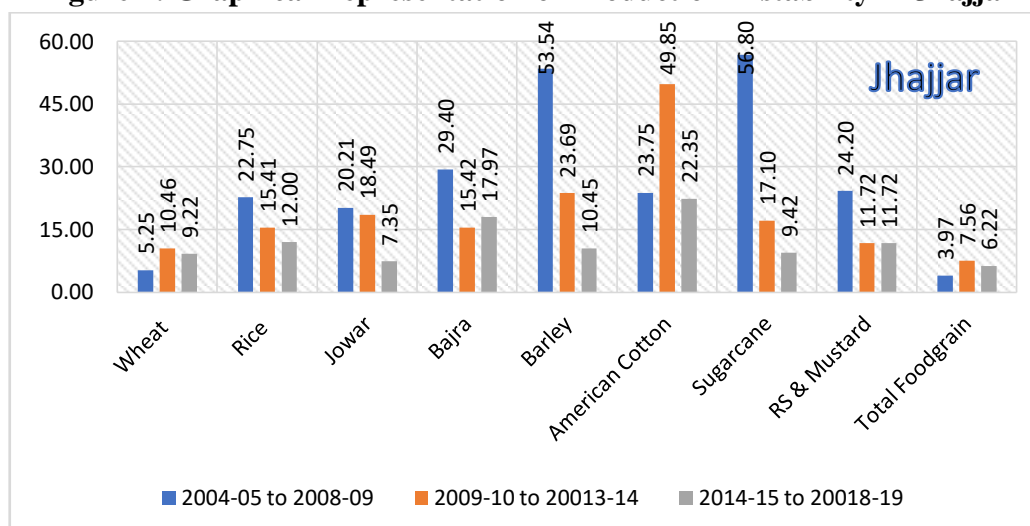
The agriculture production in Jhajjar district has eight major crops such as Wheat, Rice, Jowar, Bajra, American Cotton, Mustard, Barley and Sugarcane. The Wheat is the only crops which is shown in the low instability category in period-I followed by Rice, Jowar, Bajra, American Cotton and Mustard in the medium instability production and Barely and Sugarcane in the high instability. In period-II, the Mustard with a sharp decline is registered

in low instability category from medium instability and Barely and Sugarcane in medium instability from high instability. But the instability increases in American Cotton in period-II and is found in high instability production category. In period-III, the agriculture production in Wheat, Rice, Jowar, Barley, Mustard and Sugarcane with a declining pattern is registered in low instability category followed by the Bajra and American Cotton in medium instability production. While no crops are registered in high instability agriculture production in period-III.

Further from Figure 7, it is observed the production in Wheat always remains in low instability category for all the periods. The Rice, Jowar, Barley, Sugarcane and Mustard shows a declining trend from period-I to period-III and gets low instability. The crops Bajra and American Cotton also decreases from period-I to period-III but finally it gets only medium instability production. Moreover, the Total Foodgrain remains stationary in all the three period and is registered a low instability category.

Table 7: Production Instability among major crops in Jhajjar district (in %)

Years	LOW INSTABILITY (0 to ≤ 15)		MEDIUM INSTABILITY (>15 to ≤ 30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Wheat	5.25	Rice	22.75	Barley	53.54
	Total Foodgrain	3.97	Jowar	20.21	Sugarcane	56.80
			Bajra	29.40		
			American Cotton	23.75		
			Mustard	24.20		
2009-10 To 2013-14	Wheat	10.46	Rice	15.41	American Cotton	49.85
	Mustard	11.72	Jowar	18.49		
	Total Foodgrain	7.56	Bajra	15.42		
			Barley	23.69		
			Sugarcane	17.10		
2014-15 To 2018-19	Wheat	9.22	Bajra	17.97	NIL	
	Rice	12	American Cotton	22.35		
	Jowar	7.35				
	Barley	10.45				
	Mustard	11.72				
	Sugarcane	9.42				
	Total Foodgrain	6.22				

Figure 7: Graphical Representation of Production Instability in Jhajjar

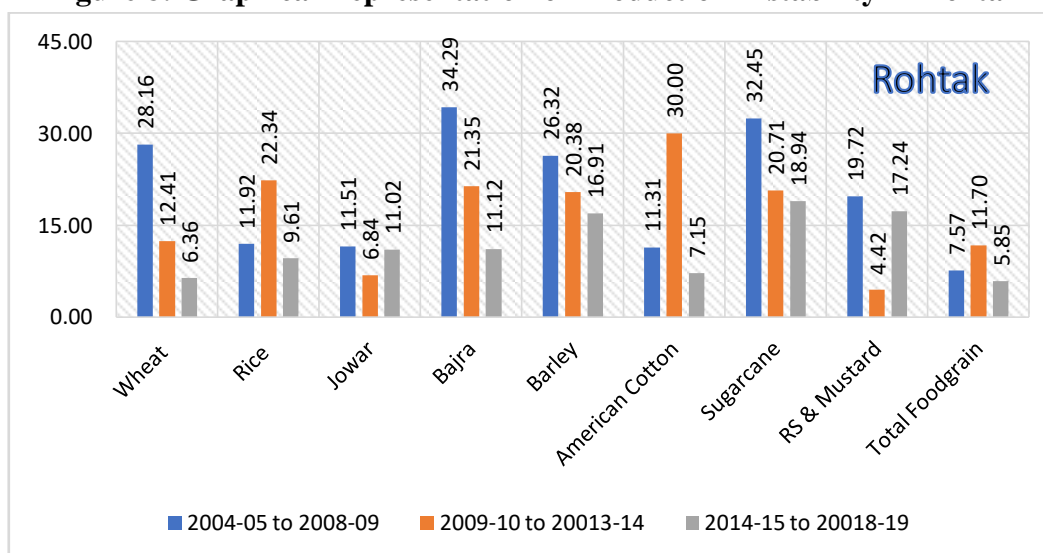
Instability in Agriculture Production of Major Crops in Rohtak District

There are eight major crops such as Wheat, Rice, Jowar, Bajra, American Cotton, Mustard, Barley and Sugarcane in agriculture production of Rohtak district. Table 8 and Figure 8 give a complete analysis of production instability for the last fifteen years. In period-I, the agriculture production in Rice, Jowar and American Cotton is registered in low instability category, in Wheat, Barley and Mustard is taken medium instability category and in Sugarcane and Bajra it is counted in high instability category. In period-II, the Bajra and Sugarcane with a sharp decline enters in to medium instability from high instability category. Similarly, Wheat and Mustard gets low instability and Rice and American Cotton attains medium instability. While there are no crops in high instability production. In period-III, the production in Wheat, Rice, Jowar, Bajra and American Cotton is again registered in low instability production range, followed by Barley, Sugarcane and Mustard in medium instability production range. While in period-III, again there is no crops in high instability production category. Further from Figure 8, it is observed that the production in Wheat decreases continuously from period-I to period-III. Rice and American Cotton also remains in low instability except the production in period-II. Jowar always admits low instability in all the three periods. Bajra with a continuous sharp decline enters in low instability category from period-I to period-III. Barely and Sugarcane also decrease continuously but the attains high and medium instability in all the periods. Moreover, the total Foodgrain always remains in low instability.

Table 8: Production Instability among major crops in Rohtak district (in %)

Years	LOW INSTABILITY (0 to ≤15)		MEDIUM INSTABILITY (>15 to ≤30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Rice	11.92	Wheat	28.16	Sugarcane	32.45
	Jowar	11.51	Barley	26.32	Bajra	34.29
	American Cotton	11.31	Mustard	19.72		
	Total Foodgrain	7.57				
2009-10	Wheat	12.41	Rice	22.34	NIL	

To 2013-14	Jowar	6.84	Bajra	21.35	
	Mustard	4.42	Barley	20.38	
	Total Foodgrain	11.70	American Cotton	30.00	
			Sugarcane	20.71	
2014-15 To 2018-19	Wheat	6.36	Barley	16.91	NIL
	Rice	9.61	Sugarcane	18.94	
	Jowar	11.02	Mustard	17.24	
	Bajra	11.12			
	American Cotton	7.15			
	Total Foodgrain	5.85			

Figure 8: Graphical Representation of Production Instability in Rohtak**Instability in Agriculture Production of Major Crops in Sonipat District**

In Sonipat district, we take Wheat, Rice, Bajra, Jowar, American Cotton, RS & Mustard, Potato, Maize and Sugarcane as its nine major crops and examine their instability using Cuddy Della Valle Index Method. Table 9 and Figure 9 give a complete data analysis report. In period-I (2004-05 to 2008-09), Wheat and Rice are registered in low instability production category followed by Jowar, Bajra, Mustard and Sugarcane which remains in medium instability production and Maize, American Cotton and Potato which shows high instability production. The crops Rice, Jowar and Bajra with a sharp decline trend are registered in low instability production in period-II (2009-10 to 2013-14).

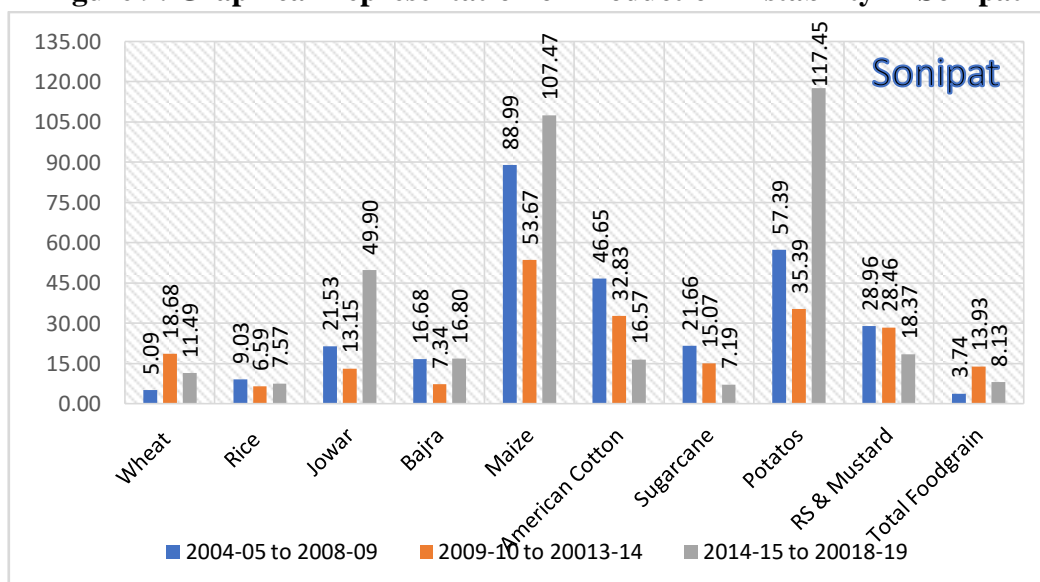
Table 9: Production Instability among major crops in Sonipat district (in %)

Years	LOW INSTABILITY (0 to ≤15)		MEDIUM INSTABILITY (>15 to ≤30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Wheat	5.09	Jowar	21.53	Maize	88.99
	Rice	9.03	Bajra	16.68	American	46.65
	Total Foodgrain	3.74	Sugarcane	21.66	Cotton	57.39
			Mustard	28.96	Potato	
2009-10	Rice	6.59	Wheat	18.68	Maize	53.67

To 2013-14	Jowar	13.15	Sugarcane	15.07	American	32.83
	Bajra	7.34	Mustard	28.46	Cotton	35.39
	Total Foodgrain	13.93			Potato	
2014-15 To 2018-19	Wheat	11.49	Bajra	16.80	Jowar	49.90
	Rice	7.57	American Cotton	16.57	Maize	107.47
	Sugarcane	7.19	Mustard	18.37	Potato	117.45
	Total Foodgrain	8.13				

While Wheat with an increasing trend gets medium instability and Maize, American Cotton and Potato remains fixed in high instability in period-II. In period-III, the production in Wheat, Rice and Sugarcane is low, Bajra, American Cotton, and Mustard is medium and Jowar, Maize and Potato is high. Figure 9 shows that Wheat, Rice and total Foodgrain always remains in low instability production in all the periods. The production in Sugarcane and Mustard decreases continuously from period-I to period-III. While in Jowar, Bajra, Maize and Potato the Figure 9 does not show any pattern in the instability production of crops from period-I to period-III.

Figure 9: Graphical Representation of Production Instability in Sonipat



Instability in Agriculture Production of Major Crops in Panipat District

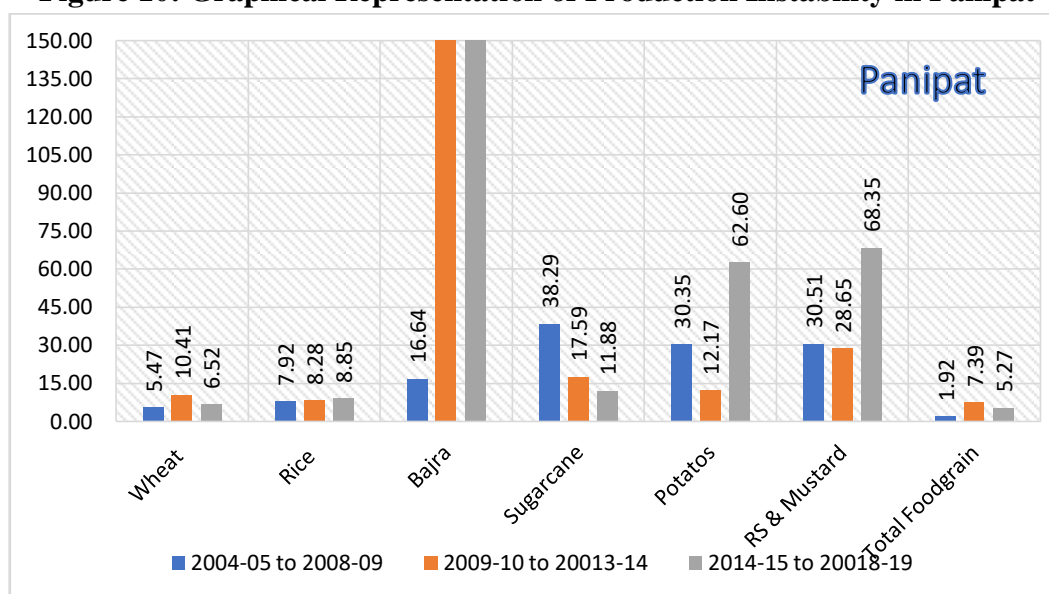
In this section, we take Wheat, Rice, Bajra, RS& Mustard, Potato, and Sugarcane as six major crops in Panipat and examine their instability using Cuddy Della Valle Index Method. Table 10 and Figure 10 presents a complete comparative data analysis. In period-I, Wheat and Rice are taken in low instability production category followed by Bajra in medium instability production and Sugarcane, Mustard and Potato in high instability production. In period-II, Potato with large decline achieves low instability production, Sugarcane and Mustard with a sharp decline gets medium instability production and Bajra takes high instability production. In period-III, the production in Wheat, Rice and Sugarcane is registered in low instability followed by Bajra, Potato and Mustard in high instability production category. While there is no crops in medium instability range. Figure 10 presents

that Wheat, Rice and Total Foodgrain always remains in low instability production in period-I, II and III. But Bajra gets high instability in period-II and III, potato and Mustard achieve high instability in period-I and period-III. While the production in Sugarcane decreases continuously from period-I to period-I to period-III.

Table 10: Production Instability among major crops in Panipat district (in %)

Years	LOW INSTABILITY (0 to ≤15)		MEDIUM INSTABILITY (>15 to ≤30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Wheat	5.47	Bajra	16.64	Sugarcane	38.29
	Rice	7.92			Potato	30.35
	Total Foodgrain	1.92			Mustard	30.51
2009-10 To 2013-14	Wheat	10.41	Sugarcane	17.59	Bajra	241.87
	Rice	8.28				
	Potato	12.17				
	Total Foodgrain	7.39				
2014-15 To 2018-19	Wheat	6.52	NIL		Bajra	183.03
	Rice	8.85			Potato	62.60
	Sugarcane	11.88			Mustard	68.35
	Total Foodgrain	5.27				

Figure 10: Graphical Representation of Production Instability in Panipat



Instability in Agriculture Production of Major Crops in Karnal District

In Karnal, Wheat, Rice, Bajra, Masoor, RS & Mustard, Potato, and Sugarcane are considered as its seven major crops. Table 11 gives the instability data for three periods. In period-I, Wheat, Rice, Sugarcane and Potato are shown in low instability production followed by Bajra, Masoor and Mustard in high instability production. While Table 11 shows nil production in medium instability category. In period-II, Wheat, Rice, Sugarcane and Potato are again registered in low instability production category. The crop Mustard with a slight decline enters in medium instability category from high instability and Bajra and Masoor are

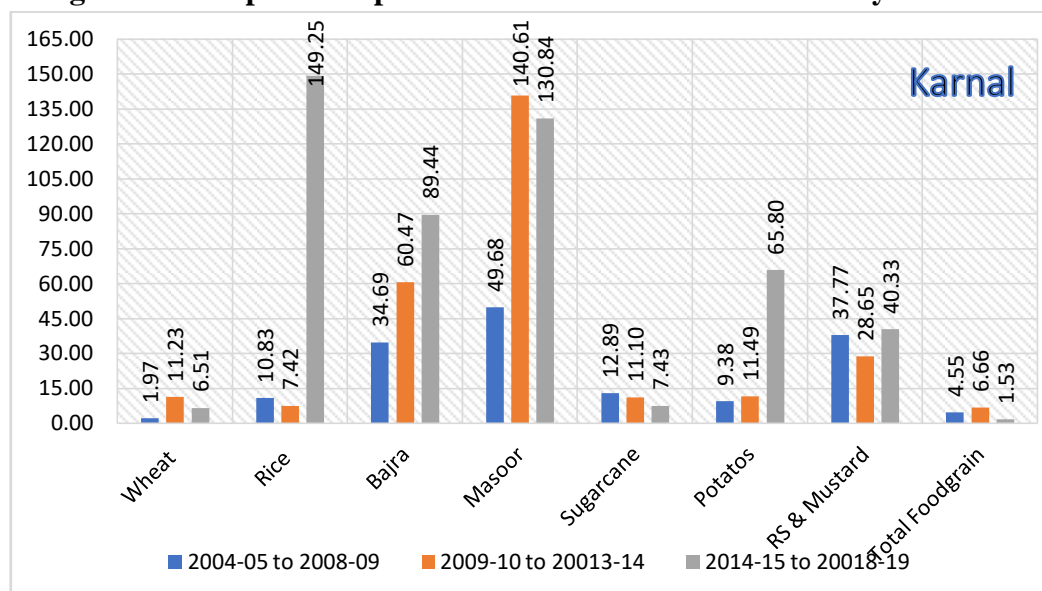
still in high instability production. But in period-III, the production in Rice and Potato are recorded in high instability production.

Therefore, in period-III it is noticed that the high instability crops are Rice, Bajra, Masoor, Potato and Mustard. While the medium instability production is registered Nil. Figure 11 shows that Wheat, Sugarcane and Total Foodgrain always remains in low instability production in period-I, II and III. Rice also attains low instability in period-I and period-II but achieves high instability in period-III. The instability in production of Bajra and Masoor continuously increases and remains in high instability for all the periods. The production in Potato remains low in period-I and II and in period-III increases, drastically. Mustard is also considered in high instability in period-I and III except in period-II.

Table 11: Production Instability among major crops in Karnal district (in %)

Years	LOW INSTABILITY (0 to ≤15)		MEDIUM INSTABILITY (>15 to ≤30)	HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Wheat	1.97	NIL	Bajra	34.69
	Rice	10.83		Masoor	49.68
	Sugarcane	12.89		Mustard	37.77
	Potato	9.38			
	Total Foodgrain	4.55			
2009-10 To 2013-14	Wheat	11.23	Mustard 28.65	Bajra	60.47
	Rice	7.42		Masoor	140.61
	Sugarcane	11.10			
	Potato	11.49			
	Total Foodgrain	6.66			
2014-15 To 2018-19	Wheat	6.51	NIL	Rice	149.25
	Sugarcane	7.43		Bajra	89.44
	Total Foodgrain	1.53		Masoor	130.84
				Potato	65.80
				Mustard	40.33

Figure 11: Graphical Representation of Production Instability in Karnal

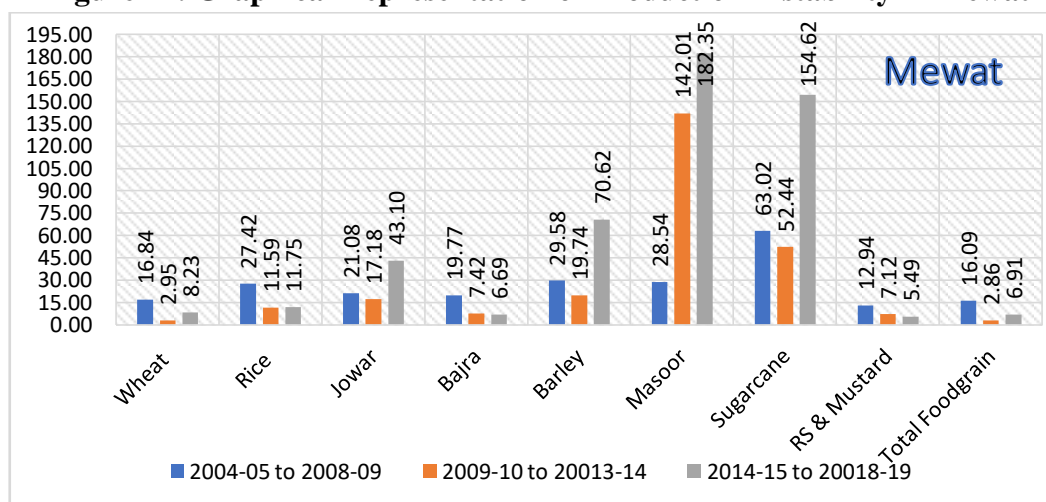


Instability in Agriculture Production of Major Crops in Mewat/Nuh District

In Mewat district, Wheat, Rice, Jowar, Bajra, Barley, Masoor, RS & Mustard, and Sugarcane are taken as its eight major crops. Table 12 give the instability data for the three periods. In period-I, Mustard is the only crops in low instability and Sugarcane is the only crop in high instability. While the crops Wheat, Rice, Jowar, Bajra, Barley, and Masoor are registered in medium instability production. In period-II, Wheat, Rice, Bajra, and Mustard with a sharp declining trend achieves low instability production followed by Jowar and Barley in medium instability and Masoor and Sugarcane in high instability. In period-III, the production in Wheat, Rice, Bajra, and Mustard remains again in low instability production and the medium instability remains nil. Therefore, the remaining crops arrives in high instability production category. Figure 12 gives a comparative analysis of all the crops versus period-I, II and III. The crops Wheat and Mustard remains in low instability for all the three periods. Rice, Bajra and Mustard shows a declining pattern from period-I to period-III and achieves low instability. Jowar, Sugarcane, Barley and Masoor gives an increasing trend, that is, low to high instability production.

Table 12: Production Instability among major crops in Mewat/Nuh district (in %)

Years	LOW INSTABILITY (0 to ≤15)		MEDIUM INSTABILITY (>15 to ≤30)		HIGH INSTABILITY (>30)	
2004-05 To 2008-09	Mustard	12.94	Wheat	16.84	Sugarcane	63.02
			Rice	27.42		
			Jowar	21.08		
			Bajra	19.77		
			Barley	29.58		
			Masoor	28.54		
			Total Foodgrain	16.09		
2009-10 To 2013-14	Wheat	2.95	Jowar	17.18	Masoor	142.01
	Rice	11.59	Barley	19.74	Sugarcane	52.44
	Bajra	7.42				
	Mustard	7.12				
	Total Foodgrain	2.82				
2014-15 To 2018-19	Wheat	8.23	NIL		Jowar	43.10
	Rice	11.75			Barley	70.62
	Bajra	6.69			Masoor	182.35
	Mustard	5.49			Sugarcane	154.62
	Total Foodgrain	6.91				

Figure 12: Graphical Representation of Production Instability in Mewat

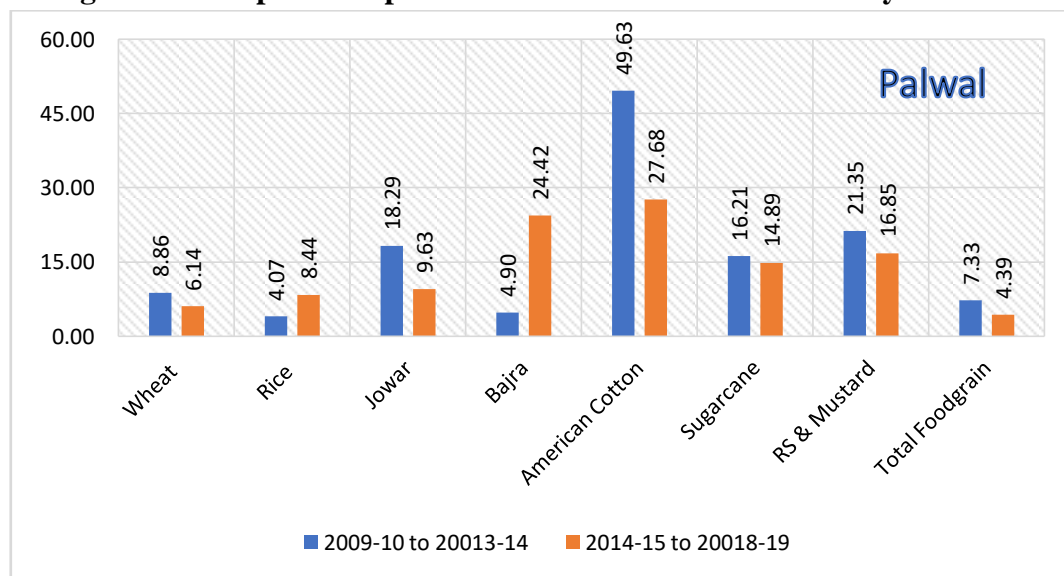
Instability in Agriculture Production of Major Crops in Palwal District

The Palwal district was established in 2008 on the map of Haryana state, therefore, we take only the two sub intervals for the production instability of major crops for period-I from 2009-10 to 2013-14 and period-II from 2014-15 to 2018-19. Wheat, Rice, Jowar, Bajra, Barley, Mustard, Sugarcane and American Cotton are the major crops in Palwal district. Table 13 gives the complete instability analysis of the crops using Cuddy Della Valle Index method. In period-I (2009-10 to 2013-14) the production in Wheat, Rice and Bajra are recorded in low instability category followed by Jowar, Sugarcane and Mustard in medium instability and American Cotton in high instability category. In period-II the Bajra gets medium instability and Jowar and Sugarcane with a sharp decline are registered in low instability. Further, it is noticed that there is no crops in high instability production category in period-II.

While Figure 13 gives a comparative analysis of all the crops in period-I and II. It is observed that Wheat and Rice always remain in low instability production range for the period-I and period-II. In Jowar, American Cotton, Mustard and Sugarcane there is a sharp decline from period-I to period-II. Also, the Figure shows that the Total Foodgrain remains under low instability in period-I and period-II.

Table 13: Production Instability among major crops in Palwal district (in %)

Years	LOW INSTABILITY (0 to ≤15)		MEDIUM INSTABILITY (>15 to ≤30)		HIGH INSTABILITY (>30)
2009-10 To 2013-14	Wheat	8.86	Jowar	18.29	American Cotton 49.63
	Rice	4.07	Sugarcane	16.21	
	Bajra	4.90	Mustard	21.35	
	Total Foodgrain	7.33			
2014-15 To 2018-19	Wheat	6.14	Bajra	24.42	NIL
	Rice	8.44	American Cotton	27.68	
	Jowar	9.63	Mustard	16.85	
	Sugarcane	14.89			
	Total Foodgrain	4.39			

Figure 13: Graphical Representation of Production Instability in Palwal

CONCLUSION

The instability in agriculture production of major crops of NCR-district of Haryana state is studied using Cuddy Della Valle Index method (CDVI). For this study a period of last fifteen years, that is, from 2004-05 to 2018-19 is taken and is divided in to three sub-intervals period-I (2004-05 to 2008-09), period-II (2009-10 to 2013-14) and period-III (2014-15 to 2018-19). Throughout, the paper it is studied that the district-wise production is low in Wheat and Rice in almost all the districts over all the three time periods except few districts. Further, it is noticed that the production in total Foodgrain remains in low instability category in all the districts. The instability in production is low in Karnal, Sonipat, Panipat, Mewat and Palwal throughout the study periods. The crops Maize, Barley Jowar, American Cotton, Sesamum, Moong, Masoor and Gram are recorded in medium and high instability production categories throughout all the periods. Therefore, new policies must be included by the Government to stabilize the instability category of crops.

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