

A Study on Estimation of Probability of Crop Failure and Crop Loss Ratio of Cotton Crop in Marathwada Region of Maharashtra

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ABSTRACT: In this paper, an attempt was made to measure risk in yield of important crop Cotton selected under study. The three parameters of viz. coefficient of variation, probability of crop failure and crop loss ratios were estimated to measure the risk. If it is related to different levels of NIL it will help to find out the indemnifiable limit for a particular area. It will also help to estimate premium rates at different levels of NIL. We have defined PCF and CLR at the yield level less than 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% of the actual yield.

KEYWORDS: Risk, Probability of Crop Failure (PCF), Crop Loss Ratio (CLR), Mean, Regression, Standard Deviation, Coefficient of Variation (CV)

I. INTRODUCTION

In this paper, the data was collected, classified, tabulated and analysed in the light of objectives of the study. The results of the analysis are presented in this paper. The data were analysed using MATLAB statistical software. The productivity (yield) (Kg/ha) data of crop cutting experiments (CCEs) conducted by the Directorate of Agriculture, Central Building, Government of Maharashtra, Pune, for last ten years 2000-01 to 2009-10 for Cotton crop was collected. The crop cutting experiments (CCEs) are being conducted by Directorate of Agriculture, Government of Maharashtra, Pune for deciding the threshold yield (Kg/ha) for the crops covered under crop insurance scheme implemented by Central and State Government. The same yield data of CCEs were collected for important Cotton crop selected under study. The data were collected district wise, talukawise and crop wise. The detail of analysis of districtwise and crop wise statistical analysis of data given here.

II. A REVIEW OF METHODS

The measurement of risks involved in the crop production will help to decide indemnifiable limits and premium rates for a crop insurance scheme and similar other studies.

Narain et al (1985) have considered coefficient of variation (CV) as an indicator of risks in the crop yield.

Dandekar (1985) considered coefficient of mean deviation (CMD) instead of coefficient of variation (CV) for measuring instability or risks in the crop yield. He also considered coefficient of mean deviation (CMD) for estimating premium rates of a crop insurance scheme. The coefficient of variation (CV) or coefficient of mean deviation (CMD) measures only year to year variability in crop yield. Estimation of risks involved in crop production is paramount importance as its study can suggest remedial measures of technical and social nature. According to Narain et al (1985), coefficient of variation (CV) is an indicator of instability or risks in the crop yield. Very few attempts have been made for measuring risks in the production of crop yield.

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Dandekar (1976) noted from the actuarial calculus that larger is the year to year variability, higher has to be the premium rates in relation to given indemnity level. He suggested that farmers with larger year to year variability in crop out-put should pay the premium at higher rates.

Narain et al (1985) have used coefficient of variation (CV) for measuring variability in crop yield. They concluded that larger the variability in crop yield. They concluded that larger the variability (CV) in crop yields, higher has to be the premium. They concluded that the premium rates depend on coefficient of variation (CV).

Ray (1985) has suggested that the probability of likely trend or tendency of risks i.e. loss recurring in future can be determined on the basis of past happenings (Past Data).

Nadkarni and Ghosh (1978) have studied critically the problem of measuring risks in the crop yield. They have suggested that only the coefficient of variation (CV) is insufficient to measure the risks in the crop yield and suggested.

- i) Probability of crop failure (PCF) and ii) Crop loss ratio (CLR), as an indicators of measuring risks.

Research Methodology:

The measurement of risks involved in the production of crops is of paramount importance to suggest remedial measures of technical and social nature. We, therefore discuss in this paper the statistical procedures and different measures used for measuring risks in the production of crop yield. The measures suggested by Nadkarni and Ghosh (1978) are modified and the risks in the crop yield are estimated at district/tehsil level using the rice crop yield data of Marathwada Region of Maharashtra.

Methods Proposed by Nadkarni and Ghosh (1978):

The procedure of estimation of PCF and CLR suggested by Nadkarni and Ghosh (1978) consists of fitting an appropriate trend (linear, quadratic, loglinear, etc) to the time series data under study. After an appropriate trend is decided on the two measures are defined as follows.

i. Probability of crop failure (PCF)

Crop failure was taken to mean all those cases where the actual crop production was less than ten percent of the trend estimate. The probability of crop failure was simply the percentage of years of crop failure to the total number of years.

ii. Crop loss ratio (CLR)

Assuming the yield level of ten percent (10%) below the trend estimate for the respective years as the insured yield level, then the CLR is defined as. "The sum of negative deviations below this insured level is expressed as the percent of the sum of actual yields for the whole period."

Probability of crop failure (PCF) was taken to mean of all these cases where the actual crop production was less than 10% or above the trend (linear) estimate (Nadkarni and Ghosh, 1978). The probability of crop failure is simply the percentage of years of crop failure to the total number of years.

In the definition of PCF, the crop failure is taken as the years where the actual yields are less than ten percent (10%) of the trend estimate. There is no explanation why only the yield level of 10% is taken as crop failure. But for the crop insurance and other studies the yield level of 10% below the trend estimate considered by Nadkarni and Ghosh (1978) is not sufficient.

If we define the PCF and CLR at different non indemnifiable limits (NIL) i.e. 0%, 10%, and 20%, it will help us in recommending the indemnifiable limits and average premium rates for the particular area.

We therefore define PCF and CLR as follows.

Probability of Crop Failure (PCF):

The crop failure may be considered as cases where actual crop yield is less than each of the non indemnifiable limits (NIL) of 0%, 10% and 20% of the trend estimate.

Thus, the PCF can be defined at any NIL level decided for the particular crop insurance scheme.

At the time of introduction of CCIS the indemnifiable limit for the crops in the Maharashtra was fixed at 80% of the average yield of the last five years. Although from the administrative or other purposes the Government may increase

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or decrease the indemnifiable limits. But from the technical point of view, it is necessary to study the PCF at different levels of NIL. We shall now define the Crop Loss Ratio (CLR).

Crop Loss Ratio (CLR):

From the crop insurance point of view, it is important to study crop loss ratio (CLR). CLR gives the sum of negative deviations in yields from the insured level (indemnifiable limit). The CLR also gives an idea about the relative premium burden on the farmers if the administrative costs are ignored.

Nadkarni and Ghosh (1978) have defined CLR at the yield level less than 10% of the trend estimate without explaining the reason for considering only 10% level. If it is related to different levels of NIL it will help to find out the indemnifiable limit for a particular area. It will also help to estimate premium rates at different levels of NIL.

The crop loss ratio (CLR) defined above at different levels of NIL is sufficient for crop insurance purpose. However, it can be defined at any level of NIL.

Proposed Method for Measuring Risks

The three parameters of risks namely coefficient of variation (CV), probability of crop failure (PCF) and crop loss ratio (CLR) were considered here in the present analysis.

When we measure risks or instability in crop yields, the question of methodology is involved. Coefficient of variation (CV) is normally accepted as indicator of instability. The coefficient of variation (CV) or coefficient of mean deviation (CMD) measure only year to year variability in crop yield.

The measures namely PCF and CLR proposed by Nadkarni and Ghosh (1978) are worth considering here. However, they need certain modifications. Nadkarni and Ghosh (1978) proposed to examine first the trend present in the time series data. This is quite adequate because with introduction of recent technology, the yields of some of the crops are showing increasing trend.

Fitting of Appropriate Trend Equations:

Year to year fluctuation in yield from its trend value represent its variability or risk. Coefficient of variation is the commonly used tool to quantify the risk. Different types of trend curves such as Linear Fit, Exponential Fit, Quadratic Fit, Third Degree Polynomial Fit, Fourth Degree Polynomial Fit, Logarithmic Fit have been attempted and the one giving highest R^2 was chosen to fit the trend for obtaining estimates of yield and for computation of risk.

Fitting of Probability Distribution and Testing Goodness of Fit:

Here, we shall estimate the risk in terms of probability of obtaining yields. Moreover, apart from coefficient of variation, the risk in terms of probability of obtaining yields below trend value i.e. 95% of the trend can be computed with help of probability distributions fitting to the given data. The most suitable distributions that are used to estimate the trend in yield is as follows:

The following different types of distributions Normal Distribution, Lognormal Distribution, Gamma Distribution, Beta Distribution, Weibull Distribution, Exponential Distribution were fitted independently to districtwise yield data for selected crops.

Estimation of Probability of Shortfall (PS) in Yield:

1) Probability as a Measure of Risk:

The probability of actual yield and gross returns per hectare failing 5 per cent or more below their respective trend values can be estimated as

$$\text{Probability [Trend Value - Observed Value} \geq (0.05 \times \text{Mean of Last three Years)]}$$

OR

$$\text{Probability [Observed Value - Trend Value} \leq (-0.05 \times \text{Mean of Last three Years)]}$$

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Average of such probabilities is the probability of shortfall in yields. The probability distributions viz., Normal, Log-normal, Gamma, Exponential, Weibull and Beta can be fitted to the data and most appropriate distribution was selected on the basis of p-value. From this the probability of shortfall in yields was estimated.

Probability of Crop Failure:

Here we define probability of crop failure was average of such probabilities is the probability of shortfall in yields. The probability distributions viz., Normal, Log-normal, Gamma, Exponential, Weibull and Beta can be fitted to the data and most appropriate distribution was selected on the basis of p-value. From this probability of crop failure (PCF) in yields was estimated.

Crop Loss Ratio:

Crop insurance point of view, it is important to study crop loss ratio (CLR). CLR is average value of ratios of negative deviations to its corresponding productivity in yield from the insured level (indemnifiable limit).

If it is related to different levels of NIL it will help to find out the indemnifiable limit for a particular area. It will also help to estimate premium rates at different levels of NIL.

We have defined CLR at the yield level less than 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% of the actual yield.

Let us denote,

d_i : deviations from actual yields below 0% to 40% of the actual yield.

p_i : actual yields

The crop loss ratio (CLR) (%) at different levels of NIL as follows,

$$CLR[0\% \text{ to } 40\% \text{ NIL}] = \frac{1}{n} \sum_{i=1}^n \frac{|d_i|}{p_i} \times 100, \quad \text{for all } i = 1, 2, 3, \dots, 10$$

At present Government has fixed uniform indemnifiable level and premium rates for each crop. However, for knowing whether the scheme is running in profit or loss, it is essential to workout actual premiums. CLR will help to decide indemnifiable limit and premium to be charged for particular area. The CLR defined at different levels of NIL will help to look into the problem both theoretically and practically. With the help of crop yield data, we shall estimate PCF and CLR.

III. ANALYSIS AND APPLICATIONS AS CASE STUDY

For estimating probability of crop failure (PCF) and crop loss ratio (CLR), the values were estimated using the trend equation. The parameters of ranks i.e. PCF and CLR were estimated according to Nadkarni and Ghosh (1978).

The production of the crops completely depends on the vagaries of nature. If there is a fluctuation in the rainfall, temperature, humidity, etc., it affects the production. As a matter of fact, there is a risk in the crop production as it depends on the vagaries of nature. Not only this, but the farmers has to face risk in the price fluctuations of the crops also. Thus, the farmers face two types of risks i.e. i) Risk in crop production and ii) Risk in price fluctuations.

Therefore, an attempt has been made to measure risk in crop production from the crop.

The statistical analysis was carried out in following steps. i) Districtwise productivity trend analysis and ii) Districtwise analysis of basic statistics.

Districtwise Data Analysis of Cotton Crop:

Cotton crop is an important cash crop in the Marathwada region. The economy of farmers depends on this crop. The failure of this crop may lead to financial loss to the farmers and it affects the income of the farmers. Not only this but it also affects the coming crop season as they have to spent money in cash for purchase of input like seed, fertilizers,

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organic manures, etc. If earlier crop failure is there, they have to take loan to purchase the input either from bank/relative or from money lenders with high rate of interest. If he has taken loan from the banks and unable to pay, he remains defaulter in the bank. A continuous failure of crop affects the complete economy of the farmers. This is a serious problem of continuous failure as Marathwada is a rainfed region.

Districtwise Basic Statistics and Trend Analysis of Productivity: Cotton Crop

For the present study the districtwise data of productivity for Cotton crop for seven districts of Marathwada Region viz. Aurangabad, Beed, Jalna, Parbhani, Hingoli, Latur and Nanded were considered for the period w.e.f. from 2000-01 to 2009-10.

The districtwise values of basic statistics viz. arithmetic mean (A.M.), standard deviation (S.D.) and coefficient of variations (CV%) were estimated for the Cotton crop to know the average yield of crop and variability in crop production. The data relates to the period (2000-01 to 2009-10). The analysis was carried out in MATLAB softwares and the results are presented in Table 1.

It can be revealed from Table 1 that the mean average yield of the Cotton crop during the period under study (2000-01 to 2009-10) for Marathwada region was 616.44q/ha. It was highest in Jalna 756.80q/ha followed by Hingoli 746.50q/ha and 720.00q/ha in Aurangabad. The lowest yield per hectore was 395.80q/ha in Nanded. The variability about mean was minimum in Beed district 29.12% and maximum in Hingoli district 54.33%. On an average it was 41.58%. As regards variability about trend, the productivity was stable in Aurangabad 11.31% followed by Beed 13.65%. More variability was observed in Hingoli i.e. 28.80%.

In case of gross returns 13639.41(Rs./ha). It was highest in 16587.70(Rs./ha) followed by 16368.70(Rs./ha) in Hingoli and 14208.10(Rs./ha) in Parbhani. The lowest was 8622.36(Rs./ha) in Nanded. The variability about mean was minimum in Beed district 39.15% and maximum in Aurangabad district 62.60%. On an average it was 51.05%.

**Table 1:- Arithmetic Mean (A.M.), Standard Deviation (S.D.),
Coefficient of Variation (CV) about Mean, Coefficient of Variation (CV) about Trend
of Cotton Crop (2001-02 to 2010-11)**

Crop: Cotton									
All Districts of Marathwada Region.									
Sr. No.	Name of the Districts	Yield				Gross Returns			
		A.M. (Kg/ha)	S.D. (Kg/ha)	CV (%) about Mean	CV (%) about Trend	A.M. (Rs./ha)	S.D. (Rs./ha)	CV (%) about Mean	CV (%) about Trend
1	Aurangabad	720.00	360.32	50.04	11.31	16304.44	10205.81	62.60	5.35
2	Beed	523.10	152.33	29.12	13.65	11425.20	4473.11	39.15	7.91
3	Jalna	756.80	292.09	38.60	20.55	16587.70	7680.63	46.30	13.32
4	Parbhani	640.80	312.35	48.74	21.64	14208.10	8027.93	56.50	13.85
5	Hingoli	746.50	405.59	54.33	28.80	16368.70	9416.10	57.53	19.95
6	Latur	532.10	184.86	34.74	13.72	11959.40	3643.51	53.04	11.40
7	Nanded	395.80	140.51	35.50	22.77	8622.36	3640.55	42.22	18.36
Average		616.44	264.01	41.58	18.92	13639.41	6726.81	51.05	12.88

The analysis indicated that the variability adjusted for trend was lower than that of CV% around mean in almost all the cases. However, more or less same trend was observed in variability by both the methods. All the values of variability adjusted for trend (CV%) was less than that of CV% around mean.

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Fitting Trend:

Different types of trend curves have been attempted and the one giving highest R^2 was chosen to fit the trend for obtaining estimates of yield and for computation of risk.

It is observed that for all the districts, the fit was good for Fourth Degree Polynomial. The coefficients were estimated and the Fourth Degree Polynomial was fitted to the data of all the districts. The estimated yields were obtained.

Table 2:- Trend Equations of Yield for Districtwise Data of Cotton

Cotton – Yield							
Districtwise Analysis							
Sr. No.	Name of District	Name of Curve	Curve Equation				
			e	d	c	b	a(Const.)
1	Aurangabad	Fourth Degree Poly. Fit	-0.094	-1.556	38.251	-51.666	240.25
2	Beed	Fourth Degree Poly. Fit	0.1811	-6.8066	71.816	-212.57	527.58
3	Jalna	Fourth Degree Poly. Fit	-1.8191	36.889	-248.79	715.96	-153.5
4	Parbhani	Fourth Degree Poly. Fit	-3.1317	65.069	-447.02	1227.2	-648
5	Hingoli	Fourth Degree Poly. Fit	-3.5402	71.236	-470.44	1250.3	-598.83
6	Latur	Fourth Degree Poly. Fit	-0.2225	2.8727	3.7397	-72.462	481.25
7	Nanded	Fourth Degree Poly. Fit	-1.2662	29.55	-237.14	768.36	-431.58

Table 3:- Trend Equations of Gross Returns for Districtwise Data of Cotton

Cotton – Gross Returns							
Districtwise Analysis							
Sr. No.	Name of District	Name of Curve	Curve Equation				
			e	d	c	b	a(Const.)
1	Aurangabad	Fourth Degree Poly. Fit	-5.1642	97.428	-366.43	2180.4	2030.5
2	Beed	Fourth Degree Poly. Fit	4.2266	-115.05	1146.2	-3243.8	9234.2
3	Jalna	Fourth Degree Poly. Fit	-34.98	753.41	-246.2	15196	-4306.5
4	Parbhani	Fourth Degree Poly. Fit	-70.058	1492.2	-10360	28203	-15989
5	Hingoli	Fourth Degree Poly. Fit	-75.665	1565.2	-10498	27861	-14500
6	Latur	Fourth Degree Poly. Fit	-7.2837	161.23	-839.51	1271.9	6964.1
7	Nanded	Fourth Degree Poly. Fit	-26.621	636.97	-5105.8	16271	-9539.6

Fitting of Probability Distributions:

The risk in terms of probability of obtaining yield or gross returns below 95 percent of the trend have been computed by fitting the suitable distributions as Normal, Log-normal, Gamma, Weibull, Exponential and Beta distributions to the time series data of productivity and gross returns. It is presented in Table 4.

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Table 4:- Probability Distribution of Yield and Gross Returns for Districtwise Data of Cotton Crop

Districtwise Analysis							
Sr. No.	Name of District	Yield			Gross Returns		
		Fitted Distribution	Parameters		Fitted Distribution	Parameters	
1	Aurangabad	Log-normal	mu	6.4335	Beta	mu	2.1567
			sd	0.6105		sd	11.1089
2	Beed	Log-normal	mu	6.2210	Beta	mu	6.4186
			sd	0.2948		sd	49.7581
3	Jalna	Beta	mu	6.8086	Beta	mu	4.1629
			sd	83.1592		sd	20.9475
4	Parbhani	Gamma	mu	4.9109	Beta	mu	2.9797
			sd	130.4851		sd	17.9806
5	Hingoli	Beta	mu	4.0009	Gamma	mu	3.4000
			sd	49.5011		sd	484.21
6	Latur	Gamma	mu	9.7303	Gamma	mu	4.6000
			sd	54.6850		sd	2610.7
7	Nanded	Beta	mu	7.5369	Beta	mu	5.0318
			sd	182.9385		sd	53.3842

For Estimating Probabilities of Crop Failure (PCF) and Crop Loss Ratio (CLR):-

For districtwise data analysis of Cotton crop, it is seen from Table 5 that the probability of crop failure (PCF). For 0% NIL, the probability of crop failure (PCF) was highest i.e. 0.5274 in Latur district and lowest i.e. 0.4820 in Parbhani district. For 5% NIL, the probability of crop failure (PCF) was highest i.e. 0.5590 in Nanded district and lowest i.e. 0.4862% in Latur district. For 10% NIL, the probability of crop failure (PCF) was highest i.e. 0.5591 in Nanded district and lowest i.e. 0.4864 in Latur district. For 15% NIL, the probability of crop failure (PCF) was highest i.e. 0.5589 in Nanded district and lowest i.e. 0.4867 in Latur district. For 20% NIL, the probability of crop failure (PCF) was highest i.e. 0.5581 in Nanded district and lowest i.e. 0.4870 in Latur district. For 25% NIL, the probability of crop failure (PCF) was highest i.e. 0.5567 in Nanded district and lowest i.e. 0.4873 in Latur district. For 30% NIL, the probability of crop failure (PCF) was highest i.e. 0.5546 in Nanded district and lowest i.e. 0.4876 in Latur district. For 35% NIL, the probability of crop failure (PCF) was highest i.e. 0.5515 in Nanded district and lowest i.e. 0.4880 in Latur district. For 40% NIL, the probability of crop failure (PCF) was highest i.e. 0.5477 in Nanded district and lowest i.e. 0.4883 in Latur district.

Table 5: - Districtwise Data Analysis of Yield of Crop Failure for Cotton Crop

Sr. No.	Name of the District	Yield-Non-Indemnifiable Limits (%) – PCF								
		0%	5%	10%	15%	20%	25%	30%	35%	40%
1	Aurangabad	0.5168	0.5215	0.5215	0.5215	0.5216	0.5216	0.5216	0.5216	0.5216
2	Beed	0.5339	0.514	0.5150	0.5158	0.5166	0.5175	0.5184	0.5193	0.5202
3	Jalna	0.4922	0.5096	0.5091	0.5083	0.5072	0.5057	0.5036	0.5009	0.4975
4	Prabhani	0.4823	0.5092	0.5095	0.5098	0.5100	0.5101	0.5101	0.5099	0.5095
5	Hingoli	0.4922	0.4982	0.4983	0.4982	0.4980	0.4976	0.4969	0.4957	0.4939
6	Latur	0.4928	0.4996	0.4996	0.4995	0.4992	0.4987	0.4980	0.4968	0.4950
7	Nanded	0.4975	0.5590	0.5591	0.5589	0.5581	0.5567	0.5546	0.5515	0.5477

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For districtwise data analysis of gross returns of Cotton crop, it is seen from Table 6 that the probability of crop failure (PCF).

For 0% NIL, the probability of crop failure (PCF) was highest i.e. 0.5320 in Aurangabad district and lowest i.e. 0.4890 in Parbhani district. For 5% NIL, the probability of crop failure (PCF) was highest i.e. 0.5295 in Nanded district and lowest i.e. 0.4700% in Latur district. For 10% NIL, the probability of crop failure (PCF) was highest i.e. 0.5304 in Nanded district and lowest i.e. 0.4704 in Latur district. For 15% NIL, the probability of crop failure (PCF) was highest i.e. 0.5313 in Nanded district and lowest i.e. 0.4710 in Latur district. For 20% NIL, the probability of crop failure (PCF) was highest i.e. 0.5321 in Nanded district and lowest i.e. 0.4716 in Latur district. For 25% NIL, the probability of crop failure (PCF) was highest i.e. 0.5330 in Nanded district and lowest i.e. 0.4725 in Latur district. For 30% NIL, the probability of crop failure (PCF) was highest i.e. 0.5337 in Nanded district and lowest i.e. 0.4735 in Latur district. For 35% NIL, the probability of crop failure (PCF) was highest i.e. 0.5343 in Nanded district and lowest i.e. 0.4749 in Latur district. For 40% NIL, the probability of crop failure (PCF) was highest i.e. 0.5347 in Nanded district and lowest i.e. 0.4767 in Latur district.

Table 6: - Districtwise Data Analysis of Gross Returns of Crop Failure for Cotton Crop

Sr. No.	Name of the District	Gross Returns-Non-Indemnifiable Limits (%) – PCF								
		0%	5%	10%	15%	20%	25%	30%	35%	40%
1	Aurangabad	0.5320	0.4997	0.4999	0.5001	0.500	0.5005	0.5008	0.5010	0.5013
2	Beed	0.5314	0.4932	0.4934	0.4937	0.4941	0.4945	0.4951	0.4959	0.4969
3	Jalna	0.5044	0.4941	0.4956	0.4976	0.5004	0.5040	0.5086	0.5141	0.5199
4	Prabhani	0.4890	0.5009	0.5017	0.5026	0.5036	0.5047	0.5060	0.5074	0.5090
5	Hingoli	0.4928	0.5008	0.5011	0.5015	0.5018	0.5022	0.5026	0.5031	0.5035
6	Latur	0.4976	0.4700	0.4704	0.4710	0.4716	0.4725	0.475	0.4749	0.4767
7	Nanded	0.4986	0.5295	0.5304	0.5313	0.5321	0.5330	0.5337	0.5343	0.5347

For districtwise data analysis of Cotton crop, it is seen from Table 7 that the crop loss ratio (CLR).

For 0% NIL, the crop loss ratio (CLR) was highest i.e. 22.02% in Hingoli district and lowest i.e. 9.76% in Aurangabad district. For 5% NIL, the crop loss ratio (CLR) was highest i.e. 28.41% in Hingoli district and lowest i.e. 13.77% in Aurangabad district. For 10% NIL, the crop loss ratio (CLR) was highest i.e. 33.55% in Hingoli district and lowest i.e. 14.50% in Aurangabad district. For 15% NIL, the crop loss ratio (CLR) was highest i.e. 33.55% in Hingoli district and lowest i.e. 16.56% in Aurangabad district. For 20% NIL, the crop loss ratio (CLR) was highest i.e. 38.32% in Hingoli district and lowest i.e. 20.98% in Aurangabad district. For 25%, 30%, 35% and 40% NIL, the crop loss ratio (CLR) was highest i.e. 50.48% in Hingoli district and lowest i.e. 0% in Aurangabad district.

Table 7: - Districtwise Data Analysis of Yield of Crop Loss Ratio for Cotton Crop

Sr. No.	Name of the District	Yield-Non-Indemnifiable Limits (%) – CLR								
		0%	5%	10%	15%	20%	25%	30%	35%	40%
1	Aurangabad	9.76	13.77	14.50	16.56	20.98	0.00	0.00	0.00	0.00
2	Beed	13.00	22.21	22.21	26.86	26.86	29.47	0.00	0.00	0.00
3	Jalna	22.02	22.02	25.55	27.99	32.82	43.15	43.15	43.15	43.15
4	Prabhani	14.81	16.63	17.95	23.34	26.93	26.93	0.00	0.00	0.00
5	Hingoli	20.18	28.41	33.55	33.55	38.32	50.48	50.48	50.48	50.48
6	Latur	12.55	14.78	18.87	0.00	0.00	0.00	0.00	0.00	0.00
7	Nanded	20.41	20.41	25.07	28.86	28.86	34.77	42.28	42.28	42.28

For districtwise data analysis of gross returns of Cotton crop, it is seen from Table 8 that the crop loss ratio (CLR).

For 0% NIL, the crop loss ratio (CLR) was highest i.e. 16.88% in Nanded district and lowest i.e. 9.65% in Aurangabad district. For 5% NIL, the crop loss ratio (CLR) was highest i.e. 29.62% in Nanded district and lowest i.e. 10.27% in

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Parbhani district. For 10% NIL, the crop loss ratio (CLR) was highest i.e. 29.62% in Nanded district and lowest i.e. 16.28% in Parbhani district. For 15% NIL, the crop loss ratio (CLR) was highest i.e. 29.62% in Nanded district and lowest i.e. 18.13% in Parbhani district. For 20% NIL, the crop loss ratio (CLR) was highest i.e. 35.68% in Nanded district and lowest i.e. 21.70% in Beed district. For 25% NIL, the crop loss ratio (CLR) was highest i.e. 47.83% in Nanded district and lowest i.e. 27.15% in Aurangabad district. For 30%, 35% and 40% NIL, the crop loss ratio (CLR) was highest i.e. 47.83% in Nanded district and lowest i.e. 0% in Aurangabad district.

Table 8 - Districtwise Data Analysis of Gross Returns of Crop Loss Ratio for Cotton Crop

Sr. No.	Name of the District	Gross Returns-Non-Indemnifiable Limits (%) – CLR								
		0%	5%	10%	15%	20%	25%	30%	35%	40%
1	Aurangabad	9.65	17.29	27.15	27.15	27.15	27.15	0.00	0.00	0.00
2	Beed	10.82	13.49	21.70	21.70	21.70	0.00	0.00	0.00	0.00
3	Jalna	12.44	14.33	16.64	18.41	0.00	0.00	0.00	0.00	0.00
4	Prabhani	10.27	10.27	18.13	18.13	0.00	0.00	0.00	0.00	0.00
5	Hingoli	12.72	14.56	16.28	20.55	0.00	0.00	0.00	0.00	0.00
6	Latur	14.02	16.85	20.42	2.71	23.71	23.71	0.00	0.00	0.00
7	Nanded	16.88	29.62	29.62	29.62	35.68	47.83	47.83	47.83	47.83

IV. CONCLUSION

It may be concluded from the foregoing analysis that the yield of Cotton crop was stable in the districts of Marathwada Region of Maharashtra. The stability of Cotton crop was more in Beed district as compared to other districts. There was less crop failure during the study period (2000-01 to 2009-10) in Beed district. Crop loss ratio was less in Aurangabad district while it was more in Hingoli district.

In this paper, the risk is measured at district levels of Marathwada Region of Maharashtra. However, more realistic picture can be had if the risks are measured at district level. The question of introduction to crop insurance schemes for Cotton crop is under consideration. The results of the present study may be helpful in considering crop insurance scheme for Cotton crop. However, non-availability of time series data, such study could not be undertaken. So there is need to make available the data by considering crop cutting experiments for Cotton crop in the districts of Maharashtra.

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