



# Instability in Rice Production in Gujarat: A Decomposition Analysis

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## Abstract

Rice is the most important and extensively grown food crop in India and is the staple food for more than half of the world population. In India, Gujarat ranks 15<sup>th</sup> in terms of area and production and 9<sup>th</sup> in productivity (2011). The scope for expanding rice production lies in enhancing productivity. The growth rates of rice area, production and productivity during 1982-83 to 2011-12 were 0.41, 1.25 and 0.83 percent per annum respectively. The growth estimate from last 30 years data shows that negligible increase was recorded in area and production of rice. Presently the yield level of rice in the state is comparatively low from national average need to be increased substantially. The magnitude of instability in area and production of rice has been higher in all the selected districts compared to state. Variability in production has been at a higher rate compared to area and productivity variability in this crop. The area-yield co-variance had a stabilizing effect on reduction of instability in rice production. It can be inferred that the wide fluctuation in production of rice crop have been due to the high variability in its productivity. The future development programmes should envisage on increase of yield for bringing stabilization in production of the crop. The area instability also needs to be reduced. This could be reduced by more investment on research for rice production technology in the state.

**Keywords:** Growth, Instability, Rice production technology, Variability, Co-variance, Investment.



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## 1. Introduction

India has the world's largest area devoted to rice cultivation, and it is the second largest producer of rice after China. Rice is the most important and extensively grown food crop in India and in Gujarat and it is the staple food for more than half of the world population (Singh and Varshney, 2010). In India, Gujarat ranks 15<sup>th</sup> in terms of area and production and 9<sup>th</sup> in productivity (2011).

Rice production is confined to South and Middle Gujarat representing the Agro-climatic Zones, I, II and III. These zones exhibit a wide range of agro-climatic variation within and between individual zones. The cropping sequence under which the rice crop is grown in different agro-climatic zones is also different. Such variations seem to have direct impact on the production and productivity of the rice crop in the state. The rice growing area of the state covers the districts of Valsad, Navsari, Dang, Surat, Bharuch, Narmada, Vadodara, Kheda, Anand, Dahod and Panchmahals (Pathak *et al.*, 2011). The scope for expanding rice production lies in enhancing productivity. Several studies have indicated that the adoption of recommended rice technology gives high yields and income to the farmers. The yield level of rice which is comparatively low compared to national level at present need to be increased substantially. Higher rice production can be achieved by adoption of all the recommended technologies by large number of farmers.

The instability in production transmitted wide variation in arrivals of the crop produce in the markets caused wide fluctuations in prices of the crop product. Apart from increasing the overall total production, stability in

production of the crop over the years is equally important in planning for agricultural development of any area. A pre-requisite for stabilizing of rice production is the necessity of examining and measurement of the extent of instability and also identification of the factors or sources causing the instability. As such an attempt has been made to examine the extent of instability and also to find out the factors responsible for causing instability in production of rice in the state of Gujarat. The study has practical utility in policy planning for boosting the production of this crop for food security in the state.

The paper is organized into four sections. The data and analytical approach used is discussed in the next section. Salient findings are discussed in section 3. Concluding remarks and policy implications are made in the last section.

## 2. Data and Methodology

The study confines to the state of Gujarat as this state is one of the major traditional rice producer in the country. Further, South Gujarat region, Ahmedabad, Valsad, Vadodara, Kheda and punchmahal districts being an important contributor to the state production of rice, were therefore selected for the present study. Secondary data in respect of area, production and productivity for the last 30 years (1982-83 to 2011-12) were obtained from the publications and records of Directorate of Agriculture, Government of Gujarat, Gandhinagar.

### 2.1. Analysis of Data

Growth Rates: The compound growth rates of area, production and productivity of rice crop were worked out using exponential function of the form,

$$Y = A B^x$$

By taking logarithm of both sides, the equation takes the linear form:

$$\text{Log } Y = \text{Log } A + X \text{Log } B$$

On writing  $\text{Log } A = a$ ,  $\text{Log } B = b$  and  $\text{Log } Y = y$ ,

The equation becomes

$$y = a + bx$$

Where;

$y$  = Dependent variable (Area, production and productivity)

$x$  = Time/Year (independent variable)

$a$  = Constant/intercept

$b$  = Regression coefficient of  $y$  on  $x$

The compound growth rate ( $r$ ) is  $= (B-1) \times 100$

The standard error of growth rate was estimated and tested for its significance with 't' statistic.

### 2.2. Instability in Production

The magnitude of instability in production of the crop was measured by working out the coefficient of variation (cv) based on time series data. Area and yield data of each selected district were detrended using the linear equation.

$$Z_t = a + bt + u_t$$

Where;

$Z_t$  = Dependent variable (Area /yield)

$a$  = Intercept

$b$  = Parameters to be estimated

$t$  = Time variable (years); and

$u_t$  = Error term with usual assumptions

After detrending, the residuals ( $u_t$ ) were centered on the mean area and mean yield ( $Z$ ) for each district. The detrended time series data ( $Z$ ) for area and yield were calculated as

$$Z = u_t \pm Z$$

The time series data of detrended production were calculated as the production of detrended area and yield. Finally, the coefficient of variation ( $cv_t$ ) of rice production was estimated from the detrended series for the study period.

The variance of production was decomposed into its constituent sources, viz., area variance yield variance and area – yield co-variance to examine the source of instability.

$$V(Q) = A^2 V(Y) + Y^2 V(A) + 2 A Y \text{Cov}(A, Y) - \text{Cov}(A, Y)^2 + R$$

Where;

$V(Q)$  = Production variance

$A$  = Mean area

$Y$  = Mean yield

$V(Y)$  = Yield variance

$V(A)$  = Area variance

$\text{Cov}(A, Y)$  = Area – yield co–variance

$\text{Cov}(A, Y)^2$  = Higher order co-variance between area and yield; and

$R$  = Residual

## 3. Result and Discussion

### 3.1. Growth Rate of Area, Production and Productivity of Rice Crop

There was slight change in area under rice cultivation in Gujarat state. During the period 1982-83 to 2011-12, there was slight increase in area by 0.41 per cent per annum (Table 3.1). Production and productivity of rice shown positive growth during the study period. Among the selected districts, growth in area was ranges between 0.01 to

1.88 % PA. The production growth was ranges between 0.91 to 2.76 %PA. Highest growth in production was observed in Ahmedabad district. Productivity growth was positive in the selected districts as well as in the state.

**Table-3.1.** Compound growth rates of area, production and productivity of rice crop in selected districts, South Gujarat region and Gujarat State (%PA)

District	Year 1982-1983 to 2011-12		
	Area	Production	Productivity
Ahmedabad	1.88**	2.76**	0.87
Vadodara	0.01	1.02	1.01
Valsad*	0.26	0.84	0.58
Kheda*	1.17	1.85**	0.68
Panchmahal*	0.25	1.13	0.88
Surat	0.43**	0.91**	0.49
South Gujarat Region	0.69	1.28	0.58
Gujarat State	0.41	1.25	0.83

(1) Valsad + Navsari\* (2) Anand+Kheda\*, (3) Panchmahal+Dahod\*

(\* areas computed taking into account districts as existing prior to their reorganisation).

\*\* Significant at 5% level of significance

### 3.2. Instability in Production, Area and Productivity of Rice Crop

The coefficient of variation method was used to estimate the extent of instability in production, area and productivity of rice crop. The coefficient of variation as a measure of instability was estimated from detrended time series data as this method is advantageous over other methods (Coppock's instability index) because it directly gives the value of instability of the character under study. The coefficient of variation of production, area and productivity of rice crop was estimated from detrended time series data for the last 30 years (1982-83 to 2011-12) for the South Gujarat region, state as a whole and also for the major rice producing districts of Gujarat. The results are presented in Table- 3.2.

The coefficient of variation for production of rice in the state of Gujarat was 20.50 per cent for the period 1982-83 to 2011-12. For the selected districts, the coefficient of variation varied from 28 to 70 percent during the study period. The coefficient of variation in production was markedly high for Panchmahal district (70.90 percent) and Vadodara (64.12 percent). Instability was at moderate level in the districts of Ahmedabad (46.16 per cent), Surat (34.56 percent), Kheda (29.01 percent), and Valsad (28.63 per cent). The coefficient of variation for rice production has been higher for the selected district compared to the state as a whole showing thereby that fluctuation in production was more in the selected districts compared to the state as a whole.

**Table-3.2.** Coefficient of Variation of Production, Area and Productivity for rice in Selected Districts of Gujarat during 1982-83 to 2011-12 (Per cent)

Districts	Coefficient of Variation		
	Production	Area	Productivity
Ahmedabad	46.16	21.69	34.19
Vadodara	64.12	43.18	35.97
Valsad*	28.63	21.19	14.36
Kheda*	29.01	16.76	19.84
Panchmahal*	70.97	20.58	59.63
Surat	34.56	27.05	14.52
South Gujarat Region	17.90	10.68	14.41
Gujarat State	20.50	8.71	16.75

(1) Valsad + Navsari\* (2) Anand+Kheda\*, (3) Panchmahal+Dahod\*

(\* areas computed taking into account districts as existing prior to their reorganisation).

The coefficient of variation for the acreage under rice crop in the state was 8.71 per cent during the study period (1982-83 to 2011-12). The variation in area was 16 to 43 percent under rice crop in the selected districts. The area instability for rice crop was found to 10.68 for South Gujarat region which is higher from the state as a whole.

The coefficient of variation for rice productivity of the state revealed that this has been 16.75 per cent during the study period. Among the districts, coefficient of variation for productivity varied from 14 to 60 percent during the study period. The extent of variability in productivity has been higher for the districts compared to the state during the study period. The foregoing discussion led to conclude that the magnitude of instability for production of rice crop was higher in the districts as well as in the state as a whole. However, area variability has been at a lower rate compared to variability in productivity.

The variability in all the three variables i.e. production, area and productivity has been higher in the districts compared to the state as a whole. The destabilizing effect on production was more compared to area and productivity. This was also corroborated earlier in the study by [Asopa and Naik \(1989\)](#).

### 3.3. Sources of Variance in Rice Production

To analyse the variables, explaining the changes in instability of rice production, production variance was decomposed into area variance, yield variance and area-yield co-variance for the selected districts and state of Gujarat using [Hazell \(1982\)](#) decomposition technique. The results are presented in Table- 3.3.

Yield variance accounted 66.17 per cent of total variance in rice production for the state. The area variance was next in line and accounted 17.90 per cent. The area-yield co-variance has been 15.92 per cent indicating thereby that area-yield co-variance has a destabilizing effect on instability of rice production. Among the selected districts, yield fluctuation has been a dominant source of total variation in rice production in the districts of Panchmahal (60.10 per cent), Ahmedabad (52.13 per cent), Kheda (45.03 percent), and South Gujarat region (64.78 per cent) while the area

variance was a dominant source in total variation in production of rice in the districts of Surat (59.78 per cent), Valsad (54.11 percent), Vadodara (41.99 percent) and Kheda (32.13 percent). In South Gujarat region, area-yield co-variance has been negative indicating thereby the stabilizing effect on the instability in rice production. The area-yield covariance has been positive in all selected districts which suggested that the combined forces of area and yield have affected the output instability in the same direction across the time period.

**Table-3.3.** Sources of Variation in rice Production during 1982-83 to 2011-12 (Per cent)

Districts	Area variance	Yield variance	Area-yield Co-variance
Ahmedabad	20.98	52.13	26.89
Vadodara	41.99	29.13	28.87
Valsad*	54.11	24.87	21.01
Kheda*	32.13	45.03	22.85
Panchmahal*	7.16	60.10	32.74
Surat	59.78	17.22	23.00
South Gujarat Region	35.58	64.78	-0.35
Gujarat State	17.90	66.17	15.92

Sum of variance = 100

(1) Valsad + Navsari\* (2) Anand+Kheda\*, (3) Panchmahal+Dahod\* (4) Ahmedabad + Gandhinagar\*

(\* areas computed taking into account districts as existing prior to their reorganisation).

The results of this study are in conformity with the studies conducted by Kumar and Sankaran (1998) at country level for turmeric crop. The foregoing discussion concluded that the change in yield has been the dominant source of total variation in production of rice in the state as well as in selected districts. The area-yield co-variance has a stabilizing effect on instability of rice production in all districts as well as in the state. The results are in corroboration with the studies conducted by Chand and Raju (2008), Bastine and Palanishami (1994) and for ginger crop by Gaikwad *et al.* (1998).

#### 4. Conclusion and Policy Implication

Area under rice crop in the state as well as in the major rice growing districts increased overtime and rice crop at present become one of the main competing crop of the kharif season in the area. On the other hand, productivity of this crop has not increased over time rather it has been lower than national average. It can be inferred that the wide fluctuation in production of rice crop have been due to the high variability in its yield as well as in production. The future development programmes should envisage on stabilization of yield for bringing stabilization in production of the crop. The yield instability also needs to be reduced. This could be reduced by more investment on research leading to evolving of suitable rice production technology for varied agro climatic conditions of the state. There is also an urgent need to popularize the available HYVs released by SAUs and identified by AICRIP in the upland drilled ecosystem, which accounts for nearly 30% area. It is because of the poor productivity of this fragile ecosystem that brings down the total productivity.

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