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Growth and instability of rice production in Assam

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Abstract

In India, looking at the different component of the rural economy, agriculture remains the mainstay of the rural sector. Agriculture in Assam is popularly known as rice culture, because it is dominated by rice as the most important cereal crop in terms of area, production and productivity. It played a leading role in improving food security in the state of Assam. Rice is consumed by about 90 percent of the state population and is grown over an area of 26.46 lakh hectares occupying around 74.25 percent of the cropped area. In Assam, agriculture largely depends on vagaries of nature and the instability in rice production. Agriculture instability has remained the subject of intense debate in the agricultural economics literature in India. While the need for increasing agricultural production or growth is obvious, the increasing in instability in agricultural production is considered adverse for several reasons. It raises the risk involve in farm productions and affects farmers income and decisions to adopt high paying technologies and make investments in farming. Instability in production affects the consumers and the price stability, and it increases variability of low-income households to market. This paper tries to find out the growth and instability of different rice and identify the sources of instability of production and productivity of rice in Assam. For these purpose different tools of analysis has been used. From the analysis of growth and instability in area, production and productivity, it was found that there existed a considerable variation in the production of different types of rice in the state.

Key Words: Agriculture, Rice, area, Production, Productivity, growth, instability.

In India, looking at the different component of the rural economy, agriculture remains the mainstay of the rural sector. The compound growth rate in agricultural production has been 2.7 percent per annum since independence. Since the first green revolution in the 1960s the food grain production has increased significantly from 82 million tons in 1960-61 to 129 million tons in 1980-81 and 233 million tons in 2008-2009 and further increased 252.68 million tones. However, the share of agriculture in the country GDP has declined from 48.7 in 1950 to 24.4 percent in 1996-97 and 18.7 percent in 2007 further down 16.1 percent in 2014-15. Further, our agriculture productivity continues to be low at 1.7 tones/ha as against the world's average of 2.6 tones/ha, leave alone the worlds best of 4 to 5 tones/ha. Rice is the main constituent of India's agricultural sector, which occupies 23 percent of the world's rice area and contributes approximately 42 percent of India's food grain production and placed 2nd largest production. As a result of improved technology, the

yield of rice has increased from 1.03 t/ha in 1967-68 to 1.75 t/ha in 1999 and further increased to 2.17 in 2010-11. (Directorate of Economics and statistics, Govt. of India)

However, a vast country like India with marked regional diversities in agro-climatic environment, resource endowment and the population density is likely to be characterized by uneven development among regions. Fertilizer consumption in Haryana, with speedy infrastructural development, could reap the benefit of improved technology better than some other states. The NPK consumption in rice increased from 40 kg/ha in 1970-71 to 175 kg/ha in 1991 in Haryana, whereas it was only 3.89 kg/ha in 1970-71 and 9.91 kg/ha in 1991 in Assam (Sardana et al, 1997). Moreover, with compared to India, per hectare consumption of fertilizer in 2010-11 was 144.14 kg, whereas in Assam it was only 65.41 kg.

Assam is the easternmost state of the Indian Union and is located between 24° 8' and 27° 56' N latitude and 89° 82' and 96° 0' E longitude with an area of 78532 sq kms. The economy of the state is predominantly rural with 70.4 percent of its population living in rural areas and depends mainly on agricultural and allied activities. Agriculture is backbone of the state economy. The growth rate in agricultural production since Five-Year Plans has been only to the order of 2 percent per annum. This growth in the coming decade has to be stepped up to over 3.5 percent per annum to feed the growing population and the improvement of per capita income.

Agriculture in Assam is popularly known as rice culture, because it is dominated by rice as the most important cereal crop in terms of area, production and productivity. It played a leading role in improving food security in the state of Assam. Rice is consumed by about 90 percent of the state population and is grown over an area of 26.46 lakh hectares occupying around 74.25 percent of the cropped area. Rice has three broad groups according to the season of harvest, viz, winter rice known as Sali rice, summer rice known as Boro rice and the autumn rice known as Ahu rice. Deep-water rice locally known as Bao rice is another rice crop being cultivated in the state in few small pockets of marshy land with high water depth once in a year. Sali rice being blessed with rainy season establishes itself as the major rice crop accounting for more than 68 percent of total rice crop area in the state. Boro and Ahu rice are the lean season (November-December to June-July) crops partially favoured by rainfall but they depend to a greater extent on irrigation for their cultivation. Though rice occupies the dominant portion of the cropped area the productivity of rice is only 1.3 t/ha (1991), which is low in comparison to the adjoining state of West Bengal (1.9 t/ha) and all India average of 1.75 t/ha. The reasons for low productivity of rice are very low amount of fertilizer consumption, slow growth of area under irrigation and area under HYV seeds. The share of HYV area to total rice has been increased from 10 percent in 1971-72 to 43 percent in 1994-95. The share of irrigated area to total rice area was found to be increasing from 1.2 percent in 1971-72 to 9.6 in 1986-87; however, it has been gradually decreasing from 8.5 percent in 1991-92 to 6.0 percent in 1994-95. Fertilizer consumption per hectare of rice area was 3.96 kg in 1971-72 that increased to 10.2 kg in 1994-95 and further increased to 65.41 kg in 2010-11. However, the recommended dose of fertilizer is 40:20:20 kg N: P: K per hectare. This showed that there is vast scope to increase the amount of fertilizer along with increase in HYV and limited area, which could contribute to an enhanced yield of rice. There exists yield gap between full adoption of technology and the partial adoption as well as non-adoption of technology in the state of Assam.

In Assam, agriculture largely depends on vagaries of nature and the instability in rice production. The existence of highly inequitable distribution of land and water resources among the cultivators leads to wide disparities in their farm income. The agro-climatic parameters such as physical and

chemical properties of soil, location, amounts and distribution of rainfall, relative humidity, duration of sunshine, minimum and maximum temperature, wind velocity etc. which vary from region to region have a great bearing on the production and productivity of agricultural enterprise and also contributes to the existence of inter-regional and inter district disparities. The analysis of area, production and yield of rice of different agro-climatic zones in the state reveals year-to-year fluctuation revealing a high degree of instability in the state.

Agriculture instability has remained the subject of intense debate in the agricultural economics literature in India. While the need for increasing agricultural production or growth is obvious, the increasing in instability in agricultural production is considered adverse for several reasons. It raises the risk involve in farm productions and affects farmers income and decisions to adopt high paying technologies and make investments in farming. Instability in production affects price stability and consumers, and it increases variability of low-income households to market. In stability in agricultural and rice production is also important for food management and macroeconomic stability (R Chand & S S Raju).

Objective: To study the pattern of growth and instability in area, production and productivity of rice in Assam and to identify the sources of instability.

Following hypothesis has been considered for the study.

There is a decelerating trend in growth of rice production in Assam.

Tools and Analysis:

Growth and instability: Time series data on area, production and productivity of different types of rice (summer, autumn and winter) grown in Assam from 1991-92 to 2011-2012 has been collected from the Directorate of Economics and Statistics, Govt. of Assam. For the needs of our study the whole period is divided into two periods viz. period I (1991-92 to 2000-01) and period II (2001-02 to 2011-2012), and overall period 1991-92 to 20011-12.

Exponential Trend Equation: Compound growth rate is calculated for the growth pattern in area, production, and yield of rice using the exponential trend equation of the following form.

$$Y_t = ab^t$$

$$\text{Log } Y_t = \text{log } a + t \text{ log } b$$

$$r = (\text{antilog 'b' } - 1) \times 100$$

Where,

Y_t = area, production or yield of rice in year 't'

a and b = parameter to be estimated

r = compound growth rate.

Semi-Log Quadratic Trend Equation: Semi-log quadratic trend equation of the following form is also fitted to the area, production and yield of rice to find out the acceleration or deceleration trend.

$$\text{Log } Y_t = a + bt + ct^2$$

Assuming positive 'b', the sign of 'c' indicate whether it has any acceleration or deceleration in area, production, and yield of rice. The problem of multicollinearity will be eliminated by means of proper transformation.

There are various methods used to measure the extent of instability. Some of the most common of these are the Standard Deviation and the Coefficient of Variation. In this study the instability in

area, production and productivity of rice will be examined by Coefficient of variation, Standard deviation and Cuddy-Della Velle Index for different period using the following formula,

- $C.V = S.D/Mean$
- $S.D = [\{ (X_i - \bar{X})^2 \}]^{1/2}$

Where, N is the total no. of observations and X_i is the area production or productivity and \bar{X} is the mean of distribution.

3. Instability Index,

$$II = CV * (1 - R^2)^{1/2}$$

Where, II is instability index or adjusted coefficient (percent). CV^* is Coefficient of variation, R^2 is coefficient of determination from a time trend regression adjusted by the no. of degrees of freedom

To identify and analyse the factor causing instability productivity of rice a multiple linear regression analysis with the following form has been used.

$$Y_p = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5$$

Y_p = Variability in productivity of rice as calculated from CDI.

X_1 = area under rice in hectares

X_2 = annual rainfall in millimeters

X_3 = area under HYV rice in hectares.

X_4 = irrigated area under rice in hectares

X_5 = Fertilizer consumption in thousand tones

In the above analysis total rice data at the state level is used, as some of the data was not be available district wise for different types of rice.

The sources of variance in production of different types of rice has been examined by decomposing the variance of production into its sources viz. Area variance, production variance and area – productivity covariance.

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

Where,

$V(Q)$	= Production variance.
\bar{A}	= Mean area.
\bar{Y}	= Mean Productivity.
$V(Y)$	= Productivity variance.
$V(A)$	= Area variance.
$COV(A, Y)$	= Area-productivity covariance
$COV(A, Y)^2$	= Higher order covariance between area and productivity.
R	= Residual

Growth Rate of Different Types of Rice: This chapter is primarily focused on the analysis of compound growth of area, production and productivity of different types of rice for the different periods mentioned below-

Period I (1991/92 to 2000/01)

Period II (2001/02 to 2011/12) and

Pooled period (1991/92 to 2011/12)

Table-1: Compound growth rate of Area, A. Yield and Production of different Rice

Period	Types of Rice	Area	A. Yield	Production
I	WINTER	1.46**	0.75	2.65
	AUTUMN	0.80	0.89	1.63
	SUMMER	1.78	-3.73	-2.14
II	WINTER	0.80	2.29*	2.92*
	AUTUMN	0.95	4.16	4.69
	SUMMER	16.70**	5.32**	19.67**
Pooled	WINTER	1.01**	1.79**	2.80**
	AUTUMN	0.73*	1.35*	1.95*
	SUMMER	8.65**	1.69	9.26*

*** denotes at 10 percent probability # Period I =1991/92-2000/01

** denotes at 5 percent probability # Period I =2001/02-2011/12

* denotes at 1 percent probability # Pooled =1991/91 -2011/12.

In Assam, growth rate in area has registered a positive and significant under winter rice and growth rate in area under autumn and rice are found only positive without any significant in period I. In the same period, it is found that the growth rate in yield under summer rice shows negative and the growth rate in yield under winter and autumn rice shows positive without any significant. In production growth rate, it is found that the winter and autumn rice has registered positive and summer rice registered negative growth rate.

During period II, the highest recorded growth rate in area was under summer rice followed by autumn and winter rice. It is also found that during same period, growth rate in yield was highest under summer rice followed by autumn and winter rice. The growth rate in production is highest under winter rice due to positive significant growth in yield followed by autumn and winter rice in period II.

The pooled period also indicated highest positive growth rate in area under summer rice followed by winter and autumn rice. While in same period, it is found that the growth rate in yield was highest under winter rice followed by summer and autumn rice. Moreover, during same period, it was observed that the growth in production is highest under summer rice followed by winter and autumn rice. Thus, it is seen that the growth rate under summer rice is highest in area, production and productively than the winter and autumn rice in Assam.

To see whether the growth rates are accelerated or decelerated the below log function is used-
 $\text{Log } p = a + bt + ct^2$

Where p is the production of rice and t is the time period, b and c are coefficient of t and t² respectively. Coefficient of t shows growth and coefficient of t² shows acceleration or deceleration in growth rates depending on the sign of the coefficient. In order to observed acceleration or deceleration in growth rate in various districts over period 1991-92 to 2011-12, the analyses are made on the basis of the sign and statistical significance of the coefficient of t² as follows:

If we observed the table 2, the period 1991-92 to 2011-12, the production of rice in Assam shows constancy in growth rate as the coefficient of t² is positive but not significant. We are not able to say whether the growth rate is accelerated or decelerated. Therefore, the hypothesis that "there is a decelerating trend in the growth of rice production in Assam" cannot be accepted.

Table- 2: Acceleration and Deceleration of Rice Production in Assam

	Coefficient(ct^2)
Assam	0.00069

*** denotes at 10 percent probability

** denotes at 5 percent probability

* denotes at 1 percent probability

Instability in Rice:

Table: 3 Instability Index for area, yield and production of different rice in Assam

Period	Types of Rice	AREA	YIELD	PRODUCTION
		CDI	CDI	CDI
I	WINTER	4.675	6.401	9.308
	AUTUMN	6.678	9.844	13.675
	SUMMER	18.760	13.891	24.654
II	WINTER	4.814	9.786	14.659
	AUTUMN	49.540	11.694	18.308
	SUMMER	16.262	8.324	18.485
POOLED	WINTER	11.651	14.713	24.7088
	AUTUMN	17.831	21.092	29.627
	SUMMER	44.6201	49.260	52.224

The trends of instability in period I, it is found that in the area in summer rice have shown highest instability followed by autumn and winter rice respectively. Area in autumn rice have shown the highest instability followed by summer and winter rice in period II. In the pooled period, it was found that instability in area under summer rice has shown highest followed by autumn and winter rice respectively. Again in period I, it is found that the instability in yield under summer rice has shown highest and winter rice shown lowest rate of instability. While in period II, it is seen that yield in autumn rice has highest instability and summer rice has lowest instability rate. During the pooled period, it was found that the yield in summer rice has shown highest instability followed by autumn and winter rice respectively. The instability rate in production is highest in summer rice and lowest in winter rice during the period I. In period II, it was found that the instability in production is highest in summer rice and lowest in winter rice. During the pooled period, it was found that summer rice has highest rate of instability and winter rice has lowest rate of instability in production.

Sources of instability in production: From the analysis of growth and instability in area, production and productivity, it was found that there existed a considerable variation in the production of different types of rice in the state. Here, considering the total rice instead of different types of rice due to non-availability of the data attempts were made to find out possible sources that caused variance in the production of rice. The variance of production has been decomposed into area variance, productivity variance and area productivity co-variance for total rice for different time period separately. The results have been presented in table 4.

Table- 4: Sources of instability in production

Period	VAR(A)	VAR(Y)	COV(A,Y)	Higher Order Interaction COV(A,Y)	Residual R	Total
I	95	11	-05	0	-1	100
II	69	8	27	0	-4	100
Pooled	75	10	19	0	-4	100

It was found that the area variance are the main source contributing to the production variance in period I, period II and the pooled period at 95 percent, 69 percent and 75 percent respectively in Assam. Again, the productivity variance is the second sources to the production in all the periods. Thus, from the above discussion we can conclude that area variance is the main source contributing to the production of rice in Assam.

Factors affecting Instability in Yield: It is a fact that many factor cause instability in productivity of rice. In this section, five factors viz., area under total rice, annual rainfall, HYV area under total rice, irrigated area under total rice and total fertilizer consumption were considered as some of the factors causing instability in yield of total rice. Therefore, a regression analysis with instability in yield of total rice as calculated from CDI as independent variable (Y) and area (ha) under total rice (X1), annual rainfall (mm) (X2), HYV area (ha) under total rice (X3), irrigated area under total rice (X4) and total fertilizer (kg/ha) consumption (X5) as explanatory variables was carried out. The results are presented for the State as a whole for different periods.

PERIOD I (1991/92-2000/01): In period I, it was observed from table 5 that the coefficient of area under total rice (-7.3), annual rainfall (-0.001), irrigated area (-3.7) and fertilizer consumption (-0.0004) had negative effect which revealed the negative relation of yield variability and these factors due to combined use of irrigation water, relatively stable growth in area under total rice, increase in combined use of fertilizer and desired rainfall during period I. whereas the positive relationship between yield variability and HYV area might be due to improper use of HYV,s. It was also seen from table 4 that all the explanatory variables were non- significant in this period.

PERIOD II (2001/2002-2001/12): The effect of irrigated area (-2.6) and fertilizer consumption (-9.9) were found to be negative on yield variability in period II, which is seen from table 5 that yield variability got reduced and it might be due to proper use of fertilizer and irrigation water. On the other hand, there was positive relationship between yield variability and area under total rice (1.37), annual rainfall (0.0003) and HYV area (5.23) which revealed that the increase variability in yield due to area under total rice, HYV area and rainfall might be due to improper use of HYV,s with damage to standing crops caused by floods and excessive rainfall. Like period I, in Period II also all explanatory variables were non-significant.

POOLED PERIOD (1991/92-2011/12): The co-efficient of total area in.... rice (4.56), HYV area (2.33) and irrigated area (9.66) were found to be positive whereas the co-efficient of annual rainfall (-0.001) and fertilizer consumption were found to be negative with yield variability having no significant. In pooled period, the yield variability reduced due to timely rainfall and proper combined use of fertilizer. Whereas the yield variability increased, it might be due to mismanagement of area in rice, improper use of HYV, s and irrigation water during the pooled period.

Table-5: Factors of instability in Yield

period	Constant	Rice area	Rainfall	HYV area	Irrigation	Fertilizer	R2
1991/92-2001-02	83.118**	-7.3	-0.001	3.28	-3.7	-0.0004	0.12
2001-02-2011/12	30.454	1.37	0.0003	5.23	-2.6	-9.9	0.4
1991/92-2011/12	131.36*	4.56	-0.001	2.33	9.66	-0.001	0.28

Conclusion: The growth of rice production has not kept pace with the population growth, resulting in an overall decline in per capita availability. Therefore, policies and programmers' should concentrate on increasing the production of rice by introducing HYV's and by adopting new technology. This needs the support of institutional credit and extension services for farmers. For increasing productivity of rice farmers must be motivated and properly trained about the uses of various inputs or resources in rice cultivation through improvement in extension services. Moreover, for this purpose steps should be taken to develop irrigation and water management systems in the state. There is also an immense need to check the fragmentation of farm holdings in Assam. For the overall development of rice cultivation in Assam, efforts for development should come from Central and State governments, agricultural research institutions and other non-government organizations without any conspiracy.

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