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GROWTH AND INSTABILITY IN PADDY PRODUCTION IN TAMIL NADU: AN INTER-DISTRICT ANALYSIS

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Abstract
Foodgrains are grown in many states in our country providing employment to a large number of people and contributing to the growth of the vital rural economy. The major foodgrains growing states in India are Andhra Pradesh, Maharashtra, Madhya Pradesh, West Bengal, Karnataka, Tamil Nadu, Bihar and Odisha, which together accounted for more than 90 per cent of area and production of Paddy. Among these states, the growing of the Paddy has assumed greater significance in Tamil Nadu. Therefore, an analysis of growth and instability in Paddy production in Tamil Nadu is of great importance for a comprehensive understanding of the food security at the state level. In this context the present paper assumes growth and instability of Paddy production in Tamil Nadu. This paper also exhibits the inter-district analysis of the Paddy production in Tamil Nadu.

Key Words: Foodgrains, Growth, Instability, Decomposition.

I. Introduction

The role played by agriculture a developing country like India and its contribution towards capital formation, employment, etc., is well known. Its linkages with industries in supplying wage goods, providing raw materials and creating demand for the industrial products. In a country like India where most of the industries depend on agriculture, the growth in agricultural output with less fluctuations in agricultural production have both, direct and indirect effect on economic growth. The direct effect will be on agricultural output growth and consequently on the overall growth. The indirect effect is the influence through the industrial output growth[1].

Agricultural production includes two components viz., food and non-food articles. Of all the food articles, foodgrains constitutes the most significant part of agricultural production of any country. Importance of foodgrains in the world economy is being recognized and there is an urgent need to raise production in view of the large gap between demand and supply of foodgrains. The role of agricultural development in overall economic development and in eliminating poverty is also equally important. As a matter of fact, sustained and accelerated development of Indian agriculture is the key to acceleration in economic development and poverty reduction, furthermore a large number of industries like textiles, silk, sugar, rice, flourmills and milk products get raw material from agriculture. Its strong forward and backward linkages within the rural sector and with the other sector of the economy provide added stimulus for growth and income generation significant progress in promoting economic growth, reduction in poverty and enhancing food security cannot be achieved without developing more fully the potential human and productive capacity of the agricultural sector and enhancing its contribution to overall economic development. A strong food and agricultural system thus, constitutes an important factor in the strategy of overall economic growth and development. Any change in agriculture sector has a spillover effect on the entire India economy[2].

Foodgrains are grown in many states in our country providing employment to a large number of people and contributing to the growth of the vital rural economy. The major foodgrains growing states in India are Andhra Pradesh, Maharashtra, Madhya Pradesh, West Bengal, Karnataka, Tamil Nadu, Bihar and Odisha, which together accounted for more than 90 per cent of area and production of Paddy. Among these states, the growing of the Paddy has assumed greater significance in Tamil Nadu. Therefore, an analysis of growth and instability in Paddy production in Tamil Nadu is of great importance for a comprehensive understanding of the food security at the state level. In this context the present paper assumes growth and instability of Paddy production in Tamil Nadu. This paper also exhibits the inter-district analysis of the Paddy production in Tamil Nadu.

Outline of the Paper

This paper is organized with five sections. The first section provides the introduction of the study. In the second discussed the agricultural situation in Tamil Nadu. The third section presents the objectives and methodology. The data responses along

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[1] *Ramakrishna, G., (1993), "Growth and Fluctuations in Indian Agriculture",* ***Asian Economic Review****, Vol. XXXV, No. 1, pp: 47-60.*
[2] *Angrei Singh (2011), "Structural Reforms and Sustaining Growth in Indian Agriculture: The Emerging Trade Order,"* ***Agriculture and Food Security Contemporary Issues,*** *Deep and Deep Publication Ltd, New Delhi, (First edition 2011), pp. 80-89.*

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with statistical analysis of findings and the empirical results of the regression models have been discussed in the fourth section, while the last section draws conclusion based on these results.

II Agricultural Situation in Tamil Nadu

The Share of Agriculture and allied activities in Gross Domestic Product (GDP) accounted for 14.45 percent (at 2004-05 constant prices) during 2010-11. Agriculture and logging alone had shared 16.3 per cent and the share of Forestry and Fishing accounted for 0.7 per cent and 0.8 per cent respectively. The shares of agriculture sector in providing employment accounted for 52 per cent at the national level and the performance of agriculture sector is a helping hand for the growth engine of the Indian Economy.

Tamil Nadu State is situated at the South Eastern extremity of the Indian Peninsula bounded on the north by Karnataka and Andhra Pradesh on the east by Bay of Bengal, on the South by the Indian Ocean and on the West by Kerala State. Tamil Nadu shares about 4 per cent in respect of the geographical area, 7 per cent of population and 3 per cent of water resources of the country. The gross area sown in 2010-11 accounted for about 44.1 per cent of the total geographical area, of which 56 per cent of the land was irrigated. The contribution of agriculture (including allied activities) of the State to the Gross State Domestic Product (GSDP) at Constant prices accounts for 9.16 percent (at 2004-05 constant prices) during 2010-11. However, the agriculture sector ensures household food security and brings forth equity in distribution of income and wealth which would result in the reduction of poverty.

Paddy (in terms of rice) the staple food for the State is raised more in the rice bowl districts of Thanjavur, Thiruvarur and Nagapattinam which accounted for about one fourth of the gross cropped area under paddy in the State. The area under rice cultivation almost remained stagnant in the recent years while the growth in yield rate had shown an increase in the production both at the State and at the All India level. As a result of the favourable seasonal conditions experienced in the State during the initial months of 2010-11, the State had covered more area under kar, kuruvai, sornavari, samba and thaladi seasons. However, the samba and thaladi crops were affected following heavy rains occurred during November. The area under paddy rose from 18.46 lakh hectares in 2009-10 to 19.06 lakh hectares in 2010-11, the increase being 3.14 per cent. Even though, the yield rate of rice had come down from 3069 kgs. / ha. in 2009-10 to 3039 kgs. / ha. during 2010-11. The total production of rice had improved from 56.65 lakh tonnes to 57.92 lakh tones respectively.

III. Objectives and Methodology

Instability in food production has remained subject of intense debate in the agricultural economics literature in India. Instability in production raises the risk involved in farm production and affects farmers' income and decisions to adopt high paying technologies and make investments in farming. It not only affects farmers, it also affects price stability and the consumers, and it increases vulnerability of low income households to market. Based on the review, objectives were formulated and suitable methodologies were selected and are presented in this section.

Objectives

The main objectives of this paper are as follows:

1. To estimate the rate of growth in Paddy production, area and yield in Tamil Nadu,
2. To examine the instability in Paddy production, area and yield in Tamil Nadu,
3. To know the sources of instability in production of Paddy in Tamil Nadu,
4. To measure the relative contribution of area, yield and their interaction to production of Paddy in Tamil Nadu; and
5. To suggest some policy measures to overcome the problems faced in the agriculture sector.

Methodology

The methodology used in the paper is discussed in the following parts of this section. It includes period of study, sources of data and analytical techniques used in this paper.

Period of Study: The study utilizes time series data with respect to area, production and yield of Paddy in the state of Tamil Nadu from the year 1979-80 to 2010-11. The entire study period is divided into two periods. Period I is Pre-reform period related to 1979-80 to 1990-91. Period II is Post-reform period related to 1991-92 to 2010-11.

Sources of Data: The present analysis was based on secondary source data relating to the area, production and yield of Paddy cultivated in Tamil Nadu. The data was obtained from various Season and Crop Reports published by the Department of Economics and Statistics, Chennai. District wise data were used to study the growth, instability and sources of instability in Paddy production in Tamil Nadu. According to the Season and Crop Report - 1979-80, there were 15 districts in Tamil Nadu.

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Presently the state is demarcated into 32 districts including so many new born districts. Comparable data were not available for the period of all the 32 years particularly for newly formed districts as these were created in different years during the study period. To make the comparison feasible, the new born districts were merged with the parent districts to form 15 original districts. The secondary data compiled from the various season and crop reports were formatted by using electronic spreadsheets (MS-Excel 2007). SPSS-15 (Statistical Package for Social Sciences) software was used for the data analysis.

Analytical Techniques : The collected data were systematically analyzed through the following techniques.
Compound Growth Rate: To study the growth pattern of area, production and yield of Paddy in Tamil Nadu for the period 1979-80 to 2010-11, the semi log transformation model was used
Instability : To measure the instability in area, yield and production of Paddy in Tamil Nadu, the coefficient of variations (CV) was worked out.

Decomposition Model
Paddy production in Tamil Nadu witnessed commendable changes in terms production, area and yield. In order to find out the sources of growth and variability in Paddy production in Tamil Nadu, Hazell's decomposition model was employed. A fairly long period of 32 years was taken to measure the sources of change in the variance of Paddy production. Here an attempt is made to break down the growth of Paddy production during 1991-92 to 2010-11 over the period of 1979-80 to 1990-91. The procedure followed to compute the extent of variability and its decomposition into different components has been described below. Hazell (1982) suggested the linearly detrended data for his entire decomposition analysis. Because the long-term trend in each variable needs to be remove in order to separate it from the short-term stochastic variation. The area and yield data for Paddy in Tamil Nadu were detrended using linear relations of the form

$$Z_t = a + b_t + e_t \qquad \dots (2)$$

Where Z_t denotes the dependent variable (area or yield), t is time and e_t is a random residual with zero mean and variance $\pm^2$. Separate regressions are run for each of the two time periods to ensure that $\sum_t e_t = 0$ for each period. Linear relations are used here because they do not assume a deterministic part to any relation between the variance of Z and time t.
After detrending the residuals are centered on the mean areas or yields for each period, $\overline{Z}$, resulting in detrended time-series data of the form

$$\hat{Z} = e_t + \overline{Z} \qquad \dots (3)$$

These detrended data are used as the basic data for decomposition of changes in average production and changes in variance of Paddy production.

Hazell decomposed the sources of change in mean production and change in production variance into four and ten components. The Hazell's decomposition procedure is given below.

Let P denote production, A denote the area sown under a particular crop and Y is the yield per hectare. Then for each crop total output in the state is P = A * Y. The variance of production, V (P) can be expressed as

$V(P) = \overline{A}^2 V(Y) + \overline{Y}^2 V(A) + 2\overline{A}\,\overline{Y}\,\mathrm{cov}(A, Y) - \mathrm{cov}(A, Y)^2 + R \dots (4)$ Where $\overline{A}$ and $\overline{Y}$ denote mean area and mean yield respectively. R denote the residual term which is expected to be small. Clearly, a change in any one of these components will lead to a change in V(P) between two periods in time. Similarly, average production, E(P) can be expressed as:

$$E(P) = \overline{A}\,\overline{Y} + \mathrm{cov}(AY) \qquad \dots (5)$$

It is affected by changes in the covariance between area and yield and by changes in mean area and mean yield. The objective of the decomposition analysis is to partition the changes in V(P) and E(P) between the first and the second periods into constituent parts, which can be attributed separately to changes in the means, variances and covariances of area and yield.

Method of Decomposition of Average Production

Using Eq. (5), average production in the first period is

$E(P_1) = \overline{A_1}\overline{Y_1} + \mathrm{cov}(A_1 Y_1) \qquad \dots (6)$ and in the second period is

$$E(P_2) = \overline{A_2}\overline{Y_2} + \mathrm{cov}(A_2 Y_2) \qquad \dots (7)$$

Each variable in the second period can be expressed as its counterpart in the first period plus the change in the variable between the two periods. For example,

$\overline{A}_2 = \overline{A}_1 + \Delta\overline{A}$

$\overline{Y}_2 = \overline{Y}_1 + \Delta\overline{Y}$

$Cov\ (A_2, Y_2) = Cov\ (A_1, Y_1) + \Delta Cov\ (A_1, Y_1)$

Eq. (4.7) can, therefore be rewritten as: $E(P_2) = (\overline{A}_1 + \Delta\overline{A})(\overline{Y}_1 + \Delta\overline{Y}) + \text{cov}(A_1Y_1) + \Delta\,\text{cov}(A, Y)$

$= \overline{A}_1\overline{Y}_1 + \overline{A}_1\Delta\overline{Y} + \overline{Y}_1\Delta\overline{A} + \Delta\overline{A}\Delta\overline{Y} + \text{cov}(A_1Y_1) + \Delta\ \text{cov}(A, Y)$ … (8)

The change in average production, Δ E(P) is then obtained by subtracting Eq. (6) from Eq. (8). Thus,

$\Delta E(P) = E(P_2) - E(P_1)$

$= \overline{A}_1\Delta\overline{Y} + \overline{Y}_1\Delta\overline{A} + \Delta\overline{A}\Delta\overline{Y} + \Delta\ \text{cov}(AY)$ … (9)

Hence there are four sources of change in average production resulted from this equation (9) which can be arranged as in Table 1. The first two terms, change in the mean yield and change in mean area are called as 'pure effects' which arise even if there were no other source of change. The third term is an interaction effect, which arise from the simultaneous occurrence of changes in mean yield and mean area. The fourth term in the equation represents interaction between area and yield covariance.

Table 1: Components of Change in Average Production

Sources of Change	Symbol	Components of Change
Change in mean yield	$\Delta\overline{Y}$	$\overline{A}_1\Delta\overline{Y}$
Change in mean area	$\Delta\overline{A}$	$\overline{Y}_1\Delta\overline{A}$
Interaction between changes in mean yield and mean area	$\Delta\overline{A}\Delta\overline{Y}$	$\Delta\overline{A}\Delta\overline{Y}$
Change in area–yield covariance	$\Delta\,\text{cov}(AY)$	$\Delta\,\text{cov}(AY)$

Methods of Decomposition of the Changes in Variance of Production

In this section, we will construct a method to partition the changes in variance of production (V(P)) between the first and the second periods into its constituent parts.

As shown in Eq. (4), the variance of production, V(P) can be expressed as,

$V(AY) = \overline{A}^2V(Y) + \overline{Y}^2V(A) + 2\overline{A}\,\overline{Y}\ \text{cov}(A, Y) - \text{cov}(A, Y)^2 + R$

Using Eq. (4), variance of production in the first period is

$V(P_1) = \overline{A}_1^{\,2}V(Y_1) + \overline{Y}_1^{\,2}V(A_1) + 2\overline{A}_1\overline{Y}_1\ \text{cov}(A_1, Y_1) - \text{cov}(A_1, Y_1)^2 + R_1$ … (10) and in the second period is

$V(P_2) = \overline{A}_2^{\,2}V(Y_2) + \overline{Y}_2^{\,2}V(A_2) + 2\overline{A}_2\overline{Y}_2\ \text{cov}(A_2, Y_2) - \text{cov}(A_2, Y_2)^2 + R_2$ … (11) each variable in the second period can be expressed as its counterpart in the first period plus the change in the variable between the two periods, i.e.,

$\overline{A}_2 = \overline{A}_1 + \Delta\overline{A}$

$\overline{Y}_2 = \overline{Y}_1 + \Delta\overline{Y}$

$V(A_2) = V(A_1) + \Delta V(A)$

$V(Y_2) = V(Y_1) + \Delta V(Y)$

$Cov\ (A_2, Y_2) = Cov\ (A_1, Y_1) + \Delta Cov\ (A_1, Y_1)$

Eq. (11) can, therefore, be rewritten as

$V(P_2) = \{\overline{A}_1 + \Delta\overline{A}\}^2\{V(Y_1) + \Delta V(Y)\} + \{\overline{Y}_1 + \Delta\overline{Y}\}^2\{V(A_1) + \Delta V(A)\} +$

$2\{\overline{A}_1 + \Delta\overline{A}\}\{\overline{Y}_1 + \Delta\overline{Y}\}\{\text{cov}(A_1, Y_1) + \Delta\ \text{cov}(A, Y)\} -$

$\{\text{cov}(A_1, Y_1) + \Delta\ \text{cov}(A, Y)\}^2 + \{R_1 + \Delta R\}$ … (12)

which can be expressed as

$$\begin{aligned} V(P_2) = {} & \bar{A}_1^{\,2} V(Y_1) + \Delta\bar{A}^{2} V(Y_1) + 2\bar{A}_1 \Delta\bar{A}\, V(Y_1) + \bar{A}_1^{\,2} \Delta V(Y) + \Delta\bar{A}^{2} \Delta V(Y) \\ & + 2\bar{A}_1 \Delta\bar{A}\, \Delta V(Y) + \bar{Y}_1^{\,2} V(A_1) + \Delta\bar{Y}^{2} V(A_1) + 2\bar{Y}_1 \Delta\bar{Y}\, V(A_1) + \bar{Y}_1^{\,2} \Delta V(A) \\ & + \Delta\bar{Y}^{2} \Delta V(A) + 2\bar{Y}_1 \Delta\bar{Y}\, \Delta V(A) + 2\bar{A}_1 \bar{Y}_1 \operatorname{cov}(A_1, Y_1) \\ & + 2\bar{A}_1 \Delta\bar{Y} \operatorname{cov}(A_1, Y_1) + 2\bar{Y}_1 \Delta\bar{A} \operatorname{cov}(A_1, Y_1) + 2\Delta\bar{A}\,\Delta\bar{Y} \operatorname{cov}(A_1, Y_1) \\ & + 2\bar{A}_1 \bar{Y}_1 \Delta \operatorname{cov}(A, Y) + 2\bar{A}_1 \Delta\bar{Y} \Delta \operatorname{cov}(A, Y) + 2\bar{Y}_1 \Delta\bar{A} \Delta \operatorname{cov}(A, Y) \\ & + 2\Delta\bar{A}\,\Delta\bar{Y} \Delta \operatorname{cov}(A, Y) - \{\operatorname{cov}(A_1, Y_1)\}^2 - \{\Delta \operatorname{cov}(A, Y)\}^2 \\ & - 2\operatorname{cov}(A_1, Y_1) \Delta \operatorname{cov}(A, Y) + R_1 + \Delta R \qquad \ldots (13) \end{aligned}$$

The change in variance of production, Δ V(P) is then obtained by subtracting Eq. (10) from Eq. (13). Thus

$$\begin{aligned} \Delta V(P) = {} & V(P_2) - V(P_1) \\ = {} & \Delta\bar{A}^{2} V(Y_1) + 2\bar{A}_1 \Delta\bar{A}\, V(Y_1) + \bar{A}_1^{\,2} \Delta V(Y) + \Delta\bar{A}^{2} \Delta V(Y) \\ & + 2\bar{A}_1 \Delta\bar{A}\, \Delta V(Y) + \Delta\bar{Y}^{2} V(A_1) + 2\bar{Y}_1 \Delta\bar{Y}\, V(A_1) + \bar{Y}_1^{\,2} \Delta V(A) \\ & + \Delta\bar{Y}^{2} \Delta V(A) + 2\bar{Y}_1 \Delta\bar{Y}\, \Delta V(A) + 2\bar{A}_1 \Delta\bar{Y} \operatorname{cov}(A_1, Y_1) \\ & + 2\bar{Y}_1 \Delta\bar{A} \operatorname{cov}(A_1, Y_1) + 2\Delta\bar{A}\,\Delta\bar{Y} \operatorname{cov}(A_1, Y_1) \\ & + 2\bar{A}_1 \bar{Y}_1 \Delta \operatorname{cov}(A, Y) + 2\bar{A}_1 \Delta\bar{Y} \Delta \operatorname{cov}(A, Y) + 2\bar{Y}_1 \Delta\bar{A} \Delta \operatorname{cov}(A, Y) \\ & + 2\Delta\bar{A}\,\Delta\bar{Y} \Delta \operatorname{cov}(A, Y) - \{\Delta \operatorname{cov}(A, Y)\}^2 \\ & - 2\operatorname{cov}(A_1, Y_1) \Delta \operatorname{cov}(A, Y) + \Delta R \qquad \ldots (14) \end{aligned}$$

which can be arranged as in Table 2.

Table 2: Components of Change in the Variance of Production

Sources of Change	Symbol	Components of Change
Change in mean yield	$\Delta\bar{Y}$	$2\bar{A}_1\Delta\bar{Y}\operatorname{cov}(A_1,Y_1)+\{2\bar{Y}_1\Delta\bar{Y}+(\Delta\bar{Y})^2\}V(A_1)$
Change in mean area	$\Delta\bar{A}$	$2\bar{Y}_1\Delta\bar{A}\operatorname{cov}(A_1,Y_1)+\{2\bar{A}_1\Delta\bar{A}+(\Delta\bar{A})^2\}V(Y_1)$
Change in yield variance	$\Delta V(Y)$	$\bar{A}_1^{\,2}\Delta V(Y)$
Change in area variance	$\Delta V(A)$	$\bar{Y}_1^{\,2}\Delta V(A)$
Interaction between changes in mean yield and mean area	$\Delta\bar{A}\Delta\bar{Y}$	$2\Delta\bar{A}\Delta\bar{Y}\operatorname{cov}(A_1,Y_1)$
Change in area–yield Covariance	$\Delta\operatorname{cov}(AY)$	$\{2\bar{A}_1\bar{Y}_1-2\operatorname{cov}(A_1,Y_1)\}\Delta\operatorname{cov}(A,Y)-\{\Delta\operatorname{cov}(A,Y)\}^2$
Interaction between changes in mean area and yield variance	$\Delta\bar{A}\Delta V(Y)$	$\{2\bar{A}_1\Delta\bar{A}+(\Delta\bar{A})^2\}\Delta V(Y)$
Interaction between changes in yields and area variance	$\Delta\bar{Y}\Delta V(A)$	$\{2\bar{Y}_1\Delta\bar{Y}+(\Delta\bar{Y})^2\}\Delta V(A)$
Interaction between changes in mean area and yield and changes in area–yield covariance	$\Delta\bar{A}\Delta\bar{Y}\Delta\operatorname{cov}(AY)$	$(2\bar{A}_1\Delta\bar{Y}+2\bar{Y}_1\Delta\bar{A}+2\Delta\bar{A}\Delta\bar{Y})\Delta\operatorname{cov}(A,Y)$
Change in residual	ΔR	$\Delta V(AY)$ - Sum of the other components

IV Analysis and Discussion

Keeping in view the objectives of the study, the collected data were systematically analyzed through the Compound growth rate analysis, Instability analysis and Decomposition Analysis. This section presents the results of analysis and interpretation.

Part I: Growth Performance of Paddy

The growth pattern, in terms of area, production and yield of Paddy cultivated in Tamil Nadu has been studied at the district level as well as the state as a whole during the pre and post reform periods and the results are presented in Part I.

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Paddy, an important food crop of Tamil Nadu is cultivated to an extent of about 19 lakh hectares, accounting for about 1/3 of the gross cross cropped area of the state. Paddy is the principal crop extensively cultivated in most of the districts of the state having a unique three-season pattern viz., Kar/Kuruvai/Sornavari (April to July), Samba/Thaladi/Pishanam (August to November) and Navarai/ Kodai (December to March).

The compound growth rates of area, production and yield of Paddy for district-wise and for the state as a whole pertaining to the pre and post reform periods were computed and presented in the Table 3.

Table 3: Growth Rate of Area, Production and Yield of Paddy (In Per cent)

District	Pre-reform Period			Post-reform Period			Overall Period		
	A	P	Y	A	P	Y	A	P	Y
Chengalpattu	-3.40	3.71	7.36	-2.79	-2.41	0.39	-1.52	0.61	2.17
South Arcot	-2.72	3.82	6.72	0.09	-0.30	-0.38	0.06	1.16	1.10
North Arcot	-6.30	-1.58	5.04	-0.93	-0.14	0.80	-0.60	0.80	1.41
Salem	-4.11	1.23	5.57	-3.94	-3.31	0.65	-1.21	0.75	1.98
Dharmapuri	-2.06	4.41	6.61	-3.43	-2.87	0.58	-0.53	1.25	1.79
Coimbatore	-6.75	-2.71	4.33	-4.92	-5.21	-0.30	-5.06	-4.55	0.54
Periyar	-2.99	1.39	4.51	-5.25	-4.90	0.38	-3.11	-1.35	1.81
Tiruchirappalli	-5.69	1.84	7.99	-0.68	-0.60	0.09	-0.39	1.31	1.71
Pudukkottai	-3.33	5.11	8.72	0.53	-1.10	-1.62	-0.26	0.97	1.23
Thanjavur	-3.07	0.98	4.18	-0.39	-2.20	-1.81	-0.61	-0.86	-0.25
Madurai	-1.22	3.18	4.45	-2.66	-2.38	0.28	-1.84	-0.16	1.71
Ramanathapuram	-1.24	4.55	5.87	-0.65	-0.41	0.24	-0.60	0.99	1.60
Tirunelveli	-3.58	1.35	5.11	-1.11	-0.91	0.20	-1.27	0.82	2.11
The Nilgiris	-3.62	0.80	4.59	-5.20	-2.09	3.29	-4.69	-1.12	3.75
Kanniyakumari	-1.72	1.99	3.77	-4.79	-3.80	1.04	-3.24	-0.57	2.77
State	**-3.14**	**2.07**	**5.38**	**-1.18**	**-1.68**	**-0.51**	**-0.86**	**0.26**	**1.13**

Source: Computed

From the table 3 it is observed that the area under paddy in the state exhibited a negative growth rate during the pre and post reform periods. However, the growth rate of area under paddy in post-reform period (-1.18%) was comparatively better than the growth rate of pre-reform period (-3.14%). The analysis clearly indicated that the growth rate of Paddy cultivated area in all districts in pre-reform period exhibited a negative trend and the same was very high in Coimbatore district (-6.75%). During the post-reform period, South Arcot and Pudukkottai districts registered a positive growth rate. But the positive growth witnessed in these two districts was very meager, 0.09% and 0.53% respectively.

It is important to note from table 3 that, there is no district registered a positive growth rate, except South Arcot, in terms of area under paddy during the overall period. The positive growth rate recorded in South Arcot district is also very meager (0.06%). During the overall study period Coimbatore (-5.06%) and The Nilgiris (-4.69%) districts registered a high negative growth rate. It is also interesting to note that the growth rate of Paddy cultivated area in the post-reform period was comparatively better than the pre-reform period in Chengalpattu, South Arcot, North Arcot, Salem, Coimbatore, Tiruchirappalli, Pudukkottai, Thanjavur, Ramanathapuram and Tirunelveli districts.

Table 3 also elucidates that the state level paddy production depicted a positive growth rate during the pre-reform period (2.07%) and overall period (0.26%), while post-reform period exhibited a negative growth rate of -1.68 per cent per annum. During the pre-reform period the highest growth rate was found in Pudukkottai district (5.11%), while Coimbatore district showed a very low growth rate (-2.71%). It is also very clear from the Table 3 that during the post-reform period, all the districts in Tamil Nadu showed negative growth rate in Paddy production. During the overall period, Coimbatore, Periyar, Nilgiris, Thanjavur, Kanniyakumari and Madurai districts exhibited a negative growth rate in Paddy production and the remaining districts were registered a positive growth rate. It is also interesting to note that the growth rate of Paddy production in North Arcot district was comparatively better in the post-reform period (-0.14%) than the pre-reform period (-1.58%).

It is apparent from the table 3 that the state level Paddy yield had shown a positive growth rate during the pre-reform period (5.38%), while the post-reform period showed a negative growth rate (-0.51%). During the pre-reform period, all districts showed a positive growth rate in Paddy yield and the highest growth was found in Pudukkottai district (8.72%). The district wise analysis of Paddy yield during the post-reform period evaluates that the following districts registered a negative growth rate: South Arcot, Coimbatore, Pudukkottai and Thanjavur. Among the districts which were showing positive growth rate during the post-reform period, the growth rate of Nilgiri district was high (3.29%) and the remaining districts recorded only meager growth of less than one per cent per annum.

Part – II: Instability in Paddy

An attempt is also made in this study is to examine how year to year fluctuations in crop output changed from one period to another period, and what is the effect of new economic policy on the instability in crop output. Accordingly, instability in area, production and yield of Paddy cultivated in the state of Tamil Nadu has been studied at the district level as well as the state as a whole during the pre and post reform periods.

In order to measure the instability in Paddy cultivation in the state of Tamil Nadu, instability indices (Coefficient of Variation) of area, production and yield at the district level as well as the state as a whole during the pre and post reform periods were calculated and the results are depicted in the Table 4.

Table 4: Instability Index of Paddy Cultivated Area, Production and Yield in Tamil Nadu

(in Per cent)

District	Pre-reform Period			Post-reform Period			Overall Period		
	A	P	Y	A	P	Y	A	P	Y
Chengalpattu	18.9	21.63	28.18	18.96	21.82	11.22	20.08	24.22	23.29
South Arcot	22.04	31.32	27.4	12.62	16.94	12.01	16.37	23.69	19.41
North Arcot	39.58	34.51	19.94	23.83	26.1	10.61	30.49	29.86	16.82
Salem	28.38	27.97	21.61	32.75	36.8	11.69	30.8	39.5	21.22
Dharmapuri	20.09	25.74	24.37	30.42	33.49	15.06	28.01	37.89	22.1
Coimbatore	28.22	15.63	19.56	44.59	46.7	14.56	52.16	44.01	16.64
Periyar	27.58	25.64	19.82	37.75	36.08	7.81	35.36	32.72	19.08
Tiruchirappalli	24.71	16.2	32.22	13.28	21.62	12.93	18.02	25.34	22.99
Pudukkottai	19.07	35.62	36.09	12.58	30.39	23.57	15.48	32.97	29.28
Thanjavur	12.64	13.59	19.23	8.57	33.27	28.52	11.07	27.04	25.19
Madurai	14.15	26.2	20.41	22.81	28.84	12.99	22.41	27.82	20.84
Ramanathapuram	10.37	42.77	37.4	8.25	43.78	38.84	10.02	44.41	40.99
Tirunelveli	19.56	22.82	22.19	17.46	20.19	8.14	20.53	23.15	21.89
The Nilgiris	17.14	16.89	26.02	32.19	44.77	27.11	42.72	35.97	38.93
Kanniyakumari	13.21	29.93	24.57	28.95	27.34	12.87	30.47	27.96	27.68
State	**14.72**	**14.1**	**21.3**	**12.07**	**21.59**	**13.04**	**13.83**	**20.57**	**18.51**

Source: Computed

It may be observed from the Table 5.16 that the magnitude of instability at state level in the area under Paddy was decreased (12.07) during the post-reform period than the pre-reform period (14.72). The district level instability in South Arcot, North Arcot, Tiruchirappalli, Pudukkottai, Thanjavur, Ramanathapuram and Tirunelveli witnessed a decline in instability during the post-reform period than the pre-reform period. At the same time, Salem, Dharmapuri, Coimbatore, Periyar, Madurai, Nilgiris and Kanniyakumari districts showed an increase in instability during post-reform period. The instability in area wise under Paddy was almost the same in both pre and post reform periods in Chengalpattu district.

It is evident from the Table 5.17 that the coefficient of variation of Paddy production in Tamil Nadu during the post-reform period has registered a very high instability than the pre-reform period. It could be observed from the district wise analysis that the instability of Paddy production in Salem, Dharmapuri, Coimbatore, Periyar, Tiruchirappalli, Thanjavur, Madurai, Ramanathapuram and Nilgiris districts were found to be more in the post-reform period than pre-reform period. It is also understood that the instability in Paddy production in South Arcot, North Arcot, Pudukkottai, Tirunelveli and Kanniyakumari districts were lower in the Post-reform period than the pre-reform period. The instability in Paddy production was almost the same in both the pre and post reform periods in Chengalpattu district.

As far as the yield of paddy in Tamil Nadu is concerned, the coefficient of variation is lower in post-reform period (13.04%) than the pre-reform period (21.3%). It is clear from the Table 5.18 that the instability in Chengalpattu, South Arcot, North Arcot, Salem, Dharmapuri, Coimbatore, Periyar, Tiruchirappalli, Pudukkottai, Madurai, Tirunelveli and Kanniyakumari

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districts were very high in the pre-reform period, whereas, it was arrested and reduced in a considerable manner during the post-reform period. At the same time the yield instability was increased during the post-reform period (28.52 per cent) from pre-reform period (19.23 per cent) in Thanjavur district. The remaining two districts viz., Ramanathapuram and The Nilgiris estimated a little bit hikes in their yield instability during the post-reform period.

Part – Iii: Components of Change in Average Production of Paddy

The pure effect of change in the mean yield and change in mean area, the effect of interaction between changes in mean area and mean yield and the change in covariance between area and yield was analyzed by using Hazell's statistical procedure. The decomposition analysis was carried out and the percentage contribution of each component towards the change in average production of Paddy was estimated for each study districts and for the state as a whole.

The results of decomposition of change in the average production of Paddy at the district level into different components have been depicted in Table 5.

Table 5: Components of Change in Average Production of Paddy(in per cent)

Districts	Change in Mean Yield	Change in Mean Area	Interaction between Changes in Mean Yield and Mean Area	Change in Area-Yield Covariance
Chengalpattu	184.68	-60.68	-25.49	1.48
South Arcot	90.75	14.37	2.55	-7.67
North Arcot	133.68	-26.61	-6.01	-1.06
Salem	87.38	5.76	2.25	4.61
Dharmapuri	48.07	37.17	11.97	2.79
Coimbatore	-18.46	111.79	9.71	-3.036
Periyar	541.44	-330.82	-125.08	14.47
Tiruchirappalli	94.8	-0.09	-0.02	5.31
Pudukkottai	133.56	-29.9	-7.5	3.83
Thanjavur	-34.35	145.79	2.78	-14.22
Madurai	467.64	-276.07	-99.12	7.55
Ramanathapuram	145.66	-33.86	-12.2	0.4
Tirunelveli	220.63	-80.28	-37.99	-2.35
The Nilgiris	-2085.57	1211.59	1039.39	-65.41
Kanniyakumari	933.01	-495.14	-322.43	-15.44
State	180.19	-70.04	-16.22	6.07

(Source: Computed)

It is clear from the results provided in the Table 5 that, Kanniyakumari, Periyar, Madurai, Tirunelveli, Chengalpattu, Ramanathapuram, North Arcot, Pudukkottai, Tiruchirappalli, South Arcot, Salem and Dharmapuri districts showed a positive change in mean yield (933.01%, 541.44%, 467.64%, 220.63%, 184.68%, 145.66%, 133.68%, 133.56%, 94.8%, 90.75%, 87.38 and 48.07%) respectively, while the negative change in mean yield showed in Nilgiris (-2085.57%), Thanjavur (-34.35%) and Coimbatore (-18.46%) districts. The Nilgiris, Thanjavur, Coimbatore, Dharmapuri, South Arcot and Salem districts showed the positive change in mean area (1211.59%, 145.79%, 111.79%, 37.17%, 14.37% and 5.76%) respectively, whereas, there was a negative change in mean area in the remaining districts.

The positive contribution was observed from interaction between mean area and yield of Paddy in the Nilgiris (1039.39%), Dharmapuri (11.97%), Coimbatore (9.71%), Thanjavur (2.78%), South Arcot (2.55%) and Salem (2.25%) districts, while the other districts witnessed to negative contribution from interaction between mean area and yield. The change in area-yield covariance was positive in Periyar (14.47%), Madurai (7.55%), Tiruchirappalli (5.31%), Salem (4.61%), Pudukkottai (3.83%), Dharmapuri (2.79%), Chengalpattu (1.48%) and Ramanathapuram (0.4%), while the same was negative in other districts. For the state as a whole, change in mean yield (180.19%) and Change in area-yield covariance (6.07%) was positive. The change in mean area (-70.04%) and the interaction between change in mean yield and area (-16.22%) was observed as negative.

Part – IV: Components of Change in the Variance of Production of Paddy

The change in variance of production of foodgrains was decomposed by using the analytical procedure developed by Hazell (1982). The results of the analysis of Paddy cultivated in Tamil Nadu are presented below.

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Table 6: Components of Change in the Variance of Production of Paddy(in per cent)

District	Change in Mean Yield	Change in Mean Area	Change in Yield Variance	Change in Area Variance	Interaction between Changes in Mean Yield and Mean Area	Change in Area-Yield Covariance	Interaction between Changes in Mean Area and Yield Variance	Interaction between Changes in Mean Yield and Area Variance	Interaction between Changes in Mean Area and Yield and Changes in Area-Yield Covariance	Change in Residual
Chengalpattu	335.67	-63.95	163.73	-202.18	-2.99	107.47	-42.08	-205.58	24.17	-14.26
South Arcot	-39.96	-4.26	6.8	42.45	-0.29	60.53	0.39	16.37	12.81	5.15
North Arcot	-173.09	3.54	-21.09	174.84	0.34	11.22	1.86	87.97	1.93	12.49
Salem	41.97	0.56	10.27	2.99	0.08	29.33	0.54	2.79	12.71	-1.22
Dharmapuri	16.31	4.24	16.69	21.63	0.59	20.74	9.35	16.18	13.73	-19.47
Coimbatore	5.58	-0.9	27.2	16.29	3.85	98.09	-21.09	2.95	-47.31	15.34
Periyar	257	-2.54	-11.5	-127.43	9.18	103.17	4.7	-114.58	6.13	-24.13
Tiruchirappalli	15.44	-0.02	3.67	0.67	0	68.9	0	0.43	19.64	-8.73
Pudukkottai	197.96	-79.11	129.78	-90.04	-4.05	138.49	-14.16	-50.8	25.46	-153.53
Thanjavur	0.24	-3.41	89.18	3.89	-0.01	23.36	-13.85	0.15	-1.49	1.93
Madurai	114.83	-53.06	74.82	-5.53	-7.62	59.42	-28.36	-4.69	4.27	-54.09
Ramanathapuram	20.74	-17.26	138	-3.56	-1.24	1.54	-22.15	-3.02	0.39	-13.45
Tirunelveli	801.89	-177.43	18.44	-77.79	-32.3	-258.48	-5.8	-91.05	-57.04	-20.43
The Nilgiris	13.69	-16.27	125.59	0.81	8.1	50.89	-93.99	1.99	-3.47	12.65
Kanniyakumari	-83.1	61.93	5.8	21.59	13.67	39.38	-3.32	37.28	3.21	3.55
State	14.98	-5.63	53.74	0.95	-0.13	52.81	-9.24	0.49	6.41	-14.38

Source: Computed

The change in mean yield was found positive and very high in Tirunelveli district (801.89%) and negative in North Arcot district (-173.09%). It is observed that the change in mean area was found positive and very high in Kanniyakumari district (61.93%) and the same was negative in Tirunelveli district (-177.43%).

Chengalpattu district registered the highest change in yield variance (163.73%) and North Arcot district registered the highest change in area variance (174.84%). It is also observed from the Table 5.36 that change in area-yield covariance was positive in all the districts except Tirunelveli (-258.48%) district.The interaction between changes in mean area and yield variance was positive in Dharmapuri (9.35%), Periyar (4.7%), North Arcot (1.86%), Salem (0.54%) and South Arcot (0.39%) districts, while the same was negative in all other districts. The change in residual was positive in Coimbatore (15.34%), Nilgiris (12.65%), North Arcot (12.49%), South Arcot (5.15%), Kanniyakumari (3.55%) and Thanjavur (1.93%) districts, while the same was negative in all other districts.

The variance in production of Paddy for the state as a whole was predominantly due to the change in yield variance (53.74%) followed by the change in area-yield covariance (52.81%), change in mean yield (14.98%), interaction between changes in mean area and yield and changes in area-yield covariance (6.41%) and change in area variance (0.95%). The change in residual, interaction between changes in mean area and yield variance, and the change in mean area were observed negative.

Conclusion and Policy Implications

The compound growth rate for area under Paddy cultivation in Tamil Nadu gets shrinking during the study period particularly after the introduction of new economic reforms. The study also found a decline in the growth rate of production and yield of Paddy.The study also concludes that there persist huge increase in the instability of area, production and yield of almost all the districts studied over the review period. Paddy cultivation in the post-reform period remained more unstable as compared to the pre-reform period. The results of the decomposition analysis revealed that the change in mean production of Paddy was mainly due to the change in mean yield.

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In the view of the above findings following suggestions are recommended for suitable policy formulations.

- Supply of land resource is limited in nature. To meet the future increased demand for foodgrains, the productivity should be boosted up by adoption of improved technologies like hybrid varieties cultivation.
- Long-term investments should be encouraged and boosted up to bring the uncultivated barren and waste lands under the plough.
- Programmes should be undertaken to evolve specific varieties to suit the soil and climatic conditions so as to derive better yields.
- Site specific techniques depending on the type of soil and pattern of rainfall have to be increasingly made familiar with the farmers.
- Packages for efficient water harvesting technology should be adopted for getting maximum benefit from the available water resources.
- The production and distribution of seed of improved varieties need to be paid special attention to bring stability in production.
- Expansion of area under irrigation, development of watershed and development of varieties resistant to insects, pests and climate stress are the other major factors for reducing variability in area, production and yield.
- There is also a need for large scale promotion of stabilization measures like crop insurance to face the consequences of production fluctuations.
- Farmers should be encouraged to use appropriate amounts of inputs like fertilizers, improved seeds, pesticides and water.
- The technological innovations so far generated by the institutions and agencies for improving the agriculture production should be transferred to the farmers by extension programmes.

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