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*Full Length Research Paper*

# Welfare enhancing growth rates in food grains production: A district level comparison of an Indian state

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**Maharastra is one of the progressive states in India but it has been reported to be a deficit state for long when one considers to major pursuit of economic activity, which is agriculture. In the present study, an attempt has been made to analyze welfare aspect of growth performance of agriculture of the Maharastra State for the period from 1970/71 to 2005/06 by using Kakwanie's (1997) growth parameters. Based on aggregated district level data on area, production and yield of food grains, the study reveals considerable variations in district wise growth rates. For the overall period of study, food grains production in most of the districts of the State recorded a deceleration of growth in respect to all agrarian parameters. A periodisation analysis as suggested by Kakwani (1997) concludes that the growth performance in Mahasrastra agriculture is highly unequal. The new policy changes have failed to bring about a shift in this pattern so as to enhance the economic wellbeing of the people.**

**Key words:** Agricultural growth, welfare, underdeveloped economy, growth diversity, Kakwani's growth parameters.

## INTRODUCTION

Relation between growth and welfare is an old one. In the early writings of classical economists, growth has been repeatedly emphasized as enhancing welfare of a nation. The relation is reemphasized in the neoclassical version of modern growth theory as well its modern version in endogenous growth theory. The concept of optimal growth is an integral part of the growth literature. This relation between growth and welfare can be extended to agriculture (Sengupta et al., 2004).

The existing empirical literature in India mainly focused on studying the secular time trend of the growth rate for different regions in India/for India as a whole (Bhalla and Alagh, 1979: Bhalla and Singh, 1997, Bhalla and Singh, 2001). Various authors also give different quantitative assessment of the contribution of various factors of growth of crop output at the state or regional level (Singh, 1981; Cauvery, 1991; Ranande, 1980). Most of the researchers have used standard curve fitting techniques to study the performance of agriculture (Chattopadhyay et al., 1993; Sen and Sengupta, 1995; Saha and Swaminathan, 1994; Rawal and Swaminathan, 1998; Chattopadhyay and Das, 2000). The use of these techniques was criticized recently by some authors and applied some modern time series techniques developed in the last two decades to study the performance of an Economy (Mukhopadhyay and Sarkar, 2001). However, all these methodologies have failed to capture the possible welfare implications in the growth process in agriculture. We propose to introduce the relation between agrarian growth and welfare in India in the context of Maharastra agriculture following the technique developed by Kakwani (1997)[1].

### CONCEPTUAL FRAMEWORK AND METHODOLOGY

Let $x = (x_1, x_2, ....., x_n)$ be the vector of values of an

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[1] Kakwani Explores the relationship between growth rates and changes in welfare using alternative procedures for measuring growth.

economic indicator given the second period for n periods. Then the least-squares growth rate R is estimated by the logarithmic transformation of the compound growth rate equation

$$x_t = x_1(1+R)^{t-1} \quad \text{.....} \quad (1)$$

If $\alpha = \log x_1 - \log(1+R)$ and $\beta = \log(1+R).$ then Equation (1) is motivated to

$$\log x_t = \alpha + \beta t + u_t \quad \text{.....} \quad (2)$$

Where t varies from 1 to n. $\alpha$ and $\beta$ is the parameters to be estimated and $u_t$ is assumed to be the white noise error term. Kakwani (1997) defined the overall growth rate $R_t$ (defined as Least square Growth Rate -LSGR) is a function of period wise growth rate ( $r_t$ ). Where

$$r_t = \frac{x_t - x_{t-1}}{x_{t-1}}, \qquad t = 2,3,.....,n \quad \text{.....} \quad (3)$$

If $\hat{\beta}$ is the least-squares estimate of $\beta$, the estimated growth rate $\hat{R}$ is obtained as antilog $(\hat{\beta}) - 1$ and it can be shown that

$$\hat{\beta} = \log(1+\hat{R}) = \sum w_t \log(1+r_t) \quad \text{.....} \quad (4)$$

where $w_t = \frac{6(t-1)(n+1-t)}{n(n+1)(n-1)}$.

This type of growth rate gives maximum weight to the growth rates at the middle of the time period. The lower weights are given to the growth rates at the beginning and at the end of the time period. However such a weighting scheme is not justified. By alternative specifications of $w_t$, Kakwani (1997) devised a host of other growth rates ( $w_t = \frac{1}{n-1}$ ) giving geometric mean growth rate (GMGR), by suitable restriction of $w_t$ restricted least square growth rate (RLSGR), an alternative weighting scheme in which $w_t$ is a monotonically increasing function of t to give increasing weight growth rate (IWGR),and arithmetic mean growth rate (AMGR)). In all the cases $\sum_{t=1}^{n} w_t = 1$. Kakwani (1997) clearly showed that none of the mechanical procedures for computing average growth rates are appropriate from the welfare point of view.

However it is difficult to choose between these growth rates. An ideal way is to specify a social welfare function and to derive an appropriate growth rate from it by introducing certain axioms.

**Axiom 1: (Monotonocity)** W(x) should be strictly increasing in each argument, that is $\partial W / \partial x_i > 0$ for all i=1, 2…n. It implies that if any one of the arguments tends to increase (or decrease) while the other remains constant, social welfare should improve (or deteriorate).

**Axiom 2: (symmetry)** W(x) = W(Π(x)) where Π(x) is any permutation of x. This implies a symmetric welfare function. In the time series analysis, this implies that the same weight is given to the agrarian parameters irrespective of the year in which they are generated. According to Kakwani (1997), this requirement of social welfare function is natural particularly when a reasonable justification of non symmetric welfare function does not exit.

**Axiom 3: (Correspondence)** If R and $R^*$ are the aggregate growth rates computed from the income streams x and $x^*$ respectively, the following arguments are equivalent:

1. $R \geq R^*$ and
2. $W(x) \geq W(x^*)$

It implies that higher growth rate is always superior. These were obviously true in Kakwani's case. In the exercise of this article also, an improvement of either of the agrarian parameters, should enhance welfare. Given this social welfare function, the concept of equivalent uniform growth rate (R) is introduced. This is the constant growth rate that would result in the same level of welfare as per the observed value of x in n years. In other words, R would give the same welfare as can be obtained from the observed value of x.

Kakwani shows that if W is assumed to be homothetic then R is a function of period-wise growth rate r. then R can be derive directly from a welfare function. This R is scale independent. Again if W satisfies Monotonocity and symmetry, then R derives from such a W will satisfy the axiom of correspondence. This formulation suggests that all procedures for estimating growth rates rely on an implicit welfare function. An evaluation of alternative growth procedures is made by examining these implicit welfare functions. Considering a more specific functional form,

$$W = \sum_{t=1}^{n} v_t \log x_t \quad \text{.....} \quad (5)$$

With $\sum v_t = 1$, it is possible to derive the following relation:

$$\log(1+R) = \sum_{t=2}^{n} w_t \log(1+r_t) \text{ where, } w_t = \sum_{j=t}^{n} v_t \Big/ \sum_{t=2}^{n} (t-1) v_t \quad \text{.....} \quad (6)$$

such that

$\sum w_t = 1$

Thus, the functional relation conceived in (3) is essentially a formula for equivalent growth rates. All the growth rates except AMGR fall under this category. For AMGR, the form of w is different. However, as argued by Kakwani (1997), this growth rates failed to satisfy the welfare axioms. The LSGR demonstrates the possibility of an inverse relationship between aggregate growth rate and aggregate welfare. It violates all the axioms. GMGR violate Axiom1, (that is, minimum requirement of welfare function). Since RLSGR gives least weight to the utility enjoyed to the beginning of the period and the largest weight to the utility in most recent year, thus it violates Axiom 2. The IWGR procedure implies that only the utility in the most recent year receive a positive welfare weight. This violates all three axioms. The AMGR procedure implies an inverse

**Table 1.** Characteristics of districts with negative growth rate.

| Variables | Number of districts with negative growth rates | | | | |
|---|---|---|---|---|---|
| | LSGR | GMGR | RLSGR | IWGR | AMGR |
| Area | 15 | 10 | 5 | 17 | 7 |
| Production | 0 | 2 | 0 | 8 | 0 |
| Yield | 0 | 1 | 1 | 8 | 0 |

relationship between the average aggregate growth rate and aggregate welfare, which violate Axiom 3. Thus, he derives a new growth rate that satisfies all the axioms that we term as Kakwani welfare growth rate (KWGR):

$$\log[1+KWGR(s)] = \sum_{t=2}^{n} w_t(s)\log(1+r_t) \quad \text{.....} \quad (7)$$

Where s is the focal point lying between 1 and n. KWGR is calculated with reference to s. The following conditions were derived by Kakwani (1997) from Equation (7).

$$w_t(s) = \frac{-2(t-1)}{n(n+1-2s)} \quad 2 \le t \le s = \frac{2(n-t+1)}{n(n+1-2s)} \quad t > s \text{ ……..} \quad (8)$$

When s=1,

$$w_t = \frac{2(n-t+1)}{n(n-1)} \quad (9)$$

The corresponding KWGR is the KWGR at the initial period this is comparable with RLSGR. Similarly, when s = n,

$$w_t(n) = \frac{2(t-1)}{n(n-1)} \quad (10)$$

This gives KWGR at the end period. It is comparable with IWGR. This equation was denoted by Kakwani (1997) as a welfare improving growth rate. According to him, this could be better understood if a period-wise growth analysis was undertaken.

Kakwani (1997) however, felt that in the periodisation analysis, the standard technique of calculating growth rates for different sub periods of a given length of time often suffers from the problem of discontinuity. To overcome this problem, he assumed a two period set up such that the growth equations for the two periods would be:

$$x_t = x_t(1+R_t)^{t-1} \text{ if } t \le n = x_t(1+R_1)^{n-1}(1+R_2)^{t-n_1} \text{ if } t \le n_1 \quad \text{……} \quad (11)$$

Where, $R_1$ and $R_2$ are the growth rates in two periods each having a length of $n_1$ and $(n - n_1)$ respectively. Kakwani (1997) provided a system of equations to estimate $R_1$, R2, and R (the overall growth rate). From the above discussion, it is clear that Kakwani (1997) considered a number of alternative growth measures based on appropriate restrictions on the weights. Since different measures are used to measure different growth rates, their ranking should obviously be different, except in the case of relative stagnancy (Sengupta et al., 2004). For example, if there were differences between IWGR and RLSGR, it would signify that the particular state has experienced either acceleration or deceleration in the growth rates for the time period under consideration. However, the end point comparison based on the KWGR method should be more meaningful from the point of social welfare. We may now turn to the data used in our analysis. Crop wise data on area production and yield of food grains of the districts of Maharastra are obtained from Statistical Abstract of Andhra Pradesh published by government of Maharastra. We have taken into account those crops which are more or less widely cultivated in all the regions of Maharastra. It is true that commercial crops (such as jute, sugarcane, and cotton) are important ingredients of modern Indian agriculture. However these crops are area specific. This requires analysis of a kind which is not very suitable for the present purpose. In this present case, we intend to understand the complexity of the growth patterns that affect more or less all the regions of India. Moreover a longer time series data is not available for the remaining crops other then food grains that we had considered in the present exercise.

In our analysis, we first computed different types of growth rates: LSGR, GMGR, RLSGR, AMGR, IWGR, KWGR (initial period), and KWGR (end period), describe earlier, for area, production and yield of total food grains for the districts of Maharastra during the period 1970/71 to 2005/2006. The entire period is then subdivided into two sub periods: 1970/71 to 1990/91 and 1991/92 to 2005/06. The first period is pro-liberalization period and the second period captures the impact of liberalization.

## Growth analysis

Since growth is a multifaceted concept, we would like to study the pattern of growth from two perspectives. We first concentrate on the dynamics of growth as illustrated by the major types of growth rates envisaged by Kakwani (1997). We then move on to the sub-period growth analysis. We first compare average growth rates of area, production and yield of food grains computed by the alternative procedures. Detailed of the numerical results are presented in Table A1. We summarize the performances of the districts in Table 1.

Our result show that the growth rates computed by the alternative procedures vary substantially for a large number of districts. A negative growth rate in respect of all alternative procedure is visible only in case of area expansion. However in case of production and yield upgradation, there is not a single district which show negative growth rate in respect of all alternative procedures. This proves that the State has considerable technical improvement even though production may some time fail to respond due to the slack in area expansion. The results also report that the number of district that had negative growth rate vary depending on which procedure is used to compute growth rate. RLSGR yields smallest number of such district, IWGR largest. This would signify that the State has experience a deceleration in the growth rates in the time period under consideration.

In order to bring out the nature of growth performance more clearly, we provide the ranking of district according to the alternative growth procedure in Table A2. From the overall ranking, we derived the growth performance of districts into four categories: Consistent performer,

**Table 2.** Growth performance of the districts of Maharashatra.

| Variables | Consistent performer | Catching up | Consistent laggard | Falling behind |
|---|---|---|---|---|
| Area | AHM,OSM | THA,DHU,SAT,SAN,SHO PAR,VHI,NAN,BUL,BHA | WAR,NAG, | RAI,RAT,NAS,JAL,POO,KOL,AUR AKO,AMR,YEO,CHA |
| Production | | THA,RAI,RAT,,NAS,DHU,AHM, POO,SAT,SAN,SHO,KOL, | WAR,BHA | JAL,AUR,PAR,BHI,NAN, OSM,BUL,AKO,AMR,YEO, NAG,CHA. |
| Yield | | THA,RAI,RAT,NAS,AHM,POO, SAT,SAN,KOL,AUR, | | DHU,JAL,SHO,PAR,BHI,NAN, OSM,BUL,AKO,AMR,YEO,WAR, NAG, BHA, CHA. |

THA: Thana; RAI: raigard RAT:Ratnagiri; NAS:Nasik; DHU:Dhulia; JAL:Jalgaon; AHM:ahamednagar; POO:Poona; SAT:Satara; SAN:sangli; SHO:Sholapur; KOL:Kolhapur; AUR:Aurangabad; PAR:Parbhani; BHI:Bhir; NAN:Nanded; OSM:Osmanabad; BUL:Buldana; AKO:Akola; AMR:Amraboti; YEO:Yeotmal; WAR:Wardha; NAG:Nagpur; BHA:Bhandra; CHA:Chandrapur.

**Table 3.** Rank correlation test showing relative stagnancy of the variables during 1970-71 to 2005-06.

| Crop/growth rate | Area | | Production | | Yield | |
|---|---|---|---|---|---|---|
| | IWGR-RLSGR | KWGR(B)-KWGR(E) | IWGR-RLSGR | KWGR(B)-KWGR(E) | IWGR-RLSGR | KWGR(B)-KWGR(E) |
| Foodgrains (n=25) | .583* | 0.530** | 0.472** | 0.412* | 0.120 | 0.019 |

,**implies significance at 1%level.*implies significant at 5% level.

consistent laggard, falling behind and catching up. The interesting thing to note is that the growth pattern of area production and yield of food grains varies across districts. Ahmednagar and Usmanabad is the leader in respect of area expansion however their position as leaders of production and yield of food grains are questionable. Although the rank of districts defer according to the alternative growth rate, we examine the nature of growth performance of different districts according to the rank of RLSGR and IWGR. If the rank of any district remains same according to these two Alternative growth procedure (when the rank will be less than 12) then that district will be treated as consistent performer and consistent laggard (when the rank will be greater than 12). Similarly a district is said to be catching up (falling behind) if the rank of RLSGR greater than IWGR (RLSGR less than IWGR). The results are presented in the Table 2.

While the findings presented in Table 2 reflect the catching up of some districts, some others are falling behind. Thus we can not speak of any general convergence. In order to test the above conjecture statistically, we used the rank correlation test as suggested by Kakwani (1997). If the test statistic is found to be significant, it is argued that the ranking according to the rival growth rates differ. Since IWGR gives greater weight to the end period while RLSGR to the beginning period, any significant difference between these two indicates that the growth pattern has shifted. Similarly comparison is made with respect to KWGR (beginning) and KWGR (end). Table 3 present the result of our analysis.

It is seen that the growth satisfies the stagnancy hypothesis in respect of yield of food grains. In fact there appears to be no major shifts among the districts in terms of the ranking based on IWGR and RLSGR criteria. Incorporating welfare criterion advanced by Kakwani (1997), the same conclusion can be drawn. Welfare enhancing growth is observed only in the case of growth of area and production of food grains. However, no such change is observed in case of growth of yield of food grains. Since these various growth rates indicate different weight structures, there inclusion indicates that the special variations of food grains cultivation in respect of yield upgradation do not offer much of a change during the span of 36 years. In other wards, no welfare enhancing growth is observed in case of yield upgradation. Next, we consider the temporal fluctuations of growth rates from which acceleration or deceleration of growth of the crops in different districts of Maharastra can be visualized. Our results are summarized in Table 3.

Table 4 clearly indicates that very few districts have shown acceleration in expansion of area, production and productivity of frood grains. This pattern of performances

**Table 4.** Showing the position of the State according to the acceleration/deceleration of growth rates of food grains during 1970/71 to 2005/06.

| Acceleration (IWGR>RLSGR) | | | Deceleration (IWGR<RLSGR) | | |
|---|---|---|---|---|---|
| **Area** | **Production** | **Yield** | **Area** | **Production** | **Yield** |
| SAT, SAN, SHO, PAR BUL, BHA, | SAN, | THA, AHM, | THA, RAI, RAT, NAS, DUL, JAL, AHM, POO, KOL, AUR, BHI, NAN, OSM, AKO, AMA, YEO, WAR, NAG, CHA | THA, RAI, RAT, NAS, DUL, JAL, AHM, POO, SAT, SHO. KOL, AUR, PAR, BHI, NAN, OSM, BUL, AKO,AMA, YEO, WAR, BHA, NAG, CHA | RAI, RAT, NAS, DUL, JAL, POO, SAT,SHO. KOL,AUR, PAR, BHI, NAN, OSM, BUL, AKO, AMA, YEO, WAR, BHA, NAG, CHA |

of the productivity of food grains in districts of Maharastra is attributed with the law of diminishing return where further growth would call for organizational reforms. There is an ongoing debate about the acceleration in the growth of major agricultural crops in the aftermath of the institutional changes brought about in the eighties. The present study using a different kind of methodology support the view that there is no substantial break has taken place in the growth of agriculture in Maharastra.

### *Sub period growth rates*

To analyze the period wise variations of growth rates of food grains of the districts of Maharastra, the entire time period was subdivided into two sub periods aforementioned, viz., 1970/71 to 1990/91 and 1991/92 to 2005/06, to examine whether any kind of break is statistically valid or not. It may be argued that while the process of globalization has been pronounced in the nineties, the period from 70's were marked by the implementation of new technologies in agriculture. This periodisation is rough and not exact. Like all break point analysis, our choice of break year is arbitrary. However, it represents a realistic turning point in government policy and the emergence of new concepts of development and growth.

Table 5 shows that there has been a marked difference between the two sub periods in the growth rates of all the variables under study, for all the districts in Maharastra. It will now be interesting to provide the ranking of different districts in terms of the changes taking place between the two sub periods. We present the results in Table 6

From the overall ranking, we describe the performance of districts into three categories: Districts which improve their position (catching up), districts which decrease their position, and the districts whose position remains constant. The performance of the districts are shown in the Table 7

Table 7 clearly indicates that there are large numbers of districts which substantially improve their position in respect of all the agrarian parameters. It implies that there seems to be a catching up effect in operation, with regard to the relative status of these laggard districts in terms of agricultural performance. In fact, these relatively less developed districts eventually are gaining access to the new technologies, particularly tube well irrigation, high yield variety (HYV) seed and chemical fertilizers, thereby improving their performance in agriculture. Statistically speaking, these changes are Insignificant as may be seen from Table 8 that shows insignificant rank ordering differences in the rank correlation test.

The relative positions of the districts are now shown in terms of deceleration/ acceleration criteria of growth rates during the two sub periods. The findings are presented in Table 9.

It is seen from Table 9 that there appears to be a mark differences in the growth pattern of food grains in terms of area, production and yield. A sharp rise in the growth of area of food grains is observed in a few districts however most of the districts show deceleration during 1991-2006 compares to the earlier ones. Thus the popular belief that the imposition of new economic policies in nineties succeeded the agricultural growth in Maharastra seems to be far from true. These findings are same with the deceleration/acceleration hypothesis as revealed by the comparison between IWGR and RLSGR (Table 3). Although, the positions of individual districts are changed, it may be seen that there appears to be same conclusion between Tables 4 and 9. In general, fewer districts appear to be accelerating according to either sub period comparison, or IWGR-RLSGR comparison.

The theoretical basis of these two types of comparison is rather arbitrary. It depends on the choice of the break point that is rather arbitrary depending only on some indirect empirical realities. Kakwani (1997) utilized this criterion to test the relative convergence of various countries. This article, however, puts forward the viewpoint that the IWGR-RLSGR comparison may be better, considering that it is free of any arbitrary break point. Rather, it depends only on the nature of the annual growth rates ($r_t$). In spite of this, there is a sizable number of states whose position remains unchanged according to either criterion. Another interesting trend seems to be the increase in the number of negative growth rates in period II than period I (Table 10) for production and yield of food grains. This trend once again supports the view that the

**Table 5.** Period wise growth rate of food grains based on LSGR.

| District | Period I | | | Period II | | | Overall | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | P | Y | A | P | Y | A | P | Y |
| Thana | 0.50 | 1.37 | 0.86 | -1.18 | 0.05 | 1.24 | -0.12 | 1.19 | 0.50 |
| Raigad | 1.13 | 2.54 | 1.39 | -1.37 | -0.15 | 1.24 | -0.16 | 1.49 | 1.13 |
| Ratnagiri | 0.56 | 3.42 | 2.84 | -1.59 | 0.54 | 2.17 | -0.39 | 2.27 | 0.56 |
| Nasik | 0.92 | 3.86 | 2.91 | -1.29 | 0.14 | 1.45 | -0.13 | 2.29 | 0.92 |
| Dhulia | 0.80 | 4.58 | 3.75 | -0.63 | 0.32 | 0.96 | -0.16 | 2.39 | 0.80 |
| Jalgaon | 1.41 | 5.98 | 4.51 | -2.19 | -2.00 | 0.19 | -0.35 | 2.59 | 1.41 |
| Ahmednagar | 4.71 | 3.53 | -1.13 | -0.96 | -2.98 | -2.04 | 0.63 | 1.79 | 4.71 |
| Poona | 1.73 | 4.52 | 2.74 | -1.85 | -1.13 | 0.73 | 0.41 | 1.91 | 1.73 |
| Satara | 0.98 | 5.09 | 4.07 | -1.52 | -0.51 | 1.03 | -0.13 | 2.34 | 0.98 |
| Sangli | 0.74 | 4.83 | 4.05 | -1.19 | -2.61 | -1.44 | 0.12 | 2.09 | 0.74 |
| Sholapur | -0.89 | 1.62 | 2.53 | -0.28 | -4.22 | -3.96 | -0.83 | 0.98 | -0.89 |
| Kolhapur | 1.35 | 4.49 | 3.10 | -1.07 | -0.70 | 0.37 | -0.29 | 1.70 | 1.35 |
| Aurangabad | 1.73 | 6.45 | 4.64 | -0.71 | 1.79 | 2.52 | 0.49 | 4.18 | 1.73 |
| Parbhani | 0.46 | 4.79 | 4.31 | 1.44 | 0.61 | -0.82 | 0.33 | 3.13 | 0.46 |
| Bhir | 1.46 | 4.17 | 2.67 | -0.08 | -0.78 | -0.70 | 0.39 | 2.01 | 1.46 |
| Nanded | 4.28 | 4.36 | -0.07 | 0.24 | 0.38 | 0.14 | -0.30 | 2.67 | 4.28 |
| Osmanabad | 1.00 | 4.59 | 3.55 | 1.97 | 0.83 | -1.11 | 0.72 | 2.60 | 1.00 |
| Buldana | 0.16 | 5.55 | 5.38 | -0.14 | -1.19 | -1.05 | 0.09 | 2.24 | 0.16 |
| Akola | 1.56 | 6.16 | 4.53 | -1.21 | -2.17 | -0.97 | 0.72 | 3.25 | 1.56 |
| Amravati | 1.97 | 5.82 | 3.78 | -0.99 | -2.11 | -1.13 | 0.40 | 1.98 | 1.97 |
| Yeotmal | -0.06 | 4.07 | 4.14 | -1.79 | -3.60 | -1.85 | -0.27 | 1.22 | -0.06 |
| Wardha | -1.05 | 2.45 | 3.54 | -2.43 | -0.56 | 1.91 | -1.74 | 0.11 | -1.05 |
| Nagpur | -0.23 | 3.64 | 3.87 | -2.47 | -2.22 | 0.25 | -1.74 | 0.07 | -0.23 |
| Bhandara | -0.86 | 1.26 | 2.13 | -0.08 | -0.65 | -0.57 | -0.53 | 1.08 | -0.86 |
| Chandrapur | 0.06 | 2.02 | 1.96 | -1.73 | -2.24 | -0.52 | -0.65 | 0.65 | 0.06 |

effects of new technology on the growth of agricultural output vary from one region to another, and it will be misleading to treat specific effects as if they are the same everywhere.

From the above analysis, it is clear that the increase in the growth of agricultural production over time has not been possible in many districts of Maharastra, mainly because of the sharp diminishing rate of growth of the cropped area. In fact, the growth of the yield which has been the striking feature in the post green revolution period , has not been so helpful in raising the growth of production due to the higher diminishing rate of growth of cropped area. Thus following Kakwani's interpretation, it appears that welfare enhancing growth, by and large, has failed in the case of Maharastra agriculture.

The periodisation analysis presented above also supports the hypothesis of uneven growth among the major districts of Maharastra in terms of growth dynamics. Interestingly, it is observed that the deceleration in the growth of food grains had taken place during the period concerned. In fact, it appears that the relative position of the districts have undergone substantial changes with respect to area expansion, yield improvement and output increment for food grains, irrespective of any time series break.

## Conclusions

Our analysis based on Kakwani's measures, yield some interesting results. First the result based on different types of growth rates allows us to reject the hypothesis that the rate of growth of agriculture for different district of Maharastra has been highly equal. This has not been possible only because of the diminishing rate of growth of the cropped area. Second, our study reveals a relative stagnation that implies a relative stability in the ranking of districts during 1971 to 2006. It indicates that contrary to the popular belief of the neo classical growth school, there is no perceptible convergence in the growth of productivity or output of agricultural products across the different districts of Maharastra. Third, some changes in the growth of agricultural productions during the pre and post liberalization periods are observed. However these changes have not been helpful to bring about a change in the long term perspective. Fourth, some kind of regional disparities are observed in the growth of output of food grains between the so called developed and laggard

**Table 6.** Period wise ranking of districts for food grains based on LSGR.

| District | Period 1 | | | Period 2 | | | overall | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | P | Y | A | P | Y | A | P | Y |
| Thana | 17 | 24 | 23 | 13 | 8 | 5 | 11 | 20 | 24 |
| Raigad | 10 | 20 | 22 | 17 | 9 | 6 | 14 | 18 | 17 |
| Ratnagiri | 16 | 19 | 16 | 19 | 4 | 2 | 20 | 10 | 5 |
| Nasik | 13 | 16 | 15 | 16 | 7 | 4 | 12 | 9 | 9 |
| Dhulia | 14 | 10 | 11 | 8 | 6 | 8 | 15 | 7 | 6 |
| Jalgaon | 8 | 3 | 4 | 23 | 17 | 12 | 19 | 6 | 3 |
| Ahmednagar | 1 | 18 | 25 | 10 | 23 | 24 | 3 | 16 | 25 |
| Poona | 4 | 11 | 17 | 22 | 15 | 9 | 5 | 15 | 21 |
| Satara | 12 | 6 | 7 | 18 | 10 | 7 | 13 | 8 | 8 |
| Sangli | 15 | 7 | 8 | 14 | 22 | 22 | 9 | 12 | 12 |
| Sholapur | 24 | 23 | 19 | 7 | 25 | 25 | 23 | 22 | 16 |
| Kolhapur | 9 | 12 | 14 | 12 | 13 | 10 | 17 | 17 | 11 |
| Aurangabad | 5 | 1 | 2 | 9 | 1 | 1 | 4 | 1 | 1 |
| Parbhani | 18 | 8 | 5 | 2 | 3 | 17 | 8 | 3 | 4 |
| Bhir | 7 | 14 | 18 | 4 | 14 | 16 | 7 | 13 | 19 |
| Nanded | 2 | 13 | 24 | 3 | 5 | 13 | 18 | 4 | 2 |
| Osmanabad | 11 | 9 | 12 | 1 | 2 | 20 | 1 | 5 | 14 |
| Buldana | 19 | 5 | 1 | 6 | 16 | 19 | 10 | 11 | 10 |
| Akola | 6 | 2 | 3 | 15 | 19 | 18 | 2 | 2 | 7 |
| Amravati | 3 | 4 | 10 | 11 | 18 | 21 | 6 | 14 | 20 |
| Yeotmal | 21 | 15 | 6 | 21 | 24 | 23 | 16 | 19 | 22 |
| Wardha | 25 | 21 | 13 | 24 | 11 | 3 | 25 | 24 | 13 |
| Nagpur | 22 | 17 | 9 | 25 | 20 | 11 | 24 | 25 | 15 |
| Bhandara | 23 | 25 | 20 | 5 | 12 | 15 | 21 | 21 | 18 |
| Chandrapur | 20 | 22 | 21 | 20 | 21 | 14 | 22 | 23 | 23 |

**Table 7.** Growth performance of the districts of Maharastra during 1970-2006.

| Variables | Improve | Decrease | Constant |
|---|---|---|---|
| Area | THA, DHU, SAN, SHO, PAR, BHI, OSM, BUL, WAR, BHA, | RAI, RAT, NAS,JAL, AHM, POO,SAT, KOL, AUR, NAN, AKO, AMR, NAG | YEO, CHA |
| Production | THA, RAI, RAT, NAS, DHU, PAR, NAN, OSM, WAR, BHA, CHA | JAL, AHM, POO, SAT, SAN, SHO, OL, BUL, AKO, AMR, YEO, NAG | AUR, BHI |
| Yield | THA, RAI, RAT, NAS, DHU, AHM, POO, KOL, AUR, BHI, NAN, WAR, BHA, CHA. | JAL, SAN, SHO, PAR, OSM, BUL, AO, AMR, YEO, NAG | SAT |

**Table 8.** Rank correlation (periodisation) showing rank ordering differences among the districts of Maharastra State.

| | Area | Production | Yield |
|---|---|---|---|
| Food grains | 0.187 | 0.121 | -0.06 |

**Table 9.** The Position of the districts according to the acceleration\deceleration of growth rates of foodgrains during 1970/71 to 2005/06.

| Acceleration (growth I < growth II) | | | Deceleration (growth-I > II) | | |
|---|---|---|---|---|---|
| **Area** | **Production** | **Yield** | **Area** | **Production** | **Yield** |
| PAR, OSM, BHA | | THA | THA,RAI,RAT,NAS, DUL,JAL,AHM,POO,SAT,SAN, SHO.KOL,AUR,BHI,NAN,BUL, AKO,AMA,YEO,WAR, NAG,CHA | THA,RAI,RAT,NAS,DUL,JAL,AHM,POO,SAT,SAN,SHO.KOL,AUR,PAR,BHI,NAN,OSM,BUL,AKO, AMA,YEO,WAR,BHA,NAG,CHA | RAI,RAT,NAS,DUL,JAL,AHM,POO,SAT,SAN, SHO.KOL,AUR,PAR,BHI,NAN,OSM,BUL,AKO,AMA,YEO,WAR,BHA,NAG,CHA |

**Table 10.** Districts showing positive and negative growth of acreage, production and yield of food grains by sub periods.

| | Period I | | Period II | | Overall | |
|---|---|---|---|---|---|---|
| **Variables** | **Positive** | **Negative** | **Positive** | **Negative** | **Positive** | **Negative** |
| Area | 20 | 5 | 3 | 25 | 10 | 15 |
| Production | 25 | 0 | 8 | 17 | 25 | 0 |
| Yield | 23 | 2 | 13 | 12 | 20 | 5 |

districts of Maharastra.

On the basis of the forgoing discussion, the following conclusions are deducted: The growth of agriculture in Maharastra over the last 35 years had been highly unequal. The less developed districts suffered a greater decline in their agricultural performance than the few advanced districts. The new agricultural technologies as well as liberalization policies have not been in any case more effective for enhancing welfare oriented growth for the districts of Maharastra.

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## Appendix

**Table A1.** Growth rates of food grains in different district of Maharastra (1970-2006).

| District | LSGR | GMGR | RLSGR | AMGR | IWGR | KWGRI | KWGRE |
|---|---|---|---|---|---|---|---|
| Thana | -0.12 | -0.18 | 0.05 | -0.08 | -0.44 | 0.11 | -0.46 |
| Raigad | -0.16 | -0.04 | 0.44 | 0.01 | -0.70 | 0.66 | -0.73 |
| Ratnagiri | -0.39 | -0.24 | 0.23 | -0.18 | -0.89 | 0.46 | -0.93 |
| Nasik | -0.13 | 0.29 | 0.80 | 0.53 | -0.49 | 1.13 | -0.54 |
| Dhulia | -0.16 | 0.18 | 0.36 | 0.36 | -0.17 | 0.55 | -0.19 |
| Jalgaon | -0.35 | 0.34 | 0.86 | 0.63 | -0.56 | 1.30 | -0.61 |
| Ahmednagar | 0.63 | 3.41 | 5.24 | 30.13 | 0.19 | 6.92 | 0.01 |
| Poona | 0.41 | 0.49 | 0.99 | 2.37 | -0.17 | 1.20 | -0.21 |
| Satara | -0.13 | 0.29 | 0.15 | 1.27 | 0.32 | 0.25 | 0.32 |
| Sangli | 0.12 | 0.56 | 0.21 | 2.04 | 0.87 | 0.24 | 0.89 |
| Sholapur | -0.83 | -0.36 | -0.51 | -0.10 | -0.33 | -0.39 | -0.33 |
| Kolhapur | -0.29 | 0.17 | 0.42 | 0.31 | -0.30 | 0.67 | -0.33 |
| Aurangabad | 0.49 | 0.72 | 1.27 | 1.17 | -0.05 | 1.54 | -0.09 |
| Parbhani | 0.33 | 0.86 | 0.73 | 1.01 | 0.84 | 0.87 | 0.84 |
| Bhir | 0.39 | 0.45 | 0.73 | 2.46 | 0.09 | 0.85 | 0.07 |
| Nanded | -0.30 | -0.01 | 0.01 | 0.07 | -0.14 | 0.12 | -0.15 |
| Osmanabad | 0.72 | 1.33 | 1.29 | 1.56 | 1.18 | 1.48 | 1.17 |
| Buldana | 0.09 | 0.54 | 0.45 | 2.08 | 0.51 | 0.58 | 0.50 |
| Akola | 0.72 | 0.69 | 1.22 | 0.81 | 0.03 | 1.40 | -0.01 |
| Amravati | 0.40 | 0.55 | 1.01 | 0.64 | -0.08 | 1.22 | -0.11 |
| Yeotmal | -0.27 | -0.51 | 0.08 | -0.43 | -1.18 | 0.20 | -1.22 |
| Wardha | -1.74 | -1.17 | -1.05 | -1.10 | -1.50 | -0.81 | -1.52 |
| Nagpur | -1.74 | -1.03 | -0.91 | -0.87 | -1.42 | -0.62 | -1.44 |
| Bhandara | -0.53 | -0.57 | -0.58 | 0.01 | -0.55 | -0.59 | -0.54 |
| Chandrapur | -0.65 | -0.76 | -0.31 | -0.63 | -1.30 | -0.19 | -1.33 |
| | | | | | | | |
| **Production** | | | | | | | |
| Thana | 1.19 | 1.18 | 1.34 | 6.81 | 0.99 | 1.39 | 0.98 |
| Raigad | 1.49 | 1.29 | 2.17 | 2.35 | 0.24 | 2.41 | 0.18 |
| Ratnagiri | 2.27 | 2.31 | 3.00 | 3.63 | 1.41 | 3.26 | 1.36 |
| Nasik | 2.29 | 3.60 | 4.46 | 8.53 | 2.06 | 5.24 | 1.98 |
| Dhulia | 2.39 | 3.27 | 4.36 | 9.83 | 1.60 | 5.06 | 1.50 |
| Jalgaon | 2.59 | 3.82 | 5.52 | 7.19 | 1.30 | 6.57 | 1.15 |
| Ahmednagar | 1.79 | 3.62 | 4.09 | 16.08 | 2.40 | 4.92 | 2.33 |
| Poona | 1.91 | 2.98 | 4.08 | 8.51 | 1.25 | 4.86 | 1.15 |
| Satara | 2.34 | 3.03 | 3.34 | 8.75 | 2.42 | 3.69 | 2.38 |
| Sangli | 2.09 | 3.28 | 2.99 | 22.98 | 3.25 | 3.31 | 3.25 |
| Sholapur | 0.98 | 2.02 | 2.65 | 8.83 | 0.89 | 3.24 | 0.82 |
| Kolhapur | 1.70 | 2.41 | 3.31 | 4.80 | 1.03 | 3.88 | 0.95 |
| Aurangabad | 4.18 | 4.71 | 6.21 | 15.71 | 2.65 | 6.93 | 2.53 |
| Parbhani | 3.13 | 3.36 | 5.85 | 7.71 | 0.17 | 6.83 | -0.01 |
| Bhir | 2.01 | 3.59 | 4.97 | 12.90 | 1.32 | 6.04 | 1.19 |
| Nanded | 2.67 | 3.32 | 4.68 | 16.95 | 1.40 | 5.40 | 1.29 |
| Osmanabad | 2.60 | 3.69 | 5.30 | 20.94 | 1.31 | 6.27 | 1.18 |
| Buldana | 2.24 | 1.77 | 4.24 | 11.23 | -1.16 | 4.96 | -1.33 |
| Akola | 3.25 | 2.05 | 4.43 | 7.60 | -0.53 | 4.85 | -0.68 |
| Amravati | 1.98 | 2.11 | 4.63 | 4.26 | -1.07 | 5.59 | -1.25 |
| Yeotmal | 1.22 | 0.65 | 2.84 | 3.65 | -1.90 | 3.42 | -2.05 |
| Wardha | 0.11 | 0.39 | 2.07 | 3.85 | -1.81 | 2.77 | -1.93 |

**Table A1.** Continued.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Nagpur | 0.07 | 0.91 | 2.47 | 3.80 | -1.33 | 3.33 | -1.46 |
| Bhandara | 1.08 | -0.84 | 1.03 | 11.99 | -2.57 | 1.02 | -2.67 |
| Chandrapur | 0.65 | -0.15 | 1.66 | 5.06 | -2.16 | 2.02 | -2.27 |
| **Yield** | | | | | | | |
| Thana | 1.31 | 1.36 | 1.29 | 6.91 | 1.44 | 1.28 | 1.44 |
| Raigad | 1.65 | 1.33 | 1.72 | 2.36 | 0.95 | 1.75 | 0.92 |
| Ratnagiri | 2.67 | 2.55 | 2.76 | 3.59 | 2.32 | 2.79 | 2.31 |
| Nasik | 2.42 | 3.29 | 3.63 | 6.75 | 2.57 | 4.06 | 2.53 |
| Dhulia | 2.56 | 3.08 | 3.98 | 7.81 | 1.77 | 4.49 | 1.69 |
| Jalgaon | 2.95 | 3.48 | 4.61 | 5.75 | 1.87 | 5.20 | 1.78 |
| Ahmednagar | 1.14 | 0.20 | -1.09 | 30.15 | 2.21 | -1.87 | 2.32 |
| Poona | 1.50 | 2.48 | 3.06 | 5.57 | 1.41 | 3.61 | 1.35 |
| Satara | 2.48 | 2.74 | 3.18 | 6.04 | 2.09 | 3.43 | 2.05 |
| Sangli | 1.96 | 2.70 | 2.78 | 12.66 | 2.36 | 3.07 | 2.34 |
| Sholapur | 1.82 | 2.39 | 3.17 | 7.96 | 1.22 | 3.65 | 1.15 |
| Kolhapur | 2.00 | 2.24 | 2.88 | 4.12 | 1.34 | 3.19 | 1.29 |
| Aurangabad | 3.68 | 3.96 | 4.88 | 10.90 | 2.70 | 5.31 | 2.63 |
| Parbhani | 2.78 | 2.48 | 5.09 | 6.08 | -0.67 | 5.91 | -0.85 |
| Bhir | 1.61 | 3.12 | 4.21 | 10.98 | 1.23 | 5.15 | 1.13 |
| Nanded | 2.98 | 3.33 | 4.67 | 15.82 | 1.54 | 5.27 | 1.44 |
| Osmanabad | 1.87 | 2.34 | 3.97 | 15.95 | 0.13 | 4.72 | 0.01 |
| Buldana | 2.15 | 1.22 | 3.78 | 7.59 | -1.66 | 4.35 | -1.82 |
| Akola | 2.51 | 1.35 | 3.17 | 5.96 | -0.56 | 3.40 | -0.67 |
| Amravati | 1.57 | 1.55 | 3.59 | 3.44 | -1.00 | 4.31 | -1.14 |
| Yeotmal | 1.49 | 1.17 | 2.76 | 3.89 | -0.73 | 3.21 | -0.84 |
| Wardha | 1.88 | 1.58 | 3.15 | 5.07 | -0.31 | 3.61 | -0.42 |
| Nagpur | 1.83 | 1.96 | 3.41 | 4.46 | 0.09 | 3.98 | -0.02 |
| Bhandara | 1.62 | -0.28 | 1.62 | 7.99 | -2.04 | 1.62 | -2.14 |
| Chandrapur | 1.31 | 0.62 | 1.98 | 4.89 | -0.87 | 2.22 | -0.96 |

**Table A2.** Ranking of districts based on different types of growth rates of food-grains: 1970-06 area.

| District | LSGR | GMGR | RLSGR | AMGR | IWGR | KWGRI | KWGRE |
|---|---|---|---|---|---|---|---|
| Thana | 11 | 18 | 19 | 19 | 16 | 20 | 16 |
| Raigad | 14 | 17 | 12 | 17 | 20 | 12 | 20 |
| Ratnagiri | 20 | 19 | 15 | 21 | 21 | 15 | 21 |
| Nasik | 12 | 12 | 8 | 13 | 17 | 8 | 17 |
| Dhulia | 15 | 14 | 14 | 14 | 13 | 14 | 12 |
| Jalgaon | 19 | 11 | 7 | 12 | 19 | 5 | 19 |
| Ahmednagar | 3 | 1 | 1 | 1 | 6 | 1 | 7 |
| Poona | 5 | 9 | 6 | 3 | 12 | 7 | 13 |
| Satara | 13 | 13 | 17 | 7 | 5 | 16 | 5 |
| Sangli | 9 | 6 | 16 | 5 | 2 | 17 | 2 |
| Sholapur | 23 | 20 | 22 | 20 | 15 | 22 | 14 |
| Kolhapur | 17 | 15 | 13 | 15 | 14 | 11 | 15 |
| Aurangabad | 4 | 4 | 3 | 8 | 9 | 2 | 9 |
| Parbhani | 8 | 3 | 9 | 9 | 3 | 9 | 3 |
| Bhir | 7 | 10 | 10 | 2 | 7 | 10 | 6 |
| Nanded | 18 | 16 | 20 | 16 | 11 | 19 | 11 |

**Table A2.** Continued.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Osmanabad | 1 | 2 | 2 | 6 | 1 | 3 | 1 |
| Buldana | 10 | 8 | 11 | 4 | 4 | 13 | 4 |
| Akola | 2 | 5 | 4 | 10 | 8 | 4 | 8 |
| Amravati | 6 | 7 | 5 | 11 | 10 | 6 | 10 |
| Yeotmal | 16 | 21 | 18 | 22 | 22 | 18 | 22 |
| Wardha | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Nagpur | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| Bhandara | 21 | 22 | 23 | 18 | 18 | 23 | 18 |
| Chandrapur | 22 | 23 | 21 | 23 | 23 | 21 | 23 |
| **Production** | | | | | | | |
| Thana | 20 | 20 | 24 | 17 | 14 | 24 | 13 |
| Raigad | 18 | 19 | 21 | 25 | 16 | 22 | 16 |
| Ratnagiri | 10 | 14 | 16 | 24 | 7 | 19 | 7 |
| Nasik | 9 | 5 | 8 | 12 | 5 | 8 | 5 |
| Dhulia | 7 | 10 | 10 | 9 | 6 | 9 | 6 |
| Jalgaon | 6 | 2 | 3 | 16 | 11 | 3 | 11 |
| Ahmednagar | 16 | 4 | 12 | 4 | 4 | 11 | 4 |
| Poona | 15 | 12 | 13 | 13 | 12 | 12 | 12 |
| Satara | 8 | 11 | 14 | 11 | 3 | 15 | 3 |
| Sangli | 12 | 9 | 17 | 1 | 1 | 18 | 1 |
| Sholapur | 22 | 17 | 19 | 10 | 15 | 20 | 15 |
| Kolhapur | 17 | 13 | 15 | 19 | 13 | 14 | 14 |
| Aurangabad | 1 | 1 | 1 | 5 | 2 | 1 | 2 |
| Parbhani | 3 | 7 | 2 | 14 | 17 | 2 | 17 |
| Bhir | 13 | 6 | 5 | 6 | 9 | 5 | 9 |
| Nanded | 4 | 8 | 6 | 3 | 8 | 7 | 8 |
| Osmanabad | 5 | 3 | 4 | 2 | 10 | 4 | 10 |
| Buldana | 11 | 18 | 11 | 8 | 20 | 10 | 20 |
| Akola | 2 | 16 | 9 | 15 | 18 | 13 | 18 |
| Amravati | 14 | 15 | 7 | 20 | 19 | 6 | 19 |
| Yeotmal | 19 | 22 | 18 | 23 | 23 | 16 | 23 |
| Wardha | 24 | 23 | 22 | 21 | 22 | 21 | 22 |
| Nagpur | 25 | 21 | 20 | 22 | 21 | 17 | 21 |
| Bhandara | 21 | 25 | 25 | 7 | 25 | 25 | 25 |
| | 23 | 24 | 23 | 18 | 24 | 23 | 24 |
| **Yield** | | | | | | | |
| Thana | 24 | 18 | 24 | 11 | 10 | 24 | 9 |
| Raigad | 17 | 20 | 22 | 25 | 15 | 22 | 15 |
| Ratnagiri | 5 | 9 | 19 | 23 | 4 | 20 | 5 |
| Nasik | 9 | 4 | 9 | 12 | 2 | 10 | 2 |
| Dhulia | 6 | 6 | 6 | 9 | 8 | 7 | 8 |
| Jalgaon | 3 | 2 | 4 | 16 | 7 | 4 | 7 |
| Ahmednagar | 25 | 24 | 25 | 1 | 5 | 25 | 4 |
| Poona | 21 | 10 | 16 | 17 | 11 | 13 | 11 |
| Satara | 8 | 7 | 12 | 14 | 6 | 15 | 6 |
| Sangli | 12 | 8 | 18 | 4 | 3 | 19 | 3 |
| Sholapur | 16 | 12 | 13 | 8 | 14 | 12 | 13 |
| Kolhapur | 11 | 14 | 17 | 21 | 12 | 18 | 12 |
| Aurangabad | 1 | 1 | 2 | 6 | 1 | 2 | 1 |
| Parbhani | 4 | 11 | 1 | 13 | 20 | 1 | 21 |
| Bhir | 19 | 5 | 5 | 5 | 13 | 5 | 14 |

**Table A2.** Continued.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Nanded | 2 | 3 | 3 | 3 | 9 | 3 | 10 |
| Osmanabad | 14 | 13 | 7 | 2 | 16 | 6 | 16 |
| Buldana | 10 | 21 | 8 | 10 | 24 | 8 | 24 |
| Akola | 7 | 19 | 14 | 15 | 19 | 16 | 19 |
| Amravati | 20 | 17 | 10 | 24 | 23 | 9 | 23 |
| Yeotmal | 22 | 22 | 20 | 22 | 21 | 17 | 20 |
| Wardha | 13 | 16 | 15 | 18 | 18 | 14 | 18 |
| Nagpur | 15 | 15 | 11 | 20 | 17 | 11 | 17 |
| Bhandara | 18 | 25 | 23 | 7 | 25 | 23 | 25 |
| Chandrapur | 23 | 23 | 21 | 19 | 22 | 21 | 22 |