Inequality in Food Grains Production in Maharashtra: A Study of Vidarbha Region

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Maharashtra has inequality in terms of district domestic products. The inequality is also reflected in variations in productivity and production of agricultural commodities across different regions of the state. Such difference is observed because of soil, climatic conditions, use of fertilizers, etc. Post-Green Revolution farmers have been using the high yielding varieties of seeds, pesticides, insecticides, fertilizers, and irrigation facilities. Therefore, the yield of the major crops has considerably increased in the Post-Green Revolution period. But yield of crops has not increased all over Maharashtra. In the Vidarbha region, the yield of all major crops except cotton has declined after Green Revolution. But yield of almost all crops has increased in Western Maharashtra. It has been observed that the farmers of lower yield areas usually suffer high cost of cultivation. Thus, farmers must be given more information about crop cultivation, climate change, water management, and use of fertilizers. The construction of farm ponds and check dams through NREGA will improve irrigation. Further, small farmers must be given priority in the formulation of agricultural policy, as this will help to improve the yield of various crops.

Introduction

In the state of Maharashtra, there exists inequality in terms of district domestic product. Some districts have higher domestic product due to the growth of the service sector. The growth of agricultural sector was not achieved uniformly across the state. After Green Revolution, the state has achieved a remarkable progress in food grains production. But the growth rate of food grains production is not uniform within and between the districts. Large variation in yield, area and production of food grains is commonly observed in the state.

Green Revolution has changed the agricultural production function, where technical know-how and natural endowments, such as irrigation facilities play an important role. The regions with good irrigation facilities and natural endowment have experienced most benefits from Green Revolution. Those farmers who have used the modern agricultural inputs have experienced an improvement in production and productivity of crops. But benefits of all

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agricultural inputs are not obtained by all the farmers. The regions with less irrigation and less natural endowment have suffered high cultivation cost. The yield of the major crops in those areas has declined after Green Revolution.

Vidarbha region has showed a declining trend in food grain output after Green Revolution. This region had high production, yield and area under cereals before Green Revolution. But after Green Revolution, the area under all food crops has declined. Only the production and area under pulses have shown a significant increase in this region after Green Revolution. The Vidarbha region is commonly considered as the cotton-growing region, while the yield and output of all major food crops are completely ignored. As far as total output, yield and area under food grains in this region are concerned, it is a very serious issue and needs large-scale intervention. This paper tries to compare the production, yield and area under food grains in Vidarbha region between the pre- and post-Green Revolution periods. It also analyzes the area, yield and their interaction effects on total food grains output in this region, in the two periods, as large variation in food grains output was expected due to Green Revolution. The paper is organized as follows: Starting with a brief introduction, the database and methodology used in the paper are discussed. Subsequently, the empirical results are presented in detail, and finally, the conclusion is offered with policy implications.

Database and Methodology

This study utilizes the district-wise agricultural database published by Economic and Political Weekly Research Foundation (EPWRF). The study includes 29 districts of Maharashtra. Such district-level data have been further classified into five regions. The list of regions and districts is given in the Appendix. The time series database is available for yield, area and production of all crops from 1960-61 to 1997-98. The whole data series is divided into two periods. The first period is considered as the period prior to Green Revolution, i.e., 1960-61 to 1982-83. It is called the pre-Green Revolution period. The second period, 1983-84 to 1997-98, is the post-Green Revolution period.

The classification and analysis of district-level data are based on formation of districts and availability of data on yield, production and area under crops. We are aware of the disadvantages in using several parameters for assessing the agricultural performance among regions. Admittedly that remains a limitation of this study.

In order to calculate the growth rate of area, yield and production, we have used compound growth function:

$$\log Y = a + bt$$

where,

Y = Area/production/yield of the specific crop in a particular time period, is the dependent variable;

t = Time variable; and

a and b are intercept and slope coefficient of the time variable, respectively.

Compound Growth Rate (%) = (Antilog b – 1)*100

The growth trend of area, production and yield of food grains is expressed by the compound growth function. First, we calculate the growth rate for the pre-Green Revolution period (1960-61 to 1982-83) and then for the post-Green Revolution period (1983-84 to 1997-98).

Goldfeld-Quandt Test

In order to examine the structural change of the difference in growth rates between the two periods, we used the Goldfeld-Quandt (G-Q) test (Greene, 2003). The null hypothesis of no difference between the growth rates is tested against the alternative hypothesis that the growth rates for the two periods are significantly different. The Goldfeld-Quandt statistic provides a test for different error variances between the two subsets of observations. Let us denote the variance in the first subset by σ_1^2 and the variance in the second subset by σ_2^2. The null hypothesis is H_0: $\sigma_1^2 < \sigma_2^2$ and the alternative hypothesis is H_1: $\sigma_1^2 > \sigma_2^2$ (i.e., the second subset of observations has smaller variance than the first subset). The sample is split into two groups with N_1 and N_2 observations such that $N_1 + N_2 = N$, and the test statistics is calculated as:

$$G\text{-}Q = \frac{RSSE_1/DF_1}{RSSE_2/DF_2}$$

where $RSSE_1$ and $RSSE_2$ are the sum of squared errors from the first $N_1 - r/2$ and the last $N_2 - r/2$ observations respectively, and $DF_1 = N_1 - K - r/2$ and $DF_2 = N_2 - K - r/2$. The statistics can be compared with an $F_{(DF1,\ DF2)}$ distribution.

We tested the hypothesis based on variance in two periods and the G-Q test value. There is evidence for smaller variance in the second group if $G\text{-}Q > 1$ and the p-value is less than 0.05. Whereas, there is evidence for larger variance in the second group if $G\text{-}Q < 1$ and the p-value is less than 0.05.

We have assumed that any change in the production of food grains depends on the changes in its area, yield and their interaction term.

The change in the aggregate crop output in time t is split into 3 components as follows:

$$Q' - Q^0 = A'Y' - A^0Y^0$$

$$= (A' - A^0)Y^0 + (Y' - Y^0)A'$$

The right-hand side of the identity can be further decomposed as:

$$Q' - Q^0 = (A' - A^0)Y^0 + (Y' - Y^0)A^0 + (A' - A^0)\ (Y' - Y^0)$$

$$\Delta Q = \Delta AY^0 + \Delta YA^0 + \Delta A\Delta Y$$

In the above model, the first element gives the area effect, the second element gives the yield effect, and the third element represents their interaction effect.

Results and Analysis

Agricultural Performance

Varieties of agricultural products are grown across the state of Maharashtra. Such crops are different in their quality and quantity due to the soil, climatic conditions, availability of insecticides and pesticides, and several other factors. But all these factors are not considered in this analysis, as we have only compared the yield, area and production of food grains in different regions of Maharashtra.

Table 1 shows the change in area, yield and output of food grains in Period 1 (pre-Green Revolution period) and Period 2 (post-Green Revolution period). The table shows that food grains production has increased in Marathwada (from 1.67% to 3.68%), Khandesh (from 2.04% to 3.84%), Western Maharashtra (from 1.65% to 2.42%), Konkan (from 1.98% to 2.48%) in Period 2. But Vidarbha region shows a decline in food grains production (from 2.45% to 1.23%) in Period 2. As far as total area under food grains in Period 2 (1983-84 to 1997-98) is concerned, it was negative in all regions of Maharashtra, except Konkan (0.80%) and Marathwada (0.05%). In Konkan and Marathwada, the change in area under food grains was negative in Period 1, but became positive in Period 2.

Table 1: Change of Output, Area and Yield in Periods 1 and 2 (% per annum)

Period	Output	Area	Yield
Western Maharashtra			
1	1.65	–0.29	2.17
2	2.42	–0.22	2.99
Konkan			
1	1.98	–0.81	2.31
2	2.48	0.80	4.00
Khandesh			
1	2.04	0.20	2.25
2	3.84	–0.11	3.67
Marathwada			
1	1.67	–0.25	2.15
2	3.68	0.05	3.00
Vidarbha			
1	2.45	0.17	2.20
2	1.23	–0.29	2.00
Maharashtra			
1	1.95	0.05	1.92
2	2.50	–0.11	3.23

The yield of major crops has increased in Konkan (from 2.31% to 4%), Khandesh (from 2.25% to 3.67%), Marathwada (from 2.15% to 3%), and Western Maharashtra (2.17% to 2.99%) in Period 2. Again the yield of major crops in Vidarbha region has declined (from 2.20% to 2%) in Period 2. The major causes of such decline in the yield are as follows: First, the rainfall in the region has declined over the period of time. Secondly, there is no facility for storing the rain water, such as check dams, farm ponds, etc. Thirdly, mostly water-intensive crops are grown in this region for which groundwater is used in large amount. The ground water level has been declining in this region, and thus, it has affected the overall cropping pattern in the region. Decline in yield, area and production of food grains is a serious issue in Vidarbha region. Thus, it is important to find out which crops are showing the declining trend in this region.

We have also calculated the compound growth rate for all food grains. The growth rate is calculated for yield, area and production of each crop. First, we calculated the growth rate for Period 1 (1960-61 to 1982-83) and then for Period 2 (1983-84 to 1997-98).

Table 2 shows that the production of bajra (1.9%) and total pulses (0.23%) has increased in Period 2, whereas the yield of wheat (1.65-1.00%), rice (1.45-0.60%), and total cereals (1.3-1.00%) has declined from first to second period. The yield of jowar (k) has increased from 1.39% to 1.69% in Period 2. The area under wheat (–1.1%), jowar (k) (–1.4%), jowar (r) (–2.00%), and total cereals (–0.96%) has negative growth rate in Period 2.

Table 2: Compound Growth Rate of Area, Production and Yield During Periods 1 and 2 in Vidarbha Region

	Periods	Bajra	Wheat	Rice	Jowar (k)	Jowar (r)	Total Cereals	Total Pulses	Total Food Grain
P	1	1.21	1.50	1.20	1.65	–0.26	1.31	–0.18	1.09
	2	1.90	0.60	0.94	0.08	–0.20	0.17	0.23	0.53
Y	1	1.45	1.65	1.45	1.39	–0.05	1.30	–0.41	1.04
	2	1.60	1.00	0.60	1.69	–0.85	1.00	0.49	0.50
A	1	0.91	0.06	0.25	1.50	0.20	0.13	0.33	0.17
	2	0.39	–1.10	0.17	–1.40	–2.00	–0.96	0.18	–0.02

Note: P: Production; Y: Yield; and A: Area

Table 3 shows that all coefficients of growth function are significant at 1% level. But coefficients of determination (R^2), which measure the goodness-of-fit of the growth functions are not significant. The area and production of total pulses in Period 2 were statistically significant and positive. The value of the R^2 was also higher and significant in Period 2. Kalamkar (2003) showed that the net returns of tur in Nagpur and Yawatmal districts were significantly higher than that of gram in Nasik and Jalgaon districts. The yield and production of total cereals were statistically significant at 1% and positive in Period 1. While in Period 2, yield of total cereals was positive, but decreased slightly. The value of R^2 achieved

Table 3: Estimates of Compound Growth Function of Food Grains in Periods 1 and 2

Crop		Period 1			Period 2		
		Intercept	Slope	R^2	Intercept	Slope	R^2
Bajra	P	1.6134*	0.0121	0.176	1.806*	0.0190***	0.213
		(0.0785)	(0.0057)		(0.092)	(0.0101)	
	Y	2.29*	0.0145**	0.201	2.57*	0.016**	0.29
		(0.086)	(0.006)		(0.064)	(0.007)	
	A	1.614*	0.0091*	0.43	1.654*	0.0039	0.031
		(0.0312)	(0.002)		(0.0548)	(0.0060)	
Wheat	P	2.22*	0.0159	0.44	2.519*	0.0060	0.046
		(0.0532)	(0.0038)		(0.068)	(0.0075)	
	Y	2.524*	0.01653*	0.57	2.89*	0.010	0.172
		(0.042)	(0.0030)		(0.0605)	(0.006)	
	A	2.612*	0.0006*	0.01	2.531*	–0.011*	0.36
		(0.018)	(0.0013)		(0.038)	(0.0042)	
Rice	P	2.73*	0.012*	0.30	2.857*	0.0094	0.098
		(0.055)	(0.0040)		(0.071)	(0.0079)	
	Y	2.698*	0.0145**	0.36	2.88*	0.006	0.074
		(0.0578)	(0.0042)		(0.053)	(0.005)	
	A	2.82	0.0025	0.24	2.8*	0.0017	0.041
		(0.0133)	(0.00097)		(0.0211)	(0.0023)	
Jowar (k)	P	2.749*	0.0165	0.45	3.16*	0.0008	0.001
		(0.054)	(0.0039)		(0.061)	(0.0067)	
	Y	2.61*	0.0139*	0.41	2.92*	0.0169**	0.31
		(0.049)	(0.0035)		(0.062)	(0.0068)	
	A	3.186*	0.0015*	0.35	3.23*	–0.014*	0.86
		(0.006)	(0.00048)		(0.0142)	(0.0015)	
Jowar (r)	P	2.458*	–0.0026	0.015	2.50*	–0.020*	0.35
		(0.061)	(0.0044)		(0.068)	(0.0075)	
	Y	2.61*	–0.005	0.0008	2.72*	–0.0085	0.13
		(0.052)	(0.0038)		(0.054)	(0.0059)	
	A	2.63*	0.002	0.43	2.626*	–0.020*	0.79
		(0.029)	(0.0021)		(0.0269)	(0.0029)	

Table 3 (Cont.)

Crop		Period 1			Period 2		
		Intercept	Slope	R^2	Intercept	Slope	R^2
Total Cereals	P	3.126* (0.0389)	0.0131* (0.0028)	0.50	3.406* (0.0434)	0.0017 (0.0047)	0.010
	Y	2.66* (0.039)	0.0133* (0.0028)	0.50	2.966* (0.04368)	0.01067** (0.007)	0.275
	A	3.47* (0.0074)	0.00132* (0.000541)	0.22	3.4819* (0.0077)	–0.0095* (0.0008)	0.90
Total Pulses	P	2.54* (0.0373)	–0.0018 (0.0027)	0.21	2.61* (0.0565)	0.023* (0.0062)	0.52
	Y	2.665* (0.0345)	0.0033* (0.00251)	0.11	2.67* (0.045)	0.00498 (0.00503)	0.07
	A	2.90* (0.007)	0.0033* (0.00051)	0.66	2.98* (0.0172)	0.0178* (0.001898)	0.87
Total Food Grains	P	3.215* (0.037)	0.0109* (0.0027)	0.43	3.45* (0.043)	0.00537 (0.0047)	0.213
	Y	2.66* (0.037)	0.0104* (0.0027)	0.407	2.92* (0.0409)	0.0051 (0.0044)	0.092
	A	3.58* (0.0068)	0.0017* (0.00048)	0.39	3.595* (0.008)	–0.0002 (0.00096)	0.0038

Note: Figures in the brackets represent standard error; * Significant at 1%; ** Significant at 5%; and *** Significant at 10%.

in Period 1 was also higher than that in Period 2. Area under jowar (r) declined significantly in Period 2. Production of jowar (k) was positive but insignificant in Period 1. The area under jowar (k) declined in Period 2 and was statistically significant. For wheat, the yield in Period 1 (1960-61 to 1982-83) was significant and positive.

Goldfeld-Quandt Test

In order to find the structural break or heteroskedasticity in production, yield and area of the food crops between the two periods, we perform the G-Q test.

The G-Q test results show that the production of pulses is significant in Period 2. The G-Q test statistic is less than 1 and significant at 1% (Table 4). As far as production of different crops is concerned, the total cereals show large variation in Period 1. The G-Q test statistic is greater than 1 and significant at 1%. While, wheat and jowar (k) show small variations in Period 2, as the G-Q test value is greater than 1 and significant at 5%.

Table 4: Goldfeld-Quandt Test Results			
Crops	**G-Q Test Results**		
	Production	**Yield**	**Area**
Bajra	1.067	2.21**	0.755
Wheat	2.081**	2.00***	2.00***
Rice	1.18	2.69*	0.755
Jowar (k)	2.40**	1.1**	0.0008*
Jowar (r)	1.50	3.06*	0.53***
Total Cereals	3.0*	1.88***	0.269*
Total Pulses	0.357*	1.00	0.13*
Total Food Grains	1.99***	2.23**	1.45
Note: * Significant at 1%; ** Significant at 5%; and *** Significant at 10%.			

As far as yield of different crops is concerned, jowar (k) shows significant result. The G-Q test statistic is greater than 1 and significant at 5%. It is surprising that not a single crop in the Vidarbha shows significant yield in the second period (1983-84 to 1997-98), i.e., the post-Green Revolution era, when high growth of yield and production of food crops is expected. The area under jowar (k) and total cereals shows significant decline in Period 2 ($G\text{-}Q < 1$ and significant at 1%).

It is clear that only production and area of total pulses have increased in the Vidarbha region in the second period. This is mainly because of two reasons: First, National Pulses Development Programme (NADP) of early 1980s was implemented in 11 districts of the state for two pulses, gram and tur. The maximum benefit of this program was achieved by the Vidarbha region. Second, pulses production requires less irrigation facilities, fertilizers and pesticides. Moreover, it can be grown on less fertile area and less effort is required in its cultivation as compared to other crops.

Dummy Variable Approach

In order to examine our hypothesis, we used dummy variables for the two periods. Dummy variables were used for production, area and yield of food grains.

Production Effect

There is either homoskedasticity or heteroskedasticity between the two periods. The Ordinary Least Square (OLS) method was used to estimate the following equation:

$$Tfo = 0.1633 + 0.84627ctre^{*} + 0.1582tpul^{*} + 0.0029dum^{***}$$

$$(0.002) \quad (0.006) \quad (0.005) \quad (0.002)$$

$R^2 = 0.9992$; and $\bar{R}^2 = 0.999$

where,

Tfo = Growth rate of total food grains;

ctre = Growth rate of total cereals;

tpul = Growth rate of total pulses; and

dum = Dummy variable is 1 for first period, and 0 for second period.

The model shows that total food grains production is a function of total cereals, pulses and dummy variable for Period 1. It is clear that production of total food grains is significant in Period 1. It was significant due to higher growth rate of production of total cereals and total pulses.

Yield Effect

In order to examine the yield effect between the two periods, the following OLS equation was estimated:

$$Tfo = -0.0135 - 0.117jaw^* + 0.0587jawr^* + 0.127tpul^* + 0.9284tcere^* + 0.0245dum^*$$

(0.076) (0.057) (0.041) (0.0025) (0.019) (0.033)

$R^2 = 0.9927$; and $\bar{R}^2 = 0.9916$

where,

jaw = Growth rate of jowar (k) ; and

jawr = Growth rate of jowar (r)

All variables are significant at 1%. The above equation shows that yield of food grains is a function of jowar (r), jowar (k), total cereals, total pulses and dummy variable for Period 1. It is clear that the yield of total food grains is positively related to total cereals, total pulses and jowar (r), and negatively related to jowar (k).

Area Effect

Total area under food crops is an important aspect for higher food grain production.

$$Tfo = 0.48 - 0.093jaw^* + 0.725tcere + 0.295tpul + 0.0055dum^*$$

(0.070) (0.025) (0.032) (0.0093) (0.0020)

$R^2 = 0.984$; and $\bar{R}^2 = 0.982$

All variables are significant at 1%. The above equation shows that the area under total food grains is a function of jowar (k), total cereals, total pulses and dummy variable for Period 1. It is clear that the area under total food grains is positively related to total cereals and total pulses, whereas it is negatively related to jowar (k). The dummy is positive and statistically significant. This implies that total area under food grains was higher in Period 1.

The above results show that production, area and yield effects are more significant in Period 1 (1960-61 to 1982-83). It implies that though Green Revolution has benefited all other regions in Maharashtra, it has not benefited the Vidarbha region. This region has not

received much attention in terms of irrigation investment, Research and Development (R&D), awareness regarding the use of High Yielding Varieties (HYV) of seeds, fertilizers, etc. Therefore, food grains output, area and yield have not increased significantly in Period 2.

Conclusion

The above results show that, in Period 1, Vidarbha region showed considerably good production and yield of major crops. The yield of wheat and total cereals was significant. Similarly, the production of wheat, jowar (k) and total cereals was relatively high in Period 1. But in the second period, i.e., the post-Green Revolution era, not a single food grain showed significant yield growth in Vidarbha region. Only the production and area under pulses have significantly increased in this region in Period 2.

Crop yield is mainly affected by the extent of irrigation, humidity, sunshine, quality of soil, HYV seeds, fertilizers, etc. In Vidarbha region, crop failure is a common phenomena. It is mainly due to irregular or unseasonal rainfall, lack of irrigation facilities, etc. Due to continuous crop failure and high indebtness of the farmers, they are unable to meet the rising cost of cultivation in this region. The government has done little to improve the plight of the farmers.

In order to improve the yield and production of all major crops, government should promote R&D in agriculture. There is need to find such HYV of seeds which are most suitable for local conditions. The work of Konkan Agricultural University has been impressive in this direction. Secondly, there is need to promote the dry-farm cultivation techniques in this region. Such techniques will help to improve the income of farmers. More investment in irrigation projects is strongly recommended in this region. There is need of some awareness regarding yield growth among the farmers. The media should spread such awareness among the farmers. Provision of public services, such as transport, health, education, drinking water, etc., should be improved in the backward regions for the poor at lower cost. Lastly, long-term planning is required by the government, agricultural research institutions, and the NGOs for improving the yield and output of all major food grains in this region. Otherwise, the rich and the agriculturally growing regions will continue to grow faster and the poor region will lag behind. It is the state government that has to take immediate steps in this direction.❍

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Appendix

Region	District
Western Maharashtra	Pune, Satara, Sangli, Solapur, Nasik, Kholapur, and Ahmadnagar
Marathwada	Aurangabad, Beed, Nanded, Osmanbad, Parbhani, Latur, and Jalna
Khandesh	Dhule and Jalgaon
Konkan	Mumbai, Thane, Ratnagiri, Raigad, and Sindhudurg
Vidarbha	Akola, Amravati, Buldhana, Bhandara, Chandrapur, Gadchiroli, Nagpur, Wardha, and Yatwatmal

Reference # 49J-2011-04-01-01

Form IV

1. Place of publication : Hyderabad
2. Periodicity of its publication : Quarterly
3. Printer's Name : E N Murthy
   Nationality : Indian
   (a) Whether a citizen of India? : Yes
   Address : M/s. ICIT Software Center Pvt. Ltd., Plot Nos. 165 & 166 P, Phase-V, IDA, Jeedimetla, Hyderabad 500055.
4. Publisher's Name : E N Murthy
   Nationality : Indian
   (a) Whether a citizen of India? : Yes
   Address : # 126, Mahalaxmi Towers, Srinagar Colony, Hyderabad 500073.
5. Editor's Name : E N Murthy
   Nationality : Indian
   (a) Whether a citizen of India? : Yes
   Address : # 126, Mahalaxmi Towers, Srinagar Colony, Hyderabad 500073.
6. Name and addresses of individuals who own the newspaper and holding more than one percent of the total capital – **IUP Publications, # 126, Mahalaxmi Towers, Srinagar Colony, Hyderabad 500073.**

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Date
April 2011

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Signature of Publisher