Region wise decadal analysis of area of major cereal crops in Maharashtra

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Abstract: *The present article describes the region wise changes in area of five major cereals (Rice, Kharip Jowar, Rabbi Jowar, Bajara and Wheat) in four decades (1960-1970, 1970-1980, 1980-1990 and 1990-2000). The changes in area are investigated by using Fisher-Pry model. Study of changes in area is useful to understand cropping pattern.*
Key Words: *Area, Cereals, Fisher-Pry model.*

I.   Introduction:

In Maharshtra the year 2013 is declared as a 'Drought Year'. Before 40 years severe drought was experienced by the agrarians in 1972. Yet, there are still important differences in these two droughts. In 1972 agrarians observed high scarcity of drinking water as well as food grains, whereas in 2013 only high scarcity of water is the experience. In 1972, India, for relatively less population imported lot of food grains from other countries, whereas in 2013 even with comparatively large population, India has enough food grains to export also. The credit of this achievement certainly goes to research and development in agro-technology by mainly agriculture universities. During the pace of time lot of forces acts on area so that there are changes in it. The new concept of 'Special Economic Zone (SEZ)' brought the reservation of land for particular type of economic activity. Such reservation definitely reduces permanently the land under cultivation too. Fluctuation in market prices or policy regarding minimum support price forces to have changing cropping pattern. Timely changes in global demands are also the reasons of diversification in cropping pattern. Global warming, fluctuation in weather and climatic conditions, soil salinity and cost of agro-technology are also some of the reasons to observe changes in cropping pattern. Still, food grains are the most important ingredients to feed the India's ever increasing population. It is also an essential raw material in many food processing industries. The food grains are daily required by every family and its requirement is continuously increasing. In such a scenario, it seems necessary to carry out in depth study on changes in area of major cereals in Maharshtra.

Brief literature review: In this section some of the selected references are cited. Saini, G.R. (1963) studied the cropping pattern of western region of Uttar Pradesh and noted high increase in the area of wheat, rice, maize and *bajara* whereas the area of other cereals decreased significantly. Singh and Kaur (1990) studied the cropping pattern in Punjab using the data for the period 1960-61 to 1994-95 and concluded that in Punjab area from cash crop is shifting towards cereals. The area of cereals during the study period rose from 45.65% to 73.46%. Out of the cereal class area of rice and wheat is significantly increased. Thomas, K.J. and et. (1990) applied exponential regression to the data on area of 16 crops during 1973-74 to 1986-87 in Kerala and concluded that annual compound growth rate of cereals is decreasing and that of cash crops is increasing. Moni and Jose (1997) used the data for the period 1975-76 to 1995-1996 in Kerala to conclude that in liberalization the area of cereal crops is being getting shifted to cash crops. Vivekananda and Satyapriya (1994) on the basis of data of 1955-56 to 1990-91 had studied the cropping pattern of Karnataka state. Study concludes that during the study period area of cereals from 55% drop down to 47%. The area of maize increased from 0.10% to 2.10%. Cash crops like oil seeds seems to be prominent leaders in Karnataka. Apart from these references many researchers came to the conclusion that in general area of cereals is declining in many parts of the country. Therefore, it is necessary to investigate the changes in area of major cereals in Maharashtra.

The present article is a research attempt to investigate the changes in major cereals in Maharashtra. The scope of the study on different aspects is mentioned in table-1.

Table-1: Different aspects of present study

Sr. No.	Aspects	Details	Remark
1	Regions	Pune, Nasik, Amravati, Nagpur, Marathwada, Mumbai	06 Regions
2	Period	1960-1970: Period of Pre Green Revolution (PRGR) 1970-1980: Period of Green Revolution (GR) 1980-1990: Period of Post Green Revolution (POGR) 1990-2000: Period of Globalization (GL)	04 Decades
3	Cereals	Rice, *Kharip Jowar, Rabbi Jowar, Bajara* and Wheat	05 Crops
4	Variables	Area	01 Variables

Material and Methods: The annual data of all districts in Maharshtra on area ('000 Ha) is used to study the changes in area. Since some of the districts are declared in mid study period or in the last few years of period of globalization, districts considered in the respective regions are given in table-2.

Table-2: Region wise districts considered in the study

Sr. No.	Region	Districts	No. of districts
1	Pune	Pune, Satara, Sangli, Kolhapur, Solapur	05
2	Nasik	Nasik, Dhule, Jalgaon, Ahmednagar	04
3	Amravati	Amravati, Akola, Buldhana, Yavatmal	04
4	Nagpur	Nagpur, Bhandara, Chandrapur, Gadchiroli, Vardha	05
5	Aurangabad	Aurangabad, Beed, Jalna, Nanded, Osmanabad, Parbhani, Latur	07
6	Mumbai	Raigad, Ratnagiri, Sindhudurg, Thane	04

Thus, out of 35 districts, 29 districts from 06 different regions of the state are treated for the present study. The district wise data on area is added to obtain region wise area of each selected cereal crop.

To investigate the crop wise shift in area or changes in area Fisher-Pry model is applied. To describe the model, suppose R_1, R_2, R_3, R_4, R_5 and R_6 are the regions under study with year wise area under given crop is A_1, A_2, A_3, A_4, A_5 and A_6. The year wise total area of the crop in the state is thus $T_A = A_1 + A_2 + A_3 + A_4 + A_5 + A_6$. Then region wise proportion of area for each year will be $P_1 = A_1/T_A, P_2 = A_2/T_A, P_3 = A_3/T_A, P_4 = A_4/T_A, P_5 = A_5/T_A$, and $P_6 = A_6/T_A$. The equation of Fisher-Pry model is then,

$$Ln[P_i/(1-P_i)] = a_i + b_i*t \qquad \text{for } i=1,2,3,4,5,6 \ldots\ldots[1]$$

where 'a' and 'b' are constants to be determined by using method of least squares and 't' is year. The MINITAB software is used to fit the model in [1]. The model parameter 'b' is interpreted as a proportion of shift in area. If 'b' is negative then area of the crop is shifted to other crops and if 'b' is positive then area is shifted to the crop from other crops. The software also tests the statistical significance of 'b'.

Analysis and discussion: The Fisher-Pry model as mentioned in equation [1] is fitted to the crop wise data on area for different regions for four decades as mentioned in table-1. The crop wise shift in area is given in table-3 to table-7.

Table-3: Percent Shift in area of Rice

Period	Region					
	Pune	Mumbai	Amravati	Nasik	Nagpur	Aurangabad
PRGR	-1.31[*]	-0.29	2.52[**]	-3.20[**]	1.36[*]	0.28
GR	0.52	-1.15[*]	1.71[*]	1.65[*]	-0.77	3.74[**]
POGR	-0.01	0.42	-1.93[*]	-1.43[*]	0.22	-0.43
GL	2.23[**]	1.52[*]	-7.52[**]	-0.46	-1.52[*]	-1.88[*]
[*] Means significant at 5 % Level of significance [**] Means significant at 5 % Level of significance						

From table-3 it is seen that in pre-green revolution period highest decrease (3.20%) in area of rice is found in Nasik region whereas highest increase (2.52%) is observed in Amravati region. During green revolution period highest decrease (1.15%) in area of rice is found in Mumbai region whereas highest increase (3.74%) is observed in Aurangabad region. In post green revolution period highest decrease (1.93%) in area of rice is found in Amravati region whereas highest increase (0.42%) is observed in Mumbai region. During globalization period highest decrease (7.52%) in area of rice is found in Mumabi region whereas highest increase (2.23%) is observed in Pune region.

Table-4: Percent Shift in area of *Kharip Jowar*

Period	Region					
	Pune	Mumbai	Amravati	Nasik	Nagpur	Aurangabad
PRGR	-3.08**	-	1.31*	-1.19*	0.61	0.04
GR	1.48*	-	-2.82**	7.62**	-2.81*	0.74
POGR	0.84	-	0.07	-0.34	-2.43*	0.67
GL	0.83	-	-1.97*	-0.91	-2.61*	2.60*
* Means significant at 5 % Level of significance ** Means significant at 5 % Level of significance						

From table-4 it is seen that in pre-green revolution period highest decrease (3.08%) in area of *kharip jowar* is found in Pune region whereas highest increase (1.31%) is observed in Amravati region. During green revolution period highest decrease (2.82%) in area of *kharip jowar* is found in Amravati region whereas highest increase (7.62%) is observed in Nasik region. In post green revolution period highest decrease (2.43%) in area of *kharip jowar* is found in Nagpur region whereas highest increase (0.84%) is observed in Pune region. During globalization period highest decrease (2.61%) in area of *kharip jowar* is found in Nagpur region whereas highest increase (2.60%) is observed in Aurangabad region.

Table-5: Percent Shift in area of *Bajara*

Period	Region					
	Pune	Mumbai	Amravati	Nasik	Nagpur	Aurangabad
PRGR	-2.83**	-	0.42	0.62	-11.85**	3.15**
GR	0.46	-	0.70	-0.19	-4.36**	0.75
POGR	-2.00	-	-2.82**	0.66	-2.25	1.55
GL	-1.47	-	-6.35**	0.92	14.36**	-0.24
* Means significant at 5 % Level of significance ** Means significant at 5 % Level of significance						

From table-5 it is seen that in pre-green revolution period highest decrease (11.85%) in area of *bajara* is found in Nagpur region whereas highest increase (3.15%) is observed in Aurangabad region. During green revolution period highest decrease (4.36%) in area of *bajara* is found in Nagpur region whereas highest increase (0.75%) is observed in Aurangabad region. In post green revolution period highest decrease (2.82%) in area of *bajara* is found in Amravati region whereas highest increase (1.55%) is observed in Aurangabad region. During globalization period highest decrease (6.35%) in area of *bajara* is found in Amravati region whereas highest increase (14.36%) is observed in Nagpur region.

Table-6: Percent Shift in area of *Rabbi Jowar*

Period	Region					
	Pune	Mumbai	Amravati	Nasik	Nagpur	Aurangabad
PRGR	0.41	-	-1.28	-3.32**	3.77**	1.09
GR	0.25	-	-2.43	0.26	-1.04	0.00009
POGR	0.88	-	-18.08**	-1.09	-2.52	0.59
GL	-0.63	-	48.71**	-0.09	-5.13**	1.45
* Means significant at 5 % Level of significance ** Means significant at 5 % Level of significance						

From table-5 it is seen that in pre-green revolution period highest decrease (3.32%) in area of *rabbi jowar* is found in Nasik region whereas highest increase (3.77%) is observed in Nagpur region. During green revolution period highest decrease (2.43%) in area of *rabbi jowar* is found in Amravti region whereas highest increase (0.26%) is observed in Nasik region. In post green revolution period highest decrease (18.08%) in area of *rabbi jowar* is found in Amravati region whereas highest increase (0.88%) is observed in Pune region. During globalization period highest decrease (5.13%) in area of *rabbi jowar* is found in Nagpur region whereas highest increase (48.71%) is observed in Amravati region.

Table-6: Percent Shift in area of *Wheat*

Period	Region					
	Pune	Mumbai	Amravati	Nasik	Nagpur	Aurangabad
PRGR	1.74	-	-2.07	2.24	-1.14	-0.30
GR	5.43	-	-0.22	-0.07	-3.47	0.05
POGR	3.92	-	-3.02	0.66	1.52	-2.77
GL	1.53	-	-2.15	0.53	-0.32	0.34
* Means significant at 5 % Level of significance ** Means significant at 5 % Level of significance						

From table-5 it is seen that in pre-green revolution period highest decrease (2.07%) in area of *wheat* is found in Amravti region whereas highest increase (2.24%) is observed in Nasik region. During green revolution period highest decrease (3.47%) in area of *wheat* is found in Nagpur region whereas highest increase (5.43%) is observed in Pune region. In post green revolution period highest decrease (2.77%) in area of *wheat* is found in Aurangabad region whereas highest increase (3.92%) is observed in Pune region. During globalization period highest decrease (2.15%) in area of *wheat* is found in Amravati region whereas highest increase (1.53%) is observed in Pune region.

II.   Conclusion:

The crop wise percent shift in area as analyzed by Fisher-Pry model and presented in table-3 to table-6 indicates that variation in shift of area in each decade is very high. In other words it can be concluded that the cropping pattern is not uniform or stable over the decades or over the regions. Thus, such unstable cropping pattern may affect the production and productivity of the crops too. Therefore, in order to assure the production of cereals at minimum level it is suggested to design the region wise 'minimum cereal area policy'.

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