

Dynamics of Land Use and Cropping Pattern and Growth Trends in Area, Production and Productivity of Major Crops in Pune District of Maharashtra

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Abstract: Agriculture is the main occupation in developing country like India. Agriculture plays an essential role in the process of economic development of less developed countries like India. Besides providing food to nation, agriculture generates employment also contributes to market of industrial goods and earns foreign exchange. Agricultural production is influenced by physical, socio-economic, technological and organizational factors. An endeavour is made to study the major crops and their growth trends in Pune district for different years. The region having 15642 sq.km. area comprises 14 tahsils of Pune district. This study is based on secondary data collected from socio-economic review and district statistical abstract of Pune district. This present study is the answer to many questions relating to land use, cropping pattern and growth trends in area production and productivity of major crops of the district as we emphasis on land use pattern, cropping pattern and growth trends in area production and productivity of major crops in this study.

The study will let us know the existing pattern of land use and cropping pattern in the district. With the help of this study we can know those various changes or factors which will help in improving land use pattern, cropping pattern and growth trends in area production and productivity of major crops of the Pune district. Such type of study represents real situation of land use pattern, cropping pattern and growth trends in area production and productivity of major crops in Pune district and helps to planners and agricultural scientist for agricultural planning at tahsil level.

The revealed that to maintaining forest area, expansion of irrigated facilities, supply of fertilizers and the area expansion of HYVs may be properly supervised for its best utilization in agriculture.

Keywords: Land use pattern, cropping pattern, growth trends

INTRODUCTION

The development of agriculture is a process through which the shift takes place from the stage of traditional agriculture to the stage of modernized agriculture resulting in increased productivity and production per unit of resource due to use of modern technology.

During the process of transformation, the position of original equilibrium changes and production function shifts to a higher level and occupies a new equilibrium position, where the profits are maximum. Land is an important input in agricultural sector but the yield of agricultural

crops mainly depend upon fertility of land for raising different crops, cropping pattern is the central element of agricultural land use. Cropping means the proportion of area under various crops at a point of time.

Pune district comes under the plain zone (transitional belt) in the central Maharashtra and located between 17°54' and 10°24' north latitude and 73°19' and 75°10' east longitude. The district is triangular in shape with its base in west of Sahyadri mountain, which runs in the north-south Direction and its apex in the extreme South-east corner near the confluence of Bhima and Nira rivers. Pune

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district bordered by Ahmednagar district in the north, Solapur and Satara districts in the south, Ahmednagar and Solapur districts of the east, Raigad and Thane district of the west.

The soil of the district is lighter in the west than that in the east. It belongs broadly to three classes viz., Black, Red and Brown. Bhima is the main river in Pune district. It originates from west side of district at Bhimashankar in Sahyadri ranges. In Pune it flows in south-east direction and enters in Solapur district. River Bhima has many tributaries viz., Welu, Ghod on the right side and Indrayani, Mula and Mutha on left side. Kanhan, Kukadi, Pavana, Meena, Gunjavani, Pushpawati, Shivganga, such other rivers also flow through Pune district. It is observed that at least one river flows through each taluka.

The general climate of the Pune district is tropical but we observe that it is cool in western region and dry in the middle region. Maximum rainfall receives from the south-west monsoon winds; some region also receives rain from north-eastern wind. Rainfall decreases as we go from west to east region.

The area of Pune district is 15642 sq.km, which is 5 per cent of total area. According to 2011 census population of the district is 94.29 lakh out of which 49.24 lakh are male and 45.05 lakh are female. The density of population is 603 person per sq.km. Out of total population 39 per cent is rural as against 61 per cent of urban.

Agriculture is one of the important occupations of the study region. The economy of study region is depending on agricultures. Considering the above facts present study was undertaken with the totality to study the changes in land use and cropping pattern and to study the growth rates in area, production and productivity of major crops.

METHODOLOGY

The study is based on the secondary time series data. The data obtained on the land use, cropping pattern for the selected thirty three years, area, production and productivity of selected crops covering the period from 1980-81 to 2012-13 in respect of Pune district were obtained by referring

the Socio-Economic Review published by Directorate of Economics and Statistics, Maharashtra state and the data were analysed by simple tabular method.

The data obtained on area, production and productivity of major cereals, pulses, oilseeds and cash crops for the period from 1980-81 to 2012-13 in respect of Pune district were used for estimation of compound growth rates. The data was analysed to have compound growth rates in area, production and productivity of the above said crops for three different periods viz., Period I 1980-81 to 1994-95, Period II 1995-96 to 2012-13 and for overall period 1980-81 to 2012-13. This became useful for studying the changes in the performance of the selected crops during the above periods in Pune district.

I. Compound Growth Rate

The compound growth rates were worked out by fitting exponential function of the following type to the data for three periods explained above

$$Y = ab^t$$

Where,

Y = Area in hectares, production in quintals and yield in quintals per hectare

a = Intercept

b = Regression coefficient

t = Time period in year

Finally the annual rate of compound growth in area, production and productivity of the crops was worked out by using the formula.

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

The significance of the estimated compound growth rates were tested with the help of students' t test.

II. The Important Factors Influencing Agricultural Production in Pune District

Identifying the important variables and their role in influencing agricultural production was used for fitting a multiple regression equation of the following type.

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + ut$$

Where,

Y = Total agricultural production of food grain + non-food grains in Pune (₹ in crores).

a = Intercept

b_i 's = Regression coefficient

X_1 = Percentage of gross irrigated area to gross sown area.

X_2 = Consumption of total fertilizer (NPK) per hectare of gross irrigated area (kg).

X_3 = Percentage of gross sown area to net sown area.

X_4 = Percentage of area of HYV seeds to gross sown area.

X_5 = Percentage of area under commercial crops to gross sown area.

X_6 = Amount of loan (short-term and medium-term) disbursed through PACCS per year (in lakh).

X_7 = Average annual rainfall in the Pune (mm).

X_8 = Area under fruits crops (ha)

X_9 = Number of milch animals (No).

ut = Error term.

RESULT AND DISCUSSION

1. Changes in Land Use Pattern

The period-wise changes in land use and cropping pattern had been shown in Table 1. The area under forest was 191900 hectares *i.e.*, 12.29 per cent of total geographical area in 1980-81, which decreased to 162100 hectares in 2012-13 *i.e.*, it decreased by 15.22 per cent over the base year. Barren and uncultivable land increased from 9.46 per cent to 9.98 per cent. Land under non-agricultural use increased from 43700 hectares to 132000 hectares during the period from 1980-81 to 2012-13. The cultivable wasteland area showed decline, it was 77800 hectares in 1980-81 and decreased to 38500 hectares *i.e.* 4.98 in 1980-81 to 2.46 per cent in 2012-13 of the total geographical area.

The area under permanent pastures and land under miscellaneous trees increased over a period. Permanent pastures increased from 44200 hectares to 72800 hectares. Current fallow land increased from 16500 hectares in 1980-81 to 36200 hectares in 2012-13. Other fallow land decreased from 40900 hectares in 1980-81 to 32400 hectares in 2012-13. The net sown area was 997800 hectares *i.e.* 63.88 per cent

Table 1
Land use pattern of Pune district (1980-81 to 2012-13) (00 ha)

Sr. No.	Particulars	1980-81 (Base Year)	1995-96	2012-13	Per cent change over base year	
					1995-96	2012-13
1.	Geographical area	15620	15620	15620	00	00
2.	Forest	1919(12.29)	1769(11.32)	1621(10.38)	-7.82	-15.52
3.	Barren and uncultivable land	1478(9.46)	1076(6.89)	1559(9.98)	-27.20	5.48
4.	Land under non-agril. Use	437(2.79)	578(3.70)	1320(8.45)	32.26	202.06
5.	Cultivable waste	778(4.98)	342(2.19)	385(2.46)	-56.04	-50.51
6.	Permanent Pastures	442(2.83)	615(3.94)	728(4.66)	39.14	64.70
7.	Land under Miscellaneous tree	14(0.09)	79(0.51)	131(0.84)	464.29	835.71
8.	Current fallow	165(1.06)	355(2.27)	362(2.32)	115.15	119.39
9.	Other fallow	409(2.62)	419(2.68)	324(2.07)	2.45	-20.78
10.	Net sown area	9978(63.88)	10387(66.5)	9190(58.84)	4.1	-7.9
	Irrigated area	1307(8.37)	2343(15)	2699(17.28)	79.26	106.50
	Unirrigated area	8671(55.51)	8044(51.50)	6491(41.56)	-7.23	-25.14
11.	Area sown more than once	895(5.73)	2709(17.34)	2523(16.15)	202.68	181.89
12.	Total cropped area	10873(69.60)	13096(83.84)	11713(74.99)	20.44	7.73
13.	Cropping intensity (%)	109	126	127.5		

(Figure in parentheses indicate the percentage to geographical area)

Table 2
Cropping pattern of Pune district (1980-81 to 2012-13) (ha)

Sr. No.	Particulars	1980-81	1995-96	2012-13	Per cent change over base year 1980-81	
					1995-96	2012-13
1.	Rice	50017(4.6)	51900(3.96)	52400(4.47)	3.77	4.76
2.	Wheat	27157(2.50)	48979(3.74)	29700(2.54)	80.36	9.36
3.	Jowar	447500(41.16)	547400(41.80)	197600(16.87)	22.32	-55.84
4.	Bajra	138025(12.69)	143900(10.99)	24800(2.12)	4.26	-82.03
5.	Maize	2900(0.27)	8745(0.67)	22000(1.88)	201.55	658.62
6.	Other cereals	97369(8.96)	23403(1.79)	7600(0.65)	-75.96	-92.20
	Total cereals	762968(70.17)	824327(62.94)	334100(28.52)	8.04	-56.21
7.	Gram	14023(1.29)	38209(2.92)	22000(1.88)	172.47	56.88
8.	Red Gram	5472(0.50)	5800(0.44)	900(0.08)	5.99	-83.55
9.	Green Gram	2722(0.25)	7400(0.56)	2000(0.17)	171.86	-26.52
10.	Black Gram	4200(0.39)	2100(0.16)	1000(0.08)	-50	-76.19
11.	Other Pulses	37736(3.47)	16973(1.30)	9100(0.78)	-55.02	-75.88
	Total Pulses	64153(5.90)	70482(5.38)	35000(2.99)	9.86	-45.44
	Total foodgrains	827121(76.07)	894809(68.32)	369100(31.51)	8.18	-55.38
12.	Sugarcane	17600(1.62)	38900(2.97)	137700(11.76)	121.02	682.39
13.	Cotton	5978(0.55)	141(0.01)	100(0.008)	-97.64	-98.33
14.	Fruits	4289(0.39)	11634(0.89)	37828(3.23)	171.25	781.98
15.	Groundnut	25185(2.32)	44845(3.42)	22500(1.92)	78.06	-10.66
16.	Sunflower	200(0.02)	3000(0.23)	2100(0.18)	1400	950
17.	Other Oilseeds	27215(2.50)	55155(4.21)	38800(3.31)	102.66	42.57
	Total oilseeds	52600(4.84)	103000(7.86)	63400(5.41)	95.82	20.53
18.	Other crops	179712(16.53)	261216(19.94)	563172(48.08)	45.35	213.38
19.	Gross cropped area.	1087300	1309700	1171300	20.44	7.73

(Figure in parentheses indicate the percentage to geographical area)

in 1980-81, which has decreased to 919000 hectares *i.e.* 58.84 per cent in 2012-13. The unirrigated area declined by 25.14 per cent while the irrigated area increased by 106.5 per cent during the period under study.

Area sown more than once increased by 181.89 per cent over the base year. The total cropped area also increased by 7.78 per cent over the base year. The intensity of cropping which is a measure of land use efficiency did show increase during period from 1980-81 to 2012-13 for the period under study, it has increased from 109 per cent to 127.5 per cent.

2. Changes in the Cropping Pattern

It can be seen from the Table 2, the area under Rice increased from 50017 hectares 1980-81 to 52400 hectares in 2012-13.

The area under wheat increased from 27157 hectares in 1980-81 to 29700 hectares in 2012-13 *i.e.* from 2.50 per cent to 2.54 per cent of the gross cropped area. The area under jowar increase in second period *i.e.* 1995-96 as compared to base year but it declined in 2012-13. The area under bajra showed increase in area during 1995-96 but tremendous decrease during 2013-13 over base year.

Total cereals showed decline in 2012-13 but there was increase 1995-96 over the base year. Area under gram was 14023 hectares in 1980-81 and increased up to 22000 hectares in 2012-13 that is from 1.29 per cent 1.88 per cent. However, area under Red gram declined over base year. Green gram decreased from 2722 hectares to 2000 hectares during 1980-81 to 2012-13 *i.e.* from 0.25 per cent to 0.17 per cent. Area under Black gram declined and total pulses

Table 3
Annual compound growth rates in area, production and productivity of cereals, pulses and Total foodgrains in Pune district

Sr. No.	Crop	Period I (1980-81 to 1994-95)			Period II (1995-96 to 2012-13)			Overall Period (1980-81 to 2012-13)		
		A	P	Y	A	P	Y	A	P	Y
1.	Rice	1.79***	-1.67*	-2.29**	3.75	-0.35	2.77	0.2	-0.42	-0.73
2.	Wheat	6.06***	4.04***	2.6***	0.22	1.21	1.67	1.77***	2.48***	1.58***
3.	Jowar	-0.29	-0.52	-0.23	-3.79***	-0.28	3.76***	-1.48***	-0.41	1.77***
4.	Bajra	2.33**	8.56***	5.26***	-8.84***	-9.26***	-0.45	-3.78***	-1.42	2.53***
5.	Maize	7.78***	8.22***	2.53***	4.35***	11.06***	5.14***	1.77***	9.66***	3.3***
	Total Cereals	0.48	0.96	0.67	-3.29***	-0.96	2.52***	-1.37***	19.55***	1.58***
6.	Gram	3.75***	4.07**	3.41**	0.42	1.64	2.48***	1.74***	3.21***	2.08***
7.	Red Gram	-1.3	-3.53	-0.04	-5.34***	-6.99***	-0.91	-3.25***	-2.62**	-0.03
8.	Green Gram	10.96***	19.54***	8.98***	-4.21**	-3.69	1.43	0.58	3.81**	3.18***
9.	Black Gram	-2.42	3.92	7.91**	-2.14**	-0.26	1.44	-2.88***	2.32***	5.14***
	Total pulses	0.79	3.93**	3.76***	-1.82	-4.64	2.26***	-0.48	-0.09	2.18***
	Total Foodgrains	1.05	1.15	0.1	-3.14**	-1.02	2.19***	-1.16***	0.16	1.34***

(*, ** and *** indicates 10, 5 and 1 per cent level of significance respectively.

decreased from 64153 hectares to 35000 hectares *i.e.* 5.9 per cent to 2.99 per cent during 1980-81 to 2012-13. Area under total foodgrains decreased from 827121 hectares to 369100 hectares during 1980-81 to 2012-13.

Area under Sugarcane showed tremendous increase in area. It was 17600 hectares in 1980-81 and increased up to 137700 hectares in 2012-13. Area under Fruits increased from 4289 hectares to 37828 hectares. Area under cotton showed, decreasing trend. Among oilseeds, Sunflower showed increasing trend and groundnut showed decreasing trend. Total oilseeds increased from 52600 hectares to 63400 hectares during 1980-81 to 2012-13. It can be seen from the table that the area under commercial crops is increasing *viz.*, Sugarcane except cotton.

3. Annual Compound Growth Rates in Area, Production and Productivity of Cereals, Pulses and Foodgrains

The periodwise annual compound growth rates in area, production and productivity of cereal crops for the period 1980-81 to 2012-13 are presented in Table 3. The compound growth rates of area,

production and productivity of all cereals, pulses, oilseeds and sugarcane fluctuated widely during the period under consideration. The productivity of cereals like wheat, jowar, bajra and maize are positive and highly significant for the entire period of 33 years. The production and productivity of total cereals increased significantly *i.e.* 19.55 and 1.58 per cent per annum, respectively during the study period. It clearly showed for Pune district the production of total cereals during the span of 33 years had increased mostly by improving the productivity of cereals and less by increase in area under cereals.

The area under total cereals was significantly decreased while production and productivity was significantly increased over the period of time. The per annum growth rates in productivity of total pulses in district have turned out to be positive and highly significant during the entire period under study. The area and production of total pulses in district had decreased at the rate of 0.48 and 0.09 per cent. In general only the productivity of pulses was increased significantly over period of time.

At the overall level, the annual compound growth rates productivity of total food grains were

Table 4
Annual compound growth rates in area, production and productivity of oilseeds and commercial crops in Pune district

Sr. No.	Crop	Period I (1980-81 to 1994-95)			Period II (1995-96 to 2012-13)			Overall Period (1980-81 to 2012-13)		
		A	P	Y	A	P	Y	A	P	Y
1.	Groundnut	3.69***	5.66***	3.5**	-1.7*	-3.41***	0.21	0.53	-0.02	1.09***
2.	Sunflower	35.79***	33***	-0.8	-3.38***	-3.4*	0.53	6.57***	6.63***	-0.35
	Total Oilseeds	5.79***	14.27***	7.95***	-1.03	-2.75**	-1.74**	1.97***	3.62***	1.59**
3.	Sugarcane	7.67***	5.47***	-2.04***	7.34***	8.11***	0.43	6.58***	6.21***	-0.35*
4.	Cotton	-28.48***	-25.13***	2.23	-5.87**	-4.64*	0.26	-8.23***	-6.38***	2.36***

(*, ** and *** indicates 10, 5 and 1 per cent level of significance respectively)

positive and significant, but area were negative and significant. It indicates that area was decline but productivity increases due to production increases.

4. Annual Compound Growth Rates in Area, Production and Productivity of Total Oilseeds and Commercial Crops

It is revealed from the Table 4, the area, production and productivity of total oilseeds, cotton and Sugarcane had fluctuated widely during the period under study in Pune district. The growth rates in area, production and productivity of total oilseeds for entire period have turned out to be positive and significant at the rate of 1.97, 3.62 and 1.59, respectively.

Among different commercial crops, area and production of cotton is declining but productivity is increased significantly. However, the growth rates of area and production of Sugarcane are positive and highly significant but productivity shows negative and significant growth rate. This attributed to different causes of increased in insect and pest problems. In sugarcane positive and highly significant growth rate for area and production which was 6.58 and 6.21 respectively were observed and for productivity it was negative and significant *i.e.* 0.35 per cent.

From the above analysis, it can be concluded that there existed wide variability in the performance of individual crops in terms of changes in their performance, total production, productivity in the district over the period under study. Thus, it clearly indicates the progress of agricultural development in Pune district and its positive effects.

5. Multiple Linear Regression Analysis

Table 5, the production function analysis with above variables was carried for the macro level time series data of agricultural development in Pune district. At the overall period (1980-81 to 2012-13) the regression coefficients of the variables *viz.*, percentage of area under commercial crops to gross sown area (X_5), and amount of loan disbursed through PACCS per year in lakhs of rupees (X_6) were turned out to be positive and highly significant while average annual rainfall in the Pune district (mm) (X_7) and area under fruits crops (ha) (X_8) were turned out to be positive and significant, association with the increase in the value of aggregate crop output in Pune district.

It is noted that if the percentage of area under commercial crops to gross sown area (X_5) increased by one per cent, the value of aggregate crop output would significantly increase by 484.659 crores in Pune district. This emphasizes importance of commercial crop *viz.* sugarcane in economy of Pune district. If amount of loan disbursed through PACCS per year in lakhs of rupees (X_6) increase by one per cent, the value of aggregate crop output would increase by 0.0678 crores. In case of average annual rainfall in the Pune district (mm) (X_7), if it increase by 1 mm the value of aggregate crop output would increase by 0.800 crores. And also if, area under fruits crops (ha) (X_8) increase by 1 ha, the value of aggregate crop output would increase by 0.062 crores.

It is thus clear that percentage of area under commercial crops to gross sown area (X_5), and amount of loan disbursed through PACCS per year in lakhs of rupees (X_6), average annual rainfall in

Table 5
Results of multiple determinations for agricultural development in Pune district

Sr. No.	Variables	Regression Coefficient	Standard Errors	't' stat
1.	Constant/intercept	3943.233		
2.	Percentage of gross irrigated area to gross sown area (X_1)	117.102	83.283	1.406
3.	Consumption of fertilizer (NPK) kg per hectare of gross irrigated area (X_2)	10.144	7.518	1.349
4.	Percentage of gross sown area to net sown area (X_3)	25.102	24.382	1.0295
5.	Percentage of area of HYV seeds to gross sown area (X_4)	19.634	57.076	0.344
6.	Percentage of area under commercial crops to gross sown area (X_5)	484.659***	78.371	6.184
7.	Amount of loan disbursed through PACCS per year in lakhs of rupees (X_6)	0.0678***	0.0217	3.118
8.	Average annual rain fall in the Pune (mm) (X_7)	0.800*	0.419	1.906
9.	Area under fruits crops (ha) (X_8)	0.062*	0.031	1.989
10.	Number of milch animals (No) (X_9)	0.0024	0.00355	0.669
11.	R^2	0.97		
12.	F Value	111.509		

(*, ** and *** indicates 10, 5 and 1 per cent level of significance respectively)

the Pune district (mm) (X_7) and area under fruits crops (ha) (X_8) have importance in the process of development in Pune district.

The regression coefficient of percentage of gross irrigated area to gross sown area (X_1), Consumption of fertilizer (NPK) (kg) per hectare of gross irrigated area (X_2), percentage of gross sown area to net sown area (X_3), percentage of area of HYV seeds to gross sown area (X_4) and number of milch animals (No) (X_9) are positive but non-significant. During period 1980-2013 value of R^2 is 0.97 and F value is 111.509.

CONCLUSIONS

1. The area under cereals, pulses, oilseeds and has commercial crop has increases, but area under total food grains had decreased over the period under study.
2. The growth rates of area, production and productivity of almost all crops increased over the entire period under study except for paddy, red gram, sunflower and sugarcane.
3. The multiple linear regression analysis indicated that the factors *viz.*, percentage of area under commercial crops to gross sown area (X_5), and amount of loan disbursed through PACCS per year in lakhs of rupees (X_6)

were turned out to be positive and highly significant while average annual rainfall in the Pune district (mm) (X_7) and area under fruits crops (ha) (X_8) have significant positive association with the increase in the value of aggregate crop output in Pune district.

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