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SPATIO-TEMPORAL ANALYSIS OF AGRICULTURAL DEVELOPMENT IN GUJARAT

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ABSTRACT

Gujarat has less fertile and mostly arid and semi-arid land. Instead of experiencing erratic behavior of monsoon, it has enjoyed a higher growth rate in agriculture for many decades. But inequality in resource distribution and disparity in agricultural development is still a greater challenge for the state in foreseeable future. Analysis presented in this paper shows a rosy picture of agricultural status of the state of Gujarat, India by constructing a composite agricultural status index at region as well as district level. The findings revealed the declined agricultural performance of Gujarat state over a decade. Eight districts namely Amreli, Surendranagar, Dahod, Bharuch, Dang, Valsad, Patan and Kutchh were found low developed in agriculture which account for about 29 per cent of the total gross cropped area of the state. The study further shows that the regions of Kutchh need greater attention for its agricultural development. For bringing about uniform regional development, model districts have also been identified to improve the agricultural status of low developed districts. Besides, the study also explores different poor performed indicators in each low developed district that require improvement in their performance for enhancing the level of development of respective districts.

KEYWORDS: Agricultural Development, Composite Index, Economic Growth, Low Developed Indicators, Model District, Regional Disparity

INTRODUCTION

Agriculture plays a vital role in the Indian economy. Instead of declining share of agriculture in gross domestic product (GDP) from about 50 per cent in early - 1950s to 14 per cent in 2011-12 it is still an important sector of the economy. Employment in agriculture has declined and presently it accounts for 52 per cent of the country's total labour force (**Arora 2013**). The declining share of agriculture in GDP and employment is consistent with the theory of economic development. Even though, a faster growth in agriculture is required for the economic development. Gujarat has achieved a remarkable place in its economic growth and development. In recent years its agricultural sector has been known to record an impressive growth rate of 9.6 per cent in agriculture during recent years. The state has faced one of the worst droughts of the last century for three successive years from 1985 to 87 (**Bhatia 1992**). It has also witnessed another severe drought for two years from 1999 to 2000. In spite of less fertile land, poor endowment of water and erratic behavior of monsoon Gujarat had achieved significant pace in agriculture development through modernization, diversification and good infrastructure for production and marketing.

The state has initiated a number of schemes such as involvement of private sector for agricultural extension seed production, promotion of micro irrigation especially drip irrigation through a state sponsored agency, Krishi Mahotsava- a special model of Agriculture extension by the state machinery, Expediting the work under Narmada project and local institutions for regulating water use and special efforts for promoting hybrids of Maize in tribal areas for promoting agriculture sector in the state. Though laudable, the actual experience till now is far from satisfactory **(Shah 2011)**.

The present study deals with the assessment of agriculture status of the state by constructing the composite agricultural status index at region as well as district level. The knowledge of agricultural status will help in identifying the measures to be adopted in the development process and bridging the disparity gap. The model districts for low developed districts have been suggested. Further, indicators which are responsible for backwardness of the respective districts in agriculture have been identified.

METHODOLOGY

Indicators of Agricultural Development

District-wise secondary data for the period 2001 and 2010 were obtained from the various reports published by State Bureau of Economics and Statistics, Directorates of Agriculture, Horticulture and Animal Husbandry, Gandhinagar. As per the availability of data and considering the relative importance of the indicator, finally selected indicators are listed below:

- Per animal productivity of milk (ML)

- Per animal productivity of wool (WL)

- Per layer productivity of eggs (EG)

- Number of livestock per 1000 ha of gross cropped area (LST)

- Number of layers per 1000 person (LYR)

- Number of sheep per 1000 person (SHP)

- Net cropped area per 100 person (NCA)

- Irrigation intensity (II)

- Cropping intensity (CI)

- NPK consumption per ha of net cropped area (NPK)

- Percentage of total area under food grains to total gross cropped area (TFA)

- Number of milk chilling centers per lakh livestock (MLCC)

- Number of cattle and poultry breeding farm per 1000 ha of gross cropped area (CPBF)

- Number of primary agricultural credit societies per 1000 ha of gross cropped area (PACS)

- Number milk and livestock co-operative societies per 1000 ha of gross cropped area (MLCS)

Per hectare productivity of 16.rice (RC), 17.wheat (WH), 18.bajara (BJ), 19.maize (MZ), 20.groundnut (GN),

21.cotton (CT), 22.potato (PT), 23.onion (ON), 24.oilseed (OL), 25.foodgrain (FG), 26.pulses (PL), 27.sugarcane (SG), 28.cereals (CR), 29.vegetables (VG), 30.fruits (FR) and 31.spices (SP).

Method of Agricultural Status Index

There are several methods for evaluating the level of development in an economy. The method used in this study for calculati9ng the indices was based on statistical background suggested by **Narain *et al*. (1991)**. Let a set of n points represents districts 1, 2… n having information on K parameters. Let $[X_{(R)ij}]$, where j= 1, 2,…,j_R represent the value of ith parameter of jth district falling in Rth region. The district level parameters (indicators) will be converted in to region level by weighted average method with the help of equation (1):

$$X^*_{(R)i} = \frac{\sum_{j=1}^{j_R} W_{(R)j}(T) X_{(R)ij}}{\sum_{j=1}^{j_R} W_{(R)j}(T)} \tag{1}$$

Where, T= types of parameters, and j_R is the total no of district falling in Rth region. Since the parameters (indicators) included in the analysis are in different unit of measurement, thus, to arrive at single composite index relating to the dimension in question, the indicators will be standardized as shown below:

$$R_{(R)i} = \frac{X^*_{(R)i} - \overline{X}^*_{(.)i}}{S_{(.)i}} \tag{2}$$

Where,

$$S_{(.)i^2} = \sum_{R=1}^{5} \left(X^*_{(R)i} - \overline{X}^*_{(.)i} \right)^2$$

$$\overline{X}^*_{(.)i} = \sum_{R=1}^{5} \frac{X^*_{(R)i}}{5}$$

$$(i=1, 2,…, k)$$

Here, $[R_{(R)i}]$ denotes the matrix of standardized indicators. The best region for each indicator (with maximum or minimum standardized value depending upon the direction of the indicators) will be identified and from this, deviation in the value of each indicator will be considered for all the indicators using the equation given below:

$$C_{(R)} = \left\{ \sum_{i=1}^{k} (R_{(R)i} - R_{(0)i})^2 \right\}^{1/2} \tag{3}$$

Where, $R_{(0)i}$ is the standardized value of the ith indicator of the best region and $C_{(R)}$ denotes the pattern of development is useful in identifying the regions that serves as 'models'. The status index of the Rth region will be obtained through formula given below:

$$D_{(R)} = \frac{C_{(R)}}{C} \tag{4}$$

Where,

$$C = \overline{C} + 2S$$

$$\bar{C} = \sum_{R=1}^{5} \frac{C_{(R)}}{5}$$

$$S = \left\{ \sum_{R=1}^{5} \frac{(C_{(R)} - \bar{C})^2}{5} \right\}^{1/2}$$

The final value of the index will be obtained as per following equation:

$$D^*_{(R)} = 1.0 - D_{(R)} \tag{5}$$

The same methodology has been used by **Rai *et al.* (2008**) for calculating the different sub-indices including agricultural status index to calculate livelihood status indices for different agro-climatic zones of India. The value of status index is non-negative and lies between 0 and 1. The value of index closer to one indicates the higher level of status, while that closer to 0 indicates the lower level of status.

After working out the indices, grouping of the districts into high, medium and low development was done employing the following formula:

$$\text{Level of development} = \overline{X} \pm 0.5\,\text{SD}$$

The regions as well as districts having the value of index more than or equal to (Mean + 0.5 S.D.) are of high level of status, value of index less than or equal to (Mean - 0.5 S.D.) are low level of status and value of index between (Mean + 0.5 S.D.) and (Mean - 0.5 S.D.) are characterize as of medium level of status regions as well as districts.

Model districts for low developed districts have been identified on the basis of composite index of development and the development distance between different districts. Model districts are better developed districts.

RESULTS AND DISCUSSIONS

Gujarat Agricultural Economy: An Overview

Agriculture and allied sector plays an important role in the State economy. The state has adopted a novel pattern of progress with the strategic development of the key sectors like energy, industry and agriculture for which it has achieved ambitious double digit growth rate since 10th Five Year Plan period. The state constitutes about 6.2 per cent of total geographical area and 4.99 per cent of total population of India. As per Census 2011, about 3.47 crores people of the state live in rural areas forming about 57.4 per cent of its total population (**GoI, 2011**). About 70.5 per cent of total workers in the state are rural based. Agriculture continues to be the primary occupation for the majority of rural people in the state (**Swain, M. 2012**).

It is shown in figure that, during the decades of eighty the average annual growth rate of agriculture GSDP in Gujarat was 8.8 per cent. After a little slowdown the growth rate reached to 9.1 per cent during 2000-05 and again it declined again to 5.5 per cent during 2005-12. Whereas, the standard deviation of annual growth rate of agriculture GSDP was continuously declined from 53.5 during 1981-94 to 10.4 during 2005-12. A nearly parallel growth rate with declining variations reveals more consistency in agricultural development in Gujarat.

Figure: Averages and standard deviations of annual growth rates of GSDP from agriculture and allied sectors in Gujarat
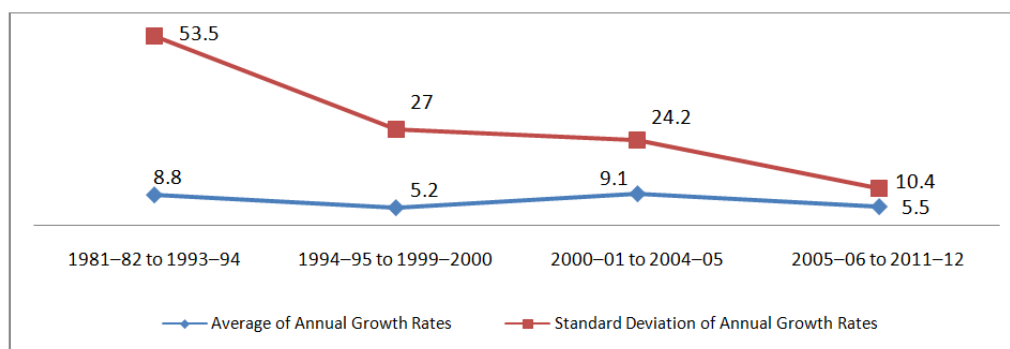
Source: 12th five year plan (2012-17), Planning commission, Govt. of India.

Figure 1

Indices of Agricultural Development

The indices of Agricultural Status at region as well as district level has been calculated using the secondary data for the year 2001 and 2010, collected from different organizations on the factors indicated in the chapter of methodology. The values of agricultural status indices at region as well as district level have been shown in the Table 1 and 2, respectively.

It can be seen from the table 1 that, the North Gujarat region ranked first and Saurashtra region placed to the last position in agricultural development in the year 2001. The values of agricultural status indices varied from 0.0901 in case of Saurashtra region to 0.3856 in respect to North Gujarat region in 2001. A little increase in the value of agricultural status index resulted to replace the Middle Gujarat from the third position (in 2001) to first position in the year 2010. The North Gujarat region was replaced to the second position and the region of Kutchh was found at last position in agricultural development during 2010. The values of agricultural status indices varied from 0.0080 (Kutchh) to 0.3442 (Middle Gujarat) in the year 2010 (Table 1).

Table 1: Composite Indices of Agricultural Development of All the Regions of Gujarat

Sr. No.	Region	2001	2010
1	Saurashtra	0.0901	0.2492
2	Middle Gujarat	0.2672	0.3442
3	South Gujarat	0.3497	0.2823
4	North Gujarat	0.3856	0.2848
5	Kutchh	0.1126	0.0080

The district level indices of agricultural status have been presented in table 2. It can be seen from the table that, in the year 2001, the district of Kheda placed to the first position and Narmada district was found to be at the last position. The values of agricultural status indices varied from 0.3319 (Kheda district) to 0.0152 (Narmada district) in 2001 (Table 2). The table revealed that the district of An and which was ranked 20 in agricultural development during 2001 replaced to first position in 2010. The last position of agricultural status was occupied by the Amreli district. The values of agricultural status indices varied from 0.0435 in case of Amreli district to 0.3589 in respect of the district of Anand in the year 2010 (Table 2).

Table 2: Composite Indices of Agricultural Development of All the Districts of Gujarat

Sr. No.	Districts	2001		2010	
		Index	Rank	Index	Rank
I	**Saurashtra**				
1	Amreli	0.1410	17	0.0435	25
2	Bhavnagar	0.1644	14	0.1575	13
3	Jamnagar	0.1363	18	0.1809	10
4	Junagadh	0.2280	9	0.1568	14
5	Porbandar	0.0555	22	0.1248	17
6	Rajkot	0.1563	15	0.1673	11
7	Surendranagar	0.1249	19	0.0664	21
II	**Middle Gujarat**				
8	Anand	0.1182	20	0.3589	1
9	Ahmedabad	0.2006	11	0.1307	16
10	Panchmahal	0.2417	7	0.1432	15
11	Vadodara	0.2372	8	0.1964	9
12	Kheda	0.3319	1	0.2156	7
13	Dahod	0.0224	24	0.0516	23
III	**South Gujarat**				
14	Bharuch	0.1735	13	0.0727	20
15	Narmada	0.0152	25	0.1658	12
16	Dang	0.1429	16	0.0472	24
17	Navsari	0.1161	21	0.2073	8
18	Surat	0.3020	3	0.2701	2
19	Val sad	0.2042	10	0.1141	18
IV	**North Gujarat**				
20	Gandhinagar	0.2749	6	0.2413	3
21	Banaskantha	0.2860	4	0.2191	6
22	Mehsana	0.2809	5	0.2383	4
23	Sabarkantha	0.3219	2	0.2296	5
24	Patan	0.0402	23	0.0604	22
V	**Kutchh**				
25	Kutchh	0.1830	12	0.0792	19

Further it was interesting to know that the value of indices of most of the districts as well as regions was found declined in the year 2010 as compared to 2001, which shows that the performance of most of districts in agricultural development has been declined over a decade.

Regional Imbalance and Classification of Districts

A suitable classification of the districts from the assumed distribution of the mean of the development indices would provide a more meaningful characterization of different stages of development (**Hrima and Shiyani 2009**). An attempt is made to classify the districts of different regions of Gujarat on the basis of their level of agricultural status. The different levels of development of the districts of different regions with respect to agricultural indices for the period 2001 and 2010 can be seen in the Table 3 and Table 4, respectively.

From the Table 3, it can be seen that during 2001, three districts of Middle Gujarat *viz.,* Panchmahal, Vadodara and Kheda, all the districts of North Gujarat except the district of Patan, and the district of Junagadh and Surat were found high level of agricultural status. Whereas two district of Saurashtra *viz.,* Porbandar and Surendranagar, two district of Middle Gujarat *viz.,* Anand and Dahod, two district of South Gujarat *viz.,* Narmada and Navsari and the district of Patan were found low developed in agricultural.

Table 3: Classification of Districts in to Different Levels of Agricultural Development for the Year 2001

Regions	Districts		
	High	**Medium**	**Low**
Saurashtra	Junagadh,	Amreli, Bhavnagar, Jamnagar, Rajkot	Porbandar, Surendrngr
Middle Gujarat	Panchmhal, Vadodara, Kheda	Amdabad	Anand, Dahod
South Gujarat	Surat	Bharuch, Dang, Valsad	Narmada, Navsari
North Gujarat	Gandhingr, Banaskntha, Mehsana, Sabrkantha		Patan
Kutchh		Kutchh	

The levels of agricultural status of different districts for the period 2010 (Table 4) revealed that, all the districts of North Gujarat except Patan district, two districts of Middle Gujarat *viz.,* Anand, Kheda and the district of Navsari and Surat were found highly developed. Whereas Two districts of Saurashtra *viz.,* Amreli, Surendranagar, three districts of South Gujarat *viz.,* Bharuch, Dang, Valsad and the district of Dahod, Patan and Kutchh were categorized under low developed districts in agriculture.

Table 4: Classification of Districts in to Different Levels of Agricultural Development for the Year 2010

Regions	Districts		
	High	**Medium**	**Low**
Saurashtra	-	Bhavnagar, Jamnagar, Junagadh, Porbandar, Rajkot	Amreli, Surendrngr
Middle Gujarat	Anand, Kheda	Amdabad, Panchmhal, Vadodara	Dahod
South Gujarat	Navsari, Surat	Narmada	Bharuch, Dang, Valsad
North Gujarat	Gandhingr, Banskntha, Mehsana, Sabrkantha	-	Patan
Kutchh	-	-	Kutchh

Table 5 shows that, in the year 2001, the no. of high developed districts was found 9 which account for about 42 per cent of the total GCA of the state and low developed districts was found 7 accounting for about 19 per cent of the total GCA of the state. The share of agriculture in total GSDP of the state was about 13 per cent in 2001 (Table 5). While during 2010, the no. of high developed districts declined up to 8 with declined proportion of GCA accounting for the state up to about 30 percent. The districts under low agricultural development was found increased up to 8 and the proportion of GCA accounting for the state of these low developed districts was also found increased up to about 29 per cent during 2010. Not much difference was found in the proportion of GCA of medium developed districts within both the periods. The share of agriculture in total GSDP was found declined up to about 11 per cent in 2010 (Table 5).

Table 5: Gross Cropped Area under Different Levels of Agricultural Development

Year	Level of Development	No. of District	% of GCA to Total GCA	% Share of Agri. in Total GSDP
2001	High level	9	41.89	13.49
	Medium level	9	39.61	
	Low level	7	18.50	
2010	High level	8	30.21	11.14
	Medium level	9	40.86	
	Low level	8	28.93	

Model District and Low Developed Indicators

For making improvement in the level of development, it is quite important to identify the districts, which might be considered as model for low developed districts. This will provide an avenue for making improvement in the developmental indicators of the low developed districts. The identification of model districts has been made on the basis of composite index of development and developmental distances between different districts (**Narain *et al.* 2002**). Eight districts covering 29 per cent of the total GCA of the State are observed to be low developed in agriculture. List of model districts for these low developed districts is given in Table 6.

Table 6: List of Model Districts for Low Agricultural Developed Districts in 2010

Low Developed Districts	Model Districts
Amreli	Bhavnagar, Jamnagar, Rajkot, Surendranagar, Patan, Kutchh
Surendranagar	Bhavnagar, Jamnagar, Kutchh
Dahod	Panchmahal, Kheda
Bharuch	Vadodara, Narmada
Dang	Valsad
Valsad	Ahmedabad, Navsari
Patan	Bhavnagar, Surendranagar, Gandhinagar, Banaskantha, Mehsana, Sabarkantha
Kutchh	Jamnagar

Further, the indicators which have low value in different low developed districts are identified and shown in Table 7. These are the different poorly performed indicators that require improvement in their performance for enhancing the level of agricultural development of respective districts. The lower

Table 7: Poor Performed Indicators in Low Agricultural Developed District In 2010

Low Developed Districts	Low Developed Indicators with Their Real Values in Bracket						
Amreli	EG (106.05)	LST (861.60)	BJ (800.00)	GN (177.00)	OL (187.00)	TFA (5.49)	II (112.85)	MLCS (0.23)
Surendranagar	EG (112.73)	LST (934.50)	BJ (960.00)	PL (414.00)	TFA (11.79)	PACS (0.38)		
Dahod	ML (214.03)	WH (1848.00)	CT (340.00)	FG (884.00)	CR (945.83)			
Bharuch	WL (0.93)	WH (1559.00)	CT (345.00)	FG (921.00)	VG (11222.01)	II (104.94)	CI (104.20)	
Dang	ML (281.43)	EG (120.43)	RC (1101.00)	FG (993.00)	CR (1080.14)	CI (104.87)	NPK (1.79)	PACS (1.06)
Valsad	NCA (8.78)							
Patan	BJ (566.00)	CT (310.00)	PL (280.00)					
Kutchh	ML (314.27)	EG (117.50)	BJ (938.00)	FG (981.00)	PL (415.00)	VG (10453.39)	MLCS (0.06)	

Note: Present value of the indicators is given in bracket.

development of Amreli district was due to lower productivity of egg, less number of livestock per unit of gross cropped area, lower productivity of oilseeds including groundnut, less proportion of foodgrain per unit of gross cropped area, lower irrigation intensity and less numbers of milk and livestock cooperative societies.

CONCLUSIONS

The study has revealed the agricultural development of Gujarat. It has been found that most of regions as well as districts were declined in their performance of agricultural development over a decade. Greater imbalance in agricultural development among different regions as well as districts of the state has been observed. The regions of Saurashtra and the Kutchh region need proper care for their agricultural performance since the value of status indices of both the regions was found very low in both the periods. The districts of Surendranagar, Dahod and Patan which were found low developed in both the periods. Eight districts including Amreli, Bharuch, Dang, Valsad and Kutchh which were found low developed in agriculture account for about 29 per cent of the total GCA of the state. Therefore these hitherto low developed districts need urgent attention of policy makers as well as of the state government for its agricultural development. In order to reduce the disparities in development among different regions, model districts have been suggested. For making improvement in the level of development poor performed indicators in different low developed districts has been identified.

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