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### **Variation in rainfall and sugarcane production in Pune district, Maharashtra: 2006-2016**

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#### **ABSTRACT:**

The sugar industry, especially co-operative sugar industry has become a back bone of rural economy in last 30 years in Pune district and western Maharashtra. Sugarcane is a cash crop grown in rural tracks of Pune district, where favorable climatic condition, rainfall, land fertility and irrigation facilities are available. Pune district has overall 17 sugar factories including 12 in co-operative sector and 5 are private. Pune district is developed in agriculture along with many facets like industry, services, transport and communication. With the development of irrigation facilities in Pune district tehsils like Baramati, Daund, Indapur, Junnar, Ambegaon, Shirur etc. are developed in sugarcane cultivation. Sugar industry has brought many changes in rural life style in Pune district. Facilities like education, health, transportation and jobs are available only due to development of sugar industry in rural areas of Pune district. But sugarcane crop is very costly comparing to other crops; it needs large amount of water, fertile soil, and fertilizers. Climatic condition and rainfall also affects on growth of sugarcane which ultimately affect on sugar industry and rural economy of the Pune district. This paper is an attempt to study the development of sugar industry in Pune district through sugarcane crop, its requirements and impact of climatic condition especially rainfall variation on sugarcane production in Pune district in last 10 years.

**KEYWORDS:** Human Development, Physiography, Economic Development, Co-Operative Movement, Rainfall Variation,

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## INTRODUCTION

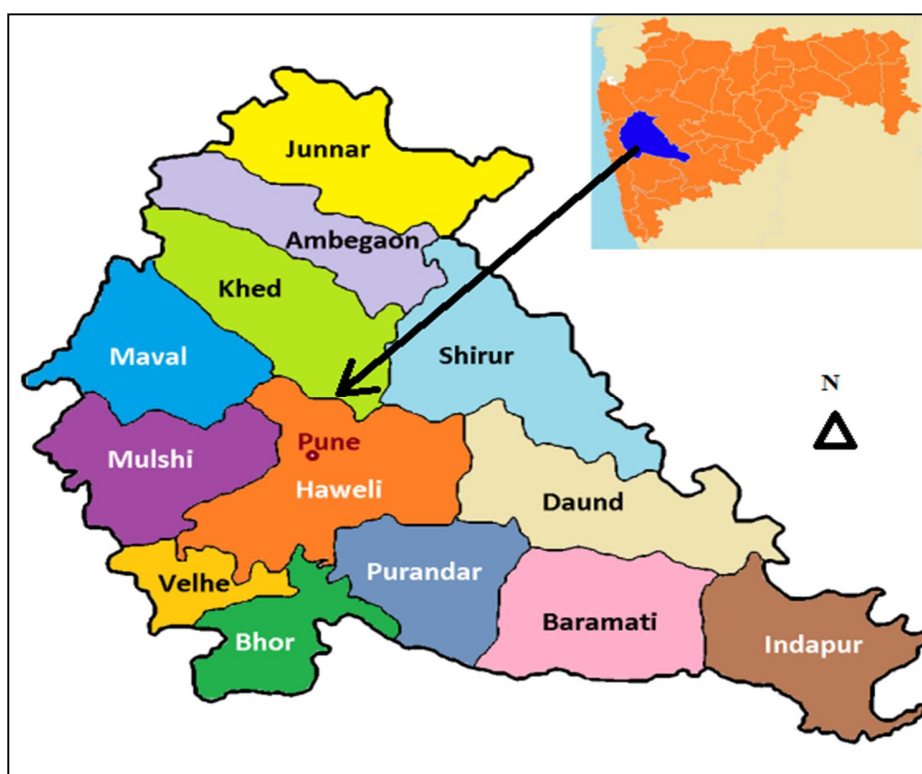
Now-a-days the focus of the study of geography is shifted towards the Man. In earlier period, Geography was supposed to be mainly study of natural environment. It mainly deals with the physical factors, processes and changes on earth surface. As defined by Richard Hartshorne (1959), 'Geography is concerned to provide accurate, orderly and rational description and interpretation of variable characters on the earth surface'. Geographers mainly study the impact of environment on human beings. In early 20<sup>th</sup> century, thanks to the Vidal-de-la-Blache, Jean Brunhes and others, the man himself becomes the center of geographical study. Human geography mainly deals with the use of natural environment surrounding the man for the betterment of him. (Fredrick Ratzel, 1905). In other words, it is a study of changing relationship between unresting man & unstable earth. (Miss. Ellen Semple, 1912)<sup>1</sup>. Geography is the study of areal differentiation in all its aspects. Such regional studies are known as *idiographic* studies. The work of Vidal de la Blache has served as model in studying regional geography for more than half a century.

Human geography touches all aspects of human life e.g. agriculture, Settlement, life style, transport, industry, social & cultural aspects, etc. Many branches have evolved for studying these different aspects. But man, his population, its activities, economic development & life style itself are very important aspects of study. From that point of view, a special branch has evolved in geography i.e. Economic Geography. Development is a dynamic concept. It has different meaning for different people. Some people say it means increase in income, others emphasis on employment, income, quality of life, happiness and so on. Economic Development has been defined as, "a process of growth, expansion or realization of potential, bringing regional resources into full productive use" (Majid Husain, 2010)<sup>2</sup>. The roots of the concept of human development can be traced to early periods in human history. Aristotle wrote, "wealth is evidently not the good we are seeking, it is merely useful and for the sake of something else." The human development approach in geography became popular by French geographers Febvre and Vidal de la Blache. Subsequently, Hartshorne, Kirk and Tuan along with William Petty, Gregory King emphasis on human development. The type of economy an area has, determined by the size of its working force and the nature of jobs available in agrarian economies controlled by climate.<sup>3</sup> This paper also studies impact of climatic factors on agriculture, especially sugarcane production in Pune district. Development of any region is mainly governed by physical factors. Sugarcane is a crop which is specially grows in tropical climate, with factors like fertile land, suitable climate, large capital

investment and irrigation facilities. In this paper, we will discuss the impact of rainfall distribution on sugarcane production in Pune district.

## EXPERIMENTAL SECTION

### *The study region*



Map No. 1: Location of Pune District in Maharashtra<sup>4</sup>

The study region i.e. Pune district is an important district in Maharashtra state. Pune district is advanced in agriculture, industry, urbanization, education, and culture. Pune district is fourth populous district in India with about 94, 26,959 population.<sup>5</sup> Pune district has the sex ratio of 915 females per 1000 males comparing to state 927 per 1000 males. The population density of the district is 603/sq.km. comparing to 365/sq.km. of the state. Pune district has an area of about 15643 sq.km. which is divided in 15 tehsils and 13 panchayats. The tehsils are Junnar, Ambegaon, Khed, Maval, Mulshi, Velhe, Bhore, Haveli, Purandar, Indapur, Daund, Baramati, Shirur, Pune city and Pimpri-chinchwad city. There are around 1866 villages in Pune district. It is bounded by Thane district to the northwest, Raigad district to the west, Satara district to the south, Solapur district to the southeast and Ahmednagar district to the north and northeast.

The district has average rainfall of 60-90 cm. during monsoon season June-Oct. Summers are hot and dry during March-May. Temperature ranges from 20°C to 38°C, sometimes may reach beyond 40°C. During winter season November to February, temperature hovers around 9°C to 14°C, sometimes drops up to 3°C. Pune district has many rivers originating in Western ghat or Sahyadri ranges, like Mula, Mutha, Pavana, Nira, Bhima, Indrayani, etc. make it water rich district. Beside that district has very fertile black cotton soil. This make Pune district most suitable for sugarcane production. Pune district is well connected with roads, railways and airways. Pune is connected by National Highways like, Mumbai-Bangalore (NH4), Pune-Sholapur- Hyderabad (NH9), Pune –Nasik (NH50), Mumbai-Pune Expressway and many state highways and local roads. It is also a major railway junction in Western railways connecting to the rest of country. Pune International Airport located at Lohegaon gives access to the rest of the world.

Pune district is most economically developed district in Maharashtra after Mumbai. All economic activities from primary to quaternary are carried out in district, but these are concentrating in specific regions. Economic development can be seen in agriculture, industry and services. Per Capita income of Pune district was Rs.34, 358 in 2001, which increase to Rs.1, 40,570 in 2011. Human Development Index (HDI) was 0.722 in 2001 which raze to 0.814 in 2011.<sup>6</sup>

### ***Aims and objectives of the study***

The main purpose of present paper is to analyze the connection between the variation in rainfall and the sugarcane production in Pune district. Pune district has varied in physical and climatic condition. In addition the demography and cultural aspects are also different in different part of the district. The main objectives of present study will be as follows:

- I) To study the development of sugarcane production in Pune district,
- II) To study the variable physico-climatic condition in Pune district,
- III) To Study the connection between the variation in rainfall and the sugarcane production in Pune district.

### **DATA SOURCES AND METHODOLOGY**

This research paper is mainly based on secondary data. The data is collected from various governmental and non-governmental sources. The authentic data of sugar production is collected by Vasantdada Sugar Institute, Manjari, Pune is used in this study. Climatic data about rainfall in Pune district is borrowed from Indian Meteorological Department (IMD), Shivajinagar, Pune. Field visits are

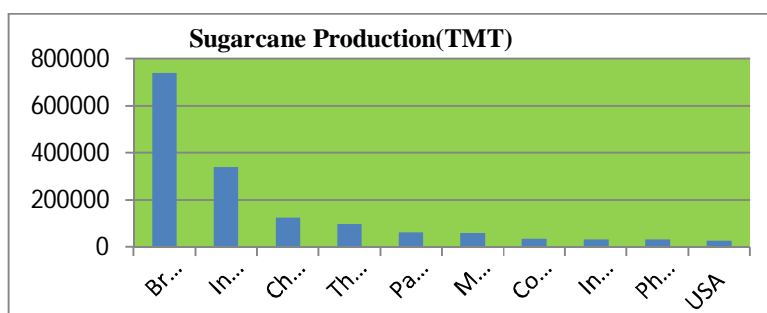
arranged to various sugar factories and sugarcane fields. Analytical method is used to assess the reasons, trends and factors of sugarcane production and their impact on rural economy in different parts of the Pune district. After collecting the secondary data, it has been tabulated and presented with the help of various statistical techniques. Various maps and diagrams have been prepared to show different types of information. The analysis and interpretation of data has been done from the geographical point of view.

### History and development of sugarcane crop

Sugarcane has many species of tall perennial true grasses of the genus *Saccharum*, tribe *Andropogoneae* and native to the tropical regions of South Asia and Melanesia which is used for sugar production. It has thick, jointed, fibrous stalks that are rich in the sugar sucrose, which accumulates in the stalk internodes. The plant is two to six meters (6 to 20 feet) tall. Sugarcane belongs to the grass family of *Poaceae* which is an economically important seed plant family that includes maize, wheat, rice, and sorghum. Sucrose extracted and purified in specialized sugar factories, is used as raw material for food industry or used to produce ethanol. Ethanol is produced on a large scale by the Brazilian sugarcane industry. Sugarcane is the world's largest crop by production quantity.<sup>7</sup> Sugarcane accounts for 80% of sugar produced; remaining is made from sugar beets. Sugarcane mainly grows in the tropical and subtropical regions, while sugar beets grow in colder temperate regions only. The Persians and then the Greeks encountered the famous "reeds that produce honey without bees". In India between the 6th and 4th centuries BC, they adopted and then spread sugarcane agriculture. Merchants began to trade sugar from India to Europe and Middle East which was considered a luxury and an expensive spice. In the 18th century AD, sugarcane plantations began in Caribbean, South American and Indian Ocean and Pacific island nations. Western ruler countries need for laborers became a major reason for large human migrations, including slave labor and indentured servants during colonial period.

Table & Figure No. 1: Top Ten Sugarcane Producers in World – 2015

Countries	Production(TMT)
Brazil	739267
India	341200
China	125536
Thailand	100096
Pakistan	63750
Mexico	61182
Colombia	34876
Indonesia	33700
Philippines	31874
U.S.A.	27906



Source: Food And Agricultural Organization of United Nations: Economic And Social Department (2015)

As seen from the Table no. 1, Brazil and India accounts for more than half of world sugarcane production, which comes under tropical climate. Mainly tropical climate with a minimum of 60 cm (24 inch) of annual rainfall is useful for sugarcane cultivation. It is one of the most efficient photosynthesizers in the plant kingdom. It is a C<sub>4</sub> plant, able to convert up to 1% of incident solar energy into biomass. Sugarcane crop can produce over 15 kg/m<sup>2</sup> of cane. It is grown in the tropical regions of Mauritius, Dominican Republic, Puerto Rico, India, Guyana, Indonesia, Pakistan, Peru, Brazil, Bolivia, Colombia, Cuba, Philippines, El Salvador, Jamaica, Hawaii, etc. The crop can't bear severe frosts. Therefore, most of the world's sugarcane is grown in between 22°N and 22°S. Sugarcane crop is confined up to the height of 1,600 meters (5,200 feet) close to the equator in countries such as Colombia, Ecuador, and Peru. Plentiful sunshine, fertilizers and water supplies increase cane production. This has made desert countries with good irrigation facilities such as Egypt some of the highest-yielding sugarcane-cultivating regions. Although some sugarcane produces seeds, modern stem cutting has become the most common reproduction method. Each cutting must contain at least one bud, and the cuttings are sometimes hand-planted. Mechanized harvesting mainly practiced in Developed countries like, USA, Australia, etc. but in eastern Developing countries sugarcane is harvested manually. The machine automatically cut the cane, separates the leaves and loads the sugarcane into the carrier. Such machines can harvest 100 long tons / hour. Once cut, sugarcane begins to lose its sugar content, and damage to the cane during mechanical harvesting accelerates this decline. This mechanical harvesting doesn't require the field to be set on fire; the remains left in the field by the machine consist of the top of the sugar cane and the dead leaves, which act as mulch for the next round of planting.

### ***Development of sugar industry in Pune district***

The beginning of sugar cultivation in Pune district at mass level started after construction of the major irrigation projects in different part of the district. Sugarcane is a water intensive crop. British had taken initiatives in the construction of various dams in Pune district. The oldest dam in Pune district is Khadakwasla dam constructed in 1869 on Mutha river, afterwards Bhatghar dam on Yelwandi river was constructed in 1927. Maharashtra state was formed on 1<sup>st</sup> May 1960; Maharashtra government gave emphasis on construction of various irrigation projects in state and especially in Pune district. The Dams like Mulshi, Chaskaman, Manikdoh, Niradevghar etc. are constructed which allows the rapid growth in the cultivation of sugarcane in Pune district. After 1980 sugar cultivation in Pune district got boost so sugar industry is flourished in Pune district, especially the co-operative sugar industry has developed in rural parts of Pune district.<sup>8</sup> Besides these major projects, Pune district has many medium irrigation

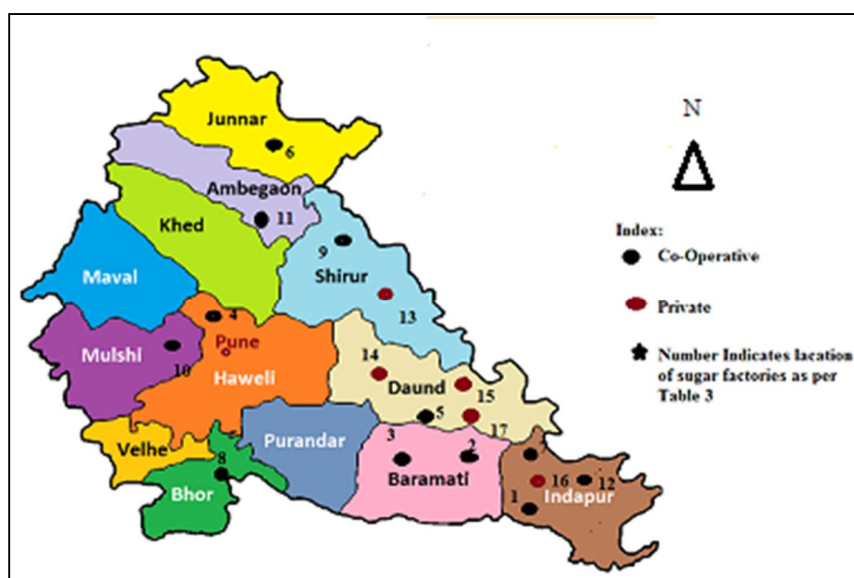


projects like Gunjawani, Pimpalgaon Joge, Yedgaon, Wadaj etc. Though Ujani Dam is a major irrigation project in Maharashtra but it has less useful for irrigation in Pune district as it situates on border of Pune and Solapur district. Many irrigation projects has network of canals for irrigation purpose e.g. Khadakwasla project, Niradevghar, Kukadi project etc. so sugarcane production has increased in tehsils like Junnar, Bhore, Ambegaon, Khed, etc.

**Table No. 2 : Major Irrigation Projects in Pune District**

S. No	Dams	Tehsil	Opening	River	Storage Capacity(Million M <sup>3</sup> )
1	Varasgaon	Mulshi	1975	Mosi	375
2	Manikdoh	Junnar	1984	Ghod	308
3	Niradevghar	Bhor	2000	Nira	337
4	BhamaAskhed	Khed	2000	Bhama	230
5	Dimbhe	Ambegaon	2000	Ghod	382
6	Temghar	Mulshi	2000	Mula	108
7	Chaskaman	Junnar	2002	Bhima	242

Source: Irrigation Department, Maharashtra.



**Map: 2 Locations of Sugar Factories in Pune District**

India is the second largest producer of sugar in the world after Brazil with share of 15% world production. It accounts for 44% sugar production in Asia. Sugar industry after cotton industry is an important agro processing industry in India. Sugarcane farming is source of livelihood for nearly 2.5 crore population in rural Maharashtra. This industry provides direct employment to 1,65,000 workers and 8 lakh workers are engaged in harvesting, cutting and transporting operations every year for simonths.

In Maharashtra, up to 1950, there were 12 private sugar factories. The Co-operative Societies Act was enacted in India in 1904 with objective to provide cheap credit to farmers and save them from exploitation of money lenders. The first co-operative sugar factory was established in Pravaranagar (Loni) in 1950-51 by pioneers of co-operative movement in Maharashtra, Padmashree Vitthalrao Vikhe Patil and Dhananjayrao Gadgil. This legacy of co-operative movement in sugar industry was carry forward by great visionary leaders like shree Yashwantrao Chavan, Vasanttrao Patil, Shankarrao Mohite Patil, Tatyasaheb Kore, Ratnappa Kumbhar and others in Western Maharashtra. Now there are 236 sugar factories are installed out of that 178 are operational (2015-16). Most of which are in co-operative sector and few are private. These factories had crushed 743 lakh tons of sugarcane and produced 84.17 lakh tones of sugar (2015-16)<sup>9</sup>. Pune district has 17 sugar factories, out of which 12 are Co-operative and 5 are in private sector. First sugar factory (Pvt.) in Pune district was installed by famous industrialist Hirachand Walchand in Bhavaninagar (Daund), while first factory in co-operative sector was started in 1957 at Malegaon (Baramati) as Malegaon Sahakari Sakhar Karkhana.

**Table No. 3: Sugar Factories in Pune District (2015-16)**

S. No	Name of Sugar Factory	Owner	Tehsil	Establishment	Crushing Capacity(TCD)
1	Shri Chhatrapati SSK, Bhavaninagar	Co-Op	Indapur	1956-57	3500
2	Malegaon SSK, Shivnagar	Co-Op	Baramati	1957-58	4000
3	ShriSomeshwar SSK, Someshwarnagar	Co-Op	Baramati	1962-63	5000
4	Yashwant SSK, Chintamaninagar	Co-Op	Haveli	1969-70	3500
5	Bhima SSK, Patas	Co-Op	Daund	1981-82	5000
6	Shri Vighneshwar SSK, Nivruttinagar	Co-Op	Junnar	1984-85	5000
7	Karmayogi Shankarraoji Patil SSK,	Co-Op	Indapur	1989-90	5000
8	Rajgad SSK, Anantnagar	Co-Op	Bhor	1991-92	1250
9	Ghodganga SSK, Nhavre	Co-Op	Shirur	1996-97	2500
10	Sant Tukaram SSK, Kasarsai	Co-Op	Mulshi	1998-99	2500
11	Bhimashankar SSK, Pargaon	Co-Op	Ambegaon	2000-01	2500
12	NiraBhima SSK, Shahajinagar	Co-Op	Indapur	2000-01	3500
13	Venkateshkrupa Sugar Mills Pvt. Ltd.	Pvt.	Shirur	2001-02	2500
14	Shrinath Mhaskoba SK, Shreenath Ngr	Pvt.	Daund	2004-05	2500
15	Anuraj Sugar Pvt. Ltd. Yewat	Pvt.	Daund	2007-08	2500
16	Baramati Agro. Shet-palgade	Pvt.	Indapur	2007-08	4500
17	Daund Sugar Pvt. Ltd. Daund	Pvt.	Daund	2007-08	5500

Source: Maharashtra Co-op. Sugar Mills Federation, Mumbai.



### ***Physico-climatic condition in Pune district***

Pune district has high degree of variation in physical and climatic conditions. Western side of district has Western Ghats (Sahyadri ranges) while eastern side is plateau region. Pune district mainly comes under Monsoon climate but there is a local variation. Western region has hot and humid climate while towards east it is hot and dry. Rainfall distribution also changes from west to east.

#### ***1) Agro-Climatic zones:***

Pune district is divided into four agro-climatic zones as described below:<sup>10</sup>

- A) **Western Ghat Zone:** This area includes the high mountain and hilly areas in western ghat having rainfall around 500 cm. Mainly Lonavala and Khandala in Pune district comes under this category which accounts for 1.16 lakh hectares of district.
- B) **Sub-Mountain Zone:** This area is dominated by red to reddish brown soils. It comprises a narrow strip running through the western hilly track of Bhore, Velhe, Mulshi, Mawal, Khed, Ambegaon and Junnar talukas of Pune district. The rainfall is between 170-250 cm. It covers an area of 3.08 lakh hectares in Pune district.
- C) **Western Maharashtra Plain Zone:** This is a wider strip situated parallel to sub-mountain zone extends towards east. It has grayish black soil and rainfall is between 95-125 cm. It spreads over central Bhore, eastern parts of Mawal, Khed, Ambegaon and Junnar talukas.
- D) **Scarcity Zone:** This area is known as famine area of the state. The rainfall is below 75 cm. This zone constitutes 8.21 lakh hectares i.e. 53% of district area. It covers Purandar, Baramati, Indapur, Daund, Shirur, Junnar, Ambegaon, Khed and Haveli talukas.

#### ***2) Soils in Pune district:***

A variety of soils are found in different part of Pune district. Deep black soil is found in plain eastern scarcity zone of Purander, Shirur, Indapur, Daund, Haveli, etc talukas which accounts larges share for 45% of the district. Red or reddish brown soil is found in sub-mountain and western ghat zone. In Pune district, Red soil covers 5%, Alluvial soil 8%, Sandy soil 12% and Sandy loam soil 30% of the area.

#### ***3) Rainfall & Temperature:***

Due to geographical conditions within the district, the rainfall is unevenly distributed. The western parts of district close to west coast are mountain & hilly with forest cover, so rainfall is more in this area comparing to eastern part. Most of the rain is brought by southwest monsoon winds during summer and about 87% rainfall occur during month of June to September.

**Table No. 4 : Talukawise Rainfalls in Pune District: 2006-2016 (in mm)**

Taluka / Year	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Pune City	779.4	689.3	909.7	1169	979.9	492.7	660.4	819.7	780.6	620.4
Haveli	859	706.1	938.3	1147.8	979.6	505.4	661.4	373.9	423.3	385.5
Mulshi	1834	1602	1836.7	1592	1792	1438	2069.4	2014.2	1452.9	2099.5
Bhor	1429.4	998	1213	1121	1129	833	1652.9	1625.6	1223	1888.9
Mawal	1442.6	1399.5	1364.8	1168	1482	1013	2296	1945.1	1632.8	2374.4
Velhe	3263	2409	1405	2043	2695.1	2070.4	2069.6	1812.4	1662.6	1832.2
Junnar	880	747.4	706	862.3	769	557.1	1158.7	963	856.6	1121.3
Khed	756.5	692.7	639.6	1018.4	637.7	436.2	797.4	589.6	804.7	815.6
Ambegaon	830.9	735	732.3	823.4	836	616.6	816.3	584.6	800.3	700.4
Shirur	674	492	859.6	849.5	441.8	321	558.6	352.5	490.5	440
Baramati	622	454	738.8	804.6	291	235	504	417.6	399.4	447.5
Indapur	640.3	345.4	932.4	805.4	399	250.6	506.4	400.5	338.3	470.7
Daund	604.9	326.7	474.3	639.3	347.6	337.4	574.9	372.6	371.4	441.3
Purandar	1476	519	497	806	602	609.4	371	371.3	388.8	270.2
District Average	1149	865	946	1061	956	694	1050	903	830	993

Source: Indian Meteorological Department, Pune

As seen from the table, the talukas like Purandar, Shirur, Daund, Baramati, Indapur are below the yearly average rainfall of the district i.e. 905 mm. while talukas like Bhor, Ambegaon, Junnar, Mulshi, Mawal, Velhe are above the district average. The rainfall distribution changes from west to east, it is more than 3000 mm. in western hilly region, drops to less than 500 mm. in eastern plateau region. So rainfall is not enough for sugarcane cultivation in eastern part of the district. The annual temperature range is 9<sup>0</sup>C to 42<sup>0</sup>C. Summer is hot and dry while winter is cool and dry. Summer temperature is low towards western hilly region while it is high towards eastern plateau region.

#### 4) Drainage & Irrigation:

Pune district has fortunately blessed with plenty of rivers originating in Sahyadri ranges. The main rivers are Mula, Mutha, Pavana, Bhima, Bhama, Nira, Ghod, Mina, Pushpavati, Indrayani, etc. flows through the district. The length of rivers flowing through district is 1252 km. Many dams are constructed on these rivers e.g. Panshet, Khadakwasla, Bhatghar, Kukadi, Niradevghar, Manikdoh, etc. Pune district has a net sown area (NSA) of 9.92 lakh hectares out of which 2.62 lakh hectares was irrigated (2012) i.e. only 26.4% of net sown area was irrigated. The percentage of irrigated area to net cropped area in Indapur (34%), Junnar (31%), Baramati (28%), Daund (25%) and Shirur (24%). The rest of tehsils irrigation percentage was below district average. The district net irrigated area has increased from 1.03 lakh hectares in 1960 to 2.62 lakh hectares in 2011. Canal irrigation accounts for 46.3% and well irrigation 53.7%. Khadakwasla, Ghod, Ujani, Veer, Pavana, Chaskaman, Kukadi etc. dams and

their canals are major sources of irrigation for the district. The district has an area of 29027 hectares under drip irrigation.<sup>11</sup>

### ***Variation in sugar production in Pune district***

Pune district comes under monsoon climate and south west monsoon is main source of rainfall. Over 73% of cropped area is cultivated under rain fed condition in the district. The average rainfall of the district is lower than the state average and variation in rainfall across different part of the district is main constraint in sugarcane production. It is a common fact that the productivity of agriculture goes down sharply whenever there is reduction in rainfall

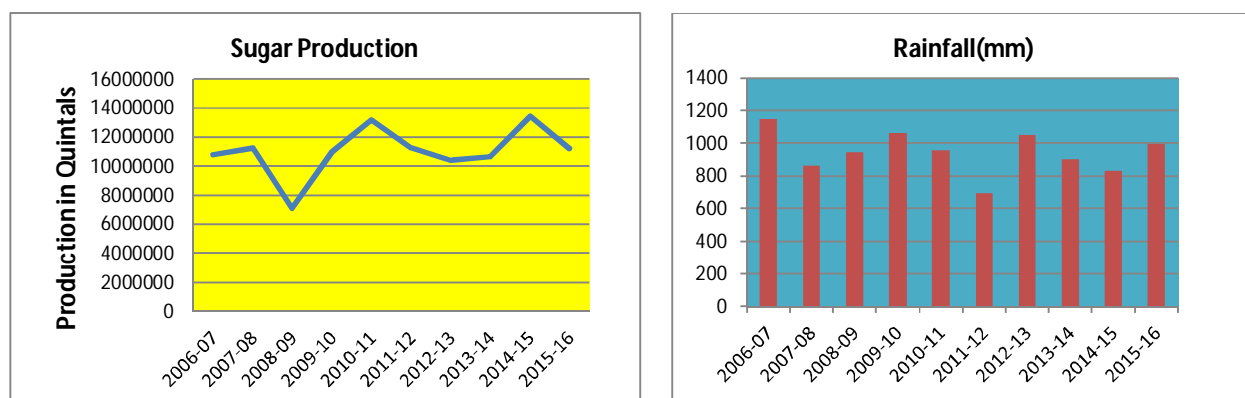
**Table No. 5: Sugar Production in Pune District: 2006-2016**

<b>Year</b>	<b>Factories in Operation</b>	<b>Cane Crushed (MT)</b>	<b>Sugar Production (QNTLS)</b>	<b>Sugarcane Recovery</b>
2006-07	15	9203056	10761861	11.69
2007-08	15	9392976	11255167	12.01
2008-09	15	6220981	7089080	11.40
2009-10	16	9505071	10980202	11.55
2010-11	16	11862488	13183476	11.19
2011-12	16	9881938	11261057	11.40
2012-13	16	9281853	10388955	11.20
2013-14	16	9476408	10657716	11.25
2014-15	16	11964833	13434775	11.23
2015-16	16	9865544	11222847	11.38

Source: Technical Performance of Sugar Mills in Maharashtra, Issues 2006-16

The maximum area of Pune district is categorized as scarcity zone, hence Rabbi Crop with 49.3%, dominate cropping pattern, while Kharif crops are 27.3%. Pune district has 10% area under sugarcane production. Out of irrigated area more than 53% is irrigated by groundwater i.e. well irrigation and remaining is by surface irrigation. So it is obvious that up and down in rainfall also replicate in district sugar production

Figure No. 2: Comparison of Sugar Production and Rainfall in Pune District: 2006-16



As seen from the comparative figures of sugar production and rainfall distribution in district, it is clear that, there is positive correlation between sugar production and rainfall. In Pune district annual average rainfall is 905mm. In the year 2006-07, when rainfall was above normal i.e. 1149 mm. sugar production was 10761861 quintals, with recovery of 11.69. In the year 2008-09 & 2011-12, when rainfall was below the district average, sugar production dropped to 7089080 & 10388955 quintals with recovery of 11.19 only.<sup>12</sup> Pune district has only 26% land under irrigation, so rest of land is rely on fluctuating monsoon. Most of the sugar factories are located in tehsils like Daund, Indapur Shirur etc. which has rainfall below the district average which also affects sugarcane production. Many irrigation projects have not constructed canals to provide water to farms.

## DISCUSSION

The study is carried out to find the connection between sugarcane production and affecting factors especially, rainfall in Pune district. The findings are as below:

- 1) Pune district has striking variation in the sense of population distribution, rural-urban ratio, physiography and climatic factors.
- 2) Pune district has suitable physiography, climate, and soil for the cultivation of sugarcane.
- 3) Pune district has many rivers and irrigation projects still only 26.4 % cultivated land are irrigated in the district. It has not fully utilized the water resources.
- 4) The district has 71 watersheds, out of 11 are semi critical and 2 are critical. Watersheds in tehsils like Baramati, Purander, Junnar and Ambegaon have semi critical watersheds.
- 5) The maximum sugar factories (i.e. 12) come under co-operative sector. This system has problems like inefficiency, corruption, politics, labor management, etc. which affects on sugar industry.

- 6) Most of the sugarcane cultivation is rely on seasonal rainfall from monsoon winds, so fluctuation in rainfall affects on the production of sugarcane in the district.
- 7) There is an urgent need for increase in irrigation facilities plus modern irrigation techniques like drip, sprinklers, etc. so that sugarcane area can be increased with the available rainfall and irrigation facility.

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