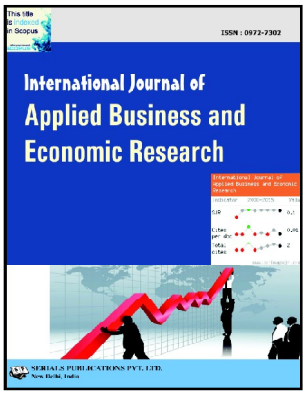

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The Study of Developinga Sustainable Crop Production Patternthrough Trend Analysis in Southern Region of Maharashtra: A Case Study of Satara District

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Abstract: *Background:* Agriculture is a primary source of living for more than 58% of population in India. The crop yield trends are reducing in different areas of the country. This reduction in yield trends may be due to the temperature, rainfall and soil conditions of the area where the crop is grown. Maharashtra has been in news due to farmer's suicides in the recent years. The report claims that most of the suicides have occurred due to low rainfall in areas which has resulted into poor yield of the crops

Purpose: The purpose of the study is to analyse the crop production trends of Southern region of Maharashtra over the last five years, and study the climatic conditions suitable for the crops. and to develop a sustainable crop production pattern in this area by a comparative study of the climatic condition prevailing in Satara.

Methodology: The crop production data is collected from Central Statistical Office, District agriculture department of Satara district. The standard requirements for each crop cultivated in region are collected from Nation Bureau of Soil Survey, Nagpur, and Maharashtra. The Statistical Package for Social Sciences was used for analysis of the data.

Findings: The different trends of crop production and climatic conditions were studied in the southern region of Maharashtra and discussions were made for developing a trend of sustainable crop production in such areas.

Research Implications/Limitations: The study is restricted to southern region of Maharashtra.

Originality: The research is needful for the farmers of this district to follow sustainable cropping pattern.

Keywords: Agriculture, Satara, Cropping Pattern, Temperature, Rainfall, Soil, Crops

1. INTRODUCTION

Agriculture plays a significant role in the overall socio-economic development of India. Itis a primary source of living for more than 58% of population in India (Anonymous, 2013). As per estimates made by the Central Statistical Office (CSO), the agriculture and allied sectors contributed 16.1% of the Gross Value Added (GVA) during 2014-15 at 2011-12 prices. During the first quarter for year 2016, agriculture and allied sectors grew 1.9% year-on-year and contributed 14.2 per cent of GVA (Anonymous, 2016). The Indian farmer's 73.33% households rely only on income from agriculture and 26.66% farmers get income from other sources like dairy, business, labor and livestock (Kaur, 2009). The statistical indications suggest that sustainability in agriculture will help to achieve the long term benefits to the country for achieving the economic development and scarcity improvement.

Maharashtra is one of the most industrialized and urbanized states in India. Its economy is predominantly agrarian. The state has witnessed a growth of 4% in year 2014-2015 in agriculture after a decline of 1% in financial year 2013-2014.According to the 2011 census, the share of agriculture and allied sector in the state was 52.7%(Anonymous, 2016). Inspite of growth in agriculture sector the state has been in news due to farmer's suicides in the recent years. The report claims that most of the suicides have occurred due to low rainfall in areas which has resulted into poor yield of the crops. Therefore the authors have undergone research in the southern region of Maharashtra to find out the cropping trend. They have come out with a sustainable cropping pattern which can match the climatic conditions and can increase the yield of the crop in southern Maharashtra. The objective of the study is

(i) to study the existing cropping trends in the drought prone areas of Southern Maharashtra

(ii) to study the climatic conditions prevailing in the area

(iii) to develop a sustainable crop production pattern with respect to the climatic conditions prevailing there.

2. LITERATURE REVIEW

Climate is one of the important driving forces in agriculture. Agricultural crop production system is greatly influenced by climatic parameters such as rainfall and temperature (Sinha *et. al.*, 1998; Kumar *et. al.*, 2004; Mall *et. al.*, 2006).Along with climate parameters soil plays a significant role for natural growth of the crop (Wang *et.al.*, 2008; Chandy 2016). Deepak *et. al.*, (2013) conducted a research on yield trends and found that the yield trends will be insufficient to meet the needs of the global crop production by 2050. This reduction in yield trends may be due to the temperature, rainfall and soil conditions of the area where the crop is grown. The farmers are unaware of the basic requirements of temperature, rainfall and soil conditions required for a particular crop. This leads to poor yield of the crop resulting into unsatisfactory results. Therefore it is very essential for the farmers to know the basic requirements for the crop and the temperature, rainfall and soil conditions prevailing in the area where the crop is grown. A crop satisfying the climatic conditions of the area where it is grown will certainly result in good production and a high yield. However Sawant and Achuthan (1995) have claimed that the rise in the crop production as compared to the past is not just only because of weather conditions. There are technologies and awareness programmes which have led to increase the crop productivity but he climatic conditions is still a key element in crop productivity. For a stable Indian Economy, where weather has become quite unpredictable, it is essential to sustain the growth of crop production and productivity.Kannan and Sunderam, 2011; have claimed in their research

that the cropping pattern have undergone significant changes over time. Weather conditions like rainfall, temperature and soil is one of the parameter which leads to growth in crop yield. It has been found that temperature and rainfall has a high impact on crop yield. Therefore the climate parameters highly affect the crop production patterns. Traore *et. al.*, (2013); reported that a variation in yield is directly related to change in temperature or rainfall. Therefore farmers should cope with the changing climatic conditions and should follow the cropping patterns which satisfy the climatic conditions.

Study Area

The Southernregion of Maharashtra state which mainly comprises of Sindhudurg, Kolhapur, Sangli, Ratnagiri, Satara, Solapur and Raigad.The area selected for current study isconducted forthe Satara district which situated on Deccan plateau and in southern region of Maharashtra. It covers the area between 17° 5′ 30.12″N to 18°11′ 12.04″ N and 73°33′ 4.34″E to 74°54′ 34.02″E, which corresponds to an area of 10475 km^2. The district is divided into 11 tehsils namely Phaltan, Man, Khatav, Koregaon, Satara, Karad, Patan, Jaoli, Mahableshwar, Wai and Khandala. The region is surrounded by several rivers called Krishna, Koyna, Venna, Vasana, Kudali,Tarali, Urmodi, Yerala, Nira, Manganga and many other smallertributaries.

The major source of livehood for the district is agriculture and study shows that 69.96% population of the district is engaged in agriculture. Out of total geographical area 75.53% population land is under cultivation. The details from Bureau of Economics and Statistics up to year 2010-2011 shows that, the net sown area of the district is 708971 hectares and net irrigated area is 230778 hectares (Survase 2015).The highest cultivated land exist in Khatav tahsil which is 11.44% and lowest is in Mahabaleshwar tahsil which is0.96 % (Dawane2015). Figure 1 shows the location map of Satara district.

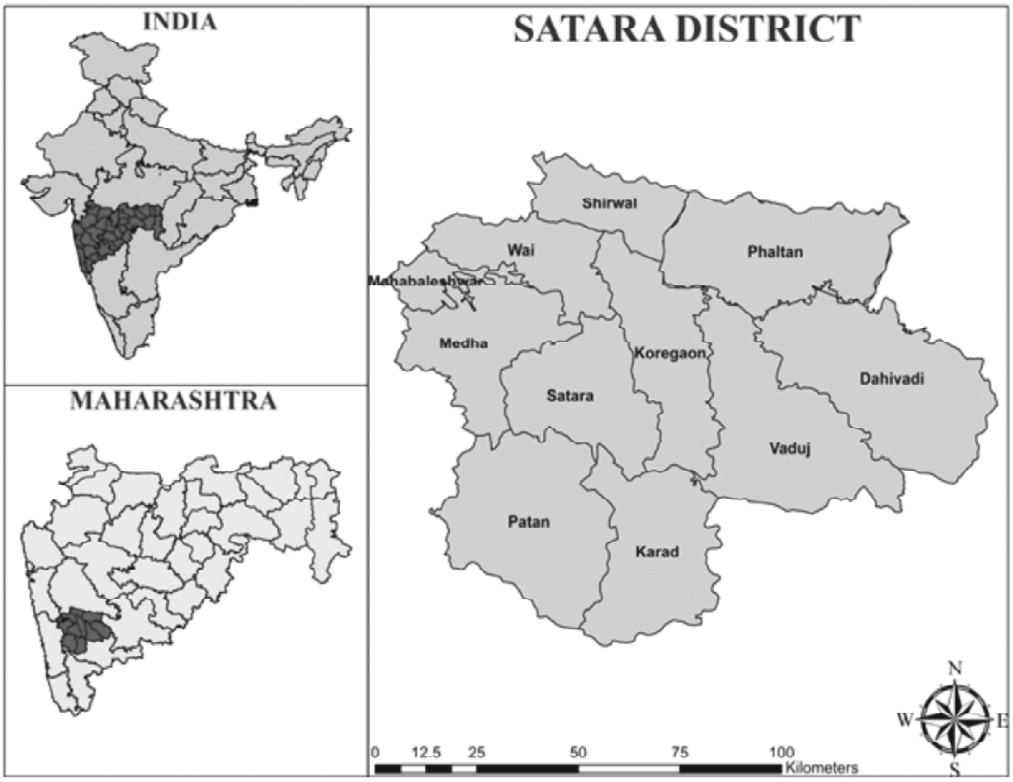

Figure 1: Location Map of the Study Area

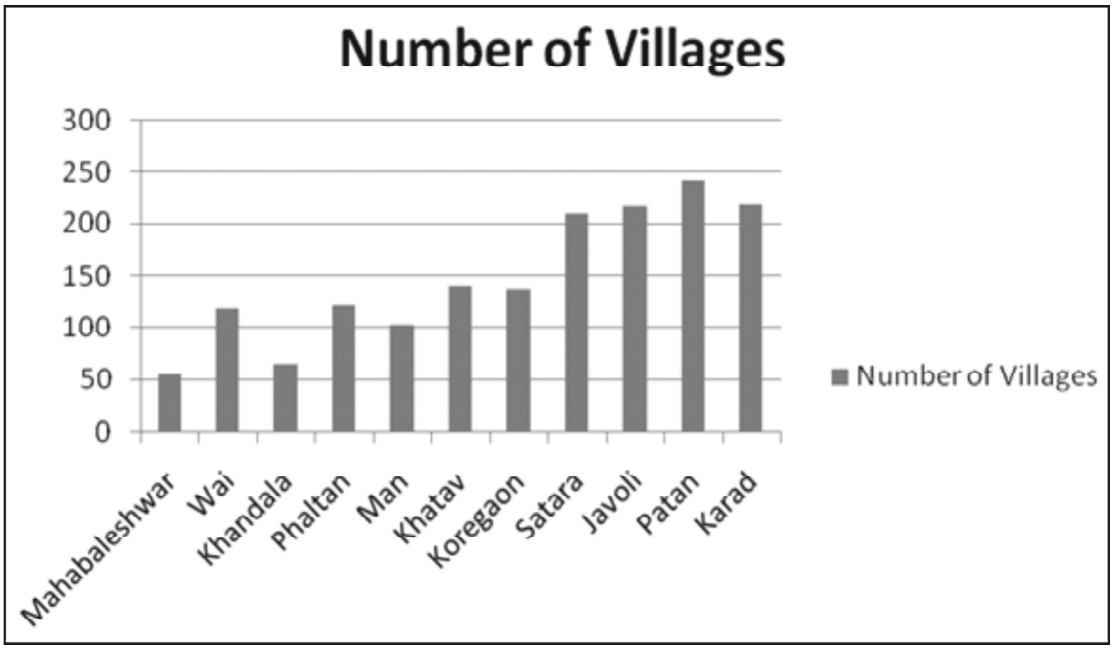

Figure 2: Number of Villages in different talukas of Satara[7]

Satara district comprises of several villages since the area is mainly occupied by the farmers. Figure 3 shows the number of villages in different talukas of Satara district. Satara, Javli, Patan and Karad have maximum number of villages.

2.1. Climate

The yearly average temperature of area varies between 11 (Minimum) to 37 (Maximum). The minimum temperature follows in the month of December and maximum temperature follows in month of May Table 1 shows talukas wise average temperature for the study area. The average annual rainfall is varies from 2000 mm to 2643 mm (Anonymous 2012). Table 2 shows the talukawise average annual rainfall.

Table 1
Talukawise average annual temperature of the Study Area

Seasons	*Taluka Name*	*Temperature°C*
Rainy season	Mahableshwar	17.6
	Karad	26.5
	Mhaswad	29.7
Winter Season	Mahableshwar	12.7
	Karad	16.3
	Mhaswad	14.9
	Wai	14.1
	Khandala	15.3
	Phaltan	14.8
	Man	14.9

Cont. table 1

Seasons	*Taluka Name*	*Temperature°C*
	Khatav	15.4
	Koregaon	15.1
	Satara	14.2
	Javli	13.9
	Patan	14
Summer Season	Mahableshwar	31.5
	Karad	33.5
	Mhaswad	37.2
	Wai	35.4
	Khandala	36.2
	Phaltan	36.9
	Man	37.2
	Khatav	36.5
	Koregaon	35.5
	Satara	35.3
	Javli	34.7
	Patan	35.1

Table 2
Taluka wise average annual rainfall of the Study Area

Taluka Name	*Amount of Rainfall in mm*
Mahabaleshwar	6126.4
Wai	734.6
Khandala	503.8
Phaltan	557.1
Man	496.2
Khatav	512.2
Koregaon	714.7
Satara	1132.1
Javli	1712.2
Patan	1882.5
Karad	713.1
Total	1371.3

2.2. Soil

The soil of the area fall under three main categories as medium black to deep black soil on the plane lands, lighter soil on slope and in the eastern part of the area, Laterite soil in the hilly region on the western side and on the small hillock on the eastern side (Anonymous 2012).

2. MATERIALS AND METHODS

The crop production data is collected from Central Statistical Office, District agriculture department of Satara district. The standard requirements for each crop cultivated in region are collected from Nation Bureau of Soil Survey, Nagpur, and Maharashtra. The Statistical Package for Social Sciences was used for analysis of the data. The different trends of crop production and climatic conditions were studied in the southern region of Maharashtra and discussions were made for developing a trend of sustainable crop production in such areas.

Table 3
Standard Requirements for Soil and Climate Parameters

Sr. No.	*Crop Name*	*Mean Temperature required in Crop Growth season*	*Rainfall (mm)*	*Soil Requirements*
1.	Rice	30-34	1110-1250	Alluvial Soil
2.	Jowar	26-30	650-850, >850	
3.	Ragi	28-34	750-900	Loamy sands to loams
4.	Wheat	20-25	250-1800	loam to clay loam
5.	Maize	21-32	900-1000	Sandy clay loam to clay loam
6.	Groundnut	24-30	700-1000	Sandy and that loamy soils
7.	Sugarcane	30-34	Adequate water	Well drained loamy soils
8.	Cotton	20-25	800·1000	Well drained
9.	Safflower	25- 30	575-625	Sandy loamy soils
10.	Udid	25-28	800-1000	Well drained
11.	Soybean	25- 30	575-625	Sandy loamy soils
12.	Gram	25-28	800-1000	Well drained

3. RESULTS AND DISCUSSIONS

The analysis of the results shows that, study area has crop production trends in different types of crops such as food grains, Oils Seeds, Pluses and Commercial/cash crops.

3.1. Food Grains

The study area shows crop production trends for all the major food grains such as Rice, Wheat, Jowar (Kharif and Rabi) and Maize. Rice is grown in many regions of Satara. Khatav and Koregaon are rice growing talukas as shown in Figure 3 but the rainfall recorded in these areas is not sufficient to grow rice. Therefore rice cannot be said as a sustainable crop for theses area. However the rainfall depicts that Mahabaleshwar and Patan are the areas with heavy rainfall and thee areas can fulfil the water requirements of rice. Kharif Jowar is one of the major crop grown in several talukas of Satara district. The Figure4shows that Patan and Wai are the maximum growers of Jowar crop. According to the district climatic condition this crop can sustain in regions having a good rainfall. For Bajra crop results reveals that the crop is production is available only in semiarid and arid regions of district. As the rainfall requirement for Bajara is less the crop is sustainable in these regions (Figure 5). For Ragi crop it is observed that ragi is grown only in Javali and Patan. According to the climate of Satara, the two talukas have very good amount of rainfall and can sustain the crop (Figure 6). Kharif maize is a major crop in Man, Koregaon and Javeli have

maximum maize production since they meet climate and soil the requirements and the crop can sustain in the region (Figure 7). Rabi Jowar is also one of the crop grown in several talukas of Satara district. Figure 8 shows that Karad and Satara are the maximum growers of Jowar crop. According to the district climatic condition this crop can sustain in regions having a good rainfall. The taluka's Phaltan, Satara, Patan, Wai and Karad are the areas with maximum wheat production (Figure 9). The rabi maize crop shows that Man, Karad, Satara and Wai have maximum maize production since they meet the requirements (Figure 10).

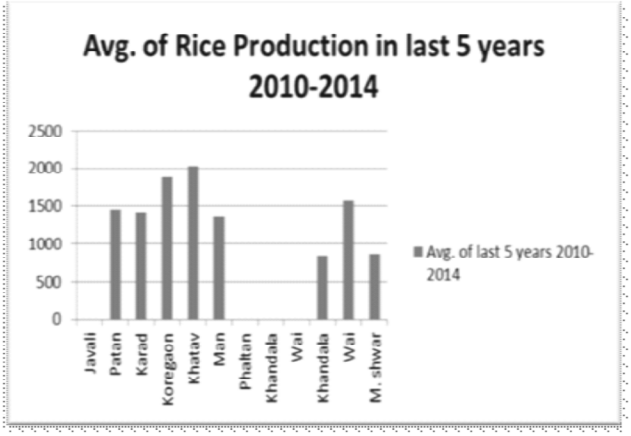

Figure 3: Rice Production Trend

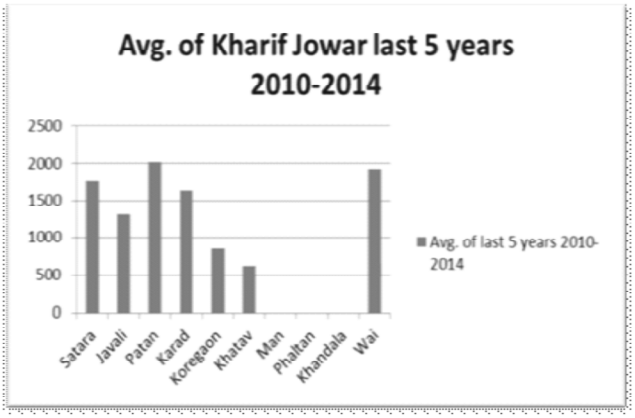

Figure 4: Kharif Jowar Production Trend

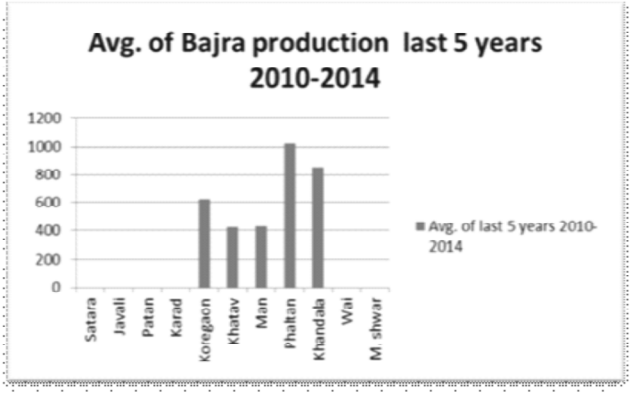

Figure 5: Bajara Production Trend

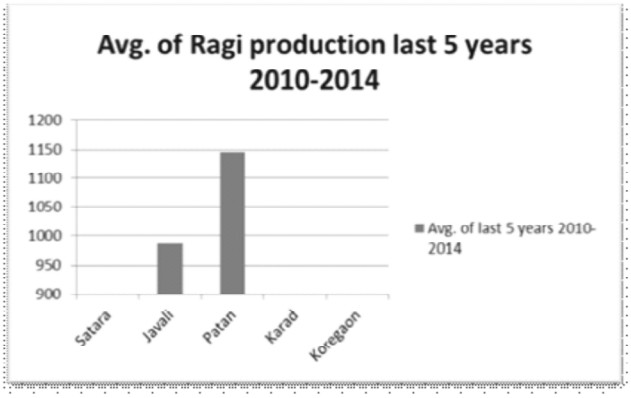

Figure 6: Ragi Production Trend

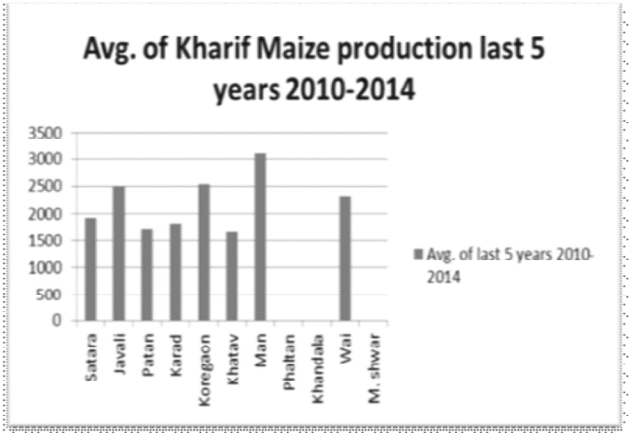

Figure 7: Maize Produciton Trend

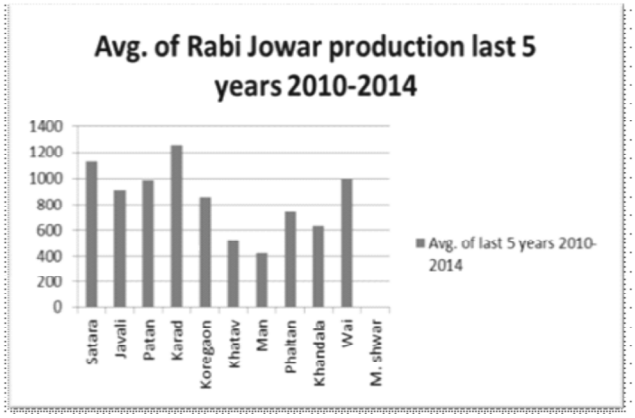

Figure 8: Rabi Jowar Production Trend

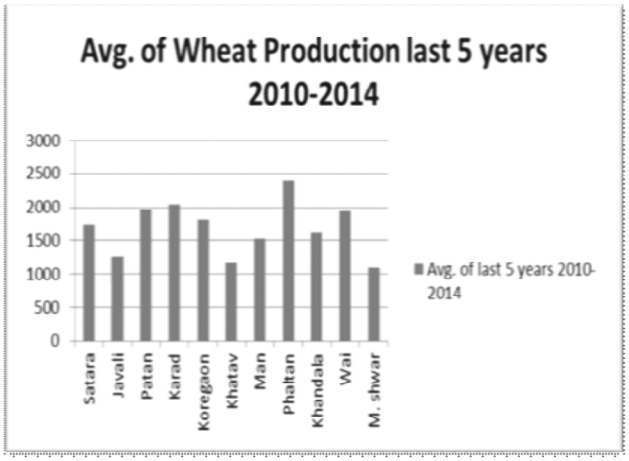

Figure 9: Wheat Production Trend

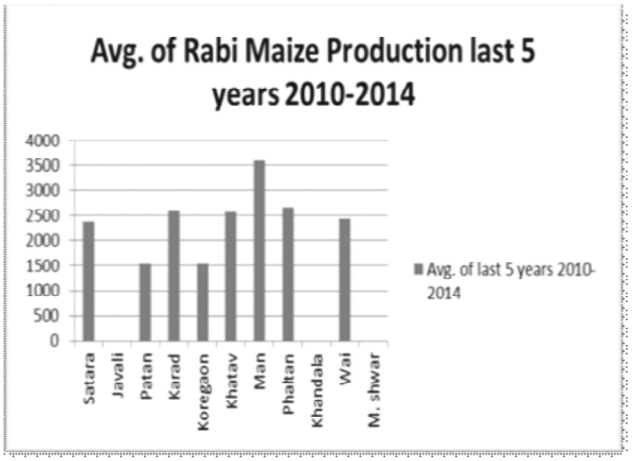

Figure 10: Rabi Maize Trend

3.2. Pulses

The Udid crop shows that the crop is sustainable in almost all regions except two tahsils, Man and Phaltan. Gram is cultivated in all tahsils of the district. The Man and Khtav tahsil shows the less production compared to other tahsils as the rainfall requirement is not met as per requirement of Mug crop. The Mug crop production is not available in Javali, Patan, Wai and Mahabaleshwar tahsil as both the tahsils are heavy rainfall tahsils and as the region shows more rainfall than required.

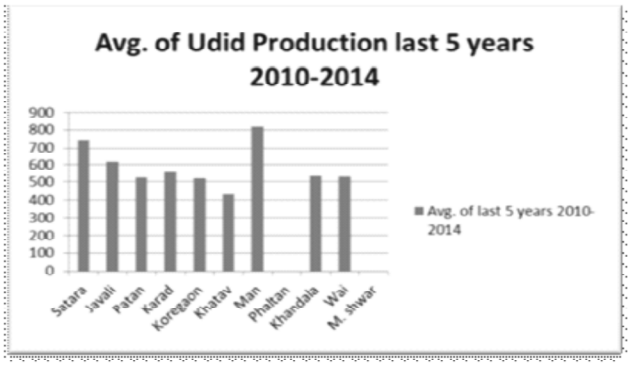

Figure 11: Udid Production Trend

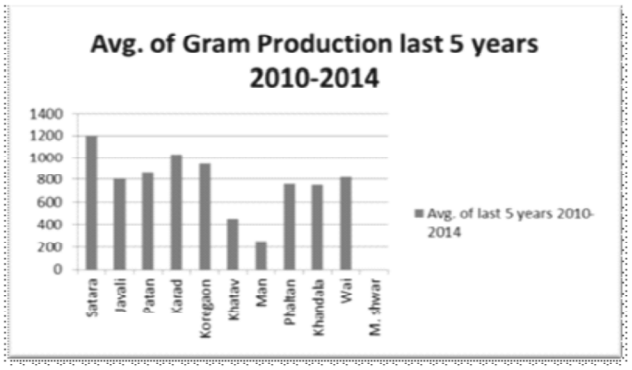

Figure 12: Gram Prodution Trend

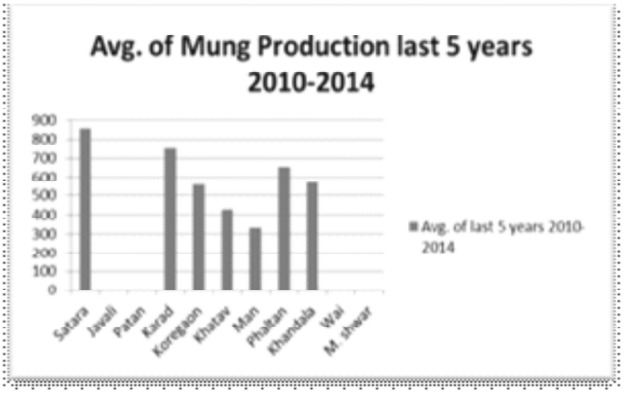

Figure 13: Mug Production Trend

3.3. Oil Seeds

The result for oil seeds shows that, the heavy rainfall areas of the district show the sustainable production of oil seeds except semiarid regions such as Man, Javali as the region shows less rainfall than required.

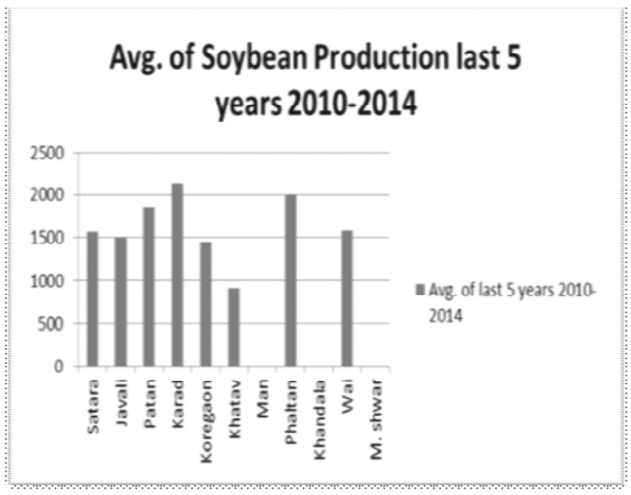

Figure 14: Soyabean Production Trend

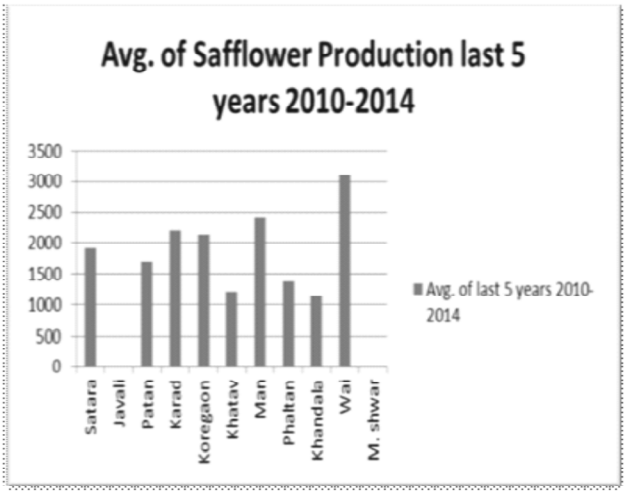

Figure 15: Safflower Production Trend

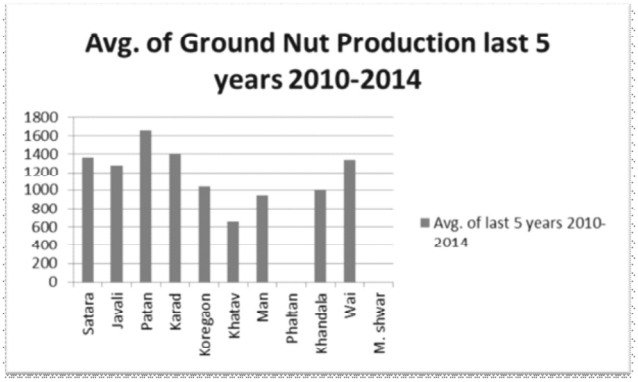

Figure 16: Groundnut Production Trend

3.4. Commercial/Cash Crops Sugarcane

Sugarcane is a major crop in Maharashtra; in spite of water scarcity it has been found that sugarcane is cultivated in all the taluka of Satara. Patan, Javli, Mahabaleshwar and Satara have a good rainfall to cultivate sugarcane.

Since sugarcane requires adequate water therefore it must be grown only in those areas where water availability is adequate. Cotton is grown only in Khatav and Man since cotton requires water availability of 800 mm only. Khatav and Man are areas with low rainfall and black soil which is suitable for cotton production.

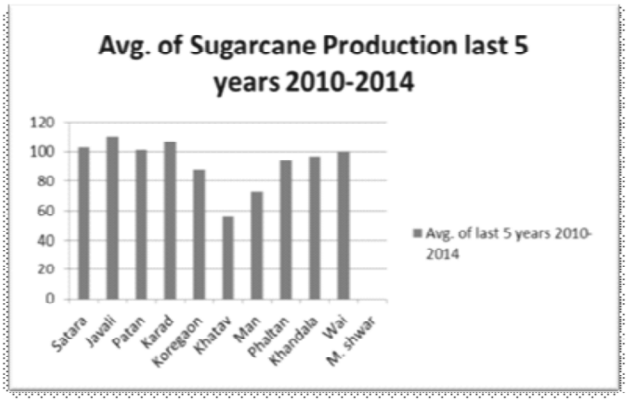

Figure 17: Sugarcane Production Trend

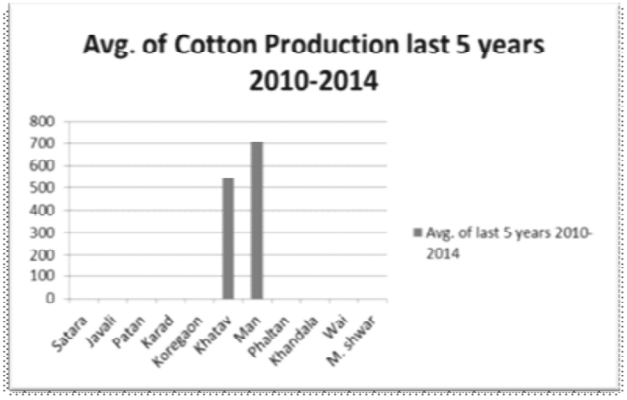

Figure 18: Cotton Production Trend

3.5. Sustainable Cropping Pattern of different talukas of Satara district

Table 4
Sustainable crop production trend of the Study Area

Rice (Mahabaleshwar, patan, Satara and Javli)
Jowar (Mahabaleshwar, Wai, Koregaon, Satara, Javli, Patan, Karad)
Rabi Jowar (Karad and Satara)
Ragi (Javali and Patan)
Wheat (Phaltan, Satara, Patan, Wai and Karad)
Maize (Man, Koregaon and Javeli)
Rabi Maize(Man, Karad, Satara and Wai)
Groundnut (Wai, Khandala , Man, Koregaon, Satara, Javli, Patan, Karad
Sugarcane
Cotton (Man, Khatav)
Safflower
Udid (Wai, Khandala, Man, Khatav, Koregaon, Satara, Javli, Patan, Karad)
Soybean
Gram

5. CONCLUSION

The existing cropping trends in the drought prone areas of southern Maharashtra are quite unsustainable. This is because the farmers are not aware of the sustainable crop production pattern with respect to climatic conditions of the region. The authors have analyzed the crops grown by the farmers and the pattern which must be followed for improving the cropping production in the region. The authors have forecasted the climatic conditions which includes temperature, rainfall and soil conditions. It has been found through the study that the southern part of Maharashtra has different temperature and rainfall conditions in the different regions. Keeping the above facts in consideration, the study reveals that according to the temperature, rainfall and soil condition rice cultivation should be made in Mahabaleshwar, Patan, Satara and Javli regions of thedistrict. Rice grown in other regions will lead to poor yield. Jowar cultivation

is suitable for Mahabaleshwar, Wai, Koregaon, Satara, Javli, Patan and Karad regions of Satara district. Similar trend has been analysed for all the crops grown in the area. For a sustainable cropping pattern the temperature, rainfall and soil conditions must be followed for high growth of the crops. The study shows that the crops grown in unsuitable climatic conditions results in poor yield. The research can be further extended by studies on increasing the yield of crops in uncertain climate through the application of different technologies. Notwithstanding the limitation of the research the study can be taken to the next level by linking several factors affecting the crop production.

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