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An Assessment of Relationship between Crop Production and Climatic Elements: A Case Study of Karveer Tehsil

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ABSTRACT

There exist a very close relationship between Crop production and variability in climate. Hence, plant development is dominantly controlled by Temperature and due to climate change there is increase in temperature. So, the warmer temperatures that shorten development stages of determinate crops will most probably reduce the yield of a given variety. The IPCC's Fourth Assessment Report concludes that, by 2020, crop yields could increase by 20% in east and Southeast Asia, but decrease by up to 30% in central and south Asia, and that rain-fed agricultural output could drop by 50% in some African countries. The present investigation is related to the study of relationship between crop production and climatic elements. This relationship is well identified by Ergograph technique. This method is coined by the A. Geddes and first used by A.G.Ogilive. It is a graphical representation that indicates the relationship between season, climatic elements and crops.

Keywords : Variability in climate, Crop production, Ergograph technique.

Introduction

Climate change has the potential to permanently damage the natural resources, natural resources are the bases for agricultural productivity and therefore, in general change in climatic elements adversely affects agricultural productivity. Future agricultural production will encounter multifaceted challenges from global climate change. The proportion of accumulation of Carbon dioxide (CO₂) and other greenhouse gases is increased radically in the atmosphere and will also increasing at unprecedented rates, causing increased radioactive forcing. Continued emissions of greenhouse gases will increase annual temperatures by 2.5° C to 4.3° C in important crop-growing regions of the world by 2080 to 2099 and at the end of century growing season temperatures in the tropics and subtropics may exceed even the most extreme seasonal temperatures measured to date (<http://www.plantphysiol.org>). These extreme seasonal temperatures will become the main cause behind the reduction of agricultural productivity of Asian countries. Specifically, those Asian countries, which have agrarian economy will affected very badly.

There exist a very close relationship between Crop production and variability in climate. Hence, plant development is dominantly controlled by Temperature and due to climate change there is increase in temperature. So, the warmer temperatures that shorten development stages of determinate crops will most probably reduce the yield of a given variety. In many annual crops, brief episodes of hot temperatures (>32–36°C) can greatly reduce seed set and hence crop yield is also reduces. In many temperate crops, such as wheat, both soil and air temperature influence development; soil temperature while the apex is close to the ground, air temperature thereafter Similarly, in irrigated or flooded rice systems, water temperature, not air temperature, controls development until the apex is above the water (<http://jxb.oxfordjournals.org>).

An assessment of the effects of climate change (entailing changes in temperature, rainfall, humidity, and extreme weather events) on the quantity and security of food supplies requires complex modeling. The IPCC's Fourth Assessment

Report concludes that, by 2020, crop yields could increase by 20% in east and Southeast Asia, but decrease by up to 30% in central and south Asia, and that rain-fed agricultural output could drop by 50% in some African countries (<http://www.sciencedirect.com>)

The present investigation is related to the study of relationship between crop production and climatic elements. This relationship is well identified by Ergograph technique. This method is coined by the A. Geddes and first used by A.G.Ogilive. It is a graphical representation that indicates the relationship between season, climatic elements and crops.

Objectives

1. To study the relationship between the crop production and changing climatic elements.
2. To suggests some measures in order to improve the crop production.

Data Base

In order to meet above mentioned objectives the required data is mainly collected from the secondary sources. Therefore, the entire study is based on secondary data. Secondary data is collected from the State Data Storage Center (SDSC) at Nashik and the data related to agricultural is collected from the District Agriculture Department, Kolhapur. The other related data is collected from Zilla parishad, District census hand-book, Socio-economic review of Kolhapur district, Gazetteers of Kolhapur district, Website of Kolhapur Municipal Corporation and available published and unpublished material, internet, Books and Maps.

Methodology

In order to find out the relationship between crop production and climatic elements Ergograph technique is employed. This method is coined by the A. Geddes and first used by A.G.Ogilive. It is a graphic representation that indicates the relationship between season, climatic elements and crops. Along the vertical axis rainfall is represented by bar diagram, besides that temperature and humidity is represented by the

line graph. The acreage of crops is shown with the help of selected scale on horizontal axis.

Study Area

The present study is restricted to Karveer tehsil. The Karveer tehsil is situated in the northern part of Kolhapur district of Maharashtra. It lies between 16° 42' 50" north to 16° 43' 55" north latitude and 74° 10' 52" east to 74° 11' 57" east longitude. The tehsil is well connected by rail and road with the major cities of India viz. Mumbai, Bengaluru, New Delhi and other important cities of Maharashtra like Pune, Sangli, and Miraj. The Karveer tehsil covered an area of 671.1 sq. km. It shares 8.2 percent of total area of Kolhapur district. The east-west width of tehsil is 30.20 km. As per 2001 census the total population of study area is 9, 06,866 and the density of population is 1272 sq/km. And north-south length is 23.40 km. The study area is a part of Krishna basin (2nd largest river of south India) and is drained by Panchaganga River, a major tributary of Krishna River. The study area is bounded by Panhala and Hatkanangale tehsil in the north-east, by Gaganavada in the west and by Kagal and Radhanagari in the south.

Determination of Relationship between Crop Production and Climatic Elements

The relationship between crop production and climatic elements is well identified by Ergograph technique. The ergograph-A is prepared for year 1997 to interpret the relationship between the crop production and climatic elements of Karveer tehsil. Variations in the cropping pattern are clearly identified due to the deviation in climatic elements of Karveer tehsil. Generally, in this particular year, the rainfall (below 10 mm) and temperature (below 70°F) is lowest in first five months. Therefore, in this specific period due to the lowest rainfall, there is absence of paddy crops and other related crops which required more quantity of water. After the month of May, especially the period between June to January, there is remarkable increase in rainfall, which reaches the highest amount of 140 mm in the month of July. Rainfall again gradually decreases after the month of August and reaches minimum amount of 8 mm in month of December.

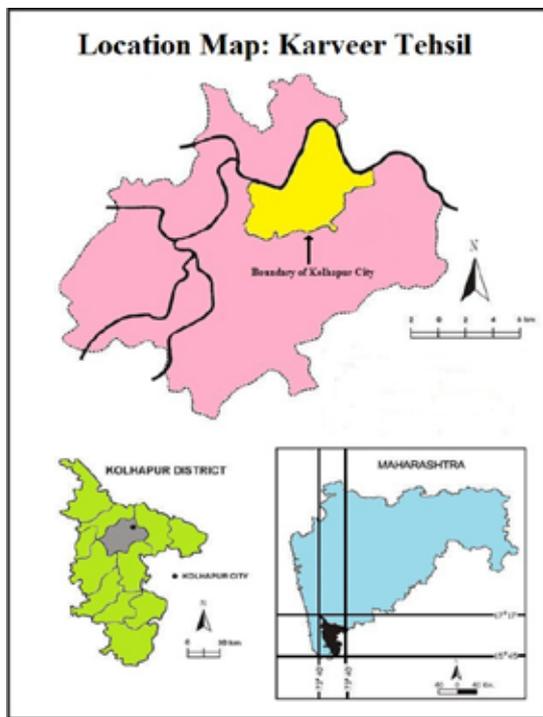


Figure 1

The relative humidity and temperature is also goes on increasing after the month of May and reaches the maximum amount and remain constant till the month of January. Therefore, the production of paddy crops and other related crops

are goes on increasing during this period of May to January. The study area is well known for its highest sugarcane production, because of its suitable climatic conditions. The share of sugarcane crop out of the total crop production in study area is near about 53.63 %, which is the highest crop production as compared to other crops. The sugarcane production is followed by Rice production (paddy crop) with 36.27 % of share in total production. In the total production share of Jawar (6.94 %), Maize (2.02 %), Other Pulses (0.73 %), Other Cereals (0.16 %) and Sunflower (0.14 %) is very low as compare to sugarcane and Rice production (fig. 2).

As per the analysis of Ergograph-B, there is no rainfall in the first four months from June to April. Later on, there is increase in rainfall from the May, which reaches the highest amount of 110 mm in the month of July. The average temperature in that year is near about 70° F, while the lowest relative humidity is 73 % in the month of April and reaches the maximum in the months of July, August, September and October (Above 90 %). The share of sugarcane in year 1998 to the total crop production in study area is 52.50 %. This share is decreased by 1.13 % due to the reduction in average annual rainfall. The sugarcane production is followed by Rice production (paddy crop) with 36.41 % of share in total production. In the total production, the share of Jawar is remains the same as compared to previous year (6.94 %), while the Maize production is increased by 0.32 % than previous year (2.34 %).

ERGOGGRAPH-A: (1997)

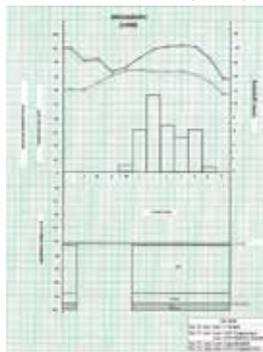


Fig. 2

ERGOGGRAPH-B: (1998)

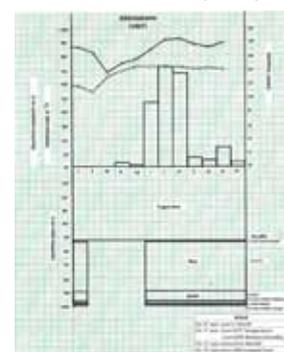


Fig. 3

Source: Agriculture department, ZillaParishad, Kolhapur, SDSC, Nashik

ERGOGGRAPH-C: (1999)

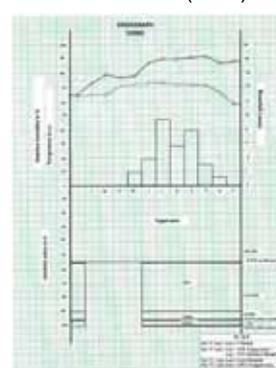


Fig. 4

ERGOGGRAPH-D: (2000)

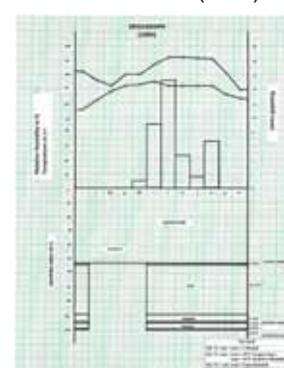


Fig. 5

Source: Agriculture department, ZillaParishad, Kolhapur, SDSC, Nashik.

The production of Other Cereals (1.40%), Other Pulses (1.05%) and Sunflower (0.03 %) is very low as compare to sugarcane and Rice production (fig. 3).

In year 1999, as per the Ergograph-C, the maximum six months are without the rainfall. The maximum rainfall of this year is 150 mm that precipitate in the month of July. There is the highest per cent of relative humidity (above 90 %) as a

result of

heavy rainfall from the July to October. While the seven months displays the temperature above 70o F. As per the analysis, the share of Sugarcane production is 53.42 % to the total production and its share is increased by 1.8 % as compared to previous year. As a result the production of Rice is reduced by 1.14 % and it becomes the 35.27 %. The share of Jawar in total production is also decreases and it becomes the 5.15%. The Maize production is 4.02 % and the share of the Other Cereals, Other Pulses and Sunflower in total production is 1.12%, 0.67% and 0.32% respectively, which is very low as compare to other crops (fig. 4).

Ergograph-D displays that near about five months (in year 2000) are represent the deficiency of rainfall. The maximum rainfall (90 mm) for that particular year is also very low as compared to previous year. But, near about seven months experiences more than 85 % of relative humidity due to the water recharge in previous year. Therefore, there is little increase in sugarcane production. Besides that there is the highest per cent of relative humidity (above 90 %) from the July to October. While the average temperature is near about 70oF. In this year, there is a minute increase in production of Sugarcane and it becomes 54.43 %. Consequently, the production of

ERGOGRAPH-E: (2001)

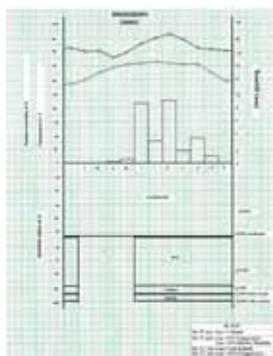


Fig. 6

ERGOGRAPH-F: (2002)

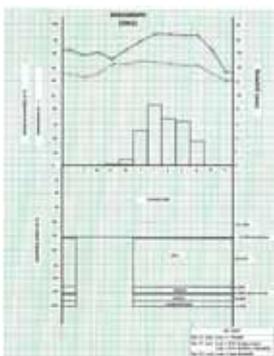


Fig. 7

ERGOGRAPH-G: (2003)

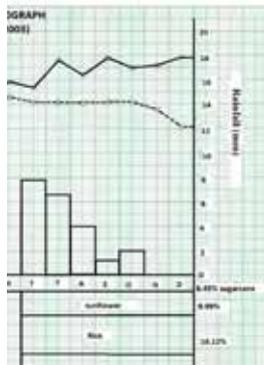


Fig. 8

Source: Agriculture department, ZillaParishad, Kolhapur, SDSC, Nashik

ERGOGRAPH-H: (2004)

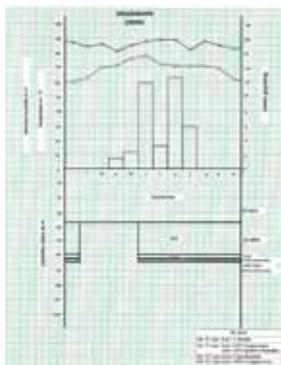
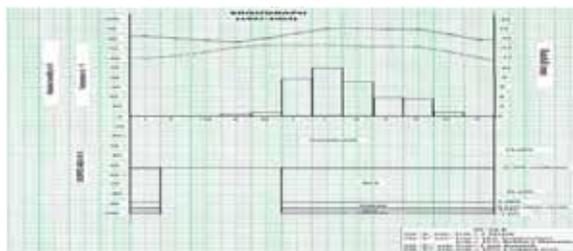


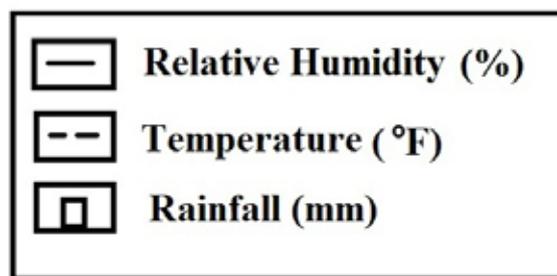
Fig. 9

ERGOGRAPH-I: (1997 to 2004)

Fig. 10



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Rice is decreases to 35.43 %. While the production of Jawar (5.13 %) and Maize (3.68 %) is also slightly reduced. As like the previous years the share of Other Pulses, Other Cereals and Sunflower production are low as compare to other crops, these are 0.57%, 0.65%, 0.16% and 0.32% respectively (fig. 5).

Consequently in the earlier two years there is reduction in rainfall and it is below 90 mm. As a result of that there is again decrease in share of sugarcane production in total production. While the temperature and relative humidity is remain similar to the earlier year.

As per the Ergograph-E, there is minute decrease in Sugarcane (51.34 %) and Rice (34.31%) crop production. Reduction in rainfall is one of the causes behind the decreased production of Sugarcane and Rice crops. The share of production of

Jawar, Other Pulses, Maize, Sunflower and Other Cereals are 5.24%, 4.35 %, 4.08 %, 0.34 % and 0.30 % respectively (fig. 6).

The year 2002 (Ergograph-F) is also received very low rainfall (below 90 mm in months of July and August) as compared to 1997, 1998 and 1999. Therefore, only one month displays more than 90 % relative humidity. As a result, there is no much improvement in share of Sugarcane (52.92 %) and Rice (35.03 %) production than earlier year. The share of Maize and Jawar in total production is 4.49 % and 5.70 % respectively. The production of Other Pulses, Sunflower and Other Cereals are very low i.e. 0.83%, 0.69 and 0.30 respectively (fig.7).

After the year 1999 there is continuous reduction in rainfall, which creates the drought like situation in Karveer Tehsil. This situation generates very brutal impact on the Sugarcane and Rice production. There is extreme decrease in Sugarcane (6.45 %) and Rice (16.12 %) production in year 2003 (Ergograph-G). In this specific year, there is highest share of Jawar (60.94 %) in total production. While, Sunflower production is also increases up to the 9.99%. The Other Cereals (0.10 %) and the Maize (0.27 %) production are also slightly decreased. The share of Other Pulses (6.10 %) in total production is increased (fig. 8).

In the year 2004, there is slight increase in rainfall, which positively affected the Sugarcane and Rice production. Sugarcane production is increased up to the 31.01% and the Rice

production reaches the 21.98 %. The share of the Jawar, Maize, Other Pulses and Other Cereals in total production is 3.10 %, 1.48 %, 0.14 % and 0.29 % respectively (fig. 9).

Conclusion

The crop production is directly proportional to climatic elements and it is identified with the help of ergograph technique devised by A. Geddes. As per the above analysis, there exists a very strong relationship between crop production and changing climatic elements. Especially, the rainfall creates very strong impact over Sugarcane production and Rice (Paddy) production. Generally, the rainfall and temperature is lowest in first four or five months. Therefore, in this particular period due to the lowest rainfall, there is absence of paddy and other related crops because they required more quantity of water. After the month of May, especially the period between June to January, there is remarkable increase in rainfall, which reaches the highest amount in month of July. Rainfall again gradually decreases after the month of August and reaches minimum in the month of December. The relative humidity and temperature is also goes on increasing after the month of May and reaches the maximum amount. It remains constant till the month of January. Therefore, the production of paddy and other related crops are goes on increasing during the months of May to January.

The average figures from 1997 to 2004 displays that the share of sugarcane crop production out of the total crop production is the highest one than the other crops in study area (near about 53.26 %). The Sugarcane production is followed by Rice production (paddy crop) with 35.10 % of share in total production. The share of Jawar (6.08 %), Maize (3.24 %), Other Pulses (1.33 %), Other Cereals (0.61 %) and Sunflower (0.35 %) crop is very low as compared to Sugarcane and Rice production.

In the earlier two years of 2001 there is reduction in rainfall, which is below 90 mm. As a result of that there is again decrease in share of sugarcane production (51.34 %) in total crop production. While the temperature and relative humidity is remain same to the earlier year. There is minute decrease in Rice production (34.31%). Therefore, the reduction in rainfall is one of the causes behind the decreased production of Sugarcane and Rice crops.

Thereafter, there is continuous reduction in rainfall; as a result there exists the lowest relative humidity after the year 1999, which creates the drought like situation in Karveer Tehsil. This situation generates very bad impact on the Sugarcane and Rice crop production. There is extreme decrease in Sugarcane (6.45 %) and Rice (16.12 %) crop production in year 2003. So, as a result of low rainfall of this specific year, there is highest share of Jawar (60.94 %) crop in total production. While, Sunflower crop production is also increases up to the 9.99%. The Other Cereals (0.10 %) and the Maize (0.27 %) production are also slightly decreased. The share of other Pulses (6.10 %) in total production is increased.

In this way, the above analysis clarify that there exists a close relationship between climatic elements and crop production. The changes in climatic conditions are responsible for increase or decrease in quantity and quality of crops. More specifically the analysis makes it clear that the rainfall is directly proportional to Sugarcane and Rice production.

Suggestions

a) To avoid the excessive flow of water, proper irrigation facilities (advanced and automatic water pumps facility for time to time water release) should be made available in the study area, which helps to retain the water storage throughout the year. It also helps to maintain the average Sugarcane and Rice production. The above analysis reveals that the Sugarcane and Rice crops are dominant crops in the study area, which required the more quantity of water than other crops. But still most of the production in the study area is depends on naturally occurring and most variable monsoon rainfall. Therefore, if the rainfall decreases, then the production of Sugarcane and Rice is also decline.

b) Maximum possible water should be stored under the ground by creating artificial barriers over the ground during monsoon season. So, at the low rainfall period, it is very easy to tap the underground water.

c) Alternative sources of water (water tankers) should be made available during the drought like situations in the study area in order to meet the water needs and to avoid the crop damage.

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