

## Reduction in crop production due to increase in excessive temperature

\*Uma Shanker Singh

University Department of Botany, Ranchi University, Ranchi, Jharkhand, India

Received : 5<sup>th</sup> April, 2022 ; Accepted : 4<sup>th</sup> May, 2022

### ABSTRACT

Our country has been witnessing the hottest March and April in the last 122 years ever since the mankind has started keeping records, that is, 1901. Citrus fruit, which is also called lemon is a household fruit and recently it saw a spike in prices which was not seen before. Lemon orchards are extremely sensitive to excess moisture and thus, due to the heavy rainfall, the bahar treatment failed and flowering did not happen leading to decline in production countrywide. The extreme weather has been extremely devastating for the other crops in India and this has been found that India lost to the tune of 5.04 million hectare of crop area to the different forms of cyclonic storms, landslides, flash floods and cloudburst till 25th November 2019. Another study tells us that 45 hailstorm events hit over 80 districts in 12 states in India in between December 2021 to 15th January 2022 therefore, devastating the agricultural crops in India. A study which was specific to only one district each in Kerala, MP and rest of Gujarat reveals that the yield of major agricultural crops namely, rice, banana, rubber, coffee, black pepper, coconut, and coconut, all rain-fed crops, showed a decline of 0.3% to 33% under different scenarios of climate change. The direct and indirect impacts of climate change leads to a decline of wheat yield to the tune of -1% and -8% and ?4% to ?36% respectively depending on the site and states. Multiple studies on rice has demonstrated that the climate change will reduce the overall rice yield by 3 to 5% under medium emission scenario and 3.5 to 10% under high emission scenario in India.

**Key Words** - Climate change, Greenhouse gases, Citrus medica, Harvesting cycle, crop productivity, Temperature rise, climate disruption, Extreme weather, Cyclones, hailstorm.

\*Corresponding author : umashankar.87@gmail.com

### INTRODUCTION

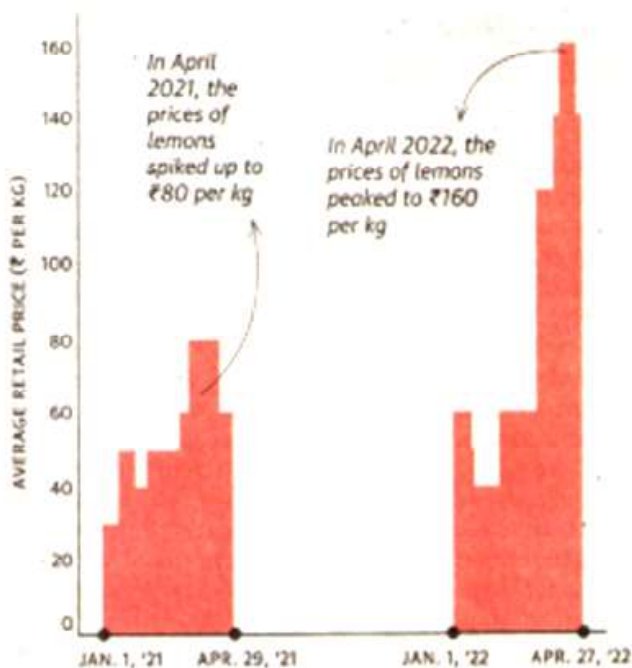
Climate change has a profound impact on the food security of this country and this has been amply demonstrated in the sharp rise in the prices of lemon and mangoes. This fruit is being sold nowadays at a very high price across the different parts of the country despite multiple attempts from the different sectors to bring it down to the level of affordability to the common citizens of this country. In most of the country's wholesale market, a 10-kg bag of lemon is selling at Rs 1,750 at present and a 10-kg bag normally comprises of 350-380

lemons, therefore, the price of a single lemon should cost Rs 5/lemon but a single lemon is retailing between Rs 10 and Rs 15 in most of the Indian markets as shown in the following table. The unprecedented rise in the price is on account of a big gap in the demand and supply of this fruit. In markets such as Mumbai, Hyderabad, Kolkata, the fruit is selling at wholesale rates of Rs 120, Rs 60, and Rs 200 respectively per kg, up from Rs 100, Rs 40 and Rs 90 a kg a month ago.

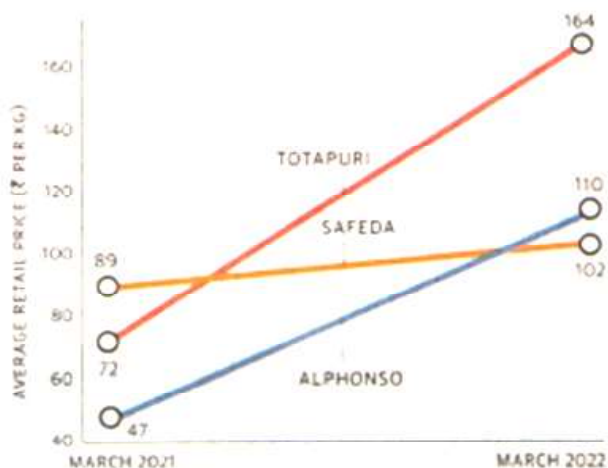
### Prices of lemon in some parts of the country

Name of Cities	Price of One Lemon (in Rs.)
Delhi	10-12
Mumbai	10-15
Kolkata	10-12
Lucknow	10-12
Ahmedabad	10-13
Panji	10-12

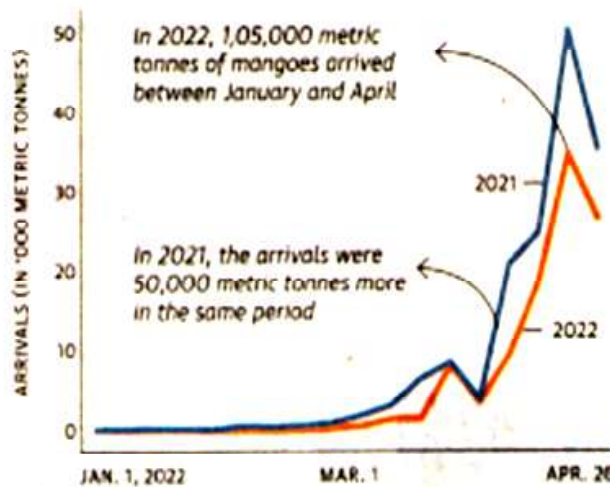
### Costly Lemons



### Costly Mangoes



### Arrivals dip in mango



### Botanical characteristics of lemon

The lemon was introduced into Spain and North Africa sometime between the years 1000 and 1200 CE. It was brought to different parts of Europe. The lemon was thought by 18th-century Swedish botanist Carolus Linnaeus to be a variety of citron (*Citrus medica*), though it is now known to be a separate hybrid species. The lemon plant (family Rutaceae) forms an evergreen spreading bush or small tree, 3–6 metres (10–20 feet) high if not pruned. Its young oval leaves have a decidedly reddish tint; later they turn green. In some varieties the young branches of the lemon are angular; some have sharp thorns at the axils of the leaves. The flowers have a sweet odour and are solitary or borne in small clusters in the axils of the leaves. Lemon trees usually bloom throughout the year, and the fruit is picked 6 to 10 times a year. Full-sized fruit for commercial purposes is about 50 mm (2 inches) in diameter. The fruit is usually picked while still green and, after curing, may be kept three months or more in storage. The fruit is known as nimbu in Hindi and has two broad categories: lemon and lime. The small, round and thin-skinned kaagzi is the mostly commonly grown variety in the country. Lime, on the other hand, refers to the dark green fruits that are grown commercially in North India and the Northeast (Britannica 2021).

### Area under lemon cultivation in India

This is one of the very important horticultural species grown across the country. Andhra Pradesh is the largest grower of lemon and estimated to have 45,000 hectares of land under lemon cultivation besides Maharashtra, Gujarat, Odisha and Tamil Nadu are the other major lemon-growing states. In India 3.17 lakh hectares of land has been put under lemon cultivation. Annually, India produces over 37.17 lakh tonnes of the fruit, which is consumed domestically. Neither we export nor do we import this fruit despite of the fact that India has immense potential to earn foreign exchange while exporting this to western and Middle East countries.

### Harvesting cycle

Farmers take fruits round the year through a horticultural system called “Bahar Treatment” and lemon growers take three “bahars” in India and they are named as Ambe, Mrig and Hasta based on the season when the flowering is induced. In the Ambe bahar the flowering is induced in January-February with a view to harvesting fruit in April. During Mrig bahar the flower blooms in June-July and harvesting is done in the month of October. In Hast bahar flowering blooms in September-October and fruits are harvested in March. These bahars overlap, and thus farmers have fruit round the year to market. Almost 60% of the crop that feeds the market is harvested from the Ambe bahar, while the Mrig bahar contributes 30% and the Hasta bahar the rest. Most of the Mrig bahar fruit is initially sent to cold storage, while fresh fruits from the other two bahars are retailed.

### Climate change destroyed the productivity

Last year, however, the withdrawal of monsoon began only on October 6 against a normal of September 17<sup>th</sup> therefore, despite the monsoon season was over but several parts of the country were still receiving rainfall and this was because combination of many climatic factors playing together namely, delayed monsoon and development of low-pressure areas at multiple places which ultimately resulted in these rainfall

events at several places. Lemon orchards are extremely sensitive to excess moisture and thus, due to the heavy rainfall, the bahar treatment failed and flowering did not happen. This fruit is normally kept in cold storage and marketed until the next fruit from the Ambe bahar arrives. Due to a significantly lower harvest this time, farmers had lower yields to store. The other reason is the failure of the Hasta bahar and the subsequent Ambe bahar on account of untimely rain. This is one of the unluckiest years when all the three bahars have failed consecutively and this led to prices of lemon gone record high levels.

### Impacts of climate change on other crops in between 2021 and 2022

The extreme weather has been extremely devastating for the crops in India and this has been found that India lost to the tune of 5.04 million hectare of crop area to the different forms of cyclonic storms, landslides, flash floods and cloudburst till 25<sup>th</sup> November 2019 (Union Minister on the floor of the Lok Sabha 2019). A study was carried out to understand the magnitude of climate disruption then the result reveals that 45 hailstorm events hit over 80 districts in 12 states in India in between December 2021 to 15<sup>th</sup> January 2022 (Richard Mahapatra 2022). These extreme weather events brought heavy rains along with it and destroyed the agricultural produce which were otherwise ready for being harvested and sold in the market and that includes vegetables also. Yet other study was carried out by the Kozhikode-based Centre for Water Resource Development and Management between 2014 and 2019 covering Kozhikode district of Kerala and Tikamgarh district of Madhya Pradesh and Gujarat including all agro-climatic zones (U. Surendran *et al.* 2019). The study reveals that the maximum temperature has increased in the range of 0.43°C to 1.92°C but the minimum temperature has shown maximum increase in the range of 0.66°C to 2.17°C. The temperature rise has a definite impact on the yield of crop. This has been seen that with the increase in the mean temperature above a threshold level will cause a reduction in agricultural yield, an

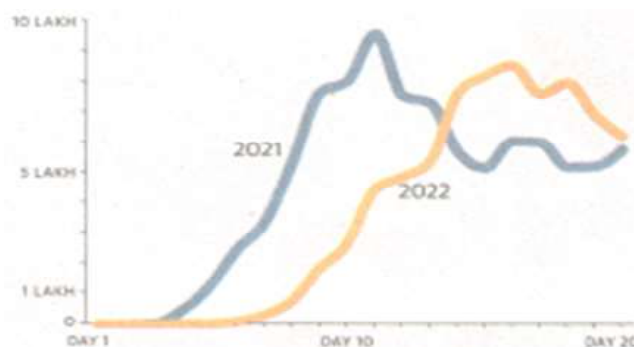
increase in maximum temperature by 1, 2, and 3 degrees Celsius could reduce the grain yield of rice by 6%, 8.4% and 25.1%, respectively, if all other climatic variables remain constant. The rainfall is found to have been increased by 166 mm to 1,434 mm. and the reasons are ever increasing concentration of greenhouse gases in the atmosphere, deforestation, industrial pollution, soil erosion, and land degradation to a large extent. The report further reveals that the yield of major agricultural crops namely, rice, banana, rubber, coffee, black pepper, coconut, and coconut, all rain-fed crops, showed a decline of 0.3% to 33% under different scenarios. The yield of rice is seen to have declined by 10% with each 1°C of temperature rise. The climate change has also impacted the crop suitability area and the study says that as much as 81% and 64% of growing areas of coffee and black pepper may not be suitable for these crops in future unless effective management strategies are adopted. Since the Kerala is covered under irrigation to the tune of 80% therefore each drop of rain needs to be conserved by rain water harvesting.

#### Impact of climate change on wheat yield in Indo-Gangetic plains of India

The Indo-Gangetic Plain (IGP) is one of the main wheat-production regions in India and the world. Recently a study was carried out by a group of scientists based on the climate modelling on the impact of climate change on the wheat production in the Indo-Gangetic plains in India. The results reveal that there is a direct (via changes in temperature and precipitation) and indirect (via a decrease in irrigation availability) impacts of climate change on wheat yields at four sites spread across different states of the IGP namely, Punjab, Haryana, Uttar Pradesh and Bihar. This further says that the direct impacts of climate change leads to a decline of wheat yield to the tune of -1% and -8% depending on the site whereas the impact of indirect impact of climate change on wheat yield leads to a significant reduction and much higher than expected. The result shows that reduction in yield may reach in the range of 4% to 36%

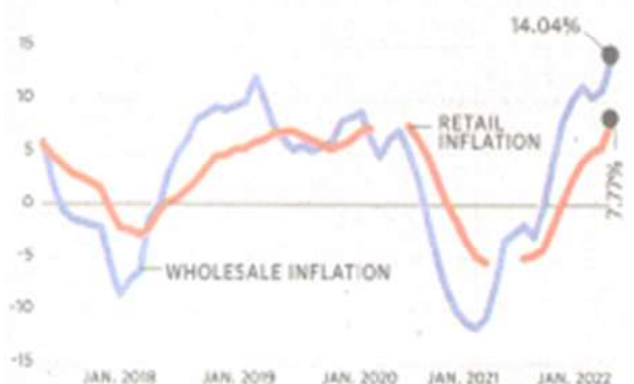
depending on the site and states (A.S.Daloz *et al.* 2021). The above impact has started to show in the Punjab where the evidences unfold that the wheat arrivals in mandis have been 20% lower this year compared to 2021 as shown in the following graph. The only reason behind the reduction is the extreme levels of heat. The average temperature in April has been consistently above the 40°C mark across Punjab in particular and in most of the wheat growing Indo-Gangetic plain in general. This yield has not only declined significantly this year but also quality of the grain has been questioned. In this period, 73 lakh metric tonnes of wheat have reached the mandis in 2022, 20% less than the 92.4 lakh recorded in 2021.

#### Wheat arrivals in Punjab mandis



#### Rising prices of wheat in Punjab

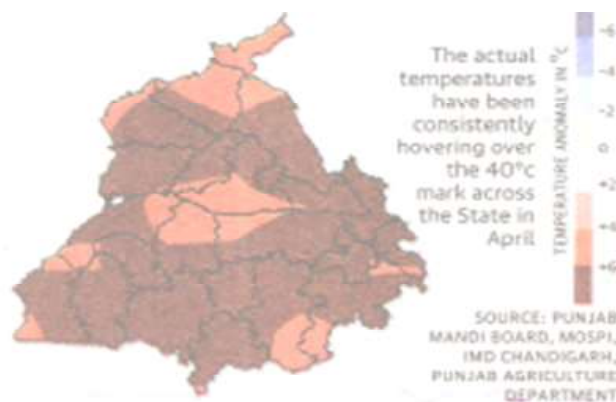
This has had its impact on the overall prices of the wheat in the open market. The wholesale inflation was over 14% and retail inflation was 7.77% in March 2022, both figures being the highest since April 2017 as shown in the following graph





### Heat map in Punjab

The map shows the temperature anomaly across Punjab between April 8 and 14, compared to the long period average. In most places, the maximum temperature was over 6°C than the usual.



### Decline in wheat yield

Crop cutting experiments show that due to the extreme heat, the yield of wheat in the State has dipped this year. Last year, the wheat productivity was 19.7 quintal per acre, while the average yields this year is below 18 quintal per acre. In some case the yield has gone down to the level of 5.67 quintal per acre.

### IMPACT OF CLIMATE CHANGE ON RICE YIELD

There are many studies on the impact of climate change on agriculture done in the Indian context and almost all of them reach to a conclusion that climate change has begun to impact our agricultural yield. A study was done on the rice in order to be able to understand how the rice yield may be impacted with the rise of temperature and other

climatic disruptions. A recent study shows that climate change will reduce the overall rice yield by 3 to 5% under medium emission scenario and 3.5 to 10% under high emission scenario in India. The study also compared the current rice production in India which is to the tune of 107 m.t but the future rice production due to climate change with medium emission is projected to be 104 m.t during mid-century (2021-2050) and 101 m.t during end century (2071- 2100). There may be some adaptation measures but that needs intensive research in and research needs money which is unfortunately lacking. The central government is spending 0.67% of the total budget to research which is extremely undesirable.

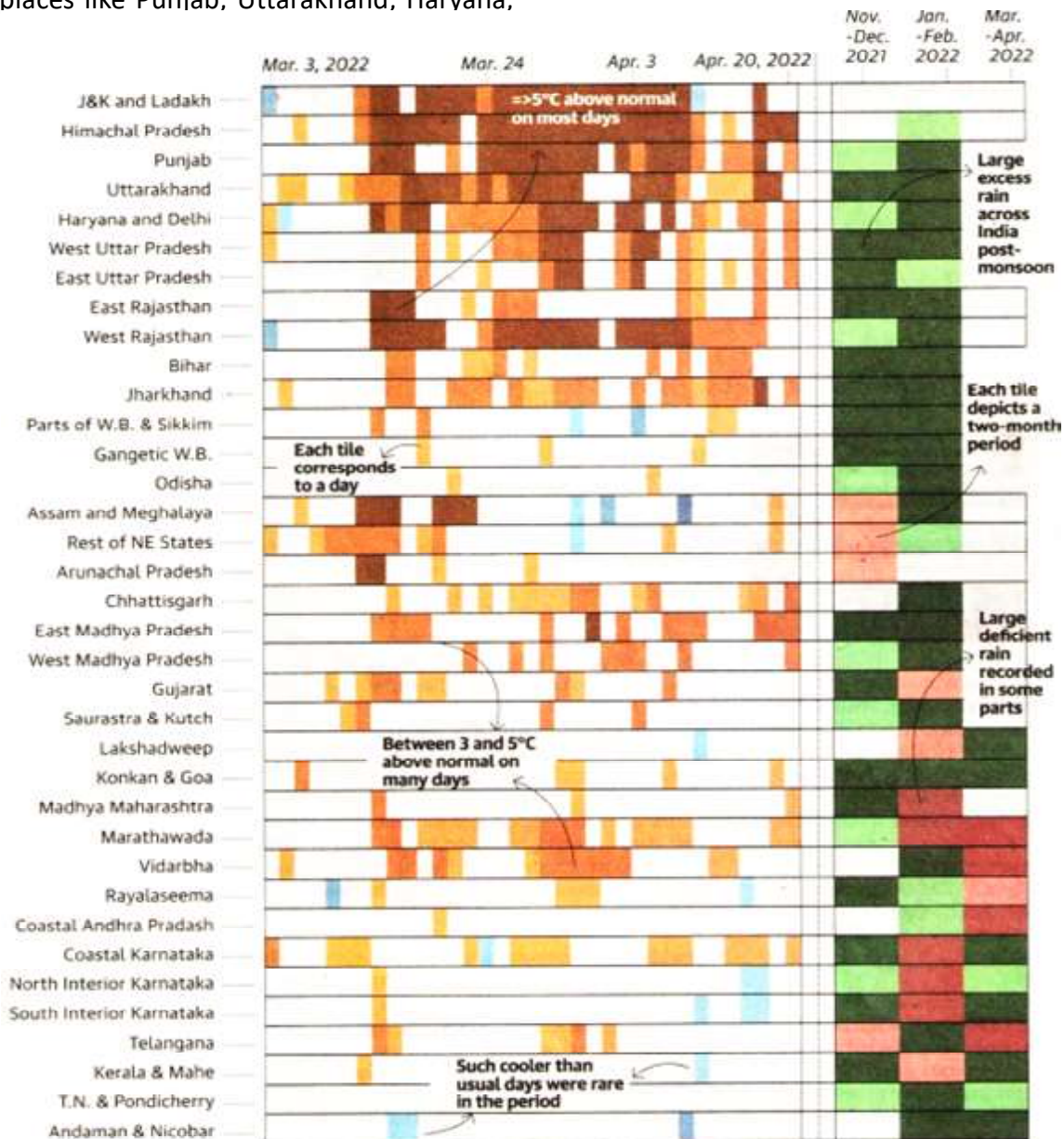
### CONCLUSION

This has been seen that in the last six months, country has received both excess rainfall and extreme heat. In the post-monsoon period, during the months of November and December last year, unseasonal rainfall over 60% the normal levels were recorded across different parts of the country and exactly the months of March and April witnessed the hottest days which was not seen in the last 122 years, ever since the mankind has started keeping records that is, 1901. This year, in the months of March and April, the northern, north-western and north-eastern regions recorded a 5°C increase in temperature from the usual levels on many days. The following chart shows the deviation in maximum temperature across different sub divisions in the country in between 3<sup>rd</sup> March and 20<sup>th</sup> April as given below.

Temperature Range	Colour Indicating Temperature Range	Rainfall Range	Colour Indicating Rainfall
Blank Box Indicates Normal Temperature with Minimal Deviations (N);		Blank Box Indicates Normal Rainfall (-19% To 19% Deviation);	
=>5°C Above N;		Large Excess Rain (Above 60%);	
3.1°C to 4.9°C Above N;		Excess Rain (20 To 59%)	
1.1°C to 2.9°C Above N;		Deficient Rain (-59 To -20%)	
1.1°C to 2.9°C Below N;		Large Deficient (-99 To -60%)	
3.1°C to 4.9°C Below N;			
=>5°C Below N			

In J & K and Ladakh, the first week of March first week witnessed a rise of temperature to the order of 1.1°C to 2.9°C and then onward the temperature grew up in between 3.1°C – 4.9°C before hitting above 5°C from normal. The days between April 3rd and 20th April 2022 witnessed some respite but most of the days were hotter than normal. Himachal Pradesh remains cool throughout the early days of summer but this also experienced a rise of temperature to the level of more than 5°C from normal throughout the month of April. Most of the places like Punjab, Uttarakhand, Haryana,

Delhi, Western, Eastern and Southern UP recorded more than 5°C compared to what it should have been during this month of year. Most of the states in north and north-east had a patch of large excess rain (above 60% of normal) during the month of November and December 2021 and January and February 2022 but some parts of the country like Madhya Maharashtra, Marathwada, Vidharba, Telangana, coastal AP and coastal Karnataka drew large rain deficient areas during January and April 2022.



SOURCE: AGRICOOOP 2022

The unseasonal heatwave across north and central India has made many of us indoor therefore, impacting the economy. The data released by the Indian meteorological department (IMD) shows that the average temperature during March was 33.1°C which broke its own record of 33.09°C in the month of March 2010. The climate has become very harsh and has impacted wheat productivity in India, the magnitude of its impact is yet to be assessed by government of India. What are the exact reasons for this abrupt change in the climate change, we don't know yet? Apparently, there are four reasons attributed for the shift in the rise of temperature in the early months of March 2022 compared to previous years and they are:

1. The anti-cyclonic circulation has continued to persist therefore; the high-pressure zone will maintain its presence in plains of north India and this will make weather conditions over the northern most dry and hot.
2. The western disturbances which bring in rain during the month of March has been weakened considerably in intensity and strength. Western disturbances usually continuous with moderate intensity until mid-March and sometimes and until end of March also. But since 4<sup>th</sup> March 2022 we have not seen any significant Western disturbance approaching Western Himalayas.
3. The reason behind early heat waves, early depressions and the weird dust storms is the continued persistence of a north-south low-pressure pattern that forms over India during winters when a La Niña phenomenon is occurring in the equatorial Pacific Ocean.
4. The Antarctica has been severely hot this time. On 18<sup>th</sup> March 2022, the surface air temperature along eastern Antarctica was historically high and recorded to be 40°C above normal. Let me remind you that Antarctica is relatively, undisturbed compared to Arctic region and normally, the temperatures around this time of the year remains in the range of minus 45°C to minus 50°C.

However, the Antarctica witnessed a temperature between minus 18°C and minus 12°C, which is by any stretch of imagination unprecedented. The impact of reduced western disturbances could be seen in the reduced rainfall in almost entire northern India in the month of March 2022 and this probably reminds us of situation way back in 2019 when India was bereft of pre-monsoon rains. The data released by IMD for the month of March 2022 shows that large swathes of Punjab, Haryana, Uttar Pradesh, Bihar, Gujarat and North East India have received no rain at all in the month of March 2022. The hills have also received 'Deficient' or 'Large Deficient' rains. Districts such as Poonch (a departure of -23 per cent), Leh (-49%), Tehri Garhwal (-48%), West Sikkim (-56%), South Sikkim (-33%), East Kameng (-38%) and East Siang (-35%) recorded 'deficient' rainfall in the hills. Baramulla (a departure of -17%), Nainital (-12%), North Sikkim (-8%), East Sikkim (-10%), Tawang (1%), Papum Pare (-12%) and Upper Siang (-15%) recorded 'normal' rainfall in the hills. If the corresponding figures of temperature rise is seen as per the data available for a period between 27<sup>th</sup> March and 2<sup>nd</sup> April 2022, maximum temperature was recorded above 40°C in various stations of Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Chhattisgarh, Odisha, Telangana, Jharkhand, Uttar Pradesh, Haryana and Delhi. Last week, Chandrapur from Maharashtra, with 44.2°C maximum temperature on 30 March, was the hottest place in the country. Therefore, this is certain that climate change has begun to show its impact and there is a strong need to study the food security issue in our country. This has been found in many studies that without CO<sub>2</sub> fertilization, effective adaptation, and genetic improvement, each degree-Celsius increase in global mean temperature would, on average, reduce global yields of wheat by 6.0%, rice by 3.2%, and maize by 7.4%, and soyabean by 3.1%. Results are highly heterogeneous across crops and geographical areas, with some positive impact estimates.

## REFERENCES

- Britannica, the Editors of Encyclopaedia. "Lemon". Encyclopaedia Britannica, 19 Mar. 2021
- Daloz, A.S., Rydsaa, J.H., Hodnebrog, Ø., Sillmann, J., van Oort, B., Mohr, C.W., Agrawal, M., Emberson, L., Stordal, F. and Zhang, T., 2021. Direct and indirect impacts of climate change on wheat yield in the Indo-Gangetic plain in India. *Journal of Agriculture and Food Research*, 4, p.100-132.
- Kuppannan Palanisami. 2017. Climate Change and India's Future Rice Production: Evidence from 13 Major Rice Growing States of India; *SciFed Journal of Global Warming*; Volume 1(2)
- Narendra Singh Tomar, Union minister of agriculture and farmers' welfare, in the Lok Sabha on November 30, 2021.
- Richard Mahapatra. 2022. Climate and food price rise: Weather systems are so extreme that farmers have lost entire crop cycle; Down to earth; Centre for Science and Environment.
- U. Surendran, B. Anagha, P. Raja, V. Kumar, K. Rajan and M. Jayakumar. 2019. Analysis of Drought from Humid, Semi-Arid and Arid Regions of India Using DrinC Model with Different Drought Indices; *Water Resources Management*.