Iosr Journal Of Agriculture And Veterinary Science (Iosr-Javs)
E-Issn: 2319-2380, P-Issn: 2319-2372. Volume 18, Issue 1 Ser. 1 (January. 2025), Pp 52-60
www.Iosrjournals.Org

A Review Of Impact Of Climate Change On Agricultural Productivity In India

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Abstract:
India is a developing country where in the recent phase it has shifted towards the tertiary sector but then to been an agrarian country many people still rely on it. Although living in 21th century in which service sectors has great influence on the Indian economy then to role of agriculture still plays important part in terms of development. Agriculture which was started a 10000 years ago has faced a lot of change and the major change that it has experienced is the climate changes. Climate change such as an increase in temperature, global warming, etc., a major fact that has a great impact on agricultural products recent scenario of changing conditions can be seen in agriculture. The improvement in technologies advancements such as upgraded irrigation facilities, hybrid crop alternatives for fertilizers, analyses of diseases in plants etc., are changing the face of agriculture. It has scope to identify the impact of climate change on agricultural productivity. An ICA framework analysis technique has been incorporated. The present research is based on secondary sources of data. This review article studies factors that change the climate and how it's effect on agriculture. The main objective of this research is to study the climate change and its impact on agriculture. The perspective was to see India as a whole region of study and to withdraw the generalization from the study. It reveals that the rate of carbon is increasing which gives negative impact on the crops; it has direct relation to the food distribution.

Keywords*: Climate change, ICA framework, agricultural pattern, food security.*

Date of Submission: 16-01-2025 Date of Acceptance: 26-01-2025

I. Introduction:

India been an agricultural country where the major livelihood is based on the primary sector which also includes animal husbandry. The scenario has been changing due to the technological revolution. Agriculture has been affected by many factors, but the major factor that affects the most is climate. Agriculture plays an important role in the economic and social development that makes a share of GDP. Recently the share of agriculture has declined which demonstrates that the dependency of agriculture is reducing. (R. K. MALL1, p. 2007). Climate change shows its effectiveness on agriculture in many ways such as its effect on crops, land, soil, diseases the plant get affected and the livestock. The effect of climate on agriculture shows the effect on economic and food supply which would determine the future economic conditions (Reilly, p. 1996).

Agriculture is the basic activity that has been practice around the world and in India known as agrarian country. Climate change put pressure on the ecosystem, and it also regional agriculture is suffered (Eitzinger J., 2009). Climatic conditions such as drought, heat waves, rainfall storm floods, global warming, and greenhouse gas effect etc. leafleting in climatic condition. This condition not only effect the farmers but also put pressure on the resources and lead to issues of food production there is an estimate that to overcome these issues, there should be some polices which would change the scenario of the agricultural production.

The adaption of the climate smart agriculture technique can be the solution which can solve the current problem faced by agriculture. Asia is facing an agitate situation where climate change is reducing agricultural production. (Rahman).

The word climate is long term phenomenon but due to human intervention in nature the climate has been changing on the earth. The temperature, rainfall drought, soil degradation level has been changing. Climate is in the hands of nature and due to disturbance, it is affecting all over the world. According to the climatic zone the area or region has the benefit. The change in climate not only affects agriculture but all the economy related to agricultural. (Pavithrapriya)

II. Rationale:

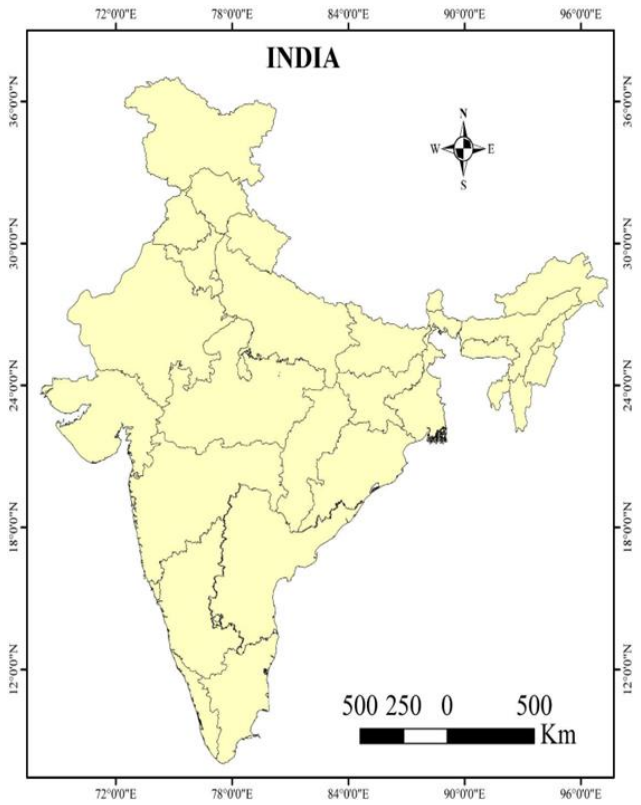
For this research I have downloaded 64 papers and out of that I have referred 15 papers for this. After going through this paper, Researcher came to know the study of climate and its impact on the agriculture and how

this affects the rest of the factors associated with it. After the in-depth analysis of the paper, it has been recognized that there is not a significant review on the topic of the impact of climate change on agricultural productivity.

III. Study Area:

India is an agriculturally rich country with millions of acres of fertile land and plenty of natural resources. India once was called as golden birds because of the diversity. It was famous for the spices and its agricultural product. The Indian agriculture gets influenced by relief, climate, and soil, infrastructural and technological factors. To review various research articles related to impact of climate on Indian agriculture, I have selected the entire India as a study region.

India is situated on the north of the equator between "8°4' N. to 37°6' N. latitude and 68°7' E. to 97°25' E. longitude. The North to South territorial distance of India measures 3,214 km. and 2,933 km. from east to west. It has a land frontier of 15,200 km. and a coastline of 7,516.6 km. The country is bounded by the Arabian Sea to the west, the Bay of Bengal to the east, and the Indian Ocean to the south.



IV. Objectives:

The following objective are propounded for the present study.

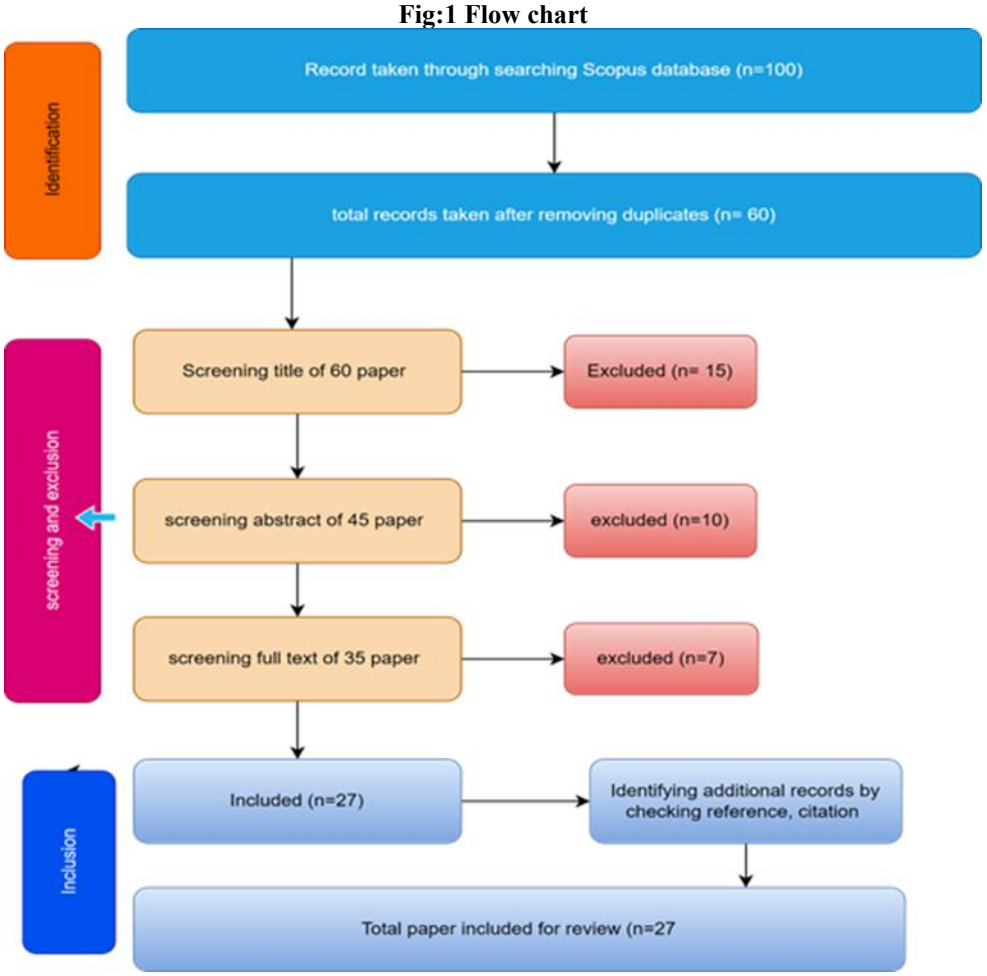
1. To review the research article and find out how climate changes effects on agriculture productivity in India.
2. To study the factors responsible for climate change and food security.

V. Data Source And Methodology:

A) Data Source: The present study is based on secondary sources of data. The research articles from research gate, pumped and springer sources. Data was also collected through Wikipedia.

B) Methodology: Researchers used the ICA framework for a systematic review to analyze scientific papers to understand impact of climate change on agricultural productivity in India. The research articles was gathered from Scopus database between 1993 to 2023 (Vaidyaet al., 2021). The research paper was downloaded on 1/02/2023. Total 100 papers were downloaded for this research and referred 27 articles out of it, which was related to my topic. About 38 articles were omitted due to not related to my research theme. The flow diagram demonstrates identifying, removing duplicates, and thoroughly screening of all published research articles. The entire technique is described in detail in the flow chart (Fig. 1). The following flow chart shows the overview of the ICA framework of present research.

Fig:1 Flow chart



VI. Significance Of The Study:

The significance of the study is that to provide a valuable, reasonable informative, critical summaryof the research based on the impact of climate change on agricultural productivity. It provides the overview of the climate change that has been taken place in the recent decade andhelps to understand the effect on the agricultural productivity in India. It provides the clear understanding about the problem faced by agriculture practices such as primary sectors.

VII. Discussion:

Climate is the long-term phenomena observed over a region. Climate is directly or indirectly related to agriculture. The main contribution towards agriculture is climate. The climate has certain elements such as temperature, solar radiation, humidity, precipitation, atmospheric pressure, and wind. Ice also affects the weather, volcanic eruptions and human activity which affects the weatherin terms affect the climatic condition over a region. The incoming solar radiation and the outgoingsolar radiation changes the temperature of the region which might be in the form of melting snowor glaciers deforesting the region also leading to changes in the pattern of agriculture. The climateis observed for over 30 years. The major difference between the climate and weather is the time span over a region. Weather is a phenomenon that records over a short period of time.

The impact of climate change is adverse on agriculture. Due to global warming the temperature has been increasing which is seen on the production. Rainfall is the major component which affectsagriculture. Untimely rainfall is the major concern of today's state of agriculture. The increase intemperature affects the coastal region as well as the region away from coast. Climate change affectthe food security in terms of 4 component that are food availability, food accessibility food utilization and food system stability (sharma, 2019)

a) Factors responsible for climate change:

The factors that are responsible for climate change are classified into two groups anthropogenic causes and natural causes.

i) Anthropogenic causes: it means the causes that have occurred due to human intervention in the nature. Human activity has changed the climate and is still changing the climatic condition over aregion, i.e. deforestation, urbanization, changes in land use, emission of greenhouse gases, burning of fossil fuel, pollution, agricultural expansion.
ii) Deforestation: the growing population is demanding more land for use. This leads to deforestation. The forest is the integral part of the climate, they play a major role in the controlling the CO2 emission and regulate the temperature. Trees help to regulate the temperature by evapotranspiration which makes the days cooler.
iii) Urbanization: the increasing population of the country is shifting towards urbanization which is the regulation factor for the economy. The urban areas incurred more economy, but then negative urbanization leads to deforestation contributes to global warming etc.
iv) Change in land use: the land has been used for many ways such as farms, recreational activity etc. The changing pattern leads to factors contributing to climatic changes.
v) Green houses gases: deforestation, using of vehicles, AC or other products or activity which creates the emission of carbon leads to global warming.
vi) Burning of fossil fuel: the energy needs are met by burning fossil fuels, the smoke releasedby the burning contains harmful emission of carbon which leads to global warming and thus affecting the climatic conditions.
vii) Pollution: the changing lifestyle and demand patterns there is the increase in the pollution.Water pollution, air pollution, noise pollution etc. change the temperature and the climate.
viii) Agricultural expansion: the change in the agricultural pattern, new invention in technology,rapid growing of crops leads to increase in nitrogenous substance in the soil which in turnleads to pollution.
ix) Natural causes: the causes that occur due to nature in which humans have no interference and it totally depends on earths components. These includes suns intensity, change in earth's orbit, ocean current circulation, volcanic eruption,melting of glaciers, rise in sea level.

i. "Suns intensity": the climate is influenced by the sun's rays and its intensity. Solar outputchanges the climate with its rate of change in the solar heating of the earth and atmosphereand the other factor is the cloud formation process. The sun's intensity changes the level of global warming.
ii. "Change in earth's orbit": the earth's axial tilt and the position of the earth during the equinox and solstice can affect the changes in the climate.
iii. "Ocean current circulation": ocean currents always uplevel the water and maintain the temperature of water. It also helps to maintain the hydrological balance.
iv. "Volcanic eruption": the plates movement results into volcanic eruption and this eruptioncauses pollution, increases the temperature which changes the climate of a region.
v. "Melting of glaciers": due to melting of the glaciers the global water level has risen and this is caused by anthropogenic causes. it is estimated that it will be continued to decreasein further time.
vi. "Rise in the sea level": due to melting of glaciers there is rise in the sea level. The rise in the thermal expansion is contributing to the rise in the sea level.
vii. Many anthropogenic and natural causes result into the change of the climate and if this continue there will be a great threat to the environment.(Fakana, 2020).

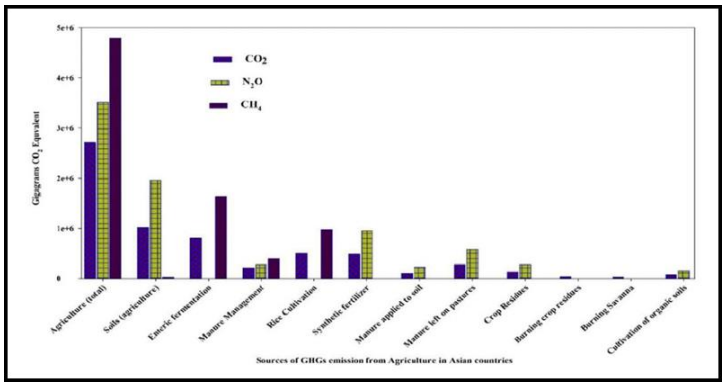


Fig 2: the image shows the emission of gases from agriculture in Asia (Muhammad Habib-ur- Rahman1)

The above chart shows the sources of GHGs emission from the agriculture in Asian Countries which includes agricultural soil, enteric fermentation, manure management, Synthetic fertilizer, Manure applied to soil, Rice cultivation, crop residue, Burning Savanna, Cultivation of organic Soil etc. which can be seen that soil produces much of the pollution from any other sources in thechart. The chart shows the emission of CO_2, N_2O and CH_4. The pollution is same as of the industrialbut it comparatively low. This changing and increasing rate of pollution is leading to rise in temperature and change in the atmosphere.

b) Climate change and its effect on the crops:

Crops are the plants that can be grown and harvested for profit and sustenance. When the same type of plant is produced on a large scale it is called a crop. Crops are used to fulfill the demand of food for humans and livestock. They are practiced either intensive or extensive methods. Crops are either food crops or nonfood crops. Food crops includepulses etc. and non-food crops include the horticulture and floriculture. Crops are taken accordingto the region and its climatic factors for their growth. Different regions produce different types ofcrops. Such crops are grown as per the geographical and climatic conditions of the regions whichin turn are affecting the crops in diverse way and one of the major reasons for such change is climate.

In simple words, climate change is harming the crops. It can be observed that the climate change and extreme climatic conditions are being increasing and seen its effect in crop production. The rate of carbon is increasing which gives negative impact on the crops. Along with CO_2 there is also negative effect of increase in O_3 in the environment. O_3 is highly reactive oxidant which damages the plant tissue and lead to the death of plant cell. Climate change is caused because of changing pattern of the rain. The floods and drought which occurs off season are included in it. The crops may get affected by various disease because of untimely rainfall which was seen in Chinaor Bangladesh. In flood like condition, these countries face the problem of high moisture content in soil where cropping areas are destroyed. It is estimated that in the upcoming years the coastal region will face tremendous flooding risk due to rise in sea level. The drought like condition has also been foreseen because of warmer conditions due to less rain. Drought affects the crops at thegrowing stage or reproductive stage. Drought causes a decrease in the water level by reducing theintake of water through the plants. The salinity in the soil is also a major cause of concern (Boter).

The figure 3 indicates the climatic effect on the agricultural production. The climate has direct, indirect and socio-economic effect on the environment. Direct effect shows the changes in morphological, physiological, phenotypic changes, and plant productivity. The indirect effect shows effect on the soil fertility, irrigation availability, and rise in the sea level, pest and heat. The socio-economic effect shows effect of food demand, farmer's response, costs, policy, trade and unequal distribution of the crops. Above mentioned effects are caused mainly due to human intervention, adaptation strategies and mitigation pattern which shows the agricultural productionand the vulnerability of climatic changes.

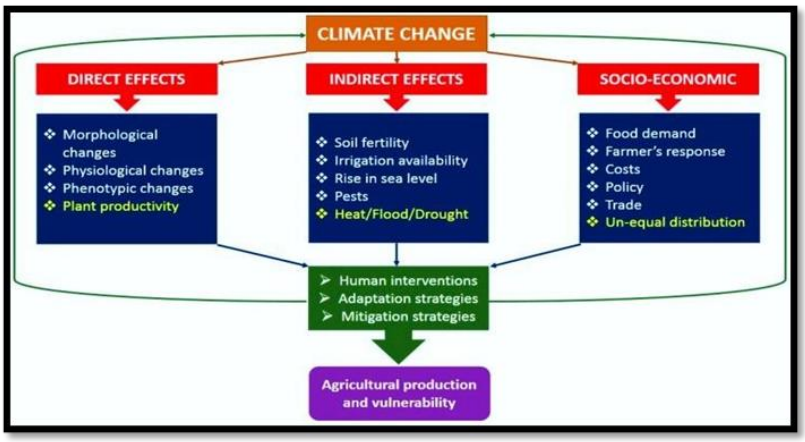


Fig.3 it indicates the climate change and its effect on the other component (Ali Raza, 2019)

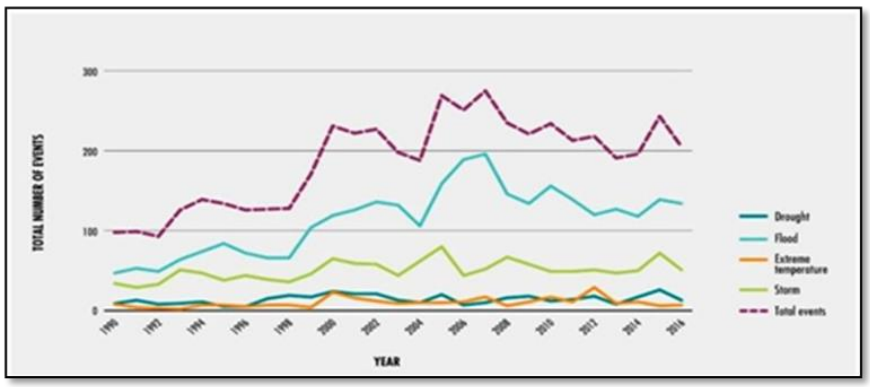


Fig 4. It shows the no. of event that has occurred with the time span from 1990 to 2016; Source: Ali Raza, 2019

The plant and crop majorly depend on temperature for their growth where the suitable temperatureaids the proper development of crops. Climate affects not only the crops or plant but also the formation of soil. The increase in the level of CO2 and other gases in the soil effect the ability of a soil to grow crops. If the soil losses its fertility due to the overuse of the chemical fertilizer, to restore the fertility of the soil there shouldbe use of cropping pattern such as Crop rotation, Planting of cover crops etc. Crop also faces the problem of the weeds, insects and diseases which is the result of climate changeand change in the atmospheric constituents. The changing climate also sometime creates a suitableenvironment for insect to breed which may be harmful for the growth of the crops. The plant alsofaces various diseases like fungal and bacterial infection due to climate change. (Reilly, Agriculture in a changing climate: impacts and adaptation, p. 1996)

c) Agricultural production and food security:

Food and Agriculture Organization (FAO) defines food security as a ‘‘situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life’’(Tubiello J. S., p. 2008) “Food security exists when all people, at all times, have physical and economic access to sufficientsafe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”. - 1996 World Food Summit (World Food Summit, 1996) As human developed, they started to practice the agriculture nearly about 10000 years ago wherethey understood the importance about growing the crops and from then all people had sufficient amount of availability of food, but due to population explosion there was a situation where there was no proper food available to the people. The rising population increased the prices of food in many parts of the world which in turn lead to decrease in nutrition level among people. (McDonald,p. 2010)

The problem regarding to food is the result of neglecting towards the nature. The increasing population is exploiting the natural resources and the demands from nature is ever increasing the per capita food consumption has also increased but the price of the food is constantly rising. The issue related to food is not like a global issue such as poverty but it is an economic phenomenon which can be converted into severe political issue. The food issue is not only faced in today’s world but it was also the issue faced during 80's and 90's time period due to which French revolution took place. According to some experts it is expected that the disasters will increase the price of the food this will also be supported by the climatic conditions and physiography of the region. The problem persists as of the improper distribution of the food, there is waste age of the food alsosometime the crops are affected by the untimely rain and other weather conditions. Although there are advancement in the technology and the method of agriculture has changed stillit has certain issues where the working population in the primary sector decreased, there is spread of the diseases increased competition among the sectors leads to loss to environment in terms of land degradation, loss of biodiversity, water problems which makes scope for finding the optimumsolution towards the planning and plotting along with sustainability of the agriculture, It might bean intense knowledge related to the agriculture. (Madina A. Abdulkadyrovaa, p. 2016). The lives and food security majorly depends on the local resources and Argo ecological and livelihood capacity. (Hussain1, p. 2016)

d) Agricultural production and climate:

Agriculture is the primary source of living for the developing country. Majority of the people depends upon this source of income. Production is basically the concept where we produce the things or manufacture things. Thus, we can say that agriculture production is the way to do agriculture in a proper planned manner and then to distribute it. Agriculture is not only related to crops but it also includes animal husbandry, fishing activities as its part. As for the process of agriculture, it includes several steps that are Ploughing, sowing, tilting, harvesting etc. which helpsin the growth of the crops. As there are many processes in the agriculture there are also certain physical factor which affect the growth of crops. The factors such as soil, irrigation method, water, light, temperature and the climate. Along with this, quality of the seed also matters. In this paper the major focus is on the climatic factor which affects the production of the crops. The climate is important factor where it is defined as the long-term phenomenon observed for overa long period of time. The climate may be dry, humid, frigid, hot etc. India experiences both tropical and sub-tropical climate, where there is mixture of dry and wet type of weather. India’s climate is described as monsoon type of climate. There is constant fluctuation due to increasing pollution it directly shows effect on the growth of crops.

e) Change in production and food security.

Food security concept as first seen in sustainable development goals (SDG) where it states that allthe people should have access to the proper nutritious food and availability of the food. The mainobject of food security includes “food availability, accessibility, utility and stability”. These objectives are not been able to fulfilled due to the changing pattern of the agriculture and these aremajorly affected by the climate. (Raj, March 2023). Climatic changes are affecting the pattern and production of the food. To feed the growing population there is need for proper management and arrangement of technology and methods to ensure proper production of the

food. To look forward for the production of the food we also look towards food security. Food securityis one of the challenges faced by the countries to tackle with. It may be in terms of undernutrition or overnutrition or population growth or increase in the priceetc. the main reason for this is poverty where the ability to purchase decreases and its effects the demand and supply. Food insecurity also causes degradation of the natural resources along with migration and instability in terms of economic and political. in the recent studies it has been seenthat the price of the food has been increased over last few years and it will increase in future. Foodsecurity also faces the pressure of increasing population. The population put burden on the land and decrease in the agricultural area with put pressure on the existing land. (ohn R Beddington1, p. 2012). it is expected that the food system provides nutrition less than 85% of its population. the increasein income level has changed the eating pattern of the people where they are more concerned withdiet which includes bread, vegetables and more of the fruits, meats in the food. (tiwari, p. 2012)

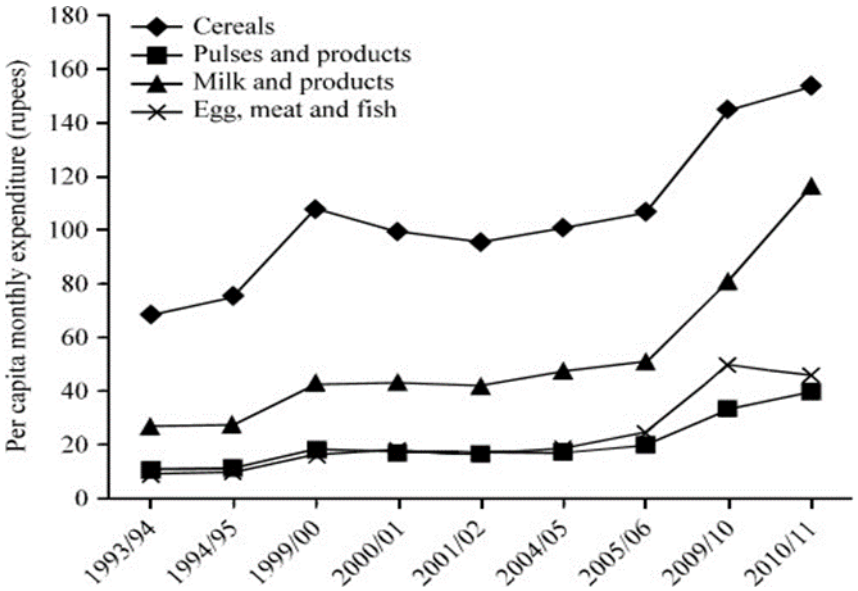


Fig: 5. Per capita monthly expenditure and the years in aspect of cereals, pulses, milk products and egg and meat (tiwari, p. 2012)

The figure 5 clearly shows that as the income pattern changes the consumption pattern also changes. The demand for the cereal is constantly high in demand as it is best source of the proteinalong with the milk egg meat and fish products. The diet of the people has shifted towards more proteins and less fats product due to increasing health issues. (tiwari, p. 2012). Climate change has direct effect on the agriculture and food security. It is a complex thing to study.The changes in the food production leads to states the food security. (Tubiello J. S., p. 2008). Climate change has a great influence on the food security especially on the developing countries and the major cause is the human activity. food is the basic necessity and need of the people, the food is supplied in all over the world but it is produced in a some or part of the world and changesin climate in that region may affect the distribution of the food to other regions of the world.(Iain R. Lake, 1 November 2012). The effect of climate change and agriculture are connected and inter related in a complex structure.The food security cover four aspects that are the food availability, Stability in food supply, consumption and available amount of food for people and the last one the food utilization by the people. All these factors get effect with the slight change in the agriculture production which takeplace due to climate change. (Tubiello, p. 2008).

VIII. Conclusion:

The research Article focuses on the impact of climate change in Agricultural productivity. Agriculture is a key part of India's economy, it contributes nearly 14% of gross domestic production in India. The impact of climate change is adverse on the surrounding environment and especially on the agriculture. Agriculture is the only way of sustenance to the living being, although Indian is shifting towards the tertiary sector then to it has to depend upon the primary sector. The face of agriculture has been changing since the population explosion, the ever-increasing demand and theindustrial growth led to some of the changes. The industrial revolution created the major issue of pollution o the land, water and even on the air. The release of harmful chemicals into the biosphere has been the reason for the change in the climate. The increased rate of carbon, Sulphur, Nitrogenin the atmosphere traps the heat and causes Global warming which in turn are changing the temperature, cycle of the seasons. These changes in the climate effect agriculture production on large scale. The issues such as soil erosion, Infertility of

the soil, are arising which are changing the pattern of the agriculture. The change in agriculture affect the production of the food. The Population is demanding but the manufacturing rate is slow which creates the burden on the land.Issues related to the availability of food starts to rise and prices hikes up creating the rift betweenthe food reaching towards each and every part of the population. The issues can be resolved by theproper management of the agriculture control on pollution and even the introduction of new sustainable technology will bring about the revolutionary change in the agriculture and adaption of new policies regarding environment such as odd and even formula, proper treatment of the effluents will control the changes in the environment and thus giving the proper stable climatic condition. Agriculture technology comes in various format such as satellite imagery, agriculture machines and software solutions such as Agricultural drones, Automated Irrigation System, genetically modified Crops, Precision Framing, Animal tracking collars etc.

Limitations:

i. There were limited data sources available to gather information. Springer was the only site whichwas in use for reviewing the article. If there were more data available then it would have been more resourceful and would have contained more information.
ii. Another limitation was that every author had a different view regarding the topic. There were no such review articles based on India. There topics which was taken for reviewing was based on oneparticular subject. It is not representing each and every state.
iii. There was no such paper available on food security that is faced in India. There were internationalarticles which had to link with India.
iv. No proper review material was available regarding the irrigational techniques.

Suggestions:

i. Through this research paper researcher wants to suggest that there should be use of climate smarttechnique for practicing agriculture. Sustainability in agriculture should be followed.
ii. Uses of chemical fertilizers and harmful pesticides should be reducing so to reduce the acidic levelof soil. And save soil from soil erosion and leeching.
iii. Climate is unpredictable phenomenon but adaption to the new modern technologies should beintroduced to the farmers so that they can sow the seeds accordingly.
iv. There should be proper guidance and awareness among the farmers regarding the agriculturalchanges, technologies.
v. Emission from Industries and from household should properly treated before disposing so thatwater and soil both will not get affected.
vi. Major issue of food production is due to unavailability and inaccessibility of food therefore propermanagement of the distribution should be taken into consideration.
vii. Proper distribution of production should be done with the use of proper agriculture resourceallocation techniques like network analysis and proximity.
viii. The agriculture should focus on the plant protection and mechanism technique which would protect the soil fertility and the use of moisture sensor technology for monitoring the moisture content in the soil. Along with it the temperature sensor technology to monitor the temperature and cultivating the crop as per the given condition of the agriculture.

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