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Global warming and impact on Indian agriculture and food production

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Abstract: Global warming refers to an average increase in the earth's temperature, which in turn courses in climate, Contribution of greenhouse gases to global warming, carbon dioxide, methane, Chloro-Fluro-Carbon (CFCs) and Nitrous oxides act like a green house, warming the earth surface. The rise in earth's temperature due to increase in carbon dioxide emission has been speculated since 1800's and its effect house been analysed. The foremost cause for transformation of global environment is the ever increasing number of human beings since 1990, the number of people has more than tripled. According to UN projection, the global population increased from 205 billion to 5 billion in less than four decades (i.e.) from 1950 to 1990 and is expected to reach 10 billion by the end of next century. Developing countries account for only 1.29 billion tones of CO_2 emission 1985 and projected increase for 2005 in 5.47 billion tonnes of carbon oxide was emitted with is projected to increase to 12.18 billion tones by 2025. The CO_2 emissions are projected to increase by 2.6 percent annually.

Keywords: Climate change – Green house effect

INTRODUCTION

The planet earth is estimated to be 5 billion years old and it has been nurturing biological species for more than 3.5 billion years. During this period, the earth has endured many types of bombardments meters and resuming of mountains etc. As human beings, we cannot completely disrupt the earth systems but affect it significantly in recent centuries, in our guest for good clothing and shelter. The far most cause for transformation of global environment is ever increasing number of human basis. Since 1900, member of people has more than tripled. According to UN projections, the global population increased from 2.5 billion to 5 billion in less than four decades i.e. form 1950 to 1990, and is expected to reach to billion by the end of next century [1]. The worst hit will be hundred of millions of small farmers, fishers and forest dependent people who are already vulnerable and food insecure. By affecting the availability of land, water and bio-diversity and the price of food, the rising demand for bio fuels, produced from food crops also has an impact on the poor. Developing countries on the other hand account for only 1.29 billion tones of CO_2 emission 1985 and projected increase for 2005 in 5.47 billion tones of carbon oxide was emitted with is projected to increase to 12.18 billion tones by 2025. The CO_2 emissions are projected to increase by 2.6 percent annually [1,7]. USA is the largest contributor globally accounting for nearly 18 percent. Data for 1985 suggests that the developed countries contribution to CO_2 emission was 3.95 billion cones and this is expected to rise to 6.71 billion tones by 2025.

METHODS OF THE STUDY

The present increase in population must 1 – 50 years equals to total increase in the world population from the time human species first emerged until the middle of this century. This paper mainly focused on secondary data from the various sources of government of publications. Though the phenomenon is explained by demographers through their theory of demographic transition, the fact remains that there has been population explosion with 50 years all over the globe, causing tremendous strain on the resources of the earth and pollution of the biosphere.

Result and Discussion

Carbon dioxide, methane chloro-fluoro-carbon (CFCs) and nitrous oxides act like a green house, warming the earth surface. The term 'green house effect'. Carbon dioxide is the most important of the green house gases (Fig. 1).

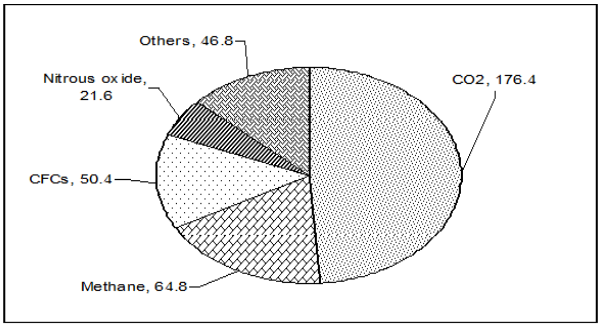

Fig. 1 Pie Diagram

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Contribution of green house gases of global warming

Sl. No.	GAS	Sources	Proportionate contribution to global warming	Pie diagrams
1.	CO_2	Deforestation cement production fossil combustion	49 %	176.4°
2.	Methane (CH_4)	Bacterial activity in paddy fields	18 %	64.8°
3.	CFCs	Refrigeration insulation and other industrial proposes	14 %	50.4°
4.	Nitrous oxide	Fertilizers, land clearings, biomass burning	6 %	21.6°
5.	Other (Ozone Carbon monoxides)	Various	13 %	46.8°

Source: The Kisan World Feb. 2008.

1. $\frac{49}{100}$ x 360 = 176.4° → CO_2
2. $\frac{18}{100}$ x 360 = 64.8° → Methane (CH_4)
3. $\frac{14}{100}$ x 360 = 50.4° → CFCs
4. $\frac{6}{100}$ x 360 = 21.6° → Nitrous oxide
5. $\frac{13}{100}$ x 360 = 46.8° → Others (Ozone Carbon monoxides)

The rise in earth's temperature due to increase in carbon dioxide emission has been speculated since 800's and its affect have been analyzed for almost a century.

Climate change projections for India

Year	Season	Temperature change (°C)		Rainfall change (°C)	
		Lowest	Highest	Lowest	Highest
	Annual	1.00	1.41	2.16	5.97
2020_S	Rabi	1.08	1.54	-1.95	4.36
	Kharif	0.87	1.17	1.81	5.10
	Annual	2.23	2.87	5.36	9.34
2050_S	Rabi	2.54	3.18	-9.22	3.82
	Kharif	1.81	2.37	7.18	10.52
	Annual	3.53	5.55	7.48	9.90
2080_S	Rabi	4.14	6.31	-24.83	-4.50
	Kharif	2.91	4.62	10.10	15.18

Source: Intensive Agriculture, 2008

The method the least square analysis

Y=a+bx

The Trend Value Analysis

Year	Highest Temperature Change (^oC)	x	x^2	y	y=a+bx
2020_S	1.41	-1	1	-1.41	0.58
2050_S	2.87	0	0	0	3.28
2080_S	5.55	1	1	5.55	5.98
N	$\Sigma y = 9.85$	$\Sigma x = 0$	$\Sigma x^2 = 2$	$\Sigma xy = 4.14$	

Y = a+bx $\quad a = \frac{\Sigma xy}{\Sigma x^2} = \frac{4.14}{2} = 2.70$

The trend value 2020s will be y = 3.28 + 2.70 (-1) = 3.28 – 270 = 0.58

The trend value 2050s will be y = 3.28 + 2.70 (0) = 3.28

The trend value 2080s will be y = 3.28 + 2.70 (1) = 3.28 + 270 = 5.98

Impact of predicted climate change on Agriculture

The climate change will affect crop yields and cropping pattern due tot direct efforts of changes in atmospheric concentration of green house gases in general and CO_2 in particular. Carbon dioxide is a perfect example of a change that could have both positive and negative effects. Carbon dioxide is expected to have positive physiological effects through increased photosynthesis. This impact should be higher on C_3 crops such as wheat and rice than in CO_4 plants like maize and grasses. The direct effects of changes in CO_2 concentration will be through the changes in soil moisture and infestation by pests and diseases because of rising temperature and relative humidity. Such indirect effects through the

increase in temperature will reduce crop duration, increase crop respiration rates, increase evopo transpiration, decrease fertilizer use efficiencies and enhanced pest infestation.

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Possible impact of climate change on wheat production in India has been worked out by climate sunrises for the period between 2000 to 2070 and is reproduced in figure 2.

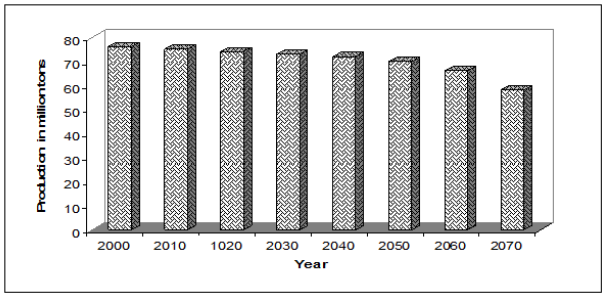

Fig 2 Possible impact of climate change on wheat production in India

Possible impact of climate change on wheat production in India

Sl. No.	Year	Production (in million Tons)
1	2000	76
2	2010	75
3	2020	74
4	2030	73
5	2040	72
6	2050	70
7	2060	66
8	2070	58

Source: Intensive Agriculture July-Dec-2008

Semi Average Method

$$\frac{76+75+74+73}{4}=\frac{298}{4}=74.5 \text{ MT}$$

$$\frac{72+70+66+58}{4}=\frac{266}{4}=66.5 \text{ MT}$$

From the figure 1 that there is general consensus that the yield of main season (Kharif) crop will increase due to the effect of higher carbon dioxide levels. However, large yield decreases are predicted for the Rabi crops because of increased temperatures. One of the potential effects of climate change on agriculture will be the shifts in the sowing time and length of growing seasons, which would alter sowing and harvesting dates of plants, crops and varieties, high temperature induced higher evopo transpiration would call for much greater efficiency of water and nutrients. Changed weed call flora and pests would require special methods of management and control, a great challenge for scientific community. There may also be a shift in climatic zones due to increased temperatures.

Regional Impact of Climate Change Condition in India

(1) Water

As a consequence of climate change farmers will face growing unpredictability and variability in water supplies and increasing frequency of droughts and floods. However, these impacts will vary tremendously from place to place. Scientist expect that a temperature increase of 1 to 3°C will be benefit agriculture in the northern latitudes, which take parts of the arid and semi arid tropics will face declining rainfall and run off an ominous trend for the mostly food insecure countries located there. But irrigation in large river basins and deltas are also at risk from a combination of reduced run off, salinity, increased flooding and sea level rise (Nile, Gangas – Brahmaputra, Mekong and Yangtse) and urban and industrial pollution. These stresses on some of the prime productive land will reduce the agricultural output, biodiversity and natural ability of eco systems to recover with possible negative impacts on millions of farmers and consumers across the World as food supply becomes progressively constained [2].

The impacts of climate change will be uneven between countries and regions, China with 140 million under nourished people should gain 100 million tones in cereal production, while India, which 200 million under nourished, is expected to lose 30 million tones. Areas projected to experience lower precipitation will need to improve water storage, management and productivity. Large irrigation schemes will need to adopt the changes in water supply regimes and support will be needed for small scale, filed based water control measures.

(2) Land

Climate change threatens to uproot many rural communities. For example, rising sea levels may force many; communities in low-lying coastal areas and river deltas in developing countries to more to higher ground. Similarly, increasingly frequent droughts brought on by climate change may leave farmers and pastoralists who rely on rain fall to

raise their crops and livestock in conflict over land and water. This displacement of people is lively to result in competition between migrants and established communities for access to land. Reconciling diverse land use needs present daunting challenges for Government at all levels. In case where land rights are informal and different customary land tenure system coexist, governments will need to work closely with local communities to establish fair and equitable systems of land tenure and develop mechanism for resolving disputes. For many displaced communities, it may be impossible to maintain their farming or pastoral traditions. Land tenure policies designed to facilitate resettlement will need to be incorporated into a breeder programme that provides opportunities for the displaced to earn livelihood outside the agricultural sector.

(3) Bio diversity

The 2005 millennium Eco system assessment estimates that by the end of this century, climate change will be the main cause of bio diversity loss, but as ultimate changes, the value of bio diversity for food and agricultural will increase. Genetic resources are the living material that local communities' researches and breeders use to adopt food and agricultural production to changing needs. Maintaining and using reservoir of genetic diversity will be the foundation for coping with climate change. The inter-governmental panel on climate change reports that a significant number of species will be at risk of extinction as the global mean temperature of particular concern are relatives of major crops surviving in the wild. For example, research by the consultative group on international agricultural research based on distribution models of wild relatives of three staple crops that sustain the poor peanuts, cowpea and potato suggests that by 2055, between 16 and 22 percent of wild species will be threatened by extinction [3].

(4) Fisheries and Aquaculture

Fisheries employ more than 200 million people world wide 98 percent from developing countries and fish is a major source of protein in many poor people's diets, comprising about 20 percent of animal protein in the diets of over 2.8 billion people. Climate change threatens this important source of income and nutrition for the poor. Here is want climate change will bring, higher water temperatures rising sea levels, melting glaciers, changes in ocean salinity and acidity, more cyclones in some area's less rain in others, shifting pattern and abundance of fish stocks. Climate change compromises the sustainability and productivity of a key economic and environmental resource, but it also presents opportunities, especially in aquaculture. Impact of climate change will affect fisheries and aquaculture dependent people as production and marketing costs will affect fisheries and aquaculture dependent people as production and marketing costs increase, buying power and exports decrease and dangers from harsher weather conditions rise. Small fishing communities in some areas will face greater uncertainty as availability, access, stability and use of aquatic food and supplies diminish and as work opportunities dwindle. Now accounting for 45 percent of global sea food consumption, aquaculture production will continue rising to meet future demand. Hence, climate offers new opportunities. Production in warmer regions will likely increase because of better growth rates, a long growing season and the availability of new fish farming areas where is was once too cold. Therefore, aquaculture development opportunities will increase in particular in tropical and sub tropical regions, such as in Africa and Latin America.

(5) Tran boundary Pests and Diseases

Pests and diseases have historically affected food production either directly through losses in food crops and animal production, or indirectly through test profits from insufficient cash crop yields. Small scale farmers naturally have the most to lose. Today there leases are being exacerbated by; the changing climate and its increasing volatility, threatening food security and rural livelihoods around the globe. While there is clear evidence that climate change is altering the distribution of animal and plant pests and diseases, the full effects are difficult to predict. Changing in temperature, moisture and atmospheric gases can fuel growth and generation rates of plants, fungi and insects, altering the interactions between pests, their natural enemies and their hosts. Changes in land cover, such as deforestation or desertification, can make remaining plants and animals increasingly vulnerable to pests and diseases. Now farming practices, different crops and animal breeds, and integrated pest management principles must be developed to help stem the spread of pests. Countries may need to consider the introduction of biological control agents or new pest or disease resistant crops and breeds. Government also needs to strengthen national animal and plant health services as a top priority [4].

Impact of Climate Change on Indian Agriculture

Impact of climate change on Indian agriculture has been studied to a limited extent. For the Indian subcontinent, it is predicted that the mean atmospheric temperature will increase by 1 to 4°C. Although the solar radiation received at the surface will be variable geographically, on an average it is expected to decrease by about 1 %. Rice occupies a pride of place in the Indian agriculture and the peninsular India comprising Mahanadi, Godavari and Kauvery deltas exclusively grow rice. Thus, climate changes affecting productivity of rice will severely affect the food security of the country. A reduction of the extent of rice yield is a distinct possibility if spikelet sterility would increase under predicted higher temperatures and if water reserves could not meet the increased evapo-transpiration.

Table projected changes in mean global temperature and precipitation.

General circulation model	Year when calculated	Temperature change©	Precipitation (%)
Urbana-Champaign	1996-1997	1.0	1.3
Max Planck Institute	1990-1991	1.1	2.1
Geophysical Fluid Dynamics Laboratory	1989	1.3	2.8
Hadley Centre	1995	1.8	2.5
Oregon State University	1985	2.8	8
Geophysical Fluid Dynamics Laboratory	1988	4.0	8
Goddard Institute for Space Studies	1982	4.2	11
United Kingdom Meteorological Office	1986	5.2	15

Source: Intensive Agriculture 2008

The projected comate changes are expected to usher in severe biophysical responses in agricultural crops, viz.

a. **Interactions with thermal regimes**: As higher temperature, in general, hastens plant maturity in annual species, the growth phases may be shortened. However, in rice, high night temperature may reduce potential yield of rice, primarily as a result of sterility.

b. **Changes in hydrological regimes**: While all GCMs predict increase in mean global precipitation, decreases are forecast in some areas and increases are not uniformly distributed. The crop weather regime may further be affected by changes in seasonal precipitation, within-season pattern of precipitation and internal variation in precipitation. Thus moisture stress during the flowering, pollination and grain-filling stages is especially harmful to maize, wheat, rice and sorghum.

c. **Physiological effects of increased CO_2**: Most plants growing in enhanced CO_2 exhibit increased rates of net photosynthesis, especially the C_3 ones. However, high CO_2 coupled with higher temperature does not show such benefits and the negative impacts could be compounded by the lower availability.

d. **Soils**: Higher temperature will accelerate the decay of soil organic matter, resulting in the releases of CO_2 to the atmosphere and decreases in C:N rations, although these two effects should be offset somewhat by greater root biomass and crop residues resulting from plant responses to higher CO_2 Sea level rises, another predicted effect of global warming, will cause increased flooding, salt-water intrusion and rising water tables in agricultural soils located near the coastlines.

e. **Pests**: Because climate variables control the geographical distribution of pests, climate change is likely to alter their ranges. Insects may extend their spread to areas where warmer winter temperatures allow their over-win-tearing and increase the possible number of generations per season

Crop Simulation Modelling on Rice Agriculture

Simulation studies were conducted at Central Rice Research Institute, Cuttack and Indian Agricultural Research Institute, New Delhi using all the years of data available for each weather station calibrated for two main rice ecotypes, viz. indica and japonica to predict the changes in rice ecotypes, several local varieties and conditions in a number of Asian countries were used to evaluate likely changes in those countries. Simulations were also made for multiple planting dates for the main season, second season and for stations where triple cropping is practiced, a third season.

Simulation models predict a change from -5.3 – 7.4 in yields for every 1C increase in temperature at the current level of CO_2. These values agree closely with 7.8% 1C increase measured in controlled environment. Using different GCM scenarios, simulation model ORYZA-1 predicted changes in overall regional annual production of +6.5%, -4.4 and -5.6% for GFDL, GISS and UKMO models. Similarly, the predicted yield reduction by INFOCROP rice model was in the range of -40.87 to 13.51% with an average of -13.95%. Taking advantage of all these estimates, it would appear that rice production in Asian region may decline by 3.8%. In India, large decreases were predicted for second season crop due to high temperature being encountered.

Tropical Rice Paddy as Source of Greenhouse Gases

Rice crop has been accredited as one of the important sources of anthropogenic CH4 and a potential source of N2O. In a collaborative study between Central Rice Research Institute, Cuttack and Space Application Centre, ISRO attempts were made to up scale CH4 flux from the rice lands of India using an integrated methodology of satellite remote sensing and GIS. Multi date SPOT-4 vegetation (VGT) S10 product, from composite Normalized Difference vegetation Index (NDVI) for a total year were used to map rice area, delineate single/doubles cropped rice area, crop calendar and growth stages. Rainfall, digital elevation and irrigation data were integrated to stratify the rice area into distinct categories related to CH4 emission. Results show that the total emission is around 5.74 T g per year. The spatial pattern showed high emission areas in the states of Tamil Nadu, West Bengal and Andhra. The temporal pattern indicates the peak emission during the months of August-September [5].

Future Agriculture under Changing Climate

Climate change due to greenhouse gas emission has the most consistent impacts on world crop production. Increases in mean global temperature cause world crop production to decrease by 0.22 (+0.44) and 0.60 (+ 0.44) and 0.60 (+0.59) percent per 1.0C increase in ambient temperature. Empirical selection for crop yield under field conditions may indirectly select plants that are responsive to continually increasing GHG levels including C02 indirect selection , however, will be inefficient because the impacts of elevated C02 should be considered among others, in the context of (i) changes in

ambient temperature, particularly nocturnal temperature and changes in moisture availability, (ii) need for more farm resources and (iii) interactions with 0_3 and other growth regulating variables including pathogens and pest. Because of many uncertainties, the IPCC has given quantitative estimates of agriculturally related economic impacts of greenhouse gas related climate change low confidence. A major source of uncertainty is our inability to accurately project future changes in economic activity, emissions and climate. Although, there has been progress in monitoring and understanding climate change, there still remain considerable uncertainty about the rates of changes that can be expected, but it is clear that these changes will be increasingly manifested in important and tangible ways. However, in spite of the fact that the source of uncertainty will always exist, the development of ways to quantify and categorize its impacts on estimates of economic activity will increase our ability to cope with it [6].

Impact on Global warming

Global warming is expected to bring about a rise in the sea level because of the expansion of sea water caused by the melting glaciers and perhaps the melting of solar ice with a rise in temperature.

1. The effect would be increase flooding of many of the coastal wet lands. This coastal erosion is expected to create shoreline loses of between 10 and 100 feet depending on local conditions.

2. It would be increased on agriculture horticulture and eco-system.

3. The effect would be increase on temperature and climate change.

4. It would be deceased on rain fall and water scarcity.

5. It would be increased the higher global temperature more water will be evaporated from the oceans.

6. The effect will be increased the climate, change affect the agriculture.

7. It due to melting the caps, walruses have tried climbing in to while fishing boats mistaking them for the floes that have disappeared.

8. Green land is lasing 250 cubic km of water each year, adding to the rising sea levels.

9. With the melting permafrost in the arctic buildings and roads in Alaska and Siberia are suffering severe damages.

10. The 2005 monsoon in Mumbai killed over 750 people when nearly a meter of rainfall.

11. The devastating hurricane Katrina which hit New Orleans, was one of the strongest Atlantic storms ever observed in 24 hours, the highest ever recorded.

12. In 2003 severe heat left nearly 30,000 people dead across Europe. The situation was so bad that in Paris, because morgues were overflowing, dead bodies were kept in vegetable cooling warehouses.

International concern the Kyoto protocol

Ever since the threat of climate change solidified its presence in the minds of the powers that be international consensus exists on the absolute necessity to take measures to compact global warming. To this end, the United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992 at the Rio earth submit by readers from 150 nations, with George Bush senior at the helm of affairs for the united states. However as time passed the convention seemed to be Weston academic exercise rather than one must would call on countries to take action to curb carbon emission. This voluntary nature died not helps underline the burgeoning or the problem either. In order to save the issue its due on the international plant form the Kyoto protocol was reviewed again in Japan in 1997. At this time industrialized the developed nations took the commitment to take the lead in combating climate change, since they were the highest pollutes. In accordance with the agreement, the target was to achieve an aggregate fall of 12% by 2012 [7].

Saving the planet

There are some steps you can take to reduce your carbon footprint and help towards a greener world.

(a) Electricity

1. Opt for Compact Fluorescents Bulbs (CFLs) using CFLs is equivalent to taking 305 million cars off the road.
2. Switch off your computers, TV sets and any other appliances when they are not in use.
3. Do not leaned the computer in stand by more it continues to consume energy. If not in use, it should be shut down.
4. Maintain the air conditioner at an optimum of 24°C no more , no les.

(b) Traveling

1. Over pool as often as possible, less the number of cars on the street, the less the carbon output.
2. Shorter distances can be traveled on foot or by using a bicycle. Very recently, locates in Bangalore made a concerned effort to use bicycles for small distance.
3. Public transport, stood be used instead of private transport, train and bus all help same a great amount of energy. One bus load of people sis equal to taking 40 vehicles off the road.
4. Hybrid cars are another good way to combat global worming. The run on electricity and do not contribute any carbon emissions to the atmosphere.

(c) Water

1. Try not to use not water if you do not need to and same energy.
2. A shower is infinitely preferable to a long bath – IT is quicker and also consumes 10% less energy.
3. Make sure your tap is not dripping after use. One take tap wastes over 20,000 liters of water annually.

d) Recycling

1. Aluminum cans, old news papers and other recyclable

items should be recycled. Recycling is an important aspects of energy saving and is very easily done.

2. Even computers can be recycled. Old computers can be sent back to the supplier or denoted to charities.

3. Segregation of wet and dry garbage is very important, because wet garbage is biodegradable an dry waste can be recycled.

4. Plastic should be avoided as far us possible since it is a huge burden on the ecologist is not biodegradable.

CONCLUSION

Much can be done to reduce agriculture contribution to green house gas emissions and it is important to pursue strategies and practices with this end in view. However, mitigation alone is not enough and will not be felt before the second half of the century. Global warming is already underway and adoption strategies are now a matter of urgency, especially for the most vulnerable poor countries. Humanity must learn to live with climate change. But we can not allow climate change to become one more aggravating factor for hunger in the world. On more taking that wizens the gap between rich countries and poor countries. The future will be extreme weather events drought and rising sea level threaten the lives and livelihoods of millions of people around the world. There is a need for a collective effort by the international community to fight this problem. It also means that knowing what the climate will be in the next fifty or one hundred years is among the most challenging problems to science.

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