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CLIMATE CHANGE AND ITS IMPACTS ON AGRICULTURE

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ABSTRACT

Agriculture provides employment for 2.6 billion people worldwide and accounts for 20 to 60 percent of the gross domestic product of many developing countries, forming the backbone of rural economies, contributing to local employment, and ensuring food security for poorer populations. The agricultural sector is also a major contributor to GHG (Greenhouse Gas) emissions. Most studies attribute about twenty to twenty-five percent of all global GHG emissions to the production of food, feed, and biofuels, including emissions from agriculture-driven land use change. Though these numbers are substantial and comparable in aggregate to the transportation sector, agriculture's potential contributions to GHG mitigation have received little attention the international dialogs on climate change mitigation. If agricultural systems are to meet the future needs of an expanding global population, significant progress will need to be made in helping the agricultural sector as a whole— and farmers in particular—increase the resilience of farming systems to climate change, better preserve soil fertility and freshwater flows, and reduce impacts on deforestation, biological diversity, and GHG emissions.

Keywords: Climate change, Greenhouse gases (GHGs), Mitigation, Agriculture, Inter governmental Panel on Climate Change (IPCC).

I. INTRODUCTION

Agriculture lies at the heart of many fundamental global challenges faced by humanity including food security, economic development, environmental degradation, and climate change. There is no humanitarian goal more crucial than feeding a world population projected to expand beyond nine billion by 2050. With consumption of all natural resource commodities increasing under the pressures of population growth and rising standards of living, there is continuing pressure for agriculture to expand and intensify. While governments, bilateral development agencies, and multilateral financial institutions are dedicating significant resources to increasing agricultural yields globally, less emphasis has been placed on making agriculture environmentally sustainable. Croplands and pasturelands already cover nearly 40 percent of the earth's land area, and agriculture consumes 70 percent of freshwater used by humans, much of which is sourced from non-renewable aquifers.

II. The objectives of this study are:

- To explore climate related issues and their potential consequences for the agricultural sector.

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- To gain understanding of GHG emissions and integrate climate change adaptation and mitigation into strategies for agriculture development.

III. METHODOLOGY

The paper is based on the secondary sources. The data has been taken from various government publications, books, journals, newspapers, magazines and websites. The paper discusses issues of impact of climate change affecting agriculture.

Agriculture is the world's largest driver of species loss and habitat conversion, and is a major contributor to toxic and nutrient pollution, soil degradation, and invasive species introductions. Climate change has already impacted on agricultural production and economic growth around the world. It has become a significantly critical global topic and adaptation strategies to cope with its potential impacts are increasingly being integrated into development policy. These impacts are critical since agriculture makes a particularly significant contribution to the economies, food security and poverty alleviation in most developing countries [1].

Fig 1: Sources of Direct Agricultural Emission

Sources of emissions	%
Enteric fermentation Ruminants (e.g., cattle, sheep, goats, water buffalo) emit CH_4 directly as a byproduct of digestion.	43%
Manure deposited on grazing lands Manure and urine that falls on grazing lands causes N_2O emissions.	16%
Synthetic fertilizers N_2O emissions from soils resulting from large amounts of nitrogen fertilizer added to crops.	15%
Rice production Most rice production systems result in CH_4 emissions from anaerobic decomposition on flooded fields. This fraction represents CH_4 emissions from rice only. N_2O emissions from fertilizers are counted in 'synthetic fertilizers'.	11%
Stored manure Livestock manure and urine cause both CH_4 emissions through increased decomposition in wet storage systems, as well as N_2O emissions in dry storage systems.	7%
Crop residues Crop residues that remain on agricultural lands are a source of N_2O.	3%
Manure deposited on croplands Manure is another source of nitrogen fertilizer for crops, resulting in N_2O emissions.	2%
Cultivation of organic soils N_2O emitted from drained organic soils.	2%

Source: FAO Stat 2010

Climate change is exacerbating the challenges faced by the agriculture sector. Climate change-induced increases in temperatures, rainfall variation and the frequency and intensity of extreme weather events are adding to pressure on the global agriculture system – which is already struggling to respond to rising demands for food and renewable energy. The changing climate is also contributing to resource problems beyond food security, such as water scarcity, pollution and soil degradation. As resource scarcity and environmental quality problems emerge, so does the urgency of addressing these challenges. Climate change is expected to negatively affect both crop and livestock production systems in most regions, although some countries may actually benefit from the changing conditions. Overall, productivity levels are expected to be lower than without climate change due to changes in temperatures, crop water requirements and water availability and quality. Agriculture is also contributing a significant share of the greenhouse gas (GHG) emissions that are causing climate change – 17% directly through agricultural activities and an additional 7% to 14% through changes in land use. The main

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direct agricultural GHGs emissions are nitrous oxide emissions from soils, applications of fertilisers, dejections from grazing animals, and methane production by ruminant animals (enteric fermentation) and paddy rice cultivation [2].

Main projections for climate change at Global Level: The projections of future climate patterns are largely based on computer-based models of the climate system that incorporate the important factors and processes of the atmosphere and the oceans, including the expected growth in greenhouse gases from socio-economic scenarios for the coming decades. The IPCC has examined the published results from many different models and on the basis of the evidence has estimated that by year 2100:

- The global average surface warming (surface air temperature change) will increase by 1.1 - 6.4 °C. The sea level will rise between 18 and 59 cm.
- The oceans will become more acidic.
- It is very likely that hot extremes, heat waves and heavy precipitation events will continue to become more frequent.
- It is very likely that there will be more precipitation at higher latitudes and it is likely that there will be less precipitation in most subtropical land areas.
- It is likely that tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and heavier precipitation associated with ongoing increases of tropical sea surface temperatures [3].

IV.GLOBAL SCENARIO OF CLIMATE CHANGE:

- Sub-Saharan Africa is highly vulnerable to negative impacts from climate variability and change, given its exposure to droughts and floods, high reliance on rainfed crops, and widespread degradation of its agricultural resource base. These vulnerabilities are very likely to increase with climate change.
- The Middle East and North Africa region is highly vulnerable to climate change, given the severe constraints imposed by high temperatures, low and erratic precipitation, prolonged drought, land degradation, and the future likelihood of increased warming and aridity.
- In Central Asia, a strong warming trend, loss of glacial melt water, and a reduction in spring and summer precipitation are expected, which could significantly reduce crop yields.
- Climate change is expected to generate both positive and negative impacts in Europe. Northern European could benefit from a longer growing season, while southeastern Europe could be negatively affected by temperature rise and increased moisture deficits [4].
- By 2030, production from agriculture and forestry was projected to decline over much of southern and eastern Australia, and over parts of eastern New Zealand; In New Zealand, initial benefits were projected close to major rivers and in western and southern areas.
- Increased temperatures and altered hydrological cycles are predicted to translate to shorter growing seasons, overall reduced biomass production, and lower grain yields. Brazil, Mexico and Argentina alone contribute

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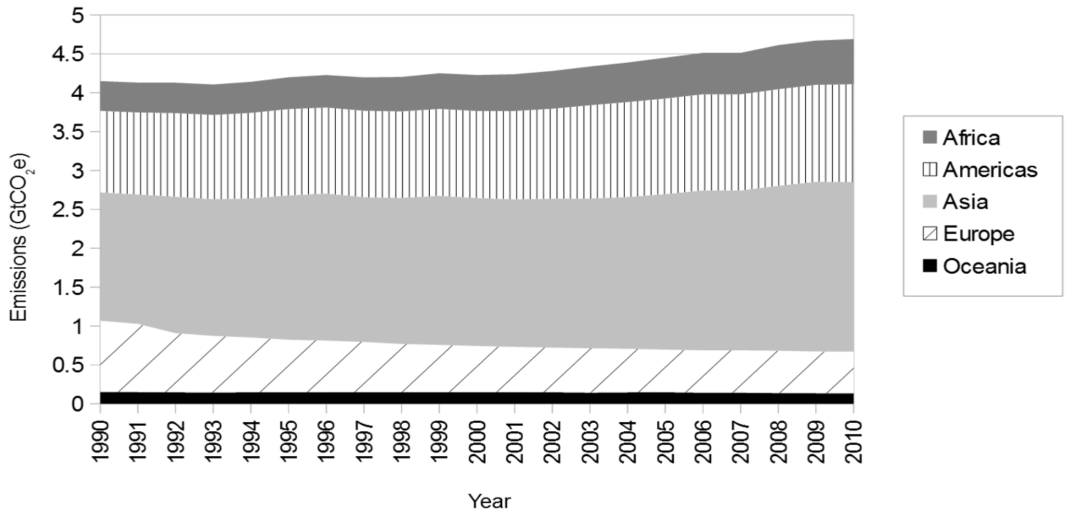
70-90% of the total agricultural production in Latin America. In these and other dry regions, maize production is expected to decrease.

- Droughts are becoming more frequent and intense in arid and semiarid western North America as temperatures have been rising, advancing the timing and magnitude of spring snow melt floods and reducing river flow volume in summer [5].

Fig 2: Greenhouse gas emissions from agriculture, by region, 1990-2010.



Source: Food and Agriculture Organization (FAO)

Fig 3: Climatic Changes by 2050 and its Effect on Agriculture

Climatic element	Expected changes by 2050's	Confidence in prediction	Effects on agriculture
CO_2	Increase from 360 ppm to 450 - 600 ppm (2005 levels now at 379 ppm)	Very high	Good for crops: increased photosynthesis; reduced water use
Sea level rise	Rise by 10 -15 cm Increased in south and offset in north by natural subsistence/rebound	Very high	Loss of land, coastal erosion, flooding, salinisation of groundwater
Temperature	Rise by 1-2ºC. Winters warming more than summers. Increased frequency of heat waves	High	Faster, shorter, earlier growing seasons, range moving north and to higher altitudes, heat stress risk, increased evapotranspiration
Precipitation	Seasonal changes by ± 10%	Low	Impacts on drought risk' soil workability, water logging irrigation supply, transpiration
Storminess	Increased wind speeds, especially in north. More intense rainfall events.	Very low	Lodging, soil erosion, reduced infiltration of rainfall
Variability	Increases across most climatic variables. Predictions uncertain	Very low	Changing risk of damaging events (heat waves, frost, droughts floods) which effect crops and timing of farm operations
Source: Climate change and Agriculture, MAFF (2000)			

The effects of rising temperatures on crop productivity vary depending on the characteristics of the crop, the timing of heat stress in relation to crop development, and the conditions under which it is grown. Maximum daytime temperature accelerates crop maturity, resulting in reduced grain filling, while higher minimum nighttime temperatures increase respiration losses. In addition to mean temperature rise, episodic heat waves

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also have a strong negative impact on yields, particularly when they occur during sensitive phenologic stages, such as during reproductive growth causing increased sterility or during seedling emergence, which affects crop stand establishment. Moreover, decreased solar radiation resulting from higher cloud and aerosol formation linked to temperature rise can suppress crop biomass production[6].

V.CLIMATE CHANGE – MITIGATION AND ADAPTATION IN AGRICULTURE

1. Assist farmers in coping with current climatic risks by providing value-added weather services to farmers. Farmers can adapt to climate changes to some degree by shifting planting dates, choosing varieties with different growth duration, or changing crop rotations.
2. An Early warning system should be put in place to monitor changes in pest and disease outbreaks. The overall pest control strategy should be based on integrated pest management because it takes care of multiple pests in a given climatic scenario.
3. Participatory and formal plant breeding to develop climate-resilient crop varieties that can tolerate higher temperatures, drought and salinity.
4. Developing short-duration crop varieties that can mature before the peak heat phase set in.
5. Selecting genotype in crops that have a higher per day yield potential to counter yield loss from heat-induced reduction in growing periods.
6. Preventive measures for drought that include on-farm reservoirs in medium lands, growing of pulses and oilseeds instead of rice in uplands, ridges and furrow system in cotton crops, growing of intercrops in place of pure crops in uplands, land grading and leveling, stabilization of field bunds by stone and grasses, graded line bunds, contour trenching for runoff collection, conservation furrows, mulching and more application of Farm yard manure (FYM).
7. Efficient water use such as frequent but shallow irrigation, drip and sprinkler irrigation for high value crops, irrigation at critical stages.
8. Efficient fertilizer use such as optimum fertilizer dose, split application of nitrogenous and potassium fertilizers, deep placement, use of neem, karanja products and other such nitrification inhibitors, liming of acid soils, use of micronutrients such as zinc and boron, use of sulphur in oilseed crops, integrated nutrient management.
9. Seasonal weather forecasts could be used as a supportive measure to optimize planting and irrigation patterns.
10. Provide greater coverage of weather linked agriculture insurance.
11. Intensify the food production system by improving the technology and input delivery system.
12. Adopt resource conservation technologies such as notillage, laser land leveling, direct seeding of rice and crop diversification which will help in reducing in the global warming potential. Crop diversification can be done by growing non-paddy crops in rain fed uplands to perform better under prolonged soil moisture stress in kharif.
13. Develop a long-term land use plan for ensuring food security and climatic resilience.

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14. National grid grain storages at the household/ community level to the district level must be established to ensure local food security and stabilize prices.
15. Provide incentives to farmers for resource conservation and efficiency by providing credit to the farmers for transition to adaptation technologies.
16. Provide technical, institutional and financial support for establishment of community banks of food, forage and seed.
17. Provide more funds to strengthen research for enhancing adaptation and mitigation capacity of agriculture [7

Long-term risks to agriculture from climate change are likely to involve increased climate variability and prevalence of extreme events combined with an acceleration of warming, glacier retreat and sea-level rise, regional changes in mean precipitation, and increased risks of land degradation and crop loss from agricultural pests. There should be a determined effort from developed and developing countries to make industrialization environment friendly by reducing greenhouse gases pumping into the atmosphere. In the same fashion, awareness programmes on climate change and its effects on various sectors viz., agriculture, health, infrastructure, water, forestry, fisheries, land and ocean biodiversity and sea level and the role played by human interventions in climate change need to be taken up on priority basis. In the process, lifestyles of people should also be changed so as not to harm earth atmosphere continuum by pumping greenhouse gases.

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