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Climate Change: Adaptation and Mitigation Measures to Enhance Availability of Soil Water for Plant's Use

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Abstract: Soil water is a necessary, precious and natural gift that supports both plants' and animal's life. Climate change causes global warming which increases loss of water in through evapo-transpiration. Water is also lost, through percolation, beyond the reach of the plant use. Both evapo-transpiration and percolation are aided by human activities. This paper aims at presenting some adaptation and mitigation measures of enhancing availability of soil water for plants' use. Indigenous variety of plants are adapted to our natural environment and conform to our biological needs hence can serve as adaptation measures. As a cover crop and wind breaks, plants can be used to combat climate change in our environment . Some of the measures suggested includes use of cultural practices such mulching, drip irrigation, need for legislation to control rampant drilling of boreholes and construction of dams.

Keywords: Climate, adaptation, mitigation, soil, plants.

I. INTRODUCTION

According to Raghunath (2010) plants extract water from the soil in the following pattern; 40% of their requirement from the first quarter (top-most layer) of root zone, 30% from the second quarter, 20% from the third quarter and 10% from the fourth quarter (bottom-most layer) of their effective root zone depth, since greater part of the root (60-75 %) lie in the top half of the depth of the root zone. The three major forces that ensures water supply for plant use are; the adsorption force for hygroscopic moisture, surface tension force for capillary moisture and gravitational force for gravitational water. Due to climate change and human activities (construction of dams and drainages, drilling boreholes and filling of natural recharge) the availability of water for plants use is being threatened.

The issue of global climate change is now the subject of discussion worldwide and its impact is now a reality with this years heavy precipitation and flood record in Pakistan, China, India and Nigeria (Sokoto, Kebbi and Jigawa). Climate change, as change in weather pattern, has serious consequences on the availability of soil water for plant use. Lawal (2010) stated that change in five climatic elements (temperature, solar radiation, precipitations, wind and humidity) threaten the very existence of crop species at an alarming rate due to draught and rise in temperature. In some literatures it has been postulated that in the next one century about 50% of plant species may be extinct due to climate change (David 2007). Ayoade (2010) defined climate as the "end product of the working of the climatic system consisting of the atmosphere, the lithosphere, the hydrosphere, the cryosphere and the biosphere interacting together and powered by solar radiation".

The ice rain recorded in 2010 in Katsina is a clear indicator that climate change is a reality. Livestock's, windscreens, roofing and other valuable items were lost as a result of that ice rain (Lawal 2010).

II. CAUSES OF CLIMATE CHANGE

The advances made in science and technology comes with some serious and in some cases disastrous consequences on climate such as leakage of nuclear materials and toxic chemicals. The factors that causes climate change can be broadly categorized into two, namely, natural factors which we have no control but to adapt and anthropogenic (human factors) which we want control through mitigation effort.

The world is rapidly changing and the machineries that brings about these changes exploits as well as destroy the natural environment in various ways. The 2010 BP's oil leakage in the Gulf of Mexico is a typical example of how human activities destroy our natural environment (Lawal 2010). According to Lawal (2010), Hiroshima and Nagasaki nuclear bombings in 1945, the Chernobyl nuclear disaster of 1986 and Bhopal gas catastrophe in 1984 epitomize the human recklessness toward our natural environment and climate. The continuous emission of green house gases (GHG) on daily bases by USA, the greatest emitter of

GHG, China, Japan, UK, Germany, France, Russia, Canada and Italy is moving our climate to eventual doom. Hart (2008) stated that most air pollution comes from human activities such as burning of fossil fuel to power industrial process and motor vehicles. The GHG emission in such a large scale and on daily basis led to the current global warming we are suffering from. Chemicals used as propellants and aerosols such as chlorofluorocarbons (CFCs) deplete the ozone layer in the atmosphere hence increasing the exposure of both plants and animals to harmful solar radiation.

Bad agricultural practices such as:

- 1) Bush burning and over grazing: Bush burning and over grazing destroys soil structure and depletes soil fertility, exposes surface soil thereby increasing rate of evapo-transpiration.
- 2) Wrong use of agrochemicals like fertilizers, herbicides and pesticides; over dose of fertilizers can lead to contamination of soil water with nitrogenous compounds (e.g. NO_2) which is harmful to both micro and macro organisms. Herbicides destroy all other plants and leave only the farmers crop to survive. Hart (2008) pointed out that chemicals used to kill unwanted animals and plants on farm yards may be collected by rain and carried into streams, especially if applied lavishly, and become harmful to other plants and animals. Some chemicals are non-biodegradable therefore remain in both plants and animals to cause a process known as bio-magnification. A process where a harmful chemical in a food chain becomes more harmful in each step of food chain.
- 3) Breeding programs that disregard landraces and emphasize on new cultivars and genetically modified crops; there is a fear for terminator gene escape which can destroy our landraces via pollination. The threat of creating super weed through the GM crops hitherto unknown to man before biotechnology is another concern for adoption landraces existence.
- 4) Improper irrigation schemes drain large quantities of water and sometimes contaminate water bodies. Rampant and unguided use of genetically modified crop species is another threat to our climate and our indigenous crop species. Incessant and rampant drilling of boreholes and continuous filling of natural lakes and valleys that serves as a natural recharge for water table have a great potentialities for lowering the water table and therefore changing the climate.
- 5) Deforestation for fuel and timber lumbering encourages desert encroachment and soil erosion makes the indigenous crops vulnerable for extinction.

Impact of climate change on soil water

The impact of climate change on the availability of water for plant use in the savannah zones of Nigeria is of serious concern, as crop failure due draught is becoming alarming. According to Kutu, Animashaun, Olawale, Murtala and Abdullahi (2015) the trend pattern of stream flow, rainfall, temperature and evaporation from 2002 – 2012 was extremely high compared to 1980 -1990 and 1991- 2001. Climate change result to global warming due to green house effect. The change in temperature affects the availability of water for plants' use. Increase in temperature increase the rate of evapotranspiration (escape of water in a gaseous form to the atmosphere) therefore making the water unavailable for plants' use.

According to Malea (2008) "climate change is causing more severe and more frequent storms and drought, resulting in timing and amount of rainfall that damage agricultural productions". Adrian *et al* (2009) predicted that increase in temperatures, seasonal changes in precipitations pattern results in both drought and flooding/water logging, longer growing seasons and more extreme weather and these are detrimental to our indigenous crop varieties.

Increase in temperature results in volatilization of some macro and micro nutrients for plants use and hence makes it unfavorable for plants survival.

"The most recent model based on temperature rise of 2-3Celcius over the next100 years suggest that up to 50% of 400,000 or so higher plant species will be threaten with extinction." (David 2007). The impact of climate change on availability of water is so glaring that the South African city impose water restriction on its resident and visitors last week the daily allowance for the city's resident was slashed from 87 litres to 50 litres (Hugh 2018). As a result of climate change lake chad's surface area has shrunk by more than 90 per cent over the past 50 years (Ifeanyi 2018).

Adaptation Measures To Increase Water Availability Our indigenous crops are endowed with genetic materials that adapt with our natural environment and provide for our biological needs that includes stabilizing climatic fluctuations.

Trees like *Perkia biglosa*, *Adansonia sp* (baobab), *Vitellaria paradoxa*, (shear butter) mango etc serves as wind breaks, improve soil properties and act as a carbon sink.

Crops like cactus, jatropha, gumb Arabic, serves as boundry crops that helps provision of raw material for industries and also prevent erosion.

Cover crops like cowpea, groundnut, kirikiri grass (*Cynadon dactylon*) enhance soil qualities to support vegetation growth to combat climate change.

The challenges facing the use of our indigenous crops to combat climate change is lack of commitment by the stake holders to fund the establishment plantations and woodlot to combat desertification which is a major factor causing climate change in Africa.

Poor yielding and late maturity of indigenous crops makes difficult to establish orchards and plantations hence the need to improve these traits. Enaboifo (2010) pointed that desertification is connected with poverty. So if people are still living in poverty desertification through deforestation will continue. The availability of water to establish plantations, rangelands and woodlot is a serious challenge in arid areas that need these plants.

Conclusion In conclusion this paper is of the view that stakeholders (national, international and local) should take the responsibility of funding research to monitor and control the utilization of our fresh water bodies and also improve our indigenous crops to adapt better for combating the bad effect of climate change.

III. RECOMMENDATIONS

The broad measures to address climate change are adaptation and mitigation measures. According to Ayoade (2010) the response strategies to tackle the problem of climate change have been mostly in form of mitigation and adaptation measures.

The best solution to climate change is to create national and international awareness and commitment to conserve our water bodies for efficient plants and human use. Farmers need to be trained on good cultural practices, such as good fertilizer management and proper application of biodegradable agrochemicals.

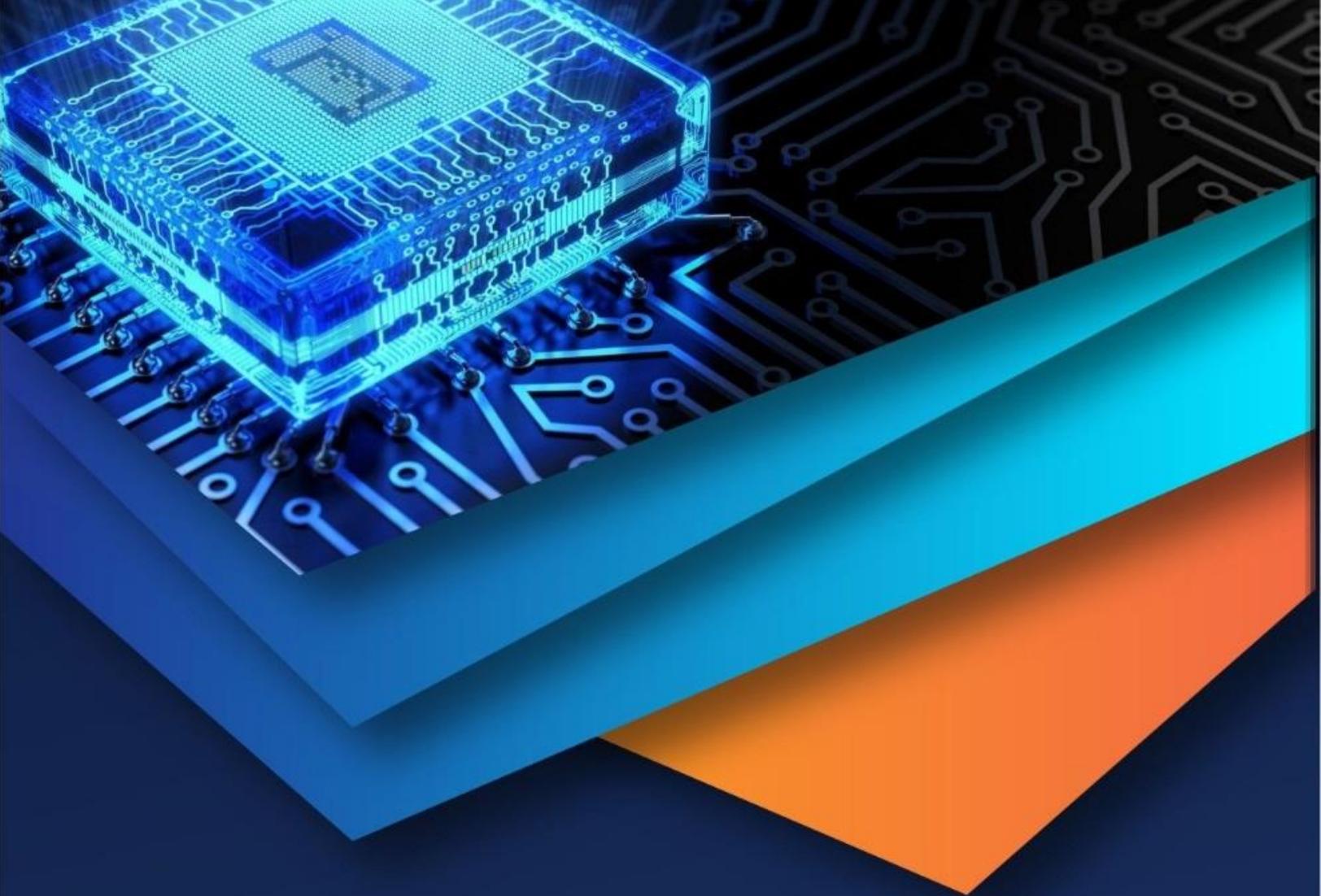
The government should take quarantine measures against importation and introduction of alien crop varieties with questionable genome. The International community should find a means of enforcing mitigation measures and use of renewable energy, like solar and wind energy, to the developed nations (especially the G8 countries).

In addition to the above some specific recommendations to control climate change include,

- A. There should be legislation for ground water exploitation and regulation to check indiscriminate construction of dams and drilling of boreholes. Mulching and drip irrigation should be encourage to conserve water.
- B. Improve meteorological stations facilities and mobility of meteorological inspectors for effective supervision, data collection, interpretation and control.
- C. Choice of the species depend on the environmental need and the objectives of the farmers, but some of the desirable traits includes: vigor, drought resistance, ability to develop moderate to high crown. Possess good stem, well rooted and have other economic values apart from enhancing environment such as edible fruit, leaves or other vegetative parts.
- D. The stakeholders should creates endowment fund for improvement soil water utilization through breeding and management our indigenous crops for combating climate change.
- E. Incentives inform of seedlings, fertilizer and other agrochemicals should be given to farmers to encourage planting and nursing of such crops for combating climate change. Punitive measures (payment of fine) should also be spelt to control deforestation.
- F. To check deforestation the government should subsidize and increase supply of kerosene and cooking gas for domestic energy needs.

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