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A Review on Adaptation Strategies for Minimizing the Impacts of Climate Change on Crop Production among Small Holder Farmers in Nigeria

Malabe K. M.[1], Pur J.T[2], Mustapha B. G[3], Ahmed K. Haruna[4], Abubakar A. A[5], Auwal Aliyu[6], Abubakar A. B. K[7], Ibrahim Y. G[8]

[1, 2]*Department of Agricultural Extension Services, University of Maiduguri, Nigeria*
[2, 3, 4, 5, 6, 7, 8]*Advanced Space Technology Application Laboratory, (ASTAL) BUK, Kano, Nigeria*

Abstract: ***This paper reviewed the adaptation strategies for minimizing the adverse effects of climate change among small holder farmers in Nigeria. Evidence indicates that the impacts of climate change in Nigeria are considerable, as a result, adaptation is paramount especially given the fact that the country is among those predicted to be adversely affected by the phenomenon. Farmers in Nigeria are not left out in the threat posed by the change in climate, however when adaptation is fully implemented, large reduction in adverse effects of climate change are possible. The review indicated that the farmers relied more on personal observation and experiences in combating climate change impacts using short-term adjustment (autonomous adaptation strategies) such as changing the crop, planting or sowing dates, diversification in crop enterprise, cultivating varieties with drought and heat tolerant abilities. Therefore, it is noted that small holder farmers used autonomous adaptation measures without legal framework for climate adaptation measures from government, policy makers or research institutes. And there is no awareness as well as training on potential benefits of adaptation by extension agents. The future impacts of climate change on crop production in many parts of Nigeria are likely to be significantly greater than those that have been experienced in the past as a result of natural climatic variability alone. The paper also indicated limited information from extension officers, inadequate knowledge and insufficient access to resources as major constraints to adaptation in Nigeria. It is recommended that there is a need to implement policies to planned adaptation strategies and improving the competencies of farmers. There should be a governmental and non-governmental organization's intervention against impact of climate change and improved access to loans at low interest rates from financial institutions for individual farmers or cooperative associations. Since, smallholder farmers in Nigeria are not left out in the threat posed by the change in climate.***

Keywords: Adaptation; strategies; climate; smallholder; farmer; impact; crop

I. INTRODUCTION

Climate change is one of the most serious environmental threats facing mankind Worldwide; it affects mankind in several ways, including its direct impact on food production (Enete and Amusa, 2010). Evidences from literature have revealed that the recent global warming has influenced agricultural productivity leading to declining food production (Kurukulasuriya and Rosenthal, 2011). The imminent danger associated with climate change are intrinsically and naturally global in both their causes and effects. This being the case, they require collective efforts on an international level or cooperation to be rightly and comprehensively address. Past studies have used a variety of approaches to capture climate change effects on crop production (Dressa and Hassan, 2010). These approaches range from simply equating average future impacts to yield losses observed in historical drought to more quantitative crop stimulation modelling. A number of researches has been conducted on the potential impact of climate change on crop production (Lobell and Burke, 2008). There is already an observed decline in crop yield and food crops production due to reduction in rainfall and relative humidity and increase in temperature in Nigeria (Agbola and Ojeleye, 2007).

Nigeria has a variety of ecosystems: from mangroves and rainforests on the Atlantic coast in the south to the savanna in the north. Whether dry or wet, these ecosystems are being battered by climate change while excessive inundation during the past decade has hurt farming in coastal communities, while desertification is destroying the Sahel. Traditionally, desertification in the Sahel has been blamed on overgrazing practices of the local population. But it has been discovered that the real problem is climate change. Peoples livelihood are being harmed and people who are already poor are becoming even more poorer and impoverished. Climate refugees are being created (Apata, 2014). Therefore, improving the farmer's capability towards responding to climate change and mitigating it effects on crop production is critical. Nigeria is believed as being vincible and unprotected to the impact of climate

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change. Agriculture is one of important sector of the national economy in Nigeria, relying upon natural rainfall (Adekunle, 2011). Nigeria's agricultural productivity, is thus to a great extent responsive to changes in local climate or global warming. Therefore, climate change is a major obstacle to crop production.

The actual and potential impacts of climate change in Nigeria are noticeable importance and have far reaching effects (Apata, 2014). Agricultural sector is vulnerable to climate change. It presents significant threats to increasing crop production, eliminating hunger and starvation (Kim, 2016). Climate change affects agriculture, a fact well known to every farmer. Year –to-year variations in temperature and precipitation that can make difference between bountiful and low crop yield. The obstinate Sahelian drought reported by Kawu (1987) as recurrent in Nigeria (1911-13, 1942-43, and 1972-73). A relatively more recent revelation (Akeh, *et al.* 2003) have reported that drought has occurred in Nigeria since 1882 up to 1886 and also 1913-1916,1942-1945,1971-1973 and 1982-1984. The awareness and realization of these facts, therefore, demand for a more detailed analysis of the imminent danger posed by climate change to crop production in Nigeria. Hence, any change in climate patterns in the country would have a great impact on both the agriculture and economy of the country. Thus, the review is based on the following headings: Approaches to Climate Change Adaptation; Overview of the effect of climate change; Causes of climate change and its effects on crop production; Climate Change Adaptation Strategies and the role of extension services; and Constraints Affecting Adaptation Measures on Climate Change by Small Holder Farmers.

A. Approaches to Climate Change Adaptation

The term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Sowunmi and Kintola, 2009). Climate change adaptation approach is a response to climate change that seeks to reduce the vulnerability of social and biological systems to relatively sudden change and thus offset the effects of climate change (Henfrey, 2018). Adaptation to climate is the process through which people reduce the adverse effects of climate variability on their agricultural activities, health and well-being and to take advantage of the opportunities that their climatic environment provides (Bancy, 2000). There are two main types of approaches of adaptation which are autonomous and planned adaptations. The autonomous adaptation approaches are the reaction of a farmer to changing precipitation patterns, in that the farmer changes crop or planting/sowing dates. Autonomous adaptation refers to the action taken by farmer in response to changing conditions in their immediate environment, irrespective of any policy-base decisions. The planned adaptation approaches or measures are conscious policy, options or strategies, frequently multi-sectoral in nature that is involving various stakeholders (government, private sectors etc.) to jointly achieve a policy outcome, aimed at facilitating specific adaptation, etc. deliberate crop selection and distribution strategies across different agro-climatic zones and substitution of new crops for old ones. Planned adaptation describes the result of policy base-decisions. Based on an awareness that conditions have changed or are about to change and that some type of action is required to achieve, maintain, or return to a desired state. Example building sea walls in anticipation of a rise in sea level. Planned adaptation is a long-term strategy as a major structural changes to overcome adversity of the impacts of climate change (Reilly, 1999).

B. Overview of the Effect of Climate Change

Climate change is an adverse environmental phenomenon that is causing massive concern all over the world (Adekunle, 2011). The climate of Nigeria varies more than any other country in West Africa due to its great length from the south to the north (1100km) that result in virtually all the climatic belts of West Africa being included within Nigeria's borders (BNRCC, 2011). There will be no region of the world will be completely spared from the impacts of climate change but the negative impacts are likely to fall most heavily on developing and poor countries in the tropical region (Peter, 2010). There is an increasing agreement in the scientific literature that in the coming decades the world will witness higher temperatures and changing precipitation levels. The effects of this will lead to low agricultural production (Apata, 2014). Evidence have shown that climate change has already affecting crop yields in many countries (IPCC,2007; Dressa, *et al.* 2008). This is notably true in low income countries, where climate change is the principal determinant of agricultural productivity and adaptive capacities are low (David, 2018). Many African countries, which have their economies monumentally base on weather-sensitive agricultural productions systems like Nigeria, are especially vulnerable to climate change (Benhin, 2006). Thus vulnerability has been validated by the destructive effects of recent inundation of Niger Delta region of Nigeria by river water in 2018 and prolong drought that are currently witnessed in some parts of Northern Nigeria. Therefore, many poor and developing countries like Nigeria that are highly unprotected to the effects of climate change. For that regard comprehending farmers' responses to climate change is vital, as this will help a great deal in planning fitting mitigation strategies.

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Climate plays a significant role in the distribution of vegetation and agriculture in Nigeria. According to federal government of Nigeria report on drought management (FGN, 1999), the Nigeria landmass is divided into seven ecological zones. This classification is based on the resemblance of climatic elements and the nature of vegetation that that can be supported. These ecological zones are the mangrove swamp, rainforest, montane forest/grassland, derive savannah, guinea savannah, Sudan savannah and the Sahel savannah (Dami, 2009). The mangrove swamp and rainforest zones, and part of derived savannah zones are found in the southern part of the country, and these zones are characterized by high rainfall intensity, long wet season, dense vegetation, rugged topography and temperature range of 26-^{0}C and small farm holdings (Mustapha, 20112). Flood and water erosion are the major problem of small holder farmers in these zones, and a sizeable hectare of agricultural land and farmer's properties are lost yearly to water erosion in the eastern part of the country (Ayuba, 2009). Cassava, yam, vegetables and maize are the major crops grown in the zones.

The savannah zone (Derived, Guinea, Sudan and Sahel savanna) is in the northern part of the country, which characterized by short wet season and long dry season, high annual average temperature of the range 28-32^{0}C, few scattered trees and grasses, gentle slope and large farm holdings (Jones, 2009). Maize, sorghum, millet, wheat, rice, cowpea, yam, pepper and onion are the major crops that thrive in the savannah zone (David, 2010). The major limiting factor to crop production in this region is water; this is because of short wet season that often commences in June and end in September. Moreover, the montane forest/grassland zone is in the high-altitude areas of the country, which includes Jos Plateau, Adamawa and Obudu mountains (Sowunmi and Akintola, 2009). The zone is known for low average annual temperature (20-23^{0}C) all year round, moderately high rainfall and rugged topography (Ayuba, 2009). Montane forest/grassland is exceptionally suitable for maize, exotic vegetables includes carrot, cabbage, cucumber and lettuce among others (Dami, 2009). The mountainous nature of this zone, cold weather and low concentration of oxygen are the obstacles to small holder farmers (Odjugo, 2010).

As the increasing population in Nigeria puts more pressure on diminishing resources, escalating environmental problems further threaten food production among small holder farmers. Land degradation because of deforestation and overgrazing which is already severe in many parts of Nigeria. Drought is a common problem in the north, while heavy rains, soil erosion and floods are major problems in the south (IFAD). As a result, effective mitigation strategies are urgently needed to ensure sustainable crop production in Nigeria.

C. Causes of Climate Change and its Effects on Crop Production

There are number of factors responsible for climate change. There is natural process within the climate system and anthropogenic (man-made or artificial). The natural factors include continental drift, volcanoes, ocean recurrent, and earths tilt. These include such processes as variations, in solar radiation, deviation in the earth's orbit, mountain building and continental drift and in greenhouse gas concentration. Climate system can take longer to fully respond to new external forces (Hassan, 2014). Most climate scientist agree that the main cause of the current global warming trend is human expansion of the "greenhouse effect" which is the warming that results when the atmosphere traps heat radiation from the earth toward space (IPPCC, 2009) The anthropogenic are agriculture is one of the artificial contributors to climate change, however it can also be harnessed to mitigate greenhouse emission. The agricultural sector was the second largest emitter in 2011. It is estimated around 10-12% of the total annual greenhouse (GHG) emissions and 75% of global deforestation come from agriculture, mostly developing countries (Amy, 2016). The National Research Council (NRC) reports indicated that vast majority of climate scientist agree that human activities, particularly the burning of fossils fuels (coal, oil and gas), are responsible for most of the climate change currently been noticed (Ozor, 2010). And also been influenced by the industrial revolution of the 19th century, which saw the large scale use of mineralized remains of an animals and plants fuels for industrial activities also exerted an influence (Hassan, 2014). This been the case, emissions from the burning of mineralized remains of an animals and plants (fossil) fuels could precede to increases in the earth's average surface temperature.

The threats posed by climate change have caused concerned among societies because crop growth could be adversely affected by changes climate includes rainfall and temperature. This is expected to affect agricultural production globally (Atieri, 2008). How crops will respond to climatic change must therefore be understood to enable development of effective adaptation measures (Schlenker and Lobell, 2010). Researchers viewed the African rain fed agriculture to be most vulnerable sector to climate variability and the potential impacts of climate change on agriculture are highly uncertain. The overall global warming is expected to add in one way or another to the difficulties of food production and scarcity (IFAD, 2010). Climate change has direct and often adverse influence on the quality and quantity of agricultural produce. The climate of an area affects the vegetation and by extension the type of crop that can be cultivated. Temperature, rainfall, humidity, and day length are important climatic elements that influence cropping production (IFAD, 2010). The effects of climate change on crop production leads to an increase in the frequency, intensity,

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and duration of floods and drought and also heat waves (Kuta, 2011). Seasonal cycles are disrupted, and crop production are adversely affected. Minimizing the effects of climate change requires adaptation. Climate change can disrupt food availability, reduced access to food, and affect food quality. The projected increases in temperature, changes in precipitation patterns, changes in extreme weather events and reduction in water availability may all results in reduced crop production (Adebanjo, 2016).

D. Climate Change Adaptation Strategies and the role of Extension Services

There is various influence that could mitigate the impacts of climate change on crop production. Which include used of improve varieties, growing drought resistant crop varieties, growing flood resistant varieties, used of pests'/diseases resistant varieties, used of weather forecast technologies, multiple cropping, prayers for Gods special intervention, information from extension agents, used of agro-chemicals and fertilizers and recycling of wastes products. Ifeanyi (2012) in his study reported that there was no significant information on how mitigate impact of climate from extension agents to be adapt by farmers. Nwalieji and Unwabuya (2012) conducted a study and reported that growing of drought resistant varieties, used of weather forecast technologies, prayer for divine intervention, construction of drainage system, use of suitable irrigation system, moving away from climate risks zones and recycling of wastes products were found to be ineffective and non-significant adaptation measures used by farmers. Ayanwuyi (2013) reported that most of the adaptation strategies used by farmers are not significant and effective. This contadict (Maddison, 2006; Ozor and Nnaji, 2013) who reported that most of the mitigation measures adapted by farmers are effective for cushioning the impacts of climate change on crop production. Agricultural extension has key roles to play in adoption of climate adaptation and mitigation strategies. This is because adaptations to climate change impacts require changes in knowledge, attitudes, resilience capacities, and skills of the people and agricultural extension can facilitate this change. Agricultural extension according to Leeuwis (2006) is a series of embedded communicative interventions that are meant, among other things, to develop and/or induce innovations which supposedly help to resolve (usually multi-actor) problematic situations. It has been observed that agricultural extension is involved in public information and education programs that could assist farmers in mitigating the effects of climate change (Nicholas, and Nnaji, 2011). According to them, such involvements include awareness creation and knowledge brokerage on the issues of climate change; building resilience capacities among vulnerable individuals, communities and regions; encouragement of wide participation of all stakeholders in addressing climate change issues; and developing appropriate frameworks for coping/adapting to climate change effects/impacts. Besides, there is very little documentation on local adaptation to climate change (Pandey, *et. al.,* 2006) especially when it is known that some African communities have developed traditional adaptation strategies to cope with climate variability and extreme events (Junje, 2009).

E. Constraints Affecting Adaptation Measures on Climate Change by Small Holder Farmers

Kiteme (2009) reported that poor transport facilities, large areas to cover, are the constraints that hindered farmers and extension staff from adoption and dissemination of information on strategies to ameliorate impacts of climate change. Ayanwuji (2013) the constraints farmers faced in climate change adaptation were public, institutional and labor constraints as well as high cost of inputs, technological and information constraints, distance access to climate information, and poor agricultural programs and service delivery constraints (Adebanjo, 2016). This agrees with of Ozor et. al., (2010) who discovered that high cost of inputs is also a major barrier to climate change adaptation among farming households in southern Nigeria. Ayanwuji (2013) constraints that hinders farmers from consummated adaption strategies was adequate dissemination of information on measures to ameliorate impacts of climate change. Adebanjo (2016) reported the following as constrains affecting adoption of adaptation measures: lack of access to weather forecast technologies, lack or inadequate government policies to empower food crop farmers, lack of access to supporting institutional facilities, lack of access to an awareness about NGOs program of climate change adaptation, and limited government irresponsiveness to climate risk management.

II. CONCLUSION

It's reviewed that adaptation strategies for minimizing the impacts of climate change on crop production among small holder farmers in Nigeria is autonomous not planned, thus the impacts of climate change in Nigeria are considerable. The small holder farmers in Nigeria relied more on personal observation and experiences in combating climate change impacts using short-term adjustment (autonomous adaptation strategies) which includes changing planting/sowing dates, diversification in crop enterprise, cultivating varieties with drought and heat tolerant abilities. And farmers were able to handle the effect of climate which includes changing sowing dates, prompt weeding and tree crops on farm lands but not strongly effective. The future impacts of climate change on crop production in many parts of Nigeria are likely to be significantly greater than those that have been experienced in the past as a result of natural climatic variability alone. The effect of climate is a reality and it's now widely acknowledging that

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there is a need to implement policies to long-term adaptation (planned adaptation strategies) aimed at preparing for the impacts of climate change on crop production and at facilitating and complementing autonomous adaptation strategies (action taken by farmers) used by small holder farmers. However, when adaptation is fully implemented, large reduction in adverse effects or brunt of climate change are possible. Therefore, adaptation is especially important in developing countries, since those countries are predicted to bear the commensurate adverse effects of climate change. Farmers in Nigeria are not left out in the threat posed by the change in climate.

III. RECOMMENDATIONS

It is recommended that government should implement policies for planned adaptation strategies. Also build and improve the competencies of small holder farmer. There should be advisory services from extension agents that would enhance and compliment the efforts of small holder farmers in mitigating the impacts of climate change on crop production. There should be participation and intervention of governmental and non-governmental organizations against the impacts of climate change. It's also recommended that awareness is the indispensable step in addressing the issue of climate change. Because, this would help farmers to adapt to climate change mitigation measures. Therefore, climate change awareness programs and campaigns by the government and its partners should be reinforcing. Because it enables farmers make informed decisions in responding to the changing climate phenomenon

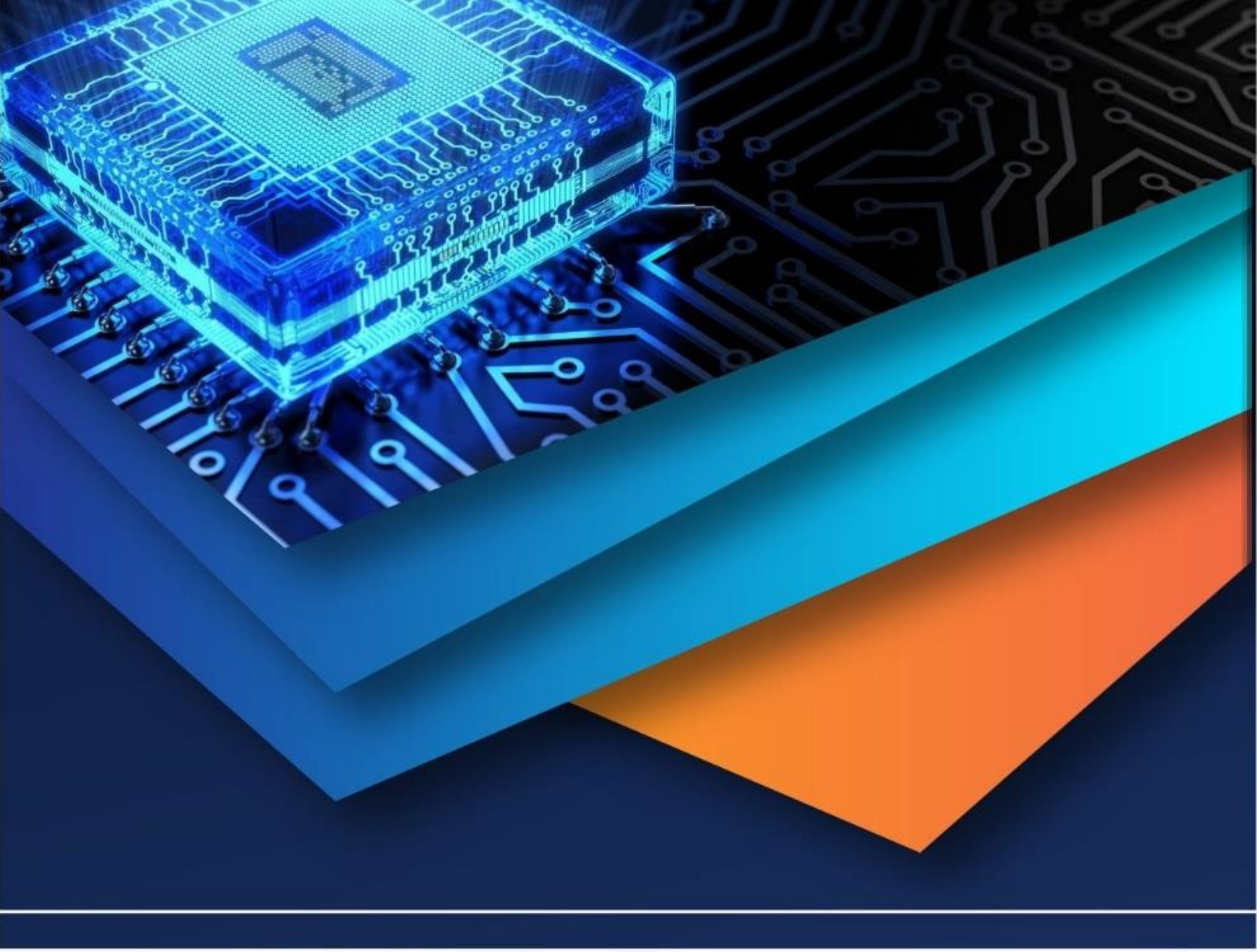
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