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DETERMINANTS OF AGRICULTURAL SUSTAINABILITY IN SOUTHEAST NIGERIA -THE CLIMATE CHANGE DEBACLE.

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ABSTRACT: *The renewed quest for sustainable economic development which is synonymous with sustainable agricultural development and hence agricultural sustainability impelled this study titled "Determinants of Agricultural Sustainability in Southeast Nigeria". Southeast Nigeria is located within latitudes 5^oN to 6^o N of the equator and longitudes 6^oE and 8^oE of the Greenwich (prime) meridian (M.S corporation, 2009). Multi-stage sampling technique was used to select a sample of 312 cassava based food crop farmers from whom data were collected using structured and validated questionnaire. Data bothering on the respondents' socio-economic characteristics, the type, quantity, and sources of inputs used and output produced were collected. These were analysed with the use of descriptive statistical tools and ordinary least square multiple regression analytical tools. Result showed that factors such as farm size, annual income, household size, level of education, and climate change are significantly and inversely proportional to sustainability level of farmers, while labour cost was significantly but directly proportional to agricultural sustainability. It was concluded that, efforts should be made at both micro and macro levels of government to improve on the mitigation and adaptive strategies of climate change available to farmers by making such more affordable, available and user friendly through extension education on the appropriate uses of such technologies in a more sustainable manner.*

KEYWORDS: Sustainability, Determinants, Regression, Climate change, Appropriate, Adaptive and Mitigation.

INTRODUCTION

In Nigeria, agriculture is the main source of food and the main employer of labour, employing about 60-70% of the population (CBN, 2005) . The dominant crops in the south are cassava, yam, palm produce, cocoa and rubber while cereals (notably millet and sorghum), groundnuts and beans dominate crop production in the northern part of the country. According to the Nigerian National Bureau of Statistics, in 2007 agriculture contributed (42.2%) to GDP followed by Oil and Gas (19.35%). Manufacturing was a mere (4.025%) and Solid Minerals (0.29%) (NBS, 2008). These analogies suggest that agriculture occupies a very prominent position in the growth and development of Nigerian economy. The concern of policy makers is how to ensure sustainable increases in food production so as to achieve sustainable food security. In the face of the obviously changing climate conditions of the world, the desire of the policy makers becomes challenging and difficult to meet.

Climate change has been identified as one of the most crucial factors that negatively affect sustainable agricultural production and the scope for reducing poverty in Nigeria. Therefore, any change in climate is bound to impact on the agricultural sector in particular and other socio-economic activities in general. The impacts could be measured in terms of effects on crop growth, availability of soil water, health and availability of farm labour, soil fertility, soil erosion, incidents of pests and diseases, and sea level rise (Nwajiuba, 2002). The Intergovernmental Panel on Climate Change (IPCC), refers to climate change as any change in climate over time, whether due to natural variability or as a result of human activity (IPCC,2007). It may also be referred to as any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). The place of this natural phenomenon in sustainable agriculture is of great concern in this study.

Sustainable agricultural production systems involve those approaches to food production that ensures constant increases in productivity without compromising the chances of future generations to provide for themselves. It involves production practices that ensure environmental conservation and no or minimal disturbance to the natural eco support system, hence protects the potentials of the natural regeneration of the flora and fauna. Sustainable development according to Brutland Commission is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (World Commission, 1987). In the view of Ballara (1991), sustainable development is humanity's ability to survive by means of the rational use of renewable resources by refraining from disrupting the ecosystem or over-exploiting natural resource and by refraining from activities that destroy cultures or societies and instead allow them to reach their potential. Generally therefore, sustainable development has to do with participatory development, human development and environmental protection. Liebhardt, (1987) defined agricultural sustainability to involve production activities that minimizes the use of external inputs and maximizes the use of internal inputs, which already exists on the farm. Further to this, Harwood, (1987) refers sustainable farming as the farmers' capacity to optimally improve agricultural productivity by rational utilization of both internal and external resources and being conscious of conserving the catchment's environment. Nwaiwu *et al* (2010a;2010b) defined external inputs as those inputs that are artificially manufactured, very capital intensive in procurement, usually purchased, depends on very high skill and technology to produce and use and not readily available to the resource poor farmers; while internal inputs refer to those inputs that are naturally endowed, relatively very cheap to produce, do not require high skill to use, depends on indigenous technology, very readily available and affordable to the farmers.

Bearing in mind these concepts (agricultural sustainability, external and internal inputs), the fact that climate change encourages the use of external inputs that are not sustainable, needs not be overemphasized. Firstly, climate change worsens drought situation through excessively high temperatures, and lack of adequate rain. This encourages the use of irrigation facilities as an adaptive strategy to this menace. Secondly, climate change exacerbates land and soil degradation and increment in the incidence of pests and diseases, which encourages the use of chemicals, fertilizer and high technology devices to circumvent the situation. These and other climate change indicators encourage the use of external inputs which are unsustainable. Climate change, coincident with increasing demand for food, feed, fibre and fuel, has the potential to irreversibly damage the natural resource base on which agriculture depends, with significant consequences for food insecurity (IAASTD, 2008). The relationship between climate change and agriculture is two-way; agriculture contributes to climate change in several major ways and climate change in general adversely affects agriculture (Ching, 2008). Yet, it is increasingly clear that the path that agriculture has been on is not sustainable nor can it feed the world without destroying the planet (IAASTD, 2008). With the spotlight once more on agriculture, and with many critical issues that need resolving, finding the answer to the question of the nature of agricultural development required becomes pertinent.

The Green Revolution and Agricultural Sustainability.

The Green Revolution drove widespread shifts in the agricultural sector from subsistence and low external input agriculture to monocropping with high yielding varieties (HYVs). This agricultural paradigm required the adoption of a 'package' of inputs, including irrigation, chemical pesticides and fertilisers, and hybrid seeds bred for disease resistance and high yield. Participating farmers often had access to credit and agro-processing facilities, transport and roads, machinery, marketing infrastructure and government price supports (Ching, 2008). By the 1970s, Green Revolution-style farming had replaced the traditional farming practices of millions of developing country farmers. By the 1990s, almost 75% of Asian rice areas were sown with these new varieties. Overall, it is estimated that 40% of all farmers in developing countries were using Green Revolution seeds by this time, with the greatest use found in Asia, followed by Latin America (Rosset et al., 2000; Shiva, 1991).

The rapid spread of Green Revolution agriculture throughout most countries of the South was accompanied by a rapid rise in pesticide use (Rosset et al., 2000). This was because the HYVs were more susceptible to pest outbreaks. Promising increases of yield were thus offset by rising costs associated with increased use of chemical inputs. In the Central Plains of Thailand, yields went up only 6.5%, while fertiliser use rose 24% and pesticides jumped by 53%. In West Java, profits associated with a 23% yield increase were virtually cancelled by 65% and 69% increases in fertilisers and pesticides respectively (Rosset et.al., 2000). Synthetic fertilisers, pesticides and herbicides are made from non-renewable raw materials such as mineral oil and natural gas or from minerals that are depleting such as phosphate and potassium. As the price of petroleum increases, so does the cost of external inputs and machinery, forcing small farmers who are dependent on these inputs into debt. The production of agrochemicals is also an important source of greenhouse gas (GHG) emissions. In particular, fertiliser production is energy intensive, accounting for 0.6-1.2% of the world's total GHGs (Bellarby et al., 2008). Industrial, chemical-intensive agriculture has also degraded soils and destroyed resources that are critical to storing carbon, such as forests and other vegetation.

The Green Revolution also brought about a shift from diversity to monocultures. When farmers opted to plant Green Revolution crop varieties and raise new breeds of livestock, many traditional, local varieties were abandoned and became extinct. And yet, maintaining agricultural biodiversity is vital to long-term food security as it is a vital insurance against crop and livestock disease outbreaks and improves the long-term resilience of rural livelihoods to adverse trends or shocks as is the case of climate change.(Pimbert, 1999). Other costs of the Green Revolution, often underestimated, included the financial costs of building huge dams for irrigation, the financial costs of the energy required in the construction and operation of such projects, the health costs of a steadily affected population due to chemical contamination of food, the costs involved in soil losses from increasingly degraded soils, genetic erosion and the draining of groundwater aquifers (Alvares, 1996). Green Revolution farming systems also required substantial irrigation, putting further strain on the world's limited water resources.

Traditionally, local farming communities were close knit as seed exchange and farming knowledge were shared freely. The Green Revolution seeds however were hybrids, for which seed saving is undesirable, as the seed from the first generation of hybrid plants does not reliably produce true copies. Therefore, new seed must be purchased for each planting and this meant that farmers were no longer preserving and storing seeds for the next planting season. This trend not only incurs extra costs for the farmers but has an impact on social cohesiveness too (Sangaralingam, 2006). From the foregoing, the green revolution agriculture aggravated environmental degradation and subsequently climate change. Many recent studies (Ching, 2008; Pimbert, 1999; Wall and Smit, 2005) have discussed sustainable agriculture and climate change but little or none has dwelt on the determinants of agricultural sustainability in view of the ravaging effects of environmental degradation and climate change. This study is therefore geared towards determining those factors that strongly affects agricultural sustainability at farm level with a key interest on the position of climate change in this regard. This has implication of better policies at all levels of government because it enables an in-depth and integrated assessment of general agriculture policies, programmes and plans to see where the gaps are, in terms of sustainable agriculture. Policies that provide disincentives against sustainable agriculture need to be changed. It furthermore promotes and facilitates the adoption of sustainable and lower input agriculture, and environmentally friendly technologies and practices. This may include the use of economic instruments and incentives for farmers to switch to sustainable agriculture, including organic agriculture.

MATERIALS AND METHODS

The study was conducted in Imo and Ebonyi states southeast zone Nigeria. Southeast Nigeria is located within latitudes 5^{o}N to 6^{o} N of the equator and longitudes 6^{o}E and 8^{o}E of the Greenwich (prime) meridian (M.S corporation, 2009). The zone occupies a total land mass of 10,952,400 hectares with a population of 16,381,729 people (NPC, 2006). The Southeast rainforest zone of Nigeria is a belt of tall trees with dense undergrowth of shorter species dominated by climbing plants (Nwajiuba and Onyeneke, 2010). There are two major seasons experienced in this zone. These are the Dry season and the Rainy season. The dry season occurs between November and March while the rainy season occurs between April and October. Although over the recent decades, it appears very difficult to create a clear cut distinction between the periods we refer to as rainy season and dry season due to climate change. The zone experiences an average annual temperature, rainfall, relative humidity, number of rain-days and hours of sunshine per day, of 27^{o}C, 1800mm, 72%, 4.4hours, and 142days respectively. Despite the observed erratic nature of both rainfall and dry spells, the location of the zone within the tropical rainforest belt of the country encourages and allows the growth and survival of most tropical food crops like yam, cassava, vegetables, rice, etc, and livestock production. Hence about 60-70% of the inhabitants of this zone are observed to engage in agriculture, mainly crop farming and animal rearing (Okoye *et al.*, 2010).

The multi-stage sampling technique was used in sample selection. The topographic peculiarity of the Southeast States enabled the clear division of the States into two distinct categories, namely the relatively hilly terrain states (Enugu, Ebonyi and Anambra) and the relatively flat terrain States (Imo and Abia). Consequently, one State was purposively selected from each category based on typical hilly or flat nature of the State. This gave rise to Imo and Ebonyi States as the two States of interest. Secondly, two agricultural zones were chosen from each of these States to get a total of four agricultural zones for the study.

Thirdly, three Local Government Areas (L.G.As) were randomly selected from each of these agricultural zones to get twelve (12) L.G.As. In the fourth stage, three communities were purposively selected from each of the 12 L.G.As to get a total of 36 communities. These were purposive due to the fact that the selections were based on the high proportion of food crop contact farmers (cassava farmers) as contained in the register of each Local Government Area Extension Department. Finally one village was randomly selected from each community to get a total of 36 villages used for the study. To ensure that adequate and representative sample was drawn at this stage, a pre-survey sampling frame was determined by compiling a list of the cassava producer households available in the chosen 36 villages. This was done with the assistance of village heads and extension agents. When this frame was determined,(331 from Imo state and 195 from Ebonyi state), the adequate sample size from each state was computed using the formula;

$$n = \frac{N}{\left(1 + N\left(e^2\right)\right)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..2.1$$

(Yamane, 1967)

Where n = sample size
N = population (sample frame)
e = level of precision in percent.

Following this model, the total sample size used for the study was 312; 181 from Imo state and 131 from Ebonyi state at (e =0.05). These were randomly selected from the sample frame.

Primary data were mainly used in thus study and were collected from cassava based food crop farmers with the aid of structured and validated questionnaire otherwise called interview schedule. The type of data collected included those that bother on the socio-economic characteristics of farmers like (age, sex, level of education, household size, annual income, etc.). Others were quantities and types of inputs/facilities used and outputs produced in physical and value terms. Further enquiry into the factors that determine the types of inputs/facilities used were also made. These included effects of (their socio-economic characteristics, farm size, climate variables, cost of labour, cost of fertilizer, etc). Information on the type of labour used (hired, family, communal), were also ascertained. Data were analysed using appropriate descriptive statistical tools and the ordinary least square (OLS) multiple regression analytical tools. The socioeconomic characteristics of farmers were analysed using mean, frequencies and percentages while the determinants of agricultural sustainability were identified with use of Ordinary Least Square regression analysis with the model Ss = f(Ag, Ed, Lc, Fc, Ld, Hs, Y,C, Ex, Ir, e)…………………..2.2
Where Ss = Sustainability which is given by

$$S_S = \frac{N_{Sin}}{T_{Nin}} \times \frac{100}{1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots2.3$$

(Adopted from Liebhardt, (1987); and Nwaiwu et al, (2010)

Where S_S = Sustainability Index or sustainable system (%)
N_{Sin} = Number of sustainable inputs used by a farmer

T_{Nin} = Total number of inputs used by a farmer.

- C= Vector for climate change (Index of climate change). This was measured using ordinal scale values to elicit from the farmers their various perceptions on some observable climate change indicators like (Ds = Frequency of dry spell, Eh Excessive heat/temperature, Hss = hours of sunshine, Fd = frequency or incidence of flooding, Re = Erratic nature of rainfall, Rv = Volume or amount of rainfall) in the study area .(Etiosa and Agho, 2007; Okon and Egbon, 1999; French *et al*, 1995; Awosika, *et al*,1992; and Oladipo,1995)..
- Ex = Number of extension contacts (measured as number of times visited by extension agents)
- Ag = Age of farmers in years
- Ed = Level of education measured by number of years spent in acquiring formal education
- Lc = Cost of labour in naira
- Ld = Size of land in hectares
- Fc = Cost of fertilizer in naira
- Hs = Household size as number of persons /household.
- Y = Annual income in naira
- Ir = Availability of irrigation facility measured as a dummy where 1 is for Yes and 0 is for No answers.
- e = the stochastic error term.

It is expected a priori that the coefficients of C, Ir, < 0 while the coefficients of Ag, Ex, Fc, Lc, Ed, Ld, Y, Hs, > 0

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Respondents

Table 3.1 shows the distribution of respondents according to their socio-economic characteristics.

Table 3.1 Distribution of Respondents According to their Socio-economic Characteristics

Socio-economic Characteristic	Mean	Standard deviation	Range
Age(years)	51.3	9.65	28-75
Household size(persons)	8	2.86	2-8
Annual Income(₦)	391,530.64	0.000022	113290-1634271
Level of Education (years)	9.60	5.94	0 – 22
Farming experience(yrs)	20.96	9.28	2-60
Farm size(hectares)	0.84	0.83	0.05- 5.00
Number of extension Contact(no. of visits)	0.73	1.2	0.00- 12.00

According to Table 3.1, the mean age of cassava producer farmers in southeast Nigeria was 51.30 years with a standard deviation of 9.65years. This implies that there was high variability in the ages of farmers, however they are still within the productive age limit during which they can fully and efficiently engage in all forms of productive labour especially farm labour. The mean household size of farmers in the study area was 8 persons per home, mean annual household income was ₦391,530.64 and mean farm size was 0.84 hectares. These categorised the farmers in the study area as smallholder and resource poor farmers because they farm on land between 0.1-5.99 hectares (Olayide,1980; Ogungbile and Olukosi, 1999, and Nwaiwu, 2007). This implies that they are mainly subsistence farmers who have very limited capacity to practice commercial farming. Consequently, they are also expected to have very weak capacity to adapt to the fast changing climate which has very adverse effects on agriculture and food production, if some abatement strategies are not strictly adopted. Furthermore, the farmers are said to be food insecure because according to the world Health Organization WHO, an individual is said to be food insecure if that person subsists on below $1.25 dollar per day (Todaro and Smith, 2011). Obviously $1 is currently equivalent to about one hundred and sixty (₦160.00) Nigerian naira which implies that $1.25 will be about ₦200. From Table 3.1 the per capita income of the farmers per day was about one hundred and thirty-four naira (₦134.00). This implies that they leave below $1.25 USA dollar per day. The table also shows that the mean frequency of extension visits to the farmers was 0.73 times. This implies that extension education in the study area was very poor as such farmers will be lacking a lot in terms of availability and use of innovations including climate change adaptive and mitigation strategies that would have helped them overcome the dangers of climate change. Finally, the mean level of education of farmers in the study area was approximately ten (10) years. This implies that they would have acquired post-primary education which makes them enlightened enough to be able to adopt available innovations when introduced to them.

Table 3.2 presents the multiple regression result showing the determinants of Agricultural sustainability in the study area. This was achieved by estimating equation 2.2 using four functional forms.

Multiple regression result showing the Determinants of Agricultural sustainability in the study area.

Predictor variables	**Linear**	**Exponential**	**Semi-log**	**Double Log**
Constant	54.158	4.065	9.655	3.580
Age(Ag)	0.327	0.006	16.212	0.294
	(4.914)*	(4.323)*	(4.665)*	(4.296)*
Farm size(Fz)	-1.644	-0.019	-0.748	-0.005
	(-2.082)**	(-1.245)	(-1.075)	(-0.397)
Climate	-0.306	-0.006	-17.422	-0.339
change(CX)	(-6.876)*	(-6.764)*	(-7.632)*	(-7.545)*
Labour cost	0.0000	0.00000217	9.428	0.154
(Lc)	(6.868)*	(5.444)*	(5.847)*	(4.861)*
Extension	-0.075	0.000	0.661	0.027
Contact(Ex)	(-0.144)	(-0.022)	(0.335)	(0.682)
Total Annual	-0.00000688	-0.0000002	-5.054	-0.116
Income(AnY)	(-2.319)*	(-3.460)*	(-3.728)*	(-4.354)*
Fertilizer	0.001	0.000012	4.928	0.066
Cost (Fc)	(1.234)	(0.776)	(1.142)	(0.777)

Household size	-0.815	-0.015	-4.603	-0.087
(Hs)	(-3.439)*	(-3.315)*	(-2.733)*	(-2.611)**
Level of	-0.928	-0.018	-4.374	-0.078
Education(Ed)	(-8.796)*	(-8.556)*	(-7.414)*	(-6.749)*
Irrigation	2.162	0.048	1.799	0.041
Facility (Irr)	(1.376)	(1.557)	(1.091)	(1.275)
R^2	0.622	0.596	0.567	0.534
R^{-2}	0.610	0.582	0.553	0.518
F-Value	(49.591)*	(44.36)*	(39.464)*	(34.42)*
Std. err.	10.636	0.20872	11.384	0.22422
TSS	90154.86	32.44	90154.84	32.440
N	312	312	312	312

Source: Field Survey Data, (2012).

According to Table 3.2, out of four functional forms tried, the linear function best explained the regression relationship between the endogenous variable sustainability and the exogenous variables with an R^2 value of 0.622. This implies that 62% of the variations in sustainability level of farmers production systems were caused by variations in the age, cost of labour, total annual income, household size, farm size, level of education of farmers and changes in climate variables. This joint influence of the independent variables on the dependent variable is also found to be statistically significant at 1% level with an F-cal of 49.59 and F-tab of 2.32. It is also obvious from the Table that out of the ten explanatory variables suspected to affect sustainability level of farmers, seven (ie age, climate change, annual income, household size, farm size, level of education and labour cost) were found to be statistically significant at 5% whereas the other three (irrigation facility, extension contact, and fertilizer cost) were not significant. This implies that changes in the significant variables seriously affected the practice of sustainable production systems by farmers.

Furthermore, the Table also shows that variables such as farm size, climate change, annual income, household size, level of education, and number of extension contact were inversely proportional to sustainability level of farmers. This implies that the higher the values of those variables, the lower the sustainability level of farmers' production systems/practices and vice versa. For instance, the larger the farm size, the higher the tendency of farmers to use hired labour instead of family labour, fertilizer instead of organic manure, herbicide instead of only manual weeding, tractor instead of hoes and shovel etc. The use of these external inputs are unsustainable production practices (Liebhart, 1987 and Nwaiwu, 2007). This is in line with a priori expectation that farm size <0. Also the higher the total annual income of farmers, the poorer the sustainable level of farmers production systems. This is because higher incomes position the farmers to be able to procure those external inputs like herbicide, fertilizers, tractor, irrigation facilities, etc whose use are not sustainable. This is also in tandem with the a priori expectation. The household size found to be inversely proportional to sustainability is not in line with the a priori expectation. The deviation could be attributed to the fact that larger household sizes encourages cultivation of large farm sizes, hence more use of fertilizers and herbicides to cope with the management requirements of the large farm sizes. Similarly, higher level of education encourages the adoption of innovations such as use of fertilizers, herbicides machinery and equipments which are not sustainable in use and in production. Liebhardt, (1987) defined agricultural sustainability to involve production activities that minimizes the use of external inputs and maximizes the use of internal inputs, which already exists on the farm. In this study, fertilizer, herbicides and machinery are regarded as external input. Although they tend to boost yield of crops at the very short run, they subsequently exacerbate environmental degradation in the long run, hence unsustainable. Also number of extension contact(Ex) though not significant is inversely proportional to sustainability because extension education through contacts with farmers exposes farmers to innovations which are unsustainable.

Besides, variables like age, labour cost, fertilizer cost, and irrigation facilities were found to be directly proportional to sustainability. This implies that the higher these variables the higher the level of sustainability of farmers. It is believed that the higher the age of farmers, the more conservative they become, hence the more difficult it is for them to accept innovations, which are most times unsustainable. Also the more they fully depend on their family labour for food production since hired labour will be more expensive for them to afford. Also the higher the labour cost, the more farmers depend on family labour and communal labour which are relatively free or cheap to use. Similarly, the higher the cost of fertilizer, the lower the tendency of farmers to use them, hence they depend on natural soil replenishment of nutrients and use of farm yard manure (organic agriculture). These are in tandem with a priori expectation. Availability of Irrigation facilities was a priori expected to be inversely proportional to sustainability level of farmers production systems, but the result shows that availability of irrigation facilities are directly proportional to sustainability. This could be attributed to the fact that the farmers concept of irrigation facilities is the availability or presence of bore holes, pipe borne water and streams which they rarely use as source of water to their farm crops. Rather the water source may have aided their production activities through its use as portable water for drinking, cooking and bathing after work. This availability of water would have indirectly reduced their cost of production because members of the farm families would fetch water much more freely and easier at little or no cost. This has serious positive effect on health of farm families and labourers hence their availability to provide a good alternative to hired labour which is unsustainable. Finally, the more the climate changes (increased temperatures, erratic and torrential rainfall, increased drought, increased inundation/ flooding/erosion, increased sunshine hours etc) the lesser the sustainability of farmers. This is also in line with the a priori expectation that climate change <0. It is believed strongly that increases in temperatures reduces a crops productive summer growing season, thus reducing the yield and productivity (Monteith, (1981); Rosenzweig and Hillel (2000). It also makes farmers to adopt strategies that are not easily affordable to them in order to keep afloat in the food production business, hence low sustainability. Torrential rains usually engender inundation which has serious ravaging effects on both farm crops and the farmers' economy which negatively affects agricultural sustainability. Increases in sunshine duration and drought also encourages the practice of highly expensive farm management practices like heavy mulching, use of irrigation facilities, hiring and payment of more farm labourers etcetera, to cope with the climate menace. These negative effects of climate change on the attainment of agricultural sustainability, demands very urgent and serious attention.

CONCLUSION AND RECOMMENDATIONS.

The above findings and analysis show that the farmers in the study area are poor smallholder farmers who have the least capacity to adapt to the fast changing climate even though their farming depends wholly on the climate system. It could therefore be noted that factors such as age, annual income, household size, farm size, level of education, labour cost and above all climate change seriously affects agricultural sustainability. It has been observed that significant changes in climate impact on agriculture and therefore affect food supply and indeed food security status of nations. The two major climate elements of greater significance to agriculture are temperature and rainfall. When temperatures increases beyond the optimum levels for crop growth it induces hastened maturity and lower yields. It also debilitates farm workers thereby reducing their efficiency and productivity. Torrential rains have be blamed for most of the recent flooding in some parts of the country coupled with sea level rise around and near rivers and oceans. These have led to leaching, erosion and loss of farm crops and worsened food security status.

Consequent upon these findings, it is concluded that in view of the weak capacities of the farmers to adapt to the changing climate, and the obvious implications on both food production and agricultural sustainability, measures should be made at both micro and macro levels to enhance the poverty status of the farmers and provide appropriate adaptation and mitigation strategies to climate change. Furthermore, extension education should be geared towards making farmers aware of; (a) the present and potential implications of their farm practice activities vis–a-vis the climate change debacle and (b) more appropriate use of agricultural innovations (like chemicals, machinery etc.) to avoid misuse thereby making them unsustainable. Finally, government at all levels should promote and facilitate the adoption of sustainable and lower input agriculture, and environmentally friendly technologies and practices. This may include the use of economic instruments and incentives for farmers to switch to sustainable agriculture, including organic agriculture.

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