

Greenhouse Farming as Adaptation to Climate Change in Nigeria

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Received: March 2, 2011 / Published: November 20, 2011.

Abstract: The effect of climate change in recent times has disrupted the onset and duration of seasons in Nigeria manifesting in the reduction of both staple and cash crops, and livestock yields. This has transformed the country to a major importer of those agricultural produce she hitherto exported. As a country where over 70% of the population depends on agriculture for survival, the impacts of climate change are a major threat to both food security and the general economy. Remedial measures which have been suggested including adoption of agronomic and tested practices, reduced burning and afforestation. An option that could be of great potential in ameliorating this situation but which has not been practiced especially in the production of specialty crops is the use of greenhouse farming. This paper discusses the impact of climate change on Nigerian agriculture. The potentials and logistics are required for effective use of greenhouse farming as an adaptation to climate change in Nigeria. It is suggested that research should be carried out to select appropriate glazing materials. The provisions of training and credit facilities for interested farmers are recommended for effective utilization of the system.

Key words: Greenhouse, climate change, glazing material, solar radiation.

1. Introduction

Before the 1960's, agriculture was the main occupation in Nigeria and mainstay of the economy due to a favourable climate. A variety of both cash and food crops could be cultivated in various parts of the country while livestock and fishes were also produced in sufficient quantities to meet the local demand and for export. Nigeria was not only a food self sufficient nation but was a major exporter of various agricultural produce. This continued until the discovery of oil as a better income earner which relegated agriculture to the background. Agriculture was so neglected that Nigeria became a major importer of some of the produce she hitherto exported. It was then realized that even though oil was a better foreign exchange earner, agriculture occupied a prominent position as staple food provider and a source of employment for a majority of the

populace many of whom were resident in the rural areas and ill-equipped for any other type of employment [1-3]. Between 1978 and now, a number of initiatives were taken to reposition the Nigerian agriculture. Such initiatives included the Operation Feed the Nation, Green Revolution and Back to Land programme. The main thrusts of these programmes were increased area of cultivation, use of high yielding seeds and agro-chemicals. While the battle to reposition the Nigerian agriculture was still on, the climate which was quite favourable for crop production and which could be predicted had changed and this change in climate further compounded the problem of agricultural productivity [1, 4]. This paper examines the consequences of climate change on Nigerian agriculture and the potentials of greenhouse farming as a remedy.

2. Climate Change

Climate is the average weather condition of an environment considered over a long period of time,

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such weather parameters including temperatures, relative humidity, solar radiation and rainfall. A significant and consistent deviation from the average values of these parameters observed over a long period of time is described as climate change, indicating a change in what is known to be the existing pattern [5, 6].

Climate change is substantially as a result of anthropogenic factors or human activities which result in the generation and concentration of greenhouse gases in the atmosphere. These activities release substantial amount of carbon dioxide to the atmosphere and they include emissions from fossil fuel combustion and cement manufacture. Other activities include land use, ozone layer depletion, livestock farming and deforestation. Over a long period of time, the carbon dioxide forms a canopy in the atmosphere which allows the sun rays, to come from the sun into the atmosphere to the ground but as the sun rays are being re-radiated, part of the radiation is not able to go back to the atmosphere because the carbon dioxide is already forming a ceiling. The result of this is that the atmosphere begins to get warmer which is referred to as global warming and this leads to a change in the climate [5].

In many places including Nigeria, climate change was for a very long time unrecognized as most of its indicators were attributed to other reasons or just accepted as act of fate. It was only in recent times that it is being realized that observations earlier made and attributed to other reasons were actually due to climate change. The following observations which were hitherto attributed to other factors have come to be realized as indicators of climate change.

(1) Deforestation, characterized by the fast disappearing of forest cover, and aggravated by human activities.

(2) Changes in temperature, rainfall and water cycle dynamics which can induce other problems.

(3) Land degradation in form of reduced soil productivity in some places due to the removal of soil

nutrients by massive soil erosion and flooding.

(4) Desertification in the Sahel with its attendant problems of loss of farm land and conflicts between farmers and herdsmen.

3. Effects of Climate Change

Climate change has manifested itself in the Nigerian agricultural system in various ways some of which includes the following:

3.1 Land Degradation

Climate change leads to land degradation which reduces the quality and productivity of land and manifests in various forms throughout the country. While in the southern part of Nigeria, the problem is coastal erosion and flooding, in the Sahelian zone of the north, the most pronounced climate change related forms of land degradation are wind erosion and related sand dune formation, drought and desertification. Sheet erosion, which results in the complete removal of arable land, is Nigeria's biggest threat to agriculture, especially in the sandy soil regions of south-eastern Nigeria [7]. Many hectares of farmlands have been lost resulting in conflicts between farmers and herdsmen over ever decreasing land, and the emergence of climate refugees arising from some unlivable areas.

3.2 Reduced Fish Production

The Lake Chad, which is the water supplier to more than 10 million people of the northern states of Nigeria, has already shrunk to one-tenth of its original size. This has not only resulted in the reduction of water for irrigation activities, but the quantum of harvestable fishes from the lake has also dwindled. The responses to the fall in fish production has led to overgrazing and hunting for animals such as jackals and monkeys which were hitherto not part of human diet. There are indications that diseases could be contacted from these animals [3].

3.3 Reduced Farmland

As the earth gets warmed up, the ice caps in some

regions of the world that are permanently under ice begins to melt and the resulting liquid flow into the seas and oceans increasing the water level. When this happens, the low lying coastal areas begin to experience flooding. The rise in water level may be accompanied with excessive evaporation and excess moisture in the atmosphere leading to excessive rainfall. While in some areas, the effect of climate change is excessive rains and flooding, in others it could be severe heat and drastically reduced rainfall. In Nigeria, there is already an increase in precipitation in the humid south resulting to increase in sea level and submerging of coastal settlements but at the same time, the already dry north is experiencing reduced precipitation making the area drier which, coupled with the temperature increases, would reduce soil moisture availability [1]. While the desert that was initially limited to the extreme north of the country is fast moving downward, the sea level in the south is rising and submerging coastal settlements. In absolute terms, the productive land area is shrinking in the face of increasing population. In the long run, this may lead to internal migration and conflicts over the shrinking resources of fertile soil and water [3].

3.4 Increased Pests and Diseases

Climate change can increase the incidence of pests and diseases that attack and decimate forest trees and animals; leading to species extinction. For example, in the UK during the drought year of 2006, significant numbers of trees died while in Australia, tens of thousands of flying foxes were reported to have died in 1994 as a direct result of extreme heat events [8]. In Nigeria, climate change is taking its toll on the various ecological zones as many commercial timber species are becoming extinct. Pests and diseases migrate in response to climate changes and variations. For example, the tsetse fly that was hitherto limited to the south, has extended its range northward and will potentially pose a threat to livestock in the drier northern areas. It is estimated that by 2030, Nigeria and

other West African countries are likely to have agricultural losses of up to 4% of GDP due to climate change [9].

3.5 Reduced Harvest

Climate change has serious consequence on food security the success of which is dependent on the age-long ability of farmers to predict when to plant their crops. Unpredictable changes in the onset of rains in the last 20 to 30 years have led to situations where crops planted with the arrival of early rains get smothered in the soil by an unexpected dry spell that can follow early planting. When the Sahelian zone suffered drought in the 1970's and 1980's, harvest failure was remarkable throughout the region. Close to one million livestock were lost, affecting meat and dairy supply throughout the country [10]. In a survey on impact of climate change on agriculture in Gude, a community in Kano state, the response of one of the farmers was as follows "the amount of rainfall has reduced drastically, a few days back it rained heavily and erosion has washed away our farmlands including the crops. This year we have suffered the impact of low rainfall and drought to the extent that we had to replant our crops three times before the rain became normal and after which pests and fungal diseases destroyed our crops" [11].

According to FAO [12] and IFAD [13], the effect of climate change is already manifesting in crop failures and livestock death causing higher economic losses, contributing to higher food prices and undermining food security. It is predicted that if mitigation efforts are not made, the crop yield of the predominantly rainfed African agriculture would drop by 50% in 2020.

The summary of the above effects is a reduction in agricultural output as can be seen from Table 1 which shows that the yield per hectare of some common staple crops has been on the decrease in recent years. Fish production is also reported to have fallen from 511.721 tonnes in 2002 to 510.762 in 2003 and to 509.201 tonnes in 2004 [14]. Nigeria's cocoa production

Table 1 Yield of some Nigerian staple crops.

Crop	Yield in tonnes/ha		
	1996/1997	1999/2000	2003/2004
Millet	1.343	1.329	1.030
Guinea corn	1.290	1.204	1.177
Groundnut	1.014	0.992	1.010
Beans	0.439	0.453	0.430
Yams	14.513	9.362	8.839
Maize	1.382	1.145	1.070
Cassava	15.554	7.839	9.431
Rice	3.184	1.516	0.955

Source: National Bureau of Statistics, 2008 [14].

output is also reported to have declined from 330,000 metric tonnes in 2006/2007, to about 212,000 metric tonnes in 2008/2009 [15].

4. Response to Climate Change

The response to climate change is being pursued in two ways and these are adaptation and mitigation. While the adaptation approach emphasizes the need to cope with the problems associated with climate change, the mitigation emphasizes the need to eliminate it where it has already surfaced and to prevent its emergence in where it has not. One of the proposed mitigation approaches is to reduce the amount of carbon released to the atmosphere since that is the primary cause. As promising as this approach appears to be, it may not be feasible in many countries including Nigeria. This is not just because the ninth largest deposits of gas are located in the country or that the country is the eighth largest oil suppliers of the world but because the economy is over 80% dependent on petroleum which is a major source of carbon dioxide [3]. Adaptation rather than mitigation may therefore be a better option of combating the effect of climate change.

Although the effect of climate change is not limited to agriculture, the effect on agriculture is considered of major concern because of the role it plays in the life of man as food supplier, the only means of life sustenance. Various efforts have therefore been made to address the situation some of which are as follows.

4.1 Agronomic Practices

Altering planting dates, application of irrigation, changes in levels of fertilization and agricultural systems are possible ways of reducing the effect of climate change. Adejuwon [1] suggested three adaptations that could be used in Nigeria and these are adaptation by crop choice, adaptation by altered tillage and husbandry and adaptation by alteration of inputs.

4.2 Introduction of New Crop Varieties

One of the effects of climate change is drought in an environment that was hitherto enjoying significant rainfall. While the climate may no longer support the traditional crops in the environment, there may be new crops that may survive under the new climate. Such crops can be identified and cultivated. The development of drought resistant varieties and short duration maturity crops that can cope with reduced moisture and which can be cultivated within the short period that rain may be available is being encouraged [5].

4.3 Afforestation Programme

Exposure makes agricultural land susceptible to degradation in various forms such as erosion and moisture loss. Afforestation which involves the planting of trees and alley farming are ways of protecting the soil surface and these are being emphasized [16, 17].

4.4 Government Policies

Government policies both national and international are aimed at regulating human activities that aggravate climate change but their success depends on the attitude of people. The Nigerian federal government climate change response master plan comprises of the National Action Plan to mitigate the effects of climate change, the Adaptation Strategies of Action in Nigeria, the National Ozone Programme of Action, the National Forestry Development Programme and the National Action Plan to Combat Desertification and National Capacity Self-Assessment (NCSA) [18].

4.5 Adoption of Tested Practices

Globally most of the effects of climate change are not entirely new but what is new is the appearance of those effects in new areas. Adapting the practices in the areas where such effects have since been in existence is a potential way of addressing the effect of climate change. The adoption of protected agriculture in areas where the effect of climate change is manifesting is also being advocated and especially in Nigeria which is dependent of rainfed agriculture, the adoption of protected agriculture for specialty crops such as tomatoes, cucumbers, peppers, berries, lettuce, flowers and a wide range of trees, shrubs, perennials and vines will be an advantage.

5. Protected Agriculture

Protected agriculture or greenhouse farming is an agricultural practice whereby crops are cultivated under a regulated environment [19]. It is widely practiced in many parts of the world such as Israel, where the natural resources for crop production especially water and land are in short supply. Among the structures employed in such circumstances is the greenhouse. As a result of climate change in recent times, the technology is gradually being introduced to countries such as Kenya, which hitherto depended on natural climate for crop production [20]. Greenhouse farming is being adopted by many countries because of its numerous benefits which include the following:

5.1 Increased Crop Yield

Many crops can be grown repeatedly throughout the year which is achievable through the regulation of carbon dioxide which is required by plants for photosynthesis. Greenhouse vegetable growers produce tomatoes, cucumbers and peppers for 10 months of the year, and lettuce and herbs for 12 months of the year with an area as small as 240 square meters supporting between 1,000 and 1,200 plants of tomatoes which are not possible with natural agriculture. A greenhouse can produce 15 to 20 times

more produce than a field of the same area. The advantage here is the possibility of producing huge quantities of produce from a small piece of land. This reduces the seasonal scarcity associated with most specialty crops such as tomatoes and increases the farmer's income [21].

5.2 Efficient Water Utilization

Greenhouse farming enables the regulation of temperature and relative humidity and by drip irrigation, crops can be grown using limited amounts of water. This is an advantage in many dry environments and even the hitherto wet areas but in which the rainfall is dwindling due to climate change.

5.3 Reduced Manpower Requirement

Weeding is a major agricultural operation but which is sparingly encountered in greenhouse farming. The manpower required in a greenhouse is therefore less when compared to open field cultivation [22].

5.4 Improved Shelf Life

Shorter maturation period and increased shelf life of produce have been recorded with greenhouse farming. Tomatoes produced in greenhouses have been reported to mature in two months as against those produced on the field which matured in three months while the shelf life of the greenhouse produced tomatoes was 21 days as against 14 days for those produced on the open field [20].

5.5 Minimal Exposure to Toxic Chemicals

Tomatoes and other vegetables are generally highly susceptible to diseases requiring heavy application of pesticides. In greenhouses, vegetables are grown with no herbicides and little or no pesticides but instead, beneficial insects and other integrated pest management techniques are used. Apart from huge savings on crop protection chemicals, which constitute a huge part of production costs, less labour is employed in a greenhouse, while exposure to chemical toxins

associated with application is minimized or eliminated altogether. It is also good for the environment [19, 21, 23].

The simplicity and flexibility in the facilities required to practice greenhouse farming makes it adaptable to many climatic environments and scales of agriculture. Greenhouse farming can be practiced on an area as small as one hectare to as much as 750 hectares. While large scale specialized farms could use a single large greenhouse, small scale farmers who cultivate various crops in small scale can use several small sized greenhouses thus enabling them to produce and sell various crops at the local level throughout the year [24, 25].

6. What Is Needed for Effective Utilization of Greenhouse Farming?

A few experimental greenhouses are found in Nigeria expectedly confined to the research institutes and hence greenhouse farming would be a new innovation in Nigeria. Three issues which are crucial to the successful use of greenhouses are appropriate design to suit local conditions, choice of appropriate glazing material and accessories, and effective management and maintenance culture. The kits which comprises of a 500 L water tank, irrigation drip lines, glazing sheet, planting materials and chemicals can be locally sourced in many places and interested farmers can raise the cost which is recoverable within a short period. There are various glazing materials from which a choice can be made but the choice of appropriate type for the local environment would determine the success of the programme. There is need for indepth research to establish which glazing material is most appropriate for each climate zone of the country. Here lies the greatest challenge in the introduction of greenhouse farming in Nigeria. Designs are available from which individuals could make a choice but there is need for training on the construction and management for the greenhouse farmers.

7. Conclusion

Global warming and climate change have upset the hitherto stable environment of many tropical countries including Nigeria leading to unpredictable onset and duration of seasons. Concerted efforts must be made to reduce its impact on crop and livestock production in order not to aggravate the food insecurity already evident in many countries. Greenhouse farming which ensures the survival of crops irrespective of the hostile ambient environment is one of the many options of accomplishing this if well exploited. To be effectively utilized, research should be conducted to identify the most appropriate glazing material for the various ecological zones of the country, training on the construction and management for interested farmers is desirable while the various poverty alleviation agencies of the federal government of Nigeria should provide credit facilities to enable interested farmers acquire the kits.

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