



**Climate Change  
Symposium  
sur le  
Changement  
Climatique  
2011**

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**Panel 16: Special Panel on Innovations in  
Agriculture and Food Security**

**Chair: Ramadjita Tabo (FARA)**

**Federica Matteoli:** Collaborative change: a communication framework for climate change adaptation and food security

**Mobolaji Oluyimika Omobowale:** Climate change adaptation strategies for sustainable food security and development in Africa: controlled environment agriculture as a viable option

**Negussie Efa:** Role of plant health clinics in enhancing adaptive capacity to climate induced plant health problems: Experiences from Kenya

**Amos Majule:** Exploring opportunities for enhancing capacities of individuals, institutions and political domains to adapt to climate change in agricultural sector: A case of Tanzania and Malawi

## Panel summary

**Federica Matteoli** presented on “Collaborative change: a communication framework for climate change adaptation and food security”. □

Federica presented on ComDev activities in DRC under the CSDI initiative. She highlighted that communication on climate change is key and could act as the bridging link between the diverse sectors impacted by climate change.

How best to insure effectiveness of communication in such a large and diverse country as DRC?

Key message: Social perspective has to be integrated in all projects.

**Mobolaji Oluyimika Omobowale** presented on “Climate change adaptation strategies for sustainable food security and development in Africa: controlled environment agriculture as a viable option”.

“Do agriculture!” currently means, “destroy the forests!” in Nigeria.

Controlled environmental agriculture (CEA) or protected agriculture: reducing GHG emissions, using renewable energy, keeping away pests, and protecting the environment.

Are there any existing cost-efficiency studies of CEA? Environmental benefits that may not be easy to assess, have long-term benefits.

Are there any adverse effect?

Key message: Source of knowledge is not necessarily elsewhere! It is in Africa and we need to use it to solve our problems.

**Negussie Efa** presented on “Role of plant health clinics in enhancing adaptive capacity to climate induced plant health problems”.

40 new plant diseases identified all over the world.

What is the difference between plant clinics and phyto sanitary laboratories?

Key message: The need for innovation that includes all actors.

**Amos Majule** presented on “Exploring opportunities for enhancing capacities of individuals, institutions and political domains to adapt to climate change in agricultural sector: a case of Tanzania and Malawi”.

Key message: Farmers have to be involved. There needs to be a focus on vulnerable communities and take into account what they are already doing.

Dr Tabo concluded the session with the questions of:

How to scale up?

What is the role of capacity building?

What is the role of renewable energy and how to explore alternative energy sources at regional level?

# **Mobolaji Oluyimika Omobowale**

## **Climate Change Adaptation Strategies for Sustainable Food Security and Socio-Economic Development in Africa: Controlled Environment Agriculture through Renewable Energy as a Viable Option**

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### **ABSTRACT**

That climate change, global warming and their consequences are already upon mankind and his environment is a fact that is not in doubt. Sadly enough, the impact of climate change is more pronounced in Africa than any other continent due to lack of both short and long term adaptation policies and strategies that could be adopted to combat this threat. Should Africa not be able to respond to the changing climate, agricultural productivity which provides a means of livelihood for about 70% of the African population would suffer serious devastating effects among which are reduction in crop yields and agricultural productivity, increased incidence of pest attacks due to an increase in temperature which favours insect growth, reduction in the amount of water available in most parts of Africa, longer drought periods, reduced soil fertility and poor livestock productivity. A viable adaptation strategy for enhancing agricultural productivity and preparing farmers for the effects of climate change in Africa is “Controlled Environment Agriculture (CEA)/Greenhouse Engineering”. This is because CEA can be practiced as a low carbon and climate compatible way of agricultural production by using renewable energy. Unlike most other continents, Africa lags terribly behind in developing research capabilities as well as good policy formulation and implementation for large scale agricultural production through CEA. Rain-fed/seasonal farming is still predominant while some other African nations depend largely on food aid from developed countries. CEA offers the possibility of multiple harvests of crops in successive cycles as there is no need to wait for certain seasons before cultivation can be done. Should the African continent embrace en-mass, the technology behind CEA, the populace would stand a good chance of being nutritionally food secure and in addition, mitigate the negative effects of climate change on agriculture by agriculture.

**KEYWORDS:** Climate Change, Agriculture, Adaptation Strategies, CEA, Food Security, Policy

### **1.0 Introduction: Climate Change and Africa-The True Picture**

The effects of climate change are being felt globally (Masafawy, 2007; OECD, 2008; Wikipedia, 2010). Observations ranging from desert encroachment, changing seasons/rainfall patterns and drought attest to this. In the absence of adequate preparation and mitigating actions, Africa would not be able to respond to the changing climate hence; agricultural productivity which is the major source of livelihood for about 70% of the population would suffer serious devastating effects (Mendelsohn, 2000; AAC, 2002; Stordal *et. al.*, 2010). The importance of agriculture to African economies is more evident in the fact that proceeds from the sector in some sub-Saharan countries contributes over of 40 percent of GDP, compared to the United States of America and Brazil where agriculture is 1.2% and 6.1% of GDP respectively (Murphy, 2010).

Scientific findings indicate that problems associated with climate change would be significant in Africa leading to hundreds of millions of people going hungry due to reduced agricultural productivity, if adequate strategies of solving the problems are not considered and implemented (Masafawy, 2007; Nyong, 2008). For instance, a two degree rise above average current temperature ranges would expose millions of people to drought, hunger and flooding thereby making more severe the general food insecurity on the African continent (Milmo, 2007). The gravity of this fact is amplified more by a projection that by 2020, 75 to 250 million people in Africa would be affected by acute water shortages which would reduce agriculture productivity by half, while desertification and loss or extinction of wildlife biodiversity would increase (IATP, 2010).

Just as climate change portends serious negative impacts for agriculture, practice of agriculture has also contributed significantly to the problem of climate change and global warming. Farming (both livestock and crop) as well as some other agro-allied activities result in the emission of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O as a direct result of the combustion of fossil fuels, deforestation, land clearing, bush burning, manufacture of agricultural machinery, application synthetic Nitrogen fertilizer and livestock waste. About 12% of anthropogenic greenhouse gas emissions globally is attributed to agriculture. Furthermore, the United Nations Environment Programme estimates

that about 80% of greenhouse gas emissions come from developing countries (Kraner *et al.*, 1999; Ngaira, 2007; Rosegrant *et al.*, 2008; UNEP, 2010; PAN, 2010; Speranza, 2010).

Greenhouse gases cause global warming when molecules of these gasses absorb outgoing long wave solar radiation resulting in less radiation reflected back to space. CO<sub>2</sub> is regarded as the most important greenhouse gas emitted from Africa specifically due to burning of fossil fuels and deforestation. Ngaira (2007) noted that warmer climates would disrupt natural ecosystems resulting in the reduction of forests while deserts and grasslands keep expanding in area. This phenomenon would ultimately make the tropics drier. Murphy (2010) also reported that a significant increase in natural disasters has been witnessed in the last 20 years, nine out of ten of which are linked to the effects of climate change. A proof of the negative impact of climate change on Africa is as reflected on the receding basin of lake Chad (Nyong, 2008). Figure 1 shows documented evidence of this from 1963 to 2001.

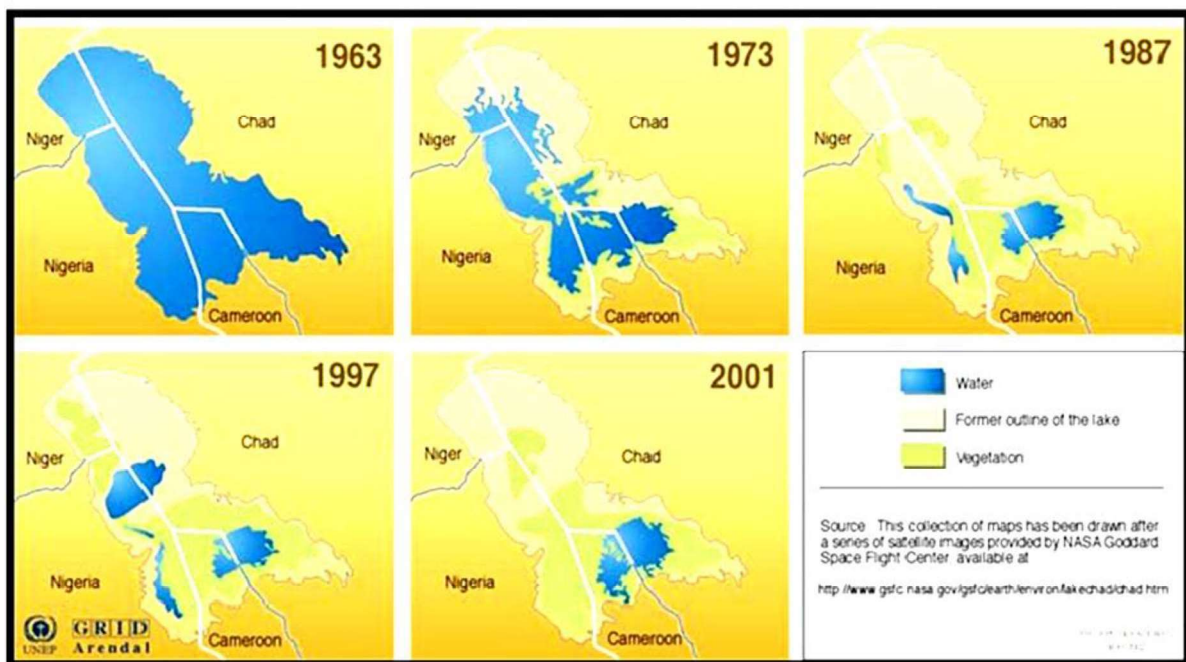


Figure 1: Disappearance of Lake Chad-1963-2001 (Source: Nyong, 2008)

A comparison between current agro-ecological belts of Africa and what it could become in the nearest future if action is not taken to reduce greenhouse gas emissions and combat the effects of changing climate on Africa is quite frightening. Figure 2 presents the current broad climatic belts of Africa which are given as:

- i) The arid and semi-arid (Sahel region, Kalahari and Namib deserts).
- ii) The tropical savanna grasslands (Sub-saharan Africa and Central Southern Africa).
- iii) The equatorial region (The Congo region and the East African highlands).
- iv) The temperate (The South Eastern tip of South Africa).

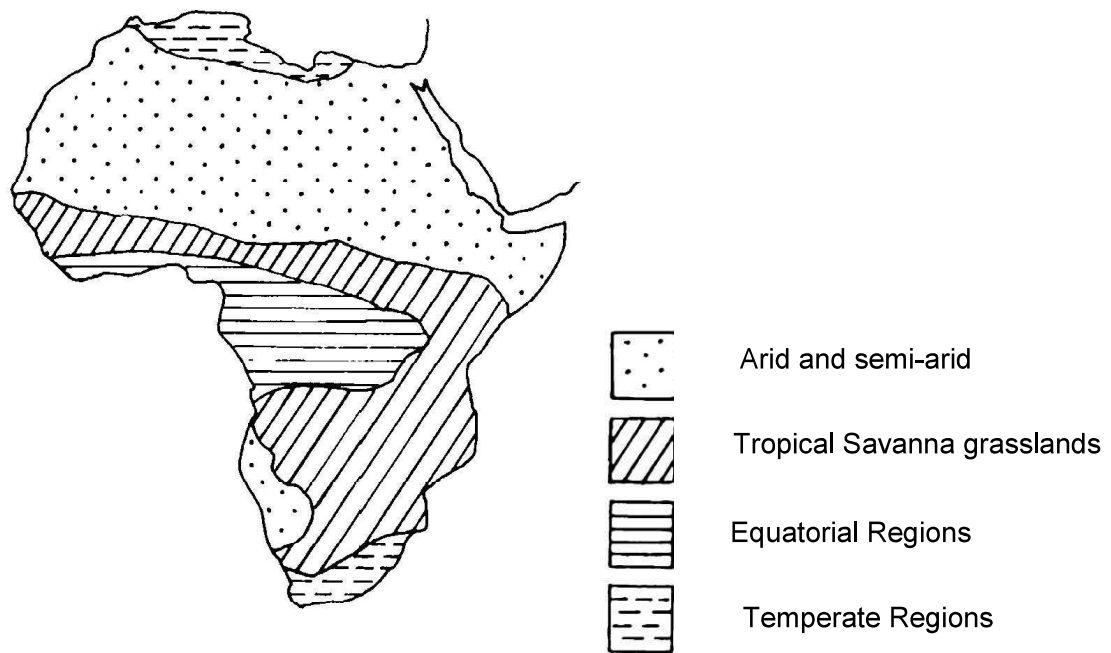


Figure 2: Africa's Current Agricultural Zones (Source: Ngaira, 2007)

If current situations persist, CO<sub>2</sub> and Ultra-Violet Beam are likely to increase, leading to a rise in global temperatures ranging from 1.5 to 4.5°C by the year 2030. This sharp increase in global warming would give rise to a change in the ecological system of Africa in which the rainforests would be gone while hot and in-habitable deserts would increase as reflected in Figure 3. Moreover by 2040, rising sea levels due to global warming and melting of the arctic ice would change the outline of the African continent as many coastal cities would be submerged as shown in Figure 4.

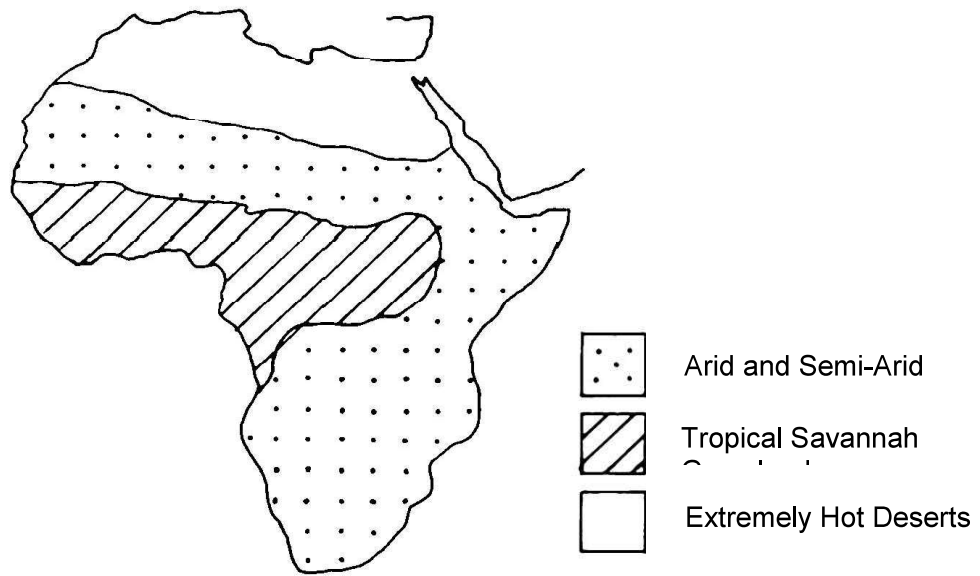


Figure 3: Predicted African Agricultural Zones by 2030 (Source: Ngaira, 2007)

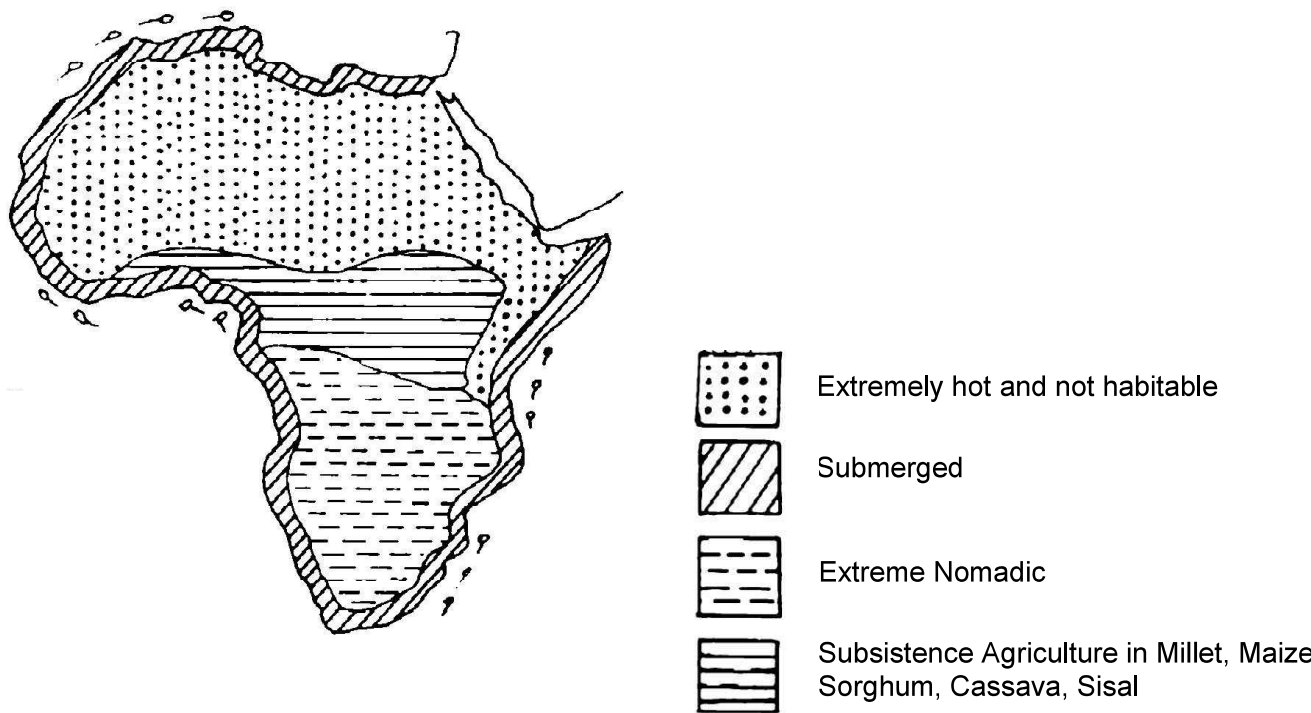


Figure 4: African agricultural Zones by 2040 (Source: Ngaira, 2007)

The survival of a nation depends to a large extent on its ability to feed its populace. Similarly, the ability of a nation to feed its populace depends on the availability of food products at an affordable price when due. Africa though blessed with numerous edible crops, seasonal variations do not allow for year round supply. Already food insecure in some countries, climate change has further worsened the situation and Africa is faced with a serious threat of total chaos should the predicted effects of climate change on the continent be left un-attended to (Yusuf *et. al.*, 2008). Considering the level of dependence on agriculture by a larger percentage of the African populace, *any action taken to improve the socio-economic well-being of Africans through agriculture without destroying the environment or increasing greenhouse gas emmissions would be a welcome development* (Nyong, 2008).

Several options have been suggested for mitigating the effects of climate change among which are carbon sequestration, abandoning high-input agriculture and synthetic agrochemicals, planting improved varieties and cover crops as well as increased water conservation methods to mention but a few (IPCC, 2008). Even though agriculture is important in achieving food security in Africa, its practice must be such that its impact on the environment is not degrading. ‘Controlled Environment Agriculture’ (CEA) or ‘Greenhouse Engineering’ offers an innovative way of applying technology towards having season independent year-round farming.

## **2.0 Climate Compatible Agricultural Development through Controlled Environment Agriculture (CEA)**

Scialabba and Lindenlauf (2010) reported that a global temperature rise of around 2°C is already inevitable and agro-ecological systems designed to mitigate the effects of climate change are required to ensure food security and sustainable livelihoods. They noted that the quest for ‘climate-proof’ or ‘climate independent’ system of farming is therefore a worthy cause. This is particularly so because of the impact of climate change on African agriculture. Considering the overall importance of agriculture to African socio-economic development, any step taken to protect and ensure sustainable agriculture would directly affect a large percentage of the population.

CEA is a system by which the natural environment is modified to achieve optimum plant growth thereby increasing crop yield. Whereas, open field agriculture is seasonal, multiple harvest is possible through CEA because crops grown in greenhouses do not necessarily depend on the outdoor climatic conditions. Certain factors are important for plant growth among which is light, CO<sub>2</sub>, temperature, humidity, water and nutrients. All these factors can be modified to create the best conditions for improved plant yield and economic returns. This makes greenhouse cultivation more desirable than open field cultivation. Rodriguez *et. al.* (2003) reported that modern agriculture constitutes a complex enterprise in which more people are to be supported with decreasing natural resources in land and water. With a highly competitive global market in which high quality, nutritious and affordable products from healthy environments are demanded, large scale CEA is inevitable for Africa.

CEA, which is reputed to be an option in converting deserts and other wastelands into fruitful agricultural use, can be practiced in a low carbon and climate compatible way by using renewable energy. This reduces the inherent dangers posed to the environment through conventional open field agriculture. Israel is an example of a nation that has successfully utilized CEA to achieve economic development and food security. Lacking in good soil and abundant water resources, Israel developed greenhouse technologies which enabled its farmers to grow more than three million roses per hectare per season, and an average of 300 tons of tomatoes per hectare per season. This amounts to four times the achievable yields in open fields (Sharma, 2005). Being in a semi-arid climatic zone, water scarcity necessitated the development of effective aqua-cultural system which is practiced in floating cages in the open sea as well as in man-made reservoirs and ponds. These greenhouse technologies resulted in export earnings for Israeli farmers from sales realized from a wide range of crops, ornamental fish and marine plants (Sharma, 2005).

Greenhouse farming offers a degree of flexibility in which method of cultivation can be adopted. These include:

- i. **Soil Culture:** This is also referred to as ground culture and it is a system where a greenhouse is constructed over a bed and cultivation is carried out underneath. In some

other cases, the greenhouse is constructed and fertile soil is transported into it for crop cultivation.

- ii. **Soilless Culture or Hydroponics:** This refers to growing of plants in a soilless media using mineral nutrient dissolved in water. Support systems are set in place for the plants and the root is flooded with fertigated water which can be recycled and used again.
- iii. **Aquaculture:** Greenhouse aquaculture refers to the cultivation of both freshwater and saltwater aquatic animals under controlled conditions.
- iv. **Aquaponics:** This refers to the cultivation of plants and aquatic animals in a recirculating environment. The methodology is such that when effluents which accumulate in the water used for growing fish becomes toxic to the fish, the water is moved to a hydroponic system where the plants take up the vital nutrients from the water. The cleansed water thereafter re-circulated back to the fish.

A recent development in CEA is the concept of “Vertical Farming”; in which rather than clearing several hectares of land for crop cultivation to meet increasing food demand, multi-storey structures are built and the internal environment is artificially modified and controlled to suit plant, animal or aqua-cultural life. Plate 1 shows the architectural design of a vertical farm currently being constructed in Singapore. Known as the “EDITT Tower” (meaning “Ecological Design in The Tropics”), the 26 storey structure would be powered using renewable energy. While solar panels would generate about 40% of its energy demand, human waste would also be converted into bio-gas and used as an energy source.

Africa currently ranks lowest among countries making use of CEA. Crop production in greenhouses covers about 443,000 ha in Asia, 105,000 ha in the Mediterranean region, 19,600 ha in the Americas, 42,500 ha in Europe and 17,000 in Africa and the Middle East. Of the 17,000 ha cultivated in Africa and Middle East, about 15,700 ha of the cultivation is carried out in North Africa and the Middle East while sub-Saharan Africa accounts for the rest (EFA, 2011).

Source of energy for powering CEA operations is a major concern especially when year round production is expected. However, judging from the renewable energy potentials of Africa, the possibilities of tapping clean energy is numerous and thus, CEA should be more widespread than

it is currently, most especially in sub-Saharan Africa. Using Nigeria as a case study, Iwayemi (2008) as well as Okafor and Joe-Uzuegbu (2010) reported that renewable energy resources which include hydro-power, solar, wind and biomass energy abound in the country. Hydro-power resources are estimated at about 14,750 Megawatts while solar radiation is estimated at 3.5-7.0 kWhour/m<sup>2</sup> per day depending on location. Wind energy potential is about 150,000 Terra-Joule per year while biomass energy is approximately  $8 \times 10^2$  Mega-Joules. The prospects of solar energy in Nigeria is particularly interesting as the country receives about  $4.851 \times 10^{12}$  KWh of energy per day from the sun and this is equivalent to energy from about 1.082 million tonnes of oil per day. The amount of radiated energy from the sun is about four thousand times the current daily crude oil production and approximately 13 thousand times that of daily natural gas production. Further analysis has it that only about 3.7% of the Nigeria's land mass is needed to collect energy equal to the nation's conventional energy reserve (Okafor and Joe-Uzuegbu, 2010).

Similarly, the renewable energy potentials of the Sahara desert which is the worlds' largest hot desert have been recognized. This energy potential if tapped would be sufficient in powering CEA in the whole of Africa. This is because the Sahara extends over nine million square kilometers and receives the most solar radiation in the world (Fiedermann *et. al.*, 2009). The Sahara desert alone is reputed to be able to power the entire world if just 1% of its land mass is covered in solar panels (Frucci, 2010); thereby delivering clean renewable energy which poses no threat to the environment.



Plate 1: The EDDIT Tower (Source: <http://inspirationgreen.com/vertical-farms.html>)

### **3.0 Conclusion and Recommendations**

Many regions of the global community are currently poorly adapted to the challenges of the current climate (OECD, 2010) and Africa is not left out from this group. In view of the current threats of climate change on the environment, food security and the socio-economic well-being of the populace, Africa needs to be in a state of readiness to tackle adverse situations brought about by global warming and environmental degradation. The technology behind CEA requires the expertise of Agricultural/Structural Engineers, Agronomists, Crop Biologists, Electrical and Electronics Engineers, Plant Nutritionists and Aqua-cultural experts depending on the kind of operation. Africa already has the potentials in all these disciplines waiting to be tapped.

Creating an enabling environment for the practice of CEA requires the formulation and implementation of suitable policies to support it. Goncharova (2007) and Silvis and Leenstra (2009) emphasized the role of good policies in the success of the agricultural sector in Netherlands, a country which earns a lot of foreign exchange from agricultural exports. The drive towards low carbon, climate compatible agricultural production aimed at reducing food importation and improving food security in Africa should be a concerted effort by the various governments in Africa. Policies and incentives targeted at encouraging CEA should be established and a conducive working environment should be created to encourage investors.

Even though the initial cost of setting up commercial CEA ventures may be high, its benefits on the long run far outweigh the initial expenses. Bearing in mind the damage that has been done to the environment through conventional mechanized agriculture in terms of greenhouse gas emissions which contributes to global warming, biodiversity loss due to deforestation and the need to cut down on these negative effects, CEA ought to be adopted, internalized and developed as a major contributor to employment generation and food production in Africa in the nearest future.

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