

## The Status of Greenhouses Utilization in Oyo State, Nigeria

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### Abstract

*The toll of climate change on the Nigerian agricultural system in recent times has resulted in the decline of agricultural production constituting a threat to food security. There is therefore an urgent need for strategies to reverse the situation and greenhouse farming is contemplated as a possible option. Towards the successful adoption of this strategy, a survey was conducted using Oyo State as a case study to establish the present status of the use of greenhouses in the region. A total of 114 greenhouses in six locations within the teaching and research institutions and primarily used for the purpose of research and as nurseries were identified. The materials used in the construction of various parts include welded mesh, aluminium, iron, glass sheet and polythene films. These greenhouses have been successfully used in the cultivation of sugarcane, sweet potato, Irish potatoes, onions, greenbean, carrot, cucumber, olive tree, citrus seedlings, seedlings of obeche and other hardwoods. Infrequent research activities have led to the abandonment of many greenhouses. Prohibitive cost of construction and maintenance has discouraged individuals from venturing into greenhouse farming. Based on the performance of the crops cultivated in these greenhouses, it is believed that whatever investment may be made in the erection of greenhouses, such could be recovered within a short period of time and hence the introduction of greenhouses for crop production as one of the many options of combating the negative effects of climate change in Nigeria is advocated. Towards this accomplishment, it is recommended that the existing greenhouses be effectively utilized, there should be public enlightenment on the potentials of greenhouses, there should be sourcing for local construction materials to reduce cost, interested individuals especially the youths should be trained on greenhouse construction and maintenance while government intervention is required.*

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**Keywords:** climate change, greenhouse, research institutions, oyo state, desert encroachment

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### INTRODUCTION

A greenhouse is a structure which is used for the production of crops under a controlled environmental condition. It is usually a glass- or plastic-enclosed structure with a framing of aluminum, galvanized steel, naturally durable or preservative treated timber (Giacomelli and Roberts, 1993; Ross, 2000; Vleeschouwer, 2001, Anonymous 2010). Greenhouses and similar buildings for crop production are designed for the protection of tender or out-of-season plants against excessive cold or heat and are often used for the propagation and growing of horticultural crops including vegetables, fruits and flowers, for plant research, for isolating plants from disease or insects, or any other circumstance in which plants require special growth conditions. A greenhouse is heated partly by the sun and partly by artificial means which makes it possible to have a controlled environment that can be adapted to the needs of particular plants. While in the tropical areas of Africa, there are only limited applications, there are a few situations in which a greenhouse can be justified because of the optimum growing conditions required for a high value crop or a research project. Greenhouses protect crops from inclement weather, shield plants from dust and storms, and help to keep out pests. Light and temperature control allows

greenhouses to turn unsuitable lands into lands that are suitable for the production of crops thereby improving food production.

The use of greenhouses dates back to the early millennia as archaeological excavations of the ancient city of Pompeii in 79 AD have uncovered the remains of early greenhouses. The Romans were among the first users of greenhouses which were used for the cultivation of cucumber and related vegetables which her emperor, Tiberius consumed every day of the year. Natural environment could not guarantee the regular supply all year round hence the use of greenhouses for their production. Prominent among the world leading users of greenhouses is Israel, where the country has most of its agriculture under greenhouses due to scarcity of water and land. Greenhouse farming is also widely practiced in the United States (Anonymous 2011a, 2011b).

The use of greenhouses in commercial agricultural is being promoted worldwide because of the numerous benefits which include the following:

- a) Because all plant growth factors can be controlled and maintained at optimum level all year round in the greenhouses, greenhouses make it possible to cultivate crops outside their normal season and

throughout the year. It is also possible for crops to mature in a lesser period than when cultivated in open field. This does not only make the crops available throughout the year but the volume of production is increased because of possible multiple annual cropping which increases the amount of crop harvested per unit area of land annually. In Kenya for example, tomatoes cultivated in greenhouses matured in two months as against a minimum of three months for those in open field. In addition, the tomatoes produced under greenhouses had a shelf-life of 21 days compared with 14 days for those grown in the open. This is a major advantage in the area of increased production and postharvest losses reduction (Anonymous 2011c).

b) Desert encroachment is increasing daily and many hectares of land hitherto used for crop production have been rendered agriculturally useless. Such areas which are not suitable for open field agricultural practice can be utilized under greenhouses (Anonymous, 2011d)

c) Greenhouses ensure better utilization of sunlight and higher accumulation of carbon dioxide (CO<sub>2</sub>) available in the protected environment, resulting in bumper harvests. The crops are also organic in nature and the chances of the weather playing spoilsport are also eliminated.

d) The drip irrigation system often used in greenhouses ensures optimal use of water as only the root zone of saplings is watered. This is of special advantage as water scarcity is increasing worldwide.

e) Greenhouses offer protection to cultivated crops in many forms such as screening the crops from insect attack and are therefore more hygienic, control of factors such as temperature and wind speed which under open condition leads to crop damage (Anonymous 2011d). Apart from huge savings on crop protection chemicals, which constitute a huge part of production cost, exposure to chemical toxins associated with application is minimized or eliminated altogether thus protecting the workers against health hazards.

As a result of these advantages of greenhouses, a number of countries have in recent times imbibed the idea of greenhouse farming. Kenya for instance, introduced greenhouse production of tomatoes, in order to ensure that the popular vegetable will not only become available throughout the year at affordable prices and increase the incomes of rural households, but that it will yield sufficient quantity to meet local demand and excess for export (Anonymous 2011c).

According to IFAD (2010), 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. Hitherto, Nigerian farmers could predict the onset and duration of seasons on the basis of which they plan their agricultural calendar but in recent years, their predictions have failed as a result of climate change. This change in climate has negatively affected the fortunes of all categories of farmers. While the peasants farmers have become impoverished because in most cases the only planting materials kept from previous harvests may be planted at the first rain which is lost and there may be no resources to purchase another material for planting during the season, for the large scale farms, who most often obtain loans for agricultural operations, instances of lost loans due to crop failure and outrageous interests are not uncommon. On the whole, there is dwindling harvest in the midst of ever increasing population which constitutes a threat to food security.

The realization of climate change as a factor in declining agricultural production in Nigeria is only recent as it had hitherto been felt that the problem could be surmounted through increased hectareage cropping, use of improved seeds and agrochemicals. Having realized that climate change is a major agricultural constraint; all hands must be on deck to check its menace. In areas where it has been recognized for quite some time, various remedial measures have been adopted and it is considered that such methods are tested in the Nigerian environment. The greenhouse is one of the many options that have been used elsewhere which could possibly be introduced in the Nigerian environment.

Although survey objectives may differ with authors, they are all targeted at improving the industry. The search for solution to the problem of fusarium foot and root rot disease of tomatoes planted in greenhouses prompted a survey work of Jarvis *et. al.* (1983) in Southwestern Ontario who recommended seed bed sterilization and irrigation with warm water. Latimer *et. al.* (2002) carried out a greenhouse survey in Virginia to identify the research and educational development programme needs of greenhouse operators. The survey undertaken by the Rutgers Cooperative Extension (2003) in New Jersey, was to generate information that was helpful to greenhouse farmers in resolving most of the pressing industry challenges while the work of Onder (2009), in Eastern Mediterranean coastal areas of Turkey was aimed at determining the general management problems, structural features and weaknesses and climate control of greenhouses. There is at present a dearth of information on the status of greenhouses in Nigeria which is very relevant to their effective use in

the country. The elimination of this gap is the main thrust of this work. This work was undertaken with the aims of determining present use of greenhouses in Nigeria, the associated problems and their potentials in boosting the Nigerian agriculture, using Oyo state as a case study.

**MATERIALS AND METHODS**

**Area of Study**

The study area for this work is Oyo State which stretches from latitude 7° N to latitude 9° N and longitude 2.8° E to longitude 4.5° E. It is bounded in the West by the Republic of Benin, in the East by Osun State, in the North by Kwara State and in the South by Ogun State (Fig. 1).



Figure 1. Map of Nigeria showing the location of Oyo State

The area lies within the rainforest region and has two distinct seasons, the raining season from April to October with an August break and dry season from November to March. The annual rainfall ranges from 1,200 – 1,300 mm. The temperatures vary from a minimum of 21°C in July to a maximum of 39°C in February. These climatic data have become unpredictable in recent times due to the effect of climate change. A good percentage of the populace are engaged in agriculture producing staple crops such as assorted vegetables, fruits, yam, cassava and

cocoyam while plantation agriculture of cocoa, kolanut and oil palm produce is a major activity. Since the primary focus of this work was to establish the status of greenhouses in the study area, all greenhouses were included in the survey. The information as to the location of greenhouses was obtained from pre-survey visits to the State Ministry of Agriculture, tertiary institutions and research institutes within the state. Six locations within the state were identified where greenhouses were in use. These were the Forestry Research Institute of Nigeria (FRIN), Ibadan; the Institute of Agricultural Research and Training (IAR&T), Moor Plantation, Ibadan; the International Institute for Tropical Agriculture (IITA), Ibadan; the National Horticultural Research (NIHORT) Ibadan; the Plant Quarantine (PQ), Ibadan and the University of Ibadan (UI).

**Design of Questionnaire**

The questionnaire was designed to capture as much relevant information as possible. Information requested included the use of greenhouses, materials of construction, crops cultivated, frequency of utilization and maintenance culture.

**Administration of questionnaire**

Considering the poor postal system in Nigeria and the lukewarm attitude of respondents to completing questionnaire, it was decided that the questionnaire be delivered by hand to be completed and collected on the spot or at least obtain a date when a return visit could be made to collect the form. During such visits, personal observation and photographic recordings of the greenhouses were made. Such visits also provided opportunities for interaction with the greenhouse workers through which additional items of information were obtained.

**RESULTS AND DISCUSSION**

**Greenhouse Population and Distribution**

A total of 114 greenhouses were identified during the survey. Their distribution among the various locations and their categorization in terms of shape and structure are presented in table 1.

Table 1. Greenhouse Population and Categorization based on Structure and Shape

Location	Total No of Greenhouse Identified	Distribution by Structure		Distribution by Shape			
		Gutter connected	Freestanding	Quonset	Rigid Frame	Rigid Wall	Truss
FRIN	1	-	1	-	-	-	1
IAR&T	3	-	3	3	-	-	-
IITA	49	20	29	19	30	-	-
NIHORT	4	4	-	-	4	-	-
PQ	54	41	13	-	54	-	-
UI	3	-	3	-	1	2	-
	114	65	49	22	89	2	1

**Purpose of Greenhouse Utilization and Crops Cultivated**

In the design of the questionnaire, three possible uses of the greenhouses were assumed. These were for the cultivation of crops for sale, cultivation of crops for personal consumption and for experimental purpose. At the end of the field work, all the greenhouses were reported to be used for experimental purpose only and not a single one was used for cultivation of crops either for sale or personal consumption.

The crops cultivated within the greenhouses included sugarcane, sweet potato, Irish potatoes, onions, greenbean, carrot, cucumber, olive tree, citrus seedlings, seedlings of obeche and other hardwoods. The experimental studies in these greenhouses are aimed at eliminating pests, development of hybrids and raising of seedlings which are later transplanted. It is also important to report that presently, greenhouses are owned by institutions and private ownership of greenhouses does not exist.

**Factors Considered in the Location of greenhouses**

One area of interest during the study was to find out the factors which are considered in the selection of where a greenhouse is erected. The results are summarized in Table 2.

Table 2. Factors Considered in the Location of a greenhouse.

Factor	No of Respondent	Frequency
Proximity	51	44.7
Orientation	34	29.8
Accessibility	19	16.7
Availability of Land	10	8.8
Total	114	100

Proximity to other facilities that are related to the use of the greenhouse was found to be a major factor. In areas where greenhouses were used as nurseries, they were located as close as possible to the fields where the seedlings will eventually be transplanted while in the case of research, they were located as close as possible to the laboratories where the analysis were carried out.

Factors such as the desired orientation of the greenhouse with respect to the prevailing wind direction and the sun are very important in the location of the structure. Greenhouse must be located in an area that these desired natural factors would not be obstructed. Where expanse of land is available, it is always easy to select a location that has not been overcrowded by other existing structures.

**Frequency of Greenhouses Use**

The responses to the question on the frequency of use of the existing greenhouses are presented in table 3.

Table 3. Frequency of Use of Greenhouses.

Period of Use	No of Respondents	Frequency
Only when an Experiment is in progress	62	54.0
All Year Round	52	46.0
Only During the Dry Season	0	0
Total	114	100

Over half of the greenhouses are only used when there is an experiment to be carried out while whenever there is no ongoing experiment, the greenhouse might not be visited. Those used all year around are mainly for the production of seedlings and hybrids where activities are always on-going. Whenever a greenhouse is not in use, no regular visit, inspection or security is provided and during such periods, the greenhouses may be vandalized while many of the accessories within the greenhouses are pilfered. Even when next such greenhouses are to be used, they become non-functional requiring a lot of fund to effect repairs and replace stolen accessories. The ultimate in such situations is the abandonment of such greenhouses. This was observed in many of the sites visited while an example of an abandoned greenhouse in the Department of Botany at the University of Ibadan is shown in plate 2.



Figure 2. An Abandoned Greenhouse at the University of Ibadan (Botany Department)

**Materials of Construction**

There are different materials used in the construction of various parts of the greenhouse. These are summarized in Table 3.

Table 3. Materials of Construction for the various parts of a Greenhouse

Section	Materials of Construction
Floor and foundation	Concrete was used for the foundation and in cases where tables were used and adequate support needed, the floor was concreted but in cases where planting on the floor was desirable, the floor was left unpaved.
Frame	Aluminum was used in many instances for the frame while on a few occasions iron was used
Wall Covering	The material used depended on what exactly was to be regulated. While some studies required an almost hermetic condition, others required natural ventilation across the structure. For this reason, a variety of materials were used for the wall covering. Materials used included wire mesh and Net, and glass sheets
Roof Covering Material	glass fibre, polythene films and wire nets

The choice of construction material is influenced by a number of factors including cost, availability, durability, ease of working and specific use of the greenhouse. For example, a greenhouse used for all year round either for seedling production or experiment can justify the cost of glass, while a house used for a month or two in a year can only justify a polythene covering.

**Greenhouse Maintenance**

The problems commonly experienced with the greenhouses visited are summarized in table 4.

Table 4. Common Greenhouse Problems

Part	Problem
Roof	- Broken glass sheet - Torn polythene films
Floor	- Weed growing on the ground - Cracking of the floor
Moat(container where water is put)	- Lack of water in the moat - Lack of water in the greenhouse
Accessories	- Air-conditions not in good working condition - Thermostats not in good working condition - Faulty pumping machine - Faulty electrical fittings

When attended to very early, these negative effects can be minimized but when left unattended to, they aggravate and may eventually lead to complete damage of the greenhouse. Since many of the greenhouses are not continuously in use, some of these problems develop during the idle period and

may not even be noticed. It is only at the commencement of a new experiment that they may be discovered when the damage must have been done. There is no maintenance culture as the greenhouses are only given attention if and when they have to be used. This is the primary reason for the dilapidated condition of a number of greenhouses found during the study.

The construction cost of greenhouses vary with size and for a 6.1m×3.1m×4.5m greenhouse, the cost varies between one and three million Naira while the annual maintenance cost would vary between N500,000.00 and N600,000.00. This prohibitive cost of construction and maintenance is assumed to be one of the reasons why many people have not ventured into the business of greenhouse farming in Nigeria.

**CONCLUSIONS AND RECOMMENDATIONS**

During the survey, a total number of 114 greenhouses were identified. The greenhouses identified were mainly owned and located within the teaching and research institutions and are also primarily used for the purpose of research and as nurseries. The materials used in the construction of various parts include wire mesh, aluminium, iron, glass sheet and polythene films and wire nets. Proximity to related service structures, accessibility and orientation are important factors in the location of a greenhouse.

These greenhouses have been successfully used in the cultivation of a number of precious vegetables which constitute a major component of the diet of the populace but which cannot be cultivated in the region even under normal climate. As a result of the prohibitive cost of construction and maintenance and lack of awareness of its potentials, entrepreneurs have not ventured into the business of greenhouse farming in the state and perhaps Nigeria in general.

Based on the performance of the crops cultivated in these greenhouses, it is believed that whatever investment may be made in the erection of greenhouses, such could be recovered within a short period of time and hence the introduction of greenhouses for crop production as one of the many options of combating the negative effects of climate change in Nigeria is advocated.

Toward this accomplishment, the following recommendations are made

- a) **Effective utilization of existing greenhouses:** Although the existing greenhouses were erected for the purpose of research, since they have proved useful in the cultivation of highly demanded crops, they provide an opportunity for income generation which will even make funds available for research. It is recommended that the abandoned greenhouses be

renovated and where research is not on-going, they should be used to produce crops for sale.

b) **Public enlightenment:** Even though greenhouses have been in use in the state for a very long time, they have been confined to the research institutes and not many individuals especially commercial farmers who perhaps would have had the resources to venture into their use are aware about them. There is the need for massive public enlightenment on the potentials of greenhouse farming especially among the farming communities.

c) **Sourcing for local construction materials:** The main reason for the high cost of the greenhouses is the materials used in construction. Appropriate local materials for use should be sourced which will go a long way to reduce the cost.

d) **Training skill:** Greenhouse construction and maintenance requires some skills. The research institutes should organize training skills for those interested and especially many of the unemployed youths.

e) **Government support and incentive:** The federal government of Nigeria has repeatedly restated her commitment to the food security programme. Greenhouse farming is one area where adequate food can be produced under any condition. Attention in terms of grants and subsidy should be provided for those who are interested in greenhouse farming.

The popularization of greenhouse farming could lead to employment creation in the sense that the construction materials can be sourced locally and technology can also be locally sourced which will make it cheap. Many youths could be given little orientation and can then be self employed either in their production or utilization for market gardening. Extension of greenhouse farming would support the development of new branch of industrial sectors producing greenhouse materials.

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