CONSTRUCTION OF GREENHOUSE IN SCIENCE LABORATORY TECHNOLOGY (SLT) BOTANICAL GARDEN IN FEDERAL POLYTECHNIC, KAURA NAMODA, ZAMFARA STATE

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Abstract

The conceptualization, designed fabrication and construction of a greenhouse as part of a botanical garden within the premises of the Science Laboratory Technology Department of the Federal Polytechnic, Kaura Namoda, is a unique and rewarding experience laced with ecological, cultural, educational and economic benefits that will last for several generations of students on campus.The fabricated greenhouses which are frames of inflated structures covered with transparent materials in which crops are grown under controlled environmental conditions have been evolved to create favorable micro-climates, which favor crop production to be possible all through the year or part of the year as required.Other technologies involved in the greenhouse design are used for controlled environmental plant production which are associated with the off-season production of ornamentals and foods of high value in cold climate areas where outdoor production is not possible.Hence, the primary environmental parameter traditionally controlled under the fabrication exercise is temperature, usually providing heat to overcome extreme cold conditions. However, environmental control can also include cooling to mitigate excessive temperature, light control either shading or adding supplemental light, carbon dioxide levels, relative humidity, water, plant nutrients and pest control.

Background of the study

A set of production guidelines known as best management practices for the purpose of this manual are voluntary activities undertaken to minimize negative effects on the environment. The manual is not intended for regulations. BMP consideration for greenhouse production include site selection, water management and irrigation, nutrient management, compositing prohibited plants, pesticides use and storage, insect, mite disease and weed management animal energy conservation. BMPs are adaptable for the diversity that exists within the industry. Applying these practices will help Massachusetts greenhouses and nurseries to remain or become healthy and profitable (Bartok, et al 2005).

Definition of Greenhouse

A greenhouse (also called a glasshouse, or if sufficient heating, a hothouse) is a structure with walls and roof made directly of transparent materials, such as glass, in which plants requiring regulated climatic conditions are grown. These structures range in size from small sheets to industrial sized buildings. A miniature greenhouse is known as a cold of greenhouse exposed to sunlight becomes significantly warmer than the external ambient temperature, protecting its contents in cold weather(Marshall et al, 2015).

A botanical garden or botanic garden is a garden dedicated to the collection, cultivation and display of a wide range of plants labelled with their botanical names. It may contain specialist plant collections, such as cacti and other succulent plants, herb gardens, plants from particular parts of the world, and so on. There may be greenhouse, shade houses, again with special collections such as tropical alpine plants or other exotic plants (Kirkwood, 2016).

Types of Greenhouse

A greenhouse is a structure with a glass or plastic roof and side walls that is used for the production of ornamentals and food crops and may be used seasonally or year round. The closed environment of a greenhouse has its own unique requirements, to be compared with outdoor production. Pest and diseases, and extremes of heat and humidity have to be controlled, and irrigation is necessary to provide water. Significant inputs of heat and light may be required, particularly with winter

production of warm-w earthier crops. Greenhouse for commercial production could be classified as free-standing or getter connected. A standing greenhouse can have a Quonset (hoot), gothic roof shades. The Quonset is usually the least expensive and is available in widths up to 36. Gothic designs have higher light transmission and shed snow easier. Gable designs may use trusses to span a width up to 60. A gather-connection greenhouse is a series of tresses connected together at the gather level. Individuals bays vary in width from 12 to 25 and have a clearance of 8' to 16' to the gathers. Bays can be put together to get any width, standard lengths; greenhouse desired (Blaustein 1979).

Greenhouse can be made any lengths, standard lengths that utilize glazing materials to advantage are 96 and 144. All greenhouses are molecular with frame spacing of 4' or 5' for hothouses and 10 or 12 for gather-connection designer.Most greenhouses are built of galvanized steel tubing and are available from many manufacturers through the U.S steel makes a strong frame to carry snow and wind loads and still allows about 80% of the light to eater. Most greenhouses are covered with a plastic glazing low-cost polyethylene film or covering applied as an air inflated double cover will last 4 years. Antirdrip agents and infra-red inhibition are added to give better service and reduced heat loss. Semi-riyid structured sheets of polycarbonates or acrylic are more permanent and have a life of at least 15 years.

Tempered glass is used for crops which required high light levels.The following is a short review of the advantages of the different styles of structures; free-standing greenhouse (Aldrick, and Bartok, 1994).

- Easier to provide separate environments as each house is controlled by its own heating/cooling system. One house can be run warm for propagation and the next one, cooler for growing.
- Individual houses could be shut down for periods when not in use saving energy.
- Best suited for heaving snow areas as multi-span house needs heat to melt snow from the gathers.
- Good for non-level sites.
- Individual houses are easier to build and maintain gather connected greenhouses.
- More cost effect for areas greater than 20,000 sf ff.
- Reduced heating costs as surface area to floor are ratio is less. Heating cost could be as much as 25% less due to reduced glazed area.
- Less land is needed about 30% more growing space could be placed on the same amount of land area.
- Heat could be centralized.
- Open-roof design that eliminates jams and reduces electricity use is available in production system in addition to the greenhouse style, there are varieties of productions.

System used inside the greenhouse: Some crops are grown in the container, on beaneles, such as many spring ornamental crops, white others are grown in the soil in the ground such as cuf flowers or vegetable crops (i.e. tomatoes, lettuce).Some crops are grown in containers or bays of growing media that are placed on the ground (tomatoes).Some greenhouses have different contributions to best management practices that will vary according to the greenhouse and system used for production.

Classification of greenhouse: Greenhouse structures of various types are used for crop production. Although there are advantages in each type for a particular application. In general, there is no single type greenhouse which can be constituted as the best. Different types of greenhouse are designed to meet the specific needs. The different types of greenhouse based on shapes, utility, materials and construction are briefly given below.

Justification

This research work ought to identify the problems associated with the need on how to construct and fabricate a greenhouse in botanical garden and also to provide guidelines on the construction of a proper greenhouse in (SLT) botanical garden in Federal Polytechnic, Kaura Namoda.

Material and Methods

Classification of Greenhouse Based on Suitability and Cost

Under this, there are different categories of greenhouse designed, and fabrication which are subject to the varied cost implicationsdepending on the modelling of each one. These categories include:

- Low cost/low tech greenhouse.
- Medium-tech greenhouse
- Hi-tech greenhouse

Other Classification

Other greenhouse can also be classified based on the type of structure, type of glazing number of spams, environmental controls employed during their individual construction. The various types are as follows:

- Quonset type, glass glazing plan sheet corrugated sheet.
- Curved roof type film, silpanlin, poly-house passive ventilated etc.
- Gable roof type, natural ventilated passive ventilated, etc.

Orientation of Greenhouse (Polyhouse) Design

The design of the greenhouse would be based upon sound scientific principles which facilitate controlled environment for the plant growth. The main components of greenhouse like structure, covering/glazing and temperature control systems need proper design for healthy growth of plants.

The orientation of the greenhouse is a compromise for wind direction, latitude of location and type of temperature control. Single greenhouse with latitude above 40^0N will have ridge mining east to west to allow low angle light to enter side rather than ends. Below 40^0N, the ridge of single greenhouse would be oriented from north to south, since the angle of sun is much higher. This orientation permits the movement of shadow of the gutter across the greenhouse. The location and orientation of the greenhouse should avoid falling of shadow on the adjacent greenhouse.

Choosing a Location

Southern side of the science laboratory technology department was chosen as it faces the area with consistent sunlight.

Choosing the Greenhouse Style/Frame

Under Nigeria conditions, Quonset type multispam greenhouse i.e. domed ceiling that is made up of steel supports or PVC tubings was choosen due to its low-cost and ease of fabrication ultraviolet resistant low density.

Polyethylene (UVLDPE) single film cladding of 200micro thickness would be sufficient for the Naturally Ventilated (NV) greenhouse. This would be fully tightened by stretching on the structure to avoid fluter and tearing. It would not be nailed or screwed to the structure as it gives the chance for tearing. The T-look of L-tock would be sued for fastening the sheet as structure, as this does not tear the sheet and sheet replacement is easy.

Design

The structure will carry the following loads which is to be designed accordingly:

a. Dead load: - Weight of all permanent construction cladding heating and cooling equipment, water pipes and all fixed service equipments to the frame.
b. Live load:- Weight superimposed by use (including hanging baslkets, shelves and persons working on roof). The greenhouse would be designed for a maximum of 15kg per square meter live load. Each member of roof should be capable of supporting 45kg of concentrated load when applied at 13 centre.
c. Wind load: - The structure would be able to withstand winds of 110 kilometer per hour and at least 50ky per square meter of wind pressure.
d. Snow load: - The greenhouse would be able to take dead load plus live load or dead load plus wind half the live load. The greenhouse would be fabricated out of galvanized iron pipes. The foundation would be 60cm x 60cm x60cm or 30cm diameter and one meter depth in PCC of 1:4:8 ratio. The vertical poles would also be covered to the height of 60cm by PCC with a thickness of 5cm. This will avoid the rusting of the poles.

Choosing the Doors and Hardwires

Greenhouse under construction will have both entry and exit ways that are both functional and fit with the specific look in which we intend to achieve. The quality doors should be guaranteed to last for very long time and should be well-insulated so heat cannot escape the greenhouse. These doors would be exactly what we need to easily access to the greenhouse at all times.

The greenhouse plans will include the proper nuts. Both and brackets so that the structure would be as strong as possible under ever the harshest weather conditions.

Choosing the Coverings

Choosing the proper covering is a key step in creating an effective growing environment in the greenhouse structure. These coverings are made of different materials and thickness. Best fit options would be used in selecting the exact covering that fits the greenhouse under fabrication and will not tear under harsh weather conditions such as snows or heavy wind. The covering i.e. fiberglass, double walled plastic or glass would be sealed to the frame as closely as possible.This will enhance sample bolting of the film to the wood.

Cooling and Ventilation

It is imperative that a way is harness to cool the greenhouse structure to keep plants from overheating. These include options for mechanical ventilation, natural ventilation and shading. Sizing fans and shutters would be adequately used. Fans would be placed in the canners of the greenhouse. Fans would be set up so that they are diagonal and create a airflow. They will run almost constantly during the winter months, to ensure the entire greenhouse is benefiting from the heater. Vends would also be installed in the ceiling of the greenhouse and also be installed as solar heat.Many only account for 25 percent of the heat in the greenhouse, so a backup heater is essential.

Thermometer or thermostats would be installed severally increase break, and would be placed at different levels of the greenhouse so that the temperature of the greenhouse would be observed at all times.

Additional Greenhouse Planning

This includes studying planting conditions for the plants we want to grow/activate. The less likely we would be able to grow other plants in the same sections. A cool house is a greenhouse designed to keep plants in tropical temperatures. We would need to choose what the temperature would be and keep it steady.

Ensuring Adequate Steady Water Supply

Ideally, this would be supplied by house water and easing directly from the over-heat water storage tanks.

Construction of Raised Beds

Slatted tables would be used in the meantime, since they will not allow water to drain through the table and into the gravel. If possible, beds would be constructed to the primary gardeners' height so as to limit ergonomic problems.

Result and Discussion

Compounds Typical Greenhouse

As seen from the above explanation, different compounds were assembled, couple which later let to a complete fabrication or, modeling and construction of a domed ceiling (Quonset type) multi-span greenhouse as explained in the definitive terms below as follows:

a. Roof transparent cover of a greenhouse.
b. Gable transparent will of a greenhouse.
c. Cladding material-cladding mounted or walls and roof of a greenhouse.
d. Rigid cladding material cladding material with such a degree of rigidity that any deformation of the structure may result in damage to it.
e. Flexibility cladding material cladding materials with such a degree.
f. Flexibility that any deformation of the structure may result in damage to it.
g. Guffter-collect and drains water and show which is place at an elevated level between two spans.
h. Column vertical structure member carrying the greenhouse structure.
i. Purlin a member who connect cladding supporting bars to the columns.
j. Ridge - Highest horizontal section on top of the roof
k. Girder- horizontal structure member connecting columns on gutter height.
l. Bracings- to support the structure against wind.
m. Arches- member supporting covering materials.
n. Foundation pipe- connection between the structure and ground.
o. Span width- center to center distance of the gutters in multispan house.
p. Greenhouse length dimension of the greenhouse in the direction of gable.
q. Greenhouse width dimension of the greenhouse in the direction of the gutter.

Table 1 Different Kinds of CoveringMaterials

Transmission	

S/N	Type	Durability	Light	Heat	Maintenance
1	Poly ethylene	One year	90%	70%	Very high
2	Poly ethylene UV resistant	Two years	90%	70%	High
3	Fiber glass	Seven years	90%	5%	Low
4	Tedlar coated fiber glass	Fifteen years	90%	5%	Low
5	Double strength glass	Fifty years	90%	5%	Low
6	Poly carbonate	Fifty years	90%	5%	Very low

When a UV stabilized polyethylene which is deep but contains BPA proves expensive, however, non-toxic LDPE (Low Density Polyethylene) proves to be an economical cladding material. Plastics are used in tropical and sub-tropical areas compared to glass/fibre glass owing to their economical feasibility. Plastics create enclosed ecosystems for plant growth.

On the other hand, hard, double walled plastics such as multiwall polycarbonate or corrugated polycarbonate or the more expensive but non BPA containing acrylic (plexiglas) which has higher light transparency.More so, fiberglass can be used when building a framed greenhouse. Fiberglass will turn yellow and lose transparency and stayclear up to 10years

Nevertheless, choosing glass is the most attractive material if you are building a greenhouse that will accelerate the botanical garden as it is very fragile and expensive acrylic to replace when it breaks but on the other side acrylic, fiberglass and polycarbonate needs replacement over time. Tempered glass is preferable because it is stronger than regular glass, consider using hardened glass for the roof. A 4mm thickness of float glass is suggested if you are in an area proved to hail. When installing a glass greenhouse, one should consider bids from construction companies to ensure the foundation and framed can handle the weight. Hence, greenhouse construction companies could be a source of very cheap glass, second hand glass can be cheaper than newly bought plastic variant.

Conclusion

The selection of all equipment that will make up the greenhouse in the botanical garden of the Science Laboratory Technology Department of Federal Polytechnic, Kaura Namoda, Zamfara State paved the way for the fabrication and building of the structure.

Since greenhouse fabrication is a daunting task, instructional manual has to be followed in achieved a befitting desired result.One has to obtain a building permit from the local authorities involved; understanding the construction and taxation of the structure and must build a framed greenhouse with a foundation as any misalignment because of setting can cause damage.

Recommendations

- It is recommended that the best and durable materials should be selected for the construction.
- It is necessary to understand certain factors when embarking on the construction of a greenhouse.
- The best position of the structure should be considered.
- To make the most of a greenhouse, it is advantageous to use additional heat.
- A print-out should be taken throughout the year as a record and also as a guide for future requirement.
- Clearing the greenhouse on regular basis would be an essential maintenance practice.
- By promoting good hygiene practice, the risk of over wintering pests disease would be reduced.

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