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Research Article

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Installation and Operational Procedure for 8m X 24m Quonset Single Span Greenhouse in North Central Nigeria

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Abstract There is an ever increasing population of farmers embracing greenhouse farming, but facing challenges in setting up and operating the facilities effectively. Presentation in this work is based on experiences gathered over a period of 5 years in a successful operation of greenhouses. Different types of greenhouses and classification were enumerated and details technological steps in setting up an 8m x 24m Quonset single span greenhouse presented.

Keywords Greenhouse, Quonset, Operation, Installation

Introduction

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 [Oxford English Dictionary2005]. The closed environment of a greenhouse has its own unique requirements, compared with outdoor production as it allows for greater control over the growing environment of plants. Depending upon the technical specification of a greenhouse, key factors which may be controlled include pests and diseases, temperature, levels of light and shade, irrigation, fertilizer application, and atmospheric humidity, and may be controlled by a computer to optimize conditions for plant growth. Greenhouses in hot, dry climates used specifically to provide shade are sometimes called shade house. [MGIBMPG.2010]. Greenhouses are increasingly important in the food supply of high-latitude countries with Almeria, Andalucía, Spain, having one of the largest complexes in the world, where greenhouses cover almost 200 km^2 [*www.publicacionescajamares*., 2016]. Salient merits which favour using greenhouses include the following: high productivity over a small area available for farming, opportunity to produce diverse course of diet; growing round the seasons; employment opportunity for the youth; education and research tool.

Classification of Greenhouses

The greenhouse can be classified based on cost/level of technology, type of structures, glazing materials, number of spans, environmental control etc. according to John W. B. Jr. [2016], the classification of greenhouses are as follows.

Classification Based on Cost/Tech.

Low Cost or Low Tech Greenhouse: Low cost greenhouse is a simple structure constructed with locally available materials such as bamboo, timber etc. The ultra violet (UV) film is used as cladding materials. Unlike conventional or hi-tech greenhouses, no specific control device for regulating environmental parameters inside

the greenhouse is provided. Simple techniques are, however, adopted for increasing or decreasing the temperature and humidity. Light intensity is reduced by incorporating shading materials like nets and the temperature reduced during summer by opening the side walls. Otherwise, inside temperature is increased when all sidewalls are covered with plastic film.

Medium Tech Greenhouse

This type of greenhouse is constructed using galvanized iron (G.I) pipes while the canopy cover is attached to the structure with the help of screws and the whole structure is firmly fixed with the ground to withstand the disturbance against wind. Exhaust fans with thermostat are provided to control the temperature, evaporative cooling pads and misting arrangements are also made to maintain a favourable humidity inside the greenhouse. As these systems are semi-automatic, hence, require a lot of attention and care, and it is very difficult and cumbersome to maintain uniform environment throughout the cropping period. These greenhouses are suitable for dry and composite climatic zones.

High Tech Greenhouse

A high-tech greenhouse is where the entire device controlling the environment parameters is supported to function automatically, to overcome some of the difficulties in medium-tech greenhouse.

Classification Based on Structure.

Quonset type, Curved roof type, and Gable roof type are some of the type available under structural classification.

Classification Based on Glazing.

The transparent material mounted on the roof of a greenhouse are of different type, they can be of glass glazing, fiberglass/reinforced plastic glazing (plain and corrugated sheet), or plastic film (UV stabilized low density poly ethylene and silapaulin)

Classification Based on Number of Spans.

Greenhouses can be single span/free standing or Multi span/ridge and furrow/gutter connected

Classification Based on Environmental Control.

Greenhouses that depend 100 percent on the environment are naturally ventilated greenhouse while those with ventilation device(s) are passive ventilation.

Greenhouse components

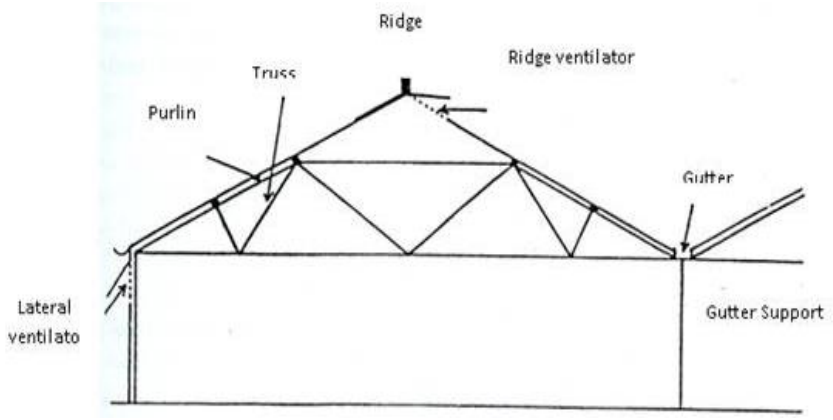

Figure 1: Components of Typical Greenhouse

A typical green house as shown in figure 1, consists of the following ; roof, transparent material mounted on the walls and roof of a greenhouse (cladding material), a components to collects and drains rain water and snow which is place at an elevated level between two spans(gutter), vertical structure member carrying the green house structure (column), a member that connects cladding supporting bars to the columns (purlin), highest horizontal section in top of the roof (ridge), horizontal structure member, connecting columns on gutter height

(girder), implement that support the structure against wind (bracings), member supporting covering materials (arches), and members connecting the structure and ground (foundation pipe),

Technological Procedure for Installation and Operation of NCAM Operated Quonset, Single Span Low Tech 8 M X 24 M Greenhouses

Plate1. A Quonset greenhouse under construction

The four main components are**;**

The netted Sides: This is an important part of integrated Pests Management strategy, it prevents insect pests from accessing the crop, acts as an air filter (prevent the flow of dust and environmental wastes into the greenhouse) and restriction of unwanted in-out movements;

The Plastic Cover: The plastic cover is a woven plastic (and not plain nylon paper). They are not easily ultraviolent (UV) degradable, not easily torn and can be repaired with needle & thread. It ensures uniform diffusion/spread of lights inside the greenhouse and excludes rain and airborne water from crop.

Steel Structure: Made from strong and portable steel material and peaked roof to allow maximum growing space and easy drainage; and

The Drip Irrigation Facilities: This includes a 1000litres capacity plastic tank on a stanchion of 1.5m high, connected to the greenhouse by heavy duty lines and high quality drippers with wide water passage. They are easily filled and drained; gravity fed and can discharge between 0.5-0.6lit/hr. In a Good Agricultural Practices (GAPs) recommendation by Burt, C. and Styles, S. W. (2007), micro irrigation was described as the most efficient system for crop production. This is because: drips brings water directly to the plants roots thus allowing Plant uses its energy to develop production and not searching for water; Soluble fertilizers (plant food) can be brought directly to the roots (fertigation); The system is suitable for all types of soils, climates and water; It is suitable for use in flat land or slight slopes; Eliminates foliar wetting; and Easy to manage accessories.

Installation Requirements

Preparatory steps for installing 1 unit of 8m × 24m greenhouse according to Dizengoff Farmer's Kit Operational Manual are as follows: clean, flat and level area of 35m × 12m; 4 bags of cement, 4 wheelbarrows of sharp sand, 14 wheelbarrow of granite, enough water for concrete preparation and curing; basic equipment such as: spade, mattock, cutler, or hoe(s); 2 ladders of 3m high; Materials for constructing tank stand; Water tank (1000lts. Capacity); Wood for soil sterilization; Manure of 2.5 – 3 tons for soil formulation and Plumber to erect tank stand and connects water supply. Other essential operational components such as Drip irrigation, Knapsack sprayer, and 1Litre hand sprayer, Hybrid Seed, Nursery set, Fertilizers, Agro-chemicals, and Personal Protective Equipment **(**PPE) must be in place and the installation should be undertaken by an expert.

Land Preparation

After the greenhouse has been properly installed, the next step is the land preparation. The farmer choices of cultivar determine the land preparation activities, for example tomato cultivation requires soil formulation, treatment and soil bagging, while planting on the bed is adequate for production of crops like cucumber, sweet melon and eggplant. Irrespective of the planting methods, a task that is unavoidable is the soil analyses**.** The procedure involves collection of soil samples at various points within the greenhouse, followed by the laboratory analysis of the samples for the pathological and nutritional contents. The results help to make decision on the best system of farming to adopt.

The type of planting methods (beds or bags) adopted determines the land preparation

Planting on Beds: The steps involves are double digging, incorporation of manure and bed shaping.

Double Digging: This entails digging the soil to a depth of 60cm. The process is repeated two times ensuring that the soil is well turned. This method of land preparation has many advantages: it ensures breaking of the hard pan which allows good root establishment and networking, facilitate proper drainage, and promote good water and nutrients uptake.

Manure application and incorporation: Three tons of dry/cured poultry manure is required which should be evenly spread and thoroughly mixed with the soil. This was to allows beneficial soil micro fauna to thrive on top by providing the important slow release nutrient to the plants and improve the soil structure by binding the soil particles together which encourage proper drainage.

Bed Shaping: The bed width should be about 90cm and the height 15cm. Soil between the rows should be lifted on top of the bed with a shovel to achieve a good bed shape. Bed forming has many advantages which include effective management of the crop, weed control and sustainable the soil structure.

Planting in Bags

Bags/Pot farming is compulsory especially for cultivation of tomatoes when the soil analysis shows the presence of bacteria wilt, or other soil borne diseases. This entails collection of the top soil mixing with the well decomposed manure, heating, cooling and potting/bagging. This method of media preparation kills most of the soil pathogens especially *Ralstonia solanacerium* that causes bacterial wilt. [Gruda, 2012]. Strict hygiene in handling was observed to avoid contamination. A pan of 10x100x200cm dimension was used in treating the soil media with heat. Steps involved are as follows

I. Collection of the top soil mixed with manure thoroughly at the ratio of 3:1(soil: manure).
II. Putting the mixture in a pan and heat up to average temperature of 120 ^{0}C
III. Constant turning of the mixture while on fire after every 5 minutes for 30 minutes
IV. Allowing the heated mixture to cool down before transferring it into bags.
V. Filled each bag to 75% capacity.
VI. Raised/prepare bed about 10cm high
VII. Placed plastic mulch to cover the ground to avoid possible contamination with the treated content in the bags
VIII. Arranged the bags below the drip lines on top of the plastic mulch making sure two drip emitters' drip in the same bag.

Nursery Practice

Nursery is important in greenhouse, since farmers can plan for timely availability of their products, ensure variety selections, and obtain high-quality seedlings. While nursery is indispensable for crops like tomatoes, and pepper, it may not be necessary for other crops like cucumber, sweet melon, and eggplant.

Nursery Procedure Involves

Adequate mixing of the nursery media (coconut peat) with water, followed by filling the tray grooves with the nursery media and pressed so that it occupies 75% of each tray groove, one seed should then be placed at the center of each groove of the tray and covered lightly by filling the remaining 25% of the groove with the nursery

media. The trays should then be placed on a raised surface to improve drainage thus reducing incidences of water logging. Irrigation is normally done using the knapsack, sprayed morning and evening with plain water for the next 5 days. From day 6, soluble NPK fertilizer (15:15:15) at the rate of 10gms per 16lits of water used to irrigate the nursery using a knapsack for 3 days and 1 days of plain water for the crop duration until the seedlings are due for transplanting. Hardening off is done within 1 to 2 days prior to transplanting. This is done by intentional reduction in irrigation interval and feeding regime so that the seedlings can acclimatize to the new environment and minimized transplanting shock.

Transplanting

Seedlings are ready for transplanting after 21 to 28 days for tomatoes and 30-45 days for pepper or when the seedlings are 7-10cms and pencil thick. Transplanting is best done in the evening and correct spacing observed when transplanting.

Table 1: Recommended spacing for selected crops in greenhouse (Dizengoff Farmer's Kit Operational Manual)

Crop	Spacing
Tomato	60cm ×60cm
Sweet Melon	60cm ×60cm
Cucumber	60cm ×60cm
Pepper	30cm ×60cm

Irrigation

Drip irrigation system

1000lts capacity tank on a tower 1.5m high supply the drip emitters by gravity. This system has an advantage of efficient water use as water drips on the plant only. Young plants are quite sensitive to water stress. Regular irrigation with small water quantities for the first one week after transplanting was practiced as recommended. Irrigation frequency and water quantity is determined by soil type, age of the crop, soil salinity and prevailing weather condition. Light soils require more water volume and higher frequency than heavy soils. As good maintenance practice; filters should always be clean first before any irrigation on daily basis and the system flush weekly to avoid clogging that cause non-uniformity in water application.

Water treatment

Water used for irrigation and spraying need to be treated with calcium hypochlorite at the rate of 10gms (i.e. 2 tea spoonful) per 1000lts of water, then left for 12 hours before use to prevent the crop from contaminating.

General Maintenance. This is categorized into three units:

Maintenance of the Structural Component: Fire, hot and sharp objects should be kept away to avoid damaging/tearing of the cladding materials. Avoid leaning, hitting, mishandling to prevent unnecessary wear and tear; regularly clean the plastic and keep door closed always for pest control.

Maintenance of Irrigation Facilities: It is essential to keep off sharp objects and fire from drip lines, control rodents, clean the filter regularly and flush the lines accordingly. The flushing procedure involves: Filling up the tank to gain maximum pressure, Open up the valves to allow water to flow; Open the extreme end of the main pipe till clean water starts coming out then fold back; Starting from the closest drip line to the tank, open its end to allow any trapped dirt come out then fold it back; this procedure is repeated for all the drip lines from the closest to the tank outwards; When through with the main pipe and drip lines, the tank and the filter are then clean; the system is ready to be used. It is recommended to perform this task weekly.

Maintenance of Knapsack Sprayer and other Pests/Diseases Control Equipments; A very important implement for effective fumigation and application of pesticides to control pests and diseases is Knapsack Sprayer**.** For effective usage of the sprayer: Always ensure correct nozzle choice and adjust it to get fine droplets, Keep nozzle up to one foot away from the target to get best fine droplet and control drift, Observe weather and spray in the cool of the day, Avoid spraying when windy as Drift may lead pesticide off target and

may compromise spray operator safety, and Avoid over spraying. Good maintenance practices include: Use of water screens provided when filling to prevent clogging; the knapsacks should be calibrated regularly and worn out parts replaced in order to maintain successful results after pesticides applications and clean the knapsack carefully using clean water after each working day, and kept appropriately. Personal Protective Equipment (PPE) like overall wear, gloves, gumboots, respirators, face shield and or goggles, should be wear following the manufacturer procedure and injuries avoided by adhering to instruction on the label.

Note. Know the target pest clearly in order to ensure proper coverage and achieve best results. This is important especially when it comes to contact pesticides. i.e. Under leave coverage (Mites), flowers (Thrips), stem and branches, soft tissues (Aphids) fruits (Ca) dark – wet place (slugs). The Systemic pesticides will be available in the plant system regardless of where they are applied.

Plate 2: clockwise; bed preparation, laying the plastic mulch, soil treatment/formulation, placement/arrangement of soil bags, raising the seedlings and arranging the drip emitter lines and transplanting

Field Activities

In a practical guide for management practices in greenhouse provided by MGIBMPG [2010], Training/Staking and trellising, De-sucking, Pollination, and Defoliation are good crop practices to realize high quantity and quality produce in greenhouses.

Training/Staking and trellising

Training/Staking is a management method which helps the plant to grow vertically. Plants were supported with a twine attached to the horizontal top and down running wires. Subsequently plants were directed manually as they grow upward. Trellising support the plants to grown vertically, carried out once the stems reaches the wire above. This provide good aeration under the laid stems, easy fertilizer application, weeding and prevent the fruit from touching the ground.

De-sucking

To prevent excessive foliage/overcrowding and encourage adequate aeration and discourage buildup of fungus and flower abortion, one or two stems should be maintained by removing any upcoming lateral shoot. Pruning tools need to be sterilized to avoid/prevent transmission of diseases.

Pollination

Pollination should be aided by tapping the trellis or training line with a stick. This is enough impact to let pollen dust into the stigma of the lower plants. Fruit setting solution at the rate of 2mls/lit of water applied twice per week to aid pollination for tomatoes.

Defoliation

All leaves below mature ripening fruits, old leaves need to be removed routinely and defoliated leaves packed out of the greenhouse since they hide insect pests, diseases pathogens, attract and or keep diseases like powdery mildew or become breeding grounds for crop enemies.

Harvesting, Sorting and Packing should be carried out as at when due.

Cleaning and Sanitation

High level of sanitation is essential in order to maintain a healthy environment inside the greenhouses by removing out the rotten fruits, weeds, dead plants and leaves. Provide foot bath and hand wash. Disinfection of the pruning tools done using Sodium Hypochlorite (Bleach) solution.

Record Keeping

Adequate documentation of all farm activities, resources expended, growth rate/yield, water usage, pest/diseases attack and preventive/control measures are essential for profitable and sustainable greenhouse cropping ventures. All these records should be taken as at due and the results always handy for periodic appraisal of the farm activities.

Conclusion

Greenhouse crop production started in NCAM with installation of four units of 8m x 24m greenhouses in 2017. The facilities under the management of land and water engineering department were used to produce vegetables such as tomatoes, pepper, and cucumber, cultivated all year round. The success recorded encouraged the centre to installed additional five units of the facilities. This presentation is intended as experience sharing for current and prospective greenhouse farmers.

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