"DESIGN AND MANUFACTURING OF MODEL GREEN HOUSE FOR PLANT PROTECTION- A-HIGH TUNNEL APPLICATIONS"

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Abstract

Design and fabrication is a process of incorporating 3D modeling or computing aided design (CAD).The meteorite makes protective nets for agriculture, which ensures pest control and growth control, and withstands harsh weather conditions. Photo- select netting for better protection of insects through bio-technical de-orientation, through high-density netting monofilament insect prevention..High tensile strength netting for protecting pests and birds; Colored shade nets for growth control and sunburns protection. High Tunnels are an increasingly popular trend for growers and a proven technology for crop production. The term "high tunnel" is a loosely defined phrase for growing vegetables in greenhouses. High value warm-season crops such as tomatoes, peppers, cucumbers, and ladies finger can be transfer into high tunnels as much as 6 weeks earlier than the outdoors, depending on location, without supplemental heating, and can extend the harvest season by up to a month in a fall. Crop quality and marketable yields are often significantly higher for crops grown in tunnels than for field grown crops, in large part because tunnel covering keep rain off crops

Key words— High tunnel design greenhouse applications, Agricultural high tunnel poly house

I. INTRODUCTION

Greenhouse effect is the natural process that warms the earth surface. When the sun's energy reaches the earth's atmosphere some of it is reflected back to the space and rest is absorbed and re-radiated by greenhouse gases. Reflecting the severity of global food insecurity, over 60% of the East African population is considered malnourished, with many regions in a state of famine[1-3]. There is broad agreement on the need to help small-scale farmers move from subsistence to sustainable and profitable farming by boosting their agricultural productivity, reducing post-harvest spoilage losses and providing market linkages. Inflation, resulting in high fuel and fertilizer prices, prevents farmers from producing larger harvests. Most countries in East Africa have an agrarian economy with over80% of the house holdsdepen ding on agriculture

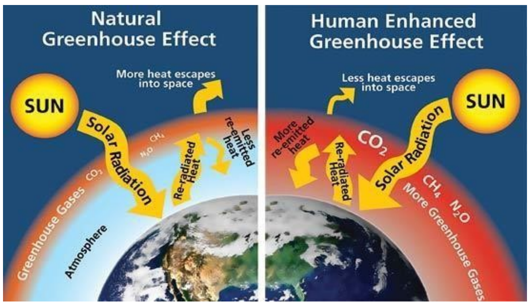

Fig.1 Greenhouse Effect

The climate is characterized by biannual dry seasons where many farmers suffer due to water shortages coupled with poor soil nutrition.

While short periods of rain benefit local farmers, heavy rainfall sometimes destroys cash crops. Greenhouses are permanent glass or plastic-covered structures that allow farmers to grow vegetables and fruits year-round throughmechanically- controlled temperature and irrigationsystems[7-9]. Greenhouses can help farmers in East Africa growand protect crops in both wet and dry seasons.

II. MATERIAL REQUIREMENT

a) With pipes: Type -UPVC No of pipes-4 Length-20 feet Diameter-0.3feet Linear joints-6 Junction joints-3 T joints-6 Pipe Glue

Fig.2 Poly Ethylene Greenhouse

b) Types of plants: Tomatoes Peppers Cucumbers Lettuce Broccoli Peas Carrots Ladies finger.

c) Covering Material:

Plastics mostly used are polyethylene film and multiwall sheets of polycarbonate material.

d) Non Bio degradable PLA material.

Fig.3 Non Bio degradable PLA material

e) Polyethylene:

LDPE Properties: Semi-rigid, translucent, very tough, weatherproof, good chemical resistance, low water absorption, easily processed by most methods, low cost. HDPE Properties: Flexible, translucent/waxy, weatherproof, good low temperature toughness (to-60'C), easy to process by most methods, low cost, good chemical resistance.

f) Polycarbonate:

Polycarbonates are strong, stiff, hard, tough, transparent engineering thermoplastics that can maintain rigidity up to 140°C and toughness down to -20°C or special grades even lower. The material is amorphous (thereby displaying excellent mechanical properties and high dimensional stability), is thermally resistant up to 135°C and rated as slow burning.

g) PLA material:

Density: 1.210–1.430 g.cm , Melting point: 150 to 160°C and Solubility in water: Insoluble in water PLA polymers range from amorphous glassy polymer to semi-crystalline and highly crystalline polymer.

Fig.4 general construction of green house

III. METHODOLOGY

Step 1: Designing of a high tunnel greenhouse prototype by using CATIA software.

Step 2: Selection of site in our college.

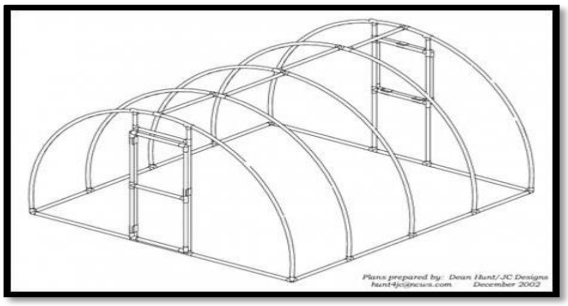

Fig .5 Design layout green house

Step 3: Construction of a high tunnel greenhouse proto type for agriculture purpose

Fertilizers:

Nitrogen (N) – is often thought of as the most important element in a nutritional program. However it is only one of several essential elements to plant growth. The most common sources of N used in liquid feed programs include: ammonium nitrate, calcium nitrate and potassium nitrate. Generally speaking no more than 50% of the total N supplied to the plant should be in the ammonium form. Phosphorus

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(P) – is another element required in relatively large quantities for plant growth.

Fig .6 Inner view of Greenhouse

However, over supplies of P may render other nutrients insoluble and therefore unavailable for plant uptake. Phosphorus is generally supplied in nutrient solutions by phosphoric acid or in some cases superphosphate may be incorporated in the growing medium to supply P. Potassium (K) or potash is used by the plant in a number of ways, but is primarily required in water relationships. Among the many greenhouse crops produced, poinsettias are notably heavy feeders of K. The most common source of K in liquid feed programs is potassium nitrate, however other sources may be used. These elements generally include: calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), boron (B), molybdenum (Mo), and chloride (Cl).

Fig 7: Common high tunnel terminology

High Tunnel Design

To Design a High Tunnel the following parameters need to be taken in consideration

• Structural Components: Before purchasing a high tunnel, it is critical to know what parts are used in the structure, how to decide on the size and shape of the unit, and what options will be needed for specific production methods. High tunnels can vary in size and shape, but all use similar parts, materials, and construction methods. A high tunnel is a series of hoops that are held in position with continuous lengths of supporting structural members (purlins and girts) and end walls with accessible doors. The exterior covering is typically a greenhouse-grade polyethylene plastic that can either remain on the structure year-round or be removed during the heat of summer. The hoop-style high tunnel in Figure 1 identifies key parts labeled with commonly used terminology.

•The Hoop: A series of hoops or bows make up the primary skeletal structure of high tunnels. These provide support for the outer covering and maintain structural integrity against environ- mental forces. The spacing of the hoops can vary, depending on the desired structural strength. Hoops are most commonly spaced at 4, 5, or 6 feet. Narrower hoop spacing provides more support for the polyethylene covering, requires the use of smaller diameter metals, and allows easier shedding of rain and snow. However, structure cost increases with more hoops, and there is a potential for increased structural shad- ing. If wider hoop spacing is used, larger outside diameter (OD) metals are needed for structural strength against wind, rain, and snow loads.

•End Walls: The size and type of end walls are designed to meet accessibility requirements for people and equipment. Most suppliers carry a variety of end wall framing packages, from simple pass-through doors to framing with larger openings that allow for the use of rototillers and tractors. It is import- ant to remember to include a small door for access if the high tunnel will be used during the coldest part of the year since large openings will greatly reduce the ability to keep the inside temperature warm. End walls can be custom framed using lumber or metal piping if the polyethylene can be securely fastened to prevent air leakage or being blown in by high winds. Polyethylene zip entry end walls are an available option from some high tunnel suppliers, but these are not recommended for High Plains growers due to

the risk of pre- mature failure of the closure system from strong winds.

• Purlins and Girts: Purlins run horizontally from end to end of the high tunnel, maintaining hoop spacing and increasing structural strength. Typical structures have three to five purlins, spaced at 4 to 8 feet apart. Girts are stronger than purlins and are generally manufactured of square tube or roll form metals. Girts provide greater structural support for polyethylene retaining systems (poly-locks), roll-up wall components, or other equipment. They are installed in positions similar to purlins to maintain hoop spacing. If the supplier provides only one ridge purlin for a particular type of high tunnel, additional purlins or wall girts must be added to prevent structural failure.

•Wind Bracing: Overall structural integrity depends on the number of angular wind braces positioned within the structure. At a minimum, these braces should be positioned between the end hoops and the baseboard at each corner. Additional angular bracing can be installed from the ridge and roof purlins and connected to the end wall framing to increase structural strength. This is especially important in high wind locations.

• High Tunnel Profiles: Overall structural integrity depends on the number of angular

wind braces positioned within the structure. At a minimum, these braces should be positioned between the end hoops and the baseboard at each corner. Additional angular bracing can be installed from the ridge and roof purlins and connected to the end wall framing to increase structural strength. This is especially important in high wind locations.

Hoop or Half-Round Style: This is the mostcommon high tunnel profile since it re- quires the smallest number of structural members and can be easily manufactured and built by individuals with little construction experience. The support hoops of the half-round profile have a smooth, gradual bend that limits the number of stress points on the plastic covering. The hoops bend from the ground on one side of the structure to the ground on the other side to form a continuous arch. This design may limit access or standing room along the sidewalls.

• Raised Hoop: The raised hoop design is a modified hoop structure with sidewalls created by extending the vertical ground posts to the desired height (typically 36 to 60 inches). The straight sidewalls allow for greater accessibility along the wall and provide more usable growing space; however, raised hoop structures are taller than typical hoop profiles. The raised hoop design is preferred when using roll-up sidewalls because it prevents rainwater from draining directly from the roof into the growing beds, which can negatively affect plant or flower quality.

•Peaked Hoop: These structures are constructed byadding a bend at the apex, or top point, of the hoop or bow to create a distinct ridge. This ridge provides additional strength against cross-winds and creates a steeper roof pitch that sheds rain and snow morequickly. Peaked hoop structures typically have distinct roof and sidewall surfaces that are divided by a wall girt or eave board. This allows for the easy integration of roll- up or drop-down sidewalls for natural ventilation.

• High Tunnel Size: Suppliers of high tunnels offer structures in various widths, lengths, and heights, all designed for the efficient use of industry standard- sized polyethylene coverings and lengths of metal tubing.

• Overall Dimensions: Structures appropriate for growing home garden crops may be as small as 8 feet wide by 10 feet long. Commercial production tunnels can be 20 to 30 feet wide and any length. Growers often use high tunnels that are 48 feet, 96 feet, or 144 feet long so that standard 100-foot or 150-foot lengths of poly- ethylene can be used efficiently. If a longer structure is needed polyethylene splices are installed to connect multiple lengths of polyethylene. It is important to remember that the larger the polyethylene sheet, the greater the difficulty of installation, and the greater the weight of the covering on the structure.

Determining High Tunnel Width: High tunnel width is a grower's personal decision based on the desired interior layout and placement of growing beds, walkways, and support trellises, and the type of equipment that will be used inside the structure. The only physical limitation on the area being covered is the size of the available site. The most affordable option is to purchase "off the shelf " high tunnel packages as these often use standard-sized steel or aluminum and polyethylene sheets that result in the most floor space at the lowest per foot cost. A typical half-round high tunnel is usually half as tall as its width. For example, a tunnel 20 feet wide will be approximately 10 feet high at the center ridge. If the structure is nar- rower than 12 feet, ground post extensions may be required to allow for more accessible headroom and more usable space next to the sidewalls. Peaked hoop designs have the widest amount of usable floor space, but overall height decreases as thestructure is widened, whichmay result in low headroom space near the sidewalls. Wider tunnels have a flatter roof pitch that may negatively affect the shedding of rain and snow, potentially leading to structural collapse.

• Exterior Coverings: The roof and sidewalls of high tunnels are typically covered with polyethylene (poly) plastic. Greenhouse-grade, 6- mil ultraviolet light (UV) protected poly should be used. Do not use construction grade poly found at construction supplyor hardware stores. The UV polymer resins in greenhouse- grade plastics increase the longevity of the covering to more than four years when securely fastened to the structure.

Poly coverings containing additional infrared or anti-condensateresins are available at a higher cost. These plastics can improve crop productivity by enhancing daytime light quality, preventing heat loss at night, and reducing the incidence ofdiseases spread by condensate drip. End walls are tall, flat surfaces that are exposed to high winds, heavy rains, and hail. They tend to receive excessive wear due to movement through the door openings. End wallscan be covered with poly sheeting, but it is preferable to use a more durable rigid product, such as corrugated or twin-walled polycarbonate sheeting.

• Polyethylene Retention: Historically, poly plastics were held in place by fastening wood lath or batten tape over the perimeter edges of the plastic sheet to the baseboard. Although inexpensive and functional, these methods did not hold as securely as a poly-ethylene lock system (poly-lock) and were time-consuming to install. Polyethylene locking systems consist of two pieces, a receiver base and a locking member. The most affordable system uses an aluminum "C" profile receiving base that has a bent wire (known as spring lock or wiggle wire) locking member inserted into it over the poly sheet (Figure 4). This provides a strong, reusable, long- lasting retainer for plastic coverings and can also be used to hold shading fabrics or insect netting. There are other types of poly-locking systems available from suppliers that function in a similar way.

• Tunnels with Opening Side Walls: If only the end wall doors can be opened, air movement will be limited and excessive heat can build up in the high tunnel. Installing roll-up or drop-down sidewalls allows poly to be incrementally opened as much as 4 to 6 feet on each side of the structure. This ability to create more venting capability lowers the temperature inthe high tunnel during periods of high sunlight or excessive heat.• Construction

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Materials: High tunnel manufacturers offer structures of compa- rable size in a wide price range, requiring buyers to carefullyevaluate the design and which components are included in the package. Structure durability is greatly affected by the quality and grade of the materials used. Most structures are built using steel tubing that is available in varying diameters and metal thicknesses. Greenhouse-grade tubing is typicallygalvanized and has an additional rust prevention coating.

Tubing is available in a variety of outside dimensions (OD), with tube sizes of 1.315 inches, 1.66 inches, 1.90 inches, 2.197 inches, and 2.375 inches OD being the most common. The smaller sizes (1.315 inches and

1.66 inches) are often used for purlins and bracing. Larger diameter tubing is used for bows, ground posts, and sidewalls.

High tunnels with additional features, such as sidewalls that open and rigid panel coverings, may include roll-formed metal components that make assembly more efficient. To make roll-formed metal, flat sheets of aluminum or galva- nized steel are cold- formed through a roll-form die to create custom structural profiles. These strong framing members are easily attached to tubular hoops using pipe clamps or self- tapping screws.

Less costly packages or do-it-yourself designs may require the use of locally available materials. Dimensional lumber is affordable and easy to use. Treated lumber is not recommended because it can accelerate degradation of the polyethylene, potentially affect plant growth, and prevent organic production certification. Other options include PVC (polyvinyl chloride), solid plastic products, and byproducts of blended plastic and wood. PVC products have limited use for high tunnels due to their limited strength and narrow temperature stability range. Solid plastic and composite prod- ucts are easy to use and resistant to weather deterioration, but have varied construction capabilities. Before using wood alternative products, evaluate their application according to manufacturers' recommended uses and guidelines.

IV. CONCLUSION

Affordable greenhouses can empower small-scale and Subsistence farmers to take control of their farming Environment. They can install drip irrigation systems to reduce water requirements by up to 50% compared with open-field conditions. They can create a cool microclimate within the structure during the hottest hours of the day and keep crops safe from winds during the night. Insects and small animals as well. Essentially, the greatest benefit of greenhouses to poor farmers is that they can increase their crop productivity in a cost-effective manner. The success or failure of the greenhouses hinges on their functional life and commercial potential. The unique features of expandability of the greenhouse, the use of the PPR pipe framework and the bolted bamboo connectors are proving to be successful so far. Further research over a 3-5 year time frame will validate the effectiveness of each feature. Longitudinal studies in the coming years. However, the initial results are encouraging. Our team has raised about $50,000 in grants to refine the technology further and disseminate it in East Africa through a network of distributed micro-enterprises over the next two years. Planning is underway with a Kenyan entrepreneur to set up a mass-manufacturing facility for the greenhouse kits.

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