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Cost effective polyhouse development for Telangana semi-arid tropics

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Abstract
Cost effective polyhouses play an important role in Indian Agriculture in the forthcoming years. The cost effective polyhouse ensures the year round growing of different cultivar varieties with good vigour. Generally, a farmer had to invest Rs. 900-1000 for one m^2 area using tubular framed polyhouse structure. To reduce the installation cost of polyhouse, a cost effective/low cost polyhouse was constructed to bring rural small and marginal farmers under polyhouse cultivation. Locally available casuarina wood was used as structural material and bamboos are used as frame work. Wooden strips using nails marks the poly grip assembly. UV stabilized polythene sheet was used as cladding material.
The present study entitled 'Cost Effective Polyhouse Development for Telangana Semi-Arid Tropics' measuring an area of 50 m^2 costs around Rs. 23,811.16/-. The cost for m^2 area is around Rs. 476.22/-. Present study is justified with cost reduction by 52.4 %.

Keywords: Cost effective polyhouse, locally available material, cladding material

1. Introduction
Temperatures and global radiation permit open air crop production throughout the year. But the problems for open air production are: Damage of plants by heavy rainfall, plant diseases by rain and high humidity, erosion and decomposition of humus by floods and surface run off, increasing use of pesticides, pesticide residues in the plants, high transpiration by global radiation and working conditions for people. Climatic conditions in the open field hamper a controlled cultivation for production deadlines.
A polyhouse can be defined as a "framed or an inflated structure, covered with a transparent or translucent material in which crops could be grown under the condition of at least partially controlled environment and large enough to permit persons to work within it to carry out cultural operations". The polyhouse is now better understood as a system of controlled environment agriculture (CEA), with a precise control of air, temperature, humidity, light, carbon dioxide, water and plant nutrition (Tiwari, G. N., 2003).
The afresh set Telangana state with periphery of thirty three districts is having net cultivated area of 4.0 M ha, of which 60% is rain-fed. The state principally falls under semi-arid tropical climate. The soils are of predominantly red soils which are most suitable for the production of horticultural crops. With diversified three agro-climatic zones, horticultural production and productivity accounts to be 10.86 lakh ha and 121.57 lakh MT, respectively. The average annual rainfall is 850 mm, receiving major share from South-West monsoon. In spite of conducive and favorable climate in Telangana State, protected cultivation is yet to gear up for the want of technology know how, capacity building and transfer of technology. With prevailing semi-arid tropical climate, there is a potential scope for greenhouse cultivation, especially for remunerative and export oriented crops. Government of Telangana is investing crores of rupees on the poly house construction and its maintenance. To establish a poly house, the farmer has to invest 900-1000/- Rs. for one m^2 area using tubular framed structure. The farmers who could not avail the subsidy, it is a back drop and burden for them to establish such green houses. So, to overcome this a low cost (wooden framed) construction of greenhouse has come into picture 500-600/- Rs. for m^2 area using wooden framed structure. They mostly use local materials like bamboos which are available on the forest.
Greenhouses made of costly materials as mentioned above are however expensive and beyond the means of the average Indian farmer. To overcome these problems and to suit to farmer's economy in construction of these greenhouses in their field, a low cost wooden structure is

necessary. These structures are suitable for any covering materials like film plastic sheets, shaded nets, UV stabilized LDPE film sheets.

The low cost polyhouse is economical for small and marginal farmers, who cannot afford huge cost as of high-tech poly house. The temperature inside the poly house is 6-10 °C higher than outsides during winter. The cold waves during winter season (December to February) do not enter inside the poly house and inside environment becomes conducive for quick germination of seed and growth of seedlings. Many times farmers produce good amount of cucumber, capsicum and tomatoes during main season, which eventually leads to the market glut and fall in price. On the other hand, due to weather extremes during winter, it is difficult to grow high value vegetables like tomato, capsicum, cucumber, gherkin etc. in open condition. Therefore, low-cost poly house technology promotes Indian farmer by off-season production of vegetable nurseries as well as for raising crops of high value vegetables (Yadav, R. K., 2014) [5].

As Telangana climate comes under Semi-arid tropics natural ventilated Saw-tooth type polyhouse suits the best. Thus the saw tooth type polyhouse were employed in the entire Telangana region.

2. Methodology

2.1. Materials required

The material required for the construction of low cost wooden framed greenhouse are: wooden posts, bamboos, coal tar, covering material, insect proof net, GI pipe, wooden strips and other miscellaneous items like nuts, bolts and nails.

The wooden posts of instance casuarina wood, were used. The average diameter considered for the posts as 6.2 cm. These wooden posts are used for main structure like side posts and central posts. The height of the side posts and central posts would be 3 m and 4.2 m long respectively. A proper selection of these posts will help in maintaining the symmetry of the structure. Usually a light weight, small diameter bamboos were used. The average diameter of the bamboos taken were 6.2 cm. The length of bamboos used were usually 5.5 m. Wood, which comes in contact with the soil is easily susceptible to decay. So, special treatment was given to the wood. Applying of coal tar to the wood which gives the protection against the decay and against termites. Even natural decay resistance woods, such as redwood and cypress should be treated. From the large varieties of plastic available today in the market, the commonly used covering material were polyethylene. Some of the plants were very sensitive to the insects and rodents. Those insects will cause changes in the quality and quantity of the crop yield. Size of the insect proof net will be 15 square meters for 50 square meters of floor area which is equivalent to ventilation area.

2.2. Design views

2.2.1. Overall dimensions of cost effective/low cost poly house

1. Length of greenhouse = 10 m
2. Width of greenhouse = 5 m
3. Distance between Side poles = 2.5 m
4. Distance between centre poles = 2.5 m
5. Depth of foundation = 0.6 m
6. Height up to gutter = 2.0 m
7. Height up to top = 3.5 m
8. Top ventilation = 0.5 m
9. Side ventilation = 0.5 m
10. The length of line joining between left side pole to central pole = 2.7 m
11. The length of line joining between right side pole to central pole = 2.91 m
12. Angle between line joining towards central pole to left side pole = 22^0
13. Angle between line joining towards central pole to right side pole = 31^0

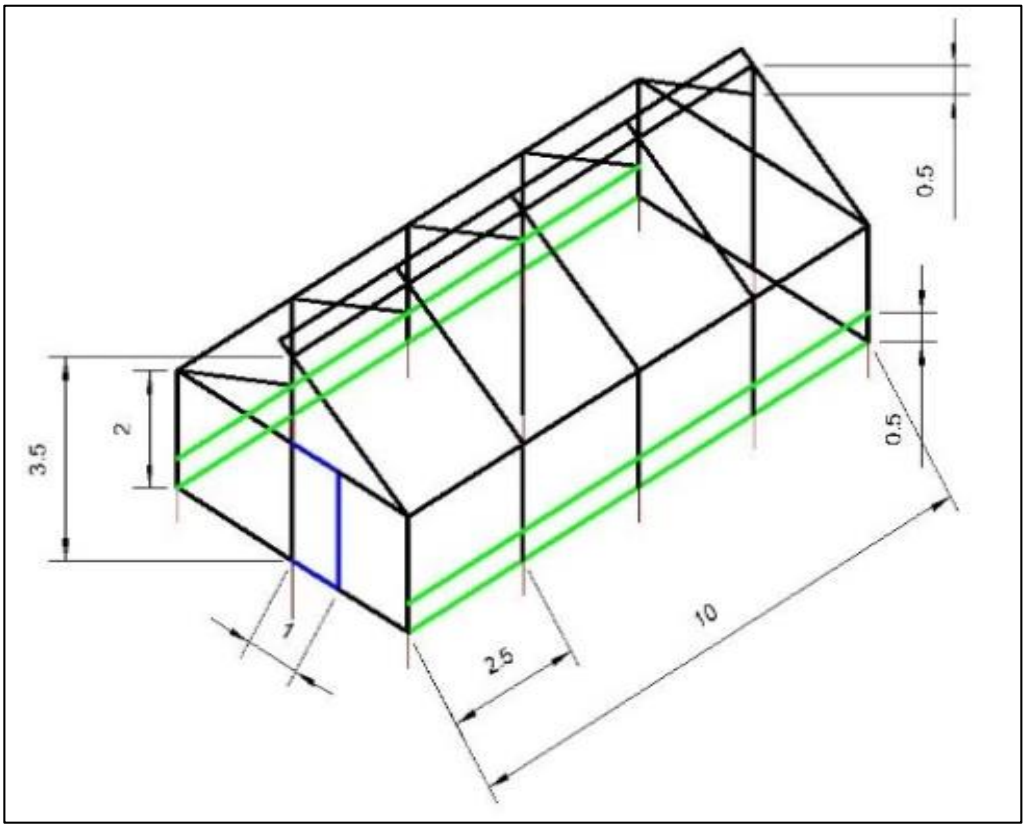

Fig 1: Isometric view of designed polyhouse (All dimensions are in meters)

Fig 2: Isometric view of developed polyhouse

2.2. Construction procedure

2.2.1. Site selection and orientation

The study was conducted in the premises of College of Agricultural Engineering, Kandi, besides IIT Hyderabad, Sangareddy, covering an area of 10 m x 5 m. The climate comes under Semi-arid tropics. The average rainfall ranges from 850 mm to 950 mm. The major contribution of rainfall is from South-West monsoon. Out of which 80% is received during the months of June to October. The construction and experimentation was carried during January to May, 2016.

Site selection and orientation of the greenhouse plays a very important role in its efficiency. An ideal site should have proper drainage so that the surface water is drained away from the greenhouse. The east-west orientation of the length of the greenhouse maintains better light level in winter as compared to the north-south oriented one.

2.2.2. Land levelling

Land levelling was an essential operation of farming. Levelled fields receive uniform penetration of irrigation water with high efficiency. The possibility of water logging and soil erosion will be reduced considerably. Land levelling was done by adopting cut and fill method. A height of 10 cm of black soil is provided on the ground surface to ensure proper levelling.

2.2.3. Marking and digging the holes

Firstly, the floor area (length × width) to be covered by the polyhouse was determined. Based on the dimensions, the four corners on the ground were marked. Wooden pegs were inserted at the corner points and tied with a rope all around to mark the rectangular area of the polyhouse. Ridge line (central line) was also marked at the same time. Depending upon the bay distance, other points were also marked on the ground for digging the holes. Following the markings, holes were dug of about 600 mm depth and 200 mm along the length by using Post hole digger.

2.2.4. Treating and placing of posts in holes

Large diameter poles were made ready in their respective lengths and were treated to prevent from termite and moisture attack which was done by coating them with coal tar and wrapped the poles with 1000 gauge black LDPE film with the help of polypropylene ropes. Creosote a dark oily wood preservative distilled from coal tar, can also be used for protecting the stems from termite attack. The centre posts were made to stand firm and straight in the length-wise direction and the holes were filled and the foundation was compacted using cement concrete groute (with the proportion of 1:3). One bay structure was completed first and the subsequent bays were constructed one after the other. Side posts were kept in position as per the marks identified earlier. Process was repeated, which was done earlier for this side posts also. The foundation was allowed to cure for 7 days to increase the stability.

2.4.5 Frame work

Frame work was very essential and was done by using low weight smaller diameter bamboos. It was difficult to attach or fix the bamboos to the wooden posts. There were so many techniques for fixing the bamboos on the wooden posts. One of the technique was by using welded GI pipe with nut and bolt mechanism. This mechanism was chosen because, GI pipe has more strength and ability to overcome the external loads. Using nut and bolts, the bamboos and wooden posts were firmly fixed with the help of welded GI pipe.

2.4.6 Covering the frame work

Polyethylene film was wrapped; rolled on the wooden posts and bamboos tightly by wooden strips placed over and with gentle hammering to fix the cladding material on the bamboo framework.

3. Results and Discussion

The main purpose of cost effective/low cost polyhouse is to grow different cultivars in controlled environmental conditions. This eventually helps in performing the cultivation practices in time for getting the potential yield. In order to achieve this objective, a wooden framed saw tooth type polyhouse was constructed to raise different cultivars. The investigation was taken up in this phase where in the Design, Development, Construction and Cost Analysis were performed. While in second phase raising of different cultivars under the modified environmental conditions inside the polyhouse were attempted.

3.1. Design, development and cost analysis

The major consideration in the design and development of low cost polyhouse has been given to the shape and structural material of the polyhouse. Bamboo has been chosen and structural material instead of steel or aluminum, mainly because it is gown locally by the farmers and the construction of the structure was easy as the job could accomplished by local artisans at a low cost.

The foundation bamboos were inserted into the soil up to 60 cm depth and well grouted with cement concrete in the ratio of 1:3. The foundation bamboos were treated with Aldrin and painted with coal-tar in order to prevent the attack of termites. For polythene grip assembly, wooden strips accompanied by nails are used to tighten the polythene sheet firmly. 200 micron UV stabilized film measuring 8m length and 6m in width was used for cladding material.

Cost analysis of low cost polyhouse (10 m × 5 m × 3.5 m)

S. No.	Item	Specification	Quantity	Approx. Rates (Rs).	Approx. Cost (Rs.)
1	Casurina wood	7.5 cm Ø, 4.2 m long 7.5 cm Ø, 3.0 m long	03 No's 10 No's	@ 180/ piece @ 160/ piece	2,140
2	Bamboo	6.2 cm Ø, 5.5 m long	24 No's	@ 110/ piece	2,640
3	M.S. Pipe	6.3 cm Ø, 6 m long	2 No's	@ 600/ piece	1200
4	Polyethylene sheet + Insect proof net	200 µ, UV Stabilised	140m^2 +25 m^2	@ 55/ piece	8525
5	Miscellaneous				1000
6	10 man-days @ 300				3000
7	Drip irrigation system				5306.16
Grand – Total					23811.16

4. Conclusion

Hot and dry conditions are very common in the Telangana region of our country as a result the relative humidity in the atmosphere would be more, in order to overcome this problem, a natural ventilating system which is basically saw tooth type structure is considered.

Generally, the polyhouse construction costs Rs. 900-1000/- which is a bane to the rural, small and marginal farmers who are occupying around 60% of the total farmer population in India. Considering economic condition of farmers, requirement and adaptability, experimentation entitled 'Low Cost Poly house: "Cost Effective Poly house Development for Telangana Semi-Arid Tropics"' was conducted. It includes Design, Development and Fabrication of the poly house. The polyhouse measuring 10m×5m×3.5m was developed using 'casuarina wood' as foundation material and 'bamboo' as a structural material. Foundation material was made out of casuarina wood and treated with Aldrin in order to prevent the attack of termites. UV stabilised plastic sheet was used for covering the structure. Wooden strips with nails were used as poly-grip mechanism. Care has to be taken to prevent the puncturing of the plastic film. This polyhouse having an area of 50 m^2 costs around Rs 23811.16/-. The cost for m^2 area is around Rs.476.22/- which reduces the cost by 52.4%.

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