

Greenhouse Design for High Rainfall, High Humidity, Moderate to High Temperature Coastal Regions



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Dr. Mathala Juliet Gupta finished her B.E.(Agriculture) from College of Agricultural Engineering, TNAU, Coimbatore and her masters and doctorate from Indian Agricultural Research Institute, New Delhi. She worked as scientist at Division of Agricultural Engineering, IARI and was transferred to ICAR-CCARI formerly known as ICAR Research Complex for Goa, Goa and is serving there since 2011. She was deputed as a visiting Scholar to Department of Agricultural and Biological Engineering, State College, Penn State University, PA, USA. Dr. Gupta is one of the leading research scientists in the field of Protected Structures: design and management and has been involved in the development of various structures viz. Greenhouse-type solar dryers, Energy-efficient Greenhouse for Cold Climatic Conditions of India, Naturally ventilated greenhouse for northern plains and currently finalizing the design of greenhouse for high rainfall, high humidity coastal regions of India.

Greenhouse technology has proven its capability to produce more per unit area, with a disease and pest free environment if suitable microclimate can be maintained. It can also assure production under inclement weather conditions. Due to its high capital investment, it is used for high value crops production. The technology was introduced in India three decades ago but in spite of concentrated efforts of the central and state governments the technology has not been successfully adopted in vast area as was expected. The area under protected cultivation in India is just 25000 Ha while China which started nearly a decade after India

has more than 2.5 Mha under protected cultivation.

The state of Goa is dependent on its neighboring states for supply of vegetables and hence the state directorate of agriculture is interested in popularizing polyhouses among farmers for production of vegetables under the National Horticultural Mission. But the structures being adopted are the designs of Pune and Bangalore, and hence the farmers are facing a lot of problems for cultivation. Under, *Rashtriya Krishi Vigyan Yojana* ICAR –CCARI was given a project for design of suitable greenhouse for the high humidity, high rainfall conditions of Goa.

LIMITATIONS /PROBLEMS ASSOCIATED WITH EXISTING GREENHOUSES DESIGN IN GOA:

A study of the existing greenhouse design being used by most of the farmers in Goa for crop production showed that the existing designs had the following problems:

- 1) Aerodynamic design of greenhouse results in rainwater flowing into the structure causing increase of relative humidity and indirectly increasing fungal diseases, stem canker etc. If the side rollable curtains are left unopened to prevent rainwater from entering, it results in humidity build up and related disease and pest problems.



Figure 1. Vertical sides show less algae growth as compared to aerodynamic shape and thus less loss in light transmissivity

- 2) The semi-circular shape of roof and aerodynamic shape results in higher reduction of transmissivity as compared to Gable and Gothic arch roof and vertical side walls due to algae growth (Figure 1).
- 3) Naturally ventilated designs have very less air exchange rates (0 - 0.05 air exchanges per min as against therecommended 1-3 air exchanges per minute), farmers resort to keeping shade net side walls or even open side walls, which result in high incidence of thrips, mites, white flies, mealy bugs, *spodoptera* etc.
- 4) Research was carried out at ICAR-CCARI with the objective of designing a suitable greenhouse for Western coastal high rainfall, high humidity conditions and also suggesting possible interventions to make the existing greenhouses acceptable for vegetable cultivation.

INTERVENTIONS TO MODIFY EXISTING DESIGNS OF GREENHOUSES FOR GOAN CLIMATIC CONDITIONS:

- 1) Inner side walls to prevent inflow of rainfall into crop area in both sides of polyhouse





- 2) Gutters on both sides along length
- 3) Mixer fans to maintain uniformity in microclimate
- 4) Fixing ventilating fans across the shortest width of the greenhouse



with insect proof vents on all other vents (total ventilation rate 1-3 air changes per min)



Design of Greenhouse Suitable for High Rainfall, High Humidity, Moderate to High Temperature Conditions:

Based on studies at ICAR-CCARI Goa, the design of greenhouse suitable for high rainfall, high humidity, moderate to high temperature conditions are

- 1) Gable or Gothic arch roof with top vents with bevel and screw arrangement to open and close them

- 2) vertical sides with outward curvature and gutters to shade from incoming rainfall and convey the runoff from covers to collection drains
- 3) Provision of mixer fans for maintaining uniform microclimate across the length
- 4) Provision of exhaust fans with insect proof net on all openings for maintaining optimum air flow rates within the greenhouse

The Figure given below is the proposed greenhouse design

