

# **GREENHOUSE**

*Technology and Applications*



*Vilas M. Salokhe*

*Ajay K. Sharma*

2<sup>nd</sup> Print

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## Technology and Application

**Vilas M. Salokhe**

*Agricultural Systems and  
Engineering*

School of Environment,  
Resources and Development  
Asian Institute of Technology  
Pathumthani, 12120  
THAILAND

**Ajay K. Sharma**

*Department of Farm machinery  
and Power Engineering*  
College of Technology and  
Engineering

Maharana Pratap University of  
Agriculture and Technology  
Udaipur-313001 (Raj.) INDIA



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## PREFACE

The world scenario has been changing from plentiful to limited resource applications; extensive to intensive farming practices; and indiscriminate use of chemicals to judicious applications. Increasing demands for non-seasonal fruits/vegetables and other agricultural products need a controlled environment where it is possible to grow them irrespective of the ambient seasonal conditions. The greenhouse technology satisfactorily answers the most of above-mentioned circumstances. Instead of being merely a sustainable practice, greenhouse technology empowers agriculture as a profession giving more marginal returns to the input. A widely accepted reason for growing plants, in greenhouses rather than outside is its ability to control the environment. A greenhouse protects crops inside from extreme temperatures, high winds, heavy rains, destructive storms, and insects and diseases. The greenhouse cultivation as the current trend, extends the growing and crop production season, which maximizes the equipment utilization, expands the export season span, increases the annual yield per unit area with efficient use of inputs supplied, and thus eventually increases profitability.

The greenhouse cultivation is an agro-system that presents important productive advantages in comparison with un-protected or open-air cultivation. Tropical conditions are favorable for vegetable production round the year if temperature and irradiation conditions are considered, but the process is greatly hindered due to frequent occurrence of unsuitable weather conditions. Greenhouse cultivation reduces these bottlenecks and thus helps providing higher yields and better fruit quality. Vegetable cultivation in tropics is a source of fresh food, nutrients, and livelihood especially for rural population and thus is very important. Many researchers have mentioned benefits of greenhouse cultivation of vegetables in tropics as extension of harvesting time, reduced water consumption, reduced susceptibility towards plant-diseases, higher yields, better quality, better use of fertilizer and other input resources, and higher returns. Moreover, adapted greenhouse constructions and fertigation systems with lower manufacturing and maintenance costs are getting important place in sustainable vegetable production. Greenhouse cultivation is being widely adopted in many developing countries of Asia and other parts of the world. It has benefited thousands of farmers by improving their crop yields and profitability.

The aim of this book is to provide in depth knowledge of the greenhouse technology and its applications to students and other readers about the greenhouse cultivation. This book written on this special topic considers the needs and requirements of the tropical situations. The book has been divided into eleven chapters. Chapter 1 details about the rationale for the protected cultivation, current practices and scope of this technology. The basic concepts and brief history of the developments of the greenhouse cultivation technology are included in the Chapter 2. The details of constituents of greenhouse environment and their effects on crop growth are enumerated in Chapter 3. The details of various types of greenhouses and the circumstances in which they are used are described in the Chapter 4. In the Chapter 5, the design details, the materials used for the constructions and their characteristics are given. The details of heating and cooling of the greenhouses are given in the Chapter 6. The root media is important in greenhouse cultivation and the details of which are included in the Chapter 7. The details of soil-water-plant relationships are given in the Chapter 8. This chapter also deals with irrigation systems and water quality requirements. Chapter 9 deals with various instrumentation and automations used in greenhouse cultivation. They are divided into climatic measurements and controls as well as soil and plant environment. The details about the insects and pests of the crops commonly grown in greenhouses are given in the Chapter 10. The final Chapter 11 gives details about important aspect of nutrient management for the greenhouse crops. In addition to above, in every chapter a number of solved examples are included for the practices of the students. At the end of each chapter a list of review questions is also included. A number of figures and tables are included in every chapter for the easy understanding of the readers.

We have tried to give all possible details about the increasingly popular technology but pointing out any misses is most welcome. We are quite confident that students at under graduate as well as graduate studies will be highly benefited by this book.

There are many people who directly or indirectly helped during writing of this book. We are grateful to Mr. Peeyush Soni for his help during manuscript preparations. In addition Mr. Jaisa Ram, Mr. Vikas Singh Atray and Mr. Rajesh Sharma of Apex Computing Centre, Udaipur helped in formatting and redrawing of some figures. Authors gratefully acknowledge their generous help.

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## Chapter 1

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# CONTROLLED ENVIRONMENT AGRICULTURE: AN INTRODUCTION

The basic agricultural needs of a society, such as food, feed and fiber are fulfilled through agricultural productivity. There is no longer enough land available for agriculture, with the exception of few countries. Thus in order to meet the food requirements of the increasing population, productivity has to increase several times more than the present yield. Agriculture is a field, which is not generally preferred due to the drudgery while working in the field. Consequently, migration from rural to urban areas has become a common feature of our society. For this reason, agriculture should become more profitable and associated hard work should be minimized.

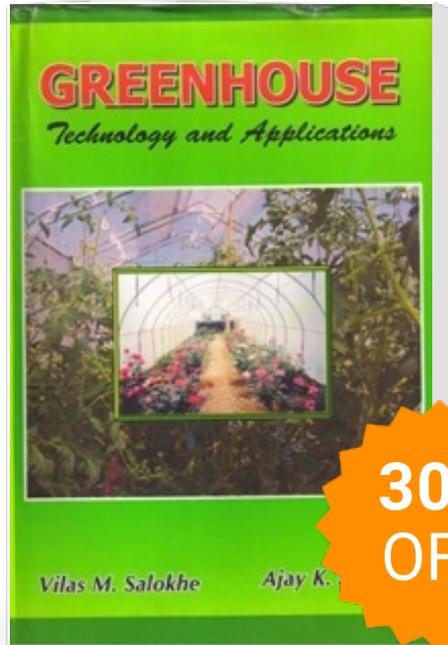
In many developing countries, agriculture has been a sustainable foreign exchange earner, which is necessary for national development. Enhancement of production of fresh fruits, vegetables, flowers and indoor plants for domestic as well as for export, therefore, becomes relevant. Export of horticultural produce requires high quality standards and assured availability. However, the traditional open field growing techniques are greatly constrained to meet export obligations resulting from the heavy use of chemicals and fertilizers. There is a need, therefore, to look for alternative technologies to increase agricultural yield. The use of efficient inputs must be improved and the latest technological developments should be incorporated as well in order to achieve the domestic as well as export food and nutritional targets.

### 1.1 Controlled Environment Agriculture

The adverse climatic conditions limit severely the plant growth all throughout the year or during parts of the year. To overcome this, the control of plant environment has become an essential strategy. The environmental factors over which some degree of control is required are illumination with regards to intensity, quality and photoperiod, air temperature, air moisture content (relative humidity), air composition on both the content of CO<sub>2</sub> and exclusion of impurities such as insects, fungus and spores.

The growth of crops is inhibited when any of these factors become restrictive. Therefore, the environment should be suitably regulated to trap the full potential of a given crop or plant type. It has been observed

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Author : A K Sharma And V  
M Salokhe

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