# GREENHOUSE OPERATION MANAGEMENT pdf

## 1: Best Colleges with Greenhouse Operations and Management Degrees

*The revised edition of Greenhouse Operation and Management is designed as a semester course for 11th and 12th grade students who are interested in various aspects of greenhouse production.*

Greenhouse Structures and Design Greenhouses are used to provide optimal environments for plant growth and development. The greenhouse design must deal with the local outdoor circumstances, like minimum, maximum and average temperature, humidity, solar radiation, clearness of the sky clouds , precipitation rain, hail and snow and average wind speed and wind direction. Some of the components of a greenhouse design are location, orientation, site selection, drainage, structure, foundation, flooring, glazing, and ventilation facilities together with the technical equipment needed to control the climate inside the greenhouse. The location and orientation of a greenhouse determine the amount of light that enters it. Determining the best location to erect the greenhouse is an important decision. A suitable greenhouse location will include a spot where the sun hits the greenhouse all day long and no shadows are cast on the greenhouse. Greenhouses can be classified as free-standing or gutter-connected. A free-standing greenhouse can have a quonset hoop , gothic, or gable roof shape. A gutter-connected greenhouse is a series of bays with gable or quonset arches connected together at the gutter level. The framing of the structure is made of aluminum, galvanized steel, PVC pipe, or such woods as redwood, cedar, or cypress. A greenhouse has a large expanse of glazing on its sides and roof so that the plants are exposed to natural light for much of the day. Glass has been the traditional glazing material, but plastic films, such as polyethylene or polyvinyl, and fibreglass or polycarbonate are increasingly used. Chapter 2 Greenhouse Glazing The greenhouse glazing, or glazing as it is referred to in the industry, represents the greatest decision in selecting the design for the greenhouse. Diffused light is better than direct light. Various glazing materials have radically different response to environmental conditions such as solar irradiance, wind, snow, and hail; and are by virtue of composition and manufacturing parameters quite different in physical properties. Key characteristics that should be considered in selecting glazing is the cost, its durability how long it lasts , its weight and ease of repair or replacement, how much light is transmitted through the material, transparent versus translucent, and how much energy moves through the material. Greenhouse glazing can be divided into three groups; plastic films, rigid plastics, and glass. The plastics can be further subdivided into generic materials such as polyvinyl chlorides, polyethylenes, polypropylenes, fiberglass, polycarbonates, acrylics, and polyesters, to name a few. Chapter 3 Greenhouse Mechanization and Material Handling The moving of plant material from one place in the greenhouse to another can be very labor-intensive due to the large quantities and the distances traveled across a greenhouse. Each handling of plant material costs money and time, and because of the large number of plant material involved, the total labor cost can be very high. Thus, greenhouse mechanization and material handling systems is generally needed to reduce labor costs and better utilize the space available in the greenhouse. Whether moving plants from the propagation room to the growing area or supplying substrate to a filling machine; the use of the benches and converyors can be a very simple, effective, efficient, and flexible means of handling plant material within most greenhouse operations. For example, replacing stationary benches with rolling benches allows the grower to increase the width of the production aisles without losing any crop production; this enables workers to move more efficiently between the benches. Having all of these systems appropriately designed and installed significantly increases your chances for successful plant production. Chapter 4 Greenhouse Heating Heating is a major concern to commercial greenhouse operations. This is due primarily to the costs involved in the purchase and operation of heating equipment as well as the potentially disastrous effects of a poorly designed system can have on crop production. Many types of heating systems are available for use in greenhouses. Heating systems are usually classified as central or local. In a central system the boiler is located in a separate house outside the greenhouse and the heat is distributed to the greenhouses by a distribution system. In a local system the heat is released directly to the greenhouse space since the furnace and thus combustion are within the greenhouse space. There are four primary systems for greenhouse heating: Selecting the proper system is important because of the significant differences between available systems.

Some systems cost less to buy or use less expensive fuels. Others may have a higher initial cost, but they are more efficient and cheaper to operate. Features to look for in a heating system include thermostats to control temperature; aluminized or stainless-steel heat exchangers for extended life in the humid, corrosive environment of greenhouses; fans to help distribute the heat throughout the greenhouse; and brackets to mount the heater to the greenhouse structure. Selecting the appropriate heating equipment depends partially on the type of fuel that is available. Suitable energy sources include natural gas, LP gas, fuel oil, wood, and electricity. The cost and availability of these sources will vary somewhat from one area to another. Greenhouse heater requirements depend upon the amount of heat loss from the structure. Heat loss from a greenhouse usually occurs by all three modes of heat transfer: Usually many types of heat exchange occur simultaneously. The heat demand for a greenhouse is normally calculated by combining all three losses as a coefficient in a heat loss equation. Chapter 5 Greenhouse Ventilation and Cooling Greenhouses structures by design gather light and to trap the considerable heat contained in sunshine. Greenhouses are so efficient at retaining relatively low levels of solar energy, that without specialized ventilation and cooling equipment, high greenhouse temperatures could severely impact plant growth. Greenhouse ventilation involves removing air from inside the greenhouse and replacing it with outside air. The purpose of ventilation is to control high temperatures during the summer caused by the influx of solar radiation, to maintain relative humidity at acceptable levels, to provide uniform air flow throughout the entire greenhouse, and to maintain acceptable levels of gas concentration in the greenhouse. Three types of ventilation systems can be distinguished: Natural ventilation is driven by two mechanisms, namely the pressure field induced by the wind around the greenhouse and the buoyancy force induced by the warmer and more humid air in the greenhouse. Forced-air ventilation is accomplished by fans that are capable to move large quantities of air at relatively low pressure drop. Evaporative cooling is a process that reduces the temperature of air by the evaporation of water into the airstream. As water is evaporated, heat energy is lost from the air which reduces its temperature. The fan and pad system has been the standard system for evaporative cooling. Fog systems operate in much the same way as a fan and pad system except that fog systems add moisture directly to the greenhouse environment where it then evaporates. In both cases, ventilation is required to exhaust the humidified air and exchange it with drier air so that evaporative cooling can continue. Shade is also used to reduce the temperature and light inside a greenhouse. There are two primary options for providing shade: Continuous positive air movement within greenhouses is highly desirable since it equalizes temperature, carbon dioxide, and humidity levels within the greenhouse. Many fungus spores germinate only when the relative humidity is very high or in a film of water on the leaves of plants. Chapter 6 Greenhouse Environmental Monitoring and Control Systems A greenhouse environment is an incredibly complex and dynamic environment and strongly influences crop cultivation. The efficiency of plant production in greenhouses depends significantly on the adjustment of optimum climate growth conditions to achieve high yield at low expense, good quality and low environmental load. To achieve these goals several parameters such as air temperature, humidity, light intensity, and carbon dioxide concentration must be controlled optimally given certain criteria through heating, lighting, ventilation and carbon dioxide injection. All of these systems are independent. They may affect or be affected by the other functions, so controlling them in an integrated mater is of great importance. Continuous monitoring and controlling of these environmental factors gives relevant information pertaining to the individual effects of the various factors towards obtaining maximum crop production. Good crop management depends on having the right information to make necessary decisions. However, even at the smallest facilities, this method is inefficient, time consuming and vulnerable to error. To improve crop management, a number of sensors and instruments can and should be used to monitor crop conditions. A control system can then use this information to make regular adjustments to equipment settings to optimize growing conditions. Today, monitoring and control systems are the standard for modern greenhouses, with continued improvements as the technology advances. The rate of growth and length of time a plant remains active is dependent on the amount of light it receives. When determining the effect of light on plant growth there are three different aspects of light that should be considered: All three of these characteristics of light affect growth and development of food crops, though in different ways and in varying magnitudes. Light quality describes the wavelengths colors of light.

Red and blue have the greatest impact on plant growth. Green light is least effective the reflection of green light gives the green color to plants. Blue light is primarily responsible for vegetative leaf growth. Red light, when combined with blue light, encourages flowering. Light intensity is the total amount of light supplied to the plant, which is then used for photosynthesis; up to a point the higher light quantity the more energy a plant can sequester in photosynthesis. In commercial greenhouses, several strategies can be used to help properly manage light levels throughout the day and seasonally. Some of the primary reasons why greenhouses manipulate light levels include temperature and irrigation management, photoperiod control, minimizing crop stress, and optimizing photosynthesis. Some of the lighting technologies include, incandescent bulbs, halogen incandescent bulbs, fluorescent lamps, compact fluorescent lamps, high-intensity discharge lamps, and light-emitting diodes. Chapter 8 Carbon Dioxide in Greenhouses The growth and health of plants is the result of the photosynthesis process in which the energy of the sun is used by the plant in combination with carbon dioxide CO2 and water to synthesize organic matter, while giving off oxygen. Consequently, carbon dioxide is one of the three major components responsible for plant growth. Carbon dioxide is present at a concentration of approximately ppm in the atmosphere. However, this is an average and the actual concentration in a given location can vary. Climatic changes can cause a four to eight percent variation in carbon dioxide concentration daily or seasonally due to increases or decreases in solar radiation, temperature, humidity, and the passage of storm fronts. In a greenhouse filled with plants, carbon dioxide concentration will closely follow ambient outside concentrations during the day as long as ventilation is provided. Carbon dioxide concentrations rise during the dark period because plants are not using carbon dioxide for photosynthesis and respiration by plants. During light periods in which ventilation is not required, carbon dioxide levels may fall below ambient level, especially in tightly sealed greenhouses. During the winter, carbon dioxide levels can easily drop below ppm to to ppm during the sunlight hours, which has a significant negative effect on the crop. Ventilation during the day can raise the carbon dioxide levels closer to ambient but never back to ambient levels of ppm. An extremely low carbon dioxide level of around ppm will completely prohibit carbon dioxide uptake and growth. Depletion only occurs at daytime, caused by photosynthesis CO2 uptake which requires light. Supplementation of carbon dioxide is seen as the only method to overcome this deficiency and increasing the level above ppm is beneficial for most crops. Chapter 9 Managing Temperature in Greenhouse Crops The most important environmental parameters that need to be controlled for optimal greenhouse climate are temperature, light, relative humidity, and carbon dioxide CO2. Temperature is the most important single parameter in greenhouse controls as temperature has a significant role in plant growth and development. For instance, the temperature of plant tissue affects the rate of leaf unfolding, flower bud development, and stem elongation. The optimal temperature depends on the plant species grown and desired level of photosynthetic activity. Different crop species have different optimum growing temperatures and these optimum temperatures can be different for the root and the shoot environment and for the different growth stages during the life of the crop.

## 2: Greenhouse Operation and Management by Paul V. Nelson

*Exceptionally comprehensive -yet accessible- GREENHOUSE OPERATION AND MANAGEMENT, 7/e provides detailed, step-by-step instructions in layman's terms for ALL aspects of the business-from the physical facilities, to the day-to-day operations, to business management and marketing.*

We are going into our third season of growing in our greenhouse, and of course, pricing is an issue that never goes away. We find it very difficult to feel as though we are making enough profit, yet staying competitive in the market. This is generally pointed at materials we start from plugs, but there is a whole different set of circumstances when we look at vegetables and herbs we grow from seed. Third, there is as much art to pricing as science. If you can stomach the math, it will help. It sounds like cost calculations are a real issue for this company and probably a great many others. But, cost is only one piece of the puzzle or, more likely, only one type of chessman on the chess board. Pricing profitably is important not just to cover costs, but to have a financially viable firm. Grower-retailers, what are your costs? For any business, one of the first challenges is to get a good idea of your costs. How are you keeping track of them and how much detail do you have? I think it first takes a commitment to track costs, and then it takes the investment of time. Michigan State published a cost accounting system adapted to Excel for greenhouse producers. There are some great resources available online see sidebar. The key is to find a system you can use and then commit the time to use it. Pick three or five key products and begin with them. Make an effort to re-visit those costs at least twice each year, working to put more detail into those costs. The more you work at it, the more concise your costing system will become. The trick is to not try to make it very detailed at the start, but work toward more detail as you get more comfortable with the system of tracking costs. The question posed by the writer of the email mentioned at the beginning of the article was one of comparing seedling and cutting plants. What are the direct costs for seedlings and cuttings? It is the seed and cutting cost. So, if you can get a system into place to track costs per container, you can vary the plant that goes into that container. Then, compare prices, and you can calculate the difference in profit. The same holds true for baskets and other containers. You likely use the same type and amount of media, tags and chemicals in identical containers, but the plant material that goes into them may differ in cost. Labor is another piece of direct cost that can be tough to allocate. Labor is most often the single largest expense for growers and retailers. It can be tough to track labor directly related to production versus retail but, again, do the best you can. How much more detail can you develop from there? Can you divide that by crop or by number of containers grown? Making simple steps toward achieving better detail is more helpful than doing nothing at all. Five dimensions of value Is cost the only input to calculating price? Functional value is how well something does its job. Butterfly weed Asclepias is great at attracting pollinators. It has high functional value compared to many other plants. Conditional value is the symbolism or meaning of a product; red roses mean love to most of us. Social value is how the product makes us look to others who are socially important to us. If our friends have succulents in their apartments, we can look cool if we do also. Epistemic value is the novelty or sensory value. Is it a new color of carrot? Is it a fragrant plant? That article is full of research showing the positive feelings that plants inspire, and the stress that plants can help mitigate. Estimating Production Cost of Greenhouse Crops. Hall, ad Kube-Pak Corp. The New Economics of Greenhouse Production. Most savvy marketers agree that people buy the benefits, not features or characteristics, of products. For example, you buy a high-wattage product feature microwave oven because it will cook food faster benefit. You buy a personal computer with more gigabytes feature so you can store more music and videos; you buy a PC with more RAM feature so your games run faster benefit. Consumers buy a deciduous tree feature to shade their home and reduce cooling costs in the summer benefits. Consumers buy basil and parsley in four-inch containers feature because they are small enough to carry but ready for eating with fresh tomatoes benefit. So, while setting the prices of your products, consider product benefits. Benefits can help you with the evidence that plants are worth more than the cost of production. Price points are important as well. People tend to buy products that end in numerals pointing to the left. Why would you leave those few cents on the table? The art of pricing comes into play with considerations such as: How much farther can you push the margin, still appeal to a broad base of your customers and continue to drive profits? Do you want to tape a nickel to each container you sell, or do you want to generate some profit? Michelle Simakis Price elasticity The last part of the art of pricing comes from a study that Drs. With the assistance of some high-caliber retailers, we devised a study to examine price elasticity or, more simply, how much does demand rise or fall when we decrease or increase prices? What we asked them was to really go against convention, and rather than decrease prices over this selling period, we asked them to increase prices over the selling period. This was over a period of four weeks during their busy season. The first step was to identify products that were similar in terms of the plant material but had an element of differentiation. For this, we used both national brands and in-house brands and compared them to unbranded products. If you think about the branded plants as the test plants and the unbranded or generic as the control plants, what we did was to vary the price of the branded plants over time while the price of the control or the generic plants was stable across the four weeks of the study. For the first week, the control plants were at a certain level, but the branded or the test plants were actually priced 10 percent lower than the control or the generic plants. Then in week two, we increased the price of the test or the branded plants to make them at the same level as the test plants or the generic plants. Then in the third week, we increased the price of the test or the branded plants to 10 percent over the price of the control or the generic plants. So, the branded plants were, in week one, 10 percent lower; in week two, the same price as, and then in week 3, 10 percent higher than the unbranded or the control plants. Signage with product benefits helped to sell plants at a premium price, while the combination of features and benefits helped sell plants at more moderate prices. We conducted this study on a wide range of plants, including roses, annuals, perennials, shrubs, and vegetable and herb transplants. We had a great deal of data to examine the impact of this price increase, particularly when we knew that the prices of other products, or at least the perception of the prices of other products, was going to be going down over the study period. What were the results? The great news was that when we raised prices by 10 percent per week, in spite of selling 8. In other words, even though we sold fewer units, the increase in price enabled the retailers to sell about 2. We increased revenue even though we decreased the number of units. Roses can be priced considering not only the cost to produce them, but for their conditional value; i. We are giving up the perceived value dimensions and the real product benefits and telling the consumer that the value lies only below the rim of the container. Sure, it makes life easier for labor which is hard to find and retain , but we cannot remain profitable and financially sustainable if everything is priced by container size. Start at a low level of detail and build to a more detailed system. Delve into your costs to find out how much key products really cost to grow. Then, engage in the art of pricing. How much does it cost you to sell them primarily labor, but also facility cost? How much are you making in profit? Could you consider raising prices? The consequence of not improving the margin is giving that away. Are you prepared to send some of your hard-earned cash out the door? After all, do you want to work to give your money away? In one study, when we raised prices by 10 percent per week, in spite of selling 8. Take proactive steps to get a handle on your costs and incorporate perceived value in some products that can be easily differentiated to boost your bottom line. Your employees, investors, customers and partners will be glad you did. Bridget is a professor in the department of horticulture at Michigan State University.

## 3: The daily grind of operations management - Greenhouse Management

*Description. For courses in Greenhouse Management. Based on the author's life-long practical experiences both in the industry and in research, Greenhouse Operation and Management, Seventh Edition, offers students a state-of-the-art guide to the operation of commercial flower and vegetable greenhouses.*

## 4: Nelson, Greenhouse Operation and Management, 7th Edition | Pearson

*The locations with a relatively high number of Greenhouse Operations & Management graduates are Mahtomedi, MN, Weldon, NC and Brainerd, MN. The most common degree awarded to students studying Greenhouse Operations &*

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## 7: Greenhouse Operation and Management - Paul V. Nelson - Google Books

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## 8: Greenhouse Management

*Greenhouse Operation and Management / Edition 7 Based on the author's life-long practical experiences both in the industry and in research, this best-selling, state-of-the-art guide to the operation of commercial flower and vegetable greenhouses presents coverage in the order in which decision-making concerns occur for a person entering the.*

## 9: Nelson, Greenhouse Operation and Management | Pearson

*Based on the author's life-long practical experiences both in the industry and in research, this best-selling, state-of-the-art guide to the operation of commercial flower and vegetable greenhouses presents coverage in the order in which decision-making concerns occur.*

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