



Great Lakes Fruit, Vegetable & Farm Market EXPO

Michigan Greenhouse Growers EXPO

December 9 - 11, 2014

DeVos Place Convention Center, Grand Rapids, MI



Greenhouse: Probing Greenhouse Vegetables - An Overview of Production Systems, Schedules and Approaches

Wednesday morning 9:00 am

Where: River Overlook (upper level) Room C & D

This session is intended for those currently investigating or in the early stages of greenhouse vegetable production. It will cover key aspects of vegetable production in greenhouses including crop choices, timing, growing systems, and considerations for those who may be interested in diversifying their current operation.

Moderator: Paul Karlovich, C Raker & Son, Litchfield, MI

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| 9:00 am | Probing Greenhouse Vegetables – An Overview of Production Systems, Schedules and Approaches |
| | <ul style="list-style-type: none">• Natalie Bumgarner, Horticulturist and Research Director, Univ. of Tennessee |
| 9:50 am | Session Ends |

Probing Greenhouse Vegetables: An Overview of Production Systems, Schedules and Approaches

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Section 1: Introduction to Common Greenhouse Vegetable Structures and Systems

It is difficult to make generalizations about the structures used in greenhouse vegetable production due to the range of scales, locations, and marketing plans. The most important thing to keep in mind is that the intended selling season, climatic conditions in the area during that season, the price that can be maintained as well as the volume of produce needed all have a large bearing on your structure and control systems. Currently, in the controlled environment vegetable marketplace, there are medium to large scale operations that invest in higher capital items such as glass glazing, high sidewalls, and extensive environmental control. The most sophisticated of these houses essentially operate as closed systems and have the capacity to closely manage temperature, humidity, light, air flow and other key factors for plant growth. These greenhouses are obviously designed to optimize production through precise environmental control systems as well as crop management equipment and tactics that achieve efficiencies over large production areas.

In these discussions about greenhouse structures and control systems, there is a spectrum that describes the degree to which we control the environment in our greenhouse. Technological advances in materials and systems have led us to the point where we have the ability to control nearly any factor of plant production that we chose. Plant factories, or completely enclosed production carried out in specially designed indoor buildings, are quite possible. The question for growers then, is not can we control the environment, but should we. For small to medium scale producers, there can be multiple routes to profitability and the greenhouse and control system that you chose can depend on your market, season, location and price.

While a range of greenhouses and environmental management can be appropriate, there are generally fewer choices in growing systems currently in use for soilless vegetable production. One of the most important distinctions is whether nutrient solution is recirculated past multiple plants or used only once before treatment or release. It is most common for leafy crop systems to be recirculating and fruiting crop systems to be single use or feed to drain. The two most common leafy crop systems currently in production are the Nutrient Film Technique (NFT) and deep flow or raft systems. Each of these systems have benefits and drawbacks. NFT systems provide flexibility of crops and schedules, but do require large amounts of manual labor and some space is lost due to providing walkways between the benches and channels. Floating raft systems have the advantage of providing more mechanization and potentially reducing the space needed for walkways and human movement. However, there can be limits to crop species and timing and a need for more homogenous crops. Also keep in mind that the volume of water that must be managed differs in these two systems and this can have implications on capital cost and areas of risk in solution management.

The two most common growing systems for vine crops are generally hanging gutters and Bato buckets. Hanging gutters probably comprise the large majority of production systems around the world. They provide a crop at a good working height for humans while enabling heating and CO₂ management to be integrated within and underneath the plant production area. As denoted by their name, the hanging gutter does consume some vertical space in the greenhouse and it more common in higher sidewall houses. Growers in shorter houses are more likely to produce a crop in Bato buckets or growing bags that sit on the floor and preserve vertical height for plant growth. Even with these differences, the general

premise of intermittently providing nutrient solution to plant roots supported in a porous, well aerated medium is similar.

Section 2: Leafy Crop Production Schedules and Practices

There can be differences in transplanting, harvesting and plant management work flows between NFT and floating raft systems. Rather than focus on those differences, the goal in this presentation is to provide an overview of scheduling, key environmental elements and crop options that are generally appropriate to both systems. In hydroponic greenhouses, the most common leafy crop has been bibb lettuce. Due to this fact, most of our estimates on production time are based on bibb. In Midwestern areas, it is common for 6 week production schedules to be used as a general reference for greenhouse lettuce. Under optimum high light summer conditions, it is not uncommon for cycles to be shorter and the opposite is true in winter. These estimates are based on a mature bibb head (in the US, often 5 to 8 ounces). Time to mature harvest and harvest weight vary when other leafy crops are produced. It is increasingly common for growers to produce mixed species products and these can be sold at a variety of maturity and leaf size. Therefore, saleable crops can be produced essentially anytime between 30 and 60 to 70 days depending on the crop, sales season, and management.

Seedling production can be carried out in rockwool, oasis foam, or a range of peat and coir mixtures. Growers make these choices based on preferences, cost, and management methods. Transplant time can vary, but 2 to 3 weeks is most common. Transplant generally takes place when seedlings begin to crowd each other and the risk of leaf and stem elongation due to light deprivation or competition occurs. Larger cell or cube size can increase time to transplant and potentially increase the efficiency of the production system. As described earlier, harvest size can vary depending on the crop and the market. Roots can be left on or removed at harvest, which can occur in the greenhouse or plants can be transported to a harvesting and packing area.

Packaging varies depending on the crop and the customer. Bibb lettuce is common sold in a crisper or clamshell when individually packaged due to protection and shelf life. Sleeves are more common for leaf mixes and romaine type lettuces. There are also several crops including spinach, kale, arugula, and basil that can be harvested multiple times and individual leaves packaged together and sold. Bulk packaging (often a plastic liner in a cardboard) is also common for restaurant, food service and other customers that do not sell heads or cubes individually. A cooler is generally necessary for leafy crop producers, as high humidity and temperatures between 35 and 40°F are optimum for lettuce storage. The harvested crop should be stored in the cooler as soon as possible after harvest.

Section 3: Vine Crop Production Schedules and Practices

A brief presentation on vine crop schedules and practices is more straightforward for vine crops because there are fewer differences between the production and management practices of growers using hanging gutter and bucket or bag systems. Schedules vary based on geographic location and the use of supplemental lighting. In broad terms, northern growers typically seed Nov. –Dec. for April through November harvests while southern growers seed in mid-summer for late fall through early summer harvests. These dates are based on available light during the season and the avoidance of the harshest winter (northern) or summer (southern) growing conditions. Cucumber crops on the other hand are generally shorter in duration and this results in 3 to 5 crops per year commonly being produced in greenhouses. There are some differences in specifics of media and nutrient management and obviously the differences in environmental control in the differing styles of greenhouses common for these two systems and crops, but those are beyond the scope of this presentation.

One of the most distinct differences between small and medium to large scale vine crop producers is seedling production. It is quite common for greenhouse producers to purchase seedlings from a specialty seedling producer. This is much less common for smaller growers due to shipping cost and

volume purchasing. In fact, many small producers start their own transplants, which can provide both benefits and drawbacks. Temperature, light management, and sanitation are all crucial areas that growers must be knowledgeable in order to produce high quality seedlings. Tomato and cucumbers are generally transplanted into larger blocks (rockwool, coir, etc) for hanging gutter systems and this can be carried out in Bato bucket systems as well.

Due to the long-term nature of the tomato crop, management is critical to sustain productivity. Irrigation and nutrient as well as temperature management, as well as cultural practices, such as clipping and suckering are important for young and mature plants. The key thing to keep in mind is that most environmental and cultural practices in tomato production are carried out to achieve optimum plant balance. This means a favorable balance between vegetative and reproductive growth in the plant throughout the season. In reality, sucker pruning, cluster pruning, fertility management, irrigation management, leaf removal and temperature and humidity management in the greenhouse all focus on optimizing and balancing plant growth and fruit production.

Section 4: Approaches and Crop Options

In large scale production, marketing is more streamlined and less variable. However, in the small production greenhouse, marketing is often as important as production. These are the growers that I have had the most experience working with over the last few years, and there are almost as many marketing strategies as there are growers. So, when marketing direct or selling to local buyers, skill and knowledge of demand in the area is as important as understanding crop production. In vine crops, beefsteak tomatoes are still a large part of the market, but cluster or tomato-on-vine (TOV) production has risen dramatically in recent years. Likewise, specialty tomatoes of all shapes, sizes and colors are prevalent in the market and grapes, cherries, and roma tomatoes can be valuable options for growers.

Variety is also the name of the game in leafy crop production. Greenhouses completely full of bibb lettuce have been changing to accommodate increasing demand for romaine (which can be a challenge in some seasons and areas), leaf lettuces of all kinds as well as a variety of other green leafy crops. Asian greens, arugula, kale, as well as basil can be viable options for growers in many areas of the country depending on the market in their region. While performance can vary, often a range of these crops can be grown successfully by a single grower in a small to medium sized greenhouse.