Web site: http://aesop.rutgers.edu/~horteng

CCEA Newsletter

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CCEA is a research organization dedicated to the improvement and vitality of the Controlled Environment Agriculture Industry. CCEA is funded by Industrial and Grower Partners who contribute a yearly partnership fee. Satellite partnership is also available to growers. Information about **CCEA** is available from:

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In this issue:

Happy Holidays!

Currently, a Poinsettia crop is being grown in the open-roof greenhouse. We are testing the floor heating system and its ability to maintain a target root zone temperature while maintaining various air temperatures.

Vision Statement
CCEA, The Center for Controlled Environment Agriculture of NJAES at Rutgers University, a partnership among growers, industry, and researchers, will devote itself to research and transferring information required for an economically viable and environmentally aware controlled environment agriculture industry. We will particularly strive to identify future trends, critical issues, appropriate emerging technologies and provide leadership for opportunities which challenge world-wide controlled environment agriculture in the 21st century.

CROP PRODUCTION IN HIGH TUNNELS

High tunnels are simple greenhouse structures using a single layer of plastic film to protect the crop from the outside environment (i.e., cold temperatures, high winds, and precipitation). The purpose of many high tunnels is to extent the growing season, i.e., to produce earlier and later in the growing season compared to outdoor production. The plants are often grown in beds covered with a dark colored plastic film and irrigated with a drip irrigation system that is installed underneath the dark film. During the day, when the sun is shining, the plastic mulch traps heat which is slowly released during the night. As a net result, the average soil temperature in high tunnels is higher than the outdoor soil temperature. This enables the transplants to grow earlier and later in the season compared to outdoor production. Because plants can be harvested earlier or later in the season, better sale prices can be expected.

High tunnels are often constructed of metal bows (similar to hoop houses) that are anchored into the soil. The end walls are outfitted with access doors, which also allow for ventilation and/or for equipment access. The equipment is used to till the soil and prepare the growing beds. The bulk of the ventilation is usually provided through roll-up sides along both sides and the entire length of the high tunnel.

These roll-up sides can be operated manually or automatically. However, for automatic operation, electricity is needed to operate the roll-up mechanism and the control system (usually a thermostat and a relay). Manual operation will require frequent adjustment of the roll-up sides to make sure the inside temperature stays within an optimal range. By placing high tunnels perpendicular to the prevailing winds, the most benefit can be obtained from naturally occurring airflow patterns. A source of irrigation water is needed, and with a fertilizer injector, water and nutrients are delivered to the plants.

Researchers at Penn State University (Drs. Mike Orzolek and Bill Lamont) have been promoting the use of high tunnels for the last ten years. They created a Center for Plasticulture and information about their activities can be found on the Center's web site (http://plasticulture.cas.psu.edu/). One of the crops that have been grown successfully in high tunnels is tomato. The standard Penn State design for tomato production is a 17 by 96 feet high tunnel that includes the following features:

- Raised beds, 18 inches wide
- Beds are covered with a 6 mil thick plastic mulch
- Drip tape is installed 2-3" under the bed
- Beds are spaced 44" apart, resulting in 4 beds (26" walkways)
- Plant spacing: 1 - 1.5 feet between plants
- Plant density: 3.7 - 5.5 square feet per plant
- Total number of plants: 240 - 360 per high tunnel

As part of the studies at Penn State University, Dr. J. Harper investigated the economics of growing crops in high tunnels. A summary of his cost analysis for a 17 by 96 feet high tunnel is shown in the following table:

High tunnel item	**Cost**
Frame (bows on 4' centers)	$ 1,700
Lumber	$ 340
Hardware (including roll-up vents)	$ 1,060
Covering (plastic film)	$ 370
Drip irrigation (includes injector)	$ 280
Labor (installation)	$ 1,440
Interest (8% on a 10-year investment)	$ 420
Total ($ 3.44 per square foot)	**$ 5,610**

The cost of production for a tomato crop in the same size high tunnel is shown in the following table (Dr. J. Harper, Penn State University):

Variable costs (e.g., crop maintenance)	$ 1,110
Fixed costs (depreciation)	$ 580
Breakeven price	**$ 0.36 per pound**

In 2002, a group of Rutgers University researchers and extension personnel received a grant to study heirloom tomato production in high tunnels. A total of six 17 by 36 feet high tunnels were purchased and two were installed at the vegetable research farm in New Brunswick, NJ, and the remaining four at the research and extension center in Centerton, NJ. The first tomato trials are scheduled to start in early 2003.

Two of the high tunnels will be equipped with automatic roll-up sides, which will be controlled by a thermostat. The remaining four high tunnels will be vented manually. We are planning to monitor temperature, relative humidity, and light conditions inside the high tunnels to investigate the effectiveness of the two ventilation systems. All except one of the high tunnels were installed with a north-south ridge orientation for maximum light interception during the darker months of the year. The remaining high tunnel was installed with an east-west ridge orientation for comparison.

Construction details of the high tunnels being constructed at the vegetable research farm on the Cook College Campus in New Brunswick. Note that the curved pieces of wood are made of (pressure treated) plywood (3/4" thick) that is lapped to make for strong connections and a total thickness of 1.5" (similar to the thickness of the 2 by 4 framing elements of the large hinged door. Additional framing for the side panels will be installed to allow the large door to be opened independently (i.e., without having to remove plastic panels or film).

The bottom of the large hinged door extends a little into the soil to create a sill-less entry for soil tillage equipment. To open the door, some soil will have to be removed.

INNOVATIVE LFGTE MICROTURBINE CHP SYSTEM INTEGRATED WITH HYDROPONICS, AQUAPONICS, AND DESALINIZATION

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This project integrates a 120 kW (four-30kW microturbines) landfill gas-to-energy (LFGTE) combined heat and power (CHP) system with a desalinization unit and a closed loop fish (aquaponic) and hydroponic plant production system. The fish (tilapia) and tomatoes are being produced year-round in the controlled environment agriculture facility at the Burlington County Research and Demonstration Greenhouse in Columbus, NJ. By combining these innovative, environmentally sound technologies into an integrated system, we will demonstrate a sustainable production technique for high quality, locally grown, fresh vegetables and fish while reducing pollution through source reduction, reduction of emissions from electrical generating facilities, and mitigation of methane gas produced by landfills.

The complete, integrated system has been operational since November 2002 and is scheduled to operate through December 2003. The design and specifications for the individual components of the system are available upon request. Performance data for the landfill gas fired microturbine and heat recovery system will be collected during the next year. The potential for fresh water production from seawater utilizing waste heat from the microturbine system will be analyzed. Yield data for the hydroponic and aquaponic systems will also be collected. Emissions from the microturbine units will be analyzed and examined for potential use as carbon dioxide enrichment of the greenhouse environment. The reduction of the so-called greenhouse gas emissions due to the operation of this integrated system will also be evaluated.

Similar projects can be installed at many of the smaller landfills throughout the US and the Caribbean Basin islands that do not generate enough landfill gas to warrant electrical generation for export to the grid. It is anticipated that the economic development potential of this system will encourage smaller landfills to collect and utilize the landfill gas in an economical and environmentally sound manner.

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