Horticultural Engineering

Volume 16 No. 4, July 2001

Website: http://aesop.rutgers.edu/~horteng

Open-Roof Greenhouse Update

Eugene Reiss and A.J. Both

Last fall, we installed a heated ebb and flood floor irrigation system in our open-roof greenhouse. This spring, the greenhouse was re-glazed with acrylic panels (twin-walled and 1/3" thick), except for the roof segments which remain glazed with double poly. This summer, the greenhouse renovation will be completed by installing the remainder of the gas-fired hot-water heating system (with perimeter and overhead heating pipes).

Figure 1 at the bottom of this page, provides the outside greenhouse dimensions (drawing not to scale). Figures 2 and 3 on page 2 show a cross sectional view of the floor and a layout of the greenhouse floor plan, respectively.

Preliminary results from a 2.5 month monitoring period (without a crop growing in the greenhouse) show that the control system is able to maintain an inside temperature that closely tracks the outdoor temperature (within a few degrees). We do not have an evaporative cooling system (e.g., high pressure fog), so cooling below the outside temperature is not possible.

During the middle of the day, when the roof is fully opened, the light intensity inside the greenhouse can exceed the outside intensity due to light reflection from the (almost vertical) roof panels.

Stay tuned for future updates on our research activities with the open-roof greenhouse system.

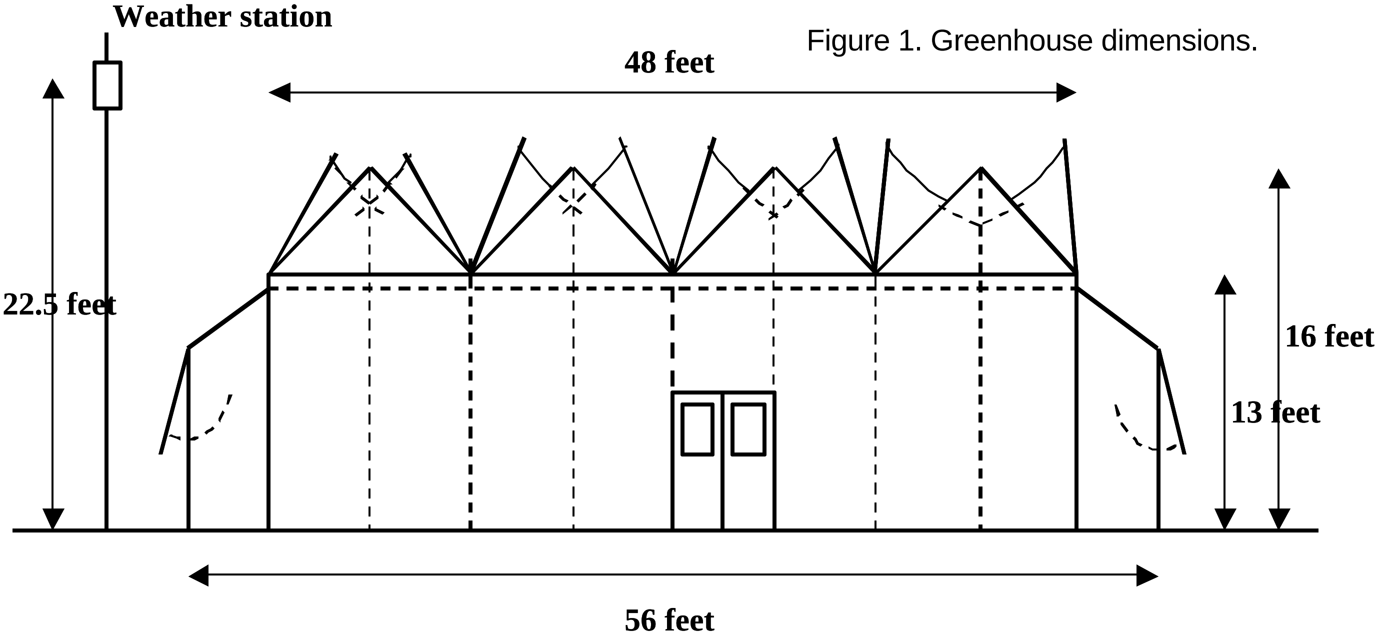

Figure 1. Greenhouse dimensions.

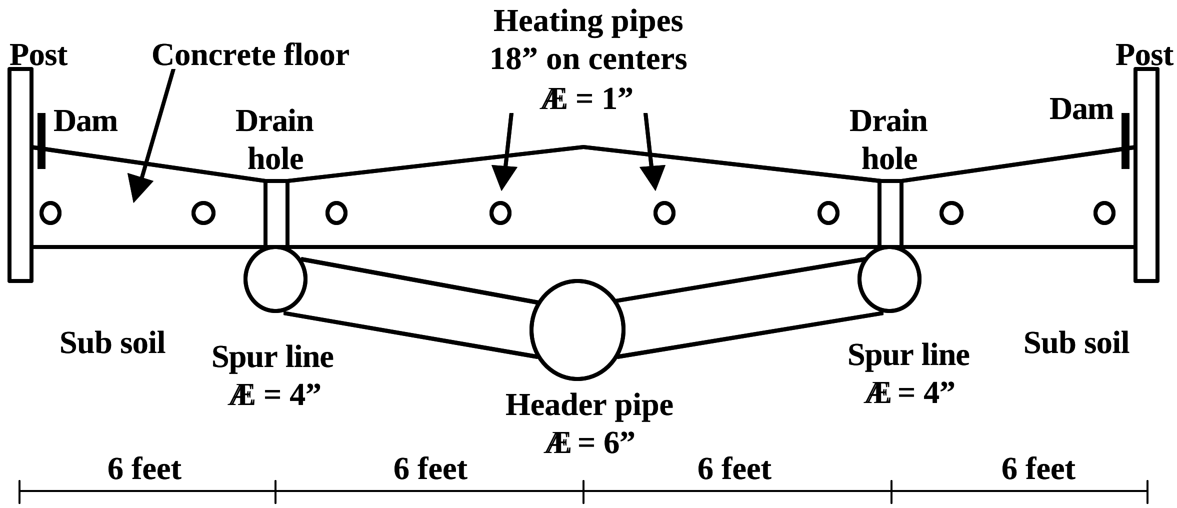

Figure 2. Cross-sectional view of the heated ebb and flood floor which was installed last fall in the open-roof greenhouse (drawing not to scale).

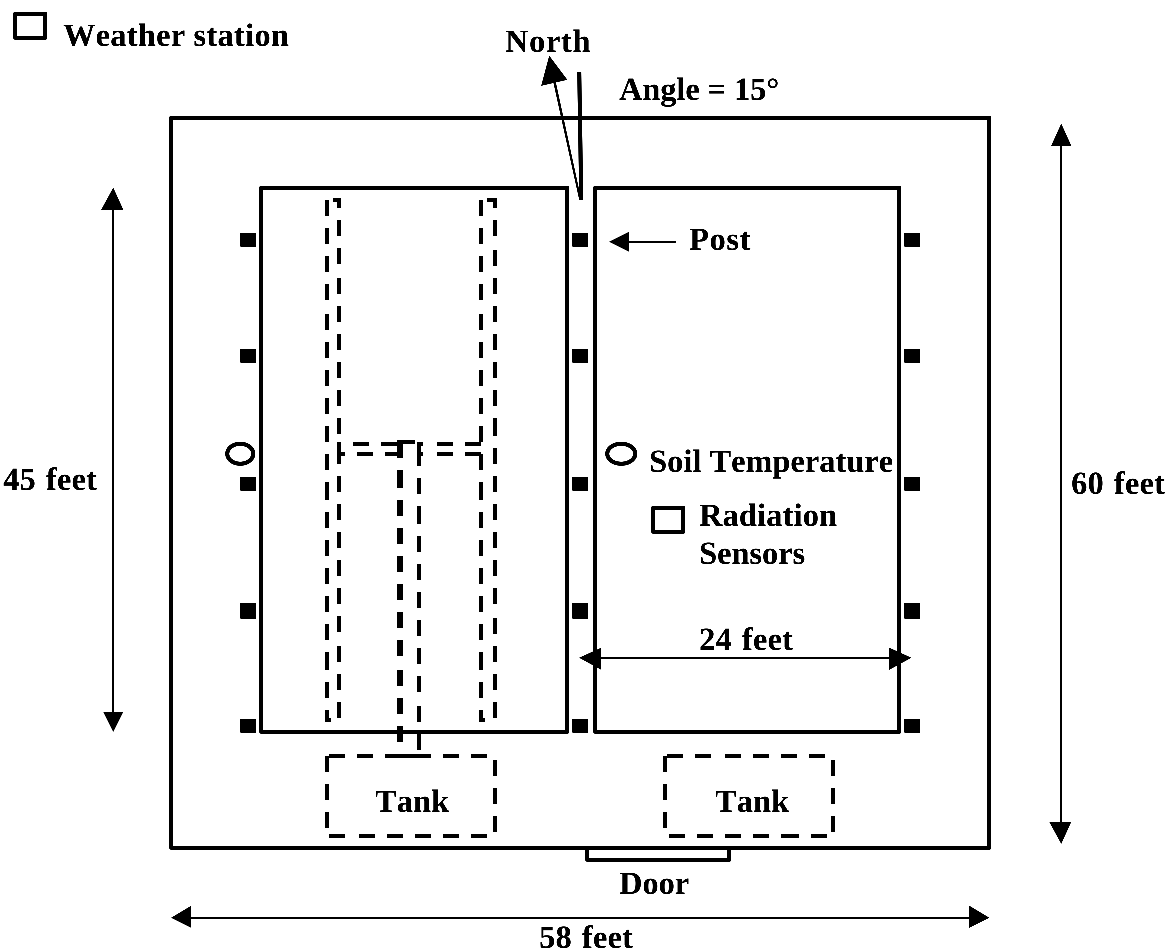

Figure 3. Layout of the open-roof greenhouse showing the underground plumbing system and nutrient solution tanks for the floor irrigation system and the location of some of the sensors used to monitor and control the greenhouse environment (drawing not to scale).

Plasticulture in the Global Community View of the Past and Future

Dr. Merle H. Jensen,
Associate Dean, College of Agriculture
University of Arizona, Tucson, AZ

At the 15th International Congress for Plastics in Agriculture and the 29th National Agricultural Plastics Congress, held September 2000 in Hershey, PA, Dr. Merle Jensen made a keynote presentation on Plasticulture with a view from the past and a look into the future.

Following is an excerpt from his talk. The complete talk and the Proceedings** from the Congress are available from:

The American Society for Plasticulture
526 Brittany Drive
State College, PA 16803-1420
(814) 238-7045

"No technology has modified the course of horticultural crop production as the use of agricultural plastics (1). As the Green Revolution expanded production of agronomic crops, plasticulture has provided yet another revolution. While more silent, plasticulture has enabled countries throughout the world to greatly extend their food production capability. Plastic films and related materials are used extensively to cover greenhouses, high and low tunnels (row covers) and for soil mulches. High tunnels are walk-in hoop structures that are normally unheated and naturally ventilated. Plastic tubes and accessories are important components of drip irrigation which today covers more than 400,000 hectares (1,000,000 acres worldwide.) Pots, labels and flats, major components in transplant and ornamental plant production, even involve plastics. Plastic films for ground covers and bag cultures are common in hydroponics/controlled environment agriculture. Plasticulture consists of many components, not only plastic but a complete management system that may include pest control, marketing, etc. Plasticulture is a whole system approach to modifying microclimates in producing high quality, high-yielding horticultural products."

Greenhouses

"The total world area of glasshouses is over 40,000 ha (*100,000 acres*) with most of those found in Northern Europe. In contrast to glasshouses, plastic greenhouses have been readily adopted on all five continents, especially in the Mediterranean region, China and Japan. Most plastic greenhouses operate on a seasonal basis, rather than year round, as is the case with most glasshouses. PVC film for greenhouses is still dominant in Asia, especially Japan.

In Japan, the area covered by plastic film greenhouses increased 35,000 ha. in just 20 years (1965-1985). In Korea, these greenhouses increased 6.3 times, from 3,099 ha in 1975 to 21,061 ha in 1986. The People's Republic of China showed equally dramatic growth: 5,300 ha in 1978 to 34,000 ha in 1988. (*today, it is over 100,000 ha, according to Dr. S. Sase).* The combined growth for both greenhouses and row covers in China exceeded 96,000 ha in just ten years. Most plastic greenhouses in Asia are high tunnels while in Europe and the United States most greenhouses are multi-span or gutter connected structures. Undoubtedly, China is one of the largest users of agricultural plastics in the world where over one billion people — 20 percent of the world's population — are being fed from only five percent of the earth's cultivated land.

Since 1960, the greenhouse has evolved into more than a plant protector. It is now better understood as a system of Controlled Environment Agriculture (CEA), with precise control over air and root temperature, water, humidity, plant nutrition, carbon dioxide and even light. The greenhouses of today can best be seen as plant or vegetable factories. Almost every aspect of the production system is automated, with the artificial environment and growing system under nearly total computer control. In a research setting, such a totally enclosed system, with artificial light, is called a growth chamber or phytotron. In the USA and Japan, such system may cover large areas."

"Controlled environment agriculture has gained in horticultural importance not only in vegetable and ornamental crop production but also in the production of plant seedlings, either from seed or through tissue culture procedures. Prior to 1960, there was commercial interest in hydroponics but this cultural system was not widely accepted because of the high cost in construction of the concrete growing beds. Interest in hydroponics was renewed with the advent of plastics. Plastics were used not only in the glazing of greenhouses, but also in place of concrete in lining the growing beds or plastic bags were filled with soilless growing media. Plastics were also important in the introduction of drip irrigation. While hydroponics and CEA are not synonymous, CEA usually accompanies hydroponics.

Today, the technology of hydroponic systems is changing rapidly with systems producing yields never before realized. Due to plastics and better environmental control systems, including new cultivars and biological control practices, the future of hydroponics appears more positive than anytime over the last 50 years."

* * * *

Dr Jensen's article had an extensive bibliography. He suggests for a complete review of plasticulture worldwide, the following publications which give an excellent review:

- Jensen, M.H. and Alan J. Malter. 1994 Protected agriculture, a global review. World Bank Technical paper No. 253, Washington DC.

Hort Technology (3 quarterly publications)

- Plasticulture Jan./Mar 1993 3(1)
- Protected Cultivation of Horticultural Crops Worldwide Jan./Mar 1995 5(1)
- Special Compendia: Using Plasticulture to Produce Vegetables July/Sept. 1996 6(3)

**The Proceedings is over 650 pages and covers all areas of Plasticulture, including mulch, drip irrigation, greenhouse glazing and plastics disposal. It is a worthwhile addition to your library.

The following abstract is also from these proceedings.

Supplemental Lighting Strategy for Greenhouse Strawberry Production

J.S. Gottdenker, G.A. Giacomelli, E. Durner
Bioresource Engng., Rutgers University

ABSTRACT: Controlled Environment, hydroponic, greenhouse cultivation of Sweet Charlie strawberries is an effective method to target niche winter markets in the Northern US between October and June. Plants were conditioned in an environmentally controlled growth chamber and transplanted into 15 cm plastic pots on ebb and flood benches in a greenhouse on September 1. Fresh fruit yields were measured within daily light integral (DLI) treatments of 12, 9, and 6 moles per square meter per day which were achieved by supplementing natural sunlight with high pressure sodium (HPS) artificial lamps. For comparison, the control consisted of only natural lighting. All treatments were exposed to incandescent night interruption for three hours at midnight, to ensure that long day conditions and plant reproductive stage would be maintained. High intensity discharge HPS supplemental lighting can help accelerate fruit maturation, which assisted in targeting specific harvest dates. However, such lighting may not be needed for maintaining high total, late season yields. Total yields averaged between 111-127 grams per plant from October through January with a density of 11 plants per square meter, for all treatments. The economic value of the supplemental lighting treatments was determined by comparing the capitol and operational costs of the supplemental lighting with the increase in return that ensued. The results indicated that regardless of the amount of supplemental lighting, an economically viable system would need to provide at least a three-fold increase of planting density, unless per plant yield can be significantly increased. Previous research has shown that comparable yields per plant are possible at 32 plants per square meter. Chocolate covered strawberries provide an interesting value- added opportunity for high-quality fresh grown strawberries, which could drastically improve economic viability of the system.

Horticultural Therapy

Joel Flagler, H.T.R.
RCE of Bergen County, NJ

Horticultural therapy is using plants and growing environments as tools to heal and rehabilitate sick and disabled people. It is not a new concept. In fact, it is one of the oldest of the healing art's, dating back to ancient Egypt. For centuries in this country, gardening and planting activities have been prescribed for people suffering from a wide range of maladies and limitations. Today, indoor and outdoor horticulture programs are common in hospitals, nursing homes, rehabilitation centers, and prisons, as well as in facilities for blind, visually impaired and developmentally and physically disabled people.

Of course, people do not have to be disabled or ill to enjoy the benefits of working with plants. Horticulture and gardening programs abound in public and vocational schools, day camps, senior and community centers, and urban housing developments.

Why does horticulture appeal so widely? That is difficult to say, yet nearly everyone knows the special satisfaction of watching a flower or vegetable grow and develop. One important component of this satisfaction is feedback or interaction between two living organisms: person and plant. Plants, whether vegetables, shrubs, or lawns, will react to the nurturing given them. Plants do not discriminate. They respond to proper care whether the person providing water and fertilizer is old or young, black or white, ambulatory or in a wheelchair. The non-threatening nature of plants contributes to their nearly universal appeal. People who grow plants quickly realize a sense of achievement and increased personal confidence, as plants reward their caretakers with new leaves, new flowers, and new fruits.

The word therapy is associated with clinical programs that treat ill or injured people. The therapeutic treatment team consists of doctors, nurses, psychologists, social workers, occupational therapists and others. Those treated are referred to as "clients" or "patients." Though particular goals vary from client to client, the overall objective is to increase their physical and mental well-being.

Horticultural programs in rehabilitation facilities differ from those in clinical facilities. The rehabilitation treatment team includes work evaluators, vocational skill instructors, and production and sales specialists, among others. The clients are referred to as "trainees" or workers." Their aims are to gain vocational skill training and employment opportunities. The training environment is modeled after horticultural businesses. The overall goal is to help people reach their maximum work potential and subsequently enter employment.

One common denominator is nearly every application of horticultural therapy is the maximum use of plant materials. The special textures of leaves, stems, flowers, and soil provide effective sensory stimulation. The same is true of plants' fragrances and tastes. Because blind and visually impaired people can't fully appreciate a colorful bed of flowering annuals, textures and scents stimulate those senses not impaired. Activities using herbs, spices and dried materials can be important stimuli for blind and partially sighted people.

Adapting horticultural activities and tools for use by ill and disabled people is a major challenge for the horticultural therapist. Common examples of adaptive gardening tools are raised beds, which may be made from halves of whiskey barrels, and hanging containers. These adaptations bring the soil level up to a height suitable for non-ambulatory gardeners. Raised beds can also be enjoyed by those working in a standing position, for stooping and kneeling become unnecessary.

Even common garden and greenhouse tools can be modified for ease in handling, using extender handles and safety grips. For clients who cannot grasp or hold onto a tool, C clamps and Velcro straps may be used to affix the tool to the user These examples are quite basic, but many sophisticated devices are available that help people with more profound physical limitations to participate. Many of the prosthetic devices used by occupational and physical therapists can be incorporated into a horticultural therapy program. No one should be denied the benefits of working with plants.

Employing the Handicapped at the Burlington County Research and Demonstration Greenhouse

David Specca
Manager

As the name implies, the Burlington County Research and Demonstration Greenhouse is a facility designed for demonstrating new technologies and ideas.

While using the handicapped as laborers in agriculture is not a new idea, the way we have adapted our production system to meet their needs is new. Handicapped workers have been our primary work force for the past six years. We have had up to seven mentally handicapped people and two trained supervisors working with our tomato crop production. By working with the employees to make the tasks easier to perform, we have been able to trim our workforce down to four handicapped workers and one supervisor. This is a rather large accomplishment given that a similar-sized traditional tomato greenhouse would employ approximately five or six regular laborers.

Key to our success is the utilization of moveable "Dutch Trays" that allow us to bring our crops into the headhouse. In the headhouse are workstations that permit access to all four sides of the bench, well within arm's reach. The workstations allow for much easier supervision of the workforce and are essential for quality control when using handicapped laborers. One will find that each employee can do certain tasks better than other tasks and we try to assign work accordingly to the extent possible.

Our handicapped employees and their supervisor are hired from the Burlington County Occupational Training Center (OTC). They are paid on a piece-rate basis. Time trials are performed for four or five common tasks that they perform such as seeding, transplanting, spacing-up, pruning and harvesting. They are paid for the percent of work they actually do, as compared to a regular employee. If they work half as fast, they get paid half as much per hour. Currently our handicapped employees make approximately 60% to 75% of a "regular pay". Don't be fooled, sometimes they do tasks quicker than a regular employee can. Not all agencies that provide handicapped workers have the piece-rate form of payment. You will need to check with the agencies directly. We also employ a few minimum-security prisoners to do our heavy work, such as pressure washing benches and discarding the spent crops.

I would offer these tips if you are considering employing handicapped people in your operation:

- Start off with just one or two handicapped employees and integrate them into your workforce.
- Assign a tolerant employee to mentor the handicapped employee. Frequent encouragement, especially at first, really helps. They thrive on constructive advice to perform their work better.
- Observe their strengths and modify their tasks accordingly.
- Keep their workday short, five to six hours per day works well.
- Be prepared for lots of laughs and some tears.
- Never, ever forget their birthday, as they most certainly will not forget yours.

Working with the handicapped does not have to hurt your bottom line. You may need to employ a few handicapped workers before finding the best fit for your needs. We have observed that employing the handicapped boosts the morale of the entire workforce once everyone gets comfortable with the new dynamics. As the employer, you will be amazed just how much they improve your perspective.

We hope that that the Horticultural Therapy article by Joel Flagler and the practical application of these principles at the Burlington Research Greenhouse Facility written by Dave Specca, will be helpful. Feel free to give us your feedback.

Solar Powered Drip Irrigation For Vegetable Production

W.H. Tietjen, J. Grande, P.J. Nitzsche,
T. Manning and E. Dager
Rutgers Cooperative Extension

ABSTRACT. In 1999 and 2000, cabbage and peppers, respectively were grown comparing solar and conventionally powered drip irrigation systems at the Rutgers University Snyder Research and Extension Farm, Pittstown, NJ. The Solar system in 1999 was operated by a 1.5 horsepower motor powered by 18 solar modules. Utilizing the sun's energy captured by photovoltaic panels, to power irrigation systems offers a cost-effective, pollution-free and virtually maintenance free alternative to diesel pumps in remote areas. Solar-powered pumping systems are capable of delivering water from rivers and wells in volumes up to 2,000 gallons per minute.

The above abstract is from The Proceedings of the 15th International Congress for Plastics in Agriculture and the 29th National Agricultural Plastics Congress, held September 2000 in Hershey, PA.

Other Proceedings Articles of Interest

Season Extension Technology
Dr. Otho Wells, Professor Emeritus
Univ. of New Hampshire

Greenhouse Technology—Open Roof Design
W.J. Roberts, Professor Emeritus
Rutgers University

Drip Technology
John Roberts
Roberts Irrigation Products, Inc.

Packaging Technology for Fresh Produce
William Romig
ETL Technologies, Phil., PA

Available from:
The American Society for Plasticulture
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(814) 238-7045

Seed Storage*

Seed is an important and costly input and requires careful treatment if the best possible performance is to be attained. Performance should be judged not only on germination percentage but also by speed of germination, uniformity of germination and seedling development.

The two most important factors in seed storage are relative humidity and temperature. High temperatures and relative humidities lead to a rapid deterioration in seed quality. Relative humidity is governed by the seed container, usually a foil wrapped sachet. Seed rapidly absorbs moisture once the packet is opened, therefore open packets should not be left lying around the seed sowing area. Seed should be stored at between 4 to 10ºC (40 to 50ºF) and 20 to 40% relative humidity. A frost- free refrigerator usually provides the ideal environment for seed storage.

The list below is a relative guide to the storage life of typical bedding plant seeds. It can be used to weigh up the risks of storing seed for extended periods of time. Ideally seed should be stored for as short a time as possible, but occasionally this is not possible. If seed is stored from season to season it should be tested for germination and vigour before use.

Short storage life

Aster, Begonia, Impatiens, Pansy, Salvia, and Viola.

Medium storage life

Ageratum, Alyssum, Antirrhinum, Celosia, Cineraria maritima, Coleus, Cyclamen, Dahlia, Dianthus, Geranium, Lobelia, Marigold, Petunia, Portulaca, and Verbena.

Long storage life

Stocks, Sweet pea and Zinnia.

Courtesy ADAS Bedding and Pot Plant Technical Notes 103. United Kingdom Newsletter published for growers.

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HORTICULTURAL ENGINEERING

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Horticultural Engineering on the Web

This Issue of Horticultural Engineering, like previous ones, will soon be available on the internet at:

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

We will send an e-mail announcing each Horticultural Engineering Newsletter as it is posted on our web site.
Thanks to those of you who have elected to receive this newsletter via the Web. We appreciate your help in saving the duplicating, postage, and handling costs.

Useful Websites:
http://ohioline.osu.edu/aex/0800.html
http://www.msstate,edu/dept/cmrec/GHSC.htm
http://www.msstate.edu/anr/plantsoil/vegfruit/tomato/ghtomato/faq.html
http://www2.msstate.edu/~ricks/
http://www.plasticulture.org

Important Date
January 14– 15, 2002
Greenhouse Engineering Short Course at Rutgers University

This 2-day course, coordinated by your editor, features timely topics for greenhouse operators and those interested in learning more about greenhouse engineering or perhaps thinking about getting started in the greenhouse business. Registration information is available for the office of Continuing Professional Education at Cook College,
Phone: (732) 932-9271, or on the web:
http://cook.rutgers.edu/~ocpe
It is not too early to plan to attend this program. Speakers include: Professor emeritus Bill Roberts, Professors George Wulster and David Mears, your editor, and more!