H o r t i c u l t u r a l E n g i n e e r i n g

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

*NEW

Greenhouses for Homeowners and Gardeners, NRAES-137

This new publication explains options for gardeners and homeowners. Whether it means tending to a collection of exotic houseplants or cultivating a year-round crop of vegetables, greenhouse gardening appeals to many people for many different reasons. A greenhouse can help garden enthusiasts get through the cold part of the year; it fills a void during winter, when weather prohibits gardening outdoors. Home greenhouses are ideal for introducing children to nature and showing them how seeds develop into flowering plants or nutritious vegetables. Retirees often adopt greenhouse gardening as a hobby to enjoy during their retirement.

G***reenhouses for Homeowners and Gardeners*** **NRAES 137** ($25.00 plus S&H/sales tax, 214 pages, June 2000) will help readers select and design the most appropriate size and style of greenhouse to fit their needs, find the best place to locate a greenhouse, and decide whether to build a greenhouse themselves or hire a contractor to do it. This comprehensive, easy-to-read book covers every style and type of greenhouse - from relatively inexpensive film-plastic-covered growing spaces to custom-designed, cozy sunspaces that extend the living space within the home. The book addresses a wide audience, including gardeners, homeowners, cooperative extension educators, and institutions (such as retirement homes, schools, and prison associations). Small farmers may also find the book useful.

The book contains eight chapters on the following topics: greenhouse basics, selecting a greenhouse, greenhouse planning, framing materials and glazing, greenhouse layouts and equipment, the greenhouse environment, window greenhouses and growth chambers, and garden structures. With this book, aspiring and practicing greenhouse operators will be able to make informed decisions about foundations, glazing and framing materials, space utilization, interior design, heating and cooling systems, supplemental lighting, watering and fertilizing systems, and other greenhouse design and construction issues. The garden structures chapter covers the design, construction, and use of cold frames, hotbeds, shade houses, rowcovers, and high tunnels.

Nearly 150 line drawings illustrate the 214-page book to help readers visualize the way greenhouses are built; evaluate alternative methods of construction; design interiors; select labor-saving equipment; and understand the skills involved in designing, building, and operating a greenhouse. Ten diverse do-it-yourself plans for home greenhouses and other garden structures are provided in an appendix. Each plan includes materials lists and construction diagrams and details. Three additional appendixes contain a greenhouse maintenance checklist, lists of greenhouse and equipment suppliers, and useful conversions. A glossary of terms that might be unfamiliar to readers and an index are included as well.

Greenhouses for Homeowners and Gardeners was written by John W. Bartok, Jr., Professor Emeritus in the Department of Natural Resources Management and Engi-

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Bioresource Engineering Department Changes

Dr. A.J. Both

As you may know, as of July 1, 2000, the Department of Bioresource Engineering at Cook College, Rutgers University, no long exists. The undergraduate teaching program in the Horticultural Engineering Option was mothballed (the remaining seniors will be allowed to graduate in May 2001), while the graduate program will be continued. The former Bioresource Engineering Department is now part of the Plant Science Department and we are still located at the same address on the Cook College Campus (20 Ag Extension Way, New Brunswick, NJ 08901-8500; phone: 732-932-9753).

What Happened?

After the retirements of Professors Bob Wolfe and Bill Roberts, only three faculty members remained in the department in the summer of 1999: Professors Gene Giacomelli, Dave Mears, and K.C. Ting. Professor George Nieswand became the department chair while he remained actively involved in teaching and research in his own department: Ecology, Evolution and Natural Resources. The department was in the process of hiring a new extension faculty member to continue with Professor Roberts' activities.

In the fall of 1999, Professor K.C. Ting was offered to chair the Department of Food, Agricultural and Biological Engineering at Ohio State University. He accepted. At that point it became clear there were not enough faculty to teach all the required undergraduate courses. The remaining faculty decided to suspend admission of new undergraduate students into the Horticultural Engineering Option, effectively mothballing the program. A.J. Both was hired as the new assistant extension specialist. He hired Eugene Reiss as a program associate to help with research and extension activities.

In the spring of 2000, Professor Gene Giacomelli was offered a professorship at the Department of Agriculture and Biosystems Engineering at the University of Arizona in Tucson. He would also become the Director of a newly developed Controlled Environment Agriculture Center. He accepted. The Department's secretarial staff was reduced from three to one when Marilyn Dominiecki accepted a position elsewhere in the University and Pearl Switlyk retired. Wei Zhao's appointment through Cooperative Extension was not renewed and he left Rutgers University.

As of July 1, 2000, Bioresource Engineering became part of the Plant Science Department chaired by Professor Chee-Kok Chin. Only two faculty remain in Bioresource Engineering: Dave Mears and A.J. Both. Provisions will be made for the remaining three seniors allowing them to fulfill all requirements needed to graduate in the Horticultural Engineering Option. They are expected to graduate in May, 2001.

What's next?

Plans have been developed to bring the number of faculty back to 5 people. The Cook College administration has given tentative permission to hire three new faculty in the coming years, one of which will be hired in the next twelve months. With a total of five faculty, the undergraduate teaching program can be revived and new students would again be allowed to major in Horticultural Engineering.

The former Department Shop will expand its activities to include servicing the Plant Science Department as well as the larger University community. All future shop activities will be performed on a for-fee basis. The goal is to eventually recoup all material and equipment expenses.

The Center for Controlled Environment Agriculture (CCEA) will remain active under the leadership of A.J. Both and Bill Roberts. Initially, the main research focus will be on the recently constructed open-roof

Department Changes (Continued)

The current graduate students and Post-docs (most of them are funded through the NJ-NSCORT project related to the challenges of continuous plant production during long-duration space missions) are continuing with their research. Several of them are still supervised by Professors Gene Giacomelli and K.C. Ting who have been appointed Visiting Professors at Cook College.

Some of the former department's office and lab space is now shared with other researchers at Cook College. The main building still houses only Bioresource Engineering students, staff, and faculty. Please feel free to drop by or give us a call and tell us about your suggestions for the future of Horticultural Engineering at Cook College. Change is often difficult, but it usually opens up a whole new set of opportunities!

Water and Nutrient Management for Greenhouses NRAES 56

The crop root zone consists of roots, water, air, nutrients and organisms. These all comprise the plant environment and cause activity based on a particular temperature.

NRAES 56 written by Dr. Tom Weiler of Cornell University is an excellent publication describing the complex interaction of the root and aerial environment with a plant growing system. The 102 page manual deals with these complex issues in 9 chapters which include:

* Crop Nutrient Needs
* Water Basics Analysis and Delivery
* Fertilizer Basics, Analysis and Formulation
* Fertilizer Proportioners
* Substrate Basics, Analysis and Formulation
* Temperature of Aerial and Root Zone

This valuable publication is available at modest cost from your Horticultural Engineering Editor or from ;

NRAES Cooperative Extension
152 Riley-Robb Hall
Ithaca, NY 14853-5701
Phone 607 255 7654

Greenhouses for Homeowners NRAES 137 continued from page 1.

neering at the University of Connecticut. He wrote the book to update similar publications that have become obsolete due to changes in materials and construction techniques. Bartok has over thirty years of experience working with hobbyists, commercial growers, institutions, and manufacturers. His book was published by the Natural Resource, Agriculture, and Engineering Service (NRAES).

Greenhouses for Homeowners and Gardeners, NRAES-137, is available for $25.00 per copy plus shipping and handling from NRAES, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701. Shipping and handling for one copy is $5.50 within the continental United States. New York residents, add 8% sales tax (calculated on both the cost of publications and the shipping and handling charges). If ordering more than one book or if ordering from outside the United States, contact NRAES for shipping rates and possible quantity discounts. Orders from outside the United States must be prepaid in U.S. funds. All major credit cards are accepted, and checks should be made payable to NRAES. For more information or a free publication catalog, contact NRAES by phone at (607) 255-7654, by fax at (607) 254-8770, or by e-mail nraes@cornell.edu. To learn more about NRAES, browse through our entire catalog, and order books online, visit its web site at < www.nraes.org >.

Other information about Greenhouses for Homeowners and Gardeners is available online at: <www.nraes.org/publications/nraes137.html >

October 16-18 New England Greenhouse Conference. Centrum Center Worchester Mass. Contact

ON-FARM AGRICHEMICAL HANDLING FACILITIES

Safe Handling and storage of agricultural chemicals require serious attention to health and environmental concerns. Improper storage and handling of pesticides can cause severe illness and potential environmental problems. A well-designed storage and handling system is necessary to prevent and to deal with personal emergencies, fires, spills and contamination.

On-Farm Agrichemical Handling Facilities, NRAES - 78 is a publication from the Northeast Regional Agricultural Engineering Service and discusses important considerations for growers who are contemplating or need to contemplate planing and constructing a pesticide storage facility.

This 22 page publication includes two appendixes: a plan for a post-frame chemical storage building, and the other is a list of companies that distribute equipment for chemical storage or containment. Also included are one table, 17 figures, conversion factors and a list of publications for further reading on the subject.

This excellent publication as written by Dr. David Ross, Extension Agriculture Engineer of the University of Maryland and John Bartok Extensions Specialist Emeritus of the University of Connecticut. It can be purchased for $6.00 plus a single copy shipping fee of $3.50 within the US. The publication is available from:

NRAES
Cooperative Extension
152 Riley-Robb Hall
Ithaca, NY 14853-5701

All major credits cards are honored. For information about quantity discounts or ordering the publication call 607 255 7654 or they can be reached by fax at 607 254 8770

e-mail address is nraes@cornell.edu

Conversion Units for English and SI System

- Temp F = 9/5C + 32 Example 10°C = 50° F
- Temperature C = 5/9(F-32) 68°F +20°C
- 25.4 mm equals one inch
- 304.8 mm equals one foot
- 1 Cubic foot = 0.028 cubic meters
- 1 horsepower = 746 watts
- 1 Btu/hr = 0.293 watts
- 1 pound = 454 grams
- 1 acre = 0.405 hectare
- 1 mph = 1.61 kilometers per hour
- 1 cfm = 0.472 liters/sec
- 1 psi = 6.894 kilopascals
- 1 inch of water = 249 pascals
- 1 foot per min = .005 meters per sec
- 700 feet per min = 3.5 meters per sec

To convert from →	→	multiply by:
foot^2	meters^2	0.093
foot	meter	0.3048
pound	kilogram	0.454
gallon	meters	0.0038
gallons/minute	meters^3/min	6.31 x 10^{-5}
liters	meters^3	0.001
gallons per minute	liters/min	0.06

Internet Use is Growing among Growers

Amongst 400 mid-western farmers who each averaged over 1500 acres Internet access is now mainstream with an expected 20 percent growth by 2001. While it is not surprising that Internet access is highest among younger, more-educated growers with large acreage, the study uncovered new information on what drives Internet usage and the potential for e-commerce.

The Study found that computer adoption today appears less motivated by recordkeeping and more by Internet acess. this is a major shift from a few years ago when Internet access was an afterthought to owning a personal computer. e-commerce plays a growing role in management decisions such as buying onlinge as well as using online information for price discovery. Farmers are still testing the waters and exploring how the Internet can be a

POTENTIAL PROBLEMS WITH UNVENTED HEATERS IN GREENHOUSES

George A Duncan,
Extension Agricultural Engineer,
University of Kentucky

Unvented heaters are often used by managers in greenhouses as a temporary source of heat for overnight cold temperature protection or as a regular heat source. "Unvented" heaters generally describe those that have no vent to the outside but dump all the products of combustion directly into the interior space. A number of unvented heaters have been sold to tobacco growers with new greenhouses. There are dangers and limitations to using these heaters that managers should be aware of for safe and successful use. The extended cold days and nights of late April caused plant symptoms in houses having unvented heaters that could have been caused by noxious gases from poor combustion. The symptoms have been observed most often on newly emerged tobacco plants. The most common symptom has been a whitening or bleaching (similar to sunscald) of the cotyledons and yellowing of the bud.

Kerosene and fuel oil are more likely than natural and propane gas to produce components in the products of combustion that are harmful to plants (and humans) if present in sufficient quantities. These products include: ethylene, sulfur dioxide, nitrous oxide and carbon monoxide. A 'clean burn' may not produce any of these in harmful quantities, but not all equipment produces a 'clean burn.' Some equipment may do so when new or in a clean laboratory test condition. However, the combination of dust, moisture and/or rust in environments like greenhouses can begin to block gas orifices and combustion air passages that interfere with proper combustion, thus causing a greater percentage of these noxious gases. Even a 'clean burner' can have some problems in 'tight' plastic greenhouses. Frequent start-up (cycling) of the burner also increases the amount of poorly burned products released into the environment.

The level of oxygen can be depleted over several hours of continuous heating thus starving the combustion process of adequate oxygen and contributing to noxious products in the gases. Some reports indicate the heaters have gone out at night. In most situations, the leaks around vent fans, shutters, curtains, and doors provide adequate oxygen. Some managers leave a small opening near the heater for fresh air to enter and replace the oxygen consumed. This is helpful. However, this does not ensure that the products of combustion are removed from the space or that they are completely safe!

How much fresh air or 'leakage' is required? The combustion of natural gas (propane is similar) requires approximately 960 cubic feet of air for each 100,000 BTU of heat produced! Thus, a greenhouse with 200,00 to 400,000 BTU/hr of heaters requires 1920 to 3840 cubic feet of 'fresh air' hourly to operate properly! This is a volume 10x10x20 ft up to 10x20x20 ft of air needed hourly. But isn't this a waste of energy to have to 'vent' out this much inside air to bring in fresh air and heat it up to greenhouse temperature? Not really. Heating this amount of air from 25 degrees to 70 degrees (typical greenhouse conditions in the spring) requires just 1700 to 3400 BTU/hr. Just a tiny bit of the 200,000

Unvented Heaters continued

to 400,000 BTU/hr of heater output! Standard heating system specifications require one sq. inch of fresh air opening for each 1,000 BTU of burner size to be located within 12 inches of the combustion area. Some managers use a flexible air duct or tubing to provide fresh air from the outside to a point near the heater. This may appear to be sufficient, but the limitation with an unvented heater is that there is no exhaust vent opening to let interior air out and 'draw' the fresh air into the greenhouse for the heater! In fact, as the gas is burned and expands the air during combustion, the inside air in a 'tight' house may be pushed back out this air inlet tube thus blocking any incoming air!

Why are unvented heaters used? Some use the portable or temporary heaters for emergency conditions. However, several greenhouses have the commercial unit heaters mounted in the greenhouse **BUT DO NOT CONNECT THE EXHAUST PIPES**! The considered opinions are that his will keep the heat in the flue gases inside the house and reduce the heating costs. While there is truth to this concept, the potential problems from the exhaust gases can be more costly than the extra fuel used. Most gas-fired unit heaters are rated at about 70-80 percent efficiency in getting the heat from the combustion chamber transferred out through the heat exchanger into the heated air stream. Dirty surfaces of the heat exchanger and poor fan performance can reduce this efficiency. Heat loss (drafts) can also occur through the vent pipes when the heater is not operating. Some unit heaters have a power vent mechanism that stops this heat loss. The decision has to be made by the manager whether to properly vent the heaters for safety of plants and humans with extra fuel consumption or risk plant and human injury. When human safety and plant health are concerned the answer is clear.

Ethylene is one of these colorless, odorless gases that can seriously affect plants. Ethylene injury has not been studied much in small tobacco, so the exact symptoms are not known. Tomato transplants are a sensitive host. Based on ethylene work in older plants, the first symptoms are yellowing of the bud, development of lateral suckers and slight downward cupping of the leaves. Sulfur dioxide is produced by fuels having a good percentage of sulfur in the gas. These and other noxious gases can cause similar curling of leaves typical of other chemical injury and/or necrotic spots on the leaves. The stage of plant growth greatly affects symptoms.

The opinions of several knowledgeable professionals vary on how likely the products of combustion might affect the tobacco plants as there are so many variables for any particular situation. The best indicators may be the smell, breathing and other sensory responses of a human in the closed space. Considerable moisture vapor and carbon dioxide also are produced in the products of combustion. For some greenhouse crops, carbon dioxide production has been a stimulus for plant growth when produced in sufficient quantities and without noxious gases. For the tobacco greenhouse, the daily ventilation in the spring precludes building up enough carbon dioxide to be of any value in stimulating plant growth. Moisture vapor can increase the humidity in the house thus causing more condensation and potential problems from the drippage.

If unvented heaters **MUST BE USED** in greenhouses, the following precautions are offered:

1. Use the cleanest burning type heater possible, preferable natural or propane gas fuel. Kerosene fuel heaters are very likely to cause plant symptoms if used for very much of the heating load.

Unvented Heaters continued

2. Maintain the burner orifices and air openings in a clean, open condition.

3. Provide definite fresh air inlet to the heater and some means for heated air to escape, with approximately one square inch of opening for each 1,000 BTUs of heater capacity. Or use small centrifugal fans to operate when the heater is operating to provide fresh air to a point near the heater. Remember: **THERE IS NO SUCH THING AS AN 'UNVENTED' (completely enclosed) HEATER f**or safe, continuous operation.

4. Have a person with good smell and eye sensory capabilities to visit the greenhouse periodically during the heavy heating period. If there is a smell or other sensations, then take corrective action promptly. (Ventilate the space, reduce heating and/or obtain a cleaner burning heater, preferably a vented unit.)

5. An ultimate test would be to obtain special containers to take a sample of the air and have a qualified air pollution laboratory analyze the sample for noxious gas components.

ALL COMBUSTION UNITS MUST BE VENTED to the outside with an approved exhaust stack that extends at least 24 inches above the ridge of the greenhouse or the highest adjacent building.

Greenhouse Growers Meeting
November 9-10, 2000

"Planning, Establishing and Expanding Greenhouse Businesses."

Holiday Inn Batavia New York
Contact Carol Peters 607 255 1602
clp7@cornell.edu

Help with Planning New Construction
Bill Roberts

An experienced consulting engineer or other design professional will usually be able to reduce both construction costs and the risk of building failure while incorporating specific needs into a completed building design. I remember many years ago calling on a grower in a rural county. He asked me about the strength of his new machinery shed. I said it looks to me like you have one- half as many roof purlins as you need. They were on 48" centers and not 24", the standard for that part of the state. The only 'plan' he had for the building was a picture from an advertisement. The ad showed visually that the roof purlins were spaced about 24" on centers and not 48" as actually installed. He had no building plans, no building permit, no 'anything' in which to address the problem.

Many folks would rather build without the requirement of a building permit. There are many reasons for this but most of the reasons have nothing to do with the strength or safety of the building. Securing a building permit requires that a plan be prepared by a competent and licensed architect or professional engineer. Once the plan is prepared then the building desired can be realized by following the plan and holding those involved, responsible for doing the construction according to the final plan.

In addition, the design professional can be contracted to provide the following specific services:

- Preparation of the site plan.
- Supervision of the actual construction.
- Ensure that construction proceeds according to the plans.
- Ease communication between the owner and the builder.

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HORTICULTURAL ENGINEERING

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Receive Horticultural Engineering via the Internet

This Issue of Horticultural Engineering like previous ones is available on the internet at

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

Thanks to those of you who have elected to receive this newsletter via the internet. Our hope is that many more of you will want to make use of the website and eliminate the need for us to send you a hard copy.

Thanks for helping us save the duplicating, postage and handling costs in our department p[articularly since our staff has been greatly diminished.

We will send an e-mail announcing each Horticultural Engineering Newsletter as it is produced.

Environmental Control and Design of Greenhouse Systems

January 8 and 9 2001

This popular greenhouse engineering and environmental control short course will again be offered. Dr. AJ Both, your editor, is the course coordinator and will be giving several presentations during the 1 1/2 days of lectures and demonstrations. The course will feature a one-half day tour to Kube Pak Corporation, the Burlington County Resource Recovery Greenhouse which is operating on methane gas produced at the adjacent landfill and Carl Blasig's very well run family operation. At Blasig's a robotic plug transplanter will be demonstrated. Watch for registration information which will soon be announced. General information and course content is available now from your editor, AJ Both. Mark the dates on your calendar and plan to attend this very informative course.