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 available to growers for a modest fee. Information on CCEA is available from:

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Vision Statement

CCEA, The Center for Controlled Environment Agriculture of NJAES of 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.

Sunset-Sunrise?

My concluding paragraph of my editorial entitled ***"Is it Sunset for the Greenhouse Industry"*** in the April newsletter, in response to the dilemma with the term **greenhouse effect** was, *"If you have any ideas for a **good phrase** let me know. If I am off-the-wall let me know that too. If you have an editorial to present to our partners and CCEA Scientific Advisors please let me know and I'll consider it for a subsequent issue!!*

Only ***Dr Tadashi Takakura*** responded to the article. He recognized the dilemma but wasn't sure he had a good substitute phrase for the term *greenhouse effect.* I can conclude that many of you feel that it is not a problem, or that you didn't have time to read the article or like me, you don't have a good suggestion for a name change. Anyhow, in this issue I'm enclosing an interesting article written by Scientific Advisory Panel member ***Peter Van Weel*** and a colleague. I would like to have your opinion on this article as well. ***Dr KC Ting*** has already commented that ***Peter*** is on the same wave length with our department's view of phytomation in the next century.

This photo of Peter was taken in his Research Facility at Aalsmeer by your Director with a digital camera. On my return trip home from teaching at MAICH in Chania Crete in May, I stopped to visit Peter and he was kind enough to take me to several greenhouse ranges and two research installations.

Dynamics in Science and Technology: Agrophysics, Information and Communication Technology in Crop Production.

J. Meuleman and P. van Weel, The Hague (The Netherlands), National Council for Agricultural Research (NRLO), Report 97/24, 1997.

Summary

Directing the human mind to become sensitive to the demands of the society of tomorrow is the key to gearing the development of science and technology and to stimulating innovations. The energy problem is a good example: since the total need for energy is less than 0.01 percent of the energy reaching the earth from the sun, there is a great deal of scope for finding sustainable solutions to the problem. Such solutions have not yet been found. Society does not devote enough attention to solving this particular issue. There are enough other, more challenging issues to think about.

A further obstacle to innovation results from increased specialisation and the limits to the human capacity for understanding. Each scientist explores his own square on the chessboard of science, but in a chess game all the pieces should play together. On the one hand this means that human understanding of processes and phenomena is restricted. And tools are necessary to increase that understanding. For example, the simulation and visualisation of processes and phenomena is a powerful tool for increased understanding. On the other hand, there should be links between separate but well-developed specialisms. This process of creating links and improving understanding is the main source of innovation.

Let us consider different areas of science and technology, resting in the natural developments of modern information technology, attempting to discover areas of innovation and tools for exploring them. It is, of course impossible, to give a complete picture. Because the human capacity for understanding has its limits, only the main areas are highlighted.

◊ Process simulation and visualisation develops further and produces tools which are advanced and ‘easy to use’. These tools can be used to study process dynamics, and also to construct, simulate and visualise virtual processes, in order to study its performance over time. Used for projects such as the ‘Betuwelijn’ rail link and the construction of a sea harbour, these tools are also helpful in studying the feasibility of new designs for production processes. Process simulation and visualisation are powerful tools for evaluating improvements in production processes, and even for completing the logistic aspects of new designs, as well as the economic and organisational aspects.

◊ When enough reliable data is available, unknown but systematic process behaviour can be modeled. The behavioural model constructed from the data can be used to realise dynamic control of such processes after modelling high order processes by using artificial intelligence techniques, for example neural and fuzzy-neural systems, especially if the complexity is too great for human understanding. Improved ‘artificial intelligence’ supplies the tools for improving the quality of semi-finished and end products in agriculture. It also is a tool for improving the quality or efficiency of the production process.

Greater insight into complex processes such as plant growth and plant development is made possible by combining a physiological approach and a 'learning-from-the-data' approach. 'Learning from the data' contributes to a better understanding of physiological processes such as plant growth and development, and their coherence. It also allows the combination of knowledge from this domain with knowledge from other domains, for example climate control. As a result, climate control can be based on the potency of the plant with respect to growth and development. Only by measuring growth and development, by using image-processing in combination with additional sensors, and a growth and development model as the basis, the speaking plant concept can be made suitable for operational use. By using the plants as a 'sensor' for the dynamic control of growth and development, it is possible to adjust growth and development to the desired moment of delivery, or to compensate, e.g., very cold or dark periods during the total cultivation period. This results not only in energy saving, but is also a powerful tool for quality control. Energy consumption will thus be related to production volume, realised quality (internal and external) and moment of delivery. Benefits are expected in terms of energy consumption, CO_2 reduction and, for example, reduction of nitrates in leaf vegetables. Plant breeding, climate control, modelling based on neural, hybrid and physiological systems, and image processing in combination will improve production in a protected environment.

◊ After a reduction in the greenhouse-cost element in the product price (currently 10-15%), improvement in the logistic system of the total production process further results in reduced labour costs and a reduction in energy costs. The reduction in energy costs will be partly realised by utilising autonomous developments in the field of energy. As stated above, the energy from the sun is more than enough for society, including horticulture, to avoid using energy from fossil sources. The process will be intensified by the better utilisation of available energy, combined with dynamic control of growth and development, taking into account realisable growth and development, depending on actual values of the parameters of growth and development models (for example light, temperature,..). In the coming decade autonomous developments in the field of energy are the increasing efficiency of solar energy systems, and the realisation of efficient industrial production of solar-energy cells. These developments require that society as a whole should work to find ways to store the over-supply of energy in the summer for use in the winter.

◊ On the one hand, the consumer market is calling for greater differentiation in product supply (consumer pull), on the other hand economies of scale result in fewer, but larger production units. Moreover, production per m^2 continues to increase. The transition from the current trend of 'producer push' to 'consumer pull' requires greater flexibility in production with respect to varieties, sizes, etc. Large production facilities. This conflict of interest can only be solved by developing flexible, modular systems for mechanisation and automation.

◊ An important way to meet consumer demand for greater differentiation is to pay more attention to product presentation. This may involve anything from the packaging of flowers and pot plants to the selling of lettuces 'ready-prepared' or in mixtures.

◊ The robotizing of the production process is an autonomous development, given the initiatives in the field of robotics in Japan and in Germany. It is more effective for agricultural practise, and more profitable for the agricultural industry, if the process concentrates on making these new tools suitable for agricultural tasks. Agriculture has its own specific problems with respect to robotizing. This is because of the biological nature of the products and the way in which they are produced. So we should concentrate less on the development of the 'body', and more on the development of 'hands' (end-effectors) and 'eyes' (3-D vision). The development of 3-D vision systems is necessary and essential to make robots suitable for agricultural production. This development is a natural one. Current developments such as PSD-sensors, and initiatives to automate image interpretation are examples of this natural development. However, specific attention should be paid to the particular problems involved in the handling of biological products by robots.

◊ The process of making mechatronic systems, including robots, suitable for agricultural production follows two lines: adapting these systems to meet with agricultural demands, and modification of the cultivation process. Research is required for both, the development of the 'hands and eyes' and the development of a method of cultivation to make crops suitable for robot handling.

◊ Systems for measuring the handling locations with sufficient accuracy are the basis of the development of precision forming systems. Accurate recording can improve production processes by providing agriculture with additional tools. If the sowing location is known, the growing location of the plant is also known within acceptable limits. This information can be used for mechanical weed control, instead of optical recognition of cultivated plants and weeds by mechanical weeders. Systems with sufficient accuracy for measuring locations are the basis of a new field of innovations. Through this innovation, achievements in modern information technology will integrate in primary production processes.

◊ Improved and integrated use of achievements in modern information technology in plant production, apart from location-specific measurements, can contribute to further reductions in the use of chemicals for crop protection by replacing preventive chemical pest control with integrated (biological and chemical) curative pest control.

◊ With regard to internal product quality, the use of magnetism has a great potential. Agricultural products consist mainly of water (dipole); these products are therefore sensitive to magnetism. Innovative techniques can be developed for measuring internal quality through the measurement of water content and mobility. The state of the art within this field of science is such that is possible to develop instruments for measuring internal quality that fulfill the requirements of current processing systems. Further developments in this field can result in relatively inexpensive measuring tools (compared to medical applications), since the costs of intensive data processing are still falling.

◊ The propagation of young plants is advanced, but in this field too innovations are expected. After an initial period of unjustified optimism (the past 15 years) it may be expected that techniques such as cell suspension (somatic embryogenesis) can be used for propagation purposes. This means a new stimulus for the propagation of young plant material in the coming 10 to 15 years.

The developments and expectations for agriculture described here are based on a dual approach. On the one hand, keeping up with natural developments (information technology, robotics) while, on the other hand, utilising innovations as soon as these natural developments have important links to the world of agriculture. Of course, knowledge from several scientific fields of science must be combined to utilise these innovations. The players, each on their own square of the chessboard, have to come together to coordinate the game 'agriculture'. And if the human mind and capacity for understanding is attuned to this.

RESPONSE FROM DR. TAKAKURA

Dear Prof. Roberts:

Regarding so-called "Greenhouse Effect" which you wrote on CCEA Newsletter, I would like to make some comments. It is very misleading expression and it is not actually greenhouse effect if you are talking global warming of the earth. The definition of greenhouse effect is that inside of a greenhouse is warmer than outside and it is due to radiation effect which is called mouse trap. Solar radiation comes in a greenhouse because it is short wave and can get through glass or plastic sheets, but once it is absorbed on the ground or plants inside the greenhouse it can not go out because it is longwave radiation. J. A. Businger, who studied greenhouse physical environment a lot in the Netherlands and he went to US and became a professor of meteorology at University of Washington, Seattle. He discussed this a lot in his chapter in Physics of Plant Environment by van Wijk. His conlcusion is that this radiation balance is only 20 to 30% of the greenhouse warming and the main reason is prevention of ventilation in the case of greenhouses. One of the definite evidences is the experiment by Wood, an English physisist who compared two model greenhouses, one is conventional type of glass and the other is made of quartz which is transparent to longwave radiation in 1900. He could find very slight inside temperature. Businger suggested to use "atmospheric effect" for global warming of the earth but it is too late to correct it. The expression "Greenhouse Effect" was already so popular and easy to remember, since greenhouse is so close to our life by our efforts. So I should say "Greenhouse Effect" for global warming does not logical reason to be called so. I am sure it is too difficult to explain to Jillian, sorry for that.

If you need more information, I will send all documents about this. Similar explanation was done by me at the ASAE meeting in Chicago several years ago when I gave a lecture there.

Best regards, Tadashi

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CCEA ANNUAL MEETING
New Brunswick Area

October 1, 9:00 AM to 12:00 Noon

(Then Join the Glazings Workshop)

October 2:, 1998 2:00 - 4:30 PM

The CCEA annual meeting of the Industrial Advisory Board and the Scientific Advisory Panel, with the Research Faculty, will be held in conjunction with the CCEA sponsored Workshop on Glazings mentioned on page 6 of this Newsletter. We will start the meeting at 9:00 on October first and then join the workshop. We will complete our business following the workshop on October 2, 1998 at 2:00 PM. We should adjourn by 4:30 PM.

GREENHOUSE COVERING RADIATION TRANSMISSION WORKSHOP
October 1 & 2, 1998 [noon to noon]
Rutgers University, New Brunswick, NJ
[Registration deadline 9/1/98]

The major companies in the greenhouse covering industry, greenhouse suppliers & manufacturers, their distributors & salespeople are invited to a workshop which will focus on solar radiation within the greenhouse environment, and the primary effects of the greenhouse covering on the light and heat environment of the crop, as well as, procedures and instrumentation for determining and interpreting glazing transmission. The registration cost of **$500** includes: Pre-workshop study guide, Notebook of lecture outline and notes, Pre-workshop product film test results [optional], Breaks and group dinner.

The *Workshop will be limited to 30 attendees representing the greenhouse glazing industry people and CCEA Partners and Advisory Boards.*

Register by September 1,1998
by http://aesop.rutgers.edu/~ccea for registration and information

Contact Gene Giacomelli, Cook College, Rutgers University
giacomel@bioresource.rutgers.edu
(732) 932-9753 (phone)
(732) 932-7931 (FAX)

....and now the complete details....

ANNOUNCING A WORKSHOP ON GREENHOUSE LIGHT TRANSMISSION

GREENHOUSE COVERING RADIATION TRANSMISSION WORKSHOP

October 1 & 2, 1998 [noon to noon]
Rutgers University, New Brunswick, NJ
[Registration deadline 9/1/98]

Light transmission in greenhouses is a complex topic. There are numerous conclusive studies and many commercial advertisements. Light transmission is difficult to measure, and a challenge to understand. What is the most up to date story?

WHO SHOULD ATTEND? The major companies in the greenhouse covering industry, greenhouse suppliers & manufacturers, their distributors & salespeople.

WHY ATTEND?

- Learn about the complexity of solar radiation within the greenhouse environment, and the primary effects of the greenhouse covering on the light and heat environment of the crop.
- Separate the information and mis-information.
- Know what critical factors to determine before judging the results of a transmission test.
- Gain understanding of procedures and instrumentation for determining and interpreting radiation transmission of greenhouse glazing.
- Become better prepared for completing an in-house test of your own films, or for supporting a professional test program of your product.
- Take advantage of an optional pre-workshop product film test.

REGISTRATION:
$550 per participant, 20% reduction if 3 or more from same company, $300 for CCEA partners. Workshop will be limited to 30 attendees. Register by September 1, 1998 at the following website.
http://aesop.rutgers.edu/~ccea
tel 732 932 9753
fax 732 932 7931
e-mail giacomel@bioresource.rutgers.edu

COST INCLUDES: Pre-workshop study guide. Notebook of lecture outline and notes. Pre-workshop product film test results [optional]. Breaks and group dinner.

DEVELOPED AND SPONSORED BY CCEA, The Center for Controlled Environment Agriculture, and the Department of Bioresource Engineering---Horticultural and Phytomation Engineering Program.

WORKSHOP PROGRAM SUMMARY:
The program contains three Lecture/ Discussion sessions, and a Demonstration session.

PART 1. Background on information and mis-information of the basic physics of the light and heat energy transmission through greenhouse glazings. Components of radiation defined. Definition of units. Measuring radiation transmission. Sensors. Proper [and incorrect] use. Glazing, structure and other factors affecting light transmission in greenhouses. Differences among laboratory tests, short and long-term tests, testing stands, and greenhouse structure test with crop. What is important to the industry and to the grower? Radiation is energy and energy is heat. Macroclimate and microclimate. Greenhouse heat transfer for winter heating and summer cooling.

PART 2. Basic plant physiology and bio-responses to plant environment. What are the needs of the plant? How does the plant use the energy? Manipulating the plant growth with radiation.

PART 3. Discussion on the responsibility of the industry. Considerations for manipulating the radiation which passes through the glazing and reaches the plant. Which wavelengths can be eliminated. Which must be maintained. What to consider when getting a product tested.

PART 4. There will be a demonstration of Greenhouse radiation measurement equipment for parameters including, PAR, solar and total wavebands. Spectroradiometer. Direct and diffuse radiation. [Bioresource Engineering greenhouses]

PRE-WORKSHOP OPTIONS:
Contact us about the optional pre-workshop product film test. [AUGUST 1ST DEADLINE]

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Open Roof Greenhouse Scenario

Many of you know that the current revolution going on in the greenhouse industry is the use of open roof structures. These include sliding thermal screens with no glazing, roofs which roll back, roofs which open at the gutter by sliding and hinging at the ridge and roofs which open at the ridge and hinge at the gutter.

CCEA is undertaking a project to construct a 48 by 60 greenhouse glazed with double poly. It can be reglazed with glass or other glazings in the future. Van Wingerden Greenhouse, a friend of CCEA is providing the greenhouse to us at cost. Construction is planned to begin around the 4th of July at Hort Farm #3, in New Brunswick.

The objective of the experiment is to take environmental and crop data to see how these types of greenhouses actually function.

RECENT CCEA AND DEPARTMENT PUBLICATIONS

GREENHOUSE SOLARIZATION PROJECT

NJAES Paper No. P-03130-05-96 *Solarization Study of Soil in Plastic Greenhouses*. Kania and Roberts. Proceedings 26th National Agricultural Plastic Congress, Atlantic City, New Jersey, June 1996

NJAES Paper no P-03130-27-96. *Soil Temperature Under a Solarized Plastic Greenhouse*. Kania, Takakura and Roberts. NABEC 9623, NABEC Annual meeting, Canaan Valley, West Virginia, August 1996

NJAES Paper No. P 03130-05-98 *Soil Sterilization to Eliminate Diseases from Greenhouses*. Kline, Roberts, Kania and Johnston Proceedings 27th National Agricultural Plastic Congress Feb 18-21, 1998 Tucson, Ariz.

NJAES Paper No. P 03130-06-98 *Simulation Analysis of Solar Sterilization Systems.* Takakura, Roberts and Kania Proceedings 27th National Agricultural Plastic Congress Feb 18-21, 1998 Tucson, Ariz.

UPLIFT CHARACTERISTICS OF FOUNDATION POSTS

NJAES Paper No. P03130-06-96. *Foundation Design for Greenhouse Construction*. Roberts and Kania. Proceedings 26th National Agricultural Plastic Congress, Atlantic City, New Jersey, June 1996

SCREENING FOR INSECT CONTROL

NJAES Paper No. P03130-4-96. *Screening for Insect Exclusion from Greenhouses.* Roberts and Kania. Proceedings 26th National Agricultural Plastic Congress, Atlantic City, New Jersey, June 1996

NJAES Paper No. P03130-09-96. *Insect Barriers for Biological Control with Good Ventilation*. Roberts. Proceedings 26th National Agricultural Plastic Congress, Atlantic City, New Jersey, June 1996

NJAES Paper No. P03130-34-96 *Screening for Insect Control. Presented at New England Greenhouse Conference, 10/21-10/23 1996*

PHYTOREMEDIATION TECHNIQUES

NJAES Paper No. P03130-12-95. *Design of a Plant Nursery System for Phytoremediation Techniques of Contaminated Water*. Giacomelli, Kania, Ting and Raskin.

NJAES Paper No. T-03232 -18-97 *Decision Support for Engineering Phytoremediation Systems Using Rhizofiltration Processes.* Fleisher PhD Thesis Bioresource Engineering Department

NJAES Paper No. D 03232-3—97 *Removal of Uranium from Water using Terrestrial Plants* Flesisher and Ting. Published in Environmental Science and Technology, Vol 31 # 12, 1997

BURLINGTON ECO-COMPLEX GREENHOUSE

NJAES Paper No. P03130-12-96. *A Methane Powered, Co-Generation One Acre R&D Greenhouse*. Roberts and Manning. NABEC 9623, NABEC Annual meeting, Canaan Valley, West Virginia, August 1996.

NJAES Paper No. P03130-13-96. *R&D Research/Demonstration Greenhouse using Methane Gas from a Landfill for Co-generation*. Roberts. International Symposium on Plant Production in Closed Ecosystems ACE Narita, Japan, August 1996.

NJAES Paper # NJAES P03130-23-97 *A Research and Demonstration Greenhouse Using Methane Gas from a Resource Recovery Facility* Roberts, International Symposium on Agricultural Mechanization and Automation, Taipei, Taiwan November 17-22, 1997

MACHINE VISION AND OTHER APPLICATIONS FOR AUTOMATION

NJAES Paper No. D-03232-29-96. *Machine Vision Techniques for Measuring the Canopy of Tomato Seedlings*. Ling and Ruzhitsky. Journal of Agricultural Engineering Research.

NJAES Paper No R-03232-03-96. *Classification of Lettuce Seedlings using Machine Vision and Artificial Neural Networks.* Lousma. Final Report of Netherlands Student's report.