

## *Curriculum Vitae*

Arend-Jan Both

Assistant Extension Specialist  
Bioresource Engineering  
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### **EDUCATION**

- Ph.D. January 1995  
Cornell University, Department of Agricultural and Biological Engineering. Major: Structures and their Environment; Minors: Floriculture and Ornamental Horticulture, and Meteorology.
- M.S. November 1988  
Agricultural University in Wageningen, the Netherlands. Department of Agricultural Engineering. Major: Structures and their Environment; Minors: Computer Science and Business Management.
- B.S. May 1986  
Agricultural University in Wageningen, the Netherlands. Field: Agricultural Engineering.

### **PROFESSIONAL EXPERIENCE**

- Assistant Extension Specialist (equivalent to Assistant Professor)  
January 2000 - present  
Rutgers, The State University of New Jersey. Bioresource Engineering, Department of Plant Biology and Pathology.
- Director, Center for Controlled Environment Agriculture, Cook College.  
July 2000 - present  
Center of Excellence at Rutgers, The State University of New Jersey.
- Research Associate and Project Coordinator  
June 1997 - December 1999  
Cornell University, Department of Agricultural and Biological Engineering. Job description: Project coordinator for the construction and operation of a commercially scaled hydroponic lettuce production greenhouse facility.

## Post Doctoral Associate

December 1994 - May 1997

Cornell University, Departments of Floriculture and Ornamental Horticulture, and Agricultural and Biological Engineering. Topic: Hydroponic vegetable production in Controlled Environment Agriculture (CEA) greenhouses with an emphasis on Bibb lettuce production in a floating hydroponic system.

## HONORS

The Honor Society of Agricultural, Food, and Biological Engineering: Alpha Epsilon. March 1999.

The Honor Society of Agriculture: Gamma Sigma Delta. May 1993.

## AWARDS

Merle V. Adams Award for Outstanding Achievement as a Junior Faculty Member. December 2005.

Department of Extension Specialists, Cook College, Rutgers University.

Blue Ribbon Award, ASAE 2005 Educational Aids Competition. July 2005. Workbook: Lighting up profits: Understanding greenhouse lighting. P.R. Fisher, E. Runkle (eds.), and A.J. Both (major contributor).

Gold Star Award for the paper: Goudarzi, S. and A.J. Both. 2004. Accounting for performance decrements in crew time calculations for space missions. Presented at the 34th International Conference on Environmental Systems, July 19-22, Colorado Springs, Colorado. SAE Technical Paper No. 2004-01-2362. As a result, this paper was also published in the *SAE 2004 Transactions Journal of Aerospace*. pp. 630-634. (published July 2005).

Extension Specialist of the Year. December 2003. Department of Agricultural and Resource Management Agents, Cook College, Rutgers University.

Blue Ribbon Award, ASAE 2003 Educational Aids Competition. July 2003. Horticultural Engineering Newsletter (previous issues can be downloaded from: <http://aesop.rutgers.edu/~horteng>).

ASAE Standards Developers Award. July 2002. ASAE. (Revision of Engineering Practice EP411).

Rutgers Cooperative Extension Team Award, Presented to the Vegetable Working Group. December 2001.

Blue Ribbon Award, ASAE 2001 Educational Aids Competition. July 2001. Horticultural Engineering Web Site: <http://aesop.rutgers.edu/~horteng>.

Honorable Mention in the Select Paper Award Program, sponsored by IET Division of ASAE. July, 2000. Kang, S., Y. Ozaki, K.C. Ting, and A.J. Both. 2000. Identification of appropriate level of automation for biomass production systems within an advanced life support system. ASAE paper No. 003075. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. 12 pp.

## PROFESSIONAL SOCIETIES AND ACTIVITIES

Associate Editor, Transactions of the ASAE and Applied Engineering in Agriculture. 2003-2006.

Secretary, Chair International Committee for Controlled Environment Guidelines, 2002-present.

Member of the International Society for Horticultural Science (ISHS).

Member of the Society for Engineering in Agricultural, Food, and Biological Systems (ASAE).

Officer of SE-303, Committee on Environment of Plant Structures, ASAE (2001-2004).

Member of P-208, Extension Committee, ASAE (2001-present).

Member of SE-406, Nursery and Greenhouse System Engineering (2004-present).  
Secretary of the NE-1017 Regional Committee on Developing and Integrating Components for Commercial Greenhouse Production Systems (2006).  
Secretary, Vice Chair, Chair of the NCR-101 Regional Committee on Controlled Environment Technology and Use (2000-2002).  
Secretary, Chair of the NE-164 Regional Committee on Decision Support for Design and Control of Plant Growth Systems (2000-2001).  
Member of the Rutgers Cooperative Extension Vegetable Working Group (2000-present).  
Member of the Rutgers Cooperative Extension Greenhouse Working Group (2001-present).

Coordinated a revision of the ANSI/ASAE Engineering Practice EP411 titled: "Guidelines for measuring and reporting environmental parameters for plant experiments in growth chambers" (2001).

#### Reviewer

USDA SBIR Plant Production and Protection (Engineering) 2005 (2 proposals).  
United States-Israel BARD Fund. 2003 (1 proposal).  
USDA SBIR Plant Production and Protection (Engineering) 2003 (15 proposals).  
Reviewer for the OARDC International Collaboration Competition, The Ohio State University 2002 (1 proposal).  
Peer reviewer of the book "Total Crop Management: A Guide to Greenhouse Crop Production". NRAES Publication No. 158. 2002.  
Peer reviewer of Chapter 21 "Environmental Control for Animals and Plants", ASHRAE's HVAC Applications Handbook. 2002.  
Judge, ASAE Educational Aids Competition, Publications: Manuals and Workbooks. 2002 (10 entries).  
USDA SBIR Plant Production and Protection (Engineering) 2002 (13 proposals).  
NASA MarsPort Engineering Design Student Competition 2002 (2 proposals).  
Reviewer for the OARDC Research Enhancement Competitive Grant Competition, The Ohio State University 2001 (1 proposal).  
Peer reviewer of the book "Energy Conservation for Commercial Greenhouses". NRAES Publication No. 3. 2001.  
Peer reviewer for papers in the following journals:

Acta Horticulturae (ISHS) (3)  
Computers and Electronics in Agriculture (2)  
Illuminating Engineering Society of North America Conference Proceeding (1)  
Transactions of the ASAE (7)  
Applied Engineering in Agriculture (2)  
HortTechnology (2)  
HortScience (1)  
Society of Automotive Engineers (1)  
Journal of Life Support and Biosphere Science (1)  
COSPAR (Committee on Space Research) (1)  
Journal of the American Society for Horticultural Science (6)

## **RUTGERS UNIVERSITY SERVICE**

Member of the search committee for greenhouse manager at the NJ EcoComplex, 2005  
Co-chair of the NJ EcoComplex Greenhouse Advisory Committee, 2003-present  
Member of the search committee for head greenhouse field technician, 2003  
Member of the external review preparation committee, Plant Biology and Pathology, 2002-present  
Member of the search committee for the chair in Plant Biology and Pathology, 2001-2002  
Member of the awards committee for the Department of Extension Specialists, 2001-2002  
Member of the proposal review committee for the PEG Program (NJAES & RCE), Spring 2001  
Member of the search committee for a faculty member in Horticultural Engineering, 2000-2001

## **RESEARCH INTERESTS**

1. Controlled Environment Agriculture, especially greenhouse environment control and the interaction of plants with the greenhouse environment.
2. Supplemental lighting for greenhouse crop production.
3. Crop modeling.
4. Application of systems engineering to controlled environment plant production.

## **PUBLICATIONS**

### Theses

Both, A.J. 1995. Dynamic simulation of supplemental lighting for greenhouse hydroponic lettuce production. Ph.D. Dissertation. Cornell University Libraries, Ithaca, NY 14853. 172 pp.  
Both, A.J. 1988. Modelvorming en computersimulatie van natuurlijke ventilatie in varkensstallen (Computer simulation of natural ventilation in pig barns). In Dutch. M.S. Thesis, Department of Agricultural Engineering, Agricultural University Wageningen, the Netherlands. 198 pp.

### Refereed journal articles

Lefsrud, M., D. Kopsell, R. Augé, and A.J. Both. 2006. Biomass Production and Pigment Accumulation in Kale Grown Under Increasing Photoperiods. Accepted for publication in HortScience.

Fleisher, D.H., L.S. Logendra, C. Moraru, A.J. Both, J. Cavazzoni, T. Gianfagna, T.C. Lee, and H. Janes. 2006. Effect of temperature perturbations on tomato (*Lycopersicon esculentum* Mill.) quality and production scheduling. Journal of Horticultural Science and Biotechnology 81(1):125-131.

Mathieu J., R. Linker, L. Levine, L. Albright, A.J. Both, R. Spanswick, R. Wheeler, E. Wheeler, D. deVilliers, R. Langhans. 2005. Evaluation of the NiCoLet Model for Simulation of Short-Term Hydroponic Lettuce Growth and Nitrate Uptake. Submitted to Biosystems Engineering.

Goudarzi, S., A.J. Both, J. Cavazzoni, and A. Kusnecov. 2005. Dynamic modeling of crew performance. In Press. Journal of Human Performance in Extreme Environments.

Goudarzi, S. and A.J. Both. 2004. Accounting for performance decrements in crew time calculations for space missions. Presented at the 34th International Conference on Environmental Systems, July 19-22, Colorado Springs, Colorado. SAE Technical Paper No. 2004-01-2362. Also published in the *SAE 2004 Transactions Journal of Aerospace*. pp. 630-634. (published July 2005).

- Armitage, A.M., M.P. Bridgen, A.J. Both, D. Hamrick, R.D. Heins, W.B. Miller, G.L. Staby, T.C. Weiler, and W.R. Woodson. 2004. Views of floriculture in the last 25 years. Submitted to Journal of the American Society for Horticultural Science.
- Kang, S. and A.J. Both. 2002. A management information system for food nutritional analysis and biomass production in an advanced life support system. Journal of Life Support and Biosphere Science 8(3/4):191-197. NJAES Paper No. D-70501-03-02.
- Goudarzi, S., J. Cavazzoni, and A.J. Both. 2002. Dynamic modeling of crew performance for long duration space missions. Presented at the 32<sup>nd</sup> International Conference on Environmental Systems, July 15-18, San Antonio, Texas. SAE Technical Paper No. 2002-01-2497. NJAES Paper No. H-70501-01-02.
- Kang, S., K.C. Ting, and A.J. Both. 2001. Systems studies and modeling of advanced life support systems. Agricultural and Biosystems Engineering 2(2):41-49. NJAES Paper No. P-70501-17-01.
- Ciolkosz, D.E., A.J. Both, and L.D. Albright. 2001. Selection and placement of greenhouse luminaires for uniformity. Applied Engineering in Agriculture 17(6):875-882.
- Albright, L.D., A.J. Both, and A.J. Chiu. 2000. Controlling greenhouse light to a consistent daily integral. Transactions of the ASAE 43(2):421-431.
- Thompson, H.C., R.W. Langhans, A.J. Both, and L.D. Albright. 1998. Shoot and root temperature effects on growth of lettuce, *Lactuca sativa*, in a floating hydroponic system. Journal of the American Society for Horticultural Science 123(3):361-364.

#### Refereed conference proceedings

- Both, A.J., E. Reiss, D.R. Mears, and W. Fang. 2005. Designing environmental control for greenhouses: Orchid production as example. Acta Horticulturae 691(2):807-813.
- Reiss, E., A.J. Both, S. Garrison, W. Kline, and J. Sudal. 2004. Season extension for tomato production using high tunnels. Acta Horticulturae 659:153-160.
- Mears, D.R. and A.J. Both. 2002. A positive pressure ventilation system with insect screening for tropical and subtropical greenhouse facilities. Acta Horticulturae 578:125-132.
- Both, A.J., D.E. Ciolkosz, and L.D. Albright. 2002. Evaluation of light uniformity underneath supplemental lighting systems. Acta Horticulturae 580:183-190.
- Both, A.J., L.D. Albright, S.S. Scholl, and R.W. Langhans. 1999. Maintaining constant root environments in floating hydroponics to study root-shoot relationships. Acta Horticulturae 507:215-221.
- Albright, L.D., A.J. Both, R.W. Langhans, and E.F. Wheeler. 1999. Dimensionless growth curves as a simple approach to predict the vegetative growth of lettuce. Acta Horticulturae 507:293-300.
- Both, A.J., L.D. Albright, and R.W. Langhans. 1998. Coordinated management of daily PAR integral and carbon dioxide for hydroponic lettuce production. Acta Horticulturae 456:45-51.
- Ciolkosz, D.E., L.D. Albright, and A.J. Both. 1998. Characterizing evapotranspiration in a greenhouse lettuce crop. Acta Horticulturae 456:255-261.
- Both, A.J., L.D. Albright, R.W. Langhans, B.G. Vinzant, and P.N. Walker. 1997. Electric energy consumption and PPF<sub>i</sub> output of nine 400 watt high pressure sodium luminaires and a greenhouse application of the results. Acta Horticulturae 418:195-202.
- Both, A.J., L.D. Albright, R.W. Langhans, R.A. Reiser, and B.G. Vinzant. 1997. Hydroponic lettuce production influenced by integrated supplemental light levels in a controlled environment agriculture facility: experimental results. Acta Horticulturae 418:45-51.
- Both, A.J., L.D. Albright, C.A. Chou, and R.W. Langhans. 1997. A microwave powered light source for plant irradiation. Acta Horticulturae 418:189-194.
- Both, A.J., A.R. Leed, E. Goto, L.D. Albright, and R.W. Langhans. 1996. Greenhouse spinach production in a NFT system. Acta Horticulturae 440:187-192.

Goto, E., A.J. Both, L.D. Albright, R.W. Langhans, and A.R. Leed. 1996. Effect of dissolved oxygen concentration on lettuce growth in floating hydroponics. *Acta Horticulturae* 440:205-210.

#### Book chapters

- Fisher, P., A.J. Both, R. Heins, and A. Enfield. 2004. Lighting plugs and liners, Chapter 9. In 'Lighting Up Profits, Understanding Greenhouse Lighting', P. Fisher and E. Runkle, eds. Published by Meister Media Worldwide, Willoughby, OH. pp. 57-61.
- Fisher, P. and A.J. Both. 2004. Photoperiod control through technology options and their costs. Chapter 8. In 'Lighting Up Profits, Understanding Greenhouse Lighting', P. Fisher and E. Runkle, eds. Published by Meister Media Worldwide, Willoughby, OH. pp. 51-56.
- Both, A.J. 2004. Carbon dioxide enrichment in greenhouses. Chapter 7. In 'Lighting Up Profits, Understanding Greenhouse Lighting', P. Fisher and E. Runkle, eds. Published by Meister Media Worldwide, Willoughby, OH. pp. 47-50.
- Fisher, P. and A.J. Both. 2004. Supplemental lighting technology and costs. Chapter 6. In 'Lighting Up Profits, Understanding Greenhouse Lighting', P. Fisher and E. Runkle, eds. Published by Meister Media Worldwide, Willoughby, OH. pp. 43-46.
- Both, A.J. and J. Faust. 2004. Light transmission in greenhouse design and coverings. Chapter 4. In 'Lighting Up Profits, Understanding Greenhouse Lighting', P. Fisher and E. Runkle, eds. Published by Meister Media Worldwide, Willoughby, OH. pp. 33-38.
- Fleisher, D.H., L.F. Rodriguez, A.J. Both, J. Cavazzoni, and K.C. Ting. 2002. Advanced life support systems in space. Submitted to CIGR Handbook of Agricultural Engineering. Volume 6: Information Technology.

#### Non-refereed publications

- Reiss, E., A.J. Both, and D.R. Mears. 2005. Comparing greenhouse floor heating designs using CFD. ASAE paper No. 05-4136. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. 19 pp.
- Sager, J.C., J.H. Norikane, A.J. Both, and T.W. Tibbitts. 2005. Quality assurance for environment of plant growth facilities. ASAE paper No. 05-4137. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. 11 pp.
- Reiss, E., A.J. Both, and D.R. Mears. 2004. Greenhouse floor heating. ASAE paper No. 04-4040. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. 13 pp.
- Both, A.J. 2004. Rutgers high tunnel research. Proceedings of the 49th New Jersey Annual Vegetable Growers' Association Meeting, Borgata Hotel Casino and Spa, Atlantic City, NJ. pp. 83-90.
- Both, A.J. 2004. Greenhouse environment control. Proceedings of the 49th New Jersey Annual Vegetable Growers' Association Meeting, Borgata Hotel Casino and Spa, Atlantic City, NJ. pp. 91-95.
- Reiss, E., D.R. Mears, and A.J. Both. 2003. Greenhouse floor heating. ASAE paper No. 03-4039. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. 14 pp.
- Fleisher, D.H., A.J. Both, C. Moraru, L. Logendra, T. Gianfagna, T.C. Lee, H. Janes, and J. Cavazzoni. 2003. Manipulation of tomato fruit quality through temperature perturbations in controlled environments. ASAE paper No. 03-4102. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. 9 pp.
- Sase, S., E. Reiss, A.J. Both, and W.J. Roberts. 2002. A natural ventilation model for open-roof greenhouses. ASAE paper No. 02-4010. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. NJAES Paper No. P-12232-04-02. 9 pp.
- Hsiang H., S. Kang, A.J. Both, and K.C. Ting. 2001. Analysis tool for food processing and nutrition (FPN) subsystem in an advanced life support system (ALSS). ASAE paper No. 01-3020. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. NJAES Paper No. P-70501-12-01. 16 pp.

- Kang, S. and A.J. Both. 2001. A management information system for food nutritional analysis and biomass production in an advanced life support system. ASAE paper No. 01-3021. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. NJAES Paper No. P-70501-11-01. 10 pp.
- Reiss, E., W.J. Roberts, and A.J. Both. 2001. Design and construction of an open-roof greenhouse with heated ebb and flood floor irrigation system. Presented at the CSAE/SCGR-NABEC Meeting in Guelph, Ontario, July 8-11, 2001. NABEC Paper No. 01-916. NJAES Paper No. P-03232-14-01. 13 pp.
- Both, A.J., E. Reiss, D.R. Mears, and W.J. Roberts. 2001. Open-roof greenhouse design with heated ebb and flood floor. ASAE paper No. 01-4058. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. NJAES Paper No. P-03232-15-01. 13 pp.
- Kang, S., K.C. Ting, and A.J. Both. 2000. Systems studies and modeling of advanced life support system. Proceedings of the 3<sup>rd</sup> International Conference on Agricultural Machinery Engineering (ICAME 2000). November 13-16, Seoul, Korea. pp. 623-631. NJAES Paper No. P-70501-13-00.
- Mears, D.R. and A.J. Both. 2000. Insect exclusion from greenhouses. Proceedings of the 15<sup>th</sup> Workshop on Agricultural Structures and ACESYS (Automation, Culture, Environment, and Systems) IV Conference. December 4-5, Tsukuba, Japan. pp. 18-26. NJAES Paper No. P-03130-23-00.
- Kang, S., Y. Ozaki, K.C. Ting, and A.J. Both. 2000. Automation for biomass production within advanced life support systems. Second IFAC/CIGR International Workshop on Bio-robotics, Information Technology, and Intelligent Control for Bioproduction Systems. November 25-26, 2000. Osaka, Japan. pp. 275-280. NJAES Paper No. P-70501-14-00.
- Kang, S., Y. Ozaki, K.C. Ting, and A.J. Both. 2000. Identification of appropriate level of automation for biomass production systems within an advanced life support system. ASAE paper No. 003075. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. 12 pp. NJAES Paper No. P-70501-11-00.
- Both, A.J. 2000. Some thoughts on supplemental lighting for greenhouse crop production. Presentation at the Environmental Control and Design of Greenhouse Systems Short Course, January 10-11, 2000. Cook College, Rutgers University. NJAES Research Paper No. P-03130-35-99. 10 pp.
- Both, A.J., L.D. Albright, and R.W. Langhans. 1999. Design of a demonstration greenhouse operation for commercial hydroponic lettuce production. ASAE paper No. 994123. ASAE, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. 12 pp.
- Both, A.J., S.S. Scholl, L.D. Albright, and R.W. Langhans. 1998. Comparing continuous lettuce production in nutrient film technique and floating hydroponics. Proceedings of the 15th International Lettuce Conference and Leafy Vegetable Crops Workshop. September 23-26, 1998. Atlantic City, NJ. pp. 16-17.
- Both, A.J. 1994. HID lighting in horticulture: a short review. Presented at the Greenhouse Systems, Automation, Culture and Environment Conference, July 20-22. New Brunswick, NJ. Northeast Regional Agricultural Engineering Service, Publication No. 72. Cornell Cooperative Extension, Cornell University, Riley-Robb Hall, Ithaca, NY 14853. pp. 208-222.
- Albright, L.D. and A.J. Both. 1994. Comparison of luminaires: efficacies and system design. Proceedings of the International Lighting for Plants in Controlled Environments Workshop. University of Wisconsin, Madison, WI. March 27-30. NASA Conference Publication CP-3309. pp. 281-297.

- Both, A.J. 1994. Luminaire layout: design and implementation (short report). Proceedings of the International Lighting for Plants in Controlled Environments Workshop. University of Wisconsin, Madison, WI. March 27-30, 1994. NASA Conference Publication CP-3309. pp. 299-301.
- Both, A.J., L.D. Albright, R.W. Langhans, B.G. Vinzant, and P.N. Walker. 1992. Research on energy consumption of HID lighting. Proceedings of the 4th National CAEP Agricultural Demand-Side Management Conference. Syracuse, NY. October 20-22. Northeast Regional Agricultural Engineering Service, Publication No. 65. Cornell Cooperative Extension, Cornell University, Riley-Robb Hall, Ithaca, NY 14853. pp. 125-134.
- Albright, L.D. and A.J. Both. 1990. Screening materials for thrips exclusion in greenhouses. Proceedings of the fifty-second annual New York State Pest Management Conference. Cornell University, Ithaca, NY 14853, USA. November 12-15. 7 pp.
- Ooster, A. van 't and A.J. Both. 1988. Towards a better understanding of relations between building design and natural ventilation in livestock buildings. Proceedings of the 3rd International Livestock Environment Symposium, April 25-27, Toronto, Canada. American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085-9659, USA. pp. 8-21.

#### Research reports

- Keren, R.D., C.M. Danis, W.P. Cowgill, A.J. Both, and D. Lewis. 2003. Enhancing the Hunterdon County agricultural economy. Final report to the Hunterdon Economic Partnership. 41 pp.
- L.D. Albright, I. Seginer, R.W. Langhans, R.M. Welch, L. Levine, W. Berry. R. Linker, J. Lea-Cox, R. Wheeler, A.J. Both, T. Englert, S. Black, D. deVilliers, J. Mathieu, C. Johnson. 2000. Modeling of the relationship between nitrate concentration and carbohydrate partitioning in hydroponic lettuce, *Lactuca sativa*, L. Nicolet Project Report, Experimental Results.
- Langhans, R.W., L.D. Albright, and A.J. Both. 1999. Hydroponic vegetable production in controlled environment agriculture facilities. Final Report to NYSERDA, ESEERCO and NYSEG. March, 1999. Cornell University, Ithaca, NY 14853. 62 pp.
- Langhans, R.W., J. Bandy, A.R. Leed, D.J. Tennessen, B.G. Vinzant, T.C. Weiler, L.D. Albright, A.J. Both, E. Goto, E.F. Wheeler, C. Zou, B.A. Ingall, J. Kossowski, M.P. Pritts, L.D. Topoleski, D.E. Wilcox, J.D. Novak, G.B. White, and A.G. Taylor. 1994. A definition of problems involved in design and operation of the controlled environment life support system (CELSS) in the human-rated test facility (HRTF). Johnson Space Center. NASA Grant NAG 9-715.144 pp.
- Langhans, R.W., L.D. Albright, A.J. Both, A.R. Leed, B.G. Vinzant, and T.C. Weiler. 1994. Energy efficiency in controlled environment agriculture (CEA) facilities. Interim Report to NYSERDA, ESEERCO and NYSEG. March 15, 1994. Cornell Univ., Ithaca, NY. 291 pp.
- Both, A.J. 1991. Review paper on the use of artificial light in horticulture. Internal report, Department of Agricultural and Biological Engineering, Cornell University, Ithaca, NY, USA. 58 pp.

#### Abstracts

- Both, A.J., L.S. Logendra, J. Cavazzoni, T. Gianfagna, T.C. Lee, and H.W. Janes. Effects of a two-week temperature perturbation during flowering of tomato (*Lycopersicon esculentum Mill.*). *Habitation* 10(3/4):131.
- Both, A.J., E. Reiss, J. Sudal, K. Holmstrom, W. Kline, S. Garrison. 2006. Rutgers high tunnel research update. Proceedings of the Annual NJ Vegetable Growers' Association Meeting. January 10-12. Atlantic City. pp. 121-124.
- Both, A.J. 2005. Rutgers high tunnel research update. Proceedings of the Annual NJ Vegetable Growers' Association Meeting. January 11-13. Atlantic City. pp. 40-41.



- Moraru, C., T.C. Lee, D.H. Fleisher, L.S. Logendra, A.J. Both, and H. Janes. 2004. Quality of hydroponically grown tomatoes subjected to a 14-day, 5°C temperature perturbation during fruit set. Institute of Food Technologists Annual Meeting. July 12-16, Las Vegas, NV.
- Both, A.J. 2004. Which structure is best for you? Proceedings of the Empire State Fruit and Vegetable Expo. February 9-12. Rochester, NY. pp. 43.
- Both, A.J. 2004. Updating high tunnel research at Rutgers University. Proceedings of the Mid Atlantic Fruit and Vegetable Convention. January 27-29. Hershey, PA. pp. 6-8.
- Fleisher, D., A.J. Both, L. Logendra, C. Moraru, T. Gianfagna, T.C. Lee, J. Cavazzoni, and H. Janes. 2004. Short-term temperature effects on hydroponically grown tomatoes – I: Production scheduling. Habitation 2004. January 4-7. Orlando Florida. Habitation 9(3/4):123.
- Lee, T.C., A.J. Both, C. Moraru, D. Fleisher, L. Logendra, T. Gianfagna, J. Cavazzoni, and H. Janes. 2004. Short-term temperature effects on hydroponically grown tomatoes – II: Quality of tomato fruits. Habitation 2004. January 4-7. Orlando Florida. Habitation 9(3/4):128.
- Both, A.J. 2003. Crop production in high tunnels. Proceedings of the Annual NJ Vegetable Growers' Association Meeting. January 14-16. Atlantic City. pp. 89-90.
- Both, A.J. 2002. Options in greenhouse coverings. Proceedings of the Annual NJ Vegetable Growers' Association Meeting. January 15-17. Atlantic City. pp. 99-100.  
Also published in Long Island Horticulture News, December 2001 issue.
- Rodriguez, L.F., A.J. Both, A.B.O. Soboyejo, K.C. Ting. 2001. The effect of uncertainty in analyses of advanced life support systems. Proceedings of the annual Meeting of the American Society for Gravitational and Space Biology, Alexandria, VA. Gravitational and Space Biology Bulletin 15(1):14.
- Both, A.J. 2001. Making sure your greenhouse is ready for spring. Proceedings of the Annual NJ Vegetable Growers' Association Meeting. January 16-18. Atlantic City. pp. 98-99.
- de Villiers, D.S., R.W. Langhans, A.J. Both, L.D. Albright, and S.S. Scholl. 1999. Intermittent CO<sub>2</sub> enrichment for hydroponic lettuce production. HortScience 34(3):532.

#### Posters

- Fleisher, D.H., A.J. Both, L. Logendra, C. Moraru, T. Gianfagna, T.C. Lee, J. Cavazzoni, and H. Janes. 2004. Short-term temperature effects on hydroponically grown tomatoes – I: Production Scheduling. Presented at the Habitation Conference on Space Habitation Research and Technology Development in Orlando, FL. January 7-10, 2004.
- Rodriguez, L.F., A.J. Both, A.B.O. Soboyejo, and K.C. Ting. 2001. The effect of uncertainty in analyses of advanced life support systems. Presented at NASA's PI and the American Society of Gravitational and Space Biology meeting in Alexandria, VA. November 7-10, 2001.
- Rodriguez, L.F., H. Hsiang, Y. Ozaki, S. Kang, S. Goudarzi, D.H. Fleisher, K.C. Ting, and A.J. Both. 2000. Top-level modeling of an ALSS utilizing object oriented techniques. Presented at NASA's Life Support and Biosphere Science meeting in Baltimore, MD. August 7-9, 2000.
- Cavazzoni, J., D.H. Fleisher, T. Gianfagna, L. Logendra, A.J. Both, and G.A. Giacomelli. 2000. Biomass production projects for the NJ-NSCORT. Presented at NASA's Life Support and Biosphere Science meeting in Baltimore, MD. August 7-9, 2000.

#### Magazine articles

- Both, A.J. and D.R. Mears. 2006. Building and maintaining greenhouses with energy conservation in mind. Greenhouse Management and Production (GMPRO). May issue. pp. xx-xx.
- Both, A.J. 2006. How to keep your greenhouse cool this summer. Greenhouse Management and Production (GMPRO). April issue. pp. 45-48.
- Both, A.J. 2005. Agricultural management practices aim to help resolve legal conflicts. Greenhouse Management and Production (GMPRO). June issue. pp. 43-46.

- Both, A.J. 2005. Is your greenhouse strong enough? Greenhouse Management and Production (GMPRO). May issue. pp. 38-41.
- Both, A.J. 2004. Greenhouse becomes 43rd ASAE historic landmark. Resource magazine (ASAE). September issue. pp 19.
- Both, A.J. 2004. Supplemental lighting. Greenhouse Product News 14(12):48-53 (reprint from OFA Bulletin July/August 2003).
- Fisher, P., A.J. Both, R. Heins, and A. Enfield. 2004. Lighting plugs and liners. Greenhouse Grower. September issue. pp. 22-26.
- Ross, D.S. and A.J. Both. 2004. Inventor of air-inflated double-layer polyethylene greenhouse honored. Mid-Atlantic Grower 6(10) August Issue. pp. 6-7.
- Both, A.J. 2004. Insect screening. American Vegetable Grower. June issue. p. 28.
- Both, A.J. 2004. Comparing greenhouse coverings. American Vegetable Grower. June issue. pp. 23-24.
- Both, A.J. 2004. Greenhouse temperature management. Greenhouse Management and Production (GMPRO). April issue. pp. 38-42.
- Fisher, P. and A.J. Both. 2004. Photoperiod control: technology options and costs. Greenhouse Grower. March issue. pp. 42-49.
- Fisher, P. and A.J. Both. 2004. Supplemental lighting: technology and costs. Greenhouse Grower. February issue. pp. 86-94.
- Both, A.J. and J.E. Faust. 2003. Light transmission: greenhouse design and coverings. Greenhouse Grower. December issue. pp. 82-86.
- Both, A.J. 2003. Oil or gas? Strategies to reduce greenhouse energy bills. Mid-Atlantic Grower (5)11 October issue. pp. 18-19.
- Both, A.J. 2003. Supplemental Lighting: Part 2. OFA Bulletin. September/October issue. pp. 1, 10-11.
- Both, A.J. 2003. Supplemental Lighting. OFA Bulletin. July/August issue. pp. 16-18.
- Both, A.J. 2003. Considering supplemental lighting? Here are some data that may help you decide. International Cut Flower Growers Association Bulletin. April issue. pp. 24-28.
- Both, A.J. 2003. Hydroponic lettuce research. Practical Hydroponics and Greenhouses. May/June issue. pp. 40-47.
- Both, A.J. 2003. Supplemental lighting. Can it help you grow better crops? Greenhouse Management and Production (GMPRO). Spring Edition. pp. 34-37.
- Both, A.J., D.R. Mears, E. Reiss, W.J. Roberts. 2002. Greenhouse floor heating. Greenhouse Management and Production (GMPRO). August issue. pp. 60-63.
- Both, A.J. 2002. How to design a mechanical ventilation system. Greenhouse Management and Production (GMPRO). May issue. pp. 67-73.
- Both, A.J. 2002. Greenhouse covering options. Greenhouse Management and Production (GMPRO). April issue. pp. 49-50.
- Both, A.J. 2002. Optimize your production environment. Greenhouse Management and Production (GMPRO). Spring Edition. pp 46-50.
- Both, A.J. 2001. The quonset climate. GrowerTalks. August issue. p. 128.
- Both, A.J. 2001. Ten ways to reduce your energy bill. Greenhouse Grower. July issue. pp. 56-62.
- Both, A.J. 2000. It's Cold Out! So Why Ventilate? GrowerTalks. December issue. pp. 82-84.
- Both, A.J. 2000. Should you use supplemental lighting? Greenhouse Management and Production (GMPRO). May issue. pp. 42-50.
- Both, A.J. and L.D. Albright. 2000. A controlled environment. Cover story in Resource Magazine (ASAE). May issue. pp. 7-8.

#### Newsletters

Both, A.J. 2002. Greenhouse ventilation. Cultivating Cumberland, Volume 7, Number 8. August.

Both, A.J. 2002. Types of glazing materials. Northeast Greenhouse IPM Notes. April issue.  
Both, A.J. 2001. Options in greenhouse coverings. Long Island Horticulture News. December issue.  
Both, A.J. 2001. Making sure your greenhouse is ready for spring. Northeast Greenhouse IPM Notes. February issue.

## **NEWSLETTERS PUBLISHED**

Horticultural Engineering Newsletter: six issues per year from 2000 through 2003.  
Center for Controlled Environment Agriculture Newsletter: four issues per year from 2000 through 2003.

## **TRANSLATION**

Spaargaren, J.J. 2001. Supplemental Lighting for Greenhouse Crops. Published by P.L. Light Systems, Inc., Beamsville, Ontario, Canada. 178 pp.

## **TEACHING**

Greenhouse Environment Control and Crop Production (11:776:321, George Wulster). Number of students: 5. Presented lectures on: Greenhouse design, light management, heating, ventilation, and cooling. Jan – Feb, 2005.

Core Seminar in Plant Biology (16:765:600; co-teaching). Number of students: 19. Two credit course. Spring, 2005.

Seminar in Plant Biology (16:765:610). Number of students: 9. One credit course. Spring, 2005.

Design and Operation of Commercial Greenhouse Systems Short Course: January 6-7, 2005. Number of attendees: 8. Presented lectures on: Overview of major greenhouse components, ventilation and cooling, heating, supplemental lighting and shading, environment control, and high tunnels.

Perspectives on Agriculture and the Environment (11:015:101). Number of students: 20. Two credit freshmen course. Fall, 2004.

Seminar in Plant Biology (16:765:610). Number of students: 7. One credit course. Spring, 2004.

Design and Operation of Commercial Greenhouse Systems Short Course: January 8-9, 2004. Number of attendees: 11. Presented lectures on: Overview of major greenhouse components, ventilation and cooling, heating, supplemental lighting and shading, environment control, and high tunnels.

Greenhouse Cost Management Workshop. Number of attendees: 13. Presented lectures on: 2003 NJ Greenhouse Survey, greenhouse systems, high tunnels, and open-roof greenhouses. October 20, 2003.

Greenhouse Design and Operation (11:015:276). Number of students: 4. One credit course. Fall, 2003.

Biosystems Engineering Measurements (11:127:290, David Fleisher). Number of students: 6. Presented a lecture on: Greenhouse Environment Control. April 1, 2003.

Design and Operation of Commercial Greenhouse Systems Short Course: January 13-14, 2003. Number of attendees: 10. Presented lectures on: Overview of major greenhouse components, ventilation and cooling, heating, supplemental lighting and shading, environment control, economics, and high tunnels.

Greenhouse Design and Operation (11:015:276). Number of students: 7. One credit course. Fall, 2002.

Applied Instrumentation and Control (11:127:450, David Fleisher). Number of students: 7. Presented a lecture on: Greenhouse Environment Control. September 26, 2002.

Greenhouse Environment Control and Crop Production (11:776:321, George Wulster). Number of students: 12. Presented lectures on: Greenhouse components, heating, ventilation and cooling, environment control, and glazing. Jan – Feb, 2002.

Design of Greenhouse Systems Short Course: January 14-15, 2002. Number of attendees: 13. Presented lectures on: Overview of major greenhouse components, ventilation and cooling, supplemental lighting and shading, and greenhouse environment control.

Energy Conservation for Biological Systems (11:127:492, David Mears). Number of students: 3. Lecture and a lab on photo-voltaics. Spring 2001.

Design of Greenhouse Systems Short Course: January 8-9, 2001. Number of attendees: 21. Presented lectures on: Overview of major greenhouse components, ventilation and cooling, and supplemental lighting and shading.

Plastics and Greenhouses (11:015:276, Gene Giacomelli). Lecture on hydroponic lettuce production. Spring 2000.

Phytomation (11:127:491, David Mears). Lectures on growing media, nutritional requirements and control, fertigation system design and automation, and plant factory concept and engineering requirements. Spring 2000.

### **PRESENTATIONS (without publication; since January, 2000)**

Greenhouse energy conservation. Bedding Plant Grower Day. Randolph, NJ. March 3, 2006. (18 attendees, 60 minutes)

Designing greenhouse systems for reduced run-off. Emma Lausten Annual Horticulture Symposium. NJ EcoComplex, Columbus, NJ. February 22, 2006. (50 attendees, 20 minutes)

Greenhouse energy considerations. Greenhouse Energy Efficiency Workshop. University of New Hampshire, Durham, NH. February 15, 2006. (36 attendees, 60 minutes, repeated three times)

Rutgers high tunnel research update. Tomato Advisory Committee. Rutgers EcoComplex, Bordentown, NJ. January 25, 2006. (25 attendees, 15 minutes)

Energy conservation from the engineer's point of view. South Jersey Greenhouse Conference. RCRE, Clayton, NJ. January 24, 2006 (30 attendees, 45 minutes)

Minimizing your greenhouse fuel heating bill. Vegetable Integrated Crop Management Twilight Meeting. Landisville Produce Cooperative, Landisville, NJ. October 19, 2005. Note: presented by Eugene Reiss, prepared by A.J. Both. (40 attendees, 20 minutes)

Farm safety for children. Farm Safety Twilight Meeting. Toyland Farm, Jobstown, NJ. September 21, 2005. (75 attendees, 20 minutes)

Greenhouse operation. Twilight Fruit, Vegetable and Flower Meeting, Secor Farms, Mahwah, NJ. April 27, 2005. (50 attendees, 30 minutes)

Controlled environments: The future of NJ agriculture? Emma Lausten Horticultural Symposium, Cook College, New Brunswick, NJ. April 4, 2005. (50 attendees, 30 minutes)

Temperature and humidity control and DIF. Spring Flower Crop Conference, Clayton, NJ. March 3, 2005. (15 attendees, 60 minutes)

Greenhouse systems and sensors. North Jersey Ornamental Horticulture Symposium and Bedding Plant Day, Randolph, NJ. February 18, 2005. (50 attendees, 60 minutes)

Rutgers high tunnel research update. Tomato Advisory Committee. Rutgers EcoComplex, Bordentown, NJ. January 19, 2005. (25 attendees, 15 minutes)

Open-roof greenhouse: floor heating and ebb and flood irrigation. Greenhouse Fall Crop Production, Mercer County Cooperative Extension. Holland Greenhouses, Hightstown, NJ. October 28, 2004. (25 attendees, 30 minutes)

Greenhouse technology for the small farm. Small Farm and Rural Living Expo, New Paltz, NY. September 19, 2004. (25 attendees, 40 minutes)

Electrical safety on the farm and in greenhouses. Third annual Rutgers farm safety/health twilight meeting, Haunter Family Farm, Cinnaminson, NJ. September 15, 2004. Note: prepared by A.J. Both, presented by Ray Samulis (Agricultural Agent, Burlington County)

Lighting technology. Invited Lecture. OFA Short Course, Columbus, Ohio. July 10, 2004. (23 attendees, 60 minutes)

Construction of high tunnels for season extension. Grower Twilight Meeting. Piazza Farms and Greenhouses, Phillipsburg, NJ. June 9, 2004. (35 attendees, 10 minutes)

Continuous canopy gas exchange measurements in controlled environments. Annual NCR-101 meeting, Brisbane, Australia. March 16, 2004. (60 attendees, 15 minutes)

Environment control to reduce pest problems. North Jersey Ornamental Horticulture Symposium and Bedding Plant Day, Randolph, NJ. February 20, 2004. (60 attendees, 60 minutes)

Which structure is best for you? Empire Expo, Rochester, NY. February 12, 2004. (80 attendees, 30 minutes)

Updating high tunnel research at Rutgers University. Mid Atlantic Fruit and Vegetable Convention, Hershey, PA. January 27, 2004 (50 attendees, 30 minutes). Note: prepared by A.J. Both, presented by Eugene Reiss (Program Associate)

Tractor safety. Second annual Rutgers farm safety/health twilight meeting, Russo's Orchard Lane Farm, Allentown, NJ. September 24, 2003. (50 attendees, 20 minutes)

Greenhouse technology for the small farm. NE small farm and rural living expo, Warren County Fairgrounds, Harmony, NJ. September 21, 2003. (50 attendees, 45 minutes)

High tunnel research update. Invited lecture for the educational program for training extension professionals and vocational ag teachers on high tunnel technology (SARE professional development workshop), Penn State high tunnel research and education facility, Rock Springs, PA. September 4, 2003. (10 attendees, 30 minutes)

High tunnel research update. Vegetable and specialty crops field day and heirloom tomato taste testing, RAREC, Centerton, NJ. August 25, 2003. (30 attendees, 10 minutes)

Supplemental lighting as an integral part of the greenhouse system. Invited lecture. OFA Short Course, Columbus, Ohio. July 14, 2003. (85 attendees, 30 min)

Greenhouse ventilation basics. Central Jersey Bedding Plant Meeting. Rutgers Fruit Research and Development Center, Cream Ridge, NJ. March 5, 2003. (40 attendees, 45 min)

Greenhouse heating. North Jersey Ornamental Horticulture Symposium and Bedding Plant Day, Randolph, NJ. February 21, 2003. (25 attendees, 30 min)

Controlled Environment Agriculture. Seminar. Department of Plant Biology and Pathology, Rutgers University. September 27, 2002.

High tunnels. Invited Lecture. Alternative Food Production Project. Rutgers University. September 16, 2002.

Hydroponic lettuce production. Three invited lectures, Lettuce mini workshop. Crop Physiology Lab, Utah State University. May 28, 2002.

Greenhouse components and open-roof greenhouses. Cornell Cooperative Extension of New York City. May 1, 2002.

Options in greenhouse coverings. New Jersey Annual Vegetable Meeting, Atlantic City, NJ. January 17, 2002.

Designing greenhouse supplemental lighting systems. Demonstration of design software at the Greenhouse Engineering Workshop organized by Ohio State University, Wooster, OH. February 27-28, 2001.

Greenhouse energy conservation. North Jersey Ornamental Horticulture Symposium and Bedding Plant Day, Clifton, NJ. February 20, 2001.

Greenhouse energy conservation. Burlington County Vegetable Growers Update, Mount Holly, NJ. February 14, 2001.

Energy and labor savings & Getting ready for spring. Two presentations at the South-Central NJ Bedding Plant Conference, Mount Holly, NJ. February 9, 2001.

Greenhouse energy conservation. Pennsylvania Capital Region Greenhouse Grower Meeting, Ephrata, PA. January 25, 2001.

Systems studies and modeling (SSM). Overview of research activities of the SSM team for the Science and Technology Working Group of NASA as part of a review and site visit. January 24, 2001.

Getting ready for spring. New Jersey Annual Vegetable Meeting, Atlantic City, NJ. January 18, 2001.

Light uniformity underneath supplemental lighting systems. Presentation at the 4<sup>th</sup> International ISHS Symposium on Artificial Lighting, Quebec City, Canada. November 9, 2000.

Greenhouse structures and equipment. Mercer County Poinsettia Program in Trenton, NJ. October 24, 2000.

Optimizing the production environment, Mistakes that costs you \$\$\$ . New England Greenhouse Conference in Worcester, MA. October 17, 2000.

Supplemental lighting for greenhouse production. Lecture for the North Jersey Ornamental Horticulture Symposium in Clifton, NJ. February 16, 2000.

Designing a modern greenhouse system: hydroponic lettuce production as an example. Lecture at the Rutgers Agricultural Research and Extension Center in Bridgeton, NJ. February 2, 2000.

### **PROFESSIONAL MEETINGS ORGANIZED (since January, 2000)**

ASAE Historic Landmark Dedication Event for the first air-inflated double-layer polyethylene greenhouse. New Brunswick, NJ. June 4, 2004. (65 participants)

NE-1017 Multi-state Project. Committee on Developing and Integrating Components for Commercial Greenhouse Production Systems New Brunswick, NJ. June 3-4, 2004. (35 participants)

Member of the organizing committee for the joint CEUG (Controlled Environment Users Group) and the NCR-101 (Committee on Controlled Environment Technology and Use) meeting at the University of East Anglia, Norwich, England. September 9-12, 2001. (97 participants)

Session organizer, NJ Vegetable Growers' Association Meeting, Atlantic City. (2001-present)

Co-chair of the Norman J. Smith Memorial New Jersey Tour of Plasticulture Systems and Grower Operations. September 19-23, 2000. (20 participants)

### **PROFESSIONAL MEETINGS ATTENDED (since January, 2000)**

On-Farm Alternate Energy Conference. Rutgers EcoComplex, Columbus, NJ. February 28, 2006.

Habitation 2006. Orlando, FL. February 5-8, 2006.

Annual ASAE (Society for Engineering in Agricultural, Food and Biological Systems) meeting in Tampa, FL. July 18-21, 2005.

Annual NE-1017 meeting at Ohio State University, Wooster, OH. July 13-14, 2005.

New Jersey Farm and Rural Energy Seminar. Bridgeton, NJ. Organized by the USDA, DOE, NJ Department of Agriculture, NJ Clean Energy Program, Rutgers EcoComplex, and Rowan University. May 12, 2005.

Annual NCR-101 (Committee on Controlled Environment Technology and Use) meeting in Tucson, AZ. March 12-15, 2005.

GreenSys2004 (ISHS). Leuven, Belgium. September 12-16, 2004.

Annual ASAE (Society for Engineering in Agricultural, Food and Biological Systems) meeting in Ottawa, Canada. August 1-4, 2004.

Ohio Florists' Association Short Course. Columbus, OH. July 10, 2004.

Annual NE-1017 (formerly NE-164; Developing and Integrating Components for Commercial Greenhouse Production Systems) meeting at Rutgers University, New Brunswick, NJ. June 3-4, 2004.

Annual NCR-101 (Committee on Controlled Environment Technology and Use) meeting in Brisbane, Australia. March 15-19, 2004.

Annual ASAE (Society for Engineering in Agricultural, Food and Biological Systems) meeting in Las Vegas, NV. July 27-30, 2003.

Ohio Florists' Association Short Course. Columbus, OH. July 13-16, 2003.

Cornell's Controlled Environment Agriculture Advisory Board meeting in Ithaca, NY. June 30-July 1, 2003.

Annual NE-164 (Decision Support for Design and Control of Plant Growth Systems) meeting at the University of Maryland, College Park, MD. May 15-17, 2003.

Annual NCR-101 (Committee on Controlled Environment Technology and Use) meeting at the University of Guelph, Guelph, ON, Canada. April 26-29, 2003.

Workshop on renewable energy for homes, farms, and businesses. Seabrook, NJ. Organized by the New Jersey Department of Environmental Protection. January 31, 2003.

Northeast Extension Leadership Development Class V. Princeton, NJ. Day-long presentation and group discussion with Dr. George R. McDowell about his book titled: "Land-grant universities and extension into the 21<sup>st</sup> century, renegotiating or abandoning a social contract". November 19, 2002.

Annual ASAE (Society for Engineering in Agricultural, Food and Biological Systems) meeting in Chicago, IL. July 28-31, 2002.

Cornell's Controlled Environment Agriculture Advisory Board meeting in Ithaca, NY. June 13-14, 2002.

Annual NCR-101 (Committee on Controlled Environment Technology and Use) meeting at Duke and NCSU University, Durham, NC. April 6-9, 2002.

Annual NE-164 (Decision Support for Design and Control of Plant Growth Systems) meeting at the University of Arizona, Tucson, AZ. March 8-9, 2002.

Annual Greenhouse Engineering Workshop organized by Ohio State University, Wooster, OH. February 27-28, 2002.

Mid-Atlantic Fruit and Vegetable Convention in Hershey, PA. January 30, 2002.

NASA's PI and the American Society of Gravitational and Space Biology meeting in Alexandria, VA. November 7-10, 2001.

Annual NCR-101 (Committee on Controlled Environment Technology and Use) meeting at the University of East Anglia, Norwich, England. September 9-14, 2001.

Cornell's Controlled Environment Agriculture Advisory Board meeting in Ithaca, NY. August 22-24, 2001.

Annual ASAE (Society for Engineering in Agricultural, Food and Biological Systems) meeting in Sacramento, CA. July 29-August 1, 2001.

Annual NE-164 (Decision Support for Design and Control of Plant Growth Systems) meeting at the University of New Hampshire, Durham, NH. June 8-9, 2001.

Cornell's Controlled Environment Agriculture Advisory Board meeting in Ithaca, NY. February 22-23, 2001.

Fourth International ISHS Symposium on Artificial Lighting in Quebec City, Canada. November 7-9, 2000.

NASA's Life Support and Biosphere Science meeting in Baltimore, MD. August 7-9, 2000.

Annual NABEC (Northeast Agricultural and Biological Engineering Conference) conference in Ithaca, NY. July 31-August 2, 2000.

Annual ASAE (Society for Engineering in Agricultural, Food and Biological Systems) meeting in Milwaukee, WI. July 9-12, 2000.

Annual NE-164 (Decision Support for Design and Control of Plant Growth Systems) meeting at the University of Kentucky, Lexington, KY. June 8-9, 2000.

Annual NCR-101 (Committee on Controlled Environment Technology and Use) meeting at Purdue University, West Lafayette, IN. March 11-14, 2000.

Annual Greenhouse Engineering Workshop organized by Ohio State University, Wooster, OH. February 28-29, 2000.

New Jersey Annual Vegetable Meeting in Atlantic City, NJ. January 20, 2000.

## **EXTENSION BULLETINS and FACT SHEETS**

- Creating a master plan for greenhouse operations (E221).
- Root-zone heating systems for commercial greenhouses (E208, in revision)
- Environmental control of greenhouses (E213, in revision)
- Evaluating greenhouse mechanical ventilation systems (E277).
- Instruments for monitoring the greenhouse aerial environment (E276).
- Principles of evaluating greenhouse aerial environments (E275).

## **EXTENSION REPORT**

- Agricultural management practices for permanent greenhouse production (in review)

## **CURRENT RESEARCH PROJECTS**

- Heated ebb and flood floor irrigation system. Open-roof greenhouse project on Hort Farm 3.
- High tunnels for early season tomato production. PEG project under the leadership of Wes Kline and Steve Garrison.
- Novel greenhouse cladding material testing (F-Clean film).
- Impact of short-term temperature perturbations on the growth and quality of tomato fruit (multidisciplinary research team; growth chamber trials).



## EXTERNAL FUNDING RECEIVED

NASA Federal Appropriation, Growth Chamber Studies (July 2004-June 2005)	\$ 5,000
NASA Federal Appropriation, Growth Chamber Studies (October 2003-June 2004)	\$ 11,000
NJ SADC (2003; with J. Willmott and G. Wulster, co-investigators)	\$ 22,250
NJ EcoComplex, Systems Studies (September 30, 2002 – September 30, 2003)	\$ 65,000
NJ-NSCORT project, Systems Studies (January 1 – June 30, 2002; no-cost extension)	\$ 29,320
NJ-NSCORT project, System Studies (May 1, 2001 – December 31, 2001)	\$ 80,514
NJ-NSCORT project, System Studies (May 1, 2000 – April 30, 2001)	\$ 125,518
Center for Controlled Environment Agriculture (CCEA, 2000-present)	\$ 38,786
<b>Total</b>	<b>\$ 377,388</b>

## INTERNAL FUNDING RECEIVED

Cook College, Office of the Executive Dean (2004; ASAE Historic Landmark)	\$ 5,000
DES Innovative Educational Grant (2003; R. Brumfield and G. Wulster, co-investigators)	\$ 5,000
NJAES, Program Development Grant (2003; D. Fennell, PI, and J. Ponessa, J. White, and G. Mainelis, co-investigators)	\$ 4,000
NJAES, Program Enhancement Grant (2001; for 5 years; S. Garrison and W. Kline, PIs)	\$ 125,000
Department of Plant Science and NJAES, upgrade environment control system (2001)	\$17,820
NJAES, Program Development Grant (2000; J. Willmott, and G. Wulster, co-investigators)	\$ 3,000
NJAES, Operating Support for CCEA and greenhouse maintenance (2000-2002)	\$ 14,000
Regional Project (Hatch) Support (2000-2006; NCR-101, NE-1017 [NE-164])	\$12,000
<b>Total</b>	<b>\$ 185,820</b>

## ALL FUNDING COMBINED

**Grand Total \$ 563,208**

## CONSULTING

BHDP Architecture for The Scotts Company in Marysville, Ohio: new greenhouse construction (\$5,000,000).

## GRADUATE STUDENTS

Lina Friis, M.S. 2004. Thesis title: Canopy CO<sub>2</sub>-exchange measurements for *Lactuca sativa* L.

‘Waldmann’s Green’. Lina conducted a five-month thesis project as part of the degree requirements from the University of Agricultural Sciences in Alnarp, Sweden. I served as project advisor.

Meenal Gogte, M.S. student in Bioresource Engineering. I served as major advisor for one semester (F03).

Sara Goudarzi, M.S. 2003. Thesis title: Dynamic crew performance model for long-duration space missions. I served as major advisor.

Hsien-hsing Hsiang, M.S. 2002. Thesis title: Top-level modeling of a food processing and nutrition (FPN) component of an advanced life support system (ALSS). I served as a member on the thesis committee.

Konomi Kumasaka, M.S. 2003. Thesis title: Canopy gas exchange of soybean [*Glycine Max* (L.) Merr., cv. Hoyt] in response to air temperature, light intensity, and aerial CO<sub>2</sub> concentration in controlled hydroponic environments. I served as major advisor.

Mark Lefsrud, Ph.D. student (University of Tennessee). I serve as an external member on his dissertation advisory committee.

Jennifer Mathieu, Ph.D. 2004 (Cornell University). Dissertation title: Lettuce crop evapotranspiration, nitrate uptake, and growth mechanistic simulation modeling: for use in fault detection in hydroponic production systems. I served as an external member on her dissertation advisory committee.

Eugene Reiss, M.S. 2006. Thesis title: Modeling greenhouse floor heating using computational fluid dynamics. I served as major advisor.

David Specca, Ph.D. student. Project: Integrating aquaculture and hydroponics. I serve as a member on his dissertation advisory committee.

Tom van der Walle, M.S. 2005. Tom conducted a six-month research project as part of the degree requirements from the Agricultural University Wageningen, the Netherlands. I served as project advisor.

Christer Wretfors, M.S. 2003. Thesis title: Growth chamber experiments and modeling for dwarf tomato varieties. Christer conducted a five-month thesis project as part of the degree requirements from the University of Agricultural Sciences in Alnarp, Sweden. I served as project advisor.

## **SUPERVISOR**

Lisa Evans, Undergraduate work-study student. October 2005-present.

Max Dubin, Undergraduate student. Independent Research in Biology (01:119:406). June-December 2005.

Jeff Akers, Head Greenhouse Field Technician. January 2004-present. (co-supervisor with Joe Florentine)

Xavier Sosa, Undergraduate work-study student. October 2003-May 2004.

Sara Goudarzi, M.S. Hourly employee. February 2003-September 2004.

Dr. Luis Rodriguez, Post Doctoral Associate. November 2002-January 2003.

Timothy Vadas, Cooperative Education student. Summer 2001, 2002.

Thanh Nguyen, Undergraduate work-study student: web site development. June 2000-May 2001.

Dr. Sukwon Kang, Post Doctoral Associate with the NJ-NSCORT project. July 2000-August 2001.

Steve Kania, M.S. Technician, Center for Controlled Environment Agriculture. July-December 2000.

Eugene Reiss, Program Associate/Research Project Coordinator II. January 2000-December 2005.