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April 26, 2002

From: Gene A. Giacomelli
Director, Controlled Environment Agriculture Center

Re: Food Growth Chamber for the Amundson-Scott
New South Pole Station

I am very pleased to inform you that the proposal from The University of Arizona, Controlled Environment Agriculture Center, and the Sadler Machine Company was selected for funding of the design, construction, testing, and delivery of a Food Growth Chamber (FGC) for the South Pole Station.

The 3-year, $425,000 project will begin as soon as contractual agreements are completed. Formal announcement will proceed after contract signing.

If you would like to discuss this in further detail, I would be please to meet with you at your convenience.

Attached is a summary of the project, and information about the participants.

Project Title: Food Growth Chamber for the Amundson-Scott New South Pole Station
Grantor: Raytheon Technical Service Company, Polar Services, Englewood, Colorado, subcontracted from NSF
Grantee: Dr. Gene A. Giacomelli, P.I.
The University of Arizona, Tucson, Arizona
Subcontractor: Mr. Phil Sadler, Sadler Machine Company, Tempe, Arizona

Summary

The New South Pole Station requires a Food Growth Chamber that will provide an appropriate level of advanced technology, which a volunteer staff can operate. The purpose for including the FGC is the psychological effect for satisfying the diet of the station personnel, as well as, their visual and sensory needs for seeing, feeling, and interacting with plants. This project will result in the design, construction, testing, and delivery of a Food Growth Chamber (FGC) by the University of Arizona, Tucson, AZ in collaboration with Sadler Machine Company, Tempe, AZ.

The FGC is divided by a transparent sealed wall into two sections, to separate the Production Room (PR) from the Enviroroom (ER). The PR is a closed, highly controlled and monitored, semi-automated plant growth environmental room with high intensity discharge (HID) lighting, atmospheric CO_2 enrichment, and a recirculating hydroponic nutrient delivery system (NDS), which has been engineered for achieving the highest production of salad and fruiting crops for the station personnel. The ER is a 'sitting' room for station personnel to relax within a semi-tropical atmosphere (elevated humidity and lighting) while viewing the active plant growth of the PR crops through the transparent wall separating the two adjacent rooms. The ER will also produce small amounts of a wide variety of edible plants, providing an area for hobbyists to enjoy, and it will provide station personnel with an escape from typical life at the station.

The first year objective is to construct and prepare the FGC for transport. Operations and maintenance educational support will be provided for the FGC during the subsequent two years of the project.

Purpose

With the past success of the McMurdo Greenhouse in providing salad crops to the 'winter-over' population, providing an enjoyable environment for station personnel to spend time, and providing a hobbyist gardening opportunity, the Office of Polar Programs supported the establishment of the South Pole Food Growth Chamber. The initial South Pole Growth Chamber was prefabricated in McMurdo in 1992, and constructed onsite by volunteers. It has been a volunteer effort from the beginning, and OPP wishes for the new South Pole Food Growth Chamber to continue in this manner.

The New South Pole Station, when completed, will be a structure of advanced design and operation. The new Food Growth Chamber will also represent advanced design and operation for growth chamber technology. Chamber operators will have a great influence on the success or failure of the growth chamber as a producer of edible crops. Employing a volunteer group of persons operating the new chamber will be considerably different than having a trained horticulturist operating the chamber. One major challenge in designing the new South Pole Food Growth Chamber will be providing appropriate levels of automated and manually operable advanced technology, so that a volunteer staff can be successful.

Including the FGC in the new station will provide an enhanced psychological effect on the station personnel, most importantly satisfying their desire for a diet of fresh salads that they are accustomed. However, the station personnel also have a desire to satisfy their visual and sensory longings for seeing, feeling, and smelling green plants. Such has not been available at the South Pole. This is the role of the Enviro-room, and it will provide station personnel with an enjoyable space filled with edible plants. This is a much smaller space than the PR and it will not have the high light intensities or the enriched CO_2 atmosphere as the PR. The focus will be on allowing station personnel to grow herbs and favored edible plants of their own choice in this area, with much lower production expectations. Providing a growing area where station personnel can recreational garden comes from the experiences learned from the McMurdo Growth Chamber. Without such separated space, there can be a reduced efficiency and yields within the high production area resulting from the recreational gardeners growing varieties that do not belong in PR, such as non-salad crops.

Goals

The UA project will provide a chamber with high plant productivity, and high energy efficiency, which satisfies the station's human sensory requirements (edible food and therapeutics issues), while requiring an appropriate minimal level of operational and maintenance skills that an informed and interested volunteer staff can provide on a day-to-day basis.

Advantages and Opportunities of the FGC

- Experience of Mr. Sadler of Sadler Machine Company, who founded the McMurdo and South Pole food production chambers, and headed operations for 5 years.
- Chamber plant production technology developed in cooperation with NASA food production in space program through University of Arizona Space Act Agreement.
- Advanced technology water-cooled lamps for plant growth.
- Lighting system utilizes the same Station chilled glycol cooling system as the HVAC system
- The Double Pass Growing Tray is an effective size for production, yet offers easy transport and movement for maximizing space utilization, harvesting and cleaning, while minimizing downtime and labor time.
- Plant trays mounted on adjustable frames to allow for varied height requirements of different crops.
- Plant trays for salad greens function as transport and post-harvest storage devices.
- Two isolated environments, the Intensive Agriculture Section (IAS) for maximum production, and the Enviro-Room (ER) for sensory stimulation and hobby gardening. This arrangement also allows for secondary capture of CO_2 from the IAS.
- Automated control system at an appropriate level of complexity for volunteer staff.
- Remote monitoring and control system that will allow access from U.S. to monitor and help guide the operation of the chamber.
- Separated utility room for safe and secure location and storage of hardware and consumables.
- Three-year program for continued support for successful implementation.
- Training courses and operational support after delivery of the FGC.

Team Personnel Vitae

Background info on technical experiences

Our collaborative group, includes the University of Arizona's Controlled Environment Agriculture Center and Sadler Machine Co. which offers expert knowledge of Controlled Environment Agriculture systems, and expert knowledge of horticultural applications at the South Pole and McMurdo Stations, respectively. We currently have ongoing efforts in developing growth chamber lighting with NASA, web-based control systems operation for agriculture, and industrial hydroponic efforts with major greenhouse tomato growers. With our association with NASA's Johnson Space Center and Kennedy Space Center, we are in touch with the cutting edge of CEA technology and are in a position to incorporate any appropriate technology into the FGC effort. Finally, extending the length of our effort to cover the period of fabrication, transport, construction at the site, and startup service, will help to guarantee the success of this effort.

Collaborators include:

Dr. Patricia Rorabaugh, Plant Sciences, The University of Arizona
Dr. Chris Choi, Ag. & Biosystems Engineering, The University of Arizona
Dr. Merle Jensen, Plant Sciences, The University of Arizona
Dr. Chieri Kubota, Plant Sciences, The University of Arizona
Stephen Kania, Ag. & Biosystems Engineering, The University of Arizona
Dr. Ralph Prince, NASA Kennedy Space Center [retired]

Philip D. Sadler, Sadler Machine Co.

Presently owns and operates a small prototype development shop in Tempe, Arizona, working in cooperation with NASA Johnson Space Center, Advanced Life Support, and the University of Arizona, Controlled Environment Agriculture Center, in the development of the SMC Water Jacketed HPS and MH Lighting System.

Mr. Sadler was a Research Specialist at the University of Arizona, Department of Agriculture and Biosystems Engineering(1996-97). He earned his B.S. in Botany from Northern Arizona University in 1978. Mr. Sadler has been involved in many prestigious research projects such as the NASA grant involving solar collection, transportation, and redistribution of light for space horticulture. He initiated United States Antarctic Program's horticultural project, established, designed, and constructed, along with his volunteer work force, the McMurdo Greenhouse 1989, and established South Pole Greenhouse 1993. He was awarded the United States Antarctic Service Medal in 1979.

Mr. Sadler has been an Invitational Symposium Speaker at the following: Ecosynthesis: Creating Open and Closed Ecosystems on Mars, 2000, Mars Greenhouse Workshop, NASA Kennedy Space Center, 1999, American Society of Agricultural Engineers Conference, 1995; the Hydroponic Society of America Conference, 1995; the Kennedy Space Center, 1994; the EPCOT Land Pavilion, 1994; the Johnson Space Center, 1994; and the Scientific Committee on Antarctic Research, Bariloche, Argentina, 1992. His publications include: Sadler, P.D. 2000, Wire Culture For an Inflatable Mars Greenhouse and other Future Inflatable Space Growth Chambers, NASA Technical Memorandum 2000-208577,
1995: Plant Hydroponics in Antarctica, ASAE Journal; Sadler, P.D. 1995, The Antarctic Horticultural Project - 16th Hydroponic Soc.; of America Conference, Tucson, AZ p.97-107;

Sadler, P.D. 1994; Greenhouses at McMurdo and South Pole Stations-Antarctic; Journal of the United States. March Vol. XXIX pg. 4-6; Sadler, P.D. 1993, Gardening on Ice- The Growing Edge. Vol. 5 No. 2 p.36-39.68; Sadler, P.D. 1992, The Establishment of Greenhouses at the United States; and McMurdo and South Pole Stations. 1992 SCAR Conference. Bariloche, Argentina.

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Doctor Gene A. Giacomelli is the Director of the Controlled Environment Agriculture Center [CEAC] at the University of Arizona in Tucson, Arizona, and he is a professor in the Agricultural and Biosystems Engineering Department. Dr. Giacomelli has B.S [Rutgers University] and M.S. [University of California-Davis] degrees in engineering, and a PhD in Horticultural Engineering [Rutgers University], with advanced study in plant science and controlled environment production horticulture. This mix of technical expertise with crop production experience, provides an application of engineering design to the horticultural production problems within intensive controlled environment plant production systems. He developed the Horticultural Engineering degree program at Rutgers University, the first of its kind in the US.

Dr. Giacomelli has designed, constructed, instrumented and operated various types of environmentally controlled greenhouses utilizing hydroponic-based crop production systems, including NFT, Ebb and Flood and aeroponic systems for greenhouse lettuce, tomato, strawberry, and numerous other crops. His professional activities have focused on Controlled environment plant production systems [greenhouse and growth chamber] research, design, development and applications, with emphases on: crop production systems, nutrient delivery systems, environmental control, mechanization, and labor productivity.

He has developed and taught a 1-day greenhouse hydroponic crop production short course for more than 10 years, and has taught a greenhouse environmental control short course for nearly 20 years.

Dr. Giacomelli has lectured and studied in numerous countries around the world, including Canada, Chile, England, New Zealand, France, Germany, Israel, Italy, Japan, Mexico, Puerto Rico, The Netherlands, Spain, Korea, and Taiwan. He has chaired or organized international symposia or workshops in the U.S., Japan, Taiwan and The Netherlands. He is an active member of numerous scientific and professional societies, serving as an officer and on technical committees for the American Society for Horticultural Science, American Society for Plasticulture, American Society of Agricultural Engineers, and the Northeast Agricultural and Biological Engineering Conference.

He is the co-developer of two patented devices.

He is currently developing a Controlled Environment Agriculture program at the University of Arizona, Tucson, which includes: educating undergraduates and graduate students in engineering, Plant Sciences and Ag. Education; researching controlled environment plant production systems, and; outreach through cooperative extension to the citizens of Arizona.

EDUCATION:

Rutgers University	Biological & Agricultural Eng'r	1973-1977	B.S.
Rutgers University	Horticultural Science	1973-1977	B.S.
University California-- Davis	Agricultural Eng'r.	1978-1980	M.S.
Rutgers University	Horticultural Eng'r.	1980-1983	Ph.D.

PROFESSIONAL EXPERIENCE:

2000-present	University of Arizona, Controlled Environment Agriculture Center, Director
2000-present	University of Arizona, Professor
1999-2000	Rutgers University, Director, Center for Controlled Environment Agriculture
1998-1999	Rutgers University, Associate Director, Center for Controlled Environment Ag.
1996-2000	Rutgers University, Professor
1989-1996	Rutgers University, Associate Professor
1983-1989	Rutgers University, Assistant Professor