NASA Contractor Report 4070


CONTRACT NASW-3165
JUNE 1987

The George Washington University
Washington, D.C.

Prepared for
NASA Office of Space Science and Applications
under Contract NASW-3165
Foreword

This bibliography is an update of NASA CR-3911 Publications of the NASA CELSS (Controlled Ecological Life Support Systems) Program published in July 1985. The CELSS Program was established within the Office of Space Science and Applications of the National Aeronautics and Space Administration (NASA) in 1979. The purpose of the CELSS Program is to develop a technology for an autonomous bioregenerative life support system with the capability of totally maintaining humans on long-term space missions. All components of this system will be stratified, recycled, and bioconverted as in a natural ecosystem. CELSS supported research is currently being conducted in a broad range of areas including food production, waste management, and systems management and support.

The purpose of compiling this bibliography is to provide the scientific community with a list of the current publications resulting from CELSS related research and to stimulate the exchange of information and ideas between scientists working in different areas of the program. Authors conducting research under the auspices of the CELSS Program have been identified with an asterisk.

The arrangement of references included in the bibliography follows the three major divisions of research described above. Documents are listed alphabetically by author under the general research area with which they are associated. Publications from 1984 (not included in CR-3911) to 1986 which either have resulted from CELSS supported research or which are relevant to CELSS research are included.

I wish to acknowledge the assistance of: James H. Bredt for overall direction, April C. Roy for data entry, Carlos Antonio Fagundo for editing, and the CELSS principal investigators for furnishing their publications lists.

Rose C. Wade
George Washington University

PRECEIVING PAGE BLANK NOT FILMED

iii
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>iii</td>
</tr>
<tr>
<td>Food Production</td>
<td>1</td>
</tr>
<tr>
<td>Waste Management</td>
<td>11</td>
</tr>
<tr>
<td>Systems Management and Control</td>
<td>17</td>
</tr>
<tr>
<td>CELSS Scientists and CELSS Supported Scientists Currently Involved in CELSS Research</td>
<td>25</td>
</tr>
</tbody>
</table>
Food Production

Andre', M. and Richaud, Ch.
Can Plants Grow in Quasi-Vacuum?
in Controlled Ecological Life Support Systems: CELSS '85
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),
NASA Ames Research Center, Moffett Field, CA, pp. 395-404. (NASA

Andre', M., Ducloux, H., Richaud, C., Massimino, D., Daguenet,
A., Massimino, J., and Gerbaud, A.
Etude des Relations entre Photosynthese, Respiration,
Transpiration et Nutrition Minerale chez le Ble'
in Twenty-Sixth Plenary Meeting of the Committee on Space

Aslam, M. and Huffaker, R.C.*
Role of Nitrite in the Induction of Nitrate Reductase Activity in
Barley Leaves.
Plant Physiology 80(4), 41. 1986.

Aslam, M., Rosichan, J.L., and Huffaker, R.C.*
Induction of Nitrate and Nitrite Reductase Activities by NO₃ and
NO₂ in Barley Leaves.

Barta, D.J. and Tibbitts, T.W.*
Diurnal Calcium Levels in Lettuce Leaves

Barta, D.J. and Tibbitts, T.W.*
Electron Probe X-ray Analysis of Mineral Concentrations Across
Leaves Deficient in Calcium
X. International Plant Nutrition Colloquium, Beltsville, MD,

Barta, D.J. and Tibbitts, T.W.*
Mineral Localization in Young Enlarging Leaves of Lettuce:
Implications for Tipburn Development
Barta, D.J. and Tibbitts, T.W.*
Use of Electron Microprobe X-ray Analysis for Determination of Low Calcium Concentrations Across Leaf Tissue

Barta, D.H. and Tibbitts, T.W.*

Berry, W., Hoshizaki, T.,* and Ulrich, A.

Bubenheim, D. and Salisbury, F.B.*
Photoperiod Sensitivity of Wheat

Bubenheim, D.L., Bugbee, B., and Salisbury, F.B.*

Bugbee, B.

Bugbee, B. and Salisbury, F.B.*
Food Production in Simulated Microgravity

Bugbee, B. and Salisbury, F.B.*
Bugbee, B. and Salisbury, F.B.*
Studies on Maximum Yield of Wheat for the Controlled Environments of Space

Bugbee, B. and Salisbury, F.B.*
Wheat Production in the Controlled Environments of Space

Bugbee, D., Bubenheim, D.L., and Salisbury, F.B.*
Temperature/Photoperiod Effects on Reproductive Development in a Long-Day Plant (Wheat)
Plant Physiology 80(suppl. 3). (Abstract) 1986.

Experiments on Plants Grown in Space: Growth and Lignification in Seedlings Exposed to Eight Days of Microgravity

Fry, I.V., Lazaroff, N., and Packer, L.*
Sulfate Dependent Iron Oxidation by Thiobacillus ferrooxidans: Characterization of a New EPR Detectable Electron Transport Component on the Reducing Side of Rusticyanin

Fry, I.V., Hrabeta, J., D'Souza, J., and Packer, L.*
Application of Photosynthetic N2-Fixing Cyanobacteria to the CELSS Program

Fry, I.V., Pescheck, G.A., Huflejt, M., and Packer, L.*
EPR Signals of Redox Active Copper in EDTA Washed Membranes of the Cyanobacterium Synechococcus 6311

Fry, I.V., Robinson, A.E., Spath, S., and Packer, L.*
The Role of Na,S in Anoxygenic Photosynthesis and H2 Production in the Cyanobacterium Nostoc muscorum
The Role of Respiration During Adaptation of the Freshwater
Cyanobacterium Synechococcus 6311 to Salinity
Archives of Biochemistry and Biophysics 244, 686-691. 1986.

Goyal, S.S. and Huffaker, R.C.*
A Novel Approach and a Fully Automated Microcomputer-Based System
to Study Kinetics of NO$_3^-$, NO$_2^-$ and NH$_4^+$ Transport Simultaneously
by Intact Wheat Seedlings

Goyal, S.S. and Huffaker, R.C.*
Induction of NO$_3^-$ Transport System in Wheat Seedlings: Effect of
NH$_4^+$ and NO$_2^-$.  

Goyal, S.S. and Huffaker, R.C.*
Nitrogen Toxicity in Plants
in Nitrogen in Crop Production, (eds. J.D. Beaton, C.A.I. Coring,
R.G. Hoeft, G.W. Randal, and R.S. Hauck), American Society of

Guerra, D., Anderson, A.J., and Salisbury, F.B.*
Reduced Phenylalanine Ammonia-Lyase and Tyrosine Ammonia-Lyase
Activities and Lignin Synthesis in Wheat Grown under Low Pressure
Sodium Lamps

Hoshizaki, T.*
Arabidopsis Seed Production Limited by CO$_2$ in Simulated Space
Experiments

Hoshizaki, T.*
Closed Culture Plant Studies: Implications for CELSS
in Controlled Ecological Life Support Systems: CELSS '85
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),
NASA Ames Research Center, Moffett Field, CA., pp. 523-540. (NASA

Huffaker, R.C.* and Ward, M.R.
Developing a Basis for the Use of NO$_3^-$, NO$_2^-$, NH$_4^+$ and Urea to
Produce Wheat for CELSS
Huffaker, R.C.* and Ward, M.R.
Effects of NO3-, NH4+ and Urea on Each Other's Uptake and
Incorporation
in Controlled Ecological Life Support Systems: CELSS '85
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),
NASA Ames Research Center, Moffett Field, CA, pp. 429-446. (NASA

Kamarei, A.R., Nakhost, Z., and Karel, M.*
Potential for the Utilization of Algal Biomass for Components of
the Diet in CELSS
in Controlled Ecological Life Support Systems: CELSS '85
NASA Ames Research Center, Moffett Field, CA, pp. 13-22. (NASA

Karel, M.* and Kamarei, A.R.
Feasibility of Producing a Range of Food Products from a Limited
Range of Undifferentiated Major Food Components

Karel, M.*, Kamarei, A.R., and Nakhost, Z.
Utilization of Non-Conventional Systems for Conversion of Biomass
to Food Components. Potential for Utilization of Algae in
Engineered Foods

Karel, M.* and Nakhost, Z.
Utilization of Non-Conventional Systems for Conversion of Biomass
to Food Components: Recovery, Optimization and Characterization
of Algal Proteins and Lipids

Karel, M.* and Nakhost, Z.
Non-Conventional Approaches to Food Processing in CELSS
in Twenty-Sixth Plenary Meeting of the Committee on Space
153. 1986.

Mehlhorn, R.J., Blumwald, E., and Packer, L.*
ESR Methods for Studies of Osmoregulation in the Cyanobacterium
Synechococcus 6311
in Membrane Transport in Plants (eds. W.J. Cram, K. Janacek, T.,
1984.
Packer, L.,* and Fry, I.V.
Photosynthate Production by Cyanobacteria (Blue-Green Algae)
in Twenty-Sixth Plenary Meeting of the Committee on Space
153. 1986.

Packer, L.,* Fry, I., and Belkin, S.
Application of Photosynthetic Nitrogen-Fixing Cyanobacteria to
the CELSS Program
in Controlled Ecological Life Support Systems: CELSS '85
NASA Ames Research Center, Moffett Field, CA, pp. 339-353. (NASA

Patterson, R.P. and Raper, C.D., Jr.*
Influence on Duration and Rate of Seed Fill on Soybean Growth and
Development

Peet, M.M., Raper, C.D., Jr.,* Tolley, L.C., and Robarge, W.P.
Tomato Responses to Ammonium and Nitrate Nutrition under
Controlled Root-Z and Ph

Petersen, G.R.*
Determining a Carbohydrate Profile for Hensenula Polymorpha

Petersen, G.R.* and Stokes, B.O.
The Development of an Unconventional Food Regeneration Process:
Quantifying the Nutritional Components of a Model Methylootropic
Yeast
in Controlled Ecological Life Support Systems: CELSS '85
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),
NASA Ames Research Center, Moffett Field, CA, pp. 329-338. (NASA

Raper, C.D., Jr.*, Patterson, R.P., List, M.L., Obendorf, R.L.,
and Downs, R.J.
Photoperiod Effects on Growth Rate of In vitro Cultured Soybean
Embryos
Raper, C.D. Jr.*, and Tolley-Henry, L.

Raper, C.D. Jr.*, and Wann, M.

Rufty, T.W., Jr., Raper, C.D., Jr.*, and Huber, S.C.
Alterations in Internal Partitioning of Carbon in Soybean Plants in Response to Nitrogen Stress

Salisbury, F.B.*
Achieving Maximum Plant Yield in a Weightless, Bioregenerative System for a Space Craft

Salisbury, F.B.*
Plant Production in Controlled Environments

Salisbury, F.B.,* and Bugbee, B.G.

Salisbury, F.B.,* Bugbee, B.G., and Bubenheim, D.
Photosynthetic Adaptations to Growth Temperature in Potato

Takano, T., Inada, K., and Takanashi, J.
Trickle Water and Feeding Systems in Plant Culture and Light-Dark
Cycle Effects on Plant Growth
in Twenty-Sixth Plenary Meeting of the Committee on Space

Tel-or, E., Huflejt, M., and Packer, L.*
Hydroperoxide Metabolism in Cyanobacteria

Thomas, J.F. and Raper, C.D., Jr.*
Internode and Petiole Elongation of Soybean in Response to
Photoperiod and End-of-Day Light Quality

Thomas, J.F. and Raper, C.D., Jr.*
Photoperiod Regulation of Floral Initiation for Soybean Plants at
Different Ages

Thompson, B.G. and Lake, B.H.
The Effects of Radiation on the Long-Term Productivity of a Plant
Based CELSS
in Twenty-Sixth Plenary Meeting of the Committee on Space

Tibbitts, T.W.*
Controlled Environment Life Support System: Calcium-Related Leaf
Injuries on Plants
NASA Ames Research Center, Moffett Field, CA, 51 pp. (NASA
Tibbitts, T.W.*
Utilization of Potatoes in CELSS: Growing Systems and Productivity

Tibbitts, T.W.* and Wheeler, R.M.
Controlled Environment Life Support System: Growth Studies with Potatoes

Tibbitts, T.W.* and Wheeler, R.M.

Tolley, L.C. and Raper, C.D., Jr.*
Cyclic Variations in Nitrogen Uptake Rate in Soybean Plants

Wann, M. and Raper, C.D., Jr.*
A Dynamic Model for Plant Growth: Validation Study under Changing Temperatures

Wheeler, R.M.
Potato Leaf Explants as a Spaceflight Plant Test System

Wheeler, R.M. and Tibbitts, T.W.*
Controlled Ecological Life Support System: Higher Plant Flight Experiments
Wheeler, R.M. and Tibbits, T.W.*
Growth and Tuberization of Potato (Solanum tuberosum L.) under Continuous Light

Wheeler, R.M. and Tibbits, T.W.*
Potato Leaf Cutting as a Spaceflight Plant Test System

Wheeler, R.M. and Tibbits, T.W.*
Utilization of Plants for Lunar Life Support. A Case for the Potato Plant

Wheeler, R.M., Tibbits, T.W.* and Najar, A.
Interactions of Irradiance Temperature and CO₂ in Growth and Tuberization of Potato

Wheeler, R.M., Schwartzkopf, S.H.,* Tibbits, T.W.,* and Langhans, R.W.
Elimination of Toxicity from Polyurethane Foam Plugs Used for Plant Culture

Effect of Temperature on Tuberization and Plant Morphology of 'Norland' Potatoes Grown under Continuous Light
Baird, B.H. and White, D.C.*
Biomass and Community Structure of the Abyssal Microbiota
Determined from the Ester-Linked Phospholipids Recovered from
Venezuela Basin and Puerto Rico Trench Sediments

Findlay, R.H., Pollard, P.C., Moriarty, D.J.W., and White. D.C.*
Quantitative Determination of Microbial Activity and Community
Nutritional Status in Estuarine Sediments: Evidence for a
Disturbance Artifact

Garavelli, J.S.
Airborne Trace Contaminants of Possible Interest in CELSS
in Controlled Ecological Life Support Systems: CELSS '85
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),
NASA Ames Research Center, Moffett Field, CA, pp. 253-262, (NASA

Gupta, A.K.*
Combustion of Chlorinated Hydrocarbons
Presented at The 22nd Meeting of the American Institute of
Aeronautics and Astronautics Aerospace Sciences Meeting, Reno,

Lee, S.S. and Shuler, M.L.*
Carbon Dioxide Evolution Rate as a Method to Monitor and Control
an Aerobic Biological Waste Treatment System
in Controlled Ecological Life Support Systems: CELSS '85
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),
NASA Ames Research Center, Moffett Field, CA, pp. 354-394. (NASA

Loser, H.R.
Description of Concept and First Feasibility Test Results of a
Life Support Subsystem of the Botany Facility Based on Water
Reclamation
in Controlled Ecological Life Support Systems: CELSS '85
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),
NASA Ames Research Center, Moffett Field, CA, pp. 65-76. (NASA


Takahashi, Y.
The Applicability of Catalytic Wet-Oxidation to CELSS
in Twenty-Sixth Plenary Meeting of the Committee on Space

Takahashi, Y. and Ohya, H.
Wet-Oxidation Waste Management System for CELSS
in Controlled Ecological Life Support Systems: CELSS '85
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),
NASA Ames Research Center, Moffett Field, CA, pp. 77-84. (NASA

Tunlid, A., Odham, A., Findlay, R.H., and White, D.C.*
Precision and Sensitivity in the Measurement of 15N Enrichment in
D-Alanine from Bacterial Cell Walls using Positive/Negative Ion
Mass Spectrometry

White, D.C.*
Methods for Microbial Biomass, Community Structure and Metabolic
Activities on Surfaces
in Proceedings of the Second International Symposium of Marine
Bacteriology, Oct. 1-5, Brest, France. 1985.

White, D.C.*
Non-Destructive Biofilm Analysis by Fourier Transform
Spectroscopy (FT/IR)
in Proceedings of the Fifth International Congress of Microbial

White, D.C.*
Quantitative Physical-Chemical Characterization of Bacterial
Habitats

White, D.C.*
Validation of Quantitative Analysis for Microbial Biomass,
Community Structure, and Metabolic Activity
in Proceedings of the Third International Workshop on the
Measurement of Microbial Activities in the Carbon Cycle in
Aquatic Ecosystems, (eds. T. Cappenberg and C.L.M. Steenbergen),
White, D.C.,* Smith, G.A., and Stanton, G.R.
Biomass, Community Structure and Metabolic Activity of the
Microbiota in Benthic Marine Sediments and Sponge Spicule Mats

White, D.C.,* Nickels, J.S., Parker, J.H., Findlay, R.H., Gehron,
M.J., Smith, G.A., and Martz, R.F.
Biochemical Measures of the Biomass, Community Structure and
Metabolic Activity of the Ground Water Microbiota
in Ground Water Quality (ed. C.H. Ward, W. Giger, and P.L.
Systems Management and Control

Andre', M., Daguenet, A., Massimino, D., and Gerbaud, A.

Auslander, D.,* Spear, R., Babcock, P., and Nadel, M.

Averner, M.M.*

Averner, M.M.*, Moore, B., Bartholomew, I., and Wharton, R.

Babcock, P.S.

Babcock, P.S., Auslander, D.M.,* and Spear, R.C.
Boudreault, R.

Haruhiko, O., Oshima, T., and Nitta, K.

Knott, W.M.*

Knott, W.M.*

Ko, K.

MacElroy, R.D.*

MacElroy, R.D.* and Bredt, J.H.*

MacElroy, R.D.*, Klein, H.P., and Averner, M.M.*
MacElroy, R.D.,* Martello, N.V.,* and Smernoff, D.T.* (eds.)
Controlled Ecological Life Support Systems: CELSS '85 Workshop

MacElroy, R.D.,* Smernoff, D.T.,* and Klein, H.P. (eds.)
Controlled Ecological Life Support Systems in Space Travel

Martello, N.V.*
Development of Space Technology for Ecological Habitats

Mitchell, C.A.,* Knight, S.L., and Ford, T.L.
Optimization of Controlled Environments for Hydroponic Production
of Leaf Lettuce for Human Life Support in CELSS

Mizutani, H.
A Large-Scale Perspective on Ecosystems

Nelson, B.
The Role of Plant Disease in the Development of Controlled
Ecological Life Support Systems

Nishi, I., Tomizawa, G., Shibuya, H., and Tateishi, M.
Fundamental Study on Gas Monitoring in CELSS
Nitta, K.

Odham, G., Tunlid, A., Valeur, A., Sundin, P., and White, D.C.*
Model System for Studies of Microbial Dynamics at Exuding Surfaces Such as the Rhizosphere

Oguchi, M., Otsubo, K., Nitta, K., and Hatayama, S.
Food Production and Gas Exchange System using Blue-Green Alga (Spirulina) for CELSS

Ohya, H. and Matsumoto, K.
Gas Exchange System and Sunlight Supply System in Microalgal Bioreactor System

Oleson, M. and Olson, R.L.
Controlled Ecological Life Support Systems (CELSS): Conceptual Design Option Study

Olson, R.C.,* Gustan, E.A., and Vinopal, T.J.
CELSS Transportation Analysis

Omasa, K. and Aiga, I.
Image Instrumentation for Extracting Plant Physiological Information
Prince, R.P. and Knott, W.M.*
Plant Growth Chamber 'M' Design

Radmer, R.,* Behrens, P., Fernandez, E., and Arnett, K.
An Analysis of the Productivity of a CELSS Continuous Algal Culture System

Radmer, R.,* Behrens, P., Cox, J., Arnett, K., and Lieberman, D.
Biomass Recycle as a Means to Improve the Energy Efficiency of CELSS Algal Culture Systems

Studies Related to a Closed Ecological Life Support System (CELSS)

Rummel, J.D.*
A Modular BLSS Simulation Model

Rummel, J.D.*
CELSS Science Needs
Operational Development of Small Plant Growth Systems  
in Controlled Ecological Life Support Systems: CELSS '85  
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),  
NASA Ames Research Center, Moffett Field, CA, pp. 129-150. (NASA  

Schwartzkopf, S.H.*  
A Non-Destructive Method for Monitoring Plant Growth  

Schwartzkopf, S.H.*  
Design of an Elemental Analysis System for CELSS Research  
in Twenty-Sixth Plenary Meeting of the Committee on Space  
156. 1986.

Schwartzkopf, S.H.*  
Electrochemical Control of pH in a Hydroponic Nutrient Solution  
in Controlled Ecological Life Support Systems: CELSS '85  
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),  
NASA Ames Research Center, Moffett Field, CA, pp. 151-158. (NASA  

Seshan, P.K., Petersen, G.R.,* Beard, B., and Dunlop, E.H.  
Design Concepts for Bioreactors in Space  
in Controlled Ecological Life Support Systems: CELSS '85  
Workshop, (eds. R.D. MacElroy, N.V. Martello, and D.T. Smernoff),  
NASA Ames Research Center, Moffett Field, CA, pp. 287-314. (NASA  

Skoog, A.I.  
BLSS, A European Approach to CELSS  
in Controlled Ecological Life Support Systems, NASA, Ames  
Research Center, Moffett Field, CA, pp. 23-33.  
1985

Skoog, A.I.  
Progress in European CELSS Activities  
in Twenty-Sixth Plenary Meeting of the Committee on Space  
152. 1986.
Smernoff, D.T. *
Atmosphere Stabilization and Element Recycle in an Experimental Mouse-Algal System

Smernoff, D.T. *, Wharton, R.A., Jr., and Averner, M.M. *
Observations on Gas Exchange and Element Recycle within a Gas-Closed Algal-Mouse System


Volk, T. and Rummel, J.D. *
The Role of Reservoir Sizes in the Maintenance of a Stable Closed System
CELSS Scientists and CELSS Supported Scientists Currently Involved in CELSS Research

R.D. Arno  
Ames Research Center  
Moffett Field, CA 94035  
(415) 694-6640

G.C Carle  
Ames Research Center  
Moffett Field, CA 94035  
(415) 694-5765

G.V. Columbo  
Umpqua Research Company  
Myrtle Creek, OR 97457  
(503) 863-5201

C.R. Davis  
Life Sciences Project Division  
Johnson Space Center  
Houston, TX 77058  
(713) 483-4164

H.J. Finger  
Ames Research Center  
Moffett Field, CA 94035  
(415) 694-6598

T. Hoshizaki  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
Pasadena, CA 91103  
(415) 792-4456

R. Huffaker  
Plant Growth Laboratory  
University of California, Davis  
Davis, CA 95616  
(916) 752-6162

G.E. Janauer  
The Research Foundation of SUNY  
P.O. Box 9  
Albany, NY 12201  
(617) 655-7741

M. Karel  
Department of Food Technology  
Massachusetts Institute of Technology  
Cambridge, MA 02139  
(617) 253-6744

S.S. Kishiyama  
Ames Research Center  
Moffett Field, CA 94035  
(415) 694-5572

R. MacElroy  
Ames Research Center  
Moffett Field, CA 94035  
(415) 694-5480

R.W. Mah  
Ames Research Center  
Moffett Field, CA 94035  
(415) 694-6538

R. Mannatt  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
Pasadena, CA 91109  
(818) 354-4256

C. Mitchell  
Department of Horticulture  
Purdue University  
West Lafayette, IN 46207  
(818) 354-3942

M. Modell  
23 Fresh Pond Place  
Cambridge, MA 02128  
(617) 457-3147

F.E. Mount  
Man Systems Division  
Man-Machine Analysis Branch  
Johnson Space Center  
Houston, TX 77058  
(713) 483-4065
L. Packer
Applied Science Division
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720
(415) 642-1872

G.R. Petersen
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-7019

D.L. Peterson
Ames Research Center
Moffett Field, CA 94035
(415) 694-5899

D.L. Pierson
NASA-Johnson Space Center
Houston, TX 77058
(713) 483-5457

R. Radmer
Martin Marietta Laboratory
1450 South Rolling Road
Baltimore, MD 21227
(301) 247-0700

D. Raper
Department of Soil Science
North Carolina State University
Raleigh, NC 27695
(919) 737-2644

S.A. Rositano
Ames Research Center
Moffett Field, CA 94035
(415) 694-5480

F. Salisbury
Department of Horticulture
Utah State University
Logan, UT 84322
(801) 750-2237

G. Salzman
National Flow Cytometry Resource
Los Alamos Scientific Laboratory
Los Alamos, NM 87545
(505) 667-2730

S. Schwartzkopf
University of New Hampshire
Durham, NH 03824
(415) 694-6055

P.K. Seshan
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

D. Stilwell
Life Sciences Project Division
Johnson Space Center
Houston, TX 77058
(713) 483-4164

T. Tibbitts
Department of Horticulture
University of Wisconsin
Madison, WI 53706
(608) 262-1491

B.J. Woolford
Man-Machine Analysis Branch
Man-Systems Division
Johnson Space Center
Houston, TX 77058
(713) 483-4065

G. Salzman
National Flow Cytometry Resource
Los Alamos Scientific Laboratory
Los Alamos, NM 87545
(505) 667-2730
Publications of research sponsored by the NASA CELSS (Controlled Ecological Life Support Systems) Program are listed, along with publications of interest to the Program. The bibliography is divided into the three major divisions of CELSS research: 1) Food Production; 2) Waste Management; and 3) Systems Management and Control. This bibliography is an update of NASA CR-3911 and includes references from 1984 through 1986.