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ARD News April 1994

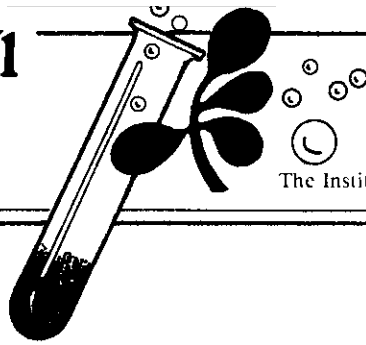
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April 1994

Volume 28, Number 5

COMMENTS FROM THE DEAN

107TH ANNUAL REPORT FOR ARD

Dear Colleagues:

Accountability remains a key element in the conduct of publicly-funded research. Taxpayers and decision makers are increasingly asking, "What are we getting in return for the tax dollars invested in research?" Scientists and research administrators must be willing and able to answer this question in a forthright manner.

Agricultural scientists have an outstanding record of increasing productivity that is well documented in comprehensive studies of return on investment in agricultural research, and demonstrated by the small percentage of disposable income U.S. consumers spend on food. I have observed that these arguments do not "sell" particularly well with the public because the data are aggregated for the U.S. and citizens/decision makers usually have interest in the outcomes from investing Nebraska tax dollars in research. In response to this interest, ARD has been publishing accomplishment reports (**RESEARCH Nebraska!** and **Endeavors**), emphasizing in-depth news and other media releases, cooperating on **IANR Impact**, using the **ARD Fact Sheet** in presentations, preparing a more "reader friendly" version of the **ARD Annual Report**, and cooperating with national entities that routinely disseminate agricultural research accomplishment reports.

We need your assistance to make our public information efforts more effective. We are asking each of you to: (i) contact Vicki Miller, ICCS science writer, with ideas for accomplishment reports that will appeal to our clientele or the general public; (ii) cooperate with Vicki or other science writers when they ask for assistance in preparing an article or news release about your research; (iii) take advantage of opportunities to discuss the impacts of your research with neighbors, service clubs, citizen groups, etc.; and (iv) present your findings at educational activities such as field days, in-depth extension meetings and conferences, in-service activities for educator affiliates, campus tours by K-12 students, meetings of primary and secondary teachers, etc. Working together we can ensure that citizens understand and appreciate the importance of agricultural, natural resources, and human resources and family sciences research.

*Darrell W. Nelson
Dean and Director*

The 107th Annual Report for the Agricultural Research Division was distributed in January. The report is mandated by legislation that established the Nebraska Agricultural Experiment Station in 1887 and is officially prepared for the Governor. Copies are sent to members of the Nebraska Congressional Delegation, state agency officials, legislators serving on the Agriculture and Natural Resources Committees, the Board of Regents, university administrators and members of the Agriculture Builders of Nebraska.

Copies of the Annual Report have been provided to unit administrators and members of the ARD Advisory Council. We have asked that unit administrators circulate the Annual Report to all faculty members with ARD appointments. A few extra copies are available for faculty who have a need or desire for a personal copy. Please contact the ARD office if you wish to receive a copy of the report.

Steve Waller and Dora Dill provided the ARD leadership for the Annual Report. We would also like to acknowledge the excellent editing and writing efforts of Judy Nelson and Vicki Miller. These two professionals along with other staff in ICCS ensured that a top quality report was published.

ARDC "RESEARCH AND EDUCATION BUILDING" GROUNDBREAKING CEREMONY

A groundbreaking ceremony for the ARDC "Research and Education Building" will be held Friday, May 13 at 1:30 p.m. The theme for the ceremony is "Seeding a Vision for the Future." The program will last approximately 30 minutes, with refreshments and tours of the ARDC offered immediately following the ceremony. IANR Departments with programs at the ARDC will have displays highlighting research activities at the facility.

This new 23,000 square foot facility will be constructed by R.L. Fauss Builders Inc. of Fremont, NE. Construction will begin in April, with completion scheduled for early 1995. ARDC offices and Saunders County Extension offices should be operating in the building by June of 1995.



The Agricultural Research Division provides information and educational programs to all people without regard to race, color, national origin, sex or handicap.



SPECIAL RESEARCH GRANT PROGRAM AWARDS

Nebraska Bankers Association Awards

The Nebraska Bankers Association annually funds projects that have some potential to stimulate economic activity in the state. Listed below are the ARD-affiliated research projects and principal investigators receiving funding for 1994:

Terry Klopfenstein, Animal Science, "Provide Intensive Training for Undergraduate Students to Enable Them to Enter Positions in Feedlot Management upon Graduation," \$14,000

Deb Rood, Agricultural Economics, "Women in Agriculture: The Critical Difference," \$2,000

Gary Bergman, Agricultural Leadership, Education and Communication, "Equipment for Nebraska LEAD Program," \$11,951

Congratulations for successfully competing for Nebraska Bankers Association grants.

Layman Awards

IANR faculty submitted 13 proposals for funding by the Layman Trust. An evaluation committee carefully reviewed each proposal and ranked the submissions in relation to quality of the science and the potential impact of the proposed research. Eight proposals were forwarded to the Vice Chancellor for Research.

The primary aim of the Layman Awards is to provide research support for various purposes: seed money to enhance the possibility of obtaining external support; funds for projects of high merit in areas of research unlikely to receive external support; mini-faculty development support for two to four weeks in length; and funds for research projects that have special importance to the teaching and public service mission of UNL.

Three proposals submitted by ARD faculty were funded:

Patricia Crews, Textiles, Clothing & Design, "Faculty Development Support to Visit the U.S. Army Natick Research, Development and Engineering Center," \$2,780

Blair Siegfried, Entomology Department, "Establishing Baseline Susceptibility of the European Corn Borer to *Bacillus thuringiensis*," \$14,000

Curtis Weller, Biological Systems Engineering, "Analysis of Mass Transfer and Gas Transition Properties of Protein Films Derived from Agricultural Commodities," \$9,715

High Risk Research Proposals

Four Innovative and High Risk Research proposals were received for consideration by ARD. This program is

designed to fund very innovative research projects with the object of developing data that can be used to support requests for external grants. These proposals can be submitted at any time during the year. These proposals will be evaluated quarterly by a subcommittee of the ARD Advisory Council.

The following project was funded by the ARD "Innovative and High Risk Research" program starting Sept. 1, 1993:

Shawn Kaeppler, Agronomy Department, "Cloning Differences Between Plant Genomes," \$15,000

SUCCESSFUL GRANT PROPOSALS IN SUSTAINABLE AGRICULTURE

The North Central Region Administrative Council of the Sustainable Agriculture Research and Education program recently evaluated 30 Low-input Sustainable Agriculture (LISA) grant proposals and nine Agriculture in Concert with the Environment (ACE) grant proposals. Thirteen LISA and four ACE proposals were recommended for funding. Four of these successful proposals were submitted by our faculty:

Glenn A. Helmers, Estimation of Reduced Machinery Ownership Costs in Diversified Cropping Systems.

John C. Allen, Quality of Life Effects of Conventional, Transitional and Sustainable Production Systems on Rural Communities and Family Farms in the Western Corn Belt.

Charles Francis, Comparing Farming Systems with Different Strategies and Input Levels: A Research/Education Program with Replicated Micro-farms.

Don Adams and Richard Clark, Improving Sustainability of Cow-calf Operations with Natural Forage Systems.

NORTH CENTRAL REGION SUSTAINABLE AGRICULTURE PROGRAM MOVES

The Regional Office for the North Central Region Sustainable Agriculture Research and Education program has moved. The new location is 13-A Campus Activities Building. You may enter from the north side. The new space will accommodate the rapidly growing space demands of the Regional Office. Kathy Westwood staffs the office full time. Lisa Jasa, Communications Specialist, is assigned to the program half time and Steve Waller, Regional Coordinator, is 35 percent in the office.

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Michael F. Kocher, Changhe Chen and Robert D. Grisso — National Research Initiative Competitive Grants Program — Simulation Model to Evaluate Ground-Based Field Crop Sprayers for Environmental Hazard — \$63,495

Dennis D. Schulte, Wayne E. Woldt and Joseph Skopp — National Research Initiative Competitive Grants Program — Measuring Groundwater Quality Impacts from Feedlot Runoff Retention Ponds and Waste Lagoons Using Integrated Geophysical and Bottom Samplings Methods — \$215,075

Darrel G. Watts and Roy Spalding — United States Department of Agriculture/Cooperative State Research Service — Management of Irrigated Corn and Soybeans to Minimize Groundwater Contamination — \$400,000

Leon George Higley — National Research Initiative Competitive Grants Program — Establishing Environmental Costs of Pesticides to Reduce Environmental Risks — \$212,439

Paul Staswick — National Research Initiative Competitive Grants Program — Jasmonate Signaling in Plants — \$207,400

Rodney A. Moxley — National Research Initiative Competitive Grants Program — Pathogenesis and Immune Response to Attaching Effacing *E. coli* from Calves — \$23,927

Rodney A. Moxley and Susan S. Sumner — National Research Initiative Competitive Grants Program — Effect of Carcass Wash Treatments on Pathogenicity of *Escherichia coli* 0157:H7 — \$174,981

Richard K. Perrin — National Research Initiative Competitive Grants Program — Development and Application of Specific Technology Assessment Techniques — \$70,537

Lloyd B. Bullerman and Milford A. Hanna — National Research Initiative Competitive Grants Program — Fate of Fumonisin and Other Fungal Metabolites in Heat Processed Corn Products — \$131,677

H. Edward Grotjan, Debora L. Hamernik, James E. Kinder, Andy J. Roberts and Shyamal Roy — National Institutes of Health — Hypothalamic Pituitary Ovarian Function: IDeA Project — \$281,774

Sara M. Azzam, Azzeddine M. Azzam and James E. Kinder — National Research Initiative Competitive Grants Program — Systems of Artificial Insemination in Beef and Dairy Enterprises — \$196,073

Thomas O. Powers — National Institutes of Health — Molecular Diagnostics of Black Fly Species Complexes — \$233,041

Glenn A. Helmers — National Research Initiative Competitive Grants Program — Biological and Optimizing Whole-Farm System Choices Including Subsystem Interaction Effects — \$121,094

Charles A. Francis — National Research Initiative Competitive Grants Program — Biological and Economic Consequences of Flexible Crop Rotations — \$274,523

Patricia Cox Crews — National Research Initiative Competitive Grants Program — WeatherOmeter for Accelerated Environmental Exposure of Textile Fibers — \$29,300

James L. Stubbendieck, Kenneth G. Hubbard, Anne M. Parkhurst and Walter H. Schacht — U. S. Department of Agriculture — Vegetation Dynamics in a Fragile Sand Hills Ecosystem — \$78,991

Terry J. Klopfenstein, Don C. Adams and Walter H. Schacht — U. S. Department of Agriculture — Integration of Rangeland and Cropland in Growing-Finishing Beef Production — \$79,062

David W. Stanley-Samuelson — National Institutes of Health — Eicosanoids Mediate Insect Immunity — \$70,511

Mark Morrison — National Research Initiative Competitive Grants Program — Molecular Biology of Protein Degradation & Utilization by *Prevotella ruminicola* — \$269,984

John H. Golbeck — National Science Foundation — Resolution and Reconstitution of Photosystem I in Cyanobacteria and Higher Plants: Molecular Biological and Physio-Chemical Studies — \$100,000

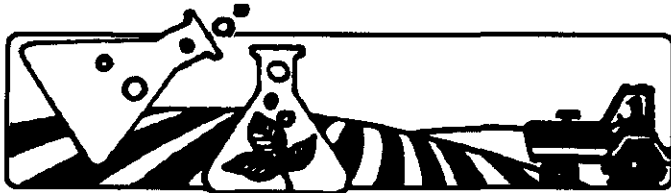
Stephen W. Ragsdale — National Institutes of Health — Mechanisms of Methyl Transfer in Acetyl-CoA Synthesis — \$155,138

Elizabeth A. Walter-Shea — NASA — Laboratory Equipment for the Southern Study Area — \$7,329

Clayton L. Kelling — National Institutes of Health — RSV Disease Immunopotential in a Homologous System — \$408,692

Marjorie F. Lou, Stephen Ragsdale, Ruma Banerjee, Marion O'Leary, James VanEtten, Pill-Soon Song and Gautam Sarath — National Institutes of Health — Request for Protein Sequencer-Amino Acid Analyzer — \$207,201

John H. Golbeck — National Science Foundation — Research Experience for Undergraduates — \$10,000



**GRANTS AND CONTRACTS
RECEIVED
FEBRUARY AND MARCH, 1994**

Agricultural Economics	
Perrin, R. K. — USDA/CSRS	70,538
Miscellaneous grants under \$5,000 each	7,500
Agricultural Meteorology	
Hubbard, K. G. — USDA	61,675
Verma, S. B., Ullman, F. G. and Arkebauer, T. J. — NSF	200,000
Wilhite, D. A. and Hubbard, K. G. — Environment Canada	20,000
Miscellaneous grants under \$5,000 each	1,000
Agronomy	
Clegg, M. D. and Frank, K. — UN Foundation	15,000
Johnson, B. — Pioneer Hi-Bred Int'l	28,075
Mason, S. C. — Crop Production Trust Fund — UN Foundation	15,000
Mortensen, D. and Martin, A. — UN Foundation	15,000
Peterson, T. — Nebr. Dept. of Environmental Quality	8,500
Thomas-Compton, M. — Crop Production Trust Fund — UN Foundation	15,000
Walters, D. — UN Foundation	15,000
Miscellaneous grants under \$5,000 each	18,410
Animal Science	
Calkins, C. R. — UN Foundation	9,930
Stock, R. A. — Eli Lilly and Company	16,000
Stock, R. A. — Nebraska Ethanol Authority	9,481
Miscellaneous grants under \$5,000 each	39,392
Biochemistry	
Banerjee, R. — National Institute of Health	89,042
Ragsdale, S. — U.S. Department of Energy	97,000
Wagner, F. W. — BioNebraska, Inc.	23,475
Biological Systems Engineering	
Weller, C. — UN Foundation	9,135
Entomology	
Higley, L. — Ohio State Research Foundation	13,000
Kramer, W. — Nebraska Department of Health	59,040
Miscellaneous grants under \$5,000 each	14,500
Food Processing Center	
Miscellaneous grants under \$5,000 each	6,361
Food Science and Technology	
Miscellaneous grants under \$5,000 each	19,979
Forestry, Fisheries and Wildlife	
Hoagland, K. D. — Nebr. Dept. of Environmental Quality	30,000
Miscellaneous grants under \$5,000 each	200
Horticulture	
Miscellaneous grants under \$5,000 each	14,385
Industrial Ag Products Center	
Hanna, M. A. — Iowa State University	42,120
Northeast Research and Extension Center	
Miscellaneous grants under \$5,000 each	17,480
Panhandle Research and Extension Center	
Binford, G. D. — Crop Production Trust Fund-UN Foundation	15,000
Wilson, R. G. — Western Sugar Co.-Growers Research Committee	22,600
Miscellaneous grants under \$5,000 each	39,427
Plant Pathology	
Mitra, A. and Dickman, M. — Consortium for Plant Biotechnology Research, Inc.	83,750
Miscellaneous grants under \$5,000 each	5,000

South Central Research and Extension Center	
Miscellaneous grants under \$5,000 each	7,449
Veterinary and Biomedical Sciences	
Kelling, C. L. — SmithKline Beecham Animal Health	41,378
Miscellaneous grants under \$5,000 each	4,047
Water Center/Environmental Programs	
Spalding, R. F. — Nebraska Department of Agriculture	30,000
Volk, B. — UN Foundation	6,055
West Central Research and Extension Center	
Wicks, G. A. — UN Foundation	8,900
Miscellaneous grants under \$5,000 each	5,456
GRAND TOTAL	1,270,279

Diane Says

A good rule for going through life is to keep the heart a little softer than the head.

**U.S. PUBLIC AGRICULTURAL RESEARCH
EXPENDITURES**

Given below are data on public agricultural research expenditures by commodity for 1980 and 1990. These data reflect expenditures by the state agricultural experiment stations and ARS. All data are expressed in inflation-corrected 1990 dollars. There are some interesting trends evident in research investments by commodity.

Commodity	1980 Expend	1990 Expend	% Change
	----- \$, millions -----		
PLANT RESEARCH	750	817	8.5
Field Crops	398	426	6.7
Corn	62	76	21.0
Sorghum	16	16	0
Wheat	48	66	32.6
Other small grains	34	33	-3.3
Soybeans	66	72	8.8
Other oil seeds	24	28	18.2
Forages	81	72	-11.8
Cotton	68	72	-9.7
Horticultural Crops	298	337	12.6
Fruits and nuts	128	139	7.6
Vegetables	123	151	20.4
Ornamentals and turf	46	48	3.8
Other Crops	54	54	0
LIVESTOCK RESEARCH	489	476	-2.7
Beef cattle	174	149	-15.5
Dairy cattle	118	117	-0.9
Swine	71	76	6.9
Poultry	73	79	8.2
Sheep	32	33	2.5
Other animals	22	24	3.1
OTHER RESEARCH	1,037	1,095	5.4
GRAND TOTAL	2,276	2,387	4.8

Data taken from Huffman (1993) The trends and market for agricultural R&D, available scientists, and new scientists IN U.S. Agricultural Research: Strategic Challenges and Options, Agricultural Research Institute, Bethesda, MD.

FY 1995 CSRS BUDGET

Listed below is the President's proposed FY 1995 budget for the USDA Cooperative States Research Service. The budget year begins Oct. 1, 1994. Given the federal budget deficit problem, the President's budget recommendation for agricultural research is positive. The President is recommending level funding for "Base Programs" and many of the programs in "National Special Grants" and "Other Research Programs." We were pleased to see that the President is recommending increases in the National Research Initiative (16 percent), Integrated Pest Management (117 percent), Pesticide Clearance (60 percent), and Sustainable Agriculture (19 percent). Congress is currently holding hearings on the USDA budget and we expect to have "mark ups" on the appropriations bills by late summer.

	FY 1993 Appropriation	FY 1994 Appropriation	FY 1995 President's Budget
----- \$, thousands -----			
BASE PROGRAMS			
Hatch Act	168,785	171,304	171,304
McIntire-Stennis	18,533	20,809	20,809
Animal Health	5,551	5,551	5,551
NATIONAL RESEARCH INIT			
Plant systems	40,000	43,900	47,000
Animal Systems	25,000	25,000	29,500
Nutrition, Food Qual	6,500	8,000	11,000
Natural Res & Envir	18,000	23,750	27,000
Eng Proc & Value-added	4,000	7,500	9,000
Markets, Trade & Pol	4,000	4,000	6,500
Total	97,500	112,150	130,000
NATIONAL SPECIAL GRANTS			
Integrated Pest Mgmt	4,457	3,228*	7,000
Pesticide Clearance	3,500	6,750	10,800
Pest Impact Assess	2,968	1,568*	2,968
Minor Use Anim Drugs	464	650	650
Biol Impact Asses	300	300	300
Rural Devel Centers	500	500	500
Trop & Subtrop Ag	3,320	3,320	0
Water Quality	8,900	4,500*	4,500
Global Change	2,000	1,250*	3,000
Total	26,459	22,566	29,718
REGION/STATE SPEC GRANTS	46,636	50,351	0
OTHER RESEARCH PROGRAMS			
Rangeland	475	475	475
Aquaculture Centers	4,000	4,000	4,000
Supp & Alter Crops	1,168	1,818	1,818
Critical Materials	400	500	0
Sustainable Ag	6,725	7,400	8,825

* A part of the funding was moved to the National Research Initiative.

INTEGRATED CROP/LIVESTOCK FARM CONTINUES TO DEVELOP AT ARDC

In the spring of 1992, the Center for Sustainable Agricultural Systems received a CSRS Special Grant to initiate an Integrated Crop/Livestock Farm at the ARDC. An Integrated Farm Committee, consisting of the Principal Investigator, Terry Klopfenstein; Project Coordinator, Gary Lesoing; Superintendent of the ARDC, Dan Duncan; and interested IANR faculty members was formed to develop objectives and a plan for the farm. The past two years the farm has incorporated existing experiments, developed new research, and now includes approximately 4,000 acres of the ARDC, focusing on integrated research in crops, livestock, forestry, soils, and horticulture.

The Integrated Farm includes: a 120-head feedlot, 120-head beef cow herd, a 140-head dairy herd, a 300-ewe flock, and about 4,000 acres of dryland and irrigated cropland, and warm and cool season grass pastures. Primary objectives developed for the Integrated Farm include:

1. Integrate innovative cropping and grazing systems and develop new systems to add value to crops and crop residues in an integrated crop/livestock farm.
2. Develop a manure application plan that will maximize the nutritive benefit of animal wastes to crops and pasture in an integrated crop/livestock farm.
3. Develop sustainable cropping practices that maximize use of renewable resources, that are environmentally sound, maintain wildlife, and are profitable in the short and long term.
4. Demonstrate cropping practices and livestock enterprises that are environmentally sound and maintain water quality.
5. Provide a demonstration and research location to educate the public about the above farming practices, with individual research projects providing answers to specific questions.
6. Optimize management of the Silver Creek area and associated wetlands ... trees, grasslands, woody perennials, fish production, wildlife, water quality.
7. Evaluate the role and impact of living wild resources (trees, wildlife, insects, etc.) in relation to sustainable agricultural systems.
8. Provide educational and extension opportunities for students, producers, and the general public both on the process of integrated farm design and the specific practices on the Integrated Crop/Livestock Farm.

To assist in meeting these objectives, established component research projects in crop, beef, and agroforestry production systems are being expanded upon. These projects include:

1. Strip cropping, crop rotations, and planting strategies to increase crop productivity.
2. Long-term integrated beef production and crop production systems.
3. Role for windbreaks and other tree plantings in crop/vegetable production enhancement.

The Integrated Farm Committee decided to compost manure from the different livestock enterprises of the Integrated Farm. Composting began in the spring of 1993. Composting adds flexibility for application to cropland, stabilizes nutrients in the livestock wastes, reduces the volume of material hauled to the field, eliminates pathogens, and kills weed seeds in the manure. The economics and feasibility of composting livestock wastes and the value of compost as a nutritive source for crops and as a soil amendment is being investigated.

Another important issue being addressed by several experiments on the Integrated Farm is the effect of grazing crop residues on subsequent crop yields. Data must be collected over different environments for several years before a meaningful conclusion can be drawn.

The LISA grants are funding research within the Integrated Farm. One grant is evaluating the effectiveness of strip cropping systems in controlling water erosion on erodible land. Different widths of 20' and 80' alternating strips of corn-alfalfa, corn-soybean, or grain sorghum-soybean will be evaluated.

The other grant evaluates the effect of tillage system (disk-plant vs ridge-till) on livestock and crop production. Crop growth and production, effects on soil properties, and animal performance will be measured in this experiment.

Other experiments being conducted on the Integrated Farm include: relay and double cropping soybeans with winter wheat, overseeding forages in soybeans for fall grazing, determination of the fate of nitrogen from manure and urine of cattle grazing crop residues during the fall and winter, and comparing the productivity of grazing and cropping systems in unprotected fields, and those protected by windbreaks.

Presentations on the development of the Integrated Farm have been made nationally at the American Society of Agronomy Meetings, a special symposium sponsored by the American Society of Agricultural Engineers, and the American Farm Bureau Federation; and locally at the Agronomy Highlights. In both 1992 and 1993, several people have toured the Integrated Farm and experiments within the farm. The SEREC included specific areas of the farm for their in-service training at the ARDC. With increasing activity, we feel the Integrated Farm will provide excellent opportunities for education and extension in 1994. For questions about specific projects on the Integrated Farm contact: Gary Leosing, 624-2275; Terry Klopfenstein, 472-6443; or Chuck Francis, 472-1581.

PROPOSALS SUBMITTED FOR FEDERAL GRANTS

The following proposals were submitted after Feb. 1, 1994 by faculty for federal grant programs. While not all grants will be funded, we applaud the faculty member's effort in submitting proposals to the various agencies.

Mark Morrison — National Institutes of Health — Nitrogen Metabolism in Colonic Bacteroides Species — \$452,010

Donald C. Adams and Richard T. Clark — North Central Region 1994 LISA Program — Improving Sustainability of Cow-Calf Operations with Natural Forage Systems — \$82,000

Craig W. Smith — National Research Initiative Competitive Grants Program — Research and Evaluation Component of the Nebraska Family Wellness Network — \$74,826

Neal B. Stolpe, Mark S. Kuzila and Patrick J. Shea — National Research Initiative Competitive Grants Program — Refined Estimation of Pesticide Mobility from MLRA Measurements and Property Databases — \$18,388

Robert D. Kuzelka and Peter J. Longo — National Research Initiative Competitive Grants Program — A Local Government Paradigm for Effective Water Quality Management in Watershed Areas — \$199,831

E. Wesley F. Peterson and Paul B. Thompson — National Research Initiative Competitive Grants Program — Sustainability, Competitiveness and Biotechnology — \$77,836

Thomas G. Franti — National Research Initiative Competitive Grants Program — Predicting Long-Term Pesticide Runoff Losses from Agricultural Management Systems — \$165,555

Gary W. Hergert and Bert R. Bock — National Research Initiative Competitive Grants Program — N-EVAL: A Decision Aid to Assess Economic and Environmental Impacts of N Management — \$39,843

Blair D. Siegfried, Kyle D. Hoagland and Scott J. Nissen — National Research Initiative Competitive Grants Program — Mechanisms of Atrazine Selective Toxicity in Freshwater Algae — \$106,891

Evert Van der Sluis — National Research Initiative Competitive Grants Program — The Impact of Cropland Diversion Programs on Rural Population Change and Farm Numbers — \$38,247

Wayne E. Woldt, Carol A. Gotway, Derrel L. Martin and Todd A. Peterson — National Research Initiative Competitive Grants Program — Use of Imprecise Information in Variable Rate Application Systems for Protection of Groundwater Quality — \$146,665