

Self-Review for 2004 Portfolio Review Expert Panel

Portfolio 1.5B: Animal Production

***Supporting Objective 1.5B: Contribute Science-
Based Information, Analysis, and Education to
Promote the Efficiency of Agricultural
Production Systems (Animal Production)***

***CSREES Goal 1: Enhance Agricultural
Opportunities for Agricultural Producers***

For the period 1998-2002



Portfolio Review Panel – Animal Production

INTRODUCTION

This report was developed by the animal Production Unit, Plant and Animal Systems (PAS), Cooperative State Research, Education, and Extension Service (CSREES), U.S. Department of Agriculture. The report is submitted to the Portfolio Review Panel convened by the CSREES Administrator, as a pilot, to assess the effectiveness of the Animal Production Unit as it leads efforts to address national problems or concerns in the animal-related agricultural fields. The report broadly describes a wide variety of programs operated and managed under the Animal Production portfolio.

The first part of the report contains general description of CSREES, its vision, mission, and functions, as well as funding authorities for all CSREES programs. The second part of the report is a general description of the Animal Production portfolio, followed by descriptions of the eight Problem Areas covered in the portfolio. These descriptions make references to numerous evidentiary materials regarding funding and other issues; these materials are contained in accompanying volumes available to the Panel for examination in Washington, D.C.

During the meetings, National Program Leaders (NPLs) with responsibility for each Program Area will provide the Panel with a brief presentation on the main points of the description and clarifications should the Panel have further questions.

It is CSREES' expectation that the Panel reviews this report before meeting in Washington, D.C.; ask the NPLs questions for clarifications during their presentations; deliberate assessment of the portfolio based on the evidentiary materials; and score the portfolio on the basis of criteria developed by the Office of Management and Budget for relevance, quality, and performance. A tool will be provided to aid the panel.

It also is CSREES' expectation that the Panel provide recommendation to the Administrator and NPLs on how to better manage the portfolio.

OVERVIEW

USDA

The mission of the United States Department of Agriculture (USDA) is to provide leadership on food, agriculture, natural resources, and related issues based on sound public policy, the best available science, and efficient management. USDA's vision is to be recognized as a dynamic organization that is able to efficiently provide the integrated program delivery needed to lead a rapidly evolving food and agriculture system. Goal 1 of the USDA strategic plan is to enhance economic opportunities for agricultural producers.

CSREES

The Cooperative State Research, Education and Extension Service (CSREES) is USDA's primary link with the Land-Grant University System and with other higher education institutions. CSREES invests public funds, as authorized and appropriated by the Congress, in basic, applied, and developmental research, extension, and teaching activities in food and fiber, agricultural, renewable natural resources, forestry, and the physical and social sciences. Through the distribution and management of formula funds, competitive grants and special grants, CSREES achieves its mission to advance knowledge for agriculture, the environment, human health and well being, and communities. Specifically, CSREES provides national program leadership to identify, develop and manage programs to support university-based and other institutional research, education, and extension, and provides fair, effective, and efficient administration of Federal assistance implementing research, education and extension awards and agreements. See the draft CSREES Strategic Plan in the Evidence Volume.

VISION

Agriculture is a knowledge-based, global enterprise, sustained by the innovation of scientists and educators.

MISSION

To advance knowledge for agriculture, the environment, human health and well being, and communities.

FUNCTIONS

Program leadership to identify, develop, and manage programs to support university-based and other institutional research, education, and extension. Fair, effective, and efficient administration of Federal assistance implementing research, education, and extension awards and agreements.

Current Trends and Opportunities

The Land-Grant University System was established by the Morrill Act of 1862 “to teach such branches of learning as are related to agriculture and the mechanic arts . . . in order to promote the liberal and practical education of the industrial classes in the several pursuits and profession in life.” At that time the scientific basis of agriculture was rudimentary, and focused primarily on increasing the productivity of lands and animals. Plant and animal breeding, nutrient management are significant milestones in the spectrum of scientific investment in agricultural productivity.

As agriculture matured and became more fully integrated into the social, political and economic structure of the Nation, broader issues, including positive and negative environmental and economic externalities, access to and the distribution of the benefits of public investment in agriculture and rural communities, and the sustainability of the scientific workforce have emerged. Breakthroughs in fundamental science, including genomics, microbiology and nanotechnology have raised the bar for the application of science, technology, and practice in producing, marketing and distributing food and fiber products. These sometimes produced additional questions regarding long term risks and benefits, ethics, and domestic and international consumer acceptance. In the post-9/11 environment, the aggregate safety and security of the food and fiber supply, terrorism aimed at food and fiber products, and protecting public health and well being became paramount.

The increasingly global nature of contemporary agriculture products offers the world the benefit of a more varied food supply, but is accompanied by increased risks of food-borne disease and invasive pests. The information available from the sciences of plant and animal genomics, remote sensing, disease epidemiology, animal and human nutrition, and market and policy analysis have transformed agriculture into a high-tech, environmentally sustainable, and profitable industry that can address the world’s accelerating food and fiber needs. Expanding scientific base beyond the production sciences to also address human health, environmental sustainability, and community and economic development is crucial to increase distribution of food and fiber to growing international markets.

Adequate nutrition is needed to promote human health, maintain a healthy body weight, and to avoid the risk of chronic disease related to food consumption. State-of-the-art scientific techniques document optimal nutritional nutrition needs from pre-birth through old age. Technological advancements like sequencing of the human and other genomes, allow scientists to develop individual nutrient requirements as determined by age, environment, gender, genetics, lifestyle, and physiology.

Partners/Stakeholders/Customers

CSREES provides federally-mandated funding to support extramural research, education and extension programming throughout the United States and its territories.

CSREES’ primary partners are public institutions of higher learning, particularly the 1862, 1890 (Historically Black) and 1995 (Tribal) land-grant colleges and universities, and the “non land-

grant” public institutions whose missions include basic, applied and developmental research, extension, and teaching activities in food and fiber, agricultural, renewable natural resources, forestry, and physical and social sciences. The scope of partner activities is broad—all aspects of agriculture, including soil and water conservation and use; plant and animal production, protection, and health; processing, distribution, safety, marketing, and utilization of food and agricultural products; forestry, including urban forestry; aquaculture; home economics and family life, human nutrition; rural and community development; sustainable agriculture; molecular biology; and biotechnology.

CSREES’ ultimate customers are citizens. CSREES works with land-grant and other institutions and industry to create and transfer the know-how and the technology from the laboratory to farmers, consumers, and agribusiness. The Cooperative Extension System provides information to every county in the Nation, offering education that links research, science, and technology to people where they live and work. Topics range from community economic development, health care, food safety, water quality, sustainable agriculture, and the environment to programs for children, youth, and families.

FUNDING AUTHORITIES FOR CSREES ACTIVITIES

RESEARCH AND EDUCATION ACTIVITIES

Research and Education programs administered by CSREES are USDA’s principal connection to the university system of the U.S. for the purpose of conducting agricultural research and education programs as authorized by the Hatch Act of 1887, as amended (7 U.S.C. 361a-361i); the Cooperative Forestry Research Act of 1962, as amended (16 U.S.C. 582a-7); Public Law 89-106, Section (2), as amended (7 U.S.C. 450i); the National Agricultural Research, Extension, and Teaching Policy Act of 1977, as amended (7 U.S.C. 3101 et seq.); the Equity in Educational Land-Grant Status Act of 1994, (7 U.S.C.PA 301); the Agricultural Research, Extension, and Education Reform Act of 1998; and the Farm Security and Rural Investment Act of 2002. Through these authorities, USDA participates with state and other cooperators to encourage and assist the state institutions in the conduct of agricultural research and education through the State Agricultural Experiment Stations (SAES) of the 50 states and the territories; by approved Schools of Forestry; the 1890 Land-Grant Institutions and Tuskegee University and West Virginia State College; Colleges of Veterinary Medicine; and other eligible institutions. The funds appropriated provide Federal support for research and education programs at these institutions.

Appropriations for research and education activities are authorized under the following Acts:

1. Payments to agricultural experiment stations under Hatch Act Agricultural Experiment Stations Act of August 11, 1955, Hatch Act of 1887 as amended – 7 U.S.C. 361a-361i, Public Law 92-318; Public Law 93-471; Public Law 95-113, as amended; Public Law 95-134; Public Law 96-205; Public Law 96-374; Public Law 96-597; Public Law 97-98; Public Law 98-213; Public Law 98-454; Public Law 99-198; Public Law 99-396; Public Law 101-624; Public Law 104-127; Public Law 105-185; and Public Law 107-171.

Funds under the Hatch Act are allocated to the State Agricultural Experiment Stations (SAES) of the 50 States, DC, Puerto Rico, Guam, the Virgin Islands, Micronesia, American Samoa, and Northern Mariana Islands for research to promote a sound and prosperous agriculture and rural life.

The foundation of the Federal-State partnership in agricultural research is financed through formula Hatch funding and matching State revenue. Hatch funding supports sustained research activities in agricultural priority areas to address pre-commercial and/or non-funded technologies of public need. Hatch funded research is complementary to ARS National Research Programs and State-based research, addressing technology gaps through coordinated programs. This mixed portfolio of activities completes a well-rounded national agricultural research agenda that has, for the past century, allowed US agriculture to become the envy of the world.

In accordance with the Agricultural Research, Extension, and Education Reform Act of 1998, Public Law 105-185, eligible State institutions are required to submit a five-year Plan of Work to CSREES for approval before Hatch Act funds are distributed. The Hatch Act provides that the distribution of Federal payments to States for fiscal year 1955 shall become a fixed base and that any sums appropriated in excess of the 1955 level shall be distributed in the following manner:

- 20% shall be allotted equally to each State.
- Not less than 52% shall be allotted to the States as follows: one half in an amount proportionate to the relative rural population of each State to the total rural population of all States, and one-half in an amount proportionate to the relative farm population of each State to the total farm population of all States.
- Not less than 25% shall be used for multi-State, multi-disciplinary, multi-institutional research activities to solve problems concerning more than one state.
- 3% shall be available to the Secretary of Agriculture for the administration of this Act.

Federal funds provided under the Hatch Act to State institutions must be matched with non-federal funding on a dollar-for-dollar basis.

In accordance with provisions of the Agricultural Research, Extension, and Education Reform Act of 1998, at least 25% of available Hatch Act funds must be used to support multi-state research; State also must use up to 25% of Hatch Act funds for activities that integrate cooperative research and extension.

The 3% of funds appropriated by the Hatch Act for administration includes disbursement of funds and a continuous review and evaluation of the research programs of SAES.

2. Cooperative Forestry Research: (McIntire-Stennis) – The Cooperative Forestry Research Act of October 10, 1962, 16 U.S.C. 582a-7; Public Law 96-374; Public Law 97-98; Public Law 99-198; Public Law 101-624; Public Law 104-127.

The Act authorizes funding of research in State institutions certified by a State representative designated by the governor of each State. The Act provides that appropriated funds be apportioned among States as determined by the Secretary after consultation with the legislatively mandated Forestry Research Advisory Council. The council consists of not fewer than 16 members representing Federal and State agencies concerned with developing and utilizing the Nation's forest resources, the forest industries, the forestry schools of the State-certified eligible institutions, SAES, and volunteer public groups concerned with forests and related natural resources. Determination of apportionments follows consideration of pertinent factors including areas of non-federal commercial forest land, volume of timber cut from growing stock, and the non-Federal dollars expended on forestry research in the State. The Act also provides that payments must be matched by funds made available and budgeted from non-Federal sources by the certified institutions for expenditure on forestry research. Three percent of funds appropriated under this Act are set-aside for Federal administration.

3. Payment to 1890 Colleges and Tuskegee University and West Virginia State College: The National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1445, Public Law 95-113; Public Law 95-547; Public Law 97-98; Public Law 99-198; Public Law 101-624; Public Law 104-127; Public Law 105-185; and Public Law 107-171.

In accordance with the Agricultural Research, Extension, and Education Reform Act of 1998, Public Law 105-185, eligible State institutions are required to submit a Plan of Work to CSREES for approval before these formula funds are distributed. The agricultural research programs at the 1890 Land-Grant Colleges and Universities are designed to generate new knowledge which will assist rural underprivileged people and small farmers obtain a higher standard of living. Therefore, there is a high concentration of research effort in the areas of small farms, sustainable agriculture, rural economic development, human nutrition, rural health, and youth and elderly.

4. Special Research Grants: Section 2(c), Act of August 4, 1965, 7 U.S.C. 450i (c), as amended by Public Law 95-113; Public Law 97-98; Public Law 99-198; Public Law 101-624; Public Law 104-127; and Public Law 105-185.

Section 2(c) of the Act of August 4, 1965, as amended, authorizes Special Research Grants for periods not to exceed three years to SAES, all colleges and universities, other research institutions and organizations, Federal agencies, private organizations or corporations, and individuals. Previously, grants were made available for the purpose of conducting research to facilitate or expand promising breakthroughs in areas of the food and agricultural sciences. However, the Agricultural Research, Extension, and Education Reform Act of 1998 expanded the purposes under this authority to include extension or education activities. Grants funded in this account are only for research projects. Special Research Grants are awarded on discretionary basis as well as through the use of competitive scientific peer and merit review processes.

5. National Research Initiative Competitive Grants: Section 2(b), Act of August 4, 1965, 7 U.S.C. 450i(b), as amended by Public Law 95-113; Public Law 97-98; Public Law 99-198; Public Law 101-624; Public Law 104-127; and Public Law 107-171.

Section 2(b) of the Act of August 4, 1965, as amended, authorizes Competitive Research Grants for periods not to exceed five years to SAES, all colleges and universities, other research institutions and organizations, Federal agencies, private organizations or corporations, and individuals to further the programs of the Department. The purpose of the National Research Initiative Competitive Grants Programs (NRICGP) is to support research with the greatest potential or expanding the knowledge base needed to solve current problems as well as meet unforeseen issues that will face the future agricultural and forestry enterprise.

6. Animal Health and Disease Research: The National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1433, Public Law 95-113; Public Law 97-98; Public Law 99-198; Public Law 101-624; Public Law 104-127; and Public Law 107-171.

Section 1433 provides for support of livestock and poultry disease research in accredited schools or colleges of veterinary medicine or SAES that conduct animal health and disease research. These funds provide support for new research initiatives and enhance research capacity leading to improved animal health, reduced use of antibacterial drugs and improved safety of foods of animal origin.

7. 1994 Institutional Research: The Equity in Educational Land-Grant Status Act of 1994, Public Law 103-382, as amended, authorizes a competitive grants program for the 30 institutions designated as 1994 institutions. Section 7201 of the Farm Security and Rural Investment Act of 2002 adds a new institution, increasing the number of recipients eligible to receive funding under this program to 31. The program allows scientists at the 1994 institutions to participate in agricultural research activities that address tribal, National, and multi-state priorities.
8. Federal Administration (direct appropriation): Authority for direct appropriations is provided in the annual Agriculture, Rural Development, Food and Drug Administration and Related Agencies Appropriation Act. These funds are used to provide support services in connection with planning and coordination of all research and education programs administered by CSREES, including the Research, Education, and Economics Data Information System.
9. Higher Education: The National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1417, Public Law 95-113; Agricultural Public Law 97-98; Public Law 99-198; Second Morrill Act of 1890; Public Law 100-339; Public Law 101-624; Public Law 103-382; Public Law 104-127; Public Law 105-185; Public Law 106-78, and Public Law 107-71.

Pursuant to Section 1417(b)(6), Higher Education-Graduate Scholarships Grants are awarded on a competitive basis to colleges and universities to conduct graduate training

programs to stimulate the development of food and agricultural scientific expertise in targeted national need areas. This program strengthens higher education in the food and agricultural sciences by producing graduates capable of fulfilling the Nation's requirements for professional and scientific expertise.

Pursuant to Section 1417(b)(1), Institution Challenge Grants are designed to stimulate and enable colleges and universities to provide the quality of education necessary to produce graduates capable of strengthening the Nation's food and agricultural scientific and professional workforce. The program is designed to strengthen institutional capacities, including curriculum, faculty, scientific instrumentation, instruction delivery systems, and student recruitment and retentions, to respond to identified state, regional, national, or international educational needs in the food and agricultural sciences, or in rural economic, community, and business development. All Federal funds competitively awarded under this program must be matched by the universities on a dollar-for-dollar basis from non-federal sources.

Pursuant to Section 1417(b)(5), the Higher Education Multicultural Scholars Program increases the ethnic and cultural diversity of the food and agricultural scientific and professional workforce and advances the educational achievement of minority Americans. This competitive program is designed to help the food and agricultural scientific and professional workforce achieve full participation by members of traditionally underrepresented racial and ethnic groups, and open to all colleges and universities with baccalaureate or higher degrees in Agriculture, Forestry, Natural Resources, Home Economics, Veterinary Medicine, and closely allied fields.

Pursuant to Section 1417(b)(4), the 1890 Institutional Teaching and Research Capacity Building Grants Program stimulates the development of high quality teaching and research programs at the 1890 land-Grant Institutions and Tuskegee University and West Virginia State College to build their capacities as full partners in the mission of the Department to provide more, and better trained, professionals for careers in the food and agricultural sciences. This program is designed to strengthen institutional teaching and research capacities, through cooperative programs with Federal and non-Federal entities, including curriculum, faculty, scientific instrumentation, instruction delivery systems, student experimental learning, student recruitment and retention, studies and experimentation, centralized research support systems, and technology delivery systems, to respond to identified State, regional, national, or international educational needs in the food and agricultural sciences, or rural economic, community, and business development.

Pursuant to Section 1455(a), the USDA-Hispanic Serving Institutions Education Partnerships Grants Program is the foundation for USDA efforts to better serve Hispanic Americans and to prepare them for careers in agriscience and agribusiness. This competitive program expands and strengthens academic programs in the food and agricultural sciences at Hispanic-serving colleges and universities, including two-year community colleges, that have at least 25% Hispanic enrollment.

The Equity in Educational Land-Grant Status Act of 1994, Public Law 103-382, as amended, authorizes the use of funds to benefit those entities identified as the 1994 land Grant Institutions, through the Tribal Colleges Education Equity Grants Program. Section 7202 of the Farm Security and Rural Investment Act of 2002 increases the authorized amount each of those 31 institutions is eligible to receive from \$50,000 to \$100,000. Funds may be used to support teaching programs in the food and agricultural sciences in the targeted need areas of curricula design and instructional materials development; faculty development and preparation for teaching; instruction delivery systems; student experimental learning; equipment and instrumentation for teaching, and student recruitment and retention.

Authorized by the National Agricultural Research, Extension, and Teaching Policy Act of 1977, Section 1417(j), as amended (7 U.S.C. 3152(j)), the Secondary and Two-year Postsecondary Agriculture Education Challenge Grants Program is designed to promote and strengthen secondary education in agribusiness and agriscience and to increase the number and/or diversity of young Americans pursuing college degrees in the food and agricultural sciences. The intent of the program is to encourage teachers to creatively incorporate elements of agriscience and agribusiness into secondary education programs.

Authorized by Section 759 of Public Law 106-78, the Alaska Native Serving and Native Hawaiian-serving Institutions Education Grants Program is aimed at recruiting, supporting and educating minority scientists and professionals, and advancing the educational capacity of Native-serving institutions.

Authorized by Public Law 103-382, as amended, the Native American Institutions Endowment Fund provides for the establishment of an endowment for the 1994 land-grant institutions. In accordance with Section 7128 of the Farm Security and Rural Investment Act of 2002, there are authorized to be appropriated such sums as necessary to carry out program for each fiscal years 1996 through 2007. The interest derived from the endowment is distributed to the 1994 land-grant institutions on a formula basis.

EXTENSION ACTIVITIES

Cooperative Extension work was established by the Smith-Lever Act of May 8, 1914, as amended. This work is further emphasized in Title XIV (National Agricultural Research, Extension, and Teaching Policy) of the Food and Agriculture Act of 1977, as amended. Partners in the Extension System are: CSREES, Cooperative Extension Services at land-grant universities throughout the U.S. and its territories, and Cooperative Extension Services in nearly all the Nation's 3,150 counties.

Smith-Lever 3 (b) & (c) formula funds of the Smith-Lever Act of 1914, as amended, comprise approximately two-thirds of the total Federal funding for extension activities. These funds are allocated to the States on the basis of the rural and farm population of each State and the territories. Formula funding permits a consistent, stable, and reliable programming source for State and county Extension cooperators and allows maximum flexibility in addressing national, regional, and local problems and issues.

States must spend 25% or two times the level spent in FY 1997 (whichever is less), on cooperative extension services in which two or more States cooperate to solve problems that concern more than one State. States must expend up to 25% of Smith-Lever 3(b) and (c) funds for activities that integrate cooperative research and extension. Smith-Lever 3(b) and (c) funding provided to an 1862 Land-Grant Institution must be matched with non-Federal funding on a dollar-for-dollar basis.

Smith-Lever 3(d) – These targeted funds are allocated to the States to address special programs or concerns of regional and national importance and are primarily distributed according to the extent of the problem that requires attention in each State. The following Extension programs are supported: Expanded Food and Nutrition Education Program (EFNEP); Pest Management; Farm Safety; Children, Youth and Families at Risk; Indian Reservations; Sustainable Agriculture.

Payments to 1890 Colleges and Tuskegee University and West Virginia State College – Public Law 95-113, as amended, provides support to the 1890 Land-Grant Colleges and Universities for fostering, developing, implementing and improving extension educational programs to benefit their clientele. In accordance with the Agricultural Research, Extension, and Education Reform Act of 1998, Public Law 105-185, eligible State institutions are required to submit a five-year Plan of Work to CSREES for approval before these formula funds are distributed.

The Renewable Resources Extension Act of 1978 provides funding for expanded natural resources education program. Funds are distributed by formula to all States for educational programs.

The Rural Health and Safety Education Act of 1990 helps rural residents avoid the numerous obstacles to maintaining their health status. This program maintains the ongoing rural health projects in Mississippi and Louisiana that focus on training health care professionals in rural areas.

1890 Facilities (section 1447) – The National Agricultural Research, Extension and Teaching Act of 1977: These funds are used to upgrade research, extension, and teaching facilities at the 1890 land-grant colleges, including Tuskegee University and West Virginia State College.

Extension Services at the 1994 Institutions – The Equity in Education Land-Grant Status Act of 1994 authorizes appropriations for Native American communities and Tribal Colleges for extension activities as set forth in the Smith Lever Act. Funding is awarded on a competitive basis.

Federal Administration (Direct Appropriation) – provides a portion of the general operating funds from the Federal staff, and national program planning, coordination, and program leadership for the extension work in partnership with the states and territories.

INTEGRATED ACTIVITIES

Water Quality – This program assists SAES and the Cooperative Extension System to become viable partners with other State and Federal agencies in addressing water quality problems of national importance. These funds are provided under competitive awards.

Food Safety – Provides for research, extension, and education programs to improve the safety of food products and to create a public that is more informed about food safety issues. These funds are provided under competitive awards.

Regional Pest Management Centers – These centers will be the focal point for team building efforts, communication networks, and stakeholder participation within a given region. The centers will bring together and help focus the institutional and individual expertise needed to successfully address a range of pest management issues confronting farmers and other pest managers.

Crops at Risk from FOPA Implementation – This program is an intermediate-term research and extension program with the at-risk cropping system as the focus. The goal of the program is developing new multiple-tactic IPM strategies designed to assist in the transition period for certain pesticides affected by the implementation of the Food Quality Protection Act of 1996. These funds are provided under competitive awards.

FOPA Risk Mitigation Program for Major Food Crop System – This program emphasizes development and implementation of new and innovative pest management systems designed to maintain the productivity and profitability of major acreage crops while meeting or exceeding environmental quality and human health standards as the Food Quality Protection Act of 1996 is implemented.

Methyl Bromide Transition Program – This program is designed to support the discovery and implementation of practical pest management alternatives for commodities affected by the methyl bromide phase-out. The program focuses on short-to medium term solutions for all commodities at risk using either combinations of presently available technologies or some newly developed practices. These funds are provided under competitive awards.

Organic Transition Program – This program supports the development and implementation of biologically based pest management practices that mitigate the ecological, agronomic and economic risks associated with a transition from conventional to organic agricultural production systems. These funds are provided under competitive awards.

International Science and Education Grants Program – This is a competitive program focused on incorporating substantive international activities into programs related to food systems agriculture and natural resources at US land-grant colleges and universities.

Critical Issues Program – This program supports the development of early prevention strategies to prevent, manage or eradicate new and emerging diseases, both plant and animal, which would prevent loss of revenue to growers and producers. These funds are provided under competitive awards.

Rural Development Centers – This program provides funds at four regional centers in Pennsylvania, Mississippi, Oregon, and Iowa. Programs are designed to improve the social and economic well-being of rural communities in their respective regions. These funds are distributed according to the extent of the problem that requires attention in each state.

Homeland Security Program – This program provides support for a unified network of public agricultural institutions to identify and respond to high risk biological pathogens in the food and agricultural system. The network will be used to increase the ability to protect the nation from disease threats by identifying, containing, and minimizing disease threats.

SECTION 2501, OUTREACH AND TECHNICAL ASSISTANCE FOR SOCIALY DISADVANTAGED FARMERS AND RANCHERS ACTIVITIES

This program provides outreach and technical assistance to encourage and assist socially disadvantaged farmers and rancher to own and operate farms and ranches and to participate in agricultural programs. CSREES assumes the responsibility for the grant making aspects of this program beginning in FY2003. Competitive grant awards will be made for multiple year projects.

GOAL 1: ENHANCE ECONOMIC OPPORTUNITIES FOR AGRICULTURAL PRODUCERS
Potential Impact of Animal Science Discovery, Learning, and Engagement

Sustaining and expanding new markets for U.S. agricultural products is critical for the long-term economic health and prosperity of the food and agricultural sector. American animal producers have superior natural resources, cutting-edge technology, a high level of learning and management skill, and a supporting infrastructure resulting in animal production capacity that exceeds domestic needs. U.S. agricultural productivity expands global markets, and results in a consistently positive balance of agricultural trade. Our animal production capability is the basis for new uses for agricultural resources in industrial and pharmaceutical markets, as well as the world's lowest percentage of disposable income spent for food. CSREES animal science discovery, learning, and engagement provides leadership and funding support to the land-grant university system in the pursuit of five goals on which contemporary agriculture depends for future growth and development.

1. Provide Information, Knowledge, and Learning to Help Expand Markets and Reduce Trade Barriers.

Timely, reliable, and valid discovery, along with education and engagement leading to adoption of new technologies and their resulting economic advantage, help the U.S. maintain its net positive agricultural balance of trade by expanding international markets. CSREES and its partners develop and distribute animal science technologies that sustain agricultural management capabilities and productivity.

Animal science discovery, learning, and engagement can help improve the efficiency of American producers so that they may continue to compete in the face of downward price pressure, expand international markets by improving product quality, and provide science based safety assurance for technological innovations to America's trading partners.

2. Support International Economic Development and Trade Capacity Building through Discovery, Learning, and Engagement.

CSREES supports the production and dissemination of animal science-based information, and provides education and technical assistance to foster economic growth and capacity building in developing countries, including those that are now transitioning to more free market economies. Access to these markets is important to U.S. growers.

Animal science discovery, learning, and engagement helps these countries make better use of tropical or arid land through the developing of climate-tolerant varieties, increasing the amount and variety of nutrients yielded per hectare, and providing sustainable fertility options for growers of developing nations.

3. Generate and Provide the Science-Based Knowledge and Technologies to New or Improved High Quality Products and Processes to Expand Markets for the Agricultural Sector.

CSREES underwrites important discovery and development contributions for animal quality improvements enhance market opportunities for agricultural and forest products. CSREES and its partners effectively demonstrate and transfer to users the knowledge to produce new marketable animal products, generate new animal uses, and enhance animal product quality. Animal science discovery, learning, and engagement assists in expanding markets through increasing the utility, transportability, and shelf life of animal products.

4. **Provide Science-Based Information, Knowledge, and Education to Facilitate Risk Management by Farmers and Ranchers.**

CSREES contributes to the improvement and strengthening of this dynamic system through sponsored research into alternative methods to identify, assess, and manage risk, providing relevant education, and extending information and practices to improve animal production.

Animal science discovery, learning, and engagement assists in managing risk by providing less capital intensive and more sustainable animal production practice options, developing varieties that are less susceptible to normal annual weather variations, and fostering adoption of management techniques that help assure more consistent product quality.

5. **Contribute Science-Based Information, Analysis, and Learning to Promote the Efficiency of Agricultural Production Systems.**

CSREES funds higher education, discovery, and engagement programs to develop and transfer technology, practices, and skills to support economically viable growing operations of various size and scale. This work reduces production costs, increases production efficiency, improves yields, improves marketing and management decisions, develops new products and uses for by-products, and finds new ways of adding value to traditional crops.

Animal science discovery, learning and engagement assists in promoting the viability of operations of various size and scale by developing attributes that are conducive to value added operations, providing lower input options, and improving yields.

The dynamic and fast changing agricultural industry requires equally flexible leadership. CSREES provides this leadership so that its partners may continue to enhance the economic viability of animal producers.

ANIMAL PRODUCTION PORTFOLIO

Animal Systems Portfolio Vision: A vibrant, globally competitive, technologically advanced, and consumer driven American animal agriculture industry that is based on and supported by high quality, innovative, and relevant research, extension and educational programs provided by USDA through partnerships with universities and the private sector as well as the in-house research programs of the Department.

Animal Systems Portfolio Mission: To provide strong research, extension, and educational program to promote the efficiency of animal production systems that are economically competitive, environmentally sound, and socially acceptable, and produce high quality and safe products for the American consumer and international markets.

The CSREES Animal Production Portfolio (APP) is a major component of a broader Animal Systems portfolio. The Animal Systems Portfolio includes both the Animal Production and Animal Protection Portfolios. The CSREES Animal Production Portfolio has been defined as those research, extension, and education programs aligned with eight problem areas (PAs) related to the efficiency of animal production systems, including reproduction (PA 301), nutrition (PA 302), genetics (PAs 303 and 304), physiological processes (PA 305), environmental stress (PA 306), animal systems and management (PA 307), and improved products (pre-harvest) (PA 308). The CSREES Animal Protection Portfolio includes new, emerging, and reemerging animal diseases, animal agricultural security and biosecurity, toxicology, and animal well-being. In describing and reporting on the performance of the portfolio, it is important to recognize that an integrated systems approach is utilized in planning, developing, and implementing programs.

The CSREES National Program Leadership Team for Animal Systems recognizes that these two components are closely linked and interdependent in terms of program development, implementation, and delivery. The Team also recognizes that these components are linked to other major program areas such as product quality (post harvest), food safety, engineering, waste management, marketing, and economics.

The APP is diverse in terms of animal commodities covered. The portfolio includes research and extension activities directed at animal production systems, including beef cattle, dairy cattle, poultry, swine, aquaculture, sheep and wool, and goats. While broad goals and needs are similar across the various commodities, there are specific needs and priorities within these commodities that are addressed in the portfolio. Program goals and delivery systems also recognize the diversity of needs across and within these commodities in terms of size, concentration, regional differences, levels of integration, and external factors impacting these systems.

The APP encourages multi-disciplinary approaches to address the needs of animal agriculture and the American consumer. The portfolio contains a balance of discipline based components including animal reproduction, nutrition, genetics, physiology, environmental stress, and product quality. The portfolio also includes integrated system-based research and extension programs. Program integration may occur at a commodity-based system level (e.g., beef or dairy), as well as a biological/discipline system level (e.g., reproduction, nutrition, or genetics). As much of the

research is very applied in nature, the extension component is highly integrated and not always evident as a separate effort.

The Team recognizes that the long-term goals of the programs within this portfolio can best be achieved through strong research, extension, and education programs that are clearly integrated. While the portfolio represents a very complex system in terms of functions and integration of these functions, there is a critical need to develop new models and delivery systems that are effective and performance based. Integrated program functions for the APP include:

- Originate fundamental knowledge from basic research at the frontiers of the biological, physical, and social sciences in animal agriculture.
- Produce, apply, and adopt applied research-based knowledge in innovative ways to address problems and issues in animal agriculture.
- Provide developmental research and technology transfer to promote the commercialization and transfer of technologies and practices to potential users in a timely, cost-effective manner.
- Provide leadership in the delivery of research-based knowledge through extension, outreach, and information dissemination to strengthen the capacity of public and private decision makers impacting animal agriculture.
- Strengthen the capacity of institutions of higher education to develop the skills of the Nation's workforce in the food and agricultural sciences.
- Assure the quality, relevancy, and performance of programs supported through Federal funding in animal agriculture.
- Optimize collaboration and cooperation across institutions and agencies in order to achieve broad strategic goals addressing the needs of farmers, ranchers, and the American Consumer.

The logic model shown on page 17 illustrates the way in which the APP responds to situations to achieve outcomes.

The Partnership

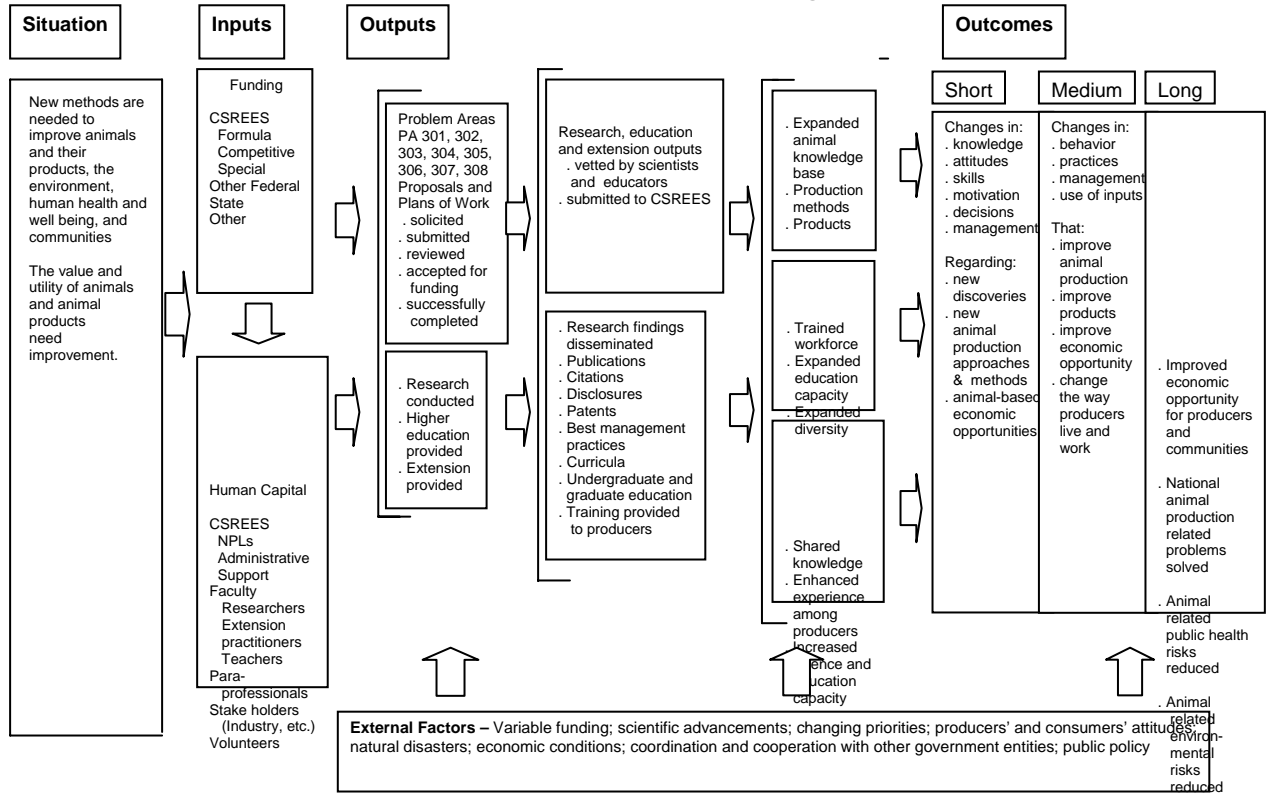
CSREES programs are based completely on a dynamic and vibrant relationship with our university and private sector partners. The APP demonstrates the linkages and interdependence between the Federal and State components of a broad-based, national agricultural research, extension, and higher education system. The agency's mission is carried out through this unique and dynamic partnership. The university-based system is critical to assuring relevancy, quality, and performance of the programs administered and led by the agency in animal agriculture. CSREES Program Leadership serves as both the catalyst and focal point for national research, extension, and education programs in animal production conducted throughout the university systems and other partners.

The Animal Systems Team (AST) supports strong program linkages with the USDA's Agricultural Research Service (ARS). It is clear that the animal agricultural industries and the American consumer are best served by closely linking and integrating the programs administered by CSREES with those of ARS. A strong university-based research, education, and extension system, linked to the in-house research programs of ARS, will help ensure a globally competitive animal industry. The AST works closely with our counterparts in ARS in program planning and implementation, ensuring that these programs are complementary.

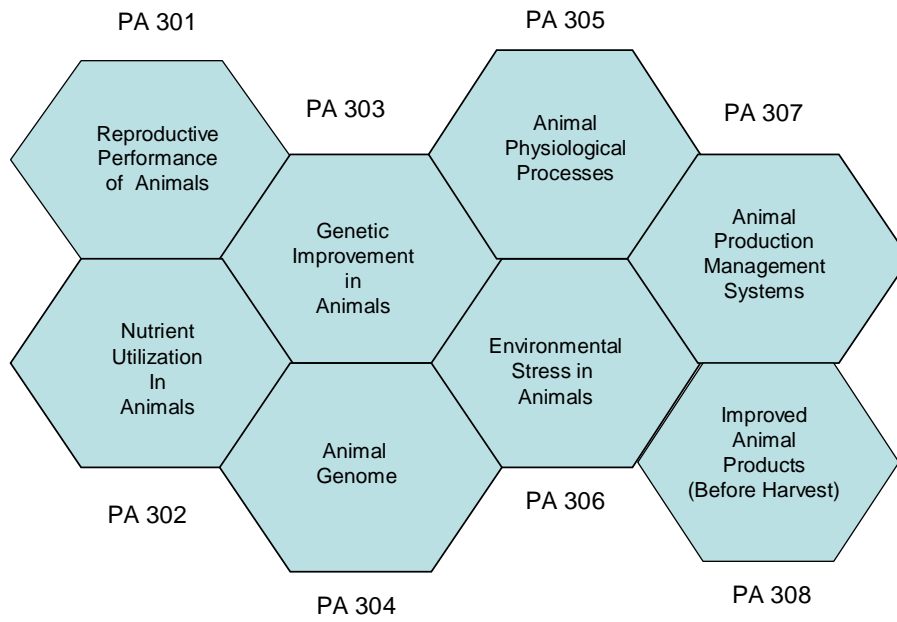
The Evidence Volume for this Portfolio contains *Appendix D: Cross-Cutting Programs* from the USDA FY 2004 Annual Performance Plan and Revised Plan for FY 2003. This appendix identifies programs or activities that USDA agencies are undertaking with other organizations to achieve a common purpose or objective.

The National Research Initiative (NRI) Competitive Grants Program has recommended for funding three research projects in the Animal Production area that are integrated with Extension or Education. The information is not yet public, so the projects and PIs will not be named here. If approved, the awards will apply to the ARS, an 1862 Land-Grant Institution, and an 1890 Land-Grant Institution.

CSREES Animal Production Logic Model



CSREES Strategic Goal 1, Objective 1.5 Portfolio, Animal Production



COOPERATIVE EXTENSION SERVICE FUNCTIONS

The Cooperative Extension System and Farm Animal Agriculture

Overview

The United States Cooperative Extension System (CES) is the educational backbone of American agriculture and the envy of agriculture globally. CES professionals are first responders in safeguarding American agriculture, identifying future research and educational needs; aiding implementation of state-of-the-art technology and science; and in providing personalized problem solving assistance in a wide range of disciplines. The CES is vibrant and responsive to contemporary U.S. demographic issues, the changing rural landscape and societal concerns, while maintaining a global perspective.

Extension serves as an unbiased professional scientific resource for evaluating technology alternatives and aiding in their proper implementation. The concept of Extension also has been adopted by many consultants and, in so doing, the impact of technology implementation is multiplied.

CSREES National Program Leaders work with land-grant and other institutions as well as industry to create and transfer technology from the laboratory to farmers, consumers and agribusiness. CES is the delivery arm of the land-grant university system, providing information, educational programming and support for decision making to every county in the Nation. CES links research, science, and technology to people where they live and work. Citizens are the ultimate customers of these activities.

Extension serves in an outreach, delivery and feedback mode to ensure the benefits of federally funded research and education programs are available to all. All citizens have an opportunity for input to make their needs known.

The Cooperative Extension System

CES is a unique, publicly funded, non-formal educational system. The system is tripartite in both funding and staffing. Public funding for Extension includes Federal, state and local sources. Some private funding also is available. Staffing includes county, multi-county or area specialists, state specialists and national program leaders. While a few specialists are shared across states, a more common practice is to develop multi-state educational programs staffed by specialists from each of the involved states. In recent years, counties in many states have re-organized to allow specialization, encourage advanced degrees, and share county-based agents and specialists, which greatly reduces the total number of county-based staff. The number of state specialists in animal agriculture has remained fairly steady in the face of cut-backs in many states. This is partly due to increased joint research, teaching, and Extension appointments.

CES links the educational and research activities of

- USDA-CSREES
- 1862 land-grant universities (57)
- 1890 land-grant universities (18)
- 1994 institutions (32)
- Hispanic serving institutions (160)
- Approximately 3,150 county administrative units.

Commercial animal production applications are emphasized at the 1862 universities while the 1890 and 1994 universities emphasize small farmer and specialty commercial farmers.

Situation

Animal agriculture in the United States is becoming more complex and challenging as new technologies are developed, new regulations established, profit margins narrowed and public scrutiny increased. Modern agricultural management systems require broad expertise and rapid availability of knowledge. Decisions once made with confidence by the manager using his or her own expertise often require input from other sources, and have implications beyond the farm gate.

Evolving operations at both ends of the scale spectrum including mega farms, added-value niche market and part time operations have created a need for changing and special expertise. Increased emphasis on human resource management, environmental management, pre-harvest food safety, animal welfare, land use and rural policy; risk management, futures and global marketing; and a whole host of other areas of expertise from farm to fork are sought from the CES. The pressure never has been greater for the CES to perform for the citizens.

CES is looked to as an unbiased source of expertise and is a major source of expertise sought by producers. This expertise may be available in paper form via articles in local newspapers, industry magazines, from radio, television, the web, CDs, meetings, or indirectly through the many extenders of knowledge such as veterinarians, consultants, agricultural educators (vo-ag), and agri-industry personnel. Often, Extension is not credited, and in some cases the delivery was direct from a non-Extension source. Extension is not the sole source of information, educational programming and support for decision-making on the farm; but often helps level the playing field for producers.

States are faced with needs in Extension expertise greater than budgets will allow. Multi-State cooperation is growing. Advanced degrees and specialization of field staff is also providing greater expertise. A major factor in improving the ability of all, including the producers themselves, to search out expertise is the rapid development of the web.

Extension Staffing

Extension staff working in the animal production area include county, area and state specialists as well as National Program Leaders. Statistics on state specialists are summarized in the two tables that follow.

State Extension Specialists in Animal Agriculture by Commodity/Species – 2003*

	Primary Responsibility*	Total Primary & Secondary*
Dairy	230	249
Beef	171	211
Swine	99	127
Sheep	49	88
Horse	34	48
Goats	4	17
Poultry		57 FTE's
Aquaculture**		230**
<hr/>		
Dairy Foods	26	32
Meats	(15)	(18)
Food Products	3	14
<hr/>		
Forages/Pasture Mgt	24	45
Range Mgt	(6)	(11)
<hr/>		
Youth/4-H	13	86

* - State Extension Specialists working part or full time in this area (not FTE's except for Poultry data). Data enclosed by () are not complete.

** - Includes both Land Grant and Sea Grant Extension; and processing as well as production areas.

State Extension Specialists in Animal Agriculture by Discipline– 2003*

	Primary Discipline	Total Primary & Secondary**
Ag Policy/Law	1	2
Ag Business	4	6
Ag Health & Safety	4	4
Ag Economics	49	55
Ag Engineering	43	49
Agronomy	43	45
Animal Welfare	1	2
Biotechnology	1	2
Consumer Behavior/Sociology	2	2
Entomology	8	8
Farm Mgt	18	24
Food Safety/Quality	2	4
Food Science/Tech	40	40
Genetics	28	33
Genomics	1	1
Human Resources	5	5
Information Mgt	3	8
Marketing	5	10
Meat Science	7	10
Microbiology	1	4
Milking Mgt/Lact Physiology	9	12
Nutrition	92	103
Rangeland Mgt	5	6
Reprod. Physiology	29	34
Soil Science/Water Quality	6	6
Mgt Systems	16	42
Toxicology	1	1
Veterinary Medicine	66	68
Youth Development	1	1
Manure Mgt Systems	1	14

* - Includes only State Specialists working in the beef, dairy, goat, sheep, swine and horse areas. Not every specialist reported their areas of expertise.

** - Individual specialists may report up to three areas including their primary.

Extension expertise in the animal production area includes nearly all of the discipline areas involved in animal production research, with the only exceptions being those unique to some areas of basic research. Due to limited staffing in each state and no limitation on needs of producers, many state specialists and most area or county specialists must be competent in several areas. All must be proficient at finding information and providing assistance on a broad range of topics. Extension personnel are also providing increased leadership in applied research due to the prevalence of split appointments.

Less detail is available on the areas of expertise of the approximately 3,850 County Agricultural Extension Agents in the U.S. The general breakdown of these follow.

- 246 Dairy
- 1,040 Livestock
- 755 General Ag
- 1,123 (Agronomic & Other) Crops
- 866 Horticulture

Potentially significant emphasis in areas of animal production would come from the general agriculture and agronomic categories in addition to the dairy and livestock groups.

Extension Direction

Extension programming for animal production is constantly changing to anticipate and address user needs as well as incorporate the latest research findings, regulatory changes and respond to new problems. In addition, the overall direction of Extension efforts have changed to address the concerns of society, consumers and the market. This includes increased emphasis in areas such as:

- Pre-harvest food safety,
- Agricultural sustainability and the specific needs of small-scale agriculture
- Food safety and security
- Comprehensive environmental protection
- Biosecurity
- Care and welfare of farm animals; and ethics in modern agriculture
- Safety in the homes, on the farms and rural roadways
- Family living and rural community infrastructure
- Rural/Urban interface
- Global trade issues

Scholarly Activities

The essence of scholarly activity is to distinguish fact from opinion. Interpreting research findings and distilling them into applied formats, whether through information dissemination or applied research efforts, is the foundation of Extension.

The transmission of knowledge to citizens via an extension program may include activities such as publications, meetings, correspondence, visitations and demonstrations. Activities associated with the transfer of knowledge, such as alternative teaching approaches for adult and distance learners; support of the livestock commodities and industries; and service to organizations are important components of an Extension appointment at a land-grant institution. Scholarly activity in the extension area involves innovative and creative work. This may include obtaining grants, publishing peer-reviewed work, documentation of knowledge transferred, adopted and its impact. It should also include development of a portfolio of professional achievements.

CSREES Funding

CSREES funding for CES has been almost exclusively via formula funding to the states. These formula funds are critical to Extension since the majority of formula funds are used for salaries. Because Extension complements and adds value to research, competitive CSREES integrated programs have been developed. To date, these programs have not been fully utilized by the Extension community and have been largely overshadowed by research interests. Additionally, in animal production systems, the opportunities of funding from these integrated sources are minimal.

Multistate Extension activities have been created in some animal production areas. In contrast to Multistate research activities, however, Multistate Extension activities are not funded. The burden of financial support rests with Extension professionals already functioning under severely restricted budgets. Multistate Extension activities therefore have been significantly limited.

A great opportunity exists for coordinating and responding to national animal production Extension needs. This easily could be implemented through a competitive process that required national cooperation among state Extension programs and industry. Strengthening the existing state-Federal partnership by instituting a competitive Extension program would allow development of comprehensive national database developments and an opportunity to address national issues such as animal identification and on farm certification programs.

It is highly unlikely that an integrated funding program could accomplish selected national Extension program needs because these needs are often broad by design. Integrated programs are based upon testable hypotheses that, once resolved, the results are disseminated through Extension. Integrated programs involve research and Extension to distribute the results. Where the results already are known, no research is needed. Therefore, we need a competitive process to focus on information distribution itself.

Extension has a Crisis of Recognition!

Extension is a common word with several meanings and has been capitalized on these pages for emphasis. Outstanding examples of Extension accomplishments occur throughout the U.S. on a continuing basis. Those directly involved are aware and appreciative of Extension, however this awareness is usually very limited outside the affected area.

Extension needs much greater visibility, recognition and appreciation at the national level. This is a national system, receiving Federal funds, and yet we have little opportunity to create national cooperation to address development of a comprehensive, world class resource such as one of the national informational databases.

National Program Leadership

The CES is uniquely successful in implementing and delivering animal production information resources to producers. A significant contributing factor to this success is the long established infrastructure connecting the county to the state to the nation. Because county, regional and state extension agents/specialists are called upon to adapt information to their communities and production environments, national program leadership is needed to monitor and assess their collective efforts. National program leadership is essential for identifying and coordinating a response to emerging issues; and representing CES professionals with other Federal agencies and departments to synergize Federal resources and planning efforts. CES is a national program applied locally. National program leadership in Extension is necessary for guiding available resources and planning for the future.

Extension Reporting

Reporting of Extension accomplishments by each of the land-grant institutions is through the Annual Report of Accomplishments toward the 5-year Plan of Work. In its present format, this report is difficult to use if one is seeking accomplishments or identifying project costs in a specific area.

Future developments within the Current Research Information System may ultimately accommodate Extension accomplishment reporting and enable good, useable impacts of Extension activities to be searched and summarized. This capability is very much needed to respond to questions concerning both funds expended in an area and the impact of that effort. Because of our inability to accurately quantify Extension's impacts, we have limited documentation of Extension's value that may be provided decision makers and the public.

National Projects

Few truly national cooperative projects exist within Extension to address a major national issue or development. Several are currently underway in the animal area and include

- Animal Production Food Safety (Pre-harvest)
- Beef Infobase
- Dairy Infobase
- Goat Infobase
- Sheep Infobase
- Swine Domain Arrays

Each of these projects is intended to create an electronically searchable national resource of expert selected, peer reviewed information, educational modules and decision support software

connected to a dynamic and current web site. Each is also intended to be a significant resource for nearly every segment of the production process and related areas. Such a national site for a species/commodity, major issue, discipline or clientele group could then be made available to universities and other sites.

Several of these national projects have identified a group of experts in each segment of knowledge to keep the segments up to date and constantly developing. The projects also have the potential to organize input on further needs and questions from the web, meetings or other communications for each segment of animal production. This could then be a valuable forum for establishing priorities for Extension programming and contribute to research priorities.

Fully developed and made available on the web, these resources could bring much increased visibility, recognition and appreciation for Extension. However, there is currently no available source of funding for broad based and comprehensive national Extension projects.

Selected Accomplishments

- Oregon livestock agents worked with the US Environmental Protection Agency (EPA) to inform farmers of their regulatory requirements under the Clean Water Act. Their educational meetings reached 215 producers who modified their production practices to improve environmental quality by altering facilities, and avoided fines and promoted their ability to stay in business. Changes for 45 producers totaled \$458,000 and moving of five feedlots cost \$600,000 (total \$1.058M). Allowing ranchers to continue their operations has an economic value, but a family/history and societal contribution value that is not calculable.
- Voluntary guidelines through the National Council of Chain Restaurants and the Food Marketing Institute have greatly impacted the capacity of farmers to make independent production management decisions. Personnel having Extension appointments have been involved in development of guidelines and industry responses.
- Rotational grazing is an important consideration in production, and programs by state Extension specialists have resulted in savings of \$84/Acre in Oregon and prevention of soil loss of 850 tons/year due to erosion in Virginia, with an annual savings of 4,600 pounds of nitrogen and 920 pounds of phosphorus.
- Animal Identification (ID) is an emerging issue that is used to trace the source of animal products from the consumer back to the farm of origin. The concept is also a useful bio-security tool for production management. Animal ID is being addressed at the national and local levels by Extension staff. Animal ID of all species will have far reaching impacts on the capacity of farmers to market their products.
- Based on voluntary accomplishment reporting from states with aquaculture Extension programs, the aggregate total annual savings and/or increases in farm revenue from these programs totaled at least \$24.18 million in 1998. Economic impacts of this magnitude are anticipated for subsequent years as well.

- The Swine Alternative Housing project included Extension personnel and was funded by a special grant from Congress that included research and educational components. The project used cooperative efforts of personnel from industry, activist groups, government, and universities. Results from current research on alternative housing have been successfully transferred through workshops and an educational package for farmers and educators.
- Nebraska Extension specialists developed a management system to reduce diarrhea in calves. A single 900-head ranch calculated savings of \$40,000 due to improved management.
- Arizona's Cooperative Extension provides computer software tools to 341 ranchers to address financial management issues by providing hands-on workshops that pinpoint profitability problems. Exit interviews indicated the overwhelming majority (>80%) of participants would change behavior and management based on this training.
- The Five-State Beef Initiative (OH, KY, MI, IL, IN) uses personnel from research and Extension to provide leadership for electronic identification of beef, to collect data and track individual animals through the system as well as to document beef safety.
- North Carolina Extension developed the North Carolina Certified Beef Production Program to promote production practices such as weaning, feeding, and parasite control that result in healthy calves. The project increased net return by \$30 per head, and the reputation of calf quality from farmers in the area.
- The North Dakota Dairy Diagnostic Team helps producers address key production management areas through benchmarks for progress, goals, and record-keeping. One farm expanded from 87 to 130 cows while maintaining production at 57 pounds per cow per day for a gross impact of about \$86,000 per year, while another modified rations to improve milk production 6.6 pounds per day for 210 cows for a gross impact of \$48,000.
- Grassland Management educational programs in West Virginia support the ruminant and poultry industries, the latter due to their need to utilize healthy grassland as part of their recycling of litter nutrients (80% of litter was used as fertilizer). Integration of forage and livestock production increases farmer's marketing and production efficiency of the 4,495 participants in all West Virginia activities (2001). Similar programs are in place in Arkansas and in Delmarva (the Delaware, Maryland, Virginia peninsula) in which Extension cooperates. These programs match nutrient availability from poultry litter/manure to crop production needs.
- The American Samoa Community College Extension Service led the formation of the Inter-agency Piggery Management Council to reduce the effluent of local piggeries into the watershed. The program includes demonstrations and grants to improve the production practices of the 188 participants in 2001 through development of pollution

baselines and understanding of the impact of animal wastes on human and environmental health.

- North Carolina State A&T helped goat producers organize a cooperative and pass certification tests and USDA inspections to market goat meat. Forty farmers are now certified and able to sell to a grocery chain that caters to ethnic markets. Fort Valley State University in Georgia and Florida A&M University have similar goat meat marketing programs that support greater goat production and utilization. Langston University is working with Oklahoma's native American tribes to use meat goats for controlling invasive plant species as part of the production process.

RELEVANCE – STAKEHOLDER FEEDBACK

The Portfolio is targeted to address critical national needs, issues, and priorities relevant to animal agriculture production. Research and extension programs must also demonstrate relevancy in terms of science. CSREES utilizes a variety of processes and networks to provide feedback to the agency in terms of relevancy to the industry and relevancy within a field of science. The Animal Systems Program Leaders have effective links to researchers, professional societies, county agents, extension specialists, farmers and ranchers, Experiment Station and Extension leadership, commodity organizations, consumer groups, advocacy organizations, advisory committees, other federal agencies, OSTP, and Congress. All serve to provide feedback either directly or indirectly to assist CSREES in identifying needs and establishing priorities to assure the relevancy of programs within the Portfolio.

Processes utilized are both formal and informal, and may include stakeholder workshops, symposia, technical reviews, peer panel recommendations, white papers, Presidential directives, interagency strategic plans for research and development, regulatory policies impacting animal production systems, industry plans and priorities. These processes and networks help the agency to evaluate the relevancy of programs relative to local, state, regional and national needs. Critical national needs and priorities are generated through aggregation of problems and issues first identified at the local or state level.

All of the programs managed by CSREES use relevancy as a criteria for pre-award evaluation of projects. Relevancy may be evaluated in terms of industry or consumer needs and priorities as well as relevancy within the field of science. As science evolves it is critical that the Animal Production Portfolio keep pace the emerging opportunities and advancements in science. The current portfolio is dynamic and ever changing to address the national needs consistent with cutting edge science. Program descriptions, progress reports, and requests for applications, reflect/demonstrate this change and responsiveness within the portfolio.

Selected Examples

Fair 2002: The Animal Systems Leadership within CSREES was actively engaged and worked with ARS, the Animal Agriculture Coalition, the Federation of Animal Science Societies (FASS), and other cooperating organizations to hold a national conclave to establish national priorities for animal agriculture research and education. More than 250 leading animal scientists, farmers, ranchers, environmentalists, commodity groups, government personnel, and others gathered to determine the critical needs in research and education facing the animal industry. “Fair 2002 - Animal Products for the Next Millennium” serves as guidance to CSREES in adjusting the Animal Production Portfolio consistent with emerging needs and priorities. Both ARS and CSREES meet with the Animal Agriculture coalition and FASS to report progress relative to these needs.

National Pork Industry Research and Extension Priorities: The National Pork Board has developed a national agenda for research and extension to address the critical needs of the industry. The report was provided to the CSREES leadership and is used by the agency to guide research and extension programs consistent with these national needs and priorities.

Chicken Genome: CSREES co-organized and sponsored a symposium entitled "Chicken Genome Sequence: Impact and Applications" in Atlanta on November 13 - 14, 2003 in which over 130 attendees from 11 different countries and the US with academic and industry affiliations participated. This symposium was recognized as the largest gathering of poultry stakeholders to discuss the future directions during the post-genome sequencing era.

Animal Reproduction Stakeholder Workshop: CSREES NPLs will provide leadership for a stakeholder workshop for the CSREES Animal Reproduction Program and multi-state projects that focus on basic and applied research in animal reproduction. The workshop is needed because the NRI Animal Reproduction program has historically been an "umbrella" program that accepts almost all proposals dealing with any aspect of reproduction. With the new emphasis in the NRI to fund larger and fewer awards, the Animal Reproduction program will need to be focused to emphasize specific priorities in the near future. The workshop will also be used to provide input to and help focus the broader agency-wide Animal Reproduction Program. The workshop will be held in conjunction with the annual SSR meetings which are already attended by a critical mass of investigators and industry representatives.

Future Trends in Animal Agriculture (FTAA): The FTAA organizing committee is composed of Co-Coordination from Agri-business, the Humane Society of the United States, United Egg Producers, and USDA/CSREES/PAS. Numerous animal activists, industry personnel and government representatives work together to develop the program for the various FTAA workshops or symposia. The audience is: decision makers in government agencies such as USDA, congressional staffers and members, activists, and industry members. The meetings are also open to the public. The goal is to provide opportunities to discuss contentious issues of significant societal interest.

National Aquaculture Workshop: ARS-CSREES National Aquaculture Program Planning Workshop, November 20-22, 2002 in St. Louis, MO. This stakeholder input workshop involved about 100 invited participants that identified priority needs and current issues to guide both research and extension programs under these two USDA agencies.

National Poultry Waste Management Symposium: The CSREES animal waste/nutrient management team, will continue to provide leadership for the National Poultry Waste Management Symposium. The three day meeting was started in 1988 by volunteers in the Land Grant Universities and industries. The meeting was deemed critical to the success of the poultry system in addressing environmental issues.

2005 International Congress on Meat Science and Technology: CSREES has provided leadership for and jointly sponsored the International Congress on Meat Science and Technology. The conference provides a forum to discuss the major trends in meat science and technology in terms of science and broad needs of the industry and consumers.

National Aquaculture Extension Questionnaire: A joint questionnaire was prepared and distributed by CSREES and NOAA National Sea Grant Program to identify constraints and priorities of the national aquaculture extension community and recommended actions by federal agencies. A National Aquaculture Extension Steering Committee was formed in December 2003 as an outcome from questionnaire respondents to provide input and guidance to joint CSREES and NOAA extension initiatives.

Regional Aquaculture Center Program: The CSREES-administered Regional Aquaculture Center Program utilizes Industry Advisory Councils (IAC) in each region to identify needs and establish priorities for regional research and extension programs in aquaculture. The IAC members are primarily producers representing diverse production systems in the region. The IAC interacts with the Technical Committees in their respective center to provide active feedback on research and extension needs as well as program performance.

National Aquaculture Strategic Plan: CSREES, through the national Science and Technology Council (NSTC) provided leadership for the development of a National Aquaculture Research and Development: Strategic Implementation Plan for Research and Development as a federal interagency initiative with broad stakeholder input. This strategic plan has been used by CSREES and ARS to guide programs consistent with broad national goals. The Strategic Plan will be updated in the near future.

Allerton III: Beyond Livestock Genomics: In July 2003, CSREES-PAS supported a stakeholder workshop hosted by the University of Illinois where approximately 30 scientists with expertise in physiology, genomics, and animal health participated. The objectives of the workshop were to: 1) identify genomic and bioinformatic tools and reagents required to exploit information from the human genome sequencing initiative, 2) discuss needs and opportunities for full implementation of genomic capabilities by related disciplines, and 3) identify needs and opportunities to ensure full technology transfer and commercialization. Recommendations from the workshop participants were summarized, published (Hamernik et al., 2003. *Animal Biotechnology* 14(1):77-82.), and used to set priorities for the NRI Animal Genome Reagent & Tools Program and the NRI Animal Functional Genomics Program.

Animal Bioinformatics Workshop: During the winter of 2002, an electronic workshop was conducted to discuss current issues and needs in animal bioinformatics. Approximately 40 scientists from the United States, Australia, and the United Kingdom communicated via email to: 1) define priorities for animal genome database development and 2) recommend ways in which the USDA could provide leadership in the area of animal genome database development. Results from the electronic workshop were summarized and presented at the Animal Comparative Mapping Workshop at the Plant and Animal Genome XI meetings in San Diego in January 2002 with an invitation for additional comments from those attending the session. Recommendations from all participants were published (Hamernik and Adelson. 2003. *Comparative and Functional Genomics* 4:271) and used to set priorities for the NRI Animal Genome Reagent & Tools Program.

National Research Council Review: Responding to Congressional mandate, the National Research Council's Board on Agriculture and Natural Resources (BANR) convened four *ad hoc*

committees to evaluate the quality of research in USDA's Research, Education, and Economics (REE) mission area and recommend future research efforts. The panels represented a wide array of expertise, including those with knowledge of public and private agricultural research and those who use or are affected by the results of the research. The full report can be found in: National Research Council. 2003. *Frontiers in Agricultural Research: Food, Health, Environment, and Communities*. Committee on Opportunities in Agriculture (Washington, D.C. National Academies Press).

Publicly-Funded Agricultural Research and the CRIS System

The U.S. system of publicly-funded science and education in the areas of food, agriculture, and natural resources supports a diverse, complex knowledge base that is vital to food and fiber production and to the economic well being of the nation. The scientific expertise available through the federal and state research system constitutes a valuable national resource with the necessary flexibility to respond to changes in demand for food and other commodities, threats to the sustainability of food and fiber production, and concerns about environmental quality. The Cooperative State Research, Education and Extension Service (CSREES) contributes a unique national perspective to the network of research partnerships maintained by the USDA and cooperating institutions. This vantage point is essential to the Agency's regional and national coordination of resources to address diverse research problems.

In recent years, the research agenda for food, agriculture, and natural resources has expanded in response to a broadening array of issues affecting producers, processors, consumers, and other user clientele. Changes in the research agenda were given impetus by the U.S. Congress when it reauthorized the USDA programs through the Food, Agriculture, Conservation, and Trade Act of 1990. This legislation emphasized food and fiber needs, long term viability and competitiveness, improvement of the quality of rural life, the assurance of supply of safe food, and enhancement of the environment and natural resource base. The growing consumer interest in environmental and social issues, as well as the increased complexity of contemporary research problems, has necessitated an increase in multi- and interdisciplinary scientific investigations. In addition, new collaborative relationships are being formed with departments outside colleges of agriculture in land-grant institutions and with institutions outside the traditional land-grant system, as well as with other groups.

The evolving U.S. system of food, agricultural, and environmental research encompasses the programs of state agricultural experiment stations (SAES); colleges and departments of forestry, home economics, and veterinary medicine; 1980 land-grant institutions and Tuskegee University; other cooperating institutions, including state and private colleges and universities; and USDA intramural research agencies (primarily the Agricultural Research Service, the Economic Research Service, and the Forest Service). These programs are closely linked to and complement the teaching and extension activities of land-grant and other institutions. At the university level, research programs also are integral to graduate education, through which scientists are prepared to confront future research challenges.

The research system operated as a network of cooperating institutions and agencies funded via state, federal, and private sources. Coordination, joint planning, and priority setting are accomplished through various national and regional mechanisms to ensure the efficient use of valuable resources.

The summaries presented are based on federal state research activity as documented in the USDA's Current Research Information System (CRIS) database. Research within the CRIS system is classified according to two major categories: 1) USDA intramural research, and 2) extramural research. Intramural research refers to programs conducted internally by USDA agencies. This research is supported by USDA-appropriated funds. Extramural research, in

contrast, is conducted by state agricultural experiment stations and other university based research organizations and institutions. This research is funded in part through projects, grants, and contracts, many of which are administered by CSREES.

The dynamics of the university-based agricultural research are described in terms of the changing levels of investment decided to broad problem areas in agriculture and to specific researchable issues identified in this report. In addition to this input analysis, however, other important indicators of programmatic change may be relevant to understanding the dynamics of agricultural science. These include changes in the mix basic and applied research over time, patterns in the number range of disciplines drawn upon to address research question, relative shifts in emphasis of commodity-specific and cross-commodity research targets, and the distribution of research efforts and support by areas of science or geographic region. For example, see the table for PA 308, which illustrates how Evans-Allen formula funds have been used by 1890 institutions to respond to areas identified as important by their stakeholders. Dynamism also might be suggested by changing patterns in the interaction between-and complementarity of research programs within the federal-state system. By addressing these questions, future analyses could contribute to a more comprehensive understanding of agricultural research.

CRIS has several characteristics valuable for program analysis. The system includes research in progress, objectives and procedures of the projects, annual financial and management data, and reports for accomplishments. Based on analysis of annual expenditures and scientist years accounted for in CRIS, coverage of the database system is nearly comprehensive for those projects supported or conducted by the USDA and for those conducted under the aegis of the SAES. CRIS documentation of agricultural research supported by sources other than the USDA, and of some university-based work conducted outside the SAES may be more variable. As the definition of agricultural research has expanded over time, and the range of scientists have extended beyond those traditionally associated with the USDA and SAES, agricultural research efforts may be understated by CRIS. This consideration may be especially important in those research areas at the boundaries of agricultural research.

It is being proposed that the CRIS Research Problem Areas (RPAs) be revised to encompass the entire CSREES portfolio of funding (i.e., research, extension, and higher education). The current RPAs would be referred to as Problem Areas (PAs). However, a process to collect resource data for the PAs to implement the new classification system has not been developed at this time. In this document, the term Problem Area (PA) is used.

EDUCATION FUNCTIONS

Research at land-grant institutions of higher learning complements the education mission of the institutions. Research faculty usually have joint appointments with both the Agricultural Experiment Station and with their Academic Programs unit, allowing fewer FTE to teach more diverse curricula than would otherwise be possible. Also, students often have the chance to learn by participating in research projects.

The following table shows the number of students earning undergraduate and doctoral degrees at U.S. institutions of higher learning in fields related to animal production.

		1999-2000		2001-2002		
		Land-Grant US Citizen	Non-Land-Grant US Citizen	Land-Grant US Citizen	Non-Land-Grant US Citizen	
Bachelors degrees	01.0101	Agricultural Business and Management, General	432	510	426	485
	01.0102	Agricultural Business/Agribusiness Operations	952	537	993	535
	01.0104	Farm and Ranch Management	102	8	78	12
	01.0302	Agricultural Animal Husbandry and Production	127	15	131	16
	01.0303	Aquaculture Operations and Production Mgmt	66	7	27	4
	01.0507	Equestrian/Equine Studies, Horse Mgmt	0	131	0	157
	02.0101	Agriculture/Agricultural Sciences, General	566	836	464	811
	02.0201	Animal Sciences, General	2712	798	2782	686
	02.0202	Agricultural Animal Breeding and Genetics	0	27	0	51
	02.0203	Agricultural Animal Health	0	2	0	0
	02.0206	Dairy Science	78	32	55	40
	02.0209	Poultry Science	103	5	90	3
	02.0299	Animal Sciences, Other	196	22	202	29
	03.0301	Fishing and Fisheries Sciences and Mgmt	108	60	104	57
	26.0101	Biology, General	5985	38797	6031	36117
	26.0607	Marine / Aquatic Biology	38	693	37	695
	26.0613	Genetics, Plant and Animal	280	0	297	18
	51.0808	Veterinarian Assistant / Animal Health Technician	44	85	78	114
	51.1104	Pre-Veterinary Studies	181	40	173	43
	51.2501	Veterinary Clinical Sciences	0	0	4	0
		TOTALS	11970	42605	11972	39873
	Doctors degrees	01.0303	Aquaculture Operations and Production Mgmt	3	0	1
02.0101		Agriculture/Agricultural Sciences, General	2	0	0	5
02.0201		Animal Sciences, General	75	3	77	0
02.0299		Animal Sciences, Other	0	3	0	0
02.0202		Agricultural Animal Breeding and Genetics	2	0	2	0
02.0204		Agricultural Animal Nutrition	7	0	1	0
02.0205		Agricultural Animal Physiology	1	0	3	0
02.0206		Dairy Science	0	0	0	0
02.0209		Poultry Science	2	0	4	0
02.0299		Animal Sciences, Other	8	0	9	6
03.0301		Fishing and Fisheries Sciences and Mgmt	12	6	14	7
26.0101		Biology, General	97	440	85	462
26.0607		Marine / Aquatic Biology	17	25	20	25
26.0613		Genetics, Plant and Animal	70	119	60	116
26.0618		Biological Immunology	3	17	3	22
51.2501		Veterinary Clinical Sciences (M.S., Ph.D.)	58	1	63	1
		TOTAL	357	614	342	644
First- professional degrees	51.2401	Veterinary Medicine (D.V.M.)	2069	170	2092	178
Grand Total		14396	43389	14406	40695	

Portfolio Analysis Animal Production

OVERVIEW

Animal production encompasses basic and applied research across several animal species and commodities including beef, dairy, swine, poultry, aquatic species, sheep, goats, horses and laboratory animals. The products from these animals represent about \$100 billion of sales at the farm gate and several times that amount at retail.

The CSREES portfolio for Animal Production is defined as the research classified to Problem Areas (PAs) 301 to 308 (see titles below) and the extension programs that relate to and support those problem areas. Animal production, as defined, does not include the PAs directly related to animal health, food safety, processing, storage or marketing. However, Animal Production indirectly supports and complements the research and education included in those related PAs through interdisciplinary efforts and collaborators among university faculty and cooperating scientists and educators.

Animal Production PAs:

- 301- Reproductive performance of animals
- 302- Nutrient utilization in animals
- 303- Genetic improvement of animals
- 304- Animal genome
- 305- Animal physiological processes
- 306- Environmental stress in animals
- 307- Animal production management systems
- 308- Improved animal products (before harvest)

ANALYSIS OF DATA

CSREES portfolio: The CSREES funding portfolio, a combination of formula funds, competitive grants, and special and other grants, provides a valuable contribution to the animal production research portfolios at universities. Most CSREES projects also include funding from multiple sources including state appropriations, other Federal agencies and private sources such as industry, foundations, and endowments. The CSREES administered funds are combined with and support these other sources of funding, thereby providing significant leveraging often at least four or five times the CSREES portion.

CSREES portion of university funding: In 1998, the CSREES portion of the national university portfolios for animal production research was \$59.6 million (16.7%); whereas, in 2002, the CSREES portion was \$69.4 million (15.2%).

CSREES funding types: In 2002, the distribution of CSREES funding was 55.6% formula funding, 25.8% competitive grants, and 18.6% special and other grants.

Allocations to PAs: Below is a summary of funding that was allocated to PAs 301 through 308 for years 1998 and 2002. The most significant changes in funding were: a large increase in PA 304, animal genome, small decreases for PA 305, animal physiological processes, and PA 306, environmental stress in animals.

Funding Allocations by PA and Year

PA	1998	2002
301	13677	15684
302	11039	11665
303	6517	8774
304	2414	6196
305	11221	10838
306	3146	2550
307	10243	12146
308	1392	1553
Total	59648	69395

Allocations to animal commodities: Throughout the 1998 to 2002 period, most of the CSREES funding was allocated to the major animal commodities beef, dairy, swine and poultry with an increasing portion being allocated to aquatic species. The table below shows the distribution of CSREES research funding for 2002 by PA and CRIS Subject of Investigation (i.e., Animal Commodity).

2002 Distribution of CSREES Funding by PA and Animal Commodity (\$000)

PA	Poultry	Beef	Dairy	Swine	Sheep & Wool	Aquatic Species	Other
301	924	2417	3518	1887	2424	2049	2465
302	1546	1856	2516	1862	137	1226	2512
303	959	1541	886	699	496	2755	1438
304	1370	945	1052	897	565	591	776
305	2202	597	1587	1195	287	1105	3845
306	498	525	544	197	1	144	641
307	948	2345	1869	733	504	4564	1183
308	272	257	231	260	203	185	145
Total	8719	10483	12203	7730	4617	12619	13025

**Animal Production Research Conducted at Universities
Problem Areas 301– 308**

University portfolio: The University funding portfolio encompasses funding from multiple sources. The sources of funding are often categorized as: 1) appropriations from state legislatures; 2) other federal agencies (e.g., the NIH, DOE, EPA, and DOD); 3) private sources including commodity organizations, direct industry support, and research endowments; and 4) grants and formula funding from the CSREES. These multiple sources of funding are combined to support an individual projects or programs at a land-grant institution providing valuable flexibility for program management. The portfolio analysis below includes the first three categories of funding for universities and not the CSREES portion of the funding portfolio which is described in more detail in other sections of the overall portfolio analyses.

University portion of funding: In 1998, the University portion of the national portfolio (sources other than CSREES) for animal production research was \$297,609 million (83%); whereas, in 2002, the University portion was \$388,043 million (85%), a \$90.4 million increase. Most of the \$90.4 million increase (60%) was due to additional funding received from other federal agencies. There were also modest increases from state appropriations \$12.6 million (13.9%).

Allocations to PAs: The table below provides a summary of funding that was allocated to PAs 301 through 308 for years 1998 and 2002. The most significant changes in funding were for PAs 304, animal genome and 305, animal physiological processes. These changes reflect the recent emphasis on genome mapping and more basic studies involving cellular and molecular biology.

Funding Allocations by PA and Year (\$000)

PA	1998	1998	2002	2002
	CSREES	Universities	CSREES	Universities
301	13677	58319	15684	71659
302	11039	57550	11655	72774
303	6517	34967	8774	36513
304	2414	10089	6196	23769
305	11221	72256	10838	120063
306	3146	13951	2550	13105
307	10243	40684	12146	41510
308	1392	9792	1553	8648
Total	59,648	297,609 (83%)	69,395	388,043 (85%)

Problem Area 301 “Reproductive Performance of Animals”

Overview

Reproductive efficiency is the major factor that affects profitability in many livestock production systems. For example, even under optimal conditions, the fertility of domestic ruminants is only about 50%. In dairy cattle and broiler-breeder populations, fertility has declined significantly over the past several decades. This decline in fertility is associated with increased genetic selection for increased milk production in dairy cattle and increased growth rates in poultry. Reducing infertility in agriculturally important females is of major importance for efficient animal production. Likewise, inhibiting reproductive activity in some production systems (e.g., feedlot heifers or bulls) or generating monosex populations of aquatic species is desirable.

A multi-disciplinary approach has been used to: 1) increase our understanding of the basic mechanisms that regulate fertility and 2) apply this knowledge to control reproduction in livestock production systems. Molecular, cellular, and systems studies have been conducted to obtain new knowledge regarding the mechanisms underlying ovarian follicular development and ovulation, fertilization and conception, semen metabolism and preservation, the factors associated with embryonic/fetal mortality, placental function, and the effects of stress on reproduction. Advances in our understanding of reproductive endocrinology and reproductive biology are being used to develop new methods to control estrus and ovulation, reliably diagnose pregnancy within days after conception, and increase the success rate of assisted reproductive technologies including sperm or embryo sexing, artificial insemination, embryo transfer, and somatic cell nuclear transfer (cloning). Basic knowledge also has been translated to various animal production systems to reduce the age of first breeding in females, improve libido, control the sex of offspring, improve spawning efficiency in fish and shellfish, and enhance larval rearing in fish and shellfish.

Project Area (PA) 301 “Reproductive Performance of Animals” interfaces with other portions of the animal production portfolio including: PA 304 “Animal Genome” (gene identification, function, and control); PA 302 “Nutrient Utilization in Animals” (hormone and nutrient interactions); and PA 307 “Animal Production Management Systems” (animal-based studies that compare production systems or segments of production systems).

The relevant fields of science include: biochemistry and biophysics, physiology, cellular biology, molecular biology, developmental biology, biology (whole systems), genetics, and immunology.

Situation

Artificial insemination is the most rapid and economical means to take advantage of genetically superior males and make genetic progress in livestock. In the turkey, dairy, and swine industries, many, if not most, of the females are bred by artificial insemination. While semen from bulls usually retains a high degree of fertilizing ability following cryopreservation, a high proportion of sperm from poultry and swine die during the freezing process. In addition, there is considerable variation within cattle, swine, and poultry in the ability of sperm to fertilize oocytes. Thus, basic and applied research are needed to develop appropriate methods for

cryopreservation of semen from poultry and swine and reliably predict sperm quality/fertilizing ability in individual males. The ability to successfully cryopreserve sperm (and oocytes or embryos) will also be applicable for germplasm conservation and biosecurity efforts.

In contrast to the dairy industry, artificial insemination is used by relatively few beef producers in the United States, which reflects the use of range or pasture-based breeding situations by many beef producers. The availability of estrus synchronization and timed artificial insemination programs that result in high pregnancy rates and live offspring may facilitate more wide-spread use of artificial insemination by beef producers. However, applied research is still needed to develop management strategies that are not labor intensive and allow optimal timing of insemination with ovulation resulting in live offspring.

Embryo transfer has been used by some producers to take advantage of genetically superior female animals. For embryo transfer to be successful, efficient procedures must be developed to reliably superovulate females and transfer embryos into recipient females such that a high pregnancy rate and live offspring are obtained. This process also depends on procedures to accurately and consistently synchronize estrous cycles in females. Basic and applied research are needed to understand and control the development of ovarian follicles, oocytes, and embryos to enhance the number of offspring obtained from genetically superior females.

New methods to diagnose pregnancy within a few days after conception are being developed. This technology will allow producers to more effectively manage the reproductive cycles of breeding animals. A better understanding of the cellular and molecular events associated with early embryonic development, implantation, and uterine biology will likely lead to better methods to diagnose pregnancy early in gestation.

Cloning by somatic cell nuclear transfer is a relatively new method to take advantage of genetically superior animals. However, somatic cell nuclear transfer is still inefficient and costly. A better understanding of the molecular and biochemical events associated with nuclear reprogramming, early embryonic development, implantation, placentation, pregnancy, and uterine biology are needed to enhance the efficiency and decrease the cost of cloning domestic animals.

Performance Criteria

1. Control fertility in livestock, poultry, and aquatic species

Performance Indicators

Scientific Outcomes (Short-term Impacts):

1. Increased knowledge of the reproductive biology of livestock, poultry, and aquatic species

Medium-term Impacts:

1. Improved pregnancy rates in breeding populations
2. Increased numbers of offspring from genetically superior females and males

3. Improved methods for sterilization or generation of monosex populations

Long-term Impacts:

1. Increased productivity from fewer animals, which will increase profitability for producers, provide product cost benefits to consumers, and conserve natural resources and enhance the environment.

Summary of CRIS data

In 1998, the total CSREES funding for PA 301 “Reproductive Performance of Animals” was \$13.677 million. The majority of CSREES funding was administered through Formula funds (Hatch and Evans-Allen; \$7.91 million or 58%) and competitive grants (NRI and SBIR; \$4.09 million or 30%). The majority of CSREES funding for PA 301 Reproductive Performance of Animals supported research on cattle (beef = \$2.577 million; dairy = \$2.577 million), sheep (\$2.437 million), and swine (\$2.384 million) with lesser amounts on other species (\$1.213 million), poultry (\$0.852 million), and aquatic species (\$0.701 million). In 1998, the total Federal investment in PA 301 “Reproductive Performance of Animals” was \$71.996 million. CSREES contributions accounted for 19% of the total Federal investment while state appropriations (\$32.88 million) was equivalent to 46% of the total Federal investment in PA 301 “Reproductive Performance of Animals in 1998.”

In 2002, the total CSREES funding for PA 301 “Reproductive Performance of Animals” was \$15.684 million, which is an increase of about \$2 million compared to 1998. The majority of CSREES funding was administered through Formula funds (Hatch and Evans-Allen; \$8.039 million or 51%) and competitive grants (NRI and SBIR; \$4.916 million or 31%). In 2002, the majority of CSREES funding for PA 301 Reproductive Performance of Animals supported research on dairy cattle (\$3.518 million), sheep (\$2.424 million), beef cattle (\$2.417 million), and aquatic species (\$2.049 million) with lesser amounts on swine (\$1.887 million), other species (\$1.455 million), and poultry (\$0.924 million). CSREES contributions for research on dairy and aquatic species increased approximately \$1 million and \$1.3 million, respectively, in 2002 compared to 1998. The total Federal investment in PA 301 “Reproductive Performance of Animals” was \$87.343 million. This represents an increase of about \$15.3 million in 2002 compared to 1998. In 2002, CSREES contributions accounted for 18% of the total Federal investment while state appropriations (\$33.162 million) accounted for 38% of the total Federal investment in PA 301 “Reproductive Performance of Animals.”

Multi-state Projects that are represented in PA 301 Reproductive Performance of Animals include:

- 1) NC-1004 Genetic and Functional Genomic Approaches to Improve Production and Quality of Pork
- 2) NC-1006 Methods to Increase Reproductive Efficiency in Cattle
- 3) NC-1010 Interpreting Cattle Genomic Data: Biology, Applications and Outreach
- 4) NCR-057 Reproductive Physiology
- 5) NE-1007 Ovarian and Environmental Influences on Embryonic/Fetal Mortality in Ruminants

- 6) S-289 Factors Associated with Genetic and Phenotypic Variation in Poultry: Molecular to Populational
- 7) S-299 Enhancing Production and Reproductive Performance of Heat-Stressed Dairy Cattle
- 8) S-1008 Genetic Selection and Crossbreeding to Enhance Reproduction and Survival of Dairy Cattle
- 9) S-1012 Nutritional Systems for Swine to Increase Reproductive Efficiency
- 10) SR-IEG-72 Enhancing Reproductive Efficiency in Cattle
- 11) S-285/SR-DC-305 Enhancing Reproductive Efficiency of Poultry
- 12) W-112 Reproductive Performance of Domestic Ruminants
- 13) W-171 Germ cell and Embryo Development and Manipulation for the Improvement of Livestock

The following table of selected research projects terminating in 2002 shows the diversity of funded research topics and the interdisciplinary nature of the research.

Percent PA 301	Title	Institution
100	Role of fibroblast growth factor-7 in uterine biology & pregnancy in pigs	Texas A&M
100	Modulation of reproductive efficiency by prolactin in the domestic turkey	Univ. Minnesota
48	Regulation of the uterine Mx gene	Univ. Idaho
50	Improving Illinois beef quality through a heifer AI & development program	Univ. Illinois
40	Improving reproduction & management of conventional & pasture-based dairy production	NCSU
75	Nutritional systems for swine to increase reproductive efficiency	Univ. Georgia
40	Aquaculture research & development for Ohio	Ohio St. Univ.
20	Production systems to reduce the cost of production & improve reproductive performance of beef cows	SDSU
70	Progesterin metabolism in the pregnant mare, fetus & newborn	Oregon St. Univ.
100	Membrane studies towards enhancing animal reproduction	Colorado St. Univ.
10	Pasture systems for horses: development of optimal supplements	Virginia Tech.
20	Molecular mechanisms involved in the secretion of pathogenicity factors through bacterial membranes	Michigan St. Univ.
100	Immunocontraception of white-tailed deer (<i>Occidocoileus virginianus</i>)	Penn. State. Univ.
60	Goat embryo production, recovery, manipulation, culture & transfer	Fort Valley St. U.
20	The regulation of vitamin D metabolism	UC – Riverside

New Priorities

With the recent efforts to sequence the chicken and bovine genomes, increased emphasis is now placed on studying the function of newly identified genes that regulate reproduction.

Reproductive biologists/physiologists are using molecular and genetic technologies to obtain new knowledge regarding the molecular events that underlie reproduction. Examples include

gene expression profiling studies in reproductive tissues or at various stages of reproduction and overexpression or inactivation of specific genes in animals by transgenesis, knockout technology, or the use of antisense or small interfering RNAs.

To date, somatic cell nuclear transfer has been used to clone cattle, sheep, swine, goats, horses, mules, cats, rabbits, rats, and mice. Yet, this process is extremely inefficient. Significant research efforts are underway to understand the molecular and biochemical processes associated with nuclear reprogramming, early embryonic development, and implantation. Additional knowledge in these areas will increase the success rate of obtaining healthy offspring from genetically superior animals.

In Fiscal Year 2001, the NRI program description for the Animal Reproduction Program was expanded to include the topic of “sterilization or generation of monosex populations.” This area of emphasis was added to encourage development of new methods of generating females that utilize feed more efficiently in growing/finishing production systems or to develop biocontainment methods for transgenic animals, including aquatic species. In addition, producing monosex populations of aquacultured organisms can enhance growth rate by producing and growing more of the faster-growing, feed-efficient sex.

In Fiscal Year 2004, the NRI program description for the Animal Reproduction Program was expanded to encourage submission of integrated research, education, and extension projects to address the growing problem of infertility in dairy cattle.

Since 2001, members of the NC-1006 multistate project (Methods to Increase Reproductive Efficiency in Cattle) have collaborated with members of a North Central Region Extension Bovine Reproductive Task Force to sponsor an annual workshop for producers and veterinarians on “Applied Reproductive Strategies in Cattle.” The workshop focuses on beef and dairy cattle in alternate years. More than 100 participants have attended the annual workshops. This series of workshops is an excellent example of an integrated research, extension, and education project.

Success Stories

As a result of NRI funding, a diagnostic test was developed to determine if cattle were pregnant within 18 days after insemination. In a research laboratory setting, this test is rapid, accurate, and affordable. The technology is currently being scaled up for commercialization by a small biotechnology company and is expected to be available to the public by the end of 2004.

As a result of NRI and Hatch funding, immunocastration methods were developed to neutralize concentrations of GnRH and thereby effectively sterilize male and female cattle. This procedure eliminates estrous cycles in feedlot heifers and results in increased feed efficiency and weight gain. The procedure also decreases libido in bulls and allows for increased rates of gain without negative effects on carcass quality.

NRI funding has also supported two independent projects that have significantly advanced our basic understanding of different molecular mediators of fertilization in mammalian livestock. In

addition to providing fundamental knowledge in this important area, both projects have led directly to development of assays for testing the fertilizing capacity of semen samples. Further development of these fertility tests should be completed soon and will eventually allow producers to assess semen fertility more rapidly and at greatly reduced cost.

Problem Area 302 – “Nutrient Utilization in Animals”

OVERVIEW

The major role of animals in agriculture is the conversion of biological matter with limited value for the human population into biological products of high quality for humans. Efficient conversion of nutrients contained in feed stocks to high quality animal products is essential for the economic viability of animal agriculture. Feed represents the largest single input cost for commercial animal production systems in the United States representing more than 70% of the cost of production of animal products in most modern production units. In addition, animal agriculture is the recipient of by-products of other agricultural production systems, thus improving the economic and biological efficiency of the total agricultural system. The downside of this system for the animal sector is that the nutrient distribution in by-products often deviates significantly from the distribution of nutrients required by the animal to which it is fed. Deficiency of one or more nutrients in the diet fed to animals results in lowered productivity and health. Excess of one or more nutrients in the diet can also reduce productivity and health of the animal, but the primary effect is typically increased excretion of the nutrient in feces and/or urine. This factor exacerbates the impact of animal production systems on the environment, an issue of increasing concern to the public.

Research in this area is focused primarily on the efficiency with which animals convert feedstuffs to human food and other products. Efficiency varies among species, animal product produced, and type of diet fed. Enhancing the efficiency of nutrient utilization for animal productivity will require fundamental knowledge on a wide range of science areas such as molecular and cellular biology, digestion, metabolic processes, and feed processing technology.

Areas of research include but are not limited to:

- Digestion and metabolism
- Nutrients required for specific life processes and longevity
- Hormone and nutrient interactions for maintenance, growth, lactation, and other productivity functions
- Composition and biological availability of nutrients in animal feed
- Effects of processing and feeding system on nutritive values of animal feed
- Alternate sources of nutrients, including forages and agricultural by-products

SITUATION

Specific nutrients required by animals to sustain life were identified by the late 1930's. The main emphasis of research since that time has been directed more towards the refinement of the definition of the quantity of each nutrient required to support maintenance and production of each animal species. Directly related is the determination of the quantity and availability of nutrients contained in the broad spectrum of feedstuffs fed to animals. One measure of progress in this Research Problem Area is the continual development and revision of feeding standards such as the Nutrient Requirements of Domestic Animals series published by the National Research Council of the National Academy of Sciences. Revisions published during the last

decade have included complex mathematical models to aid in the integration of the multitude of factors which affect the nutrient requirement of the animal and the availability of nutrients from combination of feedstuffs included in the ration to be fed to the animal. In addition to animal species, these models include recognition of the impact of the environment in which the animal is maintained, genotype of the animal, physiological state of the animal, and characteristics of the feedstuffs included in the ration.

Intensive application of genetic selection in all animal species has resulted in an animal population with significantly higher potential for production than previous generations of the same animal species. For the animal to realize that potential, it must be supplied with the proper blend of nutrients in amounts required for maximal productivity. As intensity of animal production increases, characteristics of the diet such as rate of digestion and absorption become increasingly important for the realization of the animals' genetic potential to produce the desired animal product.

During the last decade, animal production systems have come under increasing scrutiny for their impact on the environment, in particular for the contamination of water with nutrients in animal manure. This has led to the development of permits for the operation of concentrated animal feeding operations and the requirement for the development of nutrient management plans. Development of systems to minimize excretion of nutrients in animal manure while maintaining animal productivity has become the focus of a significant portion of this PA during the last decade.

PERFORMANCE CRITERIA

Improve the efficiency with which animals convert feedstuffs to human food and other products.

PERFORMANCE INDICATORS

The primary indicator is greater output of animal product from the same nutrient input. Of increasing importance is a reduction in nutrients lost in manure while maintaining animal productivity.

OUTCOMES AND OUTPUTS

Improved tools for the quantitative tracking of nutrients through animal production systems which will accurately quantify nutrient flow in diverse production systems and in animals of diverse genetic potential. These tools will aid in the development of animal production systems which maximize nutrient capture in animal product and minimize nutrient loss in animal manure.

ANALYSIS OF CRIS DATA

In 1998, the total funding from all sources for PA 302 was \$68.59 million of which 16.1% or \$11.04 million came from CSREES sources. In 2002, total funding increased 23.1% above 1998 to \$84.43 million, whereas CSREES funding remained relatively flat at \$11.66 million accounting for only 13.8% of total expenditures associated with PA 302. State Appropriations

are the largest single source of funding during both 1998 and 2002, accounting for \$42.56 million in 2002, or 50.4% of total funding. Scientific effort remained relatively stable increasing from 167 to 170 scientist-years from 1998 to 2002. Therefore, there was a significant increase in funding for research in nutrient utilization between 1998 and 2002 from funding sources other than CSREES. This shift is consistent with increased emphasis during this time to deal with the environmental impact of animal production operations funded primarily from state appropriations supplemented by funding from other USDA Agencies and other Federal Agencies.

NEW DIRECTIONS/EMPHASIS

There has been a significant change in “verbal” emphasis within PA 302 away from efficiency of nutrient utilization and towards minimization of nutrient loss in animal waste. In reality, the nature of research conducted has not shifted dramatically from the primary focus still being efficiency of nutrient utilization, but with more emphasis on quantity and composition of animal manure while maintaining yield and quality of animal product. Significant effort has been directed towards the development of “on farm” tools which can be used by animal producers to assess the impact of feeding and management practices on whole farm nutrient balance to ensure compliance with more strict environmental regulations. The fact that environmental regulations are developed and enforced at the local or state level requires that practices to meet those regulations be developed at the local or state level.

During the last two decades, a significant research focus has been directed towards the determination of characteristics of feedstuffs other than nutrient composition which impact the availability of nutrients in the digestive tract or efficiency of utilization of nutrients by the animal. Identification and characterization of these factors have impacted the development of improved feeding standards for most animal species of agricultural importance. Incorporation of these factors into feeding standards which can be used in practice has required the development of much more complex computer based systems for estimating feed allowances for farm animals. These systems are equally valuable for the estimation of nutrients contained in animal manure, the starting point for the development of whole farm nutrient management plans.

ACCOMPLISHMENTS

Accomplishment of research funded by this PA is best measured by updates or revisions to the National Research Council Nutrient Requirement Series of publications. The latest revisions for Dairy Cattle, Beef Cattle, and Swine include mathematical models to estimate nutrient requirements and the nutritive value of a ration formulated to meet nutrient requirements. These models incorporate differences in genetic background of the animal, environmental conditions under which the animal will be maintained, and the interaction among feed ingredients with in the ration and between the animal fed and the ration fed. The majority of authors of these documents are active participants in long term Multistate Research Projects or Coordinating Committees associated with this PA. For example, four members of the subcommittee responsible for the latest Dairy Cattle Revision, including the chairman, are regular participants in the NC-1009 multistate research project titled “Metabolic Relationships in Supply of Nutrients for Lactating Cows.” Two additional members of the subcommittee are regular participants in

NC-1119 multistate research project titled “Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises.” Similarly, the last revision of the NRC Beef Cattle Nutrient Requirements drew heavily on members of NCR-087, “Beef-Cow-Calf Nutrition and Management Committee,” members of NCR-206, “Nutrition and Management of Feedlot Cattle to Optimize Performance, Carcass Value and Environmental Compatibility,” members of WCC-092, “Beef Cattle Energetics,” and members of WCC-110, “Improving Ruminant Use of Forages in Sustainable Production Systems for the Western U.S.” The subcommittee responsible for the latest revision of Nutrient Requirements for Swine was derived primarily from members of NCR-042, “Committee on Swine Nutrition” and S-1012, “Nutritional Systems for Swine to Increase Reproductive Efficiency.. Members of these two committees formed the core group of authors of the second edition of “Swine Nutrition,” a textbook used in most university courses in swine nutrition and management. Among deficiencies in the multistate research portfolio is there are no research projects or coordinating committees dealing with nutrient utilization in poultry or aquaculture species. In the absence of major funding sources within CSREES other than Hatch Formula funds devoted to Nutrient Utilization, the major avenue for CSREES to impact the direction of research in this area is the active participation of the National Program Leader in multistate committee activities, especially during the revision or development of new projects and coordinating committees. In this area, success has been realized during the last decade to raise awareness of impending environmental issues and to encourage refocusing of efforts to include this issue in project objectives.

CSREES Funding Portfolio Distribution

Problem Area: ANIMAL PRODUCTION
 RPA # 302 Nutrient Utilization in Animals

(\$ in thousands)

FY	Industry	# Projects	Hatch	Special			NRI	SBIR	Other	Total
				Evans-Allen	Animal Health	Research Grants				
1998	Poultry	57	667	209	15	0	164	0	0	1055
	Beef	98	1434	0	20	62	0	0	0	1516
	Dairy	117	2069	0	22	25	216	0	0	2332
	Swine	70	1269	154	7	0	509	0	0	1939
	Sheep	33	441	35	0	25	0	0	0	501
	Aquatic	27	249	188	0	212	0	0	244	893
	Other	109	946	1197	8	180	201	0	270	2802
	Total		7075	1783	72	504	1090	0	514	11038

2002	Poultry	72	951	0	16	161	148	71	198	1545
	Beef	90	1393	0	36	125	182	0	120	1856
	Dairy	128	2113	0	33	0	370	0	0	2516
	Swine	70	1472	81	16	0	293	0	0	1862
	Sheep	19	135	0	0	0	2	0	0	137
	Aquatic	37	207	290	0	183	178	65	303	1226
	Other	44	752	1334	46	183	109	0	89	2513
	Total		7023	1705	147	652	1282	136	710	11655

Other	Other	State	Other	Self-	IND/GR	Non- CSREES
USDA	Federal	Approp.	Non-Fed.	Generated	Agrmt	Total
67	190	3847	299	309	905	5617
152	126	8429	601	5121	1028	15457
62	306	9302	515	2034	1270	13489
32	76	6794	281	2496	862	10541
45	127	2032	95	444	69	2812
46	125	1211	309	81	145	1917
122	699	4764	208	1034	891	7718
526	1649	36379	2308	11519	5170	57551

RPA
Total
6672
16973
15821
12480
3313
2810
10520
68589

SYS	OYS
15.4	99.3
39.5	169.6
38.3	175.5
27.9	123.6
9	28.9
10.6	28.3
26.6	128.5
167.3	753.7

371	1873	4709	242	797	1210	9202
847	184	11712	354	6007	1245	20349
711	462	9674	607	1488	1797	14739
183	307	6802	1097	2014	1393	11796
17	67	976	20	290	70	1440
332	307	798	136	37	252	1862
402	1830	7885	599	1500	1169	13385
2863	5030	42556	3055	12133	7136	72773

10747
22205
17255
13658
1577
3088
15898
84428

22.1	112.7
34.6	198
41	186.8
24.8	131
3.4	14.2
6.8	23.3
37.3	160.8
170	826.8

Problem Areas 303 “Genetic Improvement of Animals” and 304 “Animal Genome”

Overview

Dramatic improvements in the yields of animal protein are crucial in meeting the ever-increasing food needs in the United States and around the world. Selecting animals for breeding that excel in growth, egg, meat, milk, wool, or mohair production; are leaner; exhibit increased disease resistance; or have other desirable traits, have revolutionized poultry, livestock, and fish production. Two problem areas (PAs) address the animal genetics and genome efforts through CSREES leadership. PA 303 “Genetic Improvement of Animals” focuses on broader issues ranging from estimation of genetic parameters to the incorporation of molecular and genomic information into applied genetic improvement programs. PA 304 “Animal Genome” includes research efforts with a focus on gene mapping and related areas, such as functional genomics and bioinformatics that lead to a complete understanding of the genomic organization and function of animal genome of agriculturally important animal species. The ultimate goal of these two PAs is to provide fundamental information important to genetic-based improvements in animal production. For the purpose of brevity and because of significant convergence of genetics research, these two PAs will be presented in a combined portfolio of the Animal Genetics and Genome focus areas.

Situation

The per capita U.S. consumption of beef, pork, broiler, and turkey meat combined has risen from about 127 pounds in 1950 to more than 218 pounds in 2000. Animal geneticists are helping farmers to meet this demand with animals that are healthy and vigorous as they grow and reproduce and that use nutrients efficiently to produce adequate food and fiber for human consumption while minimizing impact on the environment. Genetic selection has increased the modern broiler chicken market weight by nearly 23 percent compared to the same bird in 1950. Total pounds of milk produced in the US have increased while the total number of dairy cows has decreased by almost 50%. Milk production per cow per lactation increased from 17,444 lbs to 25,013 lbs from 1978 to 1998 for the Holstein breed. A large percentage of this increase is due to genetic change as a result of selection as evidenced by the mean breeding values (our best estimate of genetic change) for milk which for Holstein cows increased by 4,829 lbs during this period. Such remarkable improvements in yields of animal protein are essential in meeting the ever-increasing food needs in the United States and around the world.

Animal geneticists are actively embarking upon new initiatives in animal genomics (the characterization of the sequence, structure, and function of genes) directed toward food-producing animals. The resulting genomic technologies will enhance our efforts and expertise to identify economically important genes and traits in food animals. However, this change has come at the expense of other correlated traits such as the inability of turkeys to breed naturally and the huge decrease in reproductive performance in dairy cattle. The combining of genomics with conventional genetic breeding approaches is therefore essential since it will allow agricultural scientists to optimize production, quality, and value—factors necessary for sustainability of our nation’s food and fiber production. The current CSREES portfolio in animal

genetics and genomics has positioned itself to accommodate such shifts in genetics research. For example, the emphasis on identification and mapping of DNA segregation markers including quantitative trait loci (QTL), interactions between nuclear and organellar genes (NRI RFA, 1998), etc., will remain an active area of investigation. However, the newer approaches in “functional genomics,” such as tissue specific gene expression, proteomics, metabolomics and bioinformatics, are now included for research and funding consideration in PA 303 and 304 and are also reflected in 2004 NRI RFA. As a result, a clear change is evident in animal breeding and genomic research, education and extension by the multitude of projects in CSREES portfolio that are evaluating many genetic traits and mechanisms in addition to single traits that were primarily studied in the past.

Performance Criteria

Through PA 303 and PA 304, CSREES provides leadership for a national, coordinated program to map the genome of cattle, sheep, swine, poultry, horses, and several aquatic species. In addition, CSREES provides unique multi-disciplinary and multi-institutional collaboration opportunities for researchers involved in animal genetics and genomics research through several multi-state research projects. The objective of CSREES leadership is to ensure that animal breeding, genetics, and genomics practices are used to optimize food animal production.

Performance Indicators

These research problem areas will increase our understanding in fertility, health, and fitness traits of livestock, poultry, and aquaculture species through genetic selection and evaluation programs. In addition, markers, QTLs, SNPs (single nucleotide polymorphisms), and new initiatives in genome sequencing will result in identification of new genes that control meat, milk, fiber and egg production as well as identify mechanisms associated with disease resistance and susceptibility in food animals.

Funding

Funding to support these two PAs is made available through a mixture of Hatch, Evans-Allen, special grants and competitive grants from CSREES, with additional funds from the State Agricultural Experiment Stations. Combined funding for PA 303 and 304 from all public sources was approximately \$54 million (15% of total available dollars) and \$75 million (16.4 % of the total) in 1998 and 2002, respectively. CSREES contribution to this funding effort was \$8.9 million (15%) and \$15 million (21.6%) in 1998 and 2002, respectively. On the average, approximately 44% of CSREES funds were formula-based (Hatch and Evans-Allen), about 34% were through the competitive grants, and the rest through special and other grants. A comparison of project numbers funded through these programs indicates a 14% increase from 1998 (413 projects) to 2002 (481 projects). The funding trends also indicate a corresponding increase in every funding category (Table 1). Individual PA also showed an increase in funding level across “subject of investigation” (i.e., commodities) category from 1998 to 2002 (Table 2). Research in PA 303 and 304 complements and contributes to the objectives of several other Animal Production PAs. As shown in Table 3, only less than half of the projects in PA 303 or PA 304 are coded as 100% within each of the respective PA. The remaining (>50%) projects

share 10 to 80% of the funding and effort with rest of the eight PAs in the Animal Production portfolio. The CRIS data also show an equal number of projects (45) jointly coded as PA 303 and PA 304.

New Directions and Emphasis

In line with the significant commitment to domestic animal genomics at the federal level (over \$90 million in FY 2004), the animal genetics and genomics effort is organized as a Multistate Research Project, National Research Support Project-8 (NRSP-8) under the National Animal Genome Research Program. Currently, 76 scientists and 10 industry representatives from poultry, swine, cattle/sheep, horses, aquaculture species and database committees are participants in this project. For FY 2004 a total of \$379,164 were allocated as “off-the-top” formula funds to NRSP-8 species and database coordinators. CSREES supported projects that developed chicken BAC libraries which led to the completion of the a 6.6 X draft sequence of chicken genome at Washington University, St. Louis and was supported with \$13 million from the National Human Genome Research Institute of the National Institutes of Health. In addition, CSREES National Research Initiative (NRI) is contributing \$10 million towards a multi-agency, international effort amounting to approximately \$52 million to the bovine genome sequencing project to be conducted at Baylor College of Medicine, TX. Future financial commitment is expected for the swine genome sequencing effort which is being organized by The International Swine Genome Sequencing Consortium.

There are six other multistate projects that focus on genetics and genomics research and are closely related and complementary to NRSP-8. The CSREES NRI program currently funds 19 investigator initiated projects related to genome mapping in domestic animals. In addition, 6 special grants support various cutting edge animal genetics and genomic initiatives at different institutions.

Accomplishments / Outcomes

CSREES supported efforts have led to the:

- development of the most detailed comparative map of cattle and human genes which has led to the identification of genes affecting traits of economic importance to the dairy and beef industries, such as those that affect disease resistance, and the quantity and quality of milk and meat products.
- development of a linkage map of the chicken, Bacterial Artificial Chromosome (BAC) libraries and the construction of a physical “contig” map on which the complete chicken DNA sequence has been assembled. Complete elucidation of genome structure and organization has allowed the genomics research to progress to the level of understanding how genes function and interact (i.e., functional genomics), which then leads to opportunities in proteomics and metabolomics.
- identification of genes which enhanced the pre-harvest food safety against Salmonella.

- development of a porcine genetic linkage map, the physical genetic map, and microsatellite primers for QTL research. This will assist in the elucidation of genotypic linkage with performance characteristics such as food productivity and disease resistance leading to the ability to manipulate these traits more quickly and effectively.
- development of Expressed Sequence Tags (ESTs), microsatellite and SNP markers for aquatic species. This will assist in the identification and validation of genes associated with diseases and growth in aquatic species.
- BAC library construction and development of an ovine and equine radiation hybrid map with potential of becoming the foundational “scaffolding” upon which whole genome sequencing is performed resulting in the ultimate full sequencing of map of the genome.

A list of multistate research projects is provided below;

- NC-1004: Genetic and Functional Genomic Approaches to Improve Production and Quality of Pork
- NC-1008: Advanced Technologies for the Genetic Improvement of Poultry
- NC-1010: Interpreting Cattle Genomic Data: Biology, Applications and Outreach
- NCR-199: Implementation and Strategies for National Beef Cattle Evaluation
- NCR-204: The Interface of Molecular and Quantitative Genetics in Plant and Animal Breeding
- NE-186: Genetic Maps of Aquaculture Species
- NE-1016: Genetic Bases for Resistance and Immunity to Avian Diseases
- S-289: Factors Associated with Genetic and Phenotypic Variation in Poultry: Molecular to Populational
- S-1008: Genetic Selection and Crossbreeding to Enhance Reproduction and Survival of Dairy Cattle
- S-1013: Genetic (Co)Variance of Parasite Resistance, Temperament, and Production Traits of Traditional and Non-*Bos indicus* Tropically Adapted Breeds
- WCC-1: Beef Cattle Breeding in the Western Region

Table 1: Combined Problem Areas 303 “Genetics Improvements of Animals” and 304 “Animal Genome” Funding Allocations

Year	Projects (#)	303+304 / All Sources (\$M)	303+304 / All CSREES RPAs (\$M)	NRI (\$M)	Hatch (\$M)	Evans/Allen (\$M)	Animal Health (\$M)	Special Grants (\$M)
1998	413 ¹	53.99 / 357.3 (15.1%)	8.93 / 59.65 (14.97%)	3.26 (36.5) ²	4.26 (47.7) ²	0.28 (3.1) ²	0.13 (1.4) ²	0.35 (3.9) ²
2002	481 ¹	75.25 / 457.44 (16.45%)	14.97 / 69.39 (21.57%)	4.83 (32.3) ²	5.15 (34.4) ²	0.70 (4.7) ²	0.26 (1.74) ²	1.80 (12.0) ²
Change (%)	+ 14.1	+ 8.20	+ 30.59	+ 32.50	+ 17.30	+ 60.20	+ 50.0	+ 80.5

¹: Indicates number of projects that contribute all or at least portion of funding to these programs.
²: Indicates percentage out of 303 + 304 CSREES contribution (i.e., \$8.93M and \$14.97M for FY 1998 and 2002, respectively).

Table 2: Funding Allocation for Problem Areas 303 “Genetics Improvements of Animals” and 304 “Animal Genome” Based on CSREES CRIS Subject of Investigation (i.e., Animal Commodity) Data.

Commodity	PA 303		PA 304	
	1998 (\$M)	2000 (\$M)	1998 (\$M)	2000 (\$M)
Poultry	1.48	0.96	0.62	1.37
Beef	1.10	1.54	0.40	0.94
Dairy	1.10	0.89	0.20	1.05
Swine	0.73	0.70	0.25	0.90
Sheep	0.43	0.50	0.17	0.56
Aquatic Ani.	1.10	2.70	0.70	0.59
Others	0.60	1.2	0.07	0.45
Total	6.53	8.49	2.41	5.86

Table 3: Distribution (Numbers) of CRIS-Coded Projects by PA 303 and 304

Categories	1998			2002		
	#	Coding Percentage		#	Coding Percentage	
		100%	10-80%		100%	10-80%
PA 303	302	141	161	284	102	182
PA 304	111	49	63	197	93	104
TOTAL	413	190	223	481	195	286
# PA 303 + 304 Coded Together	45			45		

Project Area 305 “Animal Physiological Processes”

Overview

The overall productivity, efficiency, and well-being of animals used for the production of food and fiber are determined by numerous complex and interactive biological processes. Efforts in this area include work on the fundamental physiological processes within the animal at the organismal, organ system, cellular, and molecular level. Areas of work include: (a) chemical and structural organization of animal cells and their specialized properties and functions, including enzymatic machinery and biochemical conversions (b) organization, structure, and function of organ systems, including endocrine, circulatory, urinary, nervous, muscular, and skeletal systems, sensory organs, the common integument and its derivatives, and body fluids; (c) physiology of vital life processes and mechanisms of function and control; (d) neural, hormonal, or other chemical messengers that serve as regulators of physiologic processes and perform integrative functions in the animal; (e) prenatal, neonatal, and postnatal development and growth of animals, including genetic control mechanisms and accretion, deposition, and degradation of proteins and fats in animal tissues, and (f) lactation physiology, including alveolar development and involution, milk synthesis, secretion and ejection, milk composition, and patterns of lactation.

The PA 305 “Animal Physiological Processes” project area interfaces with other portions of the animal production portfolio including: PA 302 “Nutrient Utilization in Animals” (hormone and nutrient interactions); PA 304 “Animal Genome” (gene identification, function and control); and PA 307 “Animal Production Management Systems” (animal-based studies that compare production systems or segments of production systems).

The relevant fields of science include: biochemistry and biophysics, physiology, cellular biology, molecular biology, developmental biology, biology (whole systems), genetics, and immunology.

Situation

Current needs of animal production enterprises include three areas: (a) increase efficiency of production to reduce production costs, improve profitability and enhance competitiveness in the global market; (b) improve uniformity of animal products for increased efficiency of production/processing and greater consumer acceptance; and (c) improve the quality and healthiness of animal products to increase consumer acceptance. Current trends in the animal production industries include increasing efficiency of protein deposition in skeletal muscle (meat), especially in monogastric animals such as poultry, swine and aquacultured finfish. Another trend is to increase the ratio of lean to fat by reducing fat deposition, particularly inter-muscular fat. Efforts to increase the quality and healthiness of animal products focus on reducing fat content, increasing content of beneficial fatty acids (e.g., omega-3 fatty acids, omega-6 fatty acids, and conjugated linoleic acid), and increasing content of specific minerals (e.g., calcium).

Performance Criteria

Influence animal physiological processes to improve the efficiency of production and quality of animal products.

Performance Indicators

Short-term Impacts:

- Increased knowledge regarding the overall understanding of physiological processes associated with skeletal muscle growth and milk production

Medium-term Impacts:

- Improved efficiency of skeletal muscle growth and milk production
- Improve the uniformity and quality of animal products

Long-term Impacts:

- Increased productivity from fewer animals, which will increase profitability for producers, provide product cost benefits to consumers, and conserve natural resources and enhance the environment
- Increased uniformity and quality of animal products leading to increased world-wide consumption of more nutritious animal products that are produced in the U.S.

Summary of CRIS data

In 1998, the total CSREES funding for PA 305 “Animal Physiological Processes” was \$11.221 million. The majority of CSREES funding was administered through Formula funds (Hatch and Evans-Allen; \$5.405 or 48%) and competitive grants (NRI and SBIR; \$4.792 or 45%). In 1998, the majority of CSREES funding for PA 305 “Animal Physiological Processes” supported research on dairy cattle (\$1.966 million), aquatic species (\$1.602 million), poultry (\$1.348 million), and swine (\$1.169 million) with lesser amounts on beef cattle (\$0.791 million), other species (\$0.773 million), and sheep (\$0.453 million). In 1998, the total Federal investment in PA 305 “Animal Physiological Processes” was \$83.477 million. CSREES contributions accounted for 13% of the total Federal investment while state appropriations (\$37.363 million) were equivalent to 45% of the total Federal investment in PA 305 “Animal Physiological Processes” in 1998.

In 2002, the total CSREES funding for PA 305 “Animal Physiological Processes” was \$10.838 million, which is a decrease of about \$0.383 million compared to 1998. The majority of CSREES funding was administered through Formula funds (Hatch and Evans-Allen; \$6.22 million or 57%) and competitive grants (NRI and SBIR; \$3.961 million or 36%). In 2002, support for PA 305 “Animal Physiological Processes” through Formula funds increased by 9% and competitive grants decreased by 9% compared to 1998. In 2002, the majority of CSREES funding for PA 305 “Animal Physiological Processes” supported research on poultry (\$2.202 million), other species (\$2.102 million), dairy cattle (\$1.587 million), swine (\$1.195 million), and aquatic species (\$1.105 million) with lesser amounts on beef cattle (\$0.597 million) and sheep (\$0.287 million). The total Federal investment in 305 Animal Physiological Processes was \$130.901 in 2002. This

represents an increase of about \$50 million in 2002 compared to 1998. In 2002, CSREES contributions accounted for 8.3% of the total Federal investment while state appropriations (\$39.339 million) were equivalent to 30% of the total Federal investment in PA 305 “Animal Physiological Processes.”

Multistate Projects that are represented in PA 305 “Animal Physiological Processes include”:

- 1) NC-131 Molecular Mechanisms Regulating Skeletal Muscle Growth and Differentiation
- 2) NC-1004 Genetic and Functional Genomic Approaches to Improve Production and Quality of Pork
- 3) NC-1008 Advanced Technologies for the Genetic Improvement of Poultry
- 4) NC-1010 Interpreting Cattle Genomic Data: Biology, Applications, and Outreach
- 5) NE-1016 Genetic Basis for Resistance and Immunity to Avian Diseases
- 6) S-289 Factors Associated with Genetic and Phenotypic Variation in Poultry: Molecular to Populational
- 7) S-299 Enhancing Production and Reproductive Performance of Heat-Stressed Dairy Cattle
- 8) S-1008 Genetic Selection and Crossbreeding to Enhance Reproduction and Survival of Dairy Cattle
- 9) W-171 Germ Cell and Embryo Development and Manipulation for the Improvement of Livestock
- 10) W-173 Stress Factors of Farm Animals and Their Effects on Performance

The following table of selected research projects terminating in 2002 shows the diversity of funded research topics and the interdisciplinary nature of the research.

Percent PA 305	Project Title	Institution
35	The Influence of Urocortin on Growth and Reproduction in Swine	Univ. Maryland – Eastern Shore
40	Accelerating Bile Acid Synthesis in Developing Swine	Iowa State University
20	Minimizing Protein in Calf Milk Replacers to Decrease Cost and Nitrogen Excretion	Univ. Illinois
80	A Median Eminence Preovulatory Module in the Hypothalamus and the Estradiol Biphasic Effect on Lh	Rutgers
100	Fibroblast Growth Factor Regulation of Skeletal Muscle Development In Vivo	Purdue University
100	Insulin-Like Growth Factor Transgenes and Mammary Development	Virginia Polytechnic Institute
100	The Role of Insulin-Like Growth Factors and Their Binding Proteins in Lactation	Rutgers University
40	Metabolic Relationships in Supply of Nutrients for Lactating Cows	Michigan State University
33	Understanding and Alleviating Heat Stress Infertility in Broiler Chickens	Miss. State Univ.
50	Callipyge Sheep: Meat Tenderness, Muscle Histology and Composition, and In Vitro Muscle Growth	Utah State Univ.

New Priorities

With the recent efforts to sequence the chicken and bovine genomes, increased emphasis is now placed on studying the function of newly identified genes that regulate skeletal muscle growth, fat deposition and milk production. Physiologists are using molecular and genomic technologies to obtain new knowledge regarding the molecular events that underlie various aspects of animal physiology. Some examples include gene expression profiling studies in skeletal muscle and the mammary gland or at various stages of growth or lactation. Other examples include over-expression or inactivation of specific genes in animals by transgenesis, knockout technology, or the use of antisense or small interfering RNAs, etc.

Success Stories

Use of Hatch and NRI funding has led to increased understanding of the role of sommatotropin in promoting skeletal muscle growth, improving lean to fat ratio, and increasing milk production. This information has contributed to the commercial development of sommatotropin and its widespread use in the dairy industry to enhance milk production and maintain lactational persistence in the face of markedly reduced fertility of dairy cattle (i.e., to maintain the period of lactation when calving interval has increased).

Problem Area 306 “Environmental Stress in Animals”

Overview

The environmental stress in animals problem area includes research on stresses from the effects of climate, handling, and other environmental factors that decrease productivity. Extremes in temperature, humidity, air movement, and noise may lead to lower reproduction, reduced feed efficiency, anorexia, reduced disease resistance, and increased mortality. This problem area does not include physiological responses and behavioral responses to environmental stress.

Because the effects of environmental stress yield compromises in animal performance via multiple pathways, many of these research projects interface with other problem areas in the animal production portfolio. Effects on reproduction from environmental stress is reported in the reproductive performance of animals problem area; nutritional compromises from environmental stress in the nutrient utilization of animals problem area; and many environmental stress projects will be reported in the animal production management systems problem area.

It is important to distinguish that animal well-being problem areas are being addressed under a different USDA strategic goal.

Situation

In many areas of the country, climatic conditions pose significant management challenges for a number of livestock industries. Extremely hot summer temperatures can incur substantial mortality losses in the poultry industry and induce severe production losses in feedlot cattle. These losses are not confined to the Gulf States, but can occur in interior Midwest locations. Developing strategies that are quickly implementable to reduce these acute losses in livestock and poultry and deal with chronic losses such as reproductive inefficiencies in many dairies exposed to above normal temperatures is economically justified.

With increasing consumer concerns relative to animal harvest procedures, the need for scientifically assessing the impacts of environmental stress immediately pre-harvest is needed. As potential markets increasingly require approved procedures during pre-harvest, information will be required for third-party verification systems.

Performance Criteria

1. Control the effects of environmental stress on animals

Performance Indicators

Short-term

1. Increase knowledge of environmental stressors that negatively impact animal production.

Long-term

1. Develop management strategies to monitor and reduce, if not eliminate, environmental stress on production animals.

Summary of CRIS data

Based upon reported data, \$14,046,000 was allocated to “environmental stress in animals” research for FY 1998 as compared to \$11,095,000 for FY 2002. This represents a loss of 21% in funding support for this problem area over the four-year time frame.

For FY 1998, CSREES accounted for \$3,095,000 of the \$14,046,000 expended, a 22% contribution to the funding effort. In FY 2002, CSREES accounted for \$2,345,000 of the \$11,095,000 allocated, a 21.1% contribution.

Of the 140 projects reported for problem area 306, only 14 projects were solely 306 and specific to one of the seven industries (species) represented. The data supports that the poultry and dairy industries received the majority of formula research funding and, for FY 2002, they also were the leading industries investigated for this problem area.

(\$000)

FY	Industry	# Projects	Hatch	Evans-	Animal	Special	NRI	SBIR	Other
				Allen	Health	Research			CSREES
1998	Poultry	42	605	117	10	0	0	0	0
	Beef	20	129	0	0	0	215	0	0
	Dairy	26	371	0	0	0	0	0	0
	Swine	20	171	0	0	0	0	100	0
	Sheep	2	7	0	0	0	0	0	0
	Aquatic	12	187	280	0	69	0	0	476
	Other	11	74	0	15	0	0	0	269
	Total	133	1544	397	25	69	215	100	745

2002	Poultry	34	218	0	26	37	216	0	0
	Beef	28	175	0	0	60	290	0	0
	Dairy	34	312	0	4	228	0	0	0
	Swine	13	197	0	0	0	0	0	0
	Sheep	4	1	0	0	0	0	0	0
	Aquatic	14	31	0	0	30	3	80	0
	Other	13	55	0	1	0	381	0	0
	Total	140	989	0	31	355	890	80	0

(\$000)			Other	Other	State	Other	
FY	Industry	# Projects	USDA	Federal	Approp.	Non-Fed.	Total
1998	Poultry	42	2	30	1663	99	2526
	Beef	20	33	598	1272	78	2325
	Dairy	26	114	17	1262	79	1843
	Swine	20	4	184	757	78	1294
	Sheep	2	0	11	59	8	85
	Aquatic	12	19	286	216	18	1551
	Other	11	34	3358	378	294	4422
	Total	133	206	4484	5607	654	14046

2002	Poultry	34	67	48	1376	34	2022
	Beef	28	88	29	1034	28	1704
	Dairy	34	109	133	2704	181	3671
	Swine	13	12	30	837	55	1131
	Sheep	4	1	46	143	0	191
	Aquatic	14	12	531	255	4	946
	Other	13	85	275	572	61	1430
	Total	140	374	1092	6921	363	11095

Multi-state Projects that are represented in PA 306 Environmental Stress in Animals include:

1. S-299 Enhancing Production and Reproductive Performance of Heat-Stresses Dairy Cattle
2. W-173 Stress Factors of Farm Animals and Their Effects on Performance

Based upon the current CRIS classifications, many of the efforts from S-299 would not be reported in PA 306.

The following table of reflects the 14 research projects funded in 2002 with 100% effort within PA 306.

Percent PA 306	Title	Institution
100	Behavioral Activity in Broiler Chickens and Its Effect on the Incidence of Skeletal Problems	UC-Davis
100	Diet, Health, Longevity	UC-Riverside
100	Strategies to Reduce the Response of Slaughter Weight Pigs to Handling Stress	Univ. of Illinois
100	Mucus Secretion in Horse Airways	Mich. State
100	Systems for Controlling Air Pollutant Emissions and Indoor Environments of Poultry, Swine and Dairy Facilities	Miss. State
100	Stress Factors of Farm Animals and Their Effects on Performance	Miss. State
100	Net Requirement Systems for Poultry	Okla. State
100	Mannheimia Haemolytica Outer Membrane Protein PipE: Characterization of Epitopes Stimulating Homologous and Heterologous Serotype Protection	Okla. State
100	The Effects of Unconditioned Air on Equine Peripheral Airways	Okla. State
100	Post-ruminal Nitrogen Supply for Fast Growing Meat Goats	Langston Univ.
100	Genetic Bases for Resistance and Immunity to Avian Disease	Penn. State
100	Development of Antibodies for the Detection of 2-Methylisoborneol (MIB) by Immunoassay	Abraxis, LLC.
100	Molecular Mechanisms of Osmoregulation in Salmon	Univ. of RI
100	Bovine Cytokine Gene Expression and Cell Activation: Stress-Induced Alterations	Tuskegee Univ.

New Priorities

With emerging *in vivo* sensor technologies, combined with the need for value-added animal identification devices, opportunities to monitor and evaluate parameters associated with the result of environmental stress will be forthcoming. These opportunities may also serve as a way to document animal handling and stress reduction programs to assist with third party certification programs.

Success Stories

In FY 2002, a state-of-the-art, environmental stress research and teaching facility was complete on the campus of the University of Arizona. This \$1.94M facility was supported by a Building and Facilities Program Grant administered through CSREES. This facility, operated by the Department of Animal Science, will provide investigators the opportunity to control environments of their choice to pursue a better understanding of environmental stress.

Researchers at Tuskegee University are determining relationships among movement, age, gait scores, bone strength, and specific leg problems in broiler chickens. This information will be used to design housing modifications in lessening environmental stress on birds. University of Illinois researchers are measuring blood parameters, particularly acid-base balance, to estimate the impact of handling stress in swine. Oklahoma State University faculty are pursuing the effects of inspired air temperatures on lower airway tracts in horses. Scientists at the University of Rhode Island are characterizing the osmotic stress proteins induced by hyperosmotic stress of

salmon. Results of such efforts enhance long-term survival and growth of juvenile salmon following transfer to seawater.

Project Area 307 “Animal Production Management Systems”

Overview

Animal Production Management Systems encompass the total operation cycle of genetic selection, reproduction, growing, feeding, handling and management of beef cattle, dairy cattle, swine, sheep, goats, poultry, aquatic animals, horses and exotic animals. Included also is the production of marketable animal products from the farm such as milk, eggs, wool and hair.

Animal-based research to compare total production systems is limited due to cost and resource requirements. The development of computer technology, analytic methods, and computer models that simulate animal production systems provide a methodology for critically evaluating alternative production systems and management decisions. Computerized production records provide a valuable resource for measuring the effect of changes in various segments of the total production system.

Areas of research include but are not limited to:

- Animal-based studies that compare production systems or segments of production systems.
- Computer simulation models of animal production systems that allow comparisons of various alternative management components and decisions.

Situation

Animal production systems are increasing in complexity at an escalating rate with new technologies, products of biotechnology and genomic research; greater attention by regulators in the areas of environment, food safety and animal welfare; increased size of operations; concerns of the rural community; and the need to make a profit to survive.

PA 307, animal production management systems, represents an aggregation of projects across a broad array of research topics and animal species. Included are applied and basic research components related to nearly every phase of animal production. The unifying characteristic of each is the role in the overall system of production, including the relationship with other segments of the system.

Interface with other portions of the animal production portfolio:

Research in PA 307 naturally has a complementary relationship to most of the other PA's in animal production since each of those areas are part of or have a direct effect upon the animal production systems. Following are examples of research in other portions of the animal production portfolio that have a contributory relationship to animal production management systems.

- PA 111 Conservation and Efficient Use of Water
- PA 112 Watershed Protection and Management
- PA 121 Management of Range Resources
- PA 131 Alternative Uses of Land
- PA 133 Pollution Prevention and Mitigation
- PA 202 Plant Genetic Resources and Biodiversity
- PA 204 Plant Product Quality and Utility (Preharvest)
- PA 205 Plant Production Management Systems
- PA 301 Reproductive Performance of Animals
- PA 302 Nutrient Utilization in Animals
- PA 303 Genetic Improvement of Animals
- PA 305 Animal Physiological Processes
- PA 306 Environmental Stress in Animals
- PA 308 Improved Animal Products (Before Harvest)
- PA 311 Animal Diseases
- PA 315 Animal Welfare/Well-Being and Protection
- PA 401 Structures, Facilities, and General Purpose Farm Supplies
- PA 402 Engineering Systems and Equipment
- PA 403 Waste Disposal, Recycling, and Reuse
- PA 601 Economics of Agricultural Production and Farm Management
- PA 711 Ensure Food Products Free of Harmful Chemicals, Including Residues from Agricultural and Other Sources

Collaboration:

Collaboration among researchers and educators related to animal production management systems occurs through many Multi-State projects. These include, but are not limited to:

- NC-225 -Improved Grazing Systems for Beef Cattle Production
- NC-1119 - Management Systems to Improve the Economic and Environmental NE-127 - Biophysical Models for Poultry Production Systems;
- NE-132 - Environmental and Economic Impacts of Nutrient Management on Dairy forage Systems;
- NE-1009 - Mastitis Resistance to Enhance Dairy Food Safety;
- Sustainability of Dairy Enterprises;
- S-277 – Breeding to Optimize Maternal Performance and Reproduction of Beef Cows in the Southern Region
- S-284 - Genetic Enhancement of Health and Survival for Dairy Cattle
- S-291 – Systems for Controlling Air Pollutant Emissions and Indoor Environments of Poultry, Swine, and Dairy Facilities
- S-299 – Enhancing Production and Reproductive Performance of Heat-Stressed Dairy Cattle

- S-1000 – Animal Manure and Waste Utilization, Treatment and Nuisance Avoidance for a Sustainable Agriculture
- W-112 - Reproductive Performance in Domestic Ruminants and
- W-173 – Stress Factors of Farm Animals and Their Effects on Performance
- W-192 – Rural Communities and Public Lands in the West: Impacts and Alternatives
- W-195 – Water Quality Issues in Poultry Production and Processing
- W-1177 – Enhancing the Competitiveness of U.S. Red Meats

Scientific discipline diversity:

Many different scientific disciplines comprise the PA 307 projects and portions of projects. Fields of science include biology (whole systems), economics, engineering, entomology and acarology; genetics, information and communication; management, nutrition and metabolism; pharmacology and physiology.

The attached Table 1 includes several representative examples of research projects on animal production management systems that include classification to PA 307. The list demonstrates the diversity of projects related to animal production management systems research and that most projects complement one or more other PAs as illustrated by the percentage classification.

Performance Criteria

Improve the ability of the animal production system to produce high quality food, fiber and/or fuel efficiently and profitably while protecting the environment, health and welfare of the animals; health and safety of the workers; and in full compatibility with the rural community.

Performance Indicators

The primary indicators of performance are pounds of product produced per animal or per measured space, quality of product, and production cost per unit.

Outcomes and Outputs

Increased understanding of the inter-relationships among the many components of the animal production management system and the impact of each on the others and on the total system.

Analysis of CRIS Data

The following table shows the distribution of the 1998 CSREES funding of PA 307 by Animal Commodity (CRIS Subject of Investigation), followed by a table showing the comparable 2002 figures.

1998 CSREES Funding Sources for PA 307

------(Funding in 000's \$)-----

Commodity	# Projects	Hatch	Evans-Allen	Special Research Grants	Other* CSREES	Total CSREES
Poultry	48	\$279	\$82	\$0	\$0	\$361
Beef	229	998	187	208	527	1,920
Dairy	133	1,073	0	243	0	1,316
Swine	59	155	328	0	220	703
Sheep/Wool	29	255	24	0	0	279
Aquatic	89	177	424	939	1,700	3,240
Other	43	42	62	49	0	153
Total	630	2,979	1,107	1,439	2,447	7,972

* Includes Animal Health, NRI, SBIR and other CSREES funding (Regional Aquaculture Centers, etc.)

2002 CSREES Funding Sources for PA 307

------(Funding in 000's \$)-----

Commodity	# Projects	Hatch	Evans-Allen	Special Research Grants	Other* CSREES	Total CSREES
Poultry	79	204	309	256	178	947
Beef	269	1,339	260	742	3	2,344
Dairy	147	1,427	0	261	182	1,870
Swine	56	160	251	187	135	733
Sheep/Wool	46	75	0	402	27	504
Aquatic	162	371	784	942	2,466	4,563
Other	50	81	526	23	60	690
Total	809	3,657	2,130	2,813	3,051	11,651

* Includes Animal Health, NRI, SBIR and other CSREES funding (Regional Aquaculture Centers, etc.)

CSREES funding for PA 307 increased 46 percent from 1998 to 2002, with the largest percentage increases being in Special Research Grants at 95 percent and Evans-Allen at 92 percent. Hatch funding increased only 23 percent during this period. Hatch funds still lead in total support of PA 307 with 31 percent. Other CSREES, Special Research Grants and Evans-Allen follow with 26, 24 and 18 percent of the total for 2002.

The CSREES portion of the total funding received by universities from all funding sources (i.e., CSREES, State Appropriations, Other Federal agencies, and Private sources including industry, foundations and endowments) increased from 22.7 percent in 1998 to 28.9 percent in 2002.

Each of the animal commodities received increased funding for projects in animal production management systems during the four year period, ranging from 4 percent for swine and 22 percent for beef; to 351 percent for “other animals” and 162 percent for poultry. Increases were 81 percent for sheep and wool; 42 percent for dairy and 41 percent for aquatic. The “other animals” category includes horses, ponies, mules, goats, pets, laboratory animals and others.

Distribution among the animal commodities of PA 307 funding for 2002 shows aquatic animal projects leading at 39.2 percent; followed by beef with 20.1, dairy 16.1, poultry 8.1, swine 6.3, other 5.9 and sheep and wool 4.3 percent.

New Directions/Emphasis

While efficiency of production per unit is still very important to profitability, increased emphasis is being placed on those segments of the production system that impact the environment, quality of food produced and welfare of the animals. The increase in average size of animal production operations has also had an influence, with greater emphasis on animal comfort and compatibility with the rural community. Some increase may also be seen in efforts addressing small farms, sustainability and economically disadvantaged family farms.

Accomplishments

Many of the accomplishments of the research in PA 307 have been in concert with efforts of Extension specialists, including those with joint research and Extension appointments. This follows naturally due to the need to consider the ramifications to the total production system of any educational effort with producers directed to one or a few segments of the system. Following are several examples of important accomplishments that are helping producers of animal products.

Systems that Improve Animal Welfare and the Environment

Although animal welfare is part of animal protection, and environmental aspects of animal operations are part of natural resources, changes in production systems to improve these areas are part of the animal production management systems and therefore a percentage of emphasis is apportioned to PA 307.

- Hoop barn developments for production of livestock have provided some significant benefits due to the generation of solid manure which has less risk of environmental damage; and a humane bedded environment for livestock. They are also low-cost and versatile and in some cases, qualify those livestock for higher value niche markets. These hoop barns are located throughout the country, however nearly 800 farmers in Iowa have constructed more than 2,200 hoop barns for swine in a relatively short span of 6-7 years.
- Early weaning of beef calves that were then kept on site, provided supplement and grazed until normal weaning time has been found to reduce stress as compared to calves weaned at a normal age when both groups were then transported to a feedlot. Stress was measured

by blood plasma analyzed for the acute phase proteins, haptoglobin and ceruloplasmin. Early weaned calves were lighter at normal weaning but had caught up by day 28. Feed efficiency and overall calf efficiency was greater for the early weaned calves.

- Castration is commonly used as a management tool by animal producers to improve the behavioral and carcass traits of males. However, physical castration may be stressful and is often associated with reduced growth. Immunocastration is an effective alternative to conventional castration. Immunocastration reduces aggressive and sexual behavior, while improving growth and carcass traits. In addition, immunocastration is not invasive and therefore enhances animal well-being.
- The mass generation rate of gaseous ammonia from poultry operations is greatly reduced by the topical liquid application of alum. This has allowed management decisions favorable for production, animal and caretaker welfare; and outside environmental air quality. Additional studies will ascertain whether liquid high-acid alum as a litter amendment will significantly reduce pathogen levels in poultry litter before land application.
- Software has been developed to predict waste stream outputs of nutrients from commercial dairies based upon measureable characteristics of cows and their feeds. This software may be used to assess the environmental impact of dairies, as well as the predicted impact of mitigation strategies.
- A “sustainable pork” model system was developed and tested on a reasonably large scale to demonstrate a production system that is animal and community friendly; environmentally neutral and has no offensive odor. Labor requirement was similar to a conventional indoor system. The piglets born and finished outdoors in bedded shelters and on pasture had a slightly improved pork tenderness, juiciness and flavor in some seasons. Muscle fiber types were also influenced by housing system. The maintenance of ground cover resulted in no buildup of nutrients in the soil. This system has been replicated in a commercial operation and interest in the concept continues.
- One of the greatest ecological threats facing North American rangelands is invasion by noxious weeds such as spotted knapweed. More than 2.1 million acres of rangeland is infested with this weed. Sheep readily graze spotted knapweed and it has good forage value for sheep. Prescription grazing by sheep can be effective in controlling spotted knapweed with minimal impacts on the native vegetation. Prescribed grazing has the potential to enhance the development of new livestock enterprises and help address this environmental problem.

Systems that Improve Efficiency, Profitability and Competitiveness

- Because feeding of stored forages represents nearly 50% of the costs associated with beef cow-calf production, profitability of such enterprises may be significantly improved by extending the grazing season into the fall and winter in the upper Midwest. Grazing of corn crop residues and stockpiled grass-legume mixtures have been shown to reduce the amounts of hay required to maintain pregnant beef cows by 87%, reducing the cost of cow-calf production as much as \$100 per cow at a hay price of \$50/ton.

- An excellent dairy cattle study of the relationship among reproduction, calving difficulty and calf loss, three important and manageable components of the production system, showed that older multiparous cows had the greatest twinning rate; perinatal death loss was larger as number of services per conception increased; perinatal death loss was greatest for cows that experienced dystocia; periparturient disorders during the previous lactation were not associated with perinatal death loss in the current lactation; primiparous cows received 29.8% assistance and multiparous cows received 10.5% assistance; female calves required less assistance regardless of parity; multiparous cows that had increased number of services per conception required assistance more often; and multiparous cows that had dystocia during the previous calving were more likely to have dystocia during the current calving.
- Cost-effective fish production in indoor recirculation aquaculture systems has considerable economic and environmental potential in the United States. The underlying concept is to control the water environment to produce fish under optimal growing conditions free from contamination. The resulting product is super fresh, free from pesticides and heavy metals and affordable to the consumer. Indoor recirculating aquaculture has been greatly advanced by the development and testing of large-scale biofilters and other indoor fish production techniques.
- Milking cows four times a day for the first 30 days of lactation and twice daily thereafter has been shown to increase production as much as \$300 per cow annually.
- Research on colostrum feeding and calf management has greatly reduced calf losses in dairy herds. The replacement heifer enterprise in dairy operations consumes about \$500/cow per year or about 20 percent of production expenses. Herds that have implemented management procedures and feeding recommendations to reduce calf losses from 15 percent to 10 percent typically save about \$5,000/yr for a 200-cow dairy operation.

Table 1

Representative Research Projects

Animal Production Management Systems - PA 307

Percent PA 307*	Project Title
100	A Decision Support Tool to Investigate Emerging Complex Problems in the Dairy Industry
25	Biophysical Models for Poultry Production Systems
40	Patterns of Utilization and Plant Responses to Grazing
100	Development of Alternative Darkling Beetle Management Strategies for Poultry Producers in the Northeast
25	Minor Use Animal Drug Program: Western Region
100	Strengthening Texas Goat Production Systems
50	Stress Factors of Farm Animals and Their Effects on Performance (W-173 - Florida)
20	Reproductive Performance in Domestic Ruminants (W-112 – California)
100	Regional Aquaculture Center
100	Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises (NC-1119 – Texas)
50	Animal Manure and Waste Utilization, Treatment and Nuisance Avoidance for a Sustainable Agriculture (S-1000 – South Carolina)
15	Integrated Crop/Livestock/Agroforestry Research for Sustainable systems in Nebraska
25	Production Systems to Improve the Efficiency and Profitability of Small and Economically Disadvantaged Livestock Family Farms
50	Mastitis Resistance to Enhance Dairy Food Safety (NE-10090 – Washington)
100	Hoop Barns for Livestock: An Alternative, Sustainable Housing System
20	Systems Approach to Dry/Deep Bedded Housing Alternatives for Pork Production
100	Rural Communities and Public Lands in the West: Impacts and Alternatives
100	Enhancing the Competitiveness of U.S. Red Meats (W-1177 – California)

* The remainder of the project is classified to one or more other PAs.

Project Area 308 “Improved Animal Products (Before Harvest)”

Overview

Products from animals include meat and meat products, poultry products (e.g., meat and eggs), fish, shellfish, dairy products (e.g., milk and cheese) and non-food products such as fiber (e.g., wool, mohair, cashmere and leather). These products represent approximately \$100 billion of sales at the farm gate and several times that amount at retail. The quality and safety of animal products prior to harvest are influenced by genetics, nutrition, and management systems, whereas, after harvest they are impacted by handling, processing, storage and marketing practices.

Research efforts are being made to improve the composition and quality of animal products to reflect consumer preferences. Information is continually needed to determine what animal product qualities are desired by consumers.

Areas of effort for this program include but are not limited to:

- the study of the physiology and biochemistry of fats, proteins, and flavor components of animal products
- factors responsible for development of flavor and other components of product quality
- the reduction in undesired fat in animal products; improving wool, hides, and other non-food animal products
- determination of consumer preferences and factors influencing product acceptability

Situation

The animal production component related to animal products bridges the farm gate; thereby linking animal products to animal production, processing, and product development and traverses numerous discipline areas including animal science, growth and development, food science and nutrition, and marketing. The portfolio represents an aggregation of projects across an array of research topics and animal species. PA 308 includes applied and basic research components with emphasis on pre-harvest research that influences product quality and consumer acceptance. Following are several characteristics of the portfolio that illustrate its relationship to the overall portfolio for Animal Production:

Interface with other portions of the animal production portfolio

Research in PA 308 complements and contributes to the objectives of many other problem areas. Below are examples of research related to improved animal products before harvest that interface with other PAs.

Basic understanding of growth and development

PA 305 “Animal Physiological Processes” and PA 302 “Nutrient Utilization in Animals”

Pre and post harvest influences

PA 502 “New and Improved Food Products after Harvest” and PA 503 “Quality Maintenance in Storing and Marketing Food Products”

Food safety

PA 711 “Ensure Food Products Free of Harmful Chemicals,” including residues from agricultural and other sources and PA 712 “Protect Food from Contamination by Pathogenic Microorganisms, Parasites, and Naturally Occurring Toxins”

Marketing

PA 601 “Economics of Agricultural Production and Farm Management,” PA 603 “Market Economics,” and PA 604 “Marketing and Distribution Practices”

Collaboration

Collaboration among researchers and educators related to animal products occurs through several Multi-State projects. These include, but are not limited to: 1) W-1177 Enhancing the competitiveness of U.S. meats; 2) NCR-97 Regulation of adipose accretion in meat animals; 3) NC-131 Molecular mechanisms regulating skeletal muscle growth and differentiation; 4) W-181 Modifying milk fat composition for improved manufacturing qualities and consumer acceptability; 5) NC-136 Improvement of thermal and alternative processes for foods; 6) S-295 Enhancing food safety through control of food-borne disease agents; 7) and WCC-1 Beef cattle breeding research in the western region.

Scientific discipline diversity:

PA 308 encompasses a diversity of scientific disciplines that contribute to animal products research. Fields of science include biochemistry and biophysics, chemistry, nutrition and metabolism, genetics, molecular biology, economics, physiology and general biology.

The attached Table 1 includes several representative examples of research projects on animal products that include classification to PA 308. The list demonstrates the diversity of projects related to animal products research and that most projects complement one or more other PAs as illustrated by the percentage classification.

Performance Criteria

Improve animal product quality and acceptability.

Performance Indicators

The primary indicators of performance are decreased fat in animal products, less animal product waste during processing and marketing, and improved consumer acceptance.

Outcomes and Outputs

Increased understanding of the basic mechanisms that control the accretion of fat and lean tissue in animals, factors that influence flavor and other components related to consumer preferences of animal products, reduce the undesired animal products in the marketplace, and increase the efficiency of producing value-added products.

Analysis of CRIS Data

In 1998, the total CSREES funding for PA 308 was \$1.39 million. Formula funding from Hatch (\$0.99 million) and Evans-Allen (\$0.18 million) representing 84% of the total funding for the PA; whereas in 2002, the total funding had increased to \$1.55 million, again mostly from Hatch (\$1.08 million) and Evans-Allen (\$0.10 million).

The following table shows the distribution of the 2002 funding by CRIS Subject of Investigation (i.e., Animal Commodity) and primary funding sources. Note that the distribution of Evans-Allen funds indicates that research is being conducted on issues of importance to the audiences of 1890 land-grant institutions. This illustrates the relevance of formula-base funding as a means of responding to stakeholder needs.

2002 Commodity	Funding Source		TOTAL
	Hatch (000)	Evans-Allen (000)	
Poultry	221	26	272
Beef	224	0	257
Dairy	217	0	231
Swine	254	0	260
Sheep/Wool	49	14	203
Aquatic Animals	24	0	185
Other (chiefly goats)	86	58	145
TOTAL	1075	98	1553

The CSREES portion of the total funding received by universities from all funding sources (i.e., CSREES, State Appropriations, Other Federal agencies, and Private sources including industry, foundations and endowments) was computed. The CSREES portion of the total increased from 12.4% in 1998 to 15.2% in 2002.

There were very modest increases in funding between 1998 and 2002. The majority of the research is funded through Hatch and Evans-Allen formula funds. A fairly equal distribution among poultry, beef, dairy and swine and lesser funding allocated to sheep/wool and aquatic animals.

New Directions/Emphasis

During the past two decades, there was less emphasis on live animal and carcass composition and more emphasis on studies of cellular and molecular mechanisms that influence product quality. Research efforts are increasingly being focused on diet and health issues and public concerns about emerging pathogens. Researchers continue to draw upon numerous fields of science including biochemistry, physiology, endocrinology, microbiology, neurology, biophysics, and histology.

Changes in program emphasis over the past decades have influenced the type and magnitude of animal product research. The overall level of funding for research on the quality of animal product quality has remained virtually unchanged. However, there has been increased emphasis on the food safety aspects of the research which is not reflected in the data for this RPA.

Accomplishments

The research represented in this portfolio has recently emphasized improvements in product quality, addressed diet/health issues, reduced animal product wastes, and increased the efficiency of producing high quality animal products. The amount of fat in animal products has decreased dramatically over the past two decades, products have increased in acceptance, and positive linkages have been made to diet and health issues and food safety. Research programs related to food safety, food science, animal health, growth and development, and value-added products also link to and complement efforts related to improving animal products. Below are examples of accomplishments for:

Improved Tenderness

- Advances to understand the hydrodynamic pressure process (HDP) and its application to reduce variability in tenderness and improve consumer acceptance of meat have been made. Research indicates that HDP can reduce aging time of retail beef for enhanced tenderness and thereby reduce energy requirements for the meat industry.
- Fundamental research on the role of genetic variations in calpastatin in meat tenderness has resulted in definition of previously unidentified alleles in calpastatin that are associated with pork quality traits, including tenderness.

Consumer acceptance/value added products

- Studies were conducted to develop and evaluate measurement techniques for rapid, objective, evaluation of wool, mohair, and other animal fibers; and, to use objective measurements to increase fiber production, quality and income to producers through improved selection, nutrition, management, and marketing efficiency. The research resulted in improved acceptance of the Optical Fiber Diameter Analyzer and Laserscan instruments for objectives measures of wool and other fibers. The instruments provided an important contribution to international tests for measuring medullation in wool and

mohair and a new method for objectively predicting cashmere style was obtained by an automatic image analysis technique. Studies also provided objective measurements fibers for scientists conducting selection, nutrition, management, and marketing experiments with sheep, Angora and Cashmere goats. The Laserscan can now be used in commercial testing applications because there is an ASTM standard in place. The cost of testing core samples and individual animals has decreased as well as the time taken to measure the samples and report the results which are of great benefit to the U.S. producer.

- Mutton can be sold fresh in retail markets using a branded product program. Programs that remove intensive labor operations from the supermarket have been well received. The harvesting plant is able to add 40 dollars to 60 dollars value to each lamb. The program put a premium on lean, meaty carcasses which was reflected in the sales volume. Color of fat and lean can be measured much more accurately using image analysis indicating that objective digital measurements can replace a subjective evaluator.
- The quality of pork related eating and processing attributes is becoming more and more important in the pork industry, especially since major quality variation exists in the U.S. pork supply. Over the past five years a project has identified several factors that influence the eating and processing quality of fresh pork. Results from these studies include that ultimate pH of the muscle is critical to the color, water-holding capacity and sensory profile. Adherence to strict quality guidelines will help promote pork quality in the global marketplace.
- The extent to which genetics influence broiler breast composition and quality was studied using outbred by inbred advanced intercross lines of chickens. Searches for genes affecting poultry meat quality traits are underway to provide information to add value to poultry in the production, processing, and retail segments of the industry.
- Feeding supranutritional levels of Vitamin E to market animals during the finishing period may not only prevent premature off-color development in fresh beef and poultry, but may also provide some protection from oxidative conditions. In addition, it has also been shown that these high levels of Vitamin E may aid in increasing the rate of muscle protein proteolysis in beef during the early postmortem aging period.

Decreased fat

- Research is dedicated to understanding regulation and mechanisms for control of adipose tissue (fat) deposition in meat animals. Adipose tissue is necessary for survival of animals because it supplies and stores energy and it is an endocrine organ. Excess fat is costly to produce and is an unwanted product for the consumer of lean meat. Growth of animals is being modified to decrease fat production by genetic selection, or by nutritional or pharmacological means.
- Mechanisms controlling adipocyte hyperplasia, differentiation, and growth (hypertrophy), and effects of somatotropin and beta-adrenergic agonists have been emphasized.
- Producers are using ultrasound techniques to predict marbling and carcasses yield in cattle and swine breeding stock. These tools will improve the profitability of the beef

industry by generating progeny that have leaner, higher quality carcasses.

Diet and health issues/food safety

- Research shows that feeding conjugated dienes, as either the free acids or amide, to lactating dairy cows increases the concentration of trans fatty acids (both trans monoenes and dienes) in milk more than feeding an equal quantity of soybean oil. Research regarding enhancement of conjugated linoleic acid (CLA) in milk will provide producers with information needed for efficient and effective production of this value-added product. Production of enhanced CLA milk will increase profits for dairy producers and has many potential health benefits to consumers related to heart disease, obesity and cancer.
- The a "Good Rendering Process (GRP)" is being developed that uses PWD-1 keratinase to decompose infectious prion protein and consequently renders animal products bovine spongiform encephalopathy(BSE)-free.
- Studies established that cows with mycoplasma mastitis (a respiratory ailment) do not always shed the pathogen in milk at "high" levels. A survey showed that approximately one third of the episodes would go undetected in an average WA state herd with one cow with mycoplasma mastitis. Moreover, the research demonstrates that freezing milk samples for detection of mycoplasma organisms is deleterious and can result in a reduction in detection efficiency.

Table 1

Representative Research Projects on Animal Products that include Classification to PA 308

Percent PA 308*	Project Title
25	Development of an enzymatic rendering process for prion-free animal products
100	Modifying milk fat composition for improved manufacturing qualities and consumer acceptability
10	Rural economic transition assistance – Hawaii
10	Genetic improvement in pork production systems and understanding genotype by environment interaction
20	Concurrent production of high value fibers and meat using lambs and kids
30	Body composition control in the chicken using anti-adipocyte monoclonal antibodies
50	Mastitis resistance to enhance dairy food safety
15	Improving turkey production performance through nutrition and management
100	Consumer evaluation of beef classified for tenderness
100	Management practices which influence morbidity, feedlot performance, and carcass characteristics of Montana beef calves
50	Ontogenic development of adipose tissue
50	Molecular mechanisms regulating skeletal muscle growth and differentiation
25	Enhancing the competitiveness of U. S. Meats
50	Functional behavior of goat milk containing low and high synthesis rate of casein variants
50	Purification of a skeletal muscle protease which degrades myosin
55	Objective measurement of wool fiber characteristics
50	Economic optimization of wean-to-finish production and the quality of Illinois pork
100	Postmortem change in the calpain system and their relation to tenderness

* The remainder of the project is classified to one or more other PAs.