

NIFA/CSREES Portfolio Review Panel Report

Animal Systems Portfolio (2005-2009)

Portfolio Review Conducted: November 3-5, 2009

Portfolio Overview:

The Animal Systems Portfolio is a comprehensive portfolio encompassing animal production and protection, addressing critical needs of animal agriculture through research, teaching and extension programs. Animal agriculture is inclusive of all species providing food, fiber, and companionship as well as all production systems that lead to a safe, secure, and wholesome food supply. The activities associated with the Animal Systems Portfolio fit into the Institute's mission areas of the past (CSREES) and is posed to contribute to the needs of the future (NIFA).

The Mission Statement for the Animal Systems team is:

Within CSREES, the Animal Systems team promotes animal production and protection systems that are efficient, economically competitive, environmental sound, and socially acceptable through research, education, and extension programs.

The Vision Statement for the Animal Systems team is:

The Animal Systems vision is to be the respected national entity that advances high-quality, innovative, and relevant agricultural animal research, extension, and education programs through partnerships with public and private organizations and agency counterparts.

The Animal Systems Portfolio was relevant to two CSREES Strategic Plan Objectives:

- 2.2 *Provide research, education, and extension in increase the efficiency of agricultural production and marketing systems*
- 4.2 *Develop and deliver research, education, and extension to reduce the number and severity of agricultural pest and disease outbreaks*

The Animal Systems Portfolio addressed the following Knowledge Areas (KAs):

- 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)*
- 309 *Animal Diseases*

- 312 *External Parasites and Pests of Animals*
- 313 *Internal Parasites in Animals*
- 314 *Toxic Chemicals, Poisonous Plants and Naturally Occurring Toxins and Other Hazards Affecting Animals*
- 315 *Animal Welfare, Well Being, and Protection*
- 721 *Insects and other Pests Affecting Humans*
- 722 *Zoonotic Diseases and Parasites Affecting Humans*

Panel Review – Overview and Process:

The Review Panel discussed many aspects of the relevancy of the Animal Systems Portfolio within the Agency in general, and in the execution of the programs associated with the portfolio more specifically. The Review Panel studied the documentation provided prior to the site review, assimilated the information and data provided by the presentations and discussions with the leaders and NPLs associated with the Portfolio, and reviewed the reporting requirements presented by the Agency's Office of Planning and Accountability. The Review Panel came to the conclusion that the review report needs to go beyond the required sections of Relevance, Quality and Performance. Consequently, this review report includes an Introductory Section and an Overarching Issues Section that the Panel hopes is helpful at this point in time as the Agency implements the 2008 Farm Bill.

Introduction:

The Animal Systems Portfolio is extremely broad, representing a huge portion of agriculture in the United States and the world, and encompasses production, protection, and the positioning of animal production in human society. There are, on the average, 2772 projects per year involving the Animal System team at CSREES/NIFA, and the Animal Systems Portfolio includes multi-faceted programs such as NAHLN (National Animal Health Laboratory Network) and EDEN (Extension Disaster Education Network) as well as programming involving other portfolios such as higher education and food safety, processing, storage, and marketing. Although the Animal Systems Portfolio was classified into 15 KAs, there was recognition by the Animal System team that further classification was required to identify themes of work because many of the programs and activities transect the KA reporting structure. The seven themes or relevancy identified were: 1) Animal Disease, 2) Genetics and Physiology; 3) Reproduction; 4) Nutrition; 5) Production Systems; 6) Animal Welfare; and 7) Disaster Preparedness and Prevention. The Review Panel agrees that the KA structure seems to be limiting in describing the broad scope of animal agriculture. The seven themes approach appeared to ease the presentation of the portfolio, but still does not adequately represent animal production and protection with all the ramifications of a systems portfolio that contributes so much to humankind. More thought must be given to the programmatic structure within the Animal Systems area so that adequate planning and reporting can be accomplished.

The individuals serving the Animal Systems Portfolio are dedicated professionals who are working tirelessly in their roles. It is noted that the Animal Systems area is allotted 13 NPLs, 4 Program Specialists and 3 Program Assistants; whereas current staffing is 9.5 NPLs, 3 Program

Specialists and 1 Program Assistants. This is 6.5 individuals less than the allotted level. The lower than optimal staffing pattern is impacting the effectiveness of the Animal Systems team and Agency programming in the area broadly referred to as animal agriculture.

We recognize that the Animal Systems team has a Mission statement and a Vision statement, and that the portfolio is linked to the former CSREES Strategic Plan and several of the USDA Goals. We further recognize the importance of this alignment in the execution of the Animal Systems Portfolio. The Review Panel had concern however, that since a large portion of the country's agriculture capacity and wealth is related to animal agriculture, there needs to be a greater voice in the current discussion in the development of programs that will be part of NIFA so that the legislative responsibilities of the Animal Systems team are reflected in whatever plans and goals may be developed in the future. The Panel felt that the NPLs affiliated with the Animal Systems Portfolio need to be more proactive in making their voice heard relative to the importance of animal production and protection and of animal food safety within the Agency. The investment in animal agriculture is not commensurate with the tremendous assets or economic value of this industry to the U.S. and global markets.

In the charge to the Review Panel, Dr. Meryl Broussard, Deputy Administrator, asked us to consider the following themes/questions:

- How can the Animal Systems team better integrate research and education/extension?
- How can the Animal Systems team balance all that they have to do within their constraints of personnel and resources?
- How can the Animal Systems team better measure their impacts?
- How can the Animal Systems team think in bigger terms?
- How can the Animal Systems team develop a portfolio that is more strategic?

The Review Panel considered these as important questions and responses are addressed in the review and as part of the Overarching Issues Section.

The Review Panel felt that the NPLs were doing the very best with what they have. They are great managers of the resources entrusted to them and they are great facilitators, bringing people together to leverage information and resources to the best of their abilities. We also believe that the NPLs need to be more proactive in articulating the importance of animals in our society, in human health and in the global setting. Messages are needed that resonate with taxpayers and with the leadership in NIFA, REE and USDA. The messages must state, unequivocally, that animal products and relationships are critical to human health and well being. This point will be addressed in more detail in the Performance Section of the report.

The Review Panel was greatly concerned about the source of the next generation of leaders of animal agriculture. There was a general feeling that the Animal Systems NPLs need to be more involved and be more proactive in developing the animal scientists of tomorrow.

The Review Panel wants to confirm that it is imperative that the very best science is funded by CSREES/NIFA. The very best science means that the bar is set high, that we reach out to

colleagues in areas of science, engineering, and math that traditionally have not been part of our review teams, and that we demand fundamental research and discoveries from those receiving funds. The ingenuity and innovation of grants awarded to principal investigators much remain central to the goals of NIFA. We applaud the notion of funding projects at the level needed to fund modern science. We look to the NPLs to provide the leadership to continue to elevate the science in NIFA, and in particular the science as it pertains to animal agriculture and providing a safe and wholesome food supply.

Overall Rating of the Animal Systems Portfolio: 85

Relevance of the Animal Systems Portfolio:

1.1 Scope

The coverage provided with the resources available is beyond what would be expected. The scope is good, but this may be to the detriment of the Animal Systems Portfolio because the areas to be covered are so important, but also much too broad. The detriment arises from the lack of sufficient resources (both in funding and manpower) to adequately address the mission of the Animal Systems Portfolio while also meeting expectations of agriculture in addressing emerging societal issues (see under focus) and addressing the critical shortage of scientists in animal protection, health, and production.

Recommendations:

- Seek ways to enhance the education/training of the next generation of scientists
- Work with others to identify ways to capture educational data

Review Panel Score = 3

1.2 Focus

The Animal Systems Portfolio has done a reasonable job of addressing issues that they deem to be the most important, and that stakeholders have expressed as priorities, given their limited resources. However, the panel felt that the process for setting priorities does not appear to be well structured, and that determining who the key stakeholders are should be addressed. The result appears to be a tendency to try to be all things to all people, and to be reactive rather than proactive. An important constituency in helping define the research agenda is university scientists who will partner in fulfilling the mission of the portfolio. Examples of areas that are lacking sufficient funding and attention currently (either funding of research or training of the workforce for these areas) include the:

- impact of animals on the environment (waste management, impact on water quality, methane production, etc.),

- antimicrobial use and resistance, alternatives to antimicrobials, and impact on human and animal health,
- impact of varied production systems on food safety and animal well-being,
- societal issues surrounding animal welfare, and
- biofuels and other uses for animal waste and byproducts.

Recommendations:

- Establish priorities to address major issues
- Strategically direct resources toward priority areas
- Involve broader representation of stakeholders in listening sessions

Review Panel Score = 2

1.3 Contemporary and/or Emerging Issues

NIFA Animals Systems is applauded for addressing contemporary issues such as agrosecurity and surveillance, for continuing to address the issue of residues from animal products through support of FARAD, and for helping to address the critical workforce shortage in animal health through the veterinary loan repayment program. The National Animal Health Laboratory Network (NAHLN), National Plant Diagnostic Network (NPDN), and the Extension Disaster Education Network (EDEN) have been very successful. However, these programs also tax a very under-resourced agency and compromises their ability to address other high priority contemporary issues. In particular, as noted above, the panel noted examples of environmental issues, antimicrobial use and resistance, animal welfare, and biofuel production from animal wastes and byproducts that do not seem to be adequately addressed in the Animal Systems Portfolio. In addition, the critical issue of almost non-existent support for doctoral and postdoctoral level training in the Animal Systems Portfolio needs to be addressed, and would be a very appropriate addition to the portfolio.

Recommendations:

- NPLs must stay current with the issues of animal agriculture
- Identify and prioritize emerging issues related to animal agriculture
- Direct discretionary funding to major issues of animal agriculture and emerging areas

Review Panel Score = 2

1.4 Solicitation and/or receptiveness for stakeholder input

NIFA Animal Systems has sought broad stakeholder input. However, there appears to be insufficient recognition of the ultimate stakeholder – the public – through addressing major societal concerns and, importantly, communicating successes to the public in a manner that they can relate to. The latter might be best accomplished through public relations professionals and partners such as Research America. The panel suggests that

NIFA prioritize stakeholders and stakeholder input to include, most importantly, the broad scientific community. This should include key scientists from other research agencies within federal government (HHS, NSF, EPA, DOD, DHS, etc.), universities, industry, and recognized highly successful scientists from a broad array of disciplines to establish a strategic research agenda. In doing so, NIFA should follow a structured and well defined priority setting process through, for example, standing committees of scientists that represent the broad community of science and who take into consideration perspectives from all stakeholders.

Recommendations:

- Reprioritize stakeholder groups, seeking broad representation including human health scientists
- Professional development for NPLs should include attending scientific meetings not normally attended by animal scientists
- Participate in environmental scanning, trend analyses, scenario planning, and situation awareness opportunities and programs

Review Panel Score = 2

1.5 Utilization of stakeholder input

The Animal Systems team has done a good job of responding to stakeholder concerns given their limited funding and manpower. They have been flexible and creative in doing so. Therefore, a major influx of funding is necessary to continue their responsiveness to stakeholders while enabling them to address major scientific challenges posed by critical societal issues such as food production, security and safety; climate change; biorenewable energy and the environment; nutrition and obesity; and the global need for food from animal sources.

Recommendations:

- Develop a strategy to transmit and translate animal agriculture science/information to the public and other governmental agencies

Review Panel Score = 3

Quality of the Animal Systems Portfolio:

The Review Panel felt that the quality of the portfolio is good given the resources, but the funding available is inadequate to address the important needs of animal agriculture.

2.1 Significance of results

Strengths:

- Some of the portfolio results are significant and have value to the mission of the agency.

- Animal welfare is an example of an important program that needs to be enhanced.

Weaknesses:

- The way the agency measures, quantifies, and markets project impacts is not equating to increased support and funding
- The portfolio is too broad, given limited resources, to make a marketable, significant impact to decision-makers
- Activities do not necessarily address the pressing issues of global animal agriculture. For example, the health and well-being of humans, animals, and the environment.

Recommendations:

- Implement a mechanism to measure and quantify impact in ways that resonate with the public in such a way as to create increased public support and funding. Additional stakeholder input will be needed to identify appropriate outputs.
- Limit the portfolio to an established set of priorities that address the largest number of stakeholders possible –it is not possible to be everything to everybody. It is necessary to prioritize activities that address pressing issues of global animal agriculture e.g. the health and well-being of humans, animals and the environment. This includes the costs and benefits of producing animals and animal products based on these outcomes.

Review Panel Score = 2

2.2 Usefulness and utilization of results

Strengths:

- Much has been done with few resources.
- The targeted funding to EDEN to deliver the regional animal agrosecurity conferences and S-CAP project are examples of successful national extension education
- Animal genome research is a success story representing leveraging of resources with NIH.

Weaknesses:

- The challenge is to improve quality, rather than emphasize quantity of activities.
- Basic research is important and there are notable achievements; however it is difficult to evaluate its usefulness or utility in the short term

Recommendations:

- Communicate Portfolio results in a fashion that the public recognizes as useful
- Appropriate funds for quality research experiences for students.....small grants or add-ons do not allow for this

Review Panel Score = 3

2.3 Integration

Strengths:

- It is evident that integration in competitive funding has received a lot of emphasis in the last five years

Weaknesses:

- Level of funding for integrated projects needs to be greater to accommodate increased collaboration, numbers of investigators, and the degree of accomplishments

Recommendations:

- Integrated projects need increased funding over a longer duration to encourage quality outcomes

Review Panel Score = 3

2.4 Interdisciplinary balance

Strengths:

- There is considerable evidence that there is much more interdisciplinary balance in this review period than previously
- Partnerships must be a priority in order to extend beyond NIFA to capitalize on leveraging resources with other agencies that include NSF, NIH, etc.

Weaknesses:

- The duration and size of the grants inhibit quality partnerships

Recommendations:

- Define direct, measurable outcomes of interdisciplinary research and prioritize funding for projects that meet these outcomes
- Provide more funds over longer duration

Review Panel Score = 3

2.5 Alignment of current state of knowledge and science and use of appropriate and/or cutting edge methodology

Strengths:

- Formula funds have done a better job of addressing State priorities than competitive grants in many cases
- Best results have been from areas where larger amounts of competitive funding have been directed

Weaknesses:

- Because of limited funding the competitive grants program of the Animal Systems Portfolio has not been attractive to qualified scientists, forcing them to turn to NSF, NIH, and other funding sources
- NIFA may lose credit for accomplishments because other funding partners contribute larger sums

Recommendations

- Increase funding for the Animal Systems Portfolio
- Maintain an appropriate mix of formula and competitive funds for the Animal Systems Portfolio. Expansion of resources should be in competitive funds needed for discovery research.
- Increase the amount of funding for each research grant
- Recruit widely for the most highly qualified people from research, extension, and teaching from educational institutions and industry to serve on all review panels
- Seek the best scientists to serve on review panels
- Expand the range of disciplinary meetings that NPL's attend to enhance their opportunities for appreciating the best discovery research, as well as developing opportunities for education, partnerships, and leveraging funding

Review Panel Score = 2

Performance of the Animal Systems Portfolio:

The breadth of the Animal Systems Portfolio and the accomplishments of the scientists, educators, and NPLs have achieved is impressive given the limited resources and governmental constraints. We applaud the efforts of the NPLs to improve communication and management of the portfolio. They have assumed the role of being the clearinghouse for animal agriculture information. The new structure of NIFA provides the opportunity for the NPLs to evolve from managers to leaders. They are in the unique position to help position animal production and protection as a centerpiece for the new agency and the New Biology of the 21st century. Currently, the New Biology of the 21st century document that Dr. Beachy referred to is limited only to food plants. Members of the Animal Portfolio team, as leaders for the animal agriculture portfolio at USDA, need to change that perception to include Animal Agriculture. Animal Agriculture is a model for the new biology as it already integrates aspects of physical and social sciences as described in the paper for production of food and fiber, but also for research that impacts animal agriculture and the biomedical community.

3.1 Productivity

Strengths:

- The scientists involved in the portfolio are highly productive.
- They leverage the small amount of funding into substantial results.
- They multiply their dollars at approximately a 5:1 ratio, which demonstrates the commitment of the people involved in animal agricultural research, extension, and education.

Weaknesses:

- Insufficient resources to do what is needed
- The tracked outcomes and outputs are not necessarily the information that is needed to evaluate productivity or education the public

Recommendations:

- Develop direct, measurable outcomes of research in the animal sciences
- Develop productivity tracking methodology
- Allocate a portion of the funding toward evaluation and assessment

Review Panel Score = 3

3.2 Comprehensiveness of Work Produced

Strengths:

- The scientists have produced significant results beyond what is expected given the available resources

Weaknesses:

- Missing critical areas –e.g. environmental area and parasitology
- Overemphasis of some less critical areas
- Have not developed a forward looking strategic approach to managing the portfolio – it is somewhat reactive rather than proactive
- Not enough resources to cover all areas of critical need

Recommendations:

- Develop a forward looking strategic plan to identify most critical areas and emerging issues
- Support priorities that improve the impact of animal agriculture on human health and well-being

- Animal agriculture fits well within the pillars of the new NIFA, food production, bioenergy, food safety, climate change, and youth and community and development. Tie the strategic plan of the Animal Systems Portfolio to the institutes being developed by NIFA
- Strategic plan needs to include specific recommendations to develop the next generation of scientists and practitioners

Suggestions: These are examples:

- Use research on alternative agriculture including comparative production systems research to engage the public in emerging issues
- Think about new opportunities to educate the public about the positive impact of animals on food and well-being
- In addition, to the benefit of the environment, the animal agriculture industry recycles waste and by-products representing opportunities in strategic planning
- Consider expanding the animal welfare portion of portfolio
- Consider tools and germ plasm pools for the future
- Prioritize bioinformatics as essential to the portfolio
- Incorporate globalization of animal agriculture into the portfolio

Panel Review Score = 3

3.3 Accountability

Strengths:

- This particular measure is difficult to assess in this portfolio.
- People spend a lot of time writing reports and the agency spends a lot of time reading reports but the impact is not well documented.

Weakness:

- The accountability does not address how well funding is being utilized.
- The agency cannot fully utilize the information it gets
- The agency, as a whole, is not collecting the correct information. (Note: NRI is doing a better job at this, but Hatch reporting is not.)

Recommendation and Suggestions:

- Assessments of impacts need to be addressed in a variety of equally important ways.
Suggestions include:

- Publications, technical bulletins, science citation impacts, patents.
- Document utilization by end user
- Students trained/educated
- Collect more appropriate data and develop benchmarks related to the data collected e.g. number of graduate students completing their PhD by (insert date), and number of students engaged in undergraduate research.
- Develop appropriate assessment measures as recommended in the previous review.
- Develop an agency-wide reporting process that is efficient and effective, that measures meaningful outputs, and that can be used to quantitatively determine impacts.

Review Panel Score = 3

3.4 Program Leadership, Partnership and Guidance

Strengths:

- They have done an excellent job of developing partnerships and linkages.
- They have done a good job of weaving into the report a wide range of activities and outcomes from their involvement in partnerships, some of which they have had only a minor role.

Weaknesses:

- We see the approach as being “let it happen rather than make it happen”
- We recognize that there are agency constraints and directives and that certain resources are in support of specific programs; however, this was perceived by the Review Panel as an excuse for not being more proactive

Recommendations (As previously stated):

- Develop a forward looking strategic plan to identify most critical areas and emerging issues related to animal agriculture
- Support priorities that improve the impact of animal agriculture on human health and well-being
- Animal agriculture is an essential component within the pillars of the new NIFA, food production, bioenergy, food safety, climate change and youth and community and development. The strategic plan of the Animal Systems Portfolio must be tied to the institutes being developed by NIFA
- Strategic plan needs to include specific recommendations to develop the next generation of scientists and practitioners

Recommendations (In addition):

- Seek ways to advocate for the Animal Systems Portfolio and the importance of animal agriculture
- Develop new partnerships with medical organizations and others that have resources and influence to bring to the table.
- With the new institutes, there will have to be a paradigm shift towards federal leadership for funding for animal agriculture or it will disappear and food supply and security will become as big an issue as energy supply and security.
- The agency needs to take a greater leadership role in exchanging information relative to global animal production and protection.

Suggestion

- When the presidential administration and priorities of the land-grant institutions are in conflict, the Institute must assume leadership

Review Panel Score = 1

3.5 Program Management

Strengths:

- The portfolio is managed extremely well and there has been a lot of progress over the last 5 years
- It is impressive what has been accomplished with a very limited budget
- The team has evolved from individual managers to team managers who look for and develop partnerships
- Managers are very busy

Weaknesses:

- Managers are very busy and without time to be leaders
- The mechanism to achieve our ultimate goal as defined by the animal production and protection portfolios has shown no improvement, in part, because of a lack of appropriate funding.

Recommendations:

- The NPLs must assume leadership roles and position the portfolio to be successful in the new institutional structure.

Review Panel Score = 3

Overarching Issues:

The National Institute of Food and Agriculture (NIFA) has been launched during a time of some of the most profound societal changes and challenges since the creation of the Agency.

Retrospectively, the Agency has performed well as reflected in the most recent scorecard of the Animal Systems Portfolio. The Review Panel wishes to compliment the achievements noted in the scorecard and the hard work of the Agency on behalf of U.S. agriculture and the American public. However, the Panel envisions necessary transformational changes based on new opportunities and new demands of society. These include:

- Reframing the mission of NIFA in terms of the importance of animals and animal products that help improve human health and quality of life;
- Moving from a focus of primarily plants to embrace animal agriculture to understand how animal systems positively impact:
 - human health
 - animal health
 - animal well-being
 - economic growth and community and rural development
 - environmental health and sustainability
 - disaster preparedness and response
- Building a cadre of excellent scientists for the future for animal health and animal agriculture.
- Embracing globalization issues of animal agriculture (food importation, food safety, and food security) with respect to mitigating against hunger and avoiding malnutrition
- Recognizing economic strongholds animal agriculture must maintain its economic relevancy and strength in the U.S. economy.
- Assuming responsibilities to support discovery and integration of new knowledge that reframes the mission and provides solutions within a new societal context to the five new priorities of the Institute:
 - Global Food Security and Hunger (increasing animal protein by 50% by 2020; ref FAO)
 - Climate Change (reducing carbon footprint through efficient animal production, e.g., “EnviroPig”)
 - Sustainable Energy (nutrient management for sustainable energy)
 - Childhood Obesity and Nutrition (promote and develop more healthful animal products and public education)
 - Food Safety (reduction of microbial contaminants from farm to fork)

The Panel was extremely disappointed that the prepublication on “A New Biology for the 21st Century” failed to recognize the significant importance of and contributions of animal agriculture to our global society.

Animal Agriculture has always been “The New Biology” and never a single discipline. Rather, it draws from many disciplines from biological to physical to mathematical sciences. Again, the mission of NIFA in terms of the importance of animals and animal products as they pertain to human health, well being and quality of life, globally is not addressed in the “New Biology.”

It is obvious to the Panel that the efforts of this Agency are underappreciated and poorly communicated to the public. Thus, a new public engagement strategy is essential for the future success of NIFA. The Institute needs to be more contemporary and more responsive to these profound societal changes. This will require exceptional science and research education and extension, strong leadership, and a new recognition of the importance of animal agriculture. In order to meet these challenges, the Agency must develop strategic collaborations with other agencies responsible for public health, animal health, environmental health, and global food security and safety. All of these issues presented will require a very bold strategy and the political will both within and outside the agency. The creation of NIFA presents the Agency with a remarkable opportunity to re-imagine and re-think itself, challenging the status quo, creating a national plan for the future of Animal Agriculture, and influencing events in animal and human health for decades to come. This panel encourages the agency that has done so much in the past to develop the vision and leadership for the future to make this goal a reality; we believe that the agency has the capacity to meet this profound and critical challenge.

Appendix A – Members of the Animal Systems Portfolio Review Team

Dr. Fuller W. Bazer, Distinguished Professor & O. D. Butler Chair, Texas A&M University

Dr. John Brake, William Neal Reynolds Distinguished Professor of Poultry Science, North Carolina State University

Dr. Billy Dictson, Director, Office of Biosecurity, New Mexico State University

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Dr. Janet Fulton, Molecular Geneticist, Hy-Line International, Dallas Center, IA

Dr. Dahlia Jackson-O'Brien, Small Ruminant Specialist, College of Agriculture and Related Sciences, Delaware State University

Dr. Lonnie King, Dean, College of Veterinary Medicine, The Ohio State University

Dr. Terry McElwain, Professor, College of Veterinary Medicine, Washington State University

Dr. Terry Nett, Professor and Associate Dean for Research & Graduate Education, College of Veterinary Medicine, Colorado State University

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