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Critical Role of Animal Science Research in Food Security and Sustainability

Animal Task Force

Brussels, Belgium

November 16–17, 2015

Science and Technology for
Sustainability Program

Board on Agriculture and Natural
Resources

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Advisers to the Nation on Science, Engineering, and Medicine

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Please note that this presentation by Dr Goldstein includes his own distillation of a very large and complex document and does not formally represent the opinions of the US National Academies of Science

- To advance science and technology
- To advise government and the nation
 - On policy for advancing science, engineering and medicine
 - On applications of science, engineering, and medicine to policy issues

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— 1862 Act of Incorporation, signed by Abraham Lincoln

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One of the first National Academy of Sciences reports was commissioned to improve the performance of compasses on sea ships.

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Methods of Operation

- **Consensus studies**
 - Balance and composition of committees
 - Report review
- **Convening activities**
 - Workshops
 - Roundtables
- **Operational programs**
 - Fellowships and associateships
 - Research and surveys
 - Education and training
 - Data banks

Committee on Considerations for Future of Animal Science Research

- **Bernard D. Goldstein (Chair) (IOM)**, Professor Emeritus, Department of Environmental and Occupational Health, University of Pittsburgh Graduate School of Public Health
- **Louis D'Abramo**, William L. Giles Distinguished Professor of Wildlife, Fisheries and Aquaculture, Mississippi State University
- **Gary F. Hartnell**, Senior Fellow, Chemistry Technology, Monsanto Company
- **Joy Mench**, Professor of Animal Science and Director of the Center for Animal Welfare, University of California, Davis
- **Sara Place**, Assistant Professor of Sustainable Beef Cattle Systems, Oklahoma State University
- **Mo Salman**, Professor of Veterinary Epidemiology, Colorado State University and Jefferson Science Fellow, U.S. Department of State
- **Dennis Treacy**, Executive Vice President and Chief Sustainability Officer, Smithfield Foods, Inc.
- **B. L. Turner II (NAS)**, Gilbert F. White Professor of Environment and Society, Arizona State University
- **Gary W. Williams**, Professor of Agricultural Economics and Co-Director, Agribusiness, Food, and Consumer Economics Research Center, Texas A&M University
- **Felicia Wu**, John A. Hannah Distinguished Professor of Food Science and Human Nutrition and Agricultural, Food and Resource Economics, Michigan State University

Study Process (Fast Track)

- Meeting 1: Open, data-gathering session held March 10–11, 2014, in Washington, DC
- Meeting 2: Open, data-gathering session held May 13–14, 2014, in Washington, DC
- Meeting 3: Closed, writing session held July 7–10, 2014, in Washington, DC
- Meeting 4: Closed, writing session held September 8–9, 2014, in Washington, DC
- Report Released: January 7, 2015

Revitalizing animal agricultural research is essential to sustainably address the global challenge of food security.

The Only Two Certain
Predictions for Animal
Agricultural Research

- 1) Between now and 2050 there will be a major crisis in animal agriculture that none of us now foresee
- 2) Between now and 2050 there will be a major advance in biological sciences that could significantly impact on animal agriculture, and that none of us now foresee

For these two reasons alone, a vibrant and responsive animal agricultural research enterprise is a necessity

Sustainability as a process

Statement of Task (1)

An *ad hoc* committee will prepare a report that will identify critical areas of R&D, technologies, and resource needs for research in the field of animal agriculture, both nationally and internationally.

Specifically, the report will identify the most important needs for future research in this area, including:

- Assessing global demand for products of animal origin in 2050 within the framework of ensuring global food security;
- Evaluating how climate change and limited natural resources may impact the ability to meet future global demand for animal products in sustainable production systems, including typical conventional, alternative and evolving animal production systems in the U.S. and internationally;

Statement of Task (2)

- Identifying factors that may impact the ability of the U.S. to meet demand for animal products, including the need for trained human capital, product safety and quality, and effective communication and adoption of new knowledge, information and technologies;
- Identifying the needs for human capital development, technology transfer and information systems for emerging and evolving animal production systems in developing countries, including the resources needed to develop and disseminate this knowledge and these technologies; and
- Describing the evolution of sustainable animal production systems relevant to production and production efficiency metrics in the U.S. and in developing countries.

The task charged to the committee was based on three underlying assumptions, supported by the literature, which the committee did not reexamine in depth:

- Global animal protein consumption will continue to increase based on population growth and increased per capita consumption of animal protein.
(UN population estimates continue to rise; EU immigration issues)
- Restricted resources (e. g., water, land, energy, capital) and global environmental change will compel complex agricultural decisions that will impact research needs.
- Rapid advances in basic biological sciences, both current and foreseeable, provide an unparalleled opportunity to maximize the yield from investments in animal science research and development.

Overview of Inputs Affecting Animal

Underlying Assumptions:

1. Global animal protein consumption is increasing.
2. Restricted resources (e.g., water, feed, land, capital, phosphorus) and climate change will drive agricultural issues.
3. Rapid advances in biological sciences provide an opportunity to maximize the yield of investments in the animal science R&D.



^a "Intensifying and increasingly market oriented often transforming smallholder systems

^b Where remoteness, marginal land resources or agro climatic vulnerability restrict intensification

^c Intensified livestock systems with diverse challenges including the environment and human health" (Bertrand 2014).

The committee recognizes that there are public organizations and literature advocating reducing the amount of animal protein in our diets with the rationale that this would improve our health and well-being and reduce the impact of these agricultural systems on the environment.

(Decreasing meat consumption may well have health and sustainability benefits)

The committee does not, however, address these issues, as it was specifically tasked with identifying research needs for animal agriculture in light of the projected global increase in human consumption of animal protein.

(In other words: we didn't consider vegetarianism in detail)

The committee does note as long as animal protein continues to be consumed there is value to R&D that improves the efficiency of its production.

Overarching Recommendations

Holistic Approaches to Animal Productivity and Sustainability

- To achieve food security, research efforts should be improved through funding efforts that instill *integration rather than independence of the individual components of the entire food chain*. Success can only be achieved through strong, overarching, and inter- and trans-disciplinary *research collaborations involving both the public and private sectors*. Animal science research should move toward a *systems approach* which emphasizes efficiency and quality of production to meet food security needs. The recently created Foundation for Food and Agricultural Research (FFAR) provides an opportunity to incorporate *holistic approaches to animal productivity and sustainability* (Chapter 5).
- PROBLEM STATEMENT: THERE IS A RELATIVE LACK OF INTEGRATION OF RESEARCH THAT SYSTEMATICALLY, COLLABORATIVELY AND HOLISTICALLY ADDRESSES ANIMAL PRODUCTIVITY AND SUSTAINABILITY

How does overfishing off the coast of West Africa increase the likelihood of an emerging infectious disease in Brussels?

Bushmeat vs Fish

- Brashares JS, et al. Bushmeat hunting, wildlife declines, and fish supply in West Africa. *Science* 306:1180–1183, 2004
- Rowcliffe JM, et al. Do bushmeat consumers have other fish to fry? *Trends Ecol Evol* 20:274–276, 2005



Overarching Recommendations (*Cont.*)

Economic, environmental and social sustainability research

- Continuing the research emphasis on improving animal productivity is necessary; however, concomitant research on the economic, environmental and social sustainability nexuses of animal production systems should also be enhanced. Both public and private funding agencies should incorporate inter- and trans-disciplinary approaches for research on animal productivity and sustainability
- **PROBLEM STATEMENT: THE FAILURE TO INCLUDE SOCIAL SCIENCE AND ECONOMIC RESEARCH HAS BEEN A SIGNIFICANT IMPEDIMENT TO THE EFFECTIVENESS OF ANIMAL AGRICULTURAL RESEARCH ON PRODUCTIVITY AND SUSTAINABILITY**

Overarching Recommendations (*Cont.*)

Engagement of broader range of disciplines in animal science

- Socioeconomic/cultural research is essential to guide and inform animal scientists and decision makers on appropriately useful and applicable animal science research as well as communication and engagement strategies to deal with these extensive challenges.

Engagement of social scientists and researchers from other relevant disciplines should be a prerequisite as appropriate for integrated animal science research projects, such as NIFA CAP grants, to secure funding and approval of such projects.

- PROBLEM STATEMENT: ANIMAL AGRICULTURAL RESEARCH HAS BEEN TOO INSULAR

Overarching Recommendations (*Cont.*)

Coalition to focus on communications research

- For research in sustainable intensification of animal agriculture to meet the challenge of future animal protein needs, it is necessary to effectively close the existing broad communication gap between the public, researchers and the food industries. This will require research to better understand the knowledge, opinions and values of the public and food system stakeholders, as well as the development of effective and *mutually respectful* communication strategies that foster ongoing stakeholder engagement
- PROBLEM STATEMENT: THERE IS A VERY IMPORTANT COMMUNICATION GAP BETWEEN THE ANIMAL AGRICULTURE SECTOR AND THE PUBLIC, INCLUDING DECISION-MAKERS.
WE NEED TO LEARN TO LISTEN

The Evolution of Risk Communication

- Get the numbers right
- Tell them the numbers
- Explain what we mean by the numbers
- Show them they've accepted similar risks in the past
- Show them it's a good deal for them
- Treat them nice
- Let them participate
- Make them partners

(Revised from Fischhoff, 1995)

Overarching Recommendations (*Cont.*)

Research directed to development of global guidelines, standards and regulations

- The United States should expand its involvement in research that assists in the development of internationally harmonized standards, guidelines and regulations related to both the trade in animal products and protection of the consumers of those products.

Margot Wallström

EU Commissioner for the Environment
25 April 2002; Washington, DC

- “We do not spend our days in Brussels as some might think in Machiavellian plotting to apply precaution to the detriment of US businesses”

Cultural issues underlying opposition to science must be directly addressed

- Anti-scientific views are broadly based and are not limited to any one segment of society or geographical area
 - Climate deniers in the face of the imperatives of global climate change
 - GMO opponents who would automatically ban a potentially useful tool to meet the perhaps doubling of global food needs by 2050
 - Precautionary principle advocates who support the ability of purveyors of herbal remedies to avoid the requirement to demonstrate safety of their products
 - Anti-vaccination advocates who put their own families and the broader community at risk

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U.S. Animal Agriculture Production

*Meeting the Current and Projected
Demand for Animal Protein*

*What are the mechanisms of
revitalization?*

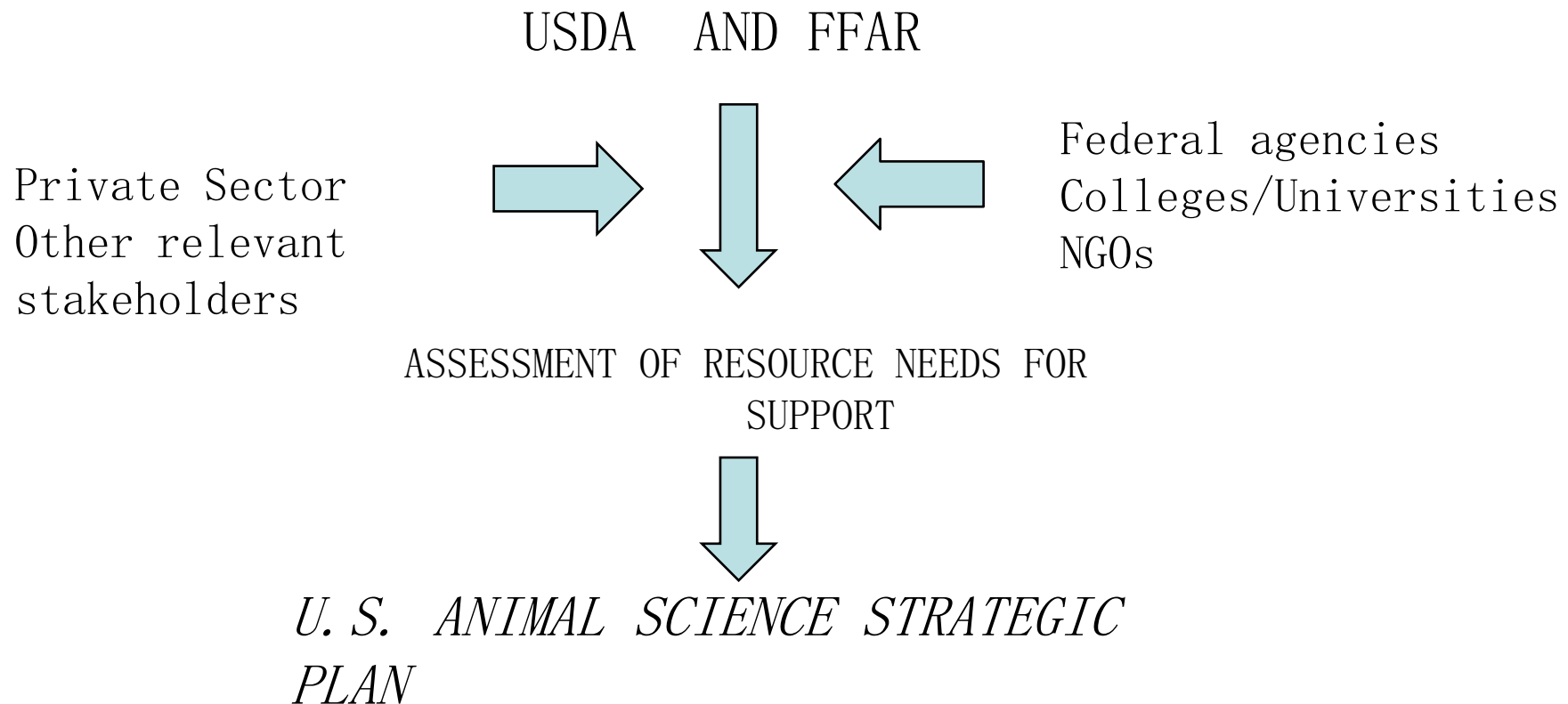
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Revitalizing Research Creating a New Paradigm

- Increasing Efficiency
- A Holistic Mandate
- A Strategic Plan (Resource Needs) with Commensurate Funding
- Synergistic Funding (Public and Private)
- Effective Communication
- Critical Understanding and Appreciation of Socioeconomic Implications

Infrastructure Revitalization



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Components of Revitalization

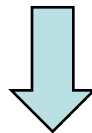
- Assessment of resource needs to support current and emerging animal science research enterprise
- Development of strategies to increase support (research, outreach, instructional needs) and enhance relevancy, i.e., the type of research conducted
 - Mechanisms to Establish Settings of Research Priority (to meet emerging needs at local, regional, and national levels)
 - Formula and Competitive Funding Allocations
 - Public-Private Partnerships
 - Curriculum Development and Delivery
 - Evaluation of Factors Affecting Hiring, Retention and Diversity

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Socioeconomic Research

- Integration of socioeconomic and animal science research with goal of identification of relevant and valued application
To guide animal scientists and decision makers

An important revitalizing step !!



- Integrated animal science research projects must include social scientists (and researchers from other relevant disciplines) as a requirement to secure approval and funding

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U. S. Food Security for
2050

*Funding and Research
Recommendations
to Meet Current and Future Demand
for Animal Protein*

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Research Recommendations (1)

- Funding: Critical Needs and Guiding Factors for Decision Making
- Support for Development and Adoption of Technology
- Understanding and Addressing Societal Concerns about Research
- Feed Ingredients and Dietary Nutrients

Funding

Guiding Factors for Decision Making

Three Criteria of Sustainability

- Reduction of environmental footprint
- Reduction of cost per unit of animal protein produced
- Enhanced recognition of societal factors in defining sustainable animal agriculture production practices

Funding

Critical Needs

- Restore research funding (especially basic research) to at least past real dollars
- Then, maintain that level to meet/exceed annual rate of research inflation
- Funding is particularly critical for agricultural production characteristics that minimize environmental impact
 - consumer demand is projected to increase significantly

Support for Development and Adoption of Technology

- Participation of both public and private sectors
- Adhere to same sustainability criteria as those for research funding to achieve higher production efficiency

Societal Concerns – Informing and Engaging

- Understand and respect societal concerns about research
 - adoption of breeding and genetic technologies
- Determine most effective methods to respectfully engage and communicate with the public; dispel misinformation and disinformation strategically

Research Recommendations (2)

- Alternative Feed Ingredients
- Use of Antibiotics
- Animal Welfare
- Climate Change Impacts

Feed Ingredients and Dietary Nutrients

A systems-based holistic approach

- **Ingredient** preparation and digestion
- **Nutrient** metabolism and utilization and controls
- Effects of nutrients on gene expression
- Ongoing collection of **nutrient requirement** knowledge (basic and applied)

Alternative Feed Ingredients

Guiding Sustainability Criteria

- Inedible to humans
- Reduce cost of production of animal protein
- Improve the environmental footprint

Must include corresponding assessment of changes in protein product on health of animal, consumer, and environment

Use of Antibiotics

- Evaluate alternatives to medically-important sub therapeutic antibiotics to achieve equivalent/greater benefits to animal health (i.e. disease prevention, increased feed efficiency)

Animal Welfare

- Research Focus on current and emerging areas
 - Housing systems
 - Management and production practices
- Establish Research Prioritization Process (FFAR, USDA–AFRI and USDA–ARS)
 - Incorporate relevant stakeholders
 - Identify specific research needs (commodity, system, basic)
 - Identify mechanisms to establish the building capacity to meet such research needs

Climate Change Impacts

- Evaluate potentially effective, geographic-specific adaptive strategies; include assessment of ability to mitigate GHG emissions and pollutants (biogeochemical cycling of C and N)
- Improve ability to quantify GHG emissions to
 - Fill knowledge gaps
 - Improve accuracy of emission inventories
 - Improve and further develop predictive mathematical models

Research Recommendations (3)

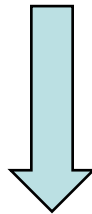
- Integration of Socioeconomics
- Communication Practices

Integration of Socioeconomics

- A source of direction (researchers, administrators, decision makers) to conduct meaningful research and achieve effective technology transfer

Communication Practices

- Improved dissemination of knowledge (animal science research results and application)
- Respect-based stakeholder engagement and participation



Informed decision making

Research Recommendations

- An Active U.S. Role
- Understanding and Overcoming Barriers to Technology Adoption
- Animal Diseases and Zoonoses

An Active U. S. Role

- Stakeholders at the national level should be involved in establishing priorities as guided by prevailing human-environment conditions within developing countries

Understanding and Overcoming Barriers to Technology Adoption

- Areas of focus:
 - Education and communication roles of local extension and advisor personnel
 - Emphasis on training of women (principal role in success of animal agriculture production systems)

Animal Diseases and Zoonoses

To alleviate chronic and extensive animal production losses to disease, adversely affecting producer livelihoods, national and regional economies and human health

- Enhancement of research and education (biosecurity training, disease etiology, diagnosis, and treatment)
- Enhancement of complementary infrastructure

Revitalizing animal agricultural research is essential to sustainably address the global challenge of food security.