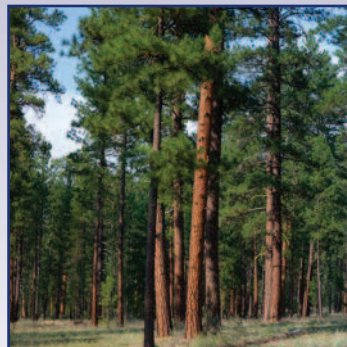


# Agriculture, Food, Nutrition and Natural Resources R&D Round Table

Research Partnerships Yield Greater Societal Returns



## Cover Photographs

**Top center: A Healthy Diet:** A diet rich in soy and whey protein, found in products such as soy milk and low-fat yogurt, has been shown to reduce breast cancer incidence in rats. Photo by Peggy Greb, Agricultural Research Service, USDA.

**Left center: A Major Food Source** – Healthy wheat growing in a field outside Clay Center, Neb. Photo by Stephen Ausmus, Agricultural Research Service, USDA.

**Right center: An Exemplary Line 1 Hereford bull.** Scientists now can supplement established methods of predicting an animal's genetic merit—that is, its own performance and that of its offspring—with DNA and profitability information. Photo by Michael MacNeil, Agricultural Research Service, USDA.

**Bottom left: Healthy Managed Forest** – This ponderosa pine forest is the desired outcome of collaborative restoration efforts in the Northwest and Southwest, led by the U.S. Forest Service and the Oregon Institute for Natural Resources. Photo by Miles Hemstrom, U.S. Forest Service.

**Bottom right: A Well Managed Farm** – The farm is located near Klingerstown, Penn. Photo by Scott Bauer, Agricultural Research Service, USDA.

# Agriculture, Food, Nutrition and Natural Resources R&D Round Table

Research Partnerships Yield Greater Societal Returns

*Washington, D.C.*

*March 15, 2011*

## **Proceedings**

*Organized by the*

**Charles Valentine Riley Memorial Foundation,  
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**United States Department of Agriculture**

Office of the Secretary  
Washington, D.C. 20250

April 19, 2011

Dear Colleague:

Thanks to the hard work of American farmers, the United States continues to be a world leader in agricultural production and technology. However, in order to sustain our leadership position, we will need to continue to support the partnership between agricultural producers and agricultural research by making strategic investments in our Nation's food and agricultural research system.


From sustainable food production to renewable energy and climate change, agriculture and natural resources are at the crossroads of the world's most pressing challenges. In the midst of these critical concerns, our economy is more dependent than ever on the continued success of our agricultural sector. Now is the time to reaffirm our investment in the science of food and agriculture.

Next year, the U.S. Department of Agriculture (USDA) will celebrate two milestones: the 150<sup>th</sup> anniversary of USDA's founding and President Lincoln's signing of the First Morrill Act, which created the historic partnership that formed the basis for the land-grant university system. The land-grant system has revolutionized American education and agriculture, helping to transform the Nation's economy and social fabric along the way. The partnership between USDA and our Nation's land-grant universities has led to innumerable scientific breakthroughs, vastly increased our agricultural productivity, and improved our way of life.

If we are to lay a foundation to out-innovate, out-educate, and out-build our competitors as leaders in agriculture, we must strengthen and build upon the example set forth in the land-grant system.

Collaboration and partnerships are essential to getting the most out of our public investment in research and development. On March 15, 2011, the Riley Memorial Foundation, together with its partners and collaborators, convened the "Agriculture, Food, Nutrition and Natural Resources Research and Development Round Table: Partnerships Yield Greater Societal Returns," at the American Association for the Advancement of Science in Washington, D.C. This roundtable epitomizes the kind of collaboration that brings together the best ideas to maximize our returns on our research investment. This is the kind of leadership that will ensure that our agricultural scientists will produce even greater innovations over the next 150 years.

Sincerely,

  
Thomas J. Vilsack  
Secretary

## Highlights

Amid historic federal deficits and ongoing budget austerity, the ability to leverage maximum benefits from public spending on research and development is crucial. With world food demands expected to double over the next 40 years and increased competition for natural resources, agricultural research and development (R&D) must be utilized to its fullest potential. Research partnerships are an important tool to leverage the relative strengths of multiple contributors—whether federal, state or private—for maximum and often diverse benefits.

The Agriculture, Food, Nutrition and Natural Resources Research and Development Round Table, which convened March 15, 2011, in Washington, D.C., addressed the multiple benefits of R&D collaborations. The program included leaders from eight collaborative projects—selected from 61 projects involving 25 federal agencies—who shared best practices and lessons learned. The collaborative research agendas ranged from mapping and marketing bovine genomics to forestalling aquifer depletion in the High Plains.

Research collaboration saves lives—reducing the incidence of Salmonella in Mexico, where food borne disease is the principal cause of mortality among preschoolers—and enhances food safety where crop grouping research assures the availability of pest control products necessary to provide a safe and abundant food supply. The common refrain among all presenters was the synergy to be gained from coupling diverse institutional strengths and capacities in projects might involve a handful of research collaborators or more than 100.

Keynote speaker Shere Abbott of the President's Office of Science and Technology Policy, reiterated President Obama's position that science and technology are central, not just relevant, to "winning the future." The cross-cutting foundations of strength in science and technology—collaborative R&D—are to be nurtured systematically rather than applied ad hoc to challenges and crises.

USDA Under Secretary for Research, Education, and Economics Catherine Woteki noted that robust agricultural and natural resources R&D enterprises are essential to address the world's most critical problems. Woteki emphasized that at USDA, the federal government's primary food and agriculture R&D agency, there is additional emphasis on taking advantage of expanded partnerships throughout the federal government, as well as with universities, state agencies and the private sector. The value of collaborative

R&D was echoed by Jane Silverthorne of the National Science Foundation (NSF), who cited six key benefits: coordination of activities at all levels, sharing of knowledge/expertise, exposure to diverse perspectives, leveraging scarce resources, building on long-term investments, and developing a shared vision for the future.

In general, the eight research collaborations highlighted at the March 15 round table were predicated on a grand purpose, one that excited principal investigators, attracted diverse funding sources, and benefited a wide breadth of human populations. Some featured projects had multiple purposes. Sequencing the bovine genome, for example, enabled farmers to predict the genetic merits of animals at birth, and greatly enhance the efficiency of milk production. But corollary benefits included the ability to engineer purebred North American bison from rancher-salvaged hybrid herds, and to recapitulate and study the 10,000-year evolution of cattle with genotypes alone. Similarly, the project to measure and lower the incidence of Salmonella in Mexican feedlots principally benefits Mexican consumers, but also facilitates the harmonious trading of meat between the United States and Mexico, which is significant and mutually beneficial.

Another common theme voiced by presenters was the inclusion of diverse institutions or professions in a common endeavor. NSF, for example, partnered with the Bill and Melinda Gates Foundation on a project called BREAD—Basic Research to Enable Agricultural Development. For another project focused on increasing the efficiency of photosynthesis, NSF partnered with a United Kingdom-based biotech council. Another collaborative project, the Ogallala Aquifer Program, harnesses the expertise of hydrologists, economists, behavioral scientists and educators to safeguard rural communities in multiple states from water scarcity by identifying ways to more efficiently utilize the largest source of U.S. freshwater.

Some research programs, like the National Food and Nutrient Analysis Program (NFNAP), are inherently governmental. Its goal—monitoring nutrient intake to maximize the genetic potential of all human populations and reduce the risk of diet-related disease—is both complex and manifestly altruistic. The project's stakeholders and institutional partners are numerous and diverse—National Institutes of Health, USDA Agricultural Research Service, Food and Drug Administration, Centers for Disease Control and Prevention, Indian Health Services and the



American Association of Cereal Chemists. The program must constantly demonstrate its agility to keep pace with food product introductions. NFNAP has examined 1,500 food products and inventoried up to 140 nutrients, but the growing diversity of ethnic foods and the constant discovery of new bioactive substances in foods pose ongoing challenges.

Two projects spotlighted at the round table shared the same focus—watershed stewardship or restoration—but from different perspectives and at different scales. USDA’s Conservation Effects Assessment Project enlists the expertise of partners like the National Aeronautics and Space Administration for remote sensing and USDA’s Agricultural Research Service for measures of soil vulnerability to rate the effects of various practices on watershed health. The goal is to determine if prescribed field-level practices have dividends at the watershed level. By contrast, the Integrated Landscape Assessment Project (ILAP), a two-year effort funded with stimulus money which created or retained 50 jobs, is more grassroots in nature. ILAP takes a more prospective approach to watershed management by surveying wildlife inventories, fire/fuel conditions, and

vegetation cover to help land managers make informed restoration decisions. Another project featured a robust and commercially promising biochemical technology to convert woody biomass into sugars and a biofuel.

In summarizing the day’s discussion, Edward Hiler, representing the Charles Valentine Riley Memorial Foundation, noted that the United States has historically enjoyed an ample food supply. At one time, complacency clouded the need for agricultural, food, nutrition and natural resources R&D investments. But the magnitude of the challenges facing U.S. and world agriculture today—including a population that is expected to increase by 50% by 2050 and growing competition for natural resources—has brought new attention to the importance of R&D. Hiler noted that nearly 150 years ago, the Morrill Land-Grant Acts established the institutional capacity to address agricultural crises. He added that based on the value of expanded partnerships highlighted in the day’s program, society would be well served by leveraging that capacity as part of expanded partnerships throughout the broad R&D community.

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## Introduction

If the challenges of both national and global food security are to be met in the decades ahead, significant attention must be directed to research and development work that addresses agriculture, food, nutrition and natural resources issues. The United Nation’s Food and Agriculture Organization (FAO) estimates global food production will need to double by 2050 to feed a population of 9.2 billion people. FAO also estimates 70% of that increased production will need to come from the creation and adoption of new technologies. Likewise, a viable and robust food, agriculture, and natural resource system within the United States will be necessary in order to ensure a safe and secure food supply for its citizens.

In recent years, federal investment in agriculture-related research and development work has lagged behind other areas of science supported by the federal government. Therefore, the *Agriculture, Food, Nutrition, and Natural Resources Research and Development Round Table* was organized to raise the profile of agriculture, food, and natural resources related R&D throughout the federal government and beyond, and to highlight the characteristics of highly productive collaborations in order to enhance future collaborations.

The round table was organized by the Charles Valentine Riley Memorial Foundation, Farm Foundation, NFP, Institute of Food Technologists, Federation of Animal Science Societies, the American Society of Agronomy, Crop Science Society of America and Soil Science Society of America in collaboration with Research, Education and Economics agencies within USDA, U.S. Forest Service, and the National Agricultural Research, Education, Extension and Economics Advisory Board.

The R&D round table program combined presentations by science policy officials with reports on exemplary R&D case studies. Following introductions by Neil Conklin, President of Farm Foundation, NPE, a policy presentation was made by Shere Abbott, Associate Director of the Office of Science and Technology Policy in the Executive Office of the President. Featured presentations were made by Catherine Woteki, USDA Under Secretary for Research, Education and Extension, and Jane Silverthorne, Deputy Division Director, Integrative Organismal Systems, National Science Foundation. A review of federal R&D budgets was led by Patrick Clemins, Director, R&D Budget and Policy Program, American Association for the Advancement of Science.

Sixty-one case studies of collaborative R&D projects were nominated as a result of a call for nominations of cases to be presented at the round table. The cases nominated involved a wide range of federal, state and local agencies, universities, and non-profit and profit organizations.

At least nine USDA agencies and 17 federal agencies outside of USDA were involved in supporting the 61 cases. Collaborators within USDA included Agricultural Research Service, Economic Research Service, National Institute of Food and Agriculture, U.S. Forest Service, Natural Resources Conservation Service, Food and Nutrition Service, Foreign Agricultural Service, Animal and Plant Health Inspection Service, and Farm Service Agency.

Collaborators from federal agencies outside USDA included the National Science Foundation, National Institutes of Health, Centers for Disease Control and Prevention, U.S. Food and Drug Administration, Indian Health Services, U.S. Environmental Protection Agency, U.S. Department of Energy, U. S. Geological Survey, National Oceanic and Atmospheric Agency, National Aeronautics and Space Agency, U. S. Fish and Wildlife Services, National Park Service, Bureau of Land Management, Bureau of Reclamation, Smithsonian Institution, and U. S. Department of State.

An independent five-member committee scored the 61 cases using four criteria: 1) strength of federal agency collaboration; 2) the strength of non-federal collaborations; 3) impact; and 4) documentation. Based on those scores, 14 cases were designated exemplary. After considering distribution of subject matter and institutions represented,

as well as the scope of the subject matter, eight cases were selected for presentation and six cases were selected for special recognition.

The eight cases selected for presentation were:

- Sequencing the bovine genome,
- National Food and Nutrient Analysis Program,
- Cooperative programs to improve safety and public health,
- Providing needed pest control tools to crop grouping system
- Sustaining rural economics through crop production and water management,
- Assessment of conservation programs,
- Making informed wild land restorations decisions, and
- Cellulosic biofuel production.

The six cases selected for special recognition were:

- Sequencing the swine genome
- National Dairy Genetic Evaluation Program,
- Center for Nutrition and Pregnancy,
- USDA National Agroforestry Center,
- Gypsy moth slow-the-spread program, and
- Best management practices to improve water quality.

All of these cases clearly demonstrate the value of collaboration and of federal investments in agriculture-related sciences and the positive impacts of such investments on society.

The round table concluded with comments on lessons learned and opportunities by Edward Hiler, Vice Chancellor Emeritus for Agriculture and Natural Resources at Texas A&M University and Secretary/Treasurer of the Riley Memorial Foundation.

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## **OSTP's Role in Moving Federal Science and Technology Toward Addressing Sustainability Challenges**

**Shere Abbott**

*Associate Director for the Environment, Office of Science and Technology Policy in the Executive Office of the President*

Dr. Catherine Woteki, USDA Under Secretary for Research, Education and Economics, will discuss the 21st century challenges and why science matters to agriculture in the next paper. And I'm going to discuss the broader challenges linked to science and technology, how we are focusing on the challenge of sustainability and climate change, how agriculture and natural resources fit into this challenge, and also add a bit about why science matters.

I just want to give you a little overview of the coverage because sometimes it's easy to get a little bit lost along the way. I'm not going to cover all of the dimensions of agricultural research and development (R&D), just some of the linkages to climate change and sustainability. The federal S&T structure is addressing science and technology for sustainability, and we're beginning to make some changes.

We need, however, new modalities for pushing R&D priorities across the government and out into the community, as well as for pulling science from the research community out to help inform what we do and what we should do to foster a stronger science-policy interface. We need to move more of what we know into action and we need knowledge to fill the gaps and lead the government in new directions.

Partnerships and collaborations are going to be the key to this process, and I'll explain a little bit about how the Office of Science and Technology Policy (OSTP) is organized and is helping organize the federal R&D structure to achieve the desired outcomes or actions, as well as identify some of the remaining challenges.

President Obama understands the important role that science occupies and understands the urgent challenges of our world and the need to come up with solutions to overcome these challenges within the federal government. This is certainly echoed from the vantage point of OSTP. Advancements in agriculture are seen as critical to achieving the administration's goals relative to urgent societal needs.

Many of the top priorities of the administration have links to science and technology and to agriculture. With the health and prosperity of the United States taking center stage, advancements in agriculture will be critical to maintaining world economies, providing safer and more nutritious food to the population, and maintaining the availability of food for the United States and the world in the face of changing challenges in production, especially climate change.

Advancements in agriculture also can help to raise our long-term standard of living, providing renewable resources of energy and enabling a more environmentally-friendly human footprint on the world by helping us to achieve what we call the transition to sustainability.

So first, let's look at some of the challenges linked to science and technology (S&T), and let's look at the centrality of science and technology overall.

There are many national and global challenges that are linked to S&T. Developments in many S&T fields have served as the drivers of our nation's economic recovery and growth—like information technology, biotech, nanotech and green tech. They furthermore provide the key to addressing global concerns about eradicating hunger and poverty and disease; transforming the global energy systems and land use practices to avoid catastrophic climate change;

and managing the intensifying competition for the world's land and freshwater resources among fiber, fuel, infrastructure, industry and ecosystem interests.

These challenges are interconnected. Poverty and local environmental degradation are linked in the vicious circle of cause and effect. For example, deforestation for fuel and desertification and erosion from overgrazing. Furthermore, preventable disease is linked to environment and poverty as can be seen in the lack of sanitation and clean water, acute air pollution in rural dwellings from traditional fuels, malnutrition, and low birth weight from inadequate diets. Economic progress further intensifies the competition for land, water and biomass, exacerbating the energy-economy-environment dilemma.

Agriculture and energy supply are two of the largest sources of human impacts on the global environment. Use of energy and water soar with income, while higher protein diets increase demand for grain for animal feed, grazing land, soybeans, fish and shellfish. There are pressures on the competition for land. Climate change driven by CO<sub>2</sub> from fossil fuel imperils food production and water supply, while also increasing demand for biofuels to replace fossil fuels.

But there are positive connections, too. Rising prosperity levels allow expenditures on environmental protection, restoration and resilience where none were affordable before. Innovative wireless technologies can lift capacity in agriculture and health care in far-flung places while creating jobs at both ends. Improving energy efficiency in buildings saves money while reducing noxious air pollution and greenhouse gases. And many climate change adaptation measures would bring benefits even if climate weren't changing—for example, strengthening defenses against tropical diseases.

There are a few other additional insights about these challenges. They're all about sustainability. The President has made clear his interest in navigating a development pathway for the nation in the global community that is sustainable. His priority for moving towards clean energy economy is one of sustainability, creating jobs and mitigating climate change. It's about the economy, it's about society and it's about the environment.

These challenges are also interdisciplinary and interlinked. Science and technology are central, not just relevant, to success. Science has found its rightful place in the center of what the government thinks, what it says, and what it does about all these challenges. And it's really true that the President is keenly interested in science and in making sure that our decisions are based on sound science.

A few other insights: Preserving the cross-cutting foundations of science and technology is equally as important as paying attention to supporting the applied goals. Cross-cutting foundations of strength in science and technology are absolutely essential as is support for the institutions that do most of the basic research; research universities, national labs and non-profits. Other key infrastructure is also important; information technology (IT), broadband, high speed computing, energy, transportation and space technology.

Science, technology, engineering and math education is essential for all of these challenges. Economic and policy conditions conducive to entrepreneurship, innovation and partnerships are also key, in terms of intellectual property rights, financing tax policy, export policy, immigration policy, transparency and predictability of the regulatory environment.

This interdisciplinary and interconnectedness mean that efforts on these priorities will involve the participation of numerous federal agencies, collaborations across multiple disciplines, partnerships between federal state and private sector, research and development, and linkages to work already underway both domestically and abroad.

So let's unpack one of the big challenges. Let's look a little more in detail at the links between climate change, agriculture and sustainability challenges to get a sense of how what we know informs both what we should do, what the research agenda should look like to address the challenges, and what OSTP's role is in building the linkages and partnerships across the federal agencies and external communities.

The earth is getting hotter. Heating is not uniform geographically. We know this. Other climate indicators are changing at a notable pace. This is also true when it comes to precipitation, but not in a uniform manner. Most places are getting wetter. Some are getting drier and, in fact, those places that are already wet are getting wetter, and those places that are already dry are getting drier. Most of the models match the observed temperature change on all the continents so we get a good sense that our models are telling us what's going on.

This has an impact. For instance, we have observed effects of changes in the East Asia monsoon on China. You're getting increasing drought in the north and increased flooding in the south. This has impacted Chinese food production, as well as flood damage, and we've seen similar effects in India. Wild fires in the United States have increased six-fold in the last 30 years. Similar trends are evident in other fire-prone regions. Pest outbreaks—for

instance, the recent surge of pine bark beetles with a longer breeding season courtesy of warming—have devastated trees weakened by heat and drought in Colorado. Those of us who like to fish are going to have a problem because it's impacting the fish and fisheries as well. Summers are hotter all over, producing worse wild fires, worse droughts, and increased water stress and declining crop yields in some regions.

The effects of climate change—much work still needs to be done to better predict the impacts of climate change on agriculture. In addition to temperature and weather stresses, climate change also is bringing changing agricultural pest pressures and a need for more diverse and resilient crop and livestock production systems. In addition, farmers will need greater access to knowledge and markets through information technology. In order to adapt to climate change, we need not only new crop varieties but also new cultivation patterns and region specific analyses, such as the probabilities of different futures as depicted by both economic and climate forecasts.

So how do we deal with this across the federal government? One of the things that we're trying to do is to reorganize our research agenda for federal climate programs. Right now we are achieving this through the U.S. Global Change Research Program (USGCRP), which is comprised of 13 federal agencies and three main elements—climate change science, mitigation and adaptation. It focuses on the challenges of the coupled human and physical climate system, as well as understanding changes and impacts of climate change. We're trying to align that program more with response strategies in order to move towards an end-to-end program to understanding change and understanding response.

There's also the piece about climate change mitigation, and we have a climate change technology program which is focused mostly on the technology and integrated modeling and analysis required to understand what are the technology impacts that are going to help reduce greenhouse gas emissions and help us understand if, in fact, our investments are having the impacts that we expect.

The third piece is on climate change adaptation which has most relevance to agriculture. This is a new area of research for the U.S. Global Change Research Program, and we're just beginning to figure it out. It is focused on vulnerability and adaptation and integrating the social, natural, behavioral and economic sciences. The major players are the National Oceanic and Atmospheric Administration (NOAA), Department of the Interior and USDA so far, with engagement among other agencies increasing steadily.

Now, this is one of the schematics that drive most people a little bit crazy. But in fact, this is taking those three meatballs and trying to put them in some logical intellectual order ranging from the bottom where you'll see the changes that we're experiencing in the planet from physical, ecological, socioeconomic and technological change, and their impacts on global change and a changing planet.

This research program that we are aligning with looks at integrated observations. We all know that our earth observations systems are absolutely critical to understanding change both in situ and from space. It also focuses on process research—understanding the physical, chemical and biological processes that are driving change, doing integrative modeling and prediction in better ways, downscaling, and trying to understand how these changes are affecting particular places. Adaptation science is really the new piece that we're looking at that involves a lot of integrated research and requires taking into consideration impacts and understanding how to respond to those impacts.

So the program informs mitigation policy, adaptation policy, and links with the societal areas of interest to decision-makers. This integrated structure is tied with a national climate assessment, which we do every three years, and tries to look at and collect and integrate all of the research that has been funded to understand what are the impacts both sectorally, as well as in particular areas and regions of the country. It's a big program—\$2.6 billion annually, 13 federal agencies and growing in terms of interest.

So trying to move this program in new directions is a fairly significant challenge, particularly when agencies tend to want to hunker down in what they typically feel comfortable in, but this is one of the things that we're focusing on.

Now, I want to take a brief look at how we do this in OSTP, because OSTP plays an interesting role within the White House and within the government. The first is basically everything about how science gets done, the policy for science and technology. We do a lot of work on R&D budgets. That's one thing that is really critical. Education and workforce issues and interagency science and technology initiatives and various policy areas, like open government and scientific integrity.

The other piece of this is science and technology for policy, that is, to pull from we know into the decisions that we need to make. In other words, how scientific knowledge gets used and how we use that to inform the President. Our structure is very flat, and there are five of us who are

Senate confirmed. John Holdren is the director of OSTP and also serves as the assistant to the President for science and technology. We have four associate directors, as well, including Carl Wieman for science, a Nobel Laureate physicist who's very keen on STEM education; I cover energy and environment; Phil Coyle for National Security International Affairs; and the technology division is now run by Aneesh Chopra, who is also the Chief Technology Officer of the United States. He's known by Jon Stewart as the Indian George Clooney, which is very hard for an old person like me to deal with, but he's a young energetic guy so it's quite a lot of fun.

There are a lot of organizational mechanisms for advancing science—for climate change and sustainability that we're looking at, and I'll talk a little bit about how we are reorganizing our overarching committees. Each of the associate directors for OSTP co-chairs with a federal agency representative a major science committee that looks across the interagency structure. So there's a committee on science; there's a committee on environment and natural resources, which we now call the committee of environment and natural resources and sustainability (CENRS). There is also a committee on national security, a committee on technology, and a committee on science, engineering, technology, and math education.

And each of these committees is the framework we use to align R&D priorities with budgets. It's cumbersome. Dr. Woteki knows the system well. But we're trying to streamline it a little bit and, in my area, we changed this into the committee on natural resources and sustainability. I'll show you a little graphic shortly to explain that. We're retooling, as I mentioned, the U.S. Global Change Research Program in this domain, so we're looking at global change through the lens of sustainability. We have a National Earth Observation Task Force that we've established in response to a Congressional request that we develop a strategy and governance plan for earth observations. This is in part to assure that we can overcome the hiccups that tend to be reflective of the fact that some of these satellite systems in particular have long lead times that tend not to align very well with political cycles. So we have to have a strategy that includes ramping them up, getting them supported and also, unfortunately, dealing with the inevitability that sometimes they don't fly, like the recently lost NASA Glory satellite.

We have a Round Table on climate information and services. This is an opportunity to coordinate federal efforts in this arena, including the development of NOAA's climate service line office, as is called for in the proposed budget for

2012. This is a way of aligning science and service delivery so that we can do better while coordinating science and adaptation planning as well as science and mitigation, all of those things. But we need to build across the federal government because no single agency possesses all the data and information necessary for the challenges that we've got.

And finally, we have an Interagency Climate Change Adaptation Task Force that is co-chaired by me, Jane Lubchenco from NOAA, and Nancy Sutley from the Council on Environmental Quality. That task force is looking at how to develop a national strategy for climate change adaptation moving adaptation through the government, making a model of the government, while also helping to align our federal R&D structure with the needs of the nation.

The National Science and Technology Council (NSTC) is a cabinet-level committee. It hardly ever meets. Our committee on environment, natural resources and sustainability [has] several subcommittees, including one on global change.

You will notice the fact that we don't have a subcommittee or a process for energy or for agriculture, and that is because there's a Department of Energy and there's a USDA that outline the R&D budget for those particular domains. But many of the challenges cross over all of the agencies, so we need a structure that better aligns our research across all the agencies for these particular fields. It's a little bit more difficult with the structure that we've got, but we're trying to make some changes to that structure.

Finally, we have a task force on the integration of science and technology for sustainability. This is to look at the whole structure, and say how do we move this forward? What are the needs? How do we fill in the gaps?

We started a global change and adaptation program under the U.S. Global Change Research Program, and those were a bunch of agency folks who had a high comfort zone on the science—designing science programs but not so much on the societal benefits or in applications. We took them out of the USGCRP, plunked them underneath the Interagency Climate Change Adaptation Task Force, and they thought about science needs—what policy needs from science. They were thinking about this in a very different direction, aiming science toward policy needs. It really made a difference in the way we think about the adaptation science program to sit back and think about what we need from research to address these various policy considerations.

Within the federal family new relationships are emerging around issues related to agriculture. Agencies are joining forces on common issues. These interagency relationships also represent opportunities for new funding and collaborations for the agricultural research community itself.

An example of interagency relationships includes things like the USDA and U.S. Agency for International Development (USAID)'s collaboration on the U.S. Government's Feed the Future Initiative. USDA is also collaborating with the Department of Energy (DOE) on biomass production; National Institutes of Health (NIH) on efforts to understand and combat obesity; NOAA and NASA on Global Earth Observations; and U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency on sustainable land use. So we're encouraging through this new structure a lot of the new interagency collaborations to look at these issues that are beyond the scope of just a single agency such as the USDA.

Now, overall the President's FY 2012 R&D budget is up. It's good news for R&D. There are a lot of tradeoffs in the budget, a lot of things are down, but generally R&D is up. USDA's Agriculture and Food Research Initiative, the competitive grants program within the National Institute for Food and Agriculture (NIFA), is up—looks like a 24% increase over FY 2010, with a proposal of \$325 million. Overall R&D funding for USDA is about \$2.2 billion. It provides increases for selected USDA research in human nutrition, food safety and sustainable bioenergy. It supports the reorganization and revitalization of NIFA. The FY 2012 budget proposes \$120 million for USDA bioenergy research and proposes \$150 some odd million for USDA research associated with the safety of food supply.

And finally, there are other agency initiatives that are tied with our challenges of sustainability, and you'll see they run the gamut from use-inspired research that NSF is supporting under its Science Engineering and Education for Sustainability Program. It's about a \$900 million program with a \$300 million bump up in FY 2012—moving all the way through DOE's energy innovation hubs and Environmental Protection Agency's (EPA) sustainability science within the Office of Research and Development (ORD). So as these programs demonstrate, a lot of research is taking place at the nexus of environment, energy, agriculture and sustainability.

Our whole approach is organized around building the science and technology for the sustainability agenda through the resource management agencies; improving the application

of science for resource management and more sustainable uses; and then, in some of the regulatory agencies, like EPA, building a notion of managing the environment you want rather than the one you've got. So it's a real systems approach in thinking about R&D and applications in new ways.

Given the urgency of some of these needs, the innovation pipeline driving development from basic discoveries to applications needs to be strengthened. For this reason, OSTP supports research efforts of scale and listing multiple skill sets to tackle specific societal needs. And this vision of systemic research is best observed in the recently established National Institute of Food and Agriculture. The vision is not to reduce investment and basic research, but to challenge basic researchers to apply more broadly and globally their discoveries.

The vision also is to create an infrastructure of greater collaboration and greater outreach to end-users. This whole approach towards sustainability is designed with that link between science and decision-making. Public-private partnerships also can be strengthened to meet the magnitude and urgency of the needs.

And I'd like to leave you with a few challenges which I like to call "the knowledge to action challenges" that are presented by the way that federal government does its work, and it is about this: how do we push policy needs down into the research community, and how do we pull the science out of the community to make decisions. The biggest challenge is breaking down the stovepipes. The second is building effective models for engaging end-users in the design and implementation of research programs; measuring progress and the efficacy of actions; and building the capacity for adaptive management.

We need to know that our investments are actually having the impacts that we hope for and that we are actually achieving this transition to sustainability, narrowing the divide between science delivery and policy formulation, that's a critical problem. Science is at the table, but we need to make it more fundamental to the decision, while developing the funding structures for integrated R&D programs.

These are all the challenges that I'd like to have considered as we think about collaborations across environment, natural resources, and agriculture R&D. *Web site: [www.ostp.gov](http://www.ostp.gov).*

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## Science Agenda for the 21st Century

**Catherine E. Woteki**

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From providing nutritious food to our children and supporting the productivity of our farmers, to helping use our natural resources to create jobs and mitigate the effects of climate change, the work of the USDA science agencies improves the lives of the American people and has impact around the world.

USDA's rich history of conducting and sponsoring agricultural research began 150 years ago, when President Lincoln established the Department of Agriculture and signed the Morrill Act that formed the basis for the Land Grant university system and the historic partnership between the states and the Federal government. Through this Act, President Lincoln forged an agreement—a compact—between the national government and the states, opening access to education as one of the tenets of American democracy. That compact focused on building our agriculture system as a base for a strong economy. The Morrill Act, followed by the Hatch Act of 1887, establishing the experiment stations, not only revolutionized

American education and agriculture—together they transformed the nation's economic and social fabric. Since then, our state colleges and universities have graduated more than 20 million students; produced countless scientific breakthroughs; pursued solutions to problems shared across our society; vastly increased agricultural productivity; and improved the lives of people everywhere.

By any measure, this partnership—enhanced over the years by the expansion of the reach of the Land Grant system to the 1890 institutions serving the African American community, the 1994 tribal colleges, and Hispanic-serving institutions, and by the creation of our world-renowned and often emulated extension system—has paid huge dividends to American agriculture and forestry, and to the American people.

Today, however, there is also growing recognition that agriculture and natural resources are at the crossroads of the world's most critical problems: increasing sustainable food

production, providing clean and abundant water, responding to climate change, developing renewable energy, and improving human health. Climate change, land use changes, population growth, and emerging pests and diseases are placing intense pressure on the world's food and agricultural system and threaten the future availability of sufficient food supplies. And the world's health authorities are increasingly focused on zoonotic disease outbreaks—those which cycle through animal populations to humans and pass back into the environment to mutate once again. The challenges facing agriculture, human and animal health, natural resources and conservation are immense, and need to be faced with the most robust research enterprise we can muster.

The four agencies in the Research, Education, and Economics (REE) mission area conduct research that would be prohibitively expensive for the private sector to do—but that is the foundation for technological development in businesses throughout America. Many of the technologies and production practices that are a product of REE research eventually move into the private sector and are used by farmers, ranchers, food processors, veterinarians and physicians, but they could not have been created without our basic research. Demonstration and commercialization of new products and processes often grow out of earlier breakthroughs like genome mapping or basic research on developing feedstocks for bioenergy. One example is our work to produce the enzyme that allows people who are lactose-intolerant to eat dairy products, which has gone on to create an entire industry.

Next year—2012—will be the year to celebrate the contributions that USDA and the Land Grant universities have made to American life. However, it comes at a time of tough financial challenges for the entire Federal government, including USDA and REE. As President Obama has indicated in his FY 2012 budget, government is going to have to live on a tighter budget, just as American families have been doing. In the face of those challenges, however, the 2012 budget still reflects the administration's strong commitment to agriculture science and education, along with a practical agenda that is fine-tuned to address the necessary belt-tightening. To be able to make the strategic investments in the food and agriculture sector and our economy in the long term, we have to make cuts to programs we care about. President Obama's 2012 budget proposes reductions in programs and terminations of projects, because these tough budget times call for tough choices to be made. That means we have to focus the budget on the highest priority and most productive programs.

The food and agriculture sectors of the economy have proven to be strong. Focusing on and enhancing these high priority programs in the budget is critical to keeping them strong,

and continuing their contributions to the future economic well-being of our country.

In his State of the Union speech earlier this winter, the President challenged us to "Win the Future." It was clear in his remarks that he sees education and scientific innovation as the keys to putting our economy back on solid footing. The food and agriculture economy is a huge engine for our country's economy, contributing to building jobs and a positive balance sheet for our country when it comes to international trade. In 2010, the United States exported \$115.8 billion of agricultural products and imported \$81.9 billion, leaving a positive trade balance of \$33.9 billion. Agriculture has maintained a surplus since 1960, and is not projected to change in the immediate future. However, in maintaining this advantage, we must never take for granted the scientific insights needed to combat the next animal or plant disease or fungus—or the next climate anomaly—that can impact those important commodities and products.

Much of the success in the food and ag sector can be traced back to the research conducted and supported by USDA. We have proven in the past, time and time again, what American agricultural science is capable of, and I want to assure you that our commitment to meet the challenges facing the sector is just as strong as ever, even in tough economic times. The 2012 budget emphasizes the efficient and effective use of research and education resources, combined with leveraging our strategic partnerships to get the greatest return on our investments. It allows USDA and REE to continue to produce and support fundamental and cutting-edge research when budgets are tight. It allows REE and its partners to address a diversity of problems and once again demonstrate our ability and capacity to rise and meet the greatest of challenges.

In keeping with the President's commitment to start the country on a path to eliminating the deficit, the budget requests \$2.6 billion for the four REE agencies or a reduction of \$244 million in discretionary funding. Within the total are requests for increases in programs addressing some of the greatest challenges to the country, including nutrition and obesity, renewable energy, climate change, food safety, and scientific collections. It also proposes to develop the capacity to use a new analytical tool, behavioral economics, to provide valuable insights to policy development and program design and to enhance the department's flagship competitive grants program, the Agriculture and Food Research Initiative (AFRI). These increases are offset by the elimination of Congressionally-designated projects and decreases or terminations of lower priority programs.

In summary, the FY 2012 budget we are proposing reflects the difficult choices we need to make to reduce the deficit while supporting targeted investments that are critical to



long-term economic growth and job creation. While reflecting the reductions needed to contribute to decrease the budget deficit and debt, the REE agencies' budgets present a balanced research, education and economics portfolio with investments in a range of issues that are a high priority to the nation. The budget looks to properly manage deficit reduction while preserving the values that matter to Americans. By investing in

the building blocks of American innovation, we will help ensure our economy is given all the necessary tools for new breakthroughs, new discoveries and the development of new industries. The increases proposed will enable the REE agencies to continue to make new discoveries and develop new technologies that contribute to the success of American agriculture.  
*Web site: <http://www.ree.usda.gov>.*

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## National Science Foundation Partnerships in Plant Genomics

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Partnerships are absolutely crucial to the advancement of science. There is no one agency that has the resources or the opportunity to bring about change or accomplish goals effectively alone. Here, I will discuss several of the partnerships that have been instrumental in National Science Foundation's (NSF) thinking about plant genomics, and some of the things that these partnerships have enabled. I will start with the Plant Genome Research Program and then discuss an activity focused on developing country agriculture that is a partnership with the Bill & Melinda Gates Foundation. I will then move onto a partnership that led to an experiment in innovation, this time with the Biotechnology and Biological Sciences Research Council in the United Kingdom. I will discuss a new program that we are just starting that represents the first fully joint review with the Japan Science and Technology Agency, and then finally talk about something that really brings all of those different perspectives together to enable a whole community of scientists to think about the best ways to use, share and manipulate data: the iPlant Collaborative.

The Plant Genome Research Program started in 1998 as part of the National Plant Genome Initiative. The National Plant Genome Initiative is the larger umbrella activity under which the Plant Genome Research Program operates, supporting the most upstream, basic research. The goal of the National Plant Genome Initiative is to understand the structure, organization and function of plant genomes with the focus on plants of economic importance, and plant processes of potential economic value. The National Plant Genome Initiative brings together government agencies so to accelerate knowledge transfer to agriculture, forestry, energy, environment, health, and all of the current and future plant-based industries. This is a lofty goal and certainly not anything that any one agency could accomplish alone.

The National Plant Genome Initiative is coordinated by the Interagency Working Group on Plant Genomes under the National Science and Technology Council Committee on Science. This group serves as a forum where agency

representatives come together several times a year to discuss ongoing activities, as well as ways to best leverage each other's investments and to partner. The current members of this group include the NSF; USDA's Agricultural Research Service, National Institute of Food and Agriculture and Forest Service; the U.S. Department of Energy; the National Institutes of Health; the U.S. Agency for International Development and most recently, the U.S. Geological Survey. The activities of the National Plant Genome Initiative are coordinated through Five-Year Plans; the current Five-Year Plan covers 2009 through 2013.

From the very beginning, starting with the first Five-Year Plan, a set of guiding principles was established for the National Plant Genome Initiative and these have not changed. The first principle is that this should be a long-term project guided by strategic plans, not reactive every year to things that happen along the way, but taking a long-term view. The future activities should be based on science; outcomes should be freely available to all, including industry and international stakeholders; support should be provided on a competitive basis so that the best science is funded; and finally, partnerships with the private sector and other nations are vital for success.

The Plant Genome Research Program invested more than a billion dollars between 1998 and 2010 on a total of 322 research awards. (A full list of funded projects is available at: [http://www.nsf.gov/bio/pubs/awards/pgr.htm?WT.si\\_n=ClickedAbstractsRecentAwards&WT.si\\_x=1&WT.si\\_cs=1&WT.z\\_pims\\_id=5338&](http://www.nsf.gov/bio/pubs/awards/pgr.htm?WT.si_n=ClickedAbstractsRecentAwards&WT.si_x=1&WT.si_cs=1&WT.z_pims_id=5338&)). The outcomes of these awards encompass a wide range of basic discoveries about how plants grow and develop, discoveries that inform downstream research focused on applications. For example, accumulation of biomass involves cellulose biosynthesis, as well as other biosynthetic pathways, and many of the genes and processes that are involved in these are fundamental to plant development. Many basic discoveries, from how plants tolerate stress, whether biotic or abiotic, to how to generate plants with increased yield or nutritional content have been funded through the Plant

Genome Research Program. Just as importantly, this program has also funded development of fundamental research resources and technologies. For example, one technology that was supported is called Targeted Induced Local Lesions IN Genomes or “TILLING.” TILLING allows rapid identification of a series of mutants or variants in any plant gene, yielding plants that are valuable for research purposes and some of which have been exploited commercially.

NSF has supported database resources and tools in partnership with other agencies in the National Plant Genome Initiative. Education and outreach have been integrated into every project funded by the NSF Plant Genome Research Program. These activities are truly integral to the research and take advantage of the resources that are being generated or developed in the program. Finally, in partnership with other National Plant Genome Initiative agencies, NSF has funded some pivotal workshops to bring communities together to talk about future needs. For example, one of the resources that NSF funded in a partnership with DOE and USDA was a sequence of the maize genome. Before this was initiated, workshops were held to discuss the kind of genome resource needed to advance the science, whether in academia or industry, or internationally.

Because of this international dimension to the science funded through the Plant Genome Research Program, it was a logical step to develop partnerships above and beyond federal agencies, that would enable leveraging of the basic discoveries made and resources developed to benefit small-holder farmers in developing countries. In 2009, NSF partnered with the Bill and Melinda Gates Foundation to start a new program called Basic Research to Enable Agricultural Development or “BREAD.” BREAD is an NSF program, but it is funded jointly by NSF and the Bill and Melinda Gates Foundation in the amount of \$24 million each over five years, with the potential to be extended. BREAD brings the Gates Foundation’s track record in agricultural development together with NSF’s peer-reviewed marketplace for new ideas through its panel system. BREAD is able to identify and support new kinds of science that would be unlikely to be funded by the agency alone. Also, because the funding that comes from the Bill and Melinda Gates Foundation is not appropriated, NSF can use it to fund international partners through sub-awards to the U.S. lead institutions on BREAD projects. This allows BREAD to support all of the research partners and not just those located in the United States.

The goals of BREAD are focused on innovative, cutting-edge science at an early concept stage that has the potential to address constraints faced by small-holder farmers in developing countries. Unlike the Bill and Melinda Gates Foundation programs, BREAD does not have any specific target countries and, while the international partners are primarily from developing countries, some projects also involve partners from developed countries that have interesting technologies or tools that can be brought to bear

on the problems under study. BREAD projects are all focused on end-user needs and NSF is particularly looking for new kinds of partners that might not have thought about how their research could address the challenges to developing country agriculture. When the BREAD program ends, its legacy will include the research outcomes and their downstream impacts, including the researchers trained as well as the extended collaborations and networks of excellence.

The awards from the first BREAD competition were announced in June 2010. A total of 15 projects totaling \$20 million were funded, and it is clear that the engagement with the community was extensive; more than 130 U.S. institutions in most of the United States and more than 200 institutions in 68 countries participated. These first awards cover a broad scope of science, from crop improvement to soils, insects and animals. The second competition is under way and the awards will be announced in June; the third competition will be announced later this summer.

Using a partnership approach, NSF is also exploring innovative review processes. One experiment was based on a new approach called a “sandpit” that was first developed in the United Kingdom by the Engineering and Physical Sciences Research Council. In this example, NSF partnered with the Biotechnology and Biological Sciences Research Council to hold a modified sandpit, called an “ideas lab”, on increasing the efficiency of photosynthesis. Increasing the efficiency of photosynthesis has been a long-standing challenge but despite considerable effort, there has been limited success, so the Ideas Lab was used as a new way to bring diverse expertise to explore approaches.

Twenty-eight participants were brought together at the Ideas Lab at Asilomar last September. In discussions led by a facilitator and mentored by experts who were not eligible to receive funding, the participants developed ideas that underwent real-time peer review. This was a five-day residential activity and by the end, several groups had formed and developed ideas. The best of these were identified by the mentors as projects to be developed for proposals. In addition, an open competition was held for anyone from the community to submit a proposal, regardless of whether or not they had participated in the Ideas Lab. All of the proposals were reviewed by a single panel that was not told which proposals originated from the Ideas Lab and which from the open competition. The awards will be announced in the last week of March.

The final example of a partnership program is called “Metabolomics for a Low Carbon Society” and involves NSF and the Japan Science and Technology Agency. The goal of this joint program is to make a catalog of all of the metabolites (the “metabolome”) in plants, microbes and algae. Surprisingly little is known about the full spectrum of metabolites present in plants, bacteria and algae, from the core metabolites to the specialized components. One goal of the

program is to identify standards and develop annotation for these metabolites with the goal of identifying those of potential downstream value. If the program is successful, it will accomplish several things. For example, it will have stimulated new ways of addressing technical challenges and will have forged new partnerships among U.S. and Japanese scientists with complementary expertise. This program is also the first to hold a truly joint review between NSF and JST. The proposals, which will each have a U.S. and a Japanese principal investigator, will be submitted in duplicate to the NSF FastLane system and the JST ERAD system. The first stage of the review will take place at NSF through its panel system, and the second stage will occur in Japan through the JST panel review. The outcomes will be announced later this year.

The final example of a partnership is the iPlant Collaborative (<http://www.iplantcollaborative.org/>). The iPlant Collaborative is a cyber infrastructure collaborative, the goal of which is to foster the growth of a multi-disciplinary community to address grand challenges in plant biology through the development of infrastructure, and in doing that, to prepare the next generation of scientists so that they can integrate computational thinking into their research. iPlant is a cyber infrastructure collaborative rather than purely a cyber infrastructure, engaging the broader plant community in a partnership with the cyber infrastructure developers to build tools to answer grand challenge questions. The process used to select the current grand challenges was to conduct workshops in which grand challenge questions were

explored, and then white papers generated afterwards. The iPlant Board of Directors, an independent review group, then selected the grand challenges for which cyber infrastructure would be developed. There are currently two projects under way: “iPG2P: Relating Genotype to Phenotype in Complex Environments” and “iPToL: Assembling the Tree of Life for the Plant Sciences”. Training and education is integrated into iPlant’s activities. One of the things that iPlant has already done, in addition to generating resources and developing educational resources, is to provide one of the first user-friendly gateways or portals to the TeraGrid.

In summary, partnerships are important for many reasons, including coordination of effort and sharing of knowledge and expertise far beyond that of any single entity. Partnerships stimulate innovative ideas from diverse perspectives and allow leveraging of scarce resources. For example, NSF is not able to provide long-term funding for the types of database and germplasm resource that ARS has, but can support the generation of new resources and their deposition. Research supported through BREAD, Metabolomics for a Low Carbon Society, and the Photosynthesis Ideas Lab builds on investments in resources made earlier by the Plant Genome Research Program and its partners in the National Plant Genome Initiative, while the iPlant Collaborative allows the community to participate in the development of a cyber infrastructure that leverages these and other investments more broadly. *Contact and Web site: [jsilver@nsf.gov](mailto:jsilver@nsf.gov); [http://www.nsf.gov/staff/staff\\_list.jsp?org=IOS&from\\_org=IOS](http://www.nsf.gov/staff/staff_list.jsp?org=IOS&from_org=IOS)*

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## Overview of Federal R&D Budgets

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Total federal spending for fiscal year FY2012, as projected by the President’s budget request, is \$3.7 trillion. By FY2016, those same projections estimate an increase to \$4.5 trillion. However, despite the overall budget growing, discretionary spending, where most of the federal research and development (R&D) investment resides, will likely decrease due to the President’s announced five-year budget freeze. The deficit is projected to decrease over the next few years as we grow out of this economic recession and tax receipts increase.

The Administration’s proposed R&D budget for FY2012 is \$147.9 billion. A 6.5 percent increase to \$66.6 billion for non-defense R&D compared to FY2010 is proposed, along with a 5.2 percent reduction to \$82.3 billion in defense R&D. Basic and applied research would receive increases at the expense of development spending.

In the FY2012 request, the Department of Defense (DOD) would fund the largest percentage of R&D at just over half, while the Department of Health and Human Services (HHS)

is the only other agency that funds more than 10 percent of the overall R&D investment at \$32.4 billion. Next is the Department of Energy (DOE) at \$13 billion, followed by National Aeronautics and Space Administration (NASA) at \$9.8 billion, the National Science Foundation (NSF) at \$6.3 billion, and then finally, the U.S. Department of Agriculture (USDA) at \$2.2 billion.

In terms of percent change from current FY2010 spending levels, the Administration's proposed changes for FY2012 would result in R&D investment increases at the National Institutes of Health (NIH) 3.3 percent; DOE, 19.9 percent; NASA, 6.0 percent; and NSF, 13.1 percent. On the other hand, USDA R&D investment would decrease by 17.7 percent.

The President's priorities of "out-innovate, out-educate, and out-build" are clear in the proposed R&D investment. To "out-innovate", the President will jumpstart innovation and scientific discovery through increases in research funding, particularly at NSF, DOE's Office of Science, and the National Institute of Standards and Technology (NIST). These three agencies would continue on their doubling track, receiving a combined \$1.5 billion increase. Clean energy technology and global change research also fare very well in the President's request. It contains a \$1.5 billion increase in R&D investment for DOE's Office of Science and energy programs as well as a 20.4 percent increase for the U.S. Global Change Research Program (USGCRP). Yet another innovation priority is a proposal for a permanent and increased research and experimentation tax credit for business and industry to help ramp up their investment in research and development. To "out-educate", the budget request proposes a program to train 100,000 new Science, Technology, Engineering and Mathematics (STEM) K-12 educators over the next 10 years. Finally, to "out-build", the President has proposed a \$3 billion Wireless Innovation Fund to deliver high speed wireless to 98% of Americans and improve cybersecurity.

Although actions are still pending on the FY2012 budget actions by Congress, the recently passed year-long continuing resolution for FY2011 contains around \$38.5 billion in cuts, the largest collection of spending cuts in history. R&D intensive programs and agencies were spared the worst of the cuts. Basic research programs fared the best, while applied research programs, especially at DOE, did not do as well, accurately reflecting the current policy debates taking place. Basic research generally has broad, bi-partisan support, but there is discussion as to how much the federal government should be involved in applied research, and the role of industry in funding the applied research stage of the innovation pipeline.

NIH is funded at \$30.7 billion in the continuing resolution, a 0.8 percent or \$260 million cut from current FY2010 spending levels. NASA is funded at \$18.5 billion, a 1.3 percent or \$239 million cut, but the Science Directorate

received \$4.9 billion, a 10.0 percent increase from current levels and just \$72 million shy of the President's FY2012 request. NSF is funded at \$6.8 billion, a 1.0 percent or \$67 million cut from current levels. The DOE's Office of Science will receive \$4.9 billion, a 0.4 percent or \$20 million cut from current levels while the applied research-oriented Energy Efficiency and Renewable Energy (EERE) program would receive \$1.8 billion, an 18.4 percent or \$408 million cut from current levels. By comparison, the EERE program had been slated for a budget of \$1.5 billion in the original H.R. 1, a 35 percent or \$775 million cut. Advanced Research Projects Agency—Energy (ARPA-E) received \$180 million in the continuing resolution.

Overall, USDA suffered a large \$501 million or 19.2 percent decrease in R&D investment in the FY2011 continuing resolution. But almost half of that decrease is due to a \$230 million rescission of prior year earmarked funds in the Agriculture Research Service (ARS) Buildings and Facilities account. Additionally, due to the moratorium on earmarks in this Congress, the \$115 million in ARS earmarks and the \$132 million in earmarks in the National Institute of Food and Agriculture (NIFA) that were included in FY2010 have been removed. The rescission and removal of earmarks almost completely accounts for the \$501 million decrease. ARS will receive \$1.1 billion in the year-long continuing resolution, a 9.4 percent or \$117 million decrease from FY2010 discretionary budget authority—this includes the removal of the earmarks but not the rescissions from the Buildings and Facilities account. NIFA's R&D budget will drop \$109 million or 13 percent to \$731 million, which also includes the removal of congressionally directed projects. However, NIFA's competitive grant program, the Agriculture and Food Research Initiative (AFRI) will see a small 1 percent increase to \$265 million. Forest Service R&D is projected to be \$327 million for FY2011, a decrease of \$41 million or 11.1 percent. In the FY2012 request, ARS and NIFA reinvest some of these funds in new programs and AFRI would receive a \$62 million or 23.7 percent increase. So, generally, USDA will invest less in R&D in FY2012 than in FY2010, but targeted initiatives are intended to make USDA a more competitive agency.

Historically, R&D spending levels have been highly correlated with discretionary budgetary trends. The R&D investment over the course of the decades since the Apollo program has been about 12% of the total discretionary budget. Therefore, the large proposed decreases in the discretionary budget in future years will likely affect the federal R&D investment. The Charles Valentine Riley Memorial Foundation worked closely with the American Association for the Advancement of Science (AAAS) and several stakeholders to write a new disciplinary chapter for the annual AAAS Research and Development Report. The resulting Chapter 27, first prepared in 2010 on the FY2011 federal budget, provides a snapshot of initiatives and investments taking place in the

federal research and development portfolio and across government to address grand societal needs. The chapter is disciplinary in nature and covers science supporting the innovations driving the success of our feed, fiber, food and fuel production, preparation and processing systems, as well as science-based decisions for optimizing biological productivity of managed lands. The chapter describes science investments across government in challenged areas, such as food safety, food security, nutrition and obesity, renewable energy production and natural resource management.

The ability for societies to overcome the challenges in these areas hinges on the capacity of public institutions to form synergistic collaborations across government to capitalize on federal R&D strengths and areas of expertise. Investments in discovery, basic and systematic research make it possible to enhance work performed while also leveraging scarce time and resources.

USDA, HHS and DOE, as well as the U.S. Departments of State, Commerce, Interior and the Environmental Protection Agency (EPA), and of course, NSF, work together and with the private sector to perform research that can be transformed into products and services for government, commercial and, in some cases, general public use.

Now let's take a look at some of the highlights of the current Chapter 27, part of AAAS's 2011 report on the FY2012 federal budget. Please note these highlights are in no way meant to be exhaustive. For food safety, the R&D spans several places in the federal portfolio with investments that capitalize on the unique expertise of each department. HHS administers food safety research related to standards, monitoring and transmission of diseases from the food supply among other areas.

Related to food security, USDA's Research, Education, and Economics (REE) mission area is a comprehensive investor in food and feed production research. REE researches agronomic practices, agroecosystem services, plant and animal breeding and germplasm work, as well as economics research, statistical analysis and much more. ARS and NIFA research and develop technologies to protect food and consumers from food contamination that may occur during production, processing or preparation. EPA also plays a role in food security research as it develops ecological indicators, assesses pesticide and antibiotics, along with other products used in production and develops approaches to limit biological risks affiliated with the products. NSF is a source of basic research on plants, ecosystems and soils. The NSF Biological Sciences (BIO) Directorate's Integrative Organismal Systems (IOS) organization is home to the Plant Genome Research Program and the Basic Research to Enable Agricultural Development (BREAD) program, which plays an essential role in addressing international food security for small-holder agriculture worldwide. Similarly, and not to be understated, the Department of State's Feed the Future Initiative supports research in developing countries—focus countries which are particularly sensitive to food security issues.

In the area of nutrition and obesity, NIH directs the majority of the government-funded research. At USDA, obesity research is also done within REE. ARS's Human Nutrition Research Centers provide critical infrastructure, using partnerships with other agencies, universities and commodity groups to thoroughly address the needs of nutrition science.

Research on the fuel potential of perennial grasses, oil seed crops and woody biomass is primarily performed by USDA and DOE. The DOE bioenergy research centers do much of the basic and discovery research, while USDA generates knowledge of regionally appropriate feed stocks, as well as other items.

Last but not least, water quality management for an abundant, safe and treatable supply of water for potable and recreational uses is a major challenge, and one that will only increase in the future as water becomes scarcer. EPA's Office of Research and Development is a key supporter of research in this area, as is USDA's REE and Natural Resource Environment mission areas, which include the Forest Service. Because water is so important for life and used in numerous ways, many other departments have research on water-related issues.

Chapter 27 is a disciplinary assessment of R&D dedicated to nutrition, food safety, food security, natural resources, and renewable energy issues. As a result, it has not captured all of the federal resources devoted to related R&D. However, Chapter 27 provides a useful look at the primary resources available in FY2010 compared to those proposed by the Administration in FY2012.

Finally, we wish to point out that the four USDA science agencies—ARS, NIFA, Economic Research Service, and Forest Service—together with their university partners, have provided the leadership around which at least 20 other government agencies and numerous other partners came together in the joint projects represented in the 61 cases nominated for presentation at today's the R&D round table. The cases involved genomics to increase the understanding of fundamental biological processes and support crop and animal production; nutrition; food safety; soil and water conservation; wild land restorations; and biofuels. There are many public and private sector collaborations occurring that further capitalize on the relative strengths of government and industry. Although changes in the ways that USDA funds are allocated are likely to occur, the major proposed reductions in total resources available for USDA are likely to jeopardize the ability of USDA and its university partners to provide the leadership to create the synergies necessary to obtain the greatest societal returns from federal investments in agriculture, food and natural resources R&D. *Contacts and Web site: pclemins@aaas.org, cgala@agronomy.org, wfisher@ift.org; www.aaas.org/spp/rd*

*Editor's note: While the scope of the presentation was not modified, some additional information was added that was not available at the time of the presentation.*

## Case Studies Selected for Presentation

### Sequencing the Bovine Genome

**Jerry Taylor** - *University of Missouri*

**Steve Kappes and Curt Van Tassell** - *Agricultural Research Service, USDA*

The development of cattle genomics resources has been very collaborative in nature. Starting with the development of a physical map necessary to construct the genome assembly, a community-based map was developed across a broad array of institutions. The Bovine Genome Sequencing Consortium involved more than 100 institutions, and a related investigation of cattle diversity incorporated 40 institutions. Finally, a smaller group developed a variety of resources necessary to develop the BovineSNP50, the *de facto* standard in cattle genomics research in the recent past. This group incorporated a number of USDA's Agriculture Research Service locations, the University of Missouri, and Illumina, Inc. This research was supported by the USDA competitive grants program, as well as funding from private companies. Results of this effort have had a major impact on the dairy artificial insemination

industry—predictions of genetic merit enhanced by this genome-wide SNP data are being calculated and actively used to make selection decisions on cows and bulls by Holstein, Jersey and Brown Swiss breeders. The industry received immediate benefits from substantial gains in accuracies of predicted genetic value early in an animal's life, allowing easier identification of superior animals at a lower cost. This outcome will permit more rapid genetic gain due to an increase in selection pressure that can be applied. Due to progress made by implementation of the technology developed by members of this consortium, farmers who wish to sell elite female genetics must genotype their cows, and bulls that have not been genotyped are no longer competitive in the marketplace.

*Contacts: taylorjerr@missouri.edu, steve.kappes@ars.usda.gov, and curtvt@ars.usda.gov.*

### National Food and Nutrient Analysis Program (NFNAP)

**John Milner** - *National Institutes of Health, National Cancer Institute*

**David Klurfeld** - *Agricultural Research Service, USDA*

To increase the breadth and depth of data on nutrients and bioactives in food available to government policy makers and university-based researchers, NFNAP was started in 1997. Currently, a consortium of nine U.S. Department of Health and Human Services agencies (6 units from National Institutes of Health, Food and Drug Administration, Centers for Disease Control and Prevention, Indian Health Services) and USDA's Agriculture Research Service contribute specific goals and funding to this activity. Objectives of NFNAP are to: identify key foods that provide more than 75% of any specific nutrient, analyze selected key foods, develop databases for high priority foods consumed by U.S. ethnic subpopulations, develop new databases for nutrients and bioactive food components, and develop a validated database for ingredients in dietary

supplements. Multiple special interest databases have been created that increase dietary knowledge and facilitate research on dietary components, such as added sugars, choline, fluoride and isoflavones. Since NFNAP started, there have been more than 5,300 peer-reviewed research studies using dietary data from the National Health and Nutrition Examination Survey, the only nationally representative diet survey in the U.S. These studies are the basis for much of the association of health and weight status with nutritional intake. *Contacts and Web sites: milnerj@mail.nih.gov and david.klurfeld@ars.usda.gov; ARS NFNAP Home Page: <http://www.ars.usda.gov/Research/docs.htm?docid=9446>; Dietary Supplement Ingredient Database: <http://dietarysupplementdatabase.usda.nih.gov/>.*

### Cooperative Partnerships to Improve Food Safety and Public Health

**Mindy Brashears and Mark Miller** - *International Center for Food Industry Excellence,*

*Texas Tech University*

In Mexico, food-borne disease is the principal cause of mortality among pre-school children. Compounding the challenges posed by food-borne disease, Mexico is the

number one export market for beef from the United States. Mexico has adopted legislation that includes a "zero tolerance" policy for the presence of *Salmonella* in imported

meat, which can have a detrimental impact on U.S. meat trade. Our team has undertaken collaborative programs to determine the extent of these problems. Our objectives were to (1) determine the *Salmonella* baseline in meat products, (2) determine the prevalence of pathogens in Mexican beef feedyards and the avenues by which pathogens are transferred to carcasses, and (3) ultimately improve the safety of the product through training in food safety. We determined avenues of contamination in a slaughter facility, and that *Salmonella* prevalence could be reduced

on carcasses with the implementation of training and interventions. We also determined that meat from open markets had up to 80% contamination with *Salmonella*, while meat in supermarkets produced in inspected facilities had less than a 5% prevalence. The findings have emphasized the need for continued efforts to further protect the food supply. The team has started similar work in Honduras, Belize and Argentina. *Contacts and Web site: mindy.brashears@ttu.edu and mfmrraider@aol.com; www.icffe.org.*

### **Providing Needed Pest Control Tools for U.S. Production, Exportation and Importation of a Wide Variety of Specialty/Minor Crops Through a Crop Grouping System**

**Steven Bradbury** - Director, Office of Pesticide Programs, U.S. Environmental Protection Agency  
**William Barney**, USDA IR-4, and **Paul Schwartz** - Agriculture Research Service, USDA

Registering pesticides is expensive. More than 100 scientific studies are required for new food use chemicals, including data development on the amount of residues on crops resulting from pesticide applications. Growers of specialty food/minor use crops have historically had difficulty securing the tools necessary to protect their crops. Pesticide manufacturers are reluctant to spend monies to develop the data when they will not recoup their initial investment through product sales. One way in which the U.S. Environmental Protection Agency's (EPA) Office of Pesticide Programs, in collaboration with the U.S. Department of Agriculture's IR-4 Project, has eased the regulatory burden of pesticide registration on all food crops is by grouping similar crops expected to have the same levels of pesticides on them following treatment. This "crop

grouping" concept allows for testing on a few representative crops in the "group" to be used for the others in the group. This effort has been used to facilitate the establishment of the maximum allowable pesticide levels (tolerances) for a large number of crops; save on research and scientific study dollars; and, reduce EPA's review time and resources. Growers benefit with pest control tools more quickly approved for U.S. production of a wide variety of specialty food crops in demand by consumers. *Contacts and Web sites: bradbury.steven@epa.gov; http://www.epa.gov/pesticides/food/feed, barney@AESOP.Rutgers.edu, and paul.schwartz@ars.usda.gov; http://ir4.rutgers.edu/NewsItems/crop%20grouping%20brochure\_crop%20grouping%20brochure.qxd.pdf. Also see EPA docket: EPA-HQ-OPP-2006-0766 at www.regulations.gov*

### **Sustaining Rural Economies through Agricultural Production and Water Management**

**David Brauer** - Agricultural Research Service, USDA  
**Daniel Devin** - Kansas State University  
**Terry A. Howell** - Agricultural Research Service, USDA

A research team of approximately 85 engineers and scientists, primarily from Kansas and Texas, has been assembled into the Ogallala Aquifer Program to address the problems associated with the decline of the Ogallala Aquifer on the southern High Plains. Aquifer depletion rates are 1 foot to 3 feet annually. Agricultural irrigation accounts for 90 percent of the groundwater withdrawals. A growing livestock industry uses another 3 percent. The region's irrigated cropland accounts for approximately 20 percent of the total irrigated acreage in the nation, using approximately 30 percent of the nation's irrigation water. Efficient use of the aquifer is important to America's agricultural production in terms of competitiveness, markets and food security, and

is of critical importance to maintaining water supplies and agricultural production for the future. Research efforts have and will lead to improved conservation of water, soil, rangeland and biotic components of the region's ecosystems. Knowledge and education efforts are needed to sustain the economic viability of agriculture and urban areas, and clarify the dynamics that affect water distribution between these two groups. Therefore it is important that the Ogallala Aquifer Program develops sound databases and new practices to guide water use, and for developing fair and equitable water policies. *Contacts and Web site: david.brauer@ars.usda.gov, ddevlin@ksu.edu, and terry.howell@ars.usda.gov; http://www.ogallala.ars.usda.gov/.*

## **Conservation Effects Assessment Project (CEAP)**

**Mark R. Walbridge** - *Agricultural Research Service, USDA*

**Lisa Fiorina Duriancik** - *Natural Resources Conservation Service, USDA*

The Conservation Effects Assessment Project (CEAP) was established to assess and quantify the effects of conservation practices on environmental quality at national, regional and watershed scales, and to build a solid foundation of science to improve resource assessment, conservation planning, and implementation. Findings inform USDA and other conservation policy and programs, and help farmers, ranchers, and land managers make informed conservation decisions. Coordination and collaboration are critical to the success of CEAP. Established in 2003, CEAP now involves > 60 partner organizations and hundreds of scientists representing 7 USDA and 6 other federal agencies and a host of non-federal partners (universities, agricultural producers, scientific societies, Non-government Organizations, and stakeholders). CEAP is organized

around 3 sets of integrated activities: 1) National and Regional Assessments for Croplands, Wetlands, Grazing Lands, and Wildlife; 2) Watershed Assessment Studies; and 3) Bibliographies, Literature Reviews, and Scientific Workshops. CEAP has produced a national research and extension network of 42 watershed studies; a significant increase in our understanding of conservation practice effects on environmental quality; improved planning tools for land managers; and an increase in the effectiveness of conservation programs. By focusing resources to improve outcomes, CEAP is making conservation management more effective. *Contacts and Web site: ark.walbridge@ars.usda.gov and Lisa.Duriancik@wdc.usda.gov; <http://www.nrcs.usda.gov/Technical/nri/ceap/>.*

## **Making Informed Wildland Restoration Decisions in the Northwest and Southwest**

**Janine Salwasser and Lisa Gaines** - *Institute for Natural Resources*

**Miles Hemstrom** - *U.S. Forest Service*

The Integrated Landscape Assessment Project (ILAP) is a two-year effort funded by the American Recovery and Reinvestment Act to create and/or retain approximately 50 jobs focused on watershed-level prioritization of restoration in Arizona, New Mexico, Oregon and Washington ([www.oregonstate.edu/inr/ilap](http://www.oregonstate.edu/inr/ilap)). The dynamics of broad-scale, multi-ownership landscapes over time are explored by evaluating and integrating information on current and future vegetation and fuel conditions, wildlife habitat, watershed conditions, climate change impacts, and the potential costs and benefits of management treatments. By early 2012, products from the project can be used by land managers, program managers, planners, and policymakers to make restoration decisions and evaluate management strategies that reduce fire risk, improve habitat, and benefit rural communities. ILAP is a partnership involving federal and state agencies, universities, local collaborative landscape groups and other partners. The project will produce consistent mid-scale vegetation data, potential vegetation data, ownership and management allocations, and other necessary mapping for all major wildland ecosystem types in the four states. State and transition computer modeling is used to forecast ecosystem

dynamics. To date, 80 GIS layers and 250 unique vegetation models have been produced by the project teams. Data are analyzed and integrated to generate new information about: 1) existing fuel conditions and how they might change over time; 2) selected wildlife habitats and how management treatments might affect them; and 3) the potential costs and benefits of different management treatments, including the economic potential of the material removed by the treatments and opportunities for new products. Decision support tools will be developed for use by land managers to make informed restoration decisions about current and future landscape conditions. Because it allows for integration of many management objectives, ILAP facilitates collaborative landscape planning and assessments over very large areas. ILAP methods should be widely applicable for wildlands throughout the west and in many other places. A regional web portal will be developed to provide access to the data, tools, models and information produced. *Contacts and Web sites: [janine.salwasser@oregonstate.edu](mailto:janine.salwasser@oregonstate.edu), [lisa.gaines@oregonstate.edu](mailto:lisa.gaines@oregonstate.edu), and [mhemstrom@fs.fed.us](mailto:mhemstrom@fs.fed.us); <http://ecoshare.info/ILAP/>; <http://www.fs.fed.us/r6/ILAP/about-ILAP.shtml>; and <http://inr.oregonstate.edu/arrafuels/>.*



## Cellulosic Biofuel Production

**JunYong (J.Y.) Zhu** - *U.S. Forest Service*

**XueJun Pan** - *University of Wisconsin*

**Bruce Dien** - *Agricultural Research Service, USDA*

This project developed a robust and commercially promising biochemical conversion technology for efficient conversion of woody biomass—especially those of softwood species—to sugars and biofuel (ethanol). We achieved an ethanol yield of 73 gallons/ton wood, or 72% theoretical yield, from lodgepole pine using conventional *Sacchromyces cerevisiae* without fermenting xylose. Furthermore, we achieved net energy output (from ethanol only) over 4 GJ/ton wood before distillation. These results represent the state of art in cellulosic ethanol research. The technology includes three components: 1) Efficient pretreatment of wood chips using sulfite (SPORL) to achieve near complete saccharification of softwood cellulose; 2) A post-pretreatment wood size reduction strategy, as opposed to pre-pretreatment size reduction as commonly practiced to significantly reduces wood size-reduction energy consumption by an

order of magnitude while achieving efficient hydrolysis at low enzyme dosages; 3) The application of metal salts to reduce or eliminate solid substrate washing to decrease water consumption in biorefinery operations. This project also developed a private and public partnership for developing technologies for commercialization. Through this project, we developed cohesive collaboration between USDA Forest Service, USDA's Agricultural Research Service, University of Wisconsin-Madison, University of Florida, and three industrial partners. The industrial partners provided advice to focus on addressing critical issues to technology commercialization. *Contacts and Web site: jzhu@fs.fed.us, xpan@wisc.edu, and Bruce.Dien@ars.usda.gov; http://www.fpl.fs.fed.us/people/bios/employee\_level\_bio.php?employee\_id=160.*

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## Case Studies Selected for Special Recognition

### International Swine Genome Sequencing Consortium

**L. Schook** - *Animal Sciences and Institute of Genomic Biology, University of Illinois*

**A. Archibald** - *Roslin Institute and Royal (Dick) School of Veterinary Studies, University of Edinburgh*

**M. Groenen** - *Wageningen University*

The pig genome was sequenced and characterized under the auspices of the Swine Genome Sequencing Consortium. In accordance with the Bermuda and Fort Lauderdale agreements and the more recent Toronto Statement, the data have been released into public sequence repositories (Genbank/EMBL, NCBI/Ensembl trace repositories). Assemblies of the genome sequence have been annotated using the Pre-Ensembl and Ensembl automated pipelines and made accessible through the Pre-Ensembl / Ensembl browsers. The pig genome was sequenced following a hybrid approach. Briefly, BAC clones selected to represent a minimal tile path across the genome were identified from the high resolution pig-human comparative physical (BAC contig) map and subjected to hierarchical shotgun sequencing. BAC clones (CHORI-242) prepared using

DNA from a single Duroc sow (Duroc 2-14) were preferentially chosen for sequencing. In practice, both ends of 768 subclones for each BAC were sequenced (average read length—707 bp) to provide ~4x coverage. BAC clones were subjected to one round of automated pre-finishing by primer walking from the ends of the clone sequence contigs constructed from the initial 4x coverage skim sequencing. This hierarchical shotgun sequencing was primarily undertaken at the Wellcome Trust Sanger Institute, with some additional clones sequenced by the National Institute of Agrobiological Sciences, Japan. In addition, 40x whole genome shotgun sequence data (Korea, China and Sanger) were generated from DNA isolated from the same animal, Duroc 2-14. *Contact and Web site: schook@illinois.edu; http://www.piggenome.org/.*

## National Dairy Genetic Evaluation Program

**H. Duane Norman - Agricultural Research Service, USDA**

The National Dairy Genetic Evaluation Program is a continuation of a USDA collaboration with the U.S. dairy industry on genetic evaluation of dairy cattle that has been ongoing since 1908. Data are provided by dairy records processing centers (yield, health, pedigree, and reproduction traits), breed registry societies (pedigrees and genotypes), and artificial-insemination organizations (pedigrees, reproduction data, and genotypes) for inclusion in the national dairy database maintained by USDA's Agricultural Research Service at the Animal Improvement Programs Laboratory (AIPL). Using those genomic and phenotypic data, genetic progress of U.S. dairy animals is analyzed by AIPL for economically important traits (milk and component yields, component percentages, longevity, mastitis resistance, fertility and calving traits, and conformation) and genetic-economic indexes for overall

merit, fluid milk and cheese yield. That information is made available to the dairy industry (including individual dairy producers) through the AIPL Web site for use in breeding and other management decisions to improve milk production of future generations of dairy animals and thus the efficiency of the national dairy herd and prices of dairy products. A more efficient national herd also provides dairy products with a smaller cattle population, thereby reducing any adverse environmental impacts and conserving natural resources. Annual milk yield of 9.1 million U.S. cows today is more than 21,000 pounds per cow compared with less than 9,500 pounds for 12.5 million cows in 1970; more than 60% of that gain is attributable to genetics.

*Contact and Web site: [duane.norman@ars.usda.gov](mailto:duane.norman@ars.usda.gov);  
<http://aipl.arsusda.gov>.*

## Center for Nutrition and Pregnancy (CNP)

**Lawrence P. (Larry) Reynolds - North Dakota State University**

The CNP was established in 2002 with an overall goal to use animal models to increase the proportion of healthy, productive offspring by ensuring an optimal maternal environment during pregnancy and lactation. Various factors—such as poor maternal nutrition, maternal activity/exercise, maternal social or environmental stress, maternal age, maternal or fetal genotype, singleton vs. multiple fetuses/offspring, sex of fetus/offspring, and assisted reproductive technologies, including in vitro fertilization and cloning,—all can lead to low-birth weight, and thereby contribute to the high neonatal mortality (8 percent to 10 percent) in livestock and humans in the United States. Moreover, growth restricted offspring may be at risk not only of postnatal complications but also may be “programmed” to develop metabolic syndrome, poor growth, inappropriate body composition, immune

dysfunction, reproductive failure, and poor cognitive development, as well as a host of other significant problems later in life. This concept has been termed “Developmental Programming.” In humans, it may perpetuate health problems and social difficulties over generations; in livestock, it may impact meat, milk and fiber production and hence economic returns. Because of the potential socioeconomic impact of Developmental Programming, CNP has received funding from a variety of state and federal agencies, as well as private companies. Since its inception, CNP has become one of the premiere centers in the United States addressing Developmental Programming, and currently involves 15 key investigators and 26 collaborators from throughout the United States and the world.

*Contact and Web site: [Larry.Reynolds@ndsu.edu](mailto:Larry.Reynolds@ndsu.edu);  
<http://www.ag.ndsu.edu/cnp/about-cnp>.*

## USDA National Agroforestry Center (NAC)

**Carlos Rodriguez-Franco and Andy Mason - U.S. Forest Service**

NAC is a long-standing partnership between USDA's Forest Service (Research & Development and State & Private Forestry mission areas) and USDA's Natural Resources Conservation Service. The Center develops and delivers science, tools and training on a broad suite of agroforestry

practices for natural resource professionals who work directly with farmers, ranchers, woodland owners and communities nationwide. Through its R&D and Technology Transfer programs, NAC cooperates with a national network of agencies, universities/extension,

non-governmental organizations, Tribes, communities, practitioners, and citizens to produce successful tools, guidebooks and informational products, and to advance science through projects such as: 1) CanVis software kit, which allows users to visually simulate applied conservation practices; 2) Windbreak Brochures that provide guidelines for establishing or renovating windbreaks/shelterbelts; 3) Conservation Buffers Guide, a planning and design tool that describes how a vegetative buffer can be applied to protect soil, improve air and water quality, produce

economic products; 4) a DVD, *Silvopasture: 30 Years of Applying Research and Innovation*, that explains the benefits and requirements for a pine silvopasture system in the Southeast United States; and 5) *Forest Farming Networks*, where citizens help with research and demonstrate the viability of growing native plants as an alternative income source. *Contacts and Web site: crodriguezfranco@fs.fed.us and amason@fs.fed.us; http://www.unl.edu/nacl.*

## Gypsy Moth Slow-the-Spread Program

**Robert Mangold and Patrick C. Tobin - U.S. Forest Service**

The gypsy moth Slow-the-Spread program (STS) is a U.S. Forest Service and cooperating state integrated pest management strategy to minimize the spread of gypsy moth, an economically important non-native pest of North American forests. The invasion of gypsy moth into new areas inimically affects ecological communities and international and interstate commerce, as well as posing a considerable nuisance to humans. The STS program is currently implemented across 11 states from Minnesota to North Carolina. The objective is to deploy grids of pheromone-baited traps along the expanding population front to identify and subsequently eliminate newly-founded colonies to prevent them from growing, coalescing, and contributing to the progression of the population front.

The STS program takes advantage of research discoveries on gypsy moth, namely its mechanism of spread through stratified dispersal, its semiochemical-based communication system, and known economic benefits from slowing its spread through a delay in the costs associated with outbreaks and quarantine measures. Prior to the implementation of STS, gypsy moth spread rates were  $\approx 20$  km/yr. Under STS, rates have been reduced to less than 4 km/yr, which has prevented gypsy moth infestation on more than 400,000 km<sup>2</sup> since 2000 at a documented benefit-to-cost ratio of 3 to 1. *Contacts and Web site: rmangold@fs.fed.us; ptobin@fs.fed.us; and http://www.gmsts.org/.*

## Development and Adoption of Best Management Practices to Improve Water Quality

**Daniel L. Devlin - Kansas State University**

The Little Arkansas River watershed is located in central Kansas. Three (2006), five (2007) and six (2008, 2009) HUC-12 watersheds were targeted for implementation of best management practices (BMPs) for atrazine herbicide. A USDA National Institute for Food and Agriculture grant was used to fund education and research activities. An educational program was delivered to train 617 farmers and pesticide dealers. Demonstration/research sites were developed at three farmer field sites to discover and evaluate the effectiveness of agricultural BMPs. The city of Wichita, state agencies and the U.S. Environmental Protection Agency provided \$190,000 in funding for incentive payments to farmers. A Kansas State University Extension agronomist made 361 on-farm visits with farmers to get their commitment to implement atrazine BMPs. From 2006-2009, farmers implemented atrazine BMPs on

51,525 corn and grain sorghum acres, resulting in 66% (2006), 40% (2007), 65% (2008), and 51% (2009) lower atrazine concentrations in streams in targeted watersheds in which BMPs had been implemented. Watershed GIS maps and modeling were used to select a subwatershed for targeted BMPs adoption efforts to reduce sediment delivery. Using funding from a USDA Natural Resources Conservation Service grant (\$450,000), a BMP implementation training and incentive program was developed. Outcomes included 25 farmers committing to implementing BMPs on 138 crop fields (4,810 acres) resulting in a reduction in annual sediment delivery to streams in the watershed from 9,219 tons to 2,926 tons. *Contact and Web site: ddevlin@ksu.edu; http://www.kcare.ksu.edu/DesktopDefault.aspx?tabid=921.*

## Lessons Learned

**Edward A. Hiler**

*Vice Chancellor for Agriculture and Natural Resources Emeritus, Texas A&M University,  
and Secretary-Treasurer, Riley Memorial Foundation*

It has been a real pleasure to see the progress that is being made. We have had very impressive speakers including the presentation of an outstanding collection of case studies. It was rather striking to me that some 25 different federal agencies collaborated in the 61 cases that were nominated for inclusion in the round table. And many of those entities are represented here today. We have seven different agencies from USDA here today, and that's what you would expect. In addition to that, we are here at the headquarters of the American Association for the Advancement of Science and we have had major involvement from the Office of Science and Technology Policy, along with representation from National Science Foundation, National Institutes of Health, U.S. Environmental Protection Agency, U.S. Department of Energy, and the U. S. Geological Survey. I would also note we have full-time representatives from eight scientific societies, as well as members of several other societies.

My approach in leading the agricultural program at Texas A&M University—and it still is called Agriculture and Life Sciences, it is research and Extension that have the AgriLife names—my approach there, my mantra was “Together We Can.” I didn't set it up that way. It just happened. And how appropriate for what we're doing here today. Obviously, we focused on making sure we're all together internally first, but then progress through partnerships is what we are really all about. The power of partnerships is something that I believe in very, very strongly.

In addition to the various agencies, I want to commend the representatives of the Riley Memorial Foundation, Farm Foundation NFP, the Institute of Food Technologists, the Federation of Animal Science Societies, the Agronomy, Soil and Crop Science Societies of America, and the others for having the vision and foresight to put this together. In addition, numerous individuals on the various planning committees provide valuable inputs. We also have several major Land Grant universities involved around the country, as well, and other state universities represented.

The purpose of the round table was to highlight 14 exemplary R&D collaborations and I'll say synergistic

collaborations. Synergism is one of my favorite words, too, and I think synergism was involved in all of the cases. To highlight these cases for the purpose of stimulating increased synergistic collaborations has been very enlightening. I am sure that there are a lot more similar cases out there and we would all benefit if we looked at a lot more.

The power of partnerships has been emphasized by nearly every speaker. Shere Abbott started by saying that partnerships are crucial. Also, Jane Silverthorne said it very well in emphasizing how absolutely crucial partnerships are. She went on to emphasize the importance of partnerships for coordination, for sharing knowledge, and for developing innovative ideas that result from sharing the knowledge and leveraging scarce resources.

We all know what we're facing in terms of available resources. And there is one good thing about—well, we try to look for the positive in everything—scarce resources. It does stimulate people to work together.

Wendy Wintersteen talked about a book that I found interesting called *The Liquid Network*. The book makes the point that individuals get a whole lot smarter when they are connected to a network and that chance favors the connected individual.

Cathie Woteki said a lot of things that I thought were really good. She mentioned that agriculture and natural resources are at the heart of the world's greatest challenges today. She also mentioned two important articles in the *Washington Post* and the societal problems covered in those articles. We've been in a situation where our government, because we have had an abundant and inexpensive food supply, if you ask many government officials to list off the top 10 issues facing our country, food doesn't get on that list. But that is going to change and that is the point that Dr. Woteki was making, and I believe that's exactly right.

Impending food shortages will create increased costs for food. We all know that. If anybody looked at the

commodity prices right now, of agriculture commodities, you'll see that that's going to get translated into an increased food cost in a hurry, and we all know about increased energy costs, as well. So strategic partnerships across federal agencies and across states—anyway you can look at it—including national and international partnerships, are very, very important.

Just talking about one of the areas that Dr. Woteki focused on, food security, there will likely be a need to double food production by the year 2050. Now, that is going to take a lot of the kinds of things that Jerry Taylor and others have talked about in terms of research findings. I found it interesting we're now producing a third more milk with half the number of cows than we were some 40 years ago. I didn't realize that research had made that much difference. I grew up on a dairy farm and things were very different then. Nutrition, food safety, availability of water, sustainability, environmental quality and global climate change are all issues that rear their ugly heads all the time, and collaborative R&D like we have heard about today can help us meet the challenges before us to the benefit of all of society.

I just had the opportunity to review a book for a church group. The book is entitled, *Our Suicidal Planet*. It was written by a couple of fellows from England. The only solution they came up with that they felt is going to make a difference is to get all the governments of the world to agree on an approach to meeting energy needs and managing carbon emissions. Technology certainly is going to help this situation, and we're seeing a lot of things in that regard right now. I think the authors of this book took a narrow view, but the broader view presented here today represented some big societal needs that move food and agriculture to the forefront, and these needs will be more and more in the forefront as time goes on.

Dr. Woteki also talked about 2012 being the 150th anniversary of the Morrill Act. That's a really interesting thing that we take for granted today. But our forefathers—Jefferson, Adams, Franklin and others—felt that the experiment that they were a part of, the experiment being a participatory democracy in this country, would only work if there was an educated electorate. College education at that time was for the elite and really the socially elite when you get down to it—not necessarily the intellectual elite. It came from the European system, and that's what the

system was in this country. A fellow by the name of Jonathan Baldwin Turner went on a campaign, became a zealot to get this thing done, to get a grand act established—an act that would provide universities where everybody who was intellectually able would have the possibility of a higher education.

There is long story associated with it. The proposed act was defeated several times before it got passed in 1862 and Lincoln signed it. The Morrill Act or the Land-Grant Act was the first civil bill that he signed, and it was during the greatest crisis we were facing in this nation. Justin Morrill was a young House member from Vermont who Turner was able to get to carry that bill. And he felt like he was successful when—just before 1860—he was able to get Lincoln to tell him: "If I'm elected president, I'll sign your bill." Then he got Stephen Douglas to say the same thing on the other side. So he felt like he had it. Then, of course, the Civil War encroached.

But that one thing of providing the opportunity for higher education made a big, big difference. Before that, universities were more like monasteries. You go to the mountain and you learn. There was nothing focused on serving the people. Extension programs—it is not surprising that when we have visitors from other parts of the world, they particularly want to know about Extension. They want to know about how to do the outreach that was a commitment to serving the public that was a part of that Land-Grant Act.

In closing, I would like to point out that the United States has historically enjoyed an ample food supply. Unfortunately, until recently complacency has clouded the need for agricultural, food, nutrition and natural resources R&D investments. However, the magnitude of the challenges facing U.S. and world agriculture today—including a population that is expected to increase by 50 percent by 2050 and growing competition for natural resources—has brought new attention to the importance of R&D. Fortunately, nearly 150 years ago, the Morrill Land-Grant Act established the institutional capacity to address agricultural crises. Today, based on the value of expanded partnerships highlighted in the R&D round table, society would be well served by leveraging that capacity as part of expanded partnerships throughout the broad R&D community.

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## Organizers and Collaborators

**Charles Valentine Riley Memorial Foundation** ([www.rileymemorial.org](http://www.rileymemorial.org)), founded in 1985, endeavors to promote a broader and more complete understanding of agriculture as the most basic human endeavor; to make secure the lever that is agriculture and its fulcrum, the natural environment, during this and succeeding generations; and to enhance agriculture through increased scientific knowledge.

**Farm Foundation, NFP** ([www.farmfoundation.org](http://www.farmfoundation.org)), works as a catalyst for sound public policy by providing objective information to foster a deeper understanding of issues shaping the future for agriculture, food systems and rural regions. Farm Foundation does not lobby or advocate.

**Institute of Food Technologists**, ([www.ift.org](http://www.ift.org)), exists to advance the science of food. Its long-range vision is to ensure a safe and abundant food supply contributing to healthier people everywhere. IFT strives to provide an inclusive and welcoming community for all food science and technology professionals and the knowledge and tools they need to enhance their professional capacity and competency.

**Federation of Animal Science Societies** ([www.fass.org](http://www.fass.org)), strengthens the common interests and collective good of member societies through a unified science-based voice that supports animal agriculture, animal products and food systems globally through effective and efficient management services.

**American Society of Agronomy** ([www.agronomy.org](http://www.agronomy.org)), **Crop Science Society of America** ([www.crops.org](http://www.crops.org)), and **Soil Science Society of America** ([www.soils.org](http://www.soils.org)) are scientific societies helping their 10,000+ members advance the disciplines and practices of agronomy, crop, soil sciences and related disciplines by supporting professional growth and science policy initiatives, and providing quality, research-based publications, certification programs, and a variety of member services.

**Agricultural Research Service** (<http://www.ars.usda.gov/main/main.htm>) is the largest intramural research agency of USDA. ARS has a workforce of around 8,000 employees, including 2,500 life and physical scientists who represent a wide range of disciplines and who work at more than 100 locations across the country and at five overseas laboratories. The ARS research agenda is broad, with about 1,200 research projects organized under four major program areas: Nutrition, Food Safety and Food Quality; Animal Production and Protection; Natural Resources and Sustainable Agricultural Systems; and Crop Production and Protection.

**Economic Research Service** (<http://www.ers.usda.gov/>) is USDA's primary source of economic information and economic and social science research. ERS' mission is to anticipate economic and policy issues related to food, agriculture, the environment, and rural development, and conduct research that informs public program and policy decisions.

**National Institutes of Food and Agriculture** (<http://www.nifa.usda.gov/>) is USDA's primary extramural research funding agency. Its mission is to advance knowledge for agriculture, the environment, and human health and wellbeing by funding targeted research, education and extension projects and programs, some of which are specific to the Land-Grant University System, others open to participation by other partner organizations.

**Forest Service** (<http://www.fs.fed.us/>) is USDA's largest agency with an overall mission to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. The Forest Service comprises three natural resource mission areas: Research and Development (R&D), State and Private Forestry, and the National Forest System. Forest Service R&D works at the forefront of science to improve the health and use of our Nation's forests and grasslands. Today, some 500-plus Forest Service researchers work in a range of biological, physical and social science fields to promote sustainable management of diverse forests and rangelands (<http://www.fs.fed.us/research/>).

### **National Agricultural Research, Extension, Education and Economics Advisory Board**

([http://nareeeab.ree.usda.gov/nal\\_display/index.php?info\\_center=20&tax\\_level=1](http://nareeeab.ree.usda.gov/nal_display/index.php?info_center=20&tax_level=1)) provides advice to the Secretary of Agriculture and Land-Grant colleges and universities on top priorities and policies for food and agricultural research, extension, education and economics. The main objective of NAREEEAB is to contribute to effective federal agricultural research, education and economics programs through broad stakeholder feedback and sound science. The Board also, by mandate, consults with appropriate agricultural committees of the U.S. Congress.

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