



U.S. Department of Agriculture Annual Report on Technology Transfer FY2015

AGRICULTURE



Crop shares of the value of California's crop output, 2012-14 average

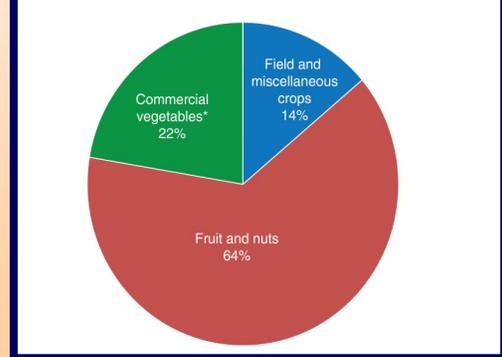


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INTRODUCTION

President Abraham Lincoln coined the phrase “the People’s Department” acknowledging the role of the Department of Agriculture in solving problems that benefits all people every day. Thus, well before the coining of the modern day phrase of “technology transfer,” it was the culture of USDA to deliver solutions to the people of the United States. Today, USDA broadly defines technology transfer as the adoption of research outcomes (i.e., solutions) for public benefit. A seemingly simple statement, the process of adoption is complicated, requiring integration of many assets from disparate sources in the successful delivery of solutions. “Public benefit” is achieved through many mechanisms including public release of information, tools, and solutions (e.g., germplasm, plants and other materials), adoption and enhancement of research outcomes by partners through collaborative research, formal cooperative research and development agreements (CRADA) authorized by the Federal Technology Transfer Act (1986), direct federal, state, or local technical assistance, or through licensing of biological materials or protected intellectual property directly to not-for-profit entities and for-profit private sector firms. Additionally, successful adoption of USDA knowledge and research outcomes typically requires complementary assets and services provided by multiple agencies in USDA, including agencies that are not primarily engaged in direct research in the physical and life science arenas.

Private sector involvement in technology transfer adds the benefits of creating new or expanded businesses, jobs, and economic prosperity. Science-based innovations from USDA intramural research --- often developed through public-private partnerships (PPPs)- create new or improved technologies, processes, products and services that benefit the nation by increasing productivity, increasing efficiency (keeping costs low) and enhancing global competitiveness for the U.S. agriculture sector. Thus, technology transfer functions are critical to accelerating utility of public R & D investments, creating economic activity, and in job creation and sustainable economic development.

The Agricultural Research Service (ARS) has been delegated authority by the Secretary of Agriculture to administer the patent program for ARS, and to review CRADAs and administer technology licensing programs for all intramural research conducted by USDA. These activities are housed in the Office of Technology Transfer.

On October 28, 2011, following a series of reports identifying the status of technology transfer from federal funds and federal laboratories, the White House issued the Presidential Memorandum – “Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses.” Issuance of this Memorandum provided an unprecedented opportunity for unifying technology transfer across USDA S&T agencies as the mechanism to deliver these outcomes for public good. In the USDA’s response to the Presidential Memorandum (<http://www.nist.gov/tpo/publications/upload/USDA-Tech-Transfer-Plan.pdf>), several initiatives were identified to promote technology transfer and commercialization. These initiatives ushered in a new era of unprecedented collaboration among agencies of USDA to enhance services and opportunities to the customers and stakeholders of the Department. This Report describes progress in implementing these initiatives.

This report also covers technology transfer activities and metrics for the Agricultural Marketing Service (AMS), Animal and Plant Health Inspection Service (APHIS), Agricultural Research Service (ARS), Economic Research Service (ERS), Foreign Agricultural Service (FAS), Food Safety and Inspection service (FSIS), Forest Service (FS), Grain Inspection, Packers and Stockyards Administration (GIPSA), and National Institute of Food and Agriculture (NIFA), Natural Resources Conservation Service (NRCS) and Rural Development (RD).

COMBINED METRIC TABLES FOR ALL USDA AGENCIES**Table 1: Invention Disclosures and Patents from APHIS, FS and ARS.**

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Invention Disclosures					
Number of new inventions disclosed	158	160	191	117	222
Patents					
Number of patent applications filed	124	122	157	119	125
Number of patents received	49	69	65	83	94

Table 2: Licenses from APHIS, FS and ARS.

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Licenses, Total Active	358	384	400	414	424
Active licenses to small business	ND	119	139	154	150
Active licenses to startups	ND	ND	13	13	13
New licenses	35	34	25	30	35
Invention Licenses, Total Active	322	341	351	363	359
New Invention Licenses	29	28	19	28	20
Income Bearing Licenses	354	379	397	412	421
Exclusive licenses	257	277	291	299	292
Partially exclusive licenses	16	14	13	15	11
Non-exclusive licenses	81	88	93	98	118
Elapsed Amount of Time for Granting Licenses					
Average (months)	5.9	5.8	3.5	5.9	2.8
Minimum (months)	0.6	0.3	0.4	0.9	0.5
Maximum (months)	18.2	19.7	12.5	21.5	10.0

Table 3: Licensing Income from ARS*.

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Earned Royalty Income	\$3,136,813	\$3,059,989	\$3,353,876	\$3,610,774	\$3,509,904
Earned Royalty Income from top 1% of licenses	N/R	N/R	N/R	N/R	N/R
Earned Royalty Income from top 5% of licenses	\$1,932,197	\$1,752,367	\$1,969,155	\$2,048,317	\$1,756,460
Earned Royalty Income from top 20% of licenses	\$2,672,414	\$2,604,008	\$2,892,796	\$3,103,143	\$2,856,924
Minimum Earned Royalty Income	\$6	\$44	\$5	\$32	\$13

Annual Reporting on Technology Transfer in USDA, FY 2015

Maximum Earned Royalty Income	\$630,847	\$757,219	\$856,987	\$575,753	\$728,017
Median Earned Royalty Income	\$4,748	\$5,000	\$3,609	\$3,232	\$3,525
Disposition of Earned Royalty Income					
Percent of Earned Royalty Income distributed to inventors	25%	25%	25%	25%	25%
Percent of Earned Royalty Income distributed to the agency or laboratory	0%	0%	0%	0%	0%
Licenses terminated for cause		0	0	0	0

*Only ARS numbers are reported due to the low numbers of AHIS and FS licenses and their generated income. N/R, data is not reported due to its proprietary nature.

Table 4: Collaborative research agreements from APHIS, FS and ARS.

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Total active CRADAs	292	274	259	267	301
Total newly executed CRADAs	102	65	86	60	80
Total active CRADAs with small businesses	N/A	130	117	102	106
Number of small businesses involved in active CRADAs	N/A	130	117	102	106
Newly executed CRADAs with small businesses					32
Total active traditional CRADAs	207	211	211	193	188
Newly executed traditional CRADAs	68	45	54	39	52
Total active non-traditional CRADAs	85	63	48	74	113
Newly executed non-traditional CRADAs	21	14	21	21	28
Total other collaborative R&D Agreements¹	14,752	14,691	16,199	16,144	14,206
Newly executed other collaborative R&D Agreements	2563	1182	3255	2656	2489

¹Includes Trust Fund Cooperative Agreements, Reimbursable Agreements, Material Transfer Research Agreements, Specific Cooperative Agreements and Non-Funded Cooperative Agreements, Challenge Cost-Share Agreements, Collections Agreements, Cooperative Agreements, Inter-agency & Intra-agency Agreements, Joint Venture Agreements, Participating Agreements, Research Cost-Reimbursable Agreements, Research Joint Venture Agreements.

Response to Presidential Memorandum on Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Business

USDA 1: New metrics proposed for standard annual reporting in addition to those required by Circular A-11 instructions on annual reporting of technology transfer

This initiative was completed in FY2013 and the new metrics are now a standard component of the metric tables.

USDA 2: Update Policy and Procedure (P&P) 141.2 “Technology Transfer in ARS”

An update is necessary to reflect statutory changes since 2000, and to reflect changes in structure and operation of the National Patent Committees, and to include licensing of biological materials and use of the ARP network. A Technology Transfer Process Working Group with representatives from the core functions involved in the technology transfer process was established. As a result of this group, changes were made in the invention disclosure review process, as well as the development of an outline for determining a strategic and tactic technology transfer plans for research projects. Based upon these changes, a new P&P was written in FY 2015 and presently going through the approval process.

USDA 3: Expand Agricultural Research Partnership (ARP) Network efforts to extend the impact of ARS research

The ATIP Network was redesigned and renamed the Agricultural Research Partnerships (ARP) Network. The mission of the new ARP Network is to extend the impact of ARS research by supporting a sustainable and competitive agricultural economy. To further this mission, the ARP Network will assist ARS in creating new partnerships and in supporting existing partnerships to advance ARS research and development (R&D) and subsequent utilization, including commercialization. This expanded mission required a broader membership base. The membership base was increased to include any organization interested in agriculture-based economic development. The ARP Network includes all players in an innovation ecosystem and has members spanning the U.S. with a shared vision to grow and sustain a competitive agricultural economy. Members include ARS and stakeholders interested in agriculture-based economic development such as, but not limited rural agribusiness; urban, community and/or economic development groups; organizations that support farmers, agritourism and/or food processors; and capital programs for business attraction and acceleration. Membership in the ARP Network is formalized through non-funded Trust agreements executed by the Office of Technology Transfer. There are currently 33 ARP Network members. This new network has a web formation in that not only all the members are connected to ARS, but they can connect to each other. We will continue to add members as appropriate.

USDA 4: Expand outreach efforts in technology transfer to scientists in ARS

OTT worked with Office of National Programs to connect ARS scientists’ research capabilities and technologies with a number of different companies. This was done through the ARP Network, responding to public solicitations, responding to industry scouting, and through webinars conducted by Federal Laboratory Consortium. This outreach effort is now an ongoing activity in OTT.

OTT began in FY 2014 the development of standard technology transfer PowerPoint training modules for ARS employees. In FY 2015, the modules were completed (Tech Transfer: Introduction, Tech Transfer: Agreements, Tech Transfer: Patenting and Tech Transfer: Licensing). The PowerPoint modules were converted and posted onto AgLearn for e-training.

USDA 5: Encourage other S&T agencies to adopt OTT's approach to technology transfer

In the past, OTT has provided technology transfer services (policy advice, agreement review, patenting / licensing services, etc.) to the USDA-Animal and Plant Health Inspection Service (APHIS) Wildlife Services, USDA Forest Service (FS), Department of Interior's Bureau of Reclamation (BoR). In FY 2015, these services were expanded through interagency agreements to include APHIS's Wildlife Services, Plant Protection and Quarantine, and Veterinary Services), as well as the FS's Forest Products Laboratory. In addition, the BoR agreement was modified to include the Department of Interior's (DoI) U.S. Fish and Wildlife Service.

USDA has a role in helping to develop Federal government technology transfer policy through OTT's active participation on the Interagency Working Group on Technology Transfer and the White House to Lab-to-Market Working Group. Through these ongoing activities, OTT is taking an active role in promoting activities which support the enhanced adoption of research outcomes.

USDA 6: Explore expanded use of Enhanced Use Lease (EUL) authority as technology transfer tool to promote longer term relationships with key customer groups

Under the 2008 Farm Bill, the Secretary was given the authority to establish a pilot project at the Beltsville Agricultural Research Center (BARC) to lease non-excess property to any private or public entities. The EUL Project was used as a technology transfer tool designed to provide longer term public-private partnerships than can be done through existing technology transfer partnership instruments. The pilot authority was used to develop a process to identify underutilized laboratory resources that could be used by the private sector to commercialize ARS research outcomes. Prospective lessees needed to establish either a licensing partnership or research collaboration with ARS. In exchange, EUL terms provide the lessee 20 years of use of the facility to develop its business. EUL authority proved to be a very successful strategy to leverage resources for entrepreneurial activities. USDA's first lessee (Plant Sensory Systems) was a small business that in FY 2013 was awarded a \$1.8 million ARPA-E grant (Better Biofuel Feedstock from Beets) based on the success of the research project conducted using BARC laboratory facilities. Access to these facilities was essential, because this small business did not have sufficient capital to build the facilities needed for this research project.

This pilot authority for BARC was reauthorized in 2014 Farm Bill. Discussion began in FY2015 to identify a partner to establish an accelerator on the BARC campus for agriculture businesses that utilize ARS technologies and/or research expertise.

USDA 7: Beginning in FY 2012 / 2013, roll out a nationwide series of regional forums to identify issues and deliver solutions

The goal of the regional forums is to provide technology-based solutions to regional agricultural problems for farmers and businesses. A multistep approach was developed for the regional forums: (1) a series of regional listening sessions comprised of businessmen, farmers, economic development organizations, regulatory and extension personnel are held to identify a broad list of regional issues; (2) from the list of issues, those with an existing research-based solution, or a researchable issues that could be addressed by ARS, local universities, cooperative extension, state agencies or agricultural businesses are selected as potential topics for a forum; and (3) finally, a forum is convened as a roundtable discussion on the potential solution(s) and their implementation. Participants in the forum may include farmers, growers, agri-business professionals, university and ARS researchers, extension service personnel, rural development personnel, NIST Regional Manufacturing Extension Partnership (MEP) staff, funding and regulatory agency personnel, as well as ARS technology transfers professionals. Holding regional listening session – forums is now an ongoing activity in OTT. In addition, the listening session – forum approach has been implemented within Mid-Atlantic region of the Federal Laboratory Consortium.

USDA 8: Provide opportunities for applicants to the USDA Small Business Innovation Research (SBIR) program to partner with ARS scientists to further develop science necessary for business success

An SBIR-Technology Transfer Program, a new collaboration between the USDA's National Institute of Food and Agriculture (NIFA) Small Business Innovation Research Program (SBIR) and ARS, was established in FY 2014. This program encourages SBIR applicants to work with ARS researchers and/or license ARS technologies. The relevant language in the SBIR Request for Applications states: "Additional factors that will be considered in the review process include whether an application involves a CRADA with a USDA laboratory, or a license to a USDA technology... A list of available technologies for licensing and CRADAs that may be considered as projects under the SBIR program can be found at the USDA Office of Technology Transfer (OTT) website." This program is now an ongoing activity of OTT and NIFA." In FY 2015, four CRADA projects were submitted for SBIR funding, three of which were awarded. Typically, 10-15% of USDA-SBIR proposals are funded. The higher success rate of CRADA-SBIR proposals (~75%) is likely due to the ARS selection process in identifying and research plan review process for solving agricultural problems of high national priority.

USDA 9: Provide Cooperative Research and Development Agreement (CRADA) partners opportunity to link to local Manufacturing Extension Partnership (MEP) resources to assist in commercialization efforts

When appropriate, ARS CRADA partners are provided a contact in their regional National Institute of Standards and Technology's Hollings Manufacturing Extension Partnership (MEP) office to provide manufacturing assistance. OTT works with MEP headquarters to identify those contacts. When a particular ARS Regional Forums (see USDA 7 initiative) has a manufacturing component, the regional MEP field staff is invited to provide an overview of the resources they have available to assist in manufacturing. Some MEP offices are part of ARS's ARP Network.

USDA 10: Work with regional incubators and economic development organizations to identify opportunities for ARS scientists and ARS commercial partners

This initiative directly addresses Section 4 of the Presidential Memorandum in establishing joint partnerships with university research parks, incubators, and other state / community economic development organizations. Since we have not yet been able to identify a project for the specific use of the University of Mississippi incubator's facilities, we expanded this initiative to include other incubators and economic development organizations. This expansion occurred through the Agricultural Research Partnerships (ARP) Network (see USDA 3 and section 3.4). Network members now include any organization interested in agriculture-based economic development such as, but not limited to: rural agribusiness, urban, community and/or economic development groups; organizations that support farmers, agritourism and/or food processors; and capital programs for business attraction and acceleration. Many economic development entities are members of our APR network, e.g., Montgomery County Department of Economic Development, Maryland Technology Development Corporation, Center for Innovative Food Technology, Innovate Mississippi, Nebraska Department of Economic Development, and California Association for Local Economic Development.

USDA 11: Establishment of the "Branded Food Products Database for Public Health" Public-Private Partnership

In FY 2013, ARS, the ATIP Foundation, and the International Life Science Institute North America (ILSI North America) established a public-private partnership to enhance the public's health through increased knowledge of the nutritional content of the nation's food supply. This will be accomplished by obtaining comprehensive food composition data from the food industry and making it available to government, industry, the scientific

community and the general public through an enhanced USDA National Nutrient Database, developed and maintained by the ARS Nutrient Data Laboratory in Beltsville, MD.

In FY2015, the public-private partnership successfully beta tested a branded food products database. Five food manufacturers participated in a beta-test by providing product label data and nutrition information on 245 products through a GS1 certified data pool provider, FSEnet. These data were then passed to ARS for incorporation into the USDA National Nutrient Database.

USDA 12: Evaluate various options for reducing license negotiation transaction costs

Several proposals for establishing standard pre-commercialization license terms for all CRADA Subject Inventions were reviewed. Possible benefits included: creating business certainty for CRADA partners; providing an additional incentive to enter into a CRADA; and reducing transaction costs for both the CRADA partner and USDA. This initiative is now completed with the pre-negotiated license language as an option in the CRADA template to be used in situations where a CRADA partner has indicated that they would like to lock in the royalty rate before proceeding with the CRADA. In 2015, when appropriate, OTT has used pre-negotiated licensing terms to a CRADA partner.

USDA 13: Develop Material Transfer Research Agreement (MTRA) as a new instrument to promote development and commercialization of materials from USDA

USDA scientists create new materials that may have value in further research and development with the private sector. Material Transfer Agreements (MTA), widely used by USDA, only allow for the transfer of materials, but not engagement in joint research between the provider and the recipient of the materials. In order to enable some collaborative research with the material, in FY 2012 by combining the Material Transfer Agreement and the Trust Fund Cooperative Agreements authorities the MTRA was created. MTRAs are now reported as a metric in the Collaborative Relationships for Research and Development Table.

USDA 14: Accountability of Scientists and Engineers in Technology Transfer Accomplishments

In 2012 the annual performance standards for scientist evaluations were revised to include technology transfer elements. In FY 2014, two new performance metrics were employed to measure the number of technology transfer units performed at each station. These new Performance Accountability Measures are Science Delivery Products and Science Delivery Activities. Science Delivery Products are products developed to enhance the usefulness of scientific information, including synthesized information from a wide range of disciplines that are delivered to clients in clear and accessible formats. Science Delivery Products include non-refereed publications, software, web and multimedia products. Science Delivery Activities are activities undertaken to enhance the usefulness of scientific information that are delivered to clients in clear and accessible form. In FY 2014 FS R&D produced 429 Science Delivery Products and in FY 2015 produced 442. In 2014 FS R&D produced 1,224 Science Delivery Activities and in 2015, FS R&D produced 2,514 Science Delivery Activities.

USDA 15: New uniform metrics for Forest Service Outcomes

A major review of all performance metrics was conducted in FY 2014 that resulted in ten new performance metrics, five existing metrics were revised, three metrics were retired, and ten existing metrics were not changed. There were no additional changes to metrics during FY 2015.

The fourth “Chief’s Science Delivery Award” was presented in February 2015 for a FS employee’s work in the area of natural resource management in the United States with global applications. Forest Service is currently reporting the number of citations of Station scientist’s publications as indices of the impact of Forest Service science. These indices are the average number of times FS scientists’ papers are cited in the Science Citation

Index during the previous 10-year period beginning two years after publication. These include the average annual number of high impact papers (papers cited more than 20 times) and the average annual number of very high impact papers (papers cited more than 50 times). As reported in the Web of Science, over the period from 2006 through October 2015, publications authored by FS R&D scientists were cited in peer reviewed scientific journals an average of 14,634 times per year for a total of 146,337 citations over the ten year period. There were 1,945 high impact papers and 596 very high impact papers for that ten year period ending in 2015. This was a 7% increase in citations for the 10 year period ending with 2015 compared to the 10 year period ending with 2014. The number of high impact papers increased by 7% and very high impact papers increased by 11% in FY 2015 compared to FY 2014.

FY 2015 marked the sixth year of operation for the Forest Service Research Data Archive (<http://www.fs.usda.gov/rds/archive>). We added 63 research data sets to our catalog in FY 2015, and now offer 200 research data sets to the public and global science community. The catalog is also searchable via science.gov. The Archive provides data repository services to the Joint Fire Science Program (<http://www.firescience.gov>); 48 of the data sets in our catalog came through that channel. Over 2,500 people downloaded a data publication in FY 2015 (> 70 percent increase relative to FY 2014). According to results from Google Scholar, there were 41 citations of our data publications in FY2015; this is a substantial increase over the 2 citations in FY2013 and the 4 citations in FY2014. Through FY2015, citations have appeared in the scientific literature (37), in dissertations (8), and in popular media (2).

USDA 16: New metrics on research outcomes related to intellectual property (patents)

FS R&D developed and implemented the Research Information Tracking System (RITS), which became the official FS reporting vehicle for all science publications in FY 2010. RITS improves the quality and consistency of data, provides transparency to the public, and reduces the need for burdensome data calls. The newest version of RITS incorporates patent data which is connected to related publications on specific technology focus areas. Patent data in RITS has now been updated to include the last 20 years of information. Going forward, patent data will be entered in RITS annually. Additional updates to improve the patent portion of RITS are planned for future releases.

Facilitating Adoption through Partnerships

As part of the USDA, the Forest Service Patent Program has enjoyed a close working relationship with Agricultural Research Service (ARS) and the Office of Technology Transfer (OTT) for many years. This partnership has grown and expanded to include FS access to the Agriculture Research Information System (ARIS) database for patent and license tracking, inclusion in OTT teleconferences, and ARS Licensing Associates assisting the FS Patent Program with license negotiations.

USDA 17: Explore additional ways FS and ARS can work together on intellectual property and related matters

Cooperative Research and Development Agreements (CRADAs) are widely used within the FS to enable researchers to work with university partners and industry leaders and are drafted by the FS Grants and Agreements Specialists. Recognizing efficiencies that could be gained by having standardized agreement language and procedures, FS has used ARS as a CRADA resource in FY 2014 and FY 2015 to assist with CRADA questions. Further collaboration on various technology transfer agreements, such as Material Transfer Agreements (MTAs) and CRADAs is planned for the next FY, as are collaborations involving jointly owned inventions and patent prosecution matters.

USDA 18: Enhance education and extension outreach efforts

Natural Inquirer is a science education journal for middle school students. The expanded *Natural Inquirer* products include science journals for upper elementary students, scientist cards for middle and high school students, Readers for K-2, and a nonformal activity guide for middle school students. All of these products are based directly on Forest Service scientists and their research. In FY 15, 60,658 *Natural Inquirers*, 11,888 *Investigators*, 7,060 Readers, and 48,000 *NSI: Nature Science Investigators* were distributed to classrooms, homeschools, and conferences. Social media followers increased by over 25 percent, and the *Natural Inquirer* Web site had over 58,000 unique visitors. Some noteworthy distribution points include the World Special Olympics, the White House Tribal Youth Initiative, the World Forestry Congress, the White House Maker Faire, the Council of Scientific Society Presidents, the National Science Teachers Association, the Ecological Society of America annual conference, and the Earth Day Network's Toolkit for Climate Change Education. All work is accomplished in cooperation with the *Natural Inquirer's* non-profit partner, the Cradle of Forestry in America Interpretive Association. <http://naturalinquirer.org>.

USDA 19: Enhance FS interactions with entrepreneurship activities at educational institutions

During FY 2015 more than \$42 million in grants and cooperative agreements were provided to educational institutions, with almost \$1 million going to minority colleges and universities: \$732,904 went to Historically Black Colleges and Universities, \$262,720 went to Hispanic Serving Institutions, \$30,000 went to Tribal Colleges and Universities. Land Grant Colleges received \$14.8 million: \$13.7 million went to 1862 schools, \$672,904 went to 1890 schools, and \$30,000 went to 1994 schools. Non-academic institutions received \$14 million in grants and agreements. A total of 892 grants and agreements were made in FY 2015.

USDA 20: Increase awareness in WS of technology transfer mechanisms, leading to increased pace of effective technology transfer and commercialization.

WS NWRC has traditionally been active in transferring technology and scientific information through use of outreach to collaborators, including WS operational personnel and through publications. Successful outcomes may include improved wildlife damage management practices, scientific information that enhances U.S. competitiveness by protecting crops and property, or increased awareness about wildlife diseases that threaten health of livestock or humans. Most of these outcomes do not require a patent and license for implementation. This initiative is designed to increase awareness among WS personnel about the importance of both formal and informal technology transfer.

In FY 2015, the Manager of WS NWRC's Technology Transfer Program provided a formal technology transfer training to all NWRC biologists and one-on-one case specific technology transfer trainings to five scientists, increasing the general knowledge and raising the awareness of scientists as to the power of partnerships, importance of developing intellectual property, and the array of technology transfer agreements available to facilitate their research. In addition, WS NWRC's Technology Transfer staff continued to reach out to WS Operations on technology transfer and intellectual property issues. WS Operations staff contacted WS NWRC's Technology Transfer Program for regulatory advice on issues related to feral swine trapping, four confidentiality agreements.

WS continues to emphasize the importance of collaborative agreements with stakeholders to offset diminishing discretionary funding, while increasing relevance of research to stakeholders, such as the private sector. WS, as part of the annual report table, continues to track the number of agreements it maintains each year, including cooperative agreements, cooperative service agreements, MOUs, and interagency agreements. In addition, WS will track numbers of specific technology transfer agreements, including CAs, MTAs, and CRADAs. In FY 2015, WS NWRC maintained or amended 10 active CRADAs, and entered into 1 new CRADA. These CRADAs brought \$193,321 in cooperative funding to the NWRC, allowing scientist for pursue collaborative research aimed

at developing products to mitigate wildlife damage issues. In addition, WS NWRC is currently partners in 69 Confidentiality Agreements, 10 of which were new in FY 2015, and 93 Material Transfer Agreements, 34 of which were new in FY 2015.

In addition to traditional technology transfer mechanisms, the WS National Wildlife Research Center publishes scientific manuscripts, book chapters and reports. In FY 2015, the NWRC released 99 publications, including 91 manuscripts in 52 peer-reviewed outlets, 3 book chapters and 1 report. In addition, the NWRC Registration Unit prepared 35 EPA data submissions for registering sodium nitrite as a toxicant for feral swine, and 4 semi-annual reports for animal drugs currently under investigation through Food and Drug Administration, Investigational New Animal Drug permits.

USDA 21: Increase knowledge of WS and NWRC and their impact in preventing wildlife conflicts, leading to increased development of collaborative research and more effective use of public resources.

WS NWRC has committed to increasing the amount of information disseminated to the general public and stakeholders on research, collaborations and products provided by the Program. The WS NWRC works closely with APHIS public affairs staff in the preparation and dissemination of information on WS NWRC research and collaborations, as well as WS's role as the premier organization for managing human-wildlife conflicts.

As part of continued efforts to increase local and regional community awareness of the WS NWRC, in FY 2015, the Center hosted tours to approximately 250 students, visiting scientists, business and agency partners, and USDA employees. Center representatives hosted booths at several university career fairs to inform students of careers and potential job opportunities with the WS NWRC. Through the USDA's blog site, Twitter site, and GovDelivery system, WS NWRC notified 10,000+ stakeholders of various research activities, accomplishments, and events. WS NWRC responded to 75 media and community requests for information and published approximately 25 brochures, factsheets, press releases and reports for the general public.

USDA 22: Increase the pace of WS technology transfer and commercialization activities.

To accomplish this objective, WS NWRC will increase its efforts to obtain partners for technologies ready to be commercialized by working with ARS and by utilizing the ATIP Program.

WS will continue maintaining existing products and registering new products with the Environmental Protection Agency and the Food and Drug Administration for use by WS personnel and the public. In FY 2015, APHIS WS maintained 24 Section 3 registrations with the Environmental Protection Agency and made 1 pesticide registration application submission for a new active ingredient intended for a product to control feral swine. A total of 28 Section 24c (Special Local Need) pesticide registrations were maintained and three new labels were obtained; 1 Experimental Use Permit was in place. In addition, APHIS WS maintained 2 Investigational New Animal Drug permits with the Food and Drug Administration.

USDA 23: Enhance Collaboration Efforts in Pest Detection and Management

PPQ's scientific support focuses on improving and developing pest detection and management tools to discover new invasive species early and respond quickly, better identify and target offshore pest threats, develop diagnostic tools and techniques, and transfer technology to cooperators and impacted industries.

Goal 1. CPHST provided new diagnostic and pest detection methods to Ports of Entry.

- Piloted the CANARY detection technology and training plant inspection station staff to conduct the assay for *Ralstonia solanacearum* on Pelargonium interceptions at the Linden, New Jersey and Atlanta, Georgia Plant Inspection Stations. S&T worked with Field Operations and Policy Management staff to successfully conduct

the pilot in two phases in 2014 and 2015. A final report has been completed and an analysis and recommendations for implementation and needed resources will be made to the PPQ Management Team in December 2015.

- In cooperation with DHS and the Edgewater Chemical and Biological Center, evaluated volatile organic compound sensing arrays to detect and differentiate warehouse beetles from Khapra beetle; results indicated that this method is potentially feasible and further testing is funded and supported for FY16 by DHS S&T Directorate. This method could quickly determine the presence of Khapra beetle in grain shipments, which is a recurring pest issue in imports (also included in Goal 2).
- Successfully completed all phase 2 objectives for the web-based image library, *imageID*, which aids in pest identification, particularly by PPQ identifiers. The enhanced version was successfully launched with new end-user training by August, prior to the target timeline, and increased the number of pest images accessible to users by 50% to over 60,000

Goal 2. Strengthened PPQ's partnership with the Dept. of Homeland Security (DHS) by developing advanced technologies for pest detection and identification, commodity treatments, and decontamination and disposal.

- In cooperation with DHS and the Edgewater Chemical and Biological Center, evaluated volatile organic compound sensing arrays to detect and differentiate warehouse beetles from Khapra beetle; results indicated that this method is potentially feasible and further testing is funded and supported for FY16 by DHS S&T Directorate. This method could quickly determine the presence of Khapra beetle in grain shipments, which is a recurring pest issue in imports.
- Cooperated work with the DHS S&T and their cooperator, Gryphon Scientific, to coordinate interviews with 49 PPQ and 16 CBP-APTL staff and site visits by DHS, Gryphon, and PPQ to Plant Inspection Stations locations in Los Indios, TX, Miami, FL and Ports of Entry locations in Pharr, TX, Baltimore, MD, Philadelphia, PA and Miami, FL. The Gryphon II project will determine the appropriate advanced detection and identification technologies for evaluation.
- Provided technical expertise to DHS Chemical and Biological Defense Division during their 3-day technical review.
- Worked with DHS S&T to develop the criteria for BAA 14 DHS-003 (Exploration of Advanced Detection Technologies for Chemical and Biological Threats, \$2M in funds), then provided expertise to evaluated several proposals. This work may be important to the rapid detection of pests at our points of entry.
- Provided expertise to evaluate several proposals for DHS S&T BAA 15 DHS-002 (Detection Systems for Identifying Agricultural Pathogens). This work may be important to the rapid detection of pests at our points of entry.

Goal 3. Provided leadership on the Port Environs initiative to understand which ports of entry pose the highest risks.

- Continued the quantitative assessment of the likelihood of plant pest entry in U.S. port environs by analyzing port and state import databases by commodity group. For 2015, a pathway centered invasion model for Asian longhorned beetle was completed, and the wood packaging material and live plant pathway components for port environs framework were finalized.
- Further refined the conceptual definition of the port environs to guide the geospatial delineation of port environs. A manuscript describing the concept of port environs will be submitted in fall 2015.
- Adapted a bioeconomic model to the port environs analysis using European gypsy moth surveillance in the Northwestern United States as a case study for wood borer and bark beetle surveillance. This includes an initial analysis of travel cost and time patterns for trap placement, and a theoretical model for estimating long-term invasion damages.

Goal 4. Better identify and target offshore pest threats.

- Pest Prioritization. Completed the first phase of a two-year effort to develop an enhanced prioritization tool for the Cooperative Agricultural Pest Survey program, to improve the risk basis for rankings and therefore

better utilize resources in all 50 states. Developed and tested separate models for arthropods and plant pathogens for predicting impact, including assessing all test species. Assessed and ranked the updated CAPS list of 95 pests based on predictive impact and provided insights into changes from previous rankings, and ongoing support for the upcoming survey FY16 year.

- Responded to stakeholder notifications, country consultations and rulemaking activities related to Q-37 (regulations governing importation of plants for planting) Costa Rica *Phaelanopsis* PIGM, Mexico Tomato Plantlets in PIGM, Western Hemisphere/Europe Rice for Planting; and Q-56 (regulations governing importation of fruits and vegetables) Argentina Lemon, Australia Citrus Expansion, Brazil Citrus, China Apple, China Grape, European Union Apples/Pears, European Union -Spain Cherry, European Union -Spain Peach, Plum, Nectarine, European Union -UK/Ireland Peppers, India Grape, Mexico Hass Avocado, Peru Pomegranate.
- Led quantitative modeling activities for development and verification of two systems approaches for safely relieving U.S. farmers from exotic fruit fly quarantines: cherry production in California (Oriental fruit fly) and citrus production in Texas (Mexican fruit fly).
- Completed 46 export risk assessments including an assessment to expand market access for Avocado from CA to Argentina, CA stone fruit to Mexico, U.S. potatoes to Indonesia, blueberry cuttings to Peru.
- Pest list reviews for - CA Avocado to China, Christmas trees to China, Lettuce and radish seeds from US to Korea, Avocado from California to New Zealand, Pacific Northwest apples to China, U.S. apples to China, U.S. Nectarines to China, U.S. Strawberries to China.
- Analyzed 46 new pests and pests of imminent threat under the New Pest Advisory Group (NPAG), and completed 23 full NPAG reports. One report was on *Phelipanche (Orobanche) aegyptiaca*, after detection in California; a new U.S. record for the parasitic plant and Federal Noxious Weed.
- Noxious Weeds;
 - Screened 331 additional species for prioritization
 - Completed 26 datasheets for NAPPRA (Not Authorized Pending Pest Risk Analysis) listing candidates (weeds). This function was recently transferred to PERAL from the Plants for Planting Group in IRM.
 - Completed 16 weed risk assessments (WRAs):
 - Two genetically modified species for APHIS Biotechnology Regulatory Services: *Sorghum halepense*, and *S. bicolor* subsp. *drummondii* (shattercane)
 - Two biofuels-related WRAs (EPA requests): *Jatropha curcas* and *Thlaspi arvense*.
 - Five WRAs for species from the “on hold” project ‘Corn Seed for Planting from South Africa.’
 - Five WRAs for species from multiple projects for ‘EU/Denmark Aquatic Plants in Growing Media.’
- Completed 30 reports on pests recommended for deregulation at ports of entry.

USDA 24: Provide Timely Scientific and Technical Support for Emergency Response and Management

PPQ must develop and maintain a high level of expertise to support preparedness in the areas of science, technical support, and technology transfer for rapid response efforts.

- S&T led the PPQ technical backstopping for High Pathogenicity Avian Influenza (HPAI) to support the Veterinary Service-led overall initiative.
 - Deployed key staff including GIS and modeling experts. S&T modelers complete clustering analyses to investigate the existence of infection patterns and determine whether specific pathways could be linked to disease spread. The insights obtained from the analytical and modeling efforts have provided the HPAI program important insights into disease dynamics and survey support needs.
 - S&T scientists established links with industrial providers of commercial scale disinfection equipment and tested a variety of equipment and protocols for their effectiveness. As a result, new options for decontamination and disposal have been made available to the HPAI program.

- The National Plant Protection Laboratory Accreditation Program continued to support a national network of labs that can conduct regulatory diagnostics. Provided quality management best practices guidance and diagnostic training to laboratory partners in the NIFA National Plant Diagnostics Network and to federal and state regulatory partners.
- Achieved ISO/IEC 17025:2005 accreditation at the CPHST Beltsville Laboratory as the culmination of several years of effort. This is the first regulatory plant diagnostic laboratory in the U.S. to achieve this level of accreditation and demonstrates implementation of a sound quality management system and internationally recognized standards for test performance and competence.
- Implemented a new off-the-shelf Laboratory Information Management System to provide detailed tracking of diagnostic samples and results. The system is currently housed at the Beltsville Laboratory but is being considered for multi-laboratory adoption in FY16.
- Worked with the Kansas Department of Agriculture and other assets in KS, and with PPQ stakeholders to provide emergency technical and survey assistance to address an outbreak of flag smut disease in Kansas wheat. This work helped to determine the severity of the infestation, provide mitigations, and prevent trade impacts on wheat exports.
- Proposed and received approval to expand CPHST operations with a new laboratory in California. This laboratory will fill a major need for additional science and technology support for West Coast pest programs and agricultural trade, and is a major initiative for FY16.
- National Clean Plant Network (NCPN) streamlining initiative. The NCPN team (consisting of PPQ and NCPN leadership) collaborated with WERA-20 leaders to organize a national workshop to bring PPQ and Industry stakeholders together who participated in a 2-day workshop to evaluate the potential of Next Generation Sequencing (NGS) technology related to its use in identification of exotic pathogens to better safeguard US agriculture and support movement of plant materials domestically and in foreign trade. Scientists from academia, state labs and industry discussed the state of the science, its impact on commodity industries, and the challenges it may pose on the regulatory community.
- CPHST Beltsville Laboratory developed a molecular assay for detection of the Citrus leprosis virus (CiLV) strain N using one-step conventional RT-PCR.
- Developed and validated conventional and qPCR methods for detection of *Phytophthora alni subsp. alni* and *P. alni subsp. multiformi* and *P. quercina*, *P. austrocedri*.
- Down-selected a CANARY Biosensor that produced a specific positive response to the targeted CiLV-C1 strain while maintaining a negative response to closely related CiLV-C2 and CiLV-N strains. Completed a sample preparation method for CANARY CiLV-C1 assay. These will be transferred in FY16 to our commercial partner for CANARY kit production, PathSensors, Inc.

Goal 1. CPHST contributed to the long-term goal of eradicating European grapevine moth (EGVM) from California.

- Convened a technical working group review for the EGVM program and delivering recommendations on survey, treatments, quality assurance, and deregulation by December 2015, as planned.
- Organized a Post-eradication Planning Group and finalizing the plan by the September target date.
- Initiated a spatial analysis study of EGVM monitoring and treatment data to evaluate program effectiveness and identify areas at risk of reinvasion.
- Completed testing to determine sterilizing pupal radiation doses as a basis for sterile insect technique eradication methods.
- In addition to the requirement targets, S&T established methods to apply new phytosanitary protections to known high risk pathways to minimize the likelihood of future reintroductions. As a result of this leadership the pathway safeguarding measures have been strengthened and methods associated with EGVM are being applied to strengthen other regulatory programs. *As a result of continuing eradication efforts, there have been no detections of EGVM within regulated areas since 2013.*

Goal 2. CPHST contributed to the long-term goal of preventing citrus greening disease (*huanglongbing*, HLB) from California.

- Provided system protocols and a field cage production system and associated manual for production of the biocontrol wasp *Tamarixia radiata* in CA conditions within targeted timelines.
- Provided training and technology transfer to California and private industry to build the capacity to produce over 2 million *T. radiata*/year. In addition, S&T provided rearing methods for a new agent, *Diaphorencythus aligarhensis*, and over 81,000 have been released in southern CA to date.
- Completed a third year of evaluation of *T. radiata* field cage production in CA. By the end of 2015, over 450,000 will have been produced, approximately doubling 2014 production. In AZ, over 120,000 *T. radiata* have been released at 32 evaluation sites. These sites are continuing to be monitored for establishment and spread rates. In Texas, the populations of Asian citrus psyllid vector in the urban environment have declined by 85% since the introduction of the biocontrol program.
- Developed new diagnostic tests to detect different types of bacteria causing citrus greening. S&T also developed a novel clustering analysis to predict hot-spot areas that could contain Asian citrus psyllids or citrus greening infected plants. This led to a more targeted survey and the new detection of several infected trees in CA in 2015.
- S&T is managing 27 projects with a total funding of \$13,469,200 to support near term solutions for the citrus industry. This funding is provided by the [USDA Huanglongbing Multi-Agency Coordination Group](#), and PPQ. S&T is responsible for the administrative and scientific management for this funding.
- Leading inter-institutional cooperative efforts with DHS to establish methods to apply therapies to manage citrus greening disease at large scales applicable to commercial production of citrus.

Goal 3. Provide scientific methods to the fruit fly program.

- Published a taxonomic revision of the *Bactrocera dorsalis* complex (Oriental fruit fly) that will improve pest identification practices, remove barriers to trade, and facilitate management options.
- Completed field trials for solid lures and attractant strips and demonstrating that these alternatives are effective and can be implemented in fruit fly programs to improve employee safety. S&T also delivered a new alternative pesticide treatment prior to an EPA deadline to discontinue a previous diazinon treatment.
- Provided key technical input on design, construction, and staffing requirements to fully complete a Program of Requirements for the Sarasota Sterile Insect Release Facility. In addition, provided input for the Program of Requirements for the Edinburg Mexican Fruit Fly facility that is now 35% complete.
- In addition to the targeted accomplishments, S&T reduced costs at the El Piño Mediterranean fruit fly facility by \$220,000 annually by developing a less expensive fruit fly diet and released an online [Compendium of Fruit Fly Host Information](#), as a comprehensive reference to support risk assessment and trade issues related to exotic fruit flies.
- S&T traveled to the Dominican Republic to advise the Ministry of Agriculture to mount an emergency response to delimit, contain, control and eradicate an outbreak of Medfly in Punta Cana. This also included on-the-job training for dealing with a plant pest emergency response, development of operational protocols, instruction on identification of Tephritid adults, immature stages and distinguishing sterile from fertile insects. Assistance also was provided in how to manage resources, advise on staffing needs, and coordinating assistance from other governments and international institutions including FAO, IAEA, OIRSA and IICA. This effort required fluency in Spanish by those involved.

Goal 4. Provide scientific methods for forest pest programs.

- Completed developmental work on radiofrequency radiation as phytosanitary treatment for wood. Radiofrequency treatment was recently accepted as an international standard and commercial scale up is in process.
- Completed testing of imidacloprid as a phytosanitary treatment and showed 2 treatments had acceptable efficacy and residue levels. In addition, S&T completed a 4-year study for the Asian longhorned beetle program that demonstrated that fall treatments of trees in quarantine area are just as effective as spring treatments. Spring treatments are logistically difficult due to a narrow time window for application; this new

method will improve the ability of the program to achieve eradication.

- Delivered a technical working group report to the Asian longhorned beetle program ahead of schedule with suggestions on simplifying survey protocols to reduce program costs without impacting effectiveness.
- S&T received a permit to release a new biocontrol agent, *Spathius galinae*, for emerald ash borer and conducted the first releases in 2015. This agent is expected to be better adapted to northern climate conditions than the current biocontrols.

USDA 25: Improve Communications between CPHST and its Customers to assure Market Relevance

CPHST aims to establish and maintain an effective dialogue with its customers to ensure development activities are useful and applicable to customer needs.

- During a consultation with the Fish and Wildlife Service, S&T was able to provide extensive documentation to support a PPQ finding that importation of Phalaenopsis orchids from China would have no effect on endangered species. The document was key in breaking an impasse in the consultation between FWS and PPQ and facilitated resolution of a major trade issue as well as setting the stage for a larger consultation on plants in growing media in general. This agreement will streamline trade analyses and reduce regulatory reviews by at least six months for all issues where there are threatened or endangered species.
- S&T conducted several technical training sessions for internal staff and domestic and foreign stakeholders to build capacity and develop technical networks. In FY 15, these included 6 risk analysis workshops held in the U.S, Malaysia, and Romania for a total of 185 people and 7 pathogen diagnostics training sessions for a total of 65 people.
- S&T engaged the Dominican Republic Ministry of Agriculture to provide technical advice on emergency response to a major Mediterranean fruit fly outbreak with serious trade impacts. S&T also helped to coordinate assistance from other governments and international institutions.
- In addition to annual program review meetings, S&T's citrus health program initiated a listening session with major PPQ and industry stakeholders to better understand the issues that were impacting each citrus state. This session provided new perspectives that influenced new project direction.
- Through the National Clean Plant Network, S&T supported a PPQ-focused network of 28 clean plant centers in 19 states. In 2015, the network was expanded to include sweet potato and roses for a total of 7 crop governing bodies, involving about 100 scientists. The network engages researchers, extension, regulators, and industry in a common vision to support pest-free propagative plants. For sweet potato in particular, the industry saw NCPN inclusion as a key part of improving production and creating new jobs. The NCPN also linked stakeholder to initiate discussions on harmonizing nursery certification. NCPN supported programs delivered millions of propagules for fruit trees, grapes, berries, citrus, and hops varieties to nurseries and growers every year.

USDA 26: Improve the CPHST Work Plan Development and Project Prioritization Process to Assure High Quality Outcomes for Customers / Stakeholders

CPHST will continue to develop a process with PPQ operations to produce mutually acceptable work plans that ensure appropriate product quality.

- Delivered employee training and guidance to all project leaders managing cooperative agreements to ensure high quality work plans and knowledge of administrative requirements.
- Provided quality management training and guidance to PPQ staff and state cooperators.
- In FY15 S&T leadership travelled to all CPHST labs and held town hall video conference calls with S&T staff to discuss the recommendations for enhancements elucidated in the CPHST Laboratory Review with S&T staffs. (*In FY14 CPHST commissioned APHIS' Policy and Program Development, Program Assessment and Accountability division, to review the CPHST network of laboratories and assess how*

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well the organization is positioned to support PPQ's scientific and technical needs. This independent review concluded that CPHST is meeting current PPQ needs, is adequately positioned to meet future needs, and provided recommendations for enhancements that will be the basis for CPHST strategic planning).

- Provided oversight of 322 cooperative agreements with domestic and foreign researchers and organizations with a total value of over \$41,368,044. This is an increase of over \$22 million from FY14, as S&T provides administration and management of all Huanglongbing Multi-Agency Coordination Group funding.
 - To further support the HLB-MAC, implemented a novel ADODR 'team approach' format to support our ADODR's and effectively manage agreements.
- Designed and implemented a new scientific project tracking system that tracks project approvals, assignments, progress, supporting documents, and deliverables within a rapid 6 month timeline. This system will support greater efficiency and accountability, communication with customers, and knowledge retention for CPHST scientific projects and utilizes a Salesforce software environment promoted by the department.

USDA 27: New Metrics (beginning FY 2014) on NIFA outcomes:

Efforts to develop procedures for requesting information from NIFA awardees are in progress. Information will be collected on: 1) number of new jobs created by a small business as the result of receiving SBIR grant funds; 2) increase in sales of technology or services developed by a small business as the result of receiving SBIR grant funds; and 3) sale to other businesses of licenses to technology developed by a small business as the result of receiving SBIR grant funds.

The data on the patents issued based upon Competitive NIFA Funding has been collected for FY2015 and is now being reported (see Table 1).

Table 1. Patents Issued in FY2015 based upon Competitive NIFA Funding.

Institution Name	Award Number	Patent Number	Issue Date	Invention Description
BOISE STATE UNIVERSITY	2009-65119-05977	8,911,748	12/16/2014	Cholera Toxin Chimera and Its Use as a Staph Vaccine
DIVISION OF AGRICULTURE	2007-35603-17744	9,005,601	4/14/2015	Bacterial Isolates for Improved Health of Poultry
EASTERN MICHIGAN UNIVERSITY	2012-67021-19958	8,952,093	2/10/2015	Bio-Based Polyurethane Dispersion Compositions And Method
IOWA CORN PROMOTION BOARD	2013-31200-06031, 2014-31100-06031, 2015-31100-06031	9,120,806	9/1/2015	Dianhydrosugar Production Process
LOUISIANA STATE UNIV A&M COL BATON ROUGE	2007-35204-05420, 2009-35204-05200	8,877,211	11/4/2014	Bovine Herpes Virus Vaccine with Multiple Mutations
MICHIGAN STATE UNIVERSITY	2001-35504-10668	8,968,515	3/3/2015	Methods For Pretreating Biomass
MICHIGAN STATE UNIVERSITY	2006-35504-17364	8,894,725	11/25/2014	Process for Producing Mixed Esters of Fatty Acids as Biofuels

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NORTH DAKOTA STATE UNIVERSITY	2012-31100-06031, 2013-31100-06031, 2014-31100-06031, 2015-31100-06031	9,096,773	8/4/2015	Highly Functional Epoxidized Resins and Coatings
OHIO STATE UNIVERSITY	2001-35504-10668	8,961,915	2/24/2015	Wet Scrubbers for Ammonia Capture
PENNSYLVANIA STATE UNIVERSITY	2008-38814-04727	9,003,983	4/14/2015	Row Crop Sidedress Applicator and Cover Crop Seeder
PENNSYLVANIA STATE UNIVERSITY	2013-31200-06031, 2014-31100-06031, 2015-31100-06031	9,119,862	9/1/2015	Anti-leukemic Property of Cyclopentenone Prostaglandin Metabolite of Omega-3 Fatty Acid
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN	2012-31100-06031, 2013-31100-06031, 2014-31100-06031, 2015-31100-06031	9,080,187	7/14/2015	Methods and Compositions for Producing Solvents
UNIVERSITY OF MASSACHUSETTS AMHERST	2013-31100-06031, 2012-31100-06031	9,040,109	5/26/2015	Enzymatically cross-linked biopolymer interfacial complexes for improved lipid particle stability
UNIVERSITY OF WISCONSIN-MADISON	2014-31100-06031, 2015-31100-06031	9,063,073	6/23/2015	SOLID WORKING ELECTRODE WITH REPLACEABLE TIP
UNIVERSITY OF WISCONSIN-MADISON	2012-31100-06031, 2013-31100-06031, 2014-31100-06031, 2015-31100-06031	9,080,212	7/14/2015	METHODS AND COMPOSITIONS FOR IMPROVED FERTILIZATION AND EMBRYONIC SURVIVAL
THE SAMUEL ROBERTS NOBLE FOUNDATION	2006-35300-17143	9,121,031	9/1/2015	Methods and Composition for Regulating production of proanthocyanidins
OREGON STATE UNIVERSITY	2005-35319-15280	9,018,002	4/28/2-15	Method to Trigger RNA Interference
UNIVERSITY OF WISCONSIN	09-CRHF-0-6055	8,871,494	10/28/2014	Overproduction of Secondary metabolites by Over-Expression of the VEA Gene
UNIVERSITY OF MINNESOTA	2011-67009-20062	International Patent Application No. PCT/US2015/020599	3/14/2015	Compositions Including Ligninsulfonate, Compositions Including Un-alkylated Lignin, and Methods of Forming
UNIVERSITY OF MINNESOTA	2011-67009-20062	Provisional Patent Application No. 62/215,017	9/6/2015	Compositions Including Ligninsulfonate, Compositions Including Un-alkylated Lignin, and Methods of Forming

USDA 28: Partner with ARS and the Animal and Plant Health Inspection Service (APHIS) at USDA on the National Plant Diagnostic Network, and the National Animal Health Laboratory Network

There are two goals for NIFA in this area.

- 1) Develop competitive funding opportunities to include ARS scientists in the development of diagnostic assays and validation protocols that are needed to support APHIS regulatory surveillance efforts for foreign and emerging plant and animal diseases.
- 2) Coordinate APHIS regulatory and ARS research efforts with relevant components of the Cooperative Extension Service in order to better identify producer needs and the transfer of relevant technology. Plans for FY 2016 are still being developed.

USDA 29: ERS is making wider use of social media and new technologies (such as mobile phone applications) to widen and expand the reach of our information services to the general public.

ERS is implementing wider use of social media and new technologies (such as mobile phone applications and open data methodologies) to widen and expand the reach of our information services to the general public. ERS has been a leading innovator in support of the Administration's Digital Strategy and Open Data initiatives, providing a wealth of products—including data and resources—designed to enhance delivery of information and services. In FY 2015, ERS used several new tools designed to help consumers more easily access critical programs and stimulate further innovation:

- **Responsive Design:** ERS has been working to optimize the website for mobile users, including developing a digital “eZine,” built with Responsive Design principles to automatically render on multiple devices/screen sizes, providing efficiencies in design/production (versus developing multiple style sheets for individual devices/platforms).
- **Web content APIs** (Application Programming Interface), offering digital professionals a machine-readable option for accessing publications, charts, and other website content. This allows external customers to integrate ERS information into their own website content.
- **APIs for select data and geospatial/mapping applications**, enabling researchers and developers to build applications using ERS data and process for additional insights.
- **Data Visualization:** New tools and technologies have been adopted to present data in a series of active online charts that allow users to interact with ERS data and design charts that reflect different views of data for an enhanced user experience.

The new products and tools extend and expand access to ERS research findings, market outlook, and data—making the Agency's information more readily available to the general public. These items were a first among USDA (and many government agencies), enabling USDA to meet its 12-month Digital Government Strategy goals to ensure high-value services and systems are available anywhere, any time, and on any device. The work also supports the President's Management Agenda to improve efficiency, share data with entrepreneurs and businesses, and stimulate job growth.

USDA 31: Engage in consultation with the Agricultural Research Partnerships Network to assist in establishing U.S. commercial partners with foreign entities.

In 2015 FAS provided updated talking points to the ARS/Office of Technology Transfer to disseminate information about FAS to ARP Network members that were interested in establishing commercial partners with foreign entities. In addition, FAS continued direct consultations with the Center for Innovation (Arlington, TX) about concepts for potential collaboration on international capacity building for transfer and commercialization of USDA technologies.

1.0. Agricultural Marketing Service (AMS)

<http://www.ams.usda.gov/AMSV1.0/>

1.1. Mission Statement

The mission of AMS is to facilitate the strategic marketing of agricultural products in domestic and international markets, while ensuring fair-trading practices, and promoting a competitive and efficient marketplace to the benefit of consumers of U.S. food and fiber products. This includes distributing market information, developing grade standards—many of which are used in the voluntary grading programs funded by user fees—protecting producers from unfair marketing practices, testing of commodities for pesticide residues, granting intellectual property rights protection to new plant varieties, and oversight of industry funded programs to promote agricultural products and research.

1.2. Nature and Structure of Program

The Agricultural Marketing Service (AMS) is a service-oriented organization that provides a vast array of marketing services to the agricultural industry. Its mission is derived from 50 statutes aimed at facilitating the marketing of food and fiber commodities in domestic and international commerce, commodity grade standards, and voluntary certification and inspection programs and laboratory testing. The challenge for AMS is to adapt these programs to changing marketing practices, scientific and technological advances and be responsive to the grading, quality and health issues facing domestic agriculture. AMS does not have a research and development program in place to address these needs. However, AMS works with other Federal, State and local agencies, academia and food and fiber industry stakeholders in developing and testing innovative technologies that improve upon current marketing tools and services in a cost effective way. Both AMS commodity and support programs and our stakeholders have benefited from this association.

1.3. Current Technology Transfer Goals, Objectives, and Measures of Success (Metrics)

Although AMS does not have a formal technology transfer program in place, the agency does oversee number of programs where innovative tools and practices have been used to assist agency stakeholders in marketing their food and fiber commodities. This collaboration provides our agricultural stakeholders with a valuable mechanism to introduce new commercial applications and standards to the marketplace, document market-enhancing claims, and uses our various internet based e-business portals to facilitate domestic and international trade. Our goal is to provide an entrepreneurial spirit, leverage these program assets to contribute to innovation, job creation, and business opportunities in the agricultural community.

AMS programs that promote these goals include the following:

Plant Variety Protection

The Plant Variety Protection (PVP) Act (of 1970, and amended in 1994), which provides legal protection in the form of intellectual property rights to developers of new varieties of plants. The intent of the Act is to “encourage the development of novel varieties of sexually reproduced plants and tuber propagated plants and to make them available to the public, providing protection to those who discover, develop and/or breed new varieties, and thereby promoting progress in agriculture in the public interest.” In order to gain protection over their intellectual property, plant breeders must demonstrate that their new varieties are distinct from previously existing variety, uniform within each generation of reproduction, and stable across generations of reproduction. Once these standards have been met, plant breeders gain control over the marketing of their new variety (i.e., advertising, exportation, importation, and sales). The term of protection is 20 years for most crops and 25 years for trees, shrubs, and vines. This creates an incentive for investment in the development for new plant varieties. Thus, the PVP Act facilitates technology transfer by protecting the intellectual property rights of those individuals who discover, develop and/or breed new plant varieties.

The AMS' Plant Variety Protection (PVP) Office has the responsibility for administering the program and is user-fee funded. Since 1970, PVP Office has issued more than 10,700 certificates of protection. The Office maintains crop databases for over 180 species including 70,000 commercial seed-reproduced varieties.

The PVP Office interacts with several Federal agencies and international organizations. These relationships help to coordinate the application of Federal regulations related to the marketing of plant varieties. For example, applicants for PVP certificates are required to submit seed samples or tissue cultures to support and enable their applications. These samples are stored at the National Center for Germplasm Resources Preservation (NCGRP) in Ft. Collins, Colorado. The PVP Office regularly discusses issues of common concern with NCGRP staff. A Memorandum of Understanding, between the two programs, is updated on a regular basis. The seed samples deposited in support of applications are made available to the public after the term of protection ends.

Seeds from outside the United States must be accompanied by a phytosanitary certificate. When they are shipped into the U.S., they must be shipped to USDA's Animal and Plant Health Inspection Service, Plant Protection and Quarantine (PPQ) Office. Once the seeds or tissues pass quarantine, PPQ sends them directly to NCGRP. Plant varieties also need to have a variety name that is unique for marketing purposes. The Federal Seed Act, administered by the AMS' Livestock, Poultry and Seed (LPS) Program, Seed Regulatory and Testing Division oversees truth-in-labeling laws to protect consumers. Such laws cover variety naming and trueness-to-variety testing. The PVP Office uses the services of the LPS Program to determine if the variety names provided in PVP applications are acceptable.

The U.S. is a member of The International Union for the Protection of New Varieties of Plants, known by its French acronym UPOV. The UPOV treaty sets forth the principles of how intellectual property rights are granted to plants. These principles are then used to enact legislation in each member country, such as the PVP Act and the Plant Patent Act. Regular meetings with UPOV working groups and the governing council helps to update treaty language and processes. As a member of this treaty organization, the PVP Office provides information about what plant varieties are seeking PVP protection. Recently, UPOV released an online version of this information so it is more quickly available to member countries. UPOV is also leading the discussion about harmonization of forms, processes, and the sharing of varietal descriptive information. The PVP Office is actively involved in these discussions.

In fiscal year (FY) 2015, the PVP Office received a total of 502 applications, ranging from agronomic crops to flowers and vegetables, requesting PVP. The Office conducted searches on 493 applications to determine whether the plant constituted a new variety. On the basis of those searches, the program issued 419 certificates of protection. At the end of the fiscal year, 7,048 certificates were in force while protection expired for 102 different varieties. During the same period, the Seed Regulatory and Testing Division cleared 1,312 different variety names and tested 231 trueness-to-variety samples for 3 different kinds of seeds.

Also, the PVP Office continued its work in developing a virtual PVP application filing (ePVP) system by launching a beta version of the web-based software for testing. The project used the Agile software development technique, which is based on iterative and incremental development where requirements and solutions evolve through collaboration between the PVPO and vendor development teams. When fully operational, the ePVP system will allow stakeholders the ability to file new plant variety applications electronically and provide PVPO examination staff the real-time tools that are necessary to conduct a complete review of the application (including varietal search in the Office database).

Pesticide Data Program

The Pesticide Data Program (PDP) is a critical element in meeting the requirements of the 1996 Food Quality Protection Act (FQPA), which directs the Secretary of Agriculture to provide improved data collection of pesticide residues, standardized analytical and data reporting methods, and increased sampling of foods most

likely to be consumed by infants and children. In a collaborative effort, AMS, the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA) coordinate and prioritize residue-testing and program activities. In addition, AMS conducts annual planning meetings with all program participants, including the cooperating State agencies, other USDA agencies and agricultural industry stakeholders, to select commodities and sampling sites for inclusion in the program.

The data collected reflects the actual residue exposure from food and enables multiple stakeholders to carry out their missions. The EPA uses the data to assess dietary risks from pesticide exposure and determine which pesticides can continue to be used in domestic agricultural production. It also uses the data to harmonize U.S. pesticide tolerance levels with international levels. The FDA uses the data to enhance its surveillance of imported foods. State public health and environmental agencies use the data to fulfill their consumer protection commitments. Growers and distributors use the data to resolve trade issues. This helps to keep diverse crop protection tools available to farmers and producers who benefit, along with consumers, from the continued competitiveness of U.S. agricultural products in the global market. Additionally, the Codex Alimentarius Committee on Pesticides Residues recognizes PDP methodologies as official and validated methods for the determination of pesticide residues in foods.

The AMS' Monitoring Programs Division (MPD) has the responsibility for administering the program, which is an appropriated program. Since 1991, PDP has tested 113 different commodities for over 640 different pesticide residues. In FY 2015, PDP tested over 10,000 samples and generated over 2.3 million data points, including positive residue detections and non-detects. All data are electronically transferred to data users by way of the PDP website or on DVD when requested.

In 2015, sampling services were provided by 10 States (California, Colorado, Florida, Maryland, Michigan, New York, North Carolina, Ohio, Texas, and Washington). Laboratory services were provided by the States of California, Florida, Michigan, New York, Ohio, Texas, and Washington, along with the AMS' National Science Laboratories.

PDP sampled and tested 22 commodities [apples, blueberries, broccoli, carrots, celery, cherries, cucumbers, grapes, green beans (fresh, canned, and frozen), nectarines, oranges, peaches, peanut butter, pears, potatoes, spinach, strawberries, sweet corn, tomatoes, and watermelon] identified by EPA for testing. The program publishes an Annual Summary, which reviews the data collected by each commodity, provides a program overview and explains sampling and testing methodologies.

AMS released the 2013 PDP Annual Summary in December 2014. The 2013 database contains over two million data points. The Program plans to release the 2014 Summary by the end of calendar year 2015.

Market News and Portal

The Market News Service (Market News) provides current, unbiased information on supply, demand, prices, movement, location, quality, condition, and other market data on agricultural products in specific markets and marketing areas – both domestic and international. The data is collected for cotton, dairy, livestock, meat, grain, poultry, eggs and specialty crops, including fruits, vegetables, nuts, ornamentals. This information is supplied to buyers and sellers, producers and handlers, transportation and logistics companies, insurance and lending institutions, and others in the marketing chain, including consumers. The information reported by Market News provides a high level of market transparency that contributes to the orderly marketing of agricultural commodities and helps to promote fair trade for all market participants. The market information also supports government policy makers and is widely used for value determinations, such as in courts and mediation.

Federal and State reporters obtain market information on a voluntary basis with the exception of the Mandatory Price Reporting for specified livestock, meat, and dairy product information. The information is accessible through the internet and e-mail subscriptions. The site issues hundreds of reports daily for some 700 products and

commodities resulting in millions of e-views by the public on an annual basis. Market News is currently in the process of expanding farmers market, auction, and regional data sources on the portal and AMS website.

For FY 2016, Market News is continuing to redesign its data and technical infrastructure to improve its service to agricultural market stakeholders by increasing information transparency, reporting speed, accuracy, and flexibility. AMS has started to develop a new market analysis and reporting system that will assist in the collection and distribution of commodity information from remote locations.

The Livestock Mandatory Reporting Program

The Livestock Mandatory Reporting (LMR) requires market information (i.e., pricing, contracting, and supply and demand conditions) to be reported by livestock processing plants that slaughter a minimum of 125,000 cattle, 100,000 swine, or process an average of 75,000 lambs to AMS, annually.

The LMR system allows the plants to transfer information electronically in order to meet this requirement. The data that is reported covers 80 percent of slaughtered cattle, 93 percent of boxed beef, 94 percent of slaughtered hogs, 56 percent of slaughtered sheep, 46 percent of boxed lamb meat, and 87 percent of wholesale pork.

Using this marketplace information, AMS has implemented a web-based interactive dashboard that provides stakeholders with real time price data paid by packers to producers for cattle, hogs, and sheep; daily and weekly prices received by packers for their sales of boxed beef and boxed lamb to retailers, wholesalers, and further processors; and information on prices received by importers of boxed lamb. It also allows the user the ability to access DataMart in order to gain a historical and/or marketing trend perspective.

The livestock and meat industry use the information for production decisions and contract pricing references and formulas. Producers use the data to evaluate market conditions and pricing.

Web-based Supply Chain Management System

The Web-based Supply Chain Management (WBSCM) is an internet-based commodity acquisition, distribution, and tracking system that support domestic and international food and nutrition programs administered by four USDA Agencies (Food and Nutrition Service (FNS), Farm Service Agency (FSA), Agriculture Marketing Service (AMS), and Foreign Agricultural Service (FAS)) and United States Agency for International Development (USAID).

AMS manages WBSCM System, develops products and purchase program technical requirements, and conducts the procurements (solicitations, awards, and contract management) in accordance with federal regulations and USDA policy. AMS purchases meat, poultry, eggs and egg products, and fruits, vegetables and tree nuts to help stabilize market conditions. The commodities acquired are furnished to FNS to meet the needs of the National School Lunch Program and other domestic nutrition assistance programs. Food purchases are coordinated with FNS to assure that the quantity, quality, and variety of commodities purchased meet the desires of schools and institutions participating in domestic nutrition assistance programs and can be used to assist individuals in meeting the Dietary Guidelines for Americans. The FSA administers the payments to vendors to whom contracts have been awarded, and ensures the proper storage of commodities when necessary. The WBSCM system allows stakeholders to review and place bids for commodities, receive procurement price information and volume needed, and tracks the delivery of the purchased commodities. The system transfers information that allows customers and vendors the ability to make informed decisions and improves transparency. The system provides data on more than 200 commodities or 32 billion pounds of food purchased for the domestic and foreign feeding programs administered by AMS, FSA, and FNS, and the USAID. Procurements in WBSCM are valued over \$12 billion. Currently, the system is supporting over 9,945 registered stakeholders that are involved in the Federal food procurement process and include State and local agencies, school districts, international recipients, commodity suppliers and processors, transportation providers and warehouses.

2.0. Animal and Plant Health Inspection Service

2.0.1. Introduction

USDA broadly defines technology transfer as the *adoption of research outcomes (i.e., solutions) for public benefit*. Seemingly a simple statement, that process of adoption is complicated, requiring integration of many assets from disparate sources in the successful delivery of solutions. “Public benefit” is achieved through many mechanisms including public release of information, tools, and solutions (e.g., germplasm, plants and other materials), adoption by partners through collaborative research, formal cooperative research and development agreements (CRADA) authorized by the Federal Technology Transfer Act (1986), direct federal, state, or local technical assistance, or through licensing of biological materials or protected intellectual property directly to not-for-profit entities and for-profit private sector firms. This report summarizes the Technology Transfer accomplishments of all APHIS Programs for fiscal year 2015.

2.0.2. Combined Metric Tables

TABLE 1. Collaborative Relationships for Research and Development (R&D)					
	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
APHIS-Wildlife Services (WS)					
• CRADAs, total active	8	9	9	9	11
- New, executed	5	3	3	1	1
▪ Amendments¹, total active	2	2	7	9	8
- New, executed	2	0	5	3	3
▪ Traditional CRADAs, total active	8	9	9	9	11
- New, executed	5	3	3	1	1
▪ Small Business Cooperators, total active	4	5	7	6	8
- New, executed	3	1	2	1	1
▪ Foreign Cooperators, total active	4	6	7	5	3
- New, executed	3	2	1	0	0
• Other Collaborative R&D Relationships					
▪ Confidentiality Agreements³	33	38	48	59	69
- New, executed	16	10	9	9	10
▪ Material Transfer Agreements³	14	30	41	71	93
- New, executed	7	9	11	18	34
Material Transfer Research Agreements					0
- New, executed					0
▪ Other Agreements², total active	109	149	81	203	269
- New, executed	69	76	72	107	147
• Publications	134	104	130	147	99
-Peer-Reviewed (Indexed) Scientific Publications	123	87	98	142	91
-Non-Indexed Publications	11	17	32	5	8
APHIS-Veterinary Services (VS)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
• CRADAs, total active	0	0	0	0	0

Annual Reporting on Technology Transfer in USDA, FY 2015

• Other Collaborative R&D Relationships					
▪ Confidentiality Agreements		0	134	1	0
- New, executed		0	134	1	0
▪ Material Transfer Agreements		11	21	9	70
- New, executed		11	21	9	29
Material Transfer Research Agreements					2
- New, executed					2
▪ Other Agreements ² , total active		26	24	58	90
- New, executed		7	3	23	87
• Publications		63	26	35	29
-Peer-Reviewed Scientific Publications		61	24	35	29
-Trade Journal Publications		2	2	0	0
APHIS-Plant Protection and Quarantine (PPQ)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
• CRADAs, total active			0	0	0
• Other Collaborative R&D Relationships					
▪ Confidentiality Agreements			0	0	1
- New, executed			0	0	1
▪ Material Transfer Agreements			0	1	9
- New, executed			0	1	8
Material Transfer Research Agreements					4
- New, executed					4
ARS Letter of Intent³					2
▪ Other Agreements ^{2,4} , total active			198	380	389
- New, executed			99	147	132
• Publications			31	68	54
-Peer-Reviewed Scientific Publications			22	39	30
-Trade Journal Publications			9	29	20

Footnotes for Table 1

¹ Amendments extend existing CRADAs for additional years to a maximum of 5 years, and/or change Statements of Work, and/or change funding levels.

² Includes Trust Fund Agreements, Interagency Agreements, Cooperative Agreements, Cooperative Service (Reimbursable) Agreements, Non-Funded Cooperative Agreements and MOUs.

³ This type of agreement was developed this year to facilitate the rapid exchange of unpublished data from ARS to APHIS PPQ to support regulatory methods and protocols and decision making.

⁴ This includes 322 cooperative agreements (CAs); 109 of total funded with **Farm Bill funds** and 37 of total CAs funded with **USDA HLB Multi-agency Coordination Initiative Funds**. This also includes 67 interagency agreements (IAs) and 35 of total IAs funded with **Farm bill funds**.

TABLE 2. Invention Disclosures and Patenting

APHIS-Wildlife Services (WS)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
• New invention disclosures in FY	1	0	2	2	4
• Patent applications filed in FY, total					
▪ Non-Provisional	0	1	0	0	0
▪ Provisional	0	0	0	0	3
• Patents issued in FY					
▪ Life Sciences	0	0	0	1	1
▪ Chemical	0	0	0	0	0
▪ Mechanical & Measurement	0	1	1	0	0
APHIS-Veterinary Services (VS)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2014
• New invention disclosures in FY	0	0	0	1	1
• Patent applications filed in FY, total					
▪ Non-Provisional	0	0	0	0	0
▪ Provisional	0	0	0	0	0
• Patents issued in FY					
▪ Life Sciences	0	0	0	0	0
▪ Chemical	0	0	0	0	0
▪ Mechanical & Measurement	0	0	0	0	0

TABLE 3. Licensing: Profile of Active¹ Licenses

APHIS-Wildlife Services (WS)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
• All licenses, total active in the FY ²					
▪ Patent licenses, total active in FY	1	1	1	1	1

¹Active means legally in force at any time during the FY, whether or not the license is income bearing. USDA licenses are patent invention and material transfer (invention) licenses. There are no other invention licenses or other IP licenses.

²WS/NWRC has only one license

TABLE 4. Income Bearing Licenses

APHIS-Wildlife Services (WS) ¹	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
• All royalty bearing licenses ¹	1	1	1	1	0
▪ Patent licenses	1	1	1	1	0

¹WS/NWRC has only one license

TABLE 5. License Income

APHIS-Wildlife Services (WS) ¹	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
▪ Patent licenses					
• Total Earned Royalty Income (ERI) ¹					
▪ Patent licenses, total ERI	\$432	\$0	\$0	\$0	\$0

¹ WS NWRC has only 1 license

TABLE 6. Disposition of License Income

APHIS-Wildlife Services (WS) ¹	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
• Income distributed, total					
- To Inventors	\$432	\$0	\$0	\$0	\$0
▪ Patent licenses, total	\$432	\$0	\$0	\$0	\$0
- To inventors	\$432	\$0	\$0	\$0	\$0

¹ WS/NWRC has only 1 license

2.1. WILDLIFE SERVICES

http://www.aphis.usda.gov/wildlife_damage/nwrc/

2.1.1. Mission Statement

The mission of USDA APHIS Wildlife Services (WS) is to provide Federal leadership and expertise to resolve wildlife conflicts to allow people and wildlife to coexist. Wildlife is an important public resource greatly valued by the American people. However, wildlife is a dynamic and mobile resource that can damage agricultural and industrial resources, pose risks to human health and safety, and affect other natural resources. The WS program carries out the Federal responsibility for helping to solve problems that occur when human activity and wildlife are in conflict with one another. The WS program strives to develop and use wildlife damage management strategies that are biologically sound, environmentally safe, and socially acceptable.

2.1.2. Nature and Structure of Research Program

WS conducts program delivery through its Regional and State Offices and National Programs, providing high quality wildlife damage management services for its customers that result in the protection of agriculture, wildlife and other natural resources, property, and human health and safety. The National Wildlife Research Center (NWRC) is the research arm of Wildlife Services. WS NWRC is the only Federal Laboratory devoted to resolving problems caused by the interaction of wild animals and society.

WS NWRC is headquartered on the Foothills Research Campus of Colorado State University in Fort Collins, CO. The WS NWRC employs more than 150 scientists, technicians, and support personnel at its Fort Collins, CO, headquarters and at the 7 field stations located throughout the United States and Monell Chemical Senses Center in Philadelphia, PA. Approximately two-thirds of WS NWRC staff is located in Fort Collins. The remainder of the highly specialized staff is located in the other 8 locations throughout the United States, facilitating a unique ability to address regional wildlife damage management issues. Further, WS NWRC routinely conducts international consultations in this specialized area.

Scientists at WS NWRC apply a diverse array of expertise to the development of practical, biologically, environmentally, and socially sound methods to resolve these problems and to maintain the quality of the environment shared with wildlife. Scientific staff specializes in several disciplines, including animal behavior/psychology, chemistry, biology, ecology, zoology, economics, genetics, immunology, pharmacology/toxicology, physiology, wildlife biology, and wildlife disease. In addition, WS NWRC works with other experts who have additional specialties through cooperative ties with universities, not-for-profit research facilities, and other public and private research entities.

WS NWRC develops effective wildlife damage management methods through contributions in the following areas:

- Damage assessment
- Investigation of the biology and behavior of problem animals
- Evaluation of the impact of management practices on wildlife and the environment
- Development and improvement of existing management technologies
- Investigation of potential applications of new management technologies
- Support for registration of chemicals, drugs, and devices used to manage wildlife
- Transfer of scientific and technical information
- Provision of scientific guidelines on wildlife damage for use by regulatory agencies
- Development of cooperative research and training with other organizations
- Responsiveness to needs of user groups and the public

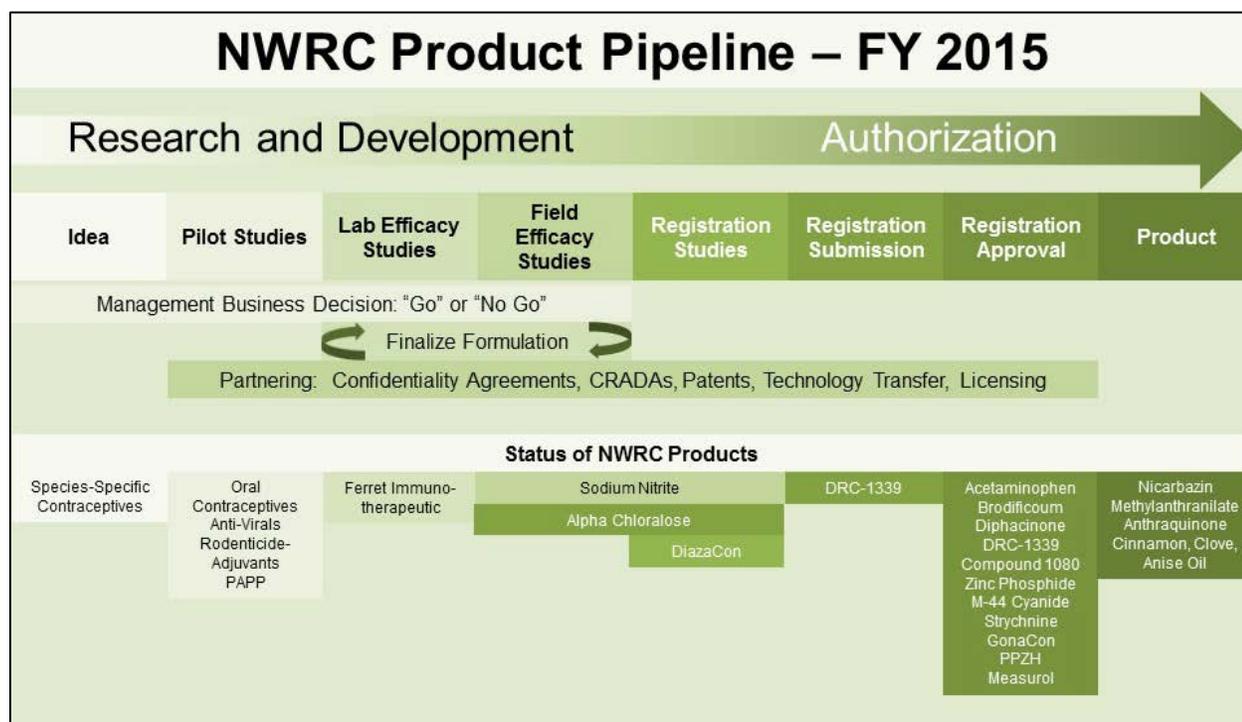
2.1.3. WS Technology Transfer Goals, Objectives, and Measures of Success

Scientists at WS NWRC produce methods, technology, and materials for reducing animal damage. Through the publication of results and the exchange of technical information, WS NWRC provides valuable data and expertise to the public and the scientific community, as well as to APHIS' WS program.

WS follows the general USDA definition of technology transfer as the adoption of research outcomes (i.e., solutions) for public benefit. Through public and private partnerships, WS NWRC research creates new or improved technologies, processes, products and services that benefit the nation by increasing productivity, increasing efficiency (keeping costs low), and enhancing global competitiveness for the U.S. agricultural sector. Technology transfer is critical to accelerating use of public research and methods development, creating economic activity, jobs, and sustaining economic development. WS uses formal instruments of technology transfer, including Confidentiality Agreements (CA), Material Transfer Agreements (MTA), Material Transfer Research Agreements (MTRA), and Cooperative Research and Development Agreements (CRADA). In addition, WS transfers technology through patents and invention licenses for commercialization by the private sector. WS has an ongoing formal agreement with ARS Office of Technology Transfer (ARS OTT) to administer WS patents and licensing and to assist with the development CRADAs. WS NWRC's Manager of the Technology Transfer Program serves as the primary liaison for APHIS to the ARS OTT and patent review committee. In addition, the Manager prepares the APHIS contribution to the USDA Annual Report on Technology Transfer by providing ARS OTT with information on APHIS technology transfer activities and metrics, including tabular metrics of inventions, licenses, CAs, MTAs, CRADAs, as well as other notable "downstream outcomes."

In addition to patents and licenses, WS transfers knowledge and technology through many other formal and informal mechanisms. Primary among these methods for WS NWRC scientists is publication in peer-reviewed scientific journals. Other important mechanisms for transferring technology and knowledge include presentations at technical or professional conferences and publications in proceedings, technical assistance to the public or stakeholders, informal and formal exchange of information and products among colleagues, public outreach via factsheets, brochures, web pages and social media and laboratory open houses.

WS Operations and the NWRC have dedicated staff devoted to registration/authorization of products with regulatory agencies, including the Environmental Protection Agency, the Food and Drug Administration, and the USDA Center for Veterinary Medicine. When products are developed, they proceed through the research and development pipeline (see schematic below) and are registered with the appropriate regulatory agencies. Products with limited private market potential, but highly desirable to WS Operations, are produced and distributed by the WS Pocatello Supply Depot. Products with significant private market potential are licensed for sale to a private company. Efforts to increase the number of APHIS products licensed by private companies include patenting innovative technology, development of CRADAs, participating in regional technology transfer fairs, interacting directly with and national, state and local governments, universities, and industries, and enhancing training for WS NWRC scientists in technology transfer.



WS currently measures success of its technology transfer using several metrics. To measure the success with which WS NWRC scientists are partnering with collaborators, WS NWRC looks at the number of agreements established with collaborators. These include CAs, MTAs, and CRADAs established with partners. However, because many of our partnerships do not necessarily involve the transfer of intellectual property, WS NWRC also follows the number of other agreements established, including cooperative agreements, cooperative service agreements, and interagency agreements, all of which measure the degree of collaboration that WS NWRC has with universities, businesses, other federal government agencies, state and local governments, non-governmental organizations, and foreign governments and universities.

Cooperator funding is very important to WS and to WS NWRC in accomplishing their mission. Efforts are being made to increase the amount of cooperator funding generated. For example, cooperator funding at WS NWRC averages about 16% of the annual budget. Cooperator funding has steadily increased during the last 5 years, generating \$2.4 million in 2011, and \$2.4 million in 2012, \$2.7 million in 2013 and \$3.5 million in 2014 and \$2.6 million in 2015. Agreements with federal cooperators account for approximately 60% of NWRC’s annual incoming cooperator funding, while 40% is obtained through agreements with non-federal collaborators.

WS NWRC tracks its outreach and communication efforts through numbers of technical publications. WS NWRC has a full-time legislative and public affairs staff person, and is increasing its outreach efforts through press releases, stakeholder announcements, fact sheets, website postings, social media, facility tours, and workshops. One area we have begun to emphasize is outreach to the business community and communication to WS Operations and stakeholders regarding the economic value received for their research investment. WS NWRC also tracks the number of registrations (existing and new) that have been obtained with regulatory agencies. This is an indicator of new product development that has been provided for use by the public or by WS operational staff.

2.1.4. WS response to Presidential Memorandum on Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Business

In the USDA's implementation plan for the Presidential Memorandum, WS described three initiatives to promote technology transfer response and commercialization.

USDA 20: Increase awareness in WS of technology transfer mechanisms, leading to increased pace of effective technology transfer and commercialization.

WS NWRC has traditionally been active in transferring technology and scientific information through use of outreach to collaborators, including WS operational personnel and through publications. Successful outcomes may include improved wildlife damage management practices, scientific information that enhances U.S. competitiveness by protecting crops and property, or increased awareness about wildlife diseases that threaten health of livestock or humans. Most of these outcomes do not require a patent and license for implementation. This initiative is designed to increase awareness among WS personnel about the importance of both formal and informal technology transfer.

In FY 2015, the Manager of WS NWRC's Technology Transfer Program provided a formal technology transfer training to all NWRC biologists and one-on-one case specific technology transfer trainings to five scientists, increasing the general knowledge and raising the awareness of scientists as to the power of partnerships, importance of developing intellectual property, and the array of technology transfer agreements available to facilitate their research. In addition, WS NWRC's Technology Transfer staff continued to reach out to WS Operations on technology transfer and intellectual property issues. WS Operations staff contacted WS NWRC's Technology Transfer Program for regulatory advice on issues related to feral swine trapping, four confidentiality agreements.

WS continues to emphasize the importance of collaborative agreements with stakeholders to offset diminishing discretionary funding, while increasing relevance of research to stakeholders, such as the private sector. WS, as part of the annual report table, continues to track the number of agreements it maintains each year, including cooperative agreements, cooperative service agreements, MOUs, and interagency agreements. In addition, WS will track numbers of specific technology transfer agreements, including CAs, MTAs, and CRADAs. In FY 2015, WS NWRC maintained or amended 10 active CRADAs, and entered into 1 new CRADA. These CRADAs brought \$193,321 in cooperative funding to the NWRC, allowing scientist for pursue collaborative research aimed at developing products to mitigate wildlife damage issues. In addition, WS NWRC is currently partners in 69 Confidentiality Agreements, 10 of which were new in FY 2015, and 93 Material Transfer Agreements, 34 of which were new in FY 2015.

In addition to traditional technology transfer mechanisms, the WS National Wildlife Research Center publishes scientific manuscripts, book chapters and reports. In FY 2015, the NWRC released 99 publications, including 91 manuscripts in 52 peer-reviewed outlets, 3 book chapters and 1 report. In addition, the NWRC Registration Unit prepared 35 EPA data submissions for registering sodium nitrite as a toxicant for feral swine, and 4 semi-annual reports for animal drugs currently under investigation through Food and Drug Administration, Investigational New Animal Drug permits.

USDA 21: Increase knowledge of WS and NWRC and their impact in preventing wildlife conflicts, leading to increased development of collaborative research and more effective use of public resources.

WS NWRC has committed to increasing the amount of information disseminated to the general public and stakeholders on research, collaborations and products provided by the Program. The WS NWRC works closely with APHIS public affairs staff in the preparation and dissemination of information on WS NWRC research and

collaborations, as well as WS's role as the premier organization for managing human-wildlife conflicts.

As part of continued efforts to increase local and regional community awareness of the WS NWRC, in FY 2015, the Center hosted tours to approximately 250 students, visiting scientists, business and agency partners, and USDA employees. Center representatives hosted booths at several university career fairs to inform students of careers and potential job opportunities with the WS NWRC. Through the USDA's blog site, Twitter site, and GovDelivery system, WS NWRC notified 10,000+ stakeholders of various research activities, accomplishments, and events. WS NWRC responded to 75 media and community requests for information and published approximately 25 brochures, factsheets, press releases and reports for the general public.

USDA 22: Increase the pace of WS technology transfer and commercialization activities.

To accomplish this objective, WS NWRC will increase its efforts to obtain partners for technologies ready to be commercialized by working with ARS and by utilizing the ATIP Program.

WS will continue maintaining existing products and registering new products with the Environmental Protection Agency and the Food and Drug Administration for use by WS personnel and the public. In FY 2015, APHIS WS maintained 24 Section 3 registrations with the Environmental Protection Agency and made 1 pesticide registration application submission for a new active ingredient intended for a product to control feral swine. A total of 28 Section 24c (Special Local Need) pesticide registrations were maintained and three new labels were obtained; 1 Experimental Use Permit was in place. In addition, APHIS WS maintained 2 Investigational New Animal Drug permits with the Food and Drug Administration.

2.1.5. Downstream Outcomes



Federal Laboratory Consortium's Award for Excellence in Technology Transfer.

On April 29, 2015, NWRC received the Federal Laboratory Consortium's (FLC) 2015 Award for Excellence in Technology Transfer for its role in the development of an automated bait cartridge and delivery system to control invasive brown treesnakes. The automated bait cartridge and delivery system was first conceived in 2009 when NWRC researchers entered into a series of cooperative agreements with Applied Design Corporation—a private engineering and design firm in Boulder, Colorado—to develop a cost-effective, environmentally-safe, and efficient system for distributing toxicant baits to invasive brown treesnakes (BTS) in remote and inaccessible areas on Guam. Three patents are being pursued as a result of this collaboration. The system includes a biodegradable bait cartridge containing acetaminophen (a registered toxicant for BTS) and an automated delivery system that can disperse up to 4 bait cartridges per second via helicopter or fixed wing aircraft. The delivery system allows for the cartridges to open and become entangled in the forest canopy as they fall. Since the BTS is an arboreal species, entanglement in the canopy is crucial for baiting. This technology is adaptable to the delivery of other payloads and could have significant benefits for other invasive species management efforts. Obvious uses

would include delivery of rodenticides or vaccines to arboreal animal populations.

The award recognizes Federal laboratories that have accomplished outstanding work in the process of transferring a technology to the commercial marketplace. The NWRC is one of fifteen Federal laboratories receiving the award in 2015. The Center also received FLC's Mid-Continent Chapter award for the development of "Notable Technology" on August 26, 2015 for the same technology.



Development of Chemical Repellents for Birds.

NWRC scientists have been working for decades towards developing chemical-based bird repellents for alleviating crop depredation and other nuisance situations. Many useful tools have resulted from those efforts. On September 15, 2015, the U.S. Patent and Trade Office issued a patent to APHIS and Dr. Scott Werner for an 'Ultraviolet Strategy for Avian Repellency' (US 9,131,678 B1). This method for repelling birds from a crop or other resource is unique. First, a bird repellent is applied to the target crop in sufficient quantities to repel birds. Then, one or two subsequent treatments are applied to the crop that includes not only the repellent, but also a visual cue that exhibits an ultraviolet absorbance spectrum or color similar to that of the repellent. This allows for future repellent treatments to be applied at significantly lower amounts than the initial treatment. Because of the potential cost savings to applicators and the opportunity to develop a unique bird management tool, interest is high among private businesses to license this technology from APHIS. A license is expected to be issued by the end of 2015.



Licensing of GonaCon-Equine.

GonaCon-Equine is a contraceptive vaccine developed by APHIS and registered with the U.S. Environmental Protection Agency for use in wild and feral horses and burros. The technology for this vaccine was issued a patent by the U.S. Patent and Trade Office in 2010 under the title 'Vaccine Composition and Adjuvant' (U.S.

7.731,939, B2). Humane Breakthrough, a newly established public benefit company (PBC), recently finalized a license under this patent and will begin production and sales of GonaCon-Equine in early 2016. This license allows Humane Breakthrough PBC to market GonaCon-Equine within the United States and internationally. In addition, the license and registration set the groundwork for Humane Breakthrough PBC in partnership with SpayFIRST! to develop other applications and markets for GonaCon.

2.2. BIOTECHNOLOGY REGULATORY SERVICES (BRS)

<http://www.aphis.usda.gov/biotechnology/index.shtml>

2.2.1. Mission Statement

The mission of BRS is to protect and enhance U.S. agricultural and natural resources using a dynamic, science-based regulatory framework to ensure the safe importation, interstate movement, and environmental release of genetically engineered (GE) organisms.

2.2.2. Nature and Structure of Program

BRS does not perform research. BRS regulates the introduction (importation, interstate movement, and release into the environment) of GE organisms that may pose a risk to plant health. Researchers and product developers, Federal or private, should understand and work with the appropriate regulatory agencies that may have oversight of an organism at different stages in the development of a product. This can facilitate efficient development of the appropriate information necessary for regulatory review.

Since 2009, BRS has provided compliance assistance to the regulated community for the voluntary adoption of a Biotechnology Quality Management System (BQMS) Program. A BQMS serves as an important tool to help organizations involved in biotechnology research and development analyze the critical control points within their management system to better maintain compliance with USDA APHIS regulations for the import, interstate movement, and environmental release of regulated GE organisms (7 CFR part 340).

The BQMS Program integrates a dynamic, science-based approach of risk assessment and mitigation, allowing for sound decision making and effective management of the research and development of regulated GE organisms. The program integrates principles from other quality management systems, such as the Codex Alimentarius Hazard Analysis Critical Control Point System and ISO 9001:2008. The BQMS program offers to organizations a flexible approach to implementing a quality management system, where the BQMS is tailored to the organization's individual size and research scope. The BRS Office of Compliance Assistance provides participants with the tools and guidance needed to develop a BQMS through training, documented guidelines and one-on-one assistance. BRS provides an initial assessment of an organization's regulatory compliance processes and assists with periodic reviews and audits of the organization's BQMS. Twenty organizations, including public sector research institutions and multi-national corporations, have voluntarily established a BQMS within their organization through the services provided by BRS. These organizations share common goals of responsible research and facilitating regulatory compliance. Information on the APHIS BRS BQMS Program can be found at http://www.aphis.usda.gov/biotechnology/compliance_assistance_main.shtml

2.3. INTERNATIONAL SERVICES

http://www.aphis.usda.gov/international_safeguarding/index.shtml

2.3.1. Mission Statement

The mission of International Services (IS) is to protect U.S. agricultural and natural resources by working with foreign governments to prevent the spread of high-risk plant pests and animal diseases; facilitate the safe international movement of agricultural commodities through science-based regulations and internationally accepted standards; and enhance global health and U.S. biosecurity through the development of science-based regulatory systems and policies around the world.

2.3.2. Nature and Structure of Program

IS' overseas presence enables APHIS to monitor and respond to pest and disease threats, develop international strategies and partnerships to prevent their spread to the United States, and support U.S. agricultural trade by resolving technical barriers. Through its services, IS contributes directly to global food security by promoting safe global trade and facilitating the development of science-based regulatory systems around the world. IS works closely with its sister units, including Veterinary Services (VS), Plant Protection and Quarantine (PPQ), Biotechnology Regulatory Services (BRS), Wildlife Services (WS) and other headquarters staffs, to ensure that its day-to-day work overseas reflects the priorities of these domestic programs. This collaboration is key to IS' success and is achieved through joint planning, enhanced communications, clear direction to the field, and implementing coordinated strategies.

IS uses technology transfer to support APHIS' work overseas by creating linkages and supporting partnerships, collaborations, and cooperative programs. As part of its mission to safeguard U.S. agriculture and expand the safe exportation of unprocessed agricultural products, IS works with international partners through bilateral and multilateral treaties and agreements to improve animal and plant health systems around the world. IS partners with international organizations, including the International Atomic Energy Agency (IAEA), World Organization for Animal Health (OIE), the Food and Agricultural Organization of the United Nations (FAO), and the International Regional Organization for Agricultural Health (OIRSA) as well as with our international trading partners to help implement appropriate technologies to control or eliminate sanitary and phytosanitary (SPS) threats to the safe trade of agricultural products.

IS has organized and led several pest control programs in the Americas designed to reduce or eliminate the populations of pests like Screwworm, Mediterranean fruit fly (MEDFLY), and Mexican fruit fly (MEXFLY). The control of these very costly pests requires a specific set of technologies involving several different control measures, including the design and methods of release of sterilized male flies, the application of environmentally friendly pesticides, and the design and application of fly traps for surveillance and population reduction. IS has also developed a robust information management system and database that is utilized by both Screwworm and MEDFLY Commission allowing for the sharing of critical information among partners. IS works throughout Central America and the Caribbean to transfer technologies for effective and sensitive fruit fly surveillance and control in collaboration with its international partners and the USDA's Agricultural Research Service.

The most recent example of this technology transfer occurred following detections of Mediterranean fruit fly in the Dominican Republic in early 2015. The Dominican Republic is a member of the CAFTA-DR free trade agreement, the countries of which now constitute the United States' fifth-largest trading partner in agricultural products. IS has transferred to the Dominican Republic many of the technologies necessary to mitigate this critical threat to the United States. IS's Action Program Office in Guatemala, which focuses on the MEDFLY program, shares this Geographic Information Systems (GIS) and Global Positioning System (GPS) technology with agencies within Mexico, Guatemala and Belize as well.

Additionally, the monitoring of technology transfer from APHIS to the Haitian Ministry of Agriculture constitutes part of an agreement between USDA and the U.S. Agency for International Development (USAID), which focuses on improving public plant health services in Haiti. To date, over ten different technologies have been transferred to Haiti to improve fruit fly surveillance and control as part of our ongoing effort to safeguard U.S. agriculture and improve safe food production for the world. Haiti exports over 25 million mangos to the U.S. each year.

The US Feral Swine Damage Management Plan includes several activities where WS, VS and IS plays important roles. The Feral Swine Program in Mexico's goal is to integrate the Mexican Agencies into the international (Regional) group in North America to develop joint activities for Feral Swine Damage Management. Coordination among WS and IS is essential for the success of this proposal. IS is the primary organization for the US-Mexico Binational negotiations to develop activities in the Feral Swine Program.

Our long-standing support of Foot-and-mouth disease (FMD) eradication from the Western Hemisphere is another example of technology transfer from the U.S. to foreign counterparts. USDA has been an active signatory partner in this effort for the last 35 years. From the beginning of this international effort, involving multiple treaties and agreements between the United States and our trading partners in the Western Hemisphere, the United States was a critical leader in the transfer of effective FMD surveillance and control strategies. Each of these strategies in turn relies on several different technologies, for which the U.S. is usually the leader in developing. The U.S. has signed several treaties and international agreements through the Department of State and via the USDA to fully support the hemispheric effort through technology transfer.

These technologies have included high-volume vaccine production, infra-red surveillance for febrile illnesses, animal computer-chip ear-tag identification, computerized methods of managing surveillance, and sanitation technologies in slaughter facilities. FMD poses a constant threat to livestock production in the U.S, with the potential to devastate our beef and pork industries if the virus were to appear in the United States. Between 1980 and 2010, the FMD virus was successfully reduced from its widespread presence in nearly all of South America to its current presence only in Venezuela. The campaign to eradicate FMD from the Western Hemisphere is nearly complete, and it could not have been accomplished without the active participation of the United States in transferring technologies essential to the program.

2.3.3. Downstream Outcomes

International Technical and Regulatory Capacity Building (ITRCB)

The ITRCB, a unit of APHIS International Services, acts as a clearinghouse to review requests for APHIS technical assistance and when appropriate, support s agency efforts facilitating technical cooperation activities with trading partners and developing countries. Training of foreign counterparts comprises a significant level of effort of the ITRCB unit. Technology transfer when it occurs is limited. One area where APHIS-IS is an active leader in developing new methods to support the Agency's control and eradication efforts of quarantine pests. In FY 15, two activities were conducted which support larger international efforts to combat invasive pests.

The Emerald Ash Borer (EAB) – *Agrilus planipennis* is native to eastern Asia and feeds on ash species. Outside its native range, which now includes North America, it is an invasive species and is highly destructive to ash trees native to North America. Research on its biology is being in progress and APHIS is attempting to control it using several methods including the use of biological control. APHIS has reared colonies of parasitoid insects that feed on EAB larvae and represent a possible control method for EAB. In 2015, APHIS transferred colonies of *Tetrastichus planipenisi*, one of the species of biological control parasitoids, to counterparts in Canada who released them in Ontario and Quebec.

In addition, IS has coordinated in technology transfer as it relates to controlling invasive pests is the example of *Lobesia botrana* the European Grapevine Moth (EGVM). This invasive moth that is a major vineyard pest was

detected in California in 2009. APHIS scientists have developed methods to mass rear EGVM in order to use sterile insect technique (SIT) to control and irradiate this invasive pest. International organizations such as the International Atomic Energy Agency (IAEA) have also supported the methods development efforts related to EGVM. In 2015 the IAEA supported an APHIS expert who provided technical assistance to Chilean plant health authorities who seek to develop their own SIT program for *Lobesia botrana*.

2.4 PLANT PROTECTION AND QUARANTINE

http://www.aphis.usda.gov/plant_health/index.shtml

2.4.1 Mission Statement

We safeguard U.S. agriculture and natural resources against the entry, establishment, and spread of economically and environmentally significant pests and we facilitate the safe trade of agricultural products.

2.4.2 Nature and Structure of PPQ's Methods and Technology Development Program

PPQ's technology development is facilitated and implemented through cooperation between its 3 divisions; namely Policy Management (PM), Field Operations (FO), and Science and Technology (S&T). CPHST is the primary component of PPQ's Science and Technology core functional area, which also includes the National Clean Plant Network (NCPN). APHIS is one of three agencies of the USDA (along with ARS and NIFA) who, through a memorandum of understanding, support research, quarantine and outreach activities for the NCPN. The NCPN is "a voluntary association of specialty crop networks that promote the use of pathogen-tested, healthy plant material for food crops in the United States" (<http://nationalcleanplantnetwork.org/about/>).

The S&T Center for Plant Health Science and Technology (CPHST) provides scientific and technical support for the regulatory decisions, policies, and operations of APHIS' Plant Protection and Quarantine (PPQ) program in order to safeguard U.S. agriculture and natural resources. CPHST is responsible for ensuring PPQ has the information, tools, and technology to make the most scientifically valid policy and regulatory decisions possible. CPHST is headquartered on the campus of North Carolina State University in Raleigh, North Carolina. The broader CPHST system however consists of approximately 240 scientists, analysts, and support staff at 7 principal laboratories, with satellite locations throughout the United States and in Guatemala. It also includes four programs and multiple work units. CPHST supports regulatory plant protection activities by developing methods and conducting analyses in the following program areas: AQI/Commodity Treatment Support, Trade Issues and Risk Analysis, Identification and Diagnostics, Pest Detection, and Pest Management.

In FY15 S&T proposed and received approval to expand CPHST operations with a new laboratory in California. This laboratory will fill a major need for additional science and technology support for West Coast pest programs and agricultural trade, and is a major initiative for FY16.

CPHST activities primarily focused on providing scientific support for PPQ needs and decision making, but also supported stakeholders such as State plant regulatory programs and the agricultural and nursery industries. CPHST conducts its work with internal stakeholders but also engages other federal agencies (i.e. ARS, NIFA, Forest Service, DOE National Labs, DHS and EPA), Tribal Nations, academia, international institutions and industry to acquire knowledge, best management practices, products and protocols, and to develop methods and protocols needed for plant protection and management of invasive pests.

2.4.3 Current Technology Transfer Goals, Objectives, and Measures of Success

PPQ is committed to use of the best science, tools, and technologies to strengthen the efficiency and effectiveness of PPQ's work. PPQ transfers new methods and technology through several mechanisms. Technical documents, protocols, risk assessments and pest survey guidelines that are distributed directly to stakeholders or are made

available through PPQ websites. Another important mechanism to transfer information is through the publication of results in peer-reviewed scientific journals. Other important mechanisms for transferring technology and knowledge include presentations at technical or professional conferences, publications in proceedings, trade publications, and direct technical assistance to the public, stakeholders and industry through various outreach activities and events.

The CPHST Identification Technology Program (ITP) provides digital pest identification tools that are available online (<http://idtools.org>) that are used by APHIS scientists as well as scientists in Customs and Border Protection, in state departments of agriculture, in domestic and international academic institutions and also by national and regional plant protection agencies to identify plant pests. In FY2015 was the release of *imageID*, a searchable online collection of high-quality images of plant pest taxa of concern to APHIS PPQ. This collection is tailored specifically for PPQ's identifiers, with images that help them recognize, learn, and compare the morphology and diagnostic characters of pest organisms. *imageID* was released on December 10, 2014 with over 38,000 images. By September 30, *imageID* contained over 60,000 images to support Identifiers at ports-of-entry make accurate identifications.

CPHST also provides technical training to stakeholders in certain areas (i.e. diagnostic testing, pest risk assessment, treatments) and also provides information and training on quality management and accreditation. For example, the CPHST Beltsville Lab provides hands-on training on newly developed molecular diagnostics for regulated plant diseases to state and academic diagnosticians and in FY 2015 conducted seven training workshops for 65 diagnosticians. The Plant Epidemiology and Risk Analysis Lab (PERAL) staff provides basic pest risk assessment training workshops for interested parties in the domestic and international plant health regulatory community. Notably they conducted basic risk assessment training to participants that included Customs and Border Protection staff, and two international pest risk assessment workshops in Kuala Lumpur with participants from Malaysia, Philippines and Vietnam as well as a fruit fly risk assessment workshop in Bucharest, Romania with participants from eleven Eastern European countries. PPQ staff also travelled to Agadir, Morocco to conduct cold treatment training for 15 plant protection officials from the Moroccan citrus industry.

The National Plant Protection Laboratory Accreditation Program (NPPLAP) accredits state, federal, industry and academic laboratories. In FY 15 NPPLAP accredited 25 labs for regulatory testing. They also certified their diagnostic analysts to perform specific diagnostics through development and distribution of proficiency tests that in FY15 were distributed to 11 laboratories and certified 33 Diagnosticians. For the first time, PT panels were sent to a plant protection organization outside of the U.S. in Columbia.

This fiscal year, the CPHST Beltsville Laboratory successfully completed all requirements for ISO/IEC 17025:2005 accreditation and became the first regulatory plant diagnostic laboratory in the U.S. to achieve this level of accreditation and demonstrates implementation of a sound quality management system and internationally recognized standards for test performance and competence.

Formal agreements, including cooperative and interagency agreements and memoranda of understanding are used to formalize collaborations with other government scientists, universities, private companies and other stakeholders. In FY2015, CPHST ended the year with 389 active agreements including 132 new agreements. The total includes 322 cooperative agreements, 109 of which are funded with Farm Bill funds and 37 of which are funded with USDA HLB Multi-agency Coordination Initiative funds. The total also includes 67 interagency agreements, 35 of which are funded with Farm Bill funds.

In FY 2015, PPQ continued the interagency agreement with the ARS Office of Technology Transfer (ARS-OTT) along with VS and WS to execute formal technology transfer activities on our behalf of PPQ. ARS-OTT worked with the PPQ National Scientific Technologies Coordinator to provide two sessions of technology transfer agreements training to the CPHST management, CPHST principle investigators, staffs in the APHIS Financial Services Branch, PPQ Resources Management Planning Service and Wildlife Service. PPQ worked closely with the ARS-OTT to identify technology transfer opportunities and will continue to in FY2016 as CPHST reviews

projects for additional technology transfer needs.

2.4.4 APHIS-PPQ response to Presidential Memorandum on Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses

In the USDA's implementation plan for the Presidential Memorandum, APHIS-PPQ described four initiatives to promote technology transfer and commercialization. The initiatives and their implementation in FY 2015 are described below.

USDA 23: Enhance Collaboration Efforts in Pest Detection and Management

PPQ's scientific support focuses on improving and developing pest detection and management tools to discover new invasive species early and respond quickly, better identify and target offshore pest threats, develop diagnostic tools and techniques, and transfer technology to cooperators and impacted industries.

Goal 1. CPHST provided new diagnostic and pest detection methods to Ports of Entry.

- Piloted the CANARY detection technology and training plant inspection station staff to conduct the assay for *Ralstonia solanacearum* on Pelargonium interceptions at the Linden, New Jersey and Atlanta, Georgia Plant Inspection Stations. S&T worked with Field Operations and Policy Management staff to successfully conduct the pilot in two phases in 2014 and 2015. A final report has been completed and an analysis and recommendations for implementation and needed resources will be made to the PPQ Management Team in December 2015.
- In cooperation with DHS and the Edgewater Chemical and Biological Center, evaluated volatile organic compound sensing arrays to detect and differentiate warehouse beetles from Khapra beetle; results indicated that this method is potentially feasible and further testing is funded and supported for FY16 by DHS S&T Directorate. This method could quickly determine the presence of Khapra beetle in grain shipments, which is a recurring pest issue in imports (also included in Goal 2).
- Successfully completed all phase 2 objectives for the web-based image library, *imageID*, which aids in pest identification, particularly by PPQ identifiers. The enhanced version was successfully launched with new end-user training by August, prior to the target timeline, and increased the number of pest images accessible to users by 50% to over 60,000

Goal 2. Strengthened PPQ's partnership with the Dept. of Homeland Security (DHS) by developing advanced technologies for pest detection and identification, commodity treatments, and decontamination and disposal.

- In cooperation with DHS and the Edgewater Chemical and Biological Center, evaluated volatile organic compound sensing arrays to detect and differentiate warehouse beetles from Khapra beetle; results indicated that this method is potentially feasible and further testing is funded and supported for FY16 by DHS S&T Directorate. This method could quickly determine the presence of Khapra beetle in grain shipments, which is a recurring pest issue in imports.
- Cooperated work with the DHS S&T and their cooperator, Gryphon Scientific, to coordinate interviews with 49 PPQ and 16 CBP-APTL staff and site visits by DHS, Gryphon, and PPQ to Plant Inspection Stations locations in Los Indios, TX, Miami, FL and Ports of Entry locations in Pharr, TX, Baltimore, MD, Philadelphia, PA and Miami, FL. The Gryphon II project will determine the appropriate advanced detection and identification technologies for evaluation.
- Provided technical expertise to DHS Chemical and Biological Defense Division during their 3-day technical review.
- Worked with DHS S&T to develop the criteria for BAA 14 DHS-003 (Exploration of Advanced Detection Technologies for Chemical and Biological Threats, \$2M in funds), then provided expertise to evaluate several proposals. This work may be important to the rapid detection of pests at our points of entry.
- Provided expertise to evaluate several proposals for DHS S&T BAA 15 DHS-002 (Detection Systems for

Identifying Agricultural Pathogens). This work may be important to the rapid detection of pests at our points of entry.

Goal 3. Provided leadership on the Port Environs initiative to understand which ports of entry pose the highest risks.

- Continued the quantitative assessment of the likelihood of plant pest entry in U.S. port environs by analyzing port and state import databases by commodity group. For 2015, a pathway centered invasion model for Asian longhorned beetle was completed, and the wood packaging material and live plant pathway components for port environs framework were finalized.
- Further refined the conceptual definition of the port environs to guide the geospatial delineation of port environs. A manuscript describing the concept of port environs will be submitted in fall 2015.
- Adapted a bioeconomic model to the port environs analysis using European gypsy moth surveillance in the Northwestern United States as a case study for wood borer and bark beetle surveillance. This includes an initial analysis of travel cost and time patterns for trap placement, and a theoretical model for estimating long-term invasion damages.

Goal 4. Better identify and target offshore pest threats.

- Pest Prioritization. Completed the first phase of a two-year effort to develop an enhanced prioritization tool for the Cooperative Agricultural Pest Survey program, to improve the risk basis for rankings and therefore better utilize resources in all 50 states. Developed and tested separate models for arthropods and plant pathogens for predicting impact, including assessing all test species. Assessed and ranked the updated CAPS list of 95 pests based on predictive impact and provided insights into changes from previous rankings, and ongoing support for the upcoming survey FY16 year.
- Responded to stakeholder notifications, country consultations and rulemaking activities related to Q-37 (regulations governing importation of plants for planting) Costa Rica *Phaelanopsis* PIGM, Mexico Tomato Plantlets in PIGM, Western Hemisphere/Europe Rice for Planting; and Q-56 (regulations governing importation of fruits and vegetables) Argentina Lemon, Australia Citrus Expansion, Brazil Citrus, China Apple, China Grape, European Union Apples/Pears, European Union -Spain Cherry, European Union -Spain Peach, Plum, Nectarine, European Union -UK/Ireland Peppers, India Grape, Mexico Hass Avocado, Peru Pomegranate.
- Led quantitative modeling activities for development and verification of two systems approaches for safely relieving U.S. farmers from exotic fruit fly quarantines: cherry production in California (Oriental fruit fly) and citrus production in Texas (Mexican fruit fly).
- Completed 46 export risk assessments including an assessment to expand market access for Avocado from CA to Argentina, CA stone fruit to Mexico, U.S. potatoes to Indonesia, blueberry cuttings to Peru.
- Pest list reviews for - CA Avocado to China, Christmas trees to China, Lettuce and radish seeds from US to Korea, Avocado from California to New Zealand, Pacific Northwest apples to China, U.S. apples to China, U.S. Nectarines to China, U.S. Strawberries to China.
- Analyzed 46 new pests and pests of imminent threat under the New Pest Advisory Group (NPAG), and completed 23 full NPAG reports. One report was on *Phelipanche (Orobanche) aegyptiaca*, after detection in California; a new U.S. record for the parasitic plant and Federal Noxious Weed.
- Noxious Weeds;
 - Screened 331 additional species for prioritization
 - Completed 26 datasheets for NAPPRA (Not Authorized Pending Pest Risk Analysis) listing candidates (weeds). This function was recently transferred to PERAL from the Plants for Planting Group in IRM.
 - Completed 16 weed risk assessments (WRAs):
 - Two genetically modified species for APHIS Biotechnology Regulatory Services: *Sorghum halepense*, and *S. bicolor* subsp. *drummondii* (shattercane)
 - Two biofuels-related WRAs (EPA requests): *Jatropha curcas* and *Thlaspi arvense*.

- Five WRAs for species from the “on hold” project ‘Corn Seed for Planting from South Africa.’
- Five WRAs for species from multiple projects for ‘EU/Denmark Aquatic Plants in Growing Media.’
- Completed 30 reports on pests recommended for deregulation at ports of entry.

USDA 24: Provide Timely Scientific and Technical Support for Emergency Response and Management

PPQ must develop and maintain a high level of expertise to support preparedness in the areas of science, technical support, and technology transfer for rapid response efforts.

- S&T led the PPQ technical backstopping for High Pathogenicity Avian Influenza (HPAI) to support the Veterinary Service-led overall initiative.
 - Deployed key staff including GIS and modeling experts. S&T modelers complete clustering analyses to investigate the existence of infection patterns and determine whether specific pathways could be linked to disease spread. The insights obtained from the analytical and modeling efforts have provided the HPAI program important insights into disease dynamics and survey support needs.
 - S&T scientists established links with industrial providers of commercial scale disinfection equipment and tested a variety of equipment and protocols for their effectiveness. As a result, new options for decontamination and disposal have been made available to the HPAI program.
- The National Plant Protection Laboratory Accreditation Program continued to support a national network of labs that can conduct regulatory diagnostics. Provided quality management best practices guidance and diagnostic training to laboratory partners in the NIFA National Plant Diagnostics Network and to federal and state regulatory partners.
- Achieved ISO/IEC 17025:2005 accreditation at the CPHST Beltsville Laboratory as the culmination of several years of effort. This is the first regulatory plant diagnostic laboratory in the U.S. to achieve this level of accreditation and demonstrates implementation of a sound quality management system and internationally recognized standards for test performance and competence.
- Implemented a new off-the-shelf Laboratory Information Management System to provide detailed tracking of diagnostic samples and results. The system is currently housed at the Beltsville Laboratory but is being considered for multi-laboratory adoption in FY16.
- Worked with the Kansas Department of Agriculture and other assets in KS, and with PPQ stakeholders to provide emergency technical and survey assistance to address an outbreak of flag smut disease in Kansas wheat. This work helped to determine the severity of the infestation, provide mitigations, and prevent trade impacts on wheat exports.
- Proposed and received approval to expand CPHST operations with a new laboratory in California. This laboratory will fill a major need for additional science and technology support for West Coast pest programs and agricultural trade, and is a major initiative for FY16.
- National Clean Plant Network (NCPN) streamlining initiative. The NCPN team (consisting of PPQ and NCPN leadership) collaborated with WERA-20 leaders to organize a national workshop to bring PPQ and Industry stakeholders together who participated in a 2-day workshop to evaluate the potential of Next Generation Sequencing (NGS) technology related to its use in identification of exotic pathogens to better safeguard US agriculture and support movement of plant materials domestically and in foreign trade. Scientists from academia, state labs and industry discussed the state of the science, its impact on commodity industries, and the challenges it may pose on the regulatory community.
- CPHST Beltsville Laboratory developed a molecular assay for detection of the Citrus leprosis virus (CiLV) strain N using one-step conventional RT-PCR.
- Developed and validated conventional and qPCR methods for detection of *Phytophthora alni subsp. alni* and *P. alni subsp. multiformi* and *P. quercina*, *P. austrocedri*.
- Down-selected a CANARY Biosensor that produced a specific positive response to the targeted CiLV-C1 strain while maintaining a negative response to closely related CiLV-C2 and CiLV-N strains. Completed a

sample preparation method for CANARY CiLV-C1 assay. These will be transferred in FY16 to our commercial partner for CANARY kit production, PathSensors, Inc.

Goal 1. CPHST contributed to the long-term goal of eradicating European grapevine moth (EGVM) from California.

- Convened a technical working group review for the EGVM program and delivering recommendations on survey, treatments, quality assurance, and deregulation by December 2015, as planned.
- Organized a Post-eradication Planning Group and finalizing the plan by the September target date.
- Initiated a spatial analysis study of EGVM monitoring and treatment data to evaluate program effectiveness and identify areas at risk of reinvasion.
- Completed testing to determine sterilizing pupal radiation doses as a basis for sterile insect technique eradication methods.
- In addition to the requirement targets, S&T established methods to apply new phytosanitary protections to known high risk pathways to minimize the likelihood of future reintroductions. As a result of this leadership the pathway safeguarding measures have been strengthened and methods associated with EGVM are being applied to strengthen other regulatory programs. *As a result of continuing eradication efforts, there have been no detections of EGVM within regulated areas since 2013.*

Goal 2. CPHST contributed to the long-term goal of preventing citrus greening disease (*huanglongbing*, HLB) from California.

- Provided system protocols and a field cage production system and associated manual for production of the biocontrol wasp *Tamarixia radiata* in CA conditions within targeted timelines.
- Provided training and technology transfer to California and private industry to build the capacity to produce over 2 million *T. radiata*/year. In addition, S&T provided rearing methods for a new agent, *Diaphorencyrtus aligarhensis*, and over 81,000 have been released in southern CA to date.
- Completed a third year of evaluation of *T. radiata* field cage production in CA. By the end of 2015, over 450,000 will have been produced, approximately doubling 2014 production. In AZ, over 120,000 *T. radiata* have been released at 32 evaluation sites. These sites are continuing to be monitored for establishment and spread rates. In Texas, the populations of Asian citrus psyllid vector in the urban environment have declined by 85% since the introduction of the biocontrol program.
- Developed new diagnostic tests to detect different types of bacteria causing citrus greening. S&T also developed a novel clustering analysis to predict hot-spot areas that could contain Asian citrus psyllids or citrus greening infected plants. This led to a more targeted survey and the new detection of several infected trees in CA in 2015.
- S&T is managing 27 projects with a total funding of \$13,469,200 to support near term solutions for the citrus industry. This funding is provided by the [USDA Huanglongbing Multi-Agency Coordination Group](#), and PPQ S&T is responsible for the administrative and scientific management for this funding.
- Leading inter-institutional cooperative efforts with DHS to establish methods to apply therapies to manage citrus greening disease at large scales applicable to commercial production of citrus.

Goal 3. Provide scientific methods to the fruit fly program.

- Published a taxonomic revision of the *Bactrocera dorsalis* complex (Oriental fruit fly) that will improve pest identification practices, remove barriers to trade, and facilitate management options.
- Completed field trials for solid lures and attractant strips and demonstrating that these alternatives are effective and can be implemented in fruit fly programs to improve employee safety. S&T also delivered a new alternative pesticide treatment prior to an EPA deadline to discontinue a previous diazinon treatment.
- Provided key technical input on design, construction, and staffing requirements to fully complete a Program of Requirements for the Sarasota Sterile Insect Release Facility. In addition, provided input for the Program of Requirements for the Edinburg Mexican Fruit Fly facility that is now 35% complete.
- In addition to the targeted accomplishments, S&T reduced costs at the El Piño Mediterranean fruit fly facility by \$220,000 annually by developing a less expensive fruit fly diet and released an online [Compendium of](#)

[Fruit Fly Host Information](#), as a comprehensive reference to support risk assessment and trade issues related to exotic fruit flies.

- S&T traveled to the Dominican Republic to advise the Ministry of Agriculture to mount an emergency response to delimit, contain, control and eradicate an outbreak of Medfly in Punta Cana. This also included on-the-job training for dealing with a plant pest emergency response, development of operational protocols, instruction on identification of Tephritid adults, immature stages and distinguishing sterile from fertile insects. Assistance also was provided in how to manage resources, advise on staffing needs, and coordinating assistance from other governments and international institutions including FAO, IAEA, OIRSA and IICA. This effort required fluency in Spanish by those involved.

Goal 4. Provide scientific methods for forest pest programs.

- Completed developmental work on radiofrequency radiation as phytosanitary treatment for wood. Radiofrequency treatment was recently accepted as an international standard and commercial scale up is in process.
- Completed testing of imidacloprid as a phytosanitary treatment and showed 2 treatments had acceptable efficacy and residue levels. In addition, S&T completed a 4-year study for the Asian longhorned beetle program that demonstrated that fall treatments of trees in quarantine area are just as effective as spring treatments. Spring treatments are logistically difficult due to a narrow time window for application; this new method will improve the ability of the program to achieve eradication.
- Delivered a technical working group report to the Asian longhorned beetle program ahead of schedule with suggestions on simplifying survey protocols to reduce program costs without impacting effectiveness.
- S&T received a permit to release a new biocontrol agent, *Spathius galinae*, for emerald ash borer and conducted the first releases in 2015. This agent is expected to be better adapted to northern climate conditions than the current biocontrols.

USDA 25: Improve Communications between CPHST and its Customers to assure Market Relevance

CPHST aims to establish and maintain an effective dialogue with its customers to ensure development activities are useful and applicable to customer needs.

- During a consultation with the Fish and Wildlife Service, S&T was able to provide extensive documentation to support a PPQ finding that importation of Phalaenopsis orchids from China would have no effect on endangered species. The document was key in breaking an impasse in the consultation between FWS and PPQ and facilitated resolution of a major trade issue as well as setting the stage for a larger consultation on plants in growing media in general. This agreement will streamline trade analyses and reduce regulatory reviews by at least six months for all issues where there are threatened or endangered species.
- S&T conducted several technical training sessions for internal staff and domestic and foreign stakeholders to build capacity and develop technical networks. In FY 15, these included 6 risk analysis workshops held in the U.S, Malaysia, and Romania for a total of 185 people and 7 pathogen diagnostics training sessions for a total of 65 people.
- S&T engaged the Dominican Republic Ministry of Agriculture to provide technical advice on emergency response to a major Mediterranean fruit fly outbreak with serious trade impacts. S&T also helped to coordinate assistance from other governments and international institutions.
- In addition to annual program review meetings, S&T's citrus health program initiated a listening session with major PPQ and industry stakeholders to better understand the issues that were impacting each citrus state. This session provided new perspectives that influenced new project direction.
- Through the National Clean Plant Network, S&T supported a PPQ-focused network of 28 clean plant centers in 19 states. In 2015, the network was expanded to include sweet potato and roses for a total of 7 crop governing bodies, involving about 100 scientists. The network engages researchers, extension, regulators, and industry in a common vision to support pest-free propagative plants. For sweet potato in

particular, the industry saw NCPN inclusion as a key part of improving production and creating new jobs. The NCPN also linked stakeholder to initiate discussions on harmonizing nursery certification. NCPN supported programs delivered millions of propagules for fruit trees, grapes, berries, citrus, and hops varieties to nurseries and growers every year.

USDA 26: Improve the CPHST Work Plan Development and Project Prioritization Process to Assure High Quality Outcomes for Customers / Stakeholders

CPHST will continue to develop a process with PPQ operations to produce mutually acceptable work plans that ensure appropriate product quality.

- Delivered employee training and guidance to all project leaders managing cooperative agreements to ensure high quality work plans and knowledge of administrative requirements.
- Provided quality management training and guidance to PPQ staff and state cooperators.
- In FY15 S&T leadership travelled to all CPHST labs and held town hall video conference calls with S&T staff to discuss the recommendations for enhancements elucidated in the CPHST Laboratory Review with S&T staffs. *(In FY14 CPHST commissioned APHIS' Policy and Program Development, Program Assessment and Accountability division, to review the CPHST network of laboratories and assess how well the organization is positioned to support PPQ's scientific and technical needs. This independent review concluded that CPHST is meeting current PPQ needs, is adequately positioned to meet future needs, and provided recommendations for enhancements that will be the basis for CPHST strategic planning).*
- Provided oversight of 322 cooperative agreements with domestic and foreign researchers and organizations with a total value of over \$41,368,044. This is an increase of over \$22 million from FY14, as S&T provides administration and management of all Huanglongbing Multi-Agency Coordination Group funding.
 - To further support the HLB-MAC, implemented a novel ADODR 'team approach' format to support our ADODR's and effectively manage agreements.
- Designed and implemented a new scientific project tracking system that tracks project approvals, assignments, progress, supporting documents, and deliverables within a rapid 6 month timeline. This system will support greater efficiency and accountability, communication with customers, and knowledge retention for CPHST scientific projects and utilizes a Salesforce software environment promoted by the department.

2.4.5. Downstream Outcomes



PPQ is flying the friendly skies: Developing remotely piloted vehicle technology to protect American agriculture.

The PPQ S&T Phoenix Lab has successfully deployed a Remotely Piloted Vehicle (RPV) in support of the Pink Bollworm Eradication Program. The RPV was designed to effectively release sterile pink bollworm over cotton in Arizona as an Integrated Pest Management (IPM) component. The RPV was compared to traditional Cessna 206 and hand release methods and results concluded that the RPV was just as effective as the other two methods and at a fraction of the cost. Pink bollworm has not been detected within the United States PBW Eradication Zone since May of 2012. There is potential for incursion from pink bollworm in central Mexican states. The development of rapid response techniques such as RPVs is critical to the long-term success of the Pink Bollworm Eradication Program. The development of the RPV was in response to the National Cotton Council's request that such technology be explored.

We recently developed a small, Vertical Takeoff and Landing (VTOL) Remotely Piloted Vehicle (VTOL-RPV) with assistance from an industry cooperator to visually detect Asian Longhorned Beetle (ALB) damage in forests. ALB presents a significant environmental and financial risk to the forests of the United States and if left unchecked, estimates of total urban canopy destruction reach upwards of 34.9% at a value loss of \$699 Billion USD. ALB is able to survive and reproduce in any location within the lower 48 States, which contain host trees. As a result of this threat, PPQ launched the ALB Eradication Program, which intends to respond to ALB's incursion by eradicating this invasive exotic species from the United States. RPV proof of concept took place in a forest near Bethel, OH. Current survey and detection methods include spotting, ground assessments and climbing or bucket truck assessments. These methods require great human input and are costly. RPVs are launched near potential infestations zones and are visually surveyed by ground crews via live streaming video which is faster and safer than current processes. VTOL-RPVs are also being developed to visually detect Asian Gypsy Moth (AGM) egg masses on the superstructure of vessels arriving at US ports of call. The proposed method for survey and detection was presented to DHS CBP in an internal white paper written by CPHST S&T and described as a means of aiding CBP officers in detecting AGM egg masses by utilizing RPV's and their remote sensing abilities. Current detection methods involve visually scanning the superstructure of vessels. This method, however, is limited to regions safely accessible or visible from the deck of the ship. The RPV may provide surveyors with the ability to safely detect egg masses in the higher reaches of the ship, such as masts and light fixtures, as well as along the outer hull. The continued development of this technique support PPQ's mission to safeguard U.S. agriculture and natural resources against the entry, establishment, and spread of economically and environmentally significant pests and directly supports CPHST's efforts in the areas of Pest Detection, and Pest Management. For more information please access the story on the [USDA Week In Review](#).



Tools for managing the spotted lanternfly.

The spotted lanternfly (SLF), *Lycorma delicatula* (Hemiptera: Fulgoridae), is an Asian plant pest that was detected in September 2014 in Pennsylvania. It attacks over 65 different plant species but prefers feeding on tree-of-heaven (*Ailanthus altissima*) and grape (*Vitis*). The pest likely arrived in the US as egg masses on imported stone or packing material. The infestation was caught relatively early and is contained mostly in several townships in eastern Berks County, with a few new finds in adjacent counties. The Pennsylvania Department of Agriculture is currently attempting to eradicate this infestation. Eggs are deposited in the fall on tree trunks, buildings, under loose bark, on and under rocks, and other objects. An egg mass resembles a smudge of dried mud and contains 25-35 eggs. After overwintering as eggs, they emerge in the spring and nymphs walk, hop, and feed on a variety of hosts. Adults are strong jumpers and are capable of short flights but tend to aggregate and do

not appear to fly much. The PPQ CPHST Laboratory in Otis, MA worked with the Pennsylvania Department of Agriculture to conduct a chipping study in Berks County, PA in February 2015 to develop an effective approach for destroying egg masses to treat infested wood in the quarantine zone. Chipped or intact wood was placed in screened barrels and monitored for emergence. No spotted lanternfly nymphs were found in chipped treatments, as opposed to intact controls averaging in the range of 500 nymphs per barrel. Mid-winter chipping was found to be a suitable way to treat wood infested with SLF egg masses. In addition, the PPQ CPHST Otis Laboratory has expertise in trap and lure technology and began looking for attractants to develop and improve trapping and detection technology for this pest. In the summer of 2015 they discovered three attractive compounds that are being considered and tested in the field. Work to locate SLF's natural enemies from the native range of the pest will also be initiated in 2016.



A new ally in the fight against the emerald ash borer.

Emerald ash borer (EAB) is a metallic wood-boring beetle from Asia that was discovered in the Detroit, MI area in 2002. Since then, it has spread through much of the Midwest and East, killing nearly 100% of ash trees in areas where the pest has established. PPQ's CPHST Otis Laboratory has been working for a several years with USDA's Forest Service, Agricultural Research Service, and others to find natural enemies that may help control EAB populations. This effort led to the discovery of three species of stingless wasps from China, all of which were previously unknown to science. After extensive evaluations, the group determined that these wasps specifically attack EAB. The larvae of two of the wasps feed on EAB larvae under the bark of ash trees, while the third attacks EAB eggs. These wasps were transferred to a PPQ rearing facility in Brighton, MI, and the wasps they produce have been released in states throughout much of the range of EAB in the U.S. The research contingent has been monitoring results of the releases to determine the ability of the wasps to establish themselves and, eventually, suppress EAB. Unfortunately, one of the wasps that attack larvae, known as *Spathius agrili*, did not establish in the northern portions of EAB's range. This was especially unfortunate because the wasp's relatively long ovipositor (which the females use to penetrate bark and deposit eggs) allowed it to attack EAB in larger, thicker-barked trees when compared to the other wasp that attacks larvae. In an effort to re-fill that niche, our research team returned to Asia, this time working with Russian scientists to discover a closely related species, *Spathius galinae*, which is adapted to more northerly climates. After evaluation, *Spathius galinae* was also provided to the Brighton facility for rearing and, this summer, was released for the first time into North American EAB populations. Scientists from the Otis lab, along with their collaborators, will continue to monitor the outcomes of these releases as well as conducting additional studies to assess and optimize the use of these biological control agents of EAB. This work is a key part of PPQ's effort to create a self-sustaining system of natural resistance to EAB with the goal of allowing ash trees to continue to be a viable part of North America's natural and urban forests.



New tools for detecting invasive wood-boring pests.

Some of the most damaging pests coming into the U.S. in recent decades have been tree-killing wood-borers such as emerald ash borer and Asian longhorned beetle. An international standard, ISPM-15, was approved requiring fumigation or heat treatment of solid wood packaging materials – the most likely source of such insects – but a number of these pests continue to slip through the system. Finding any resulting infestations early makes mitigating their effects much simpler and more cost-effective. Attractant-baited traps can be excellent tools for detecting incipient populations of pests, but unfortunately the study of attractants for wood-boring beetles has lagged far behind those for some other insect groups such as moths. For several years, PPQ’s Otis Laboratory on Cape Cod has coordinated and sponsored a broad effort to develop attractant-baited trapping systems for wood borers. Our partners in this effort include university researchers, USDA Forest Service, USDA’s Agricultural Research Service, and state agencies. In addition, the Otis lab works with international organizations, as trapping tests on pests that don’t exist in the U.S. must be conducted overseas. Overall, this work has greatly improved our understanding of how these beetles use chemical and visual cues to find their needs such as food and mates.

Attractants have been identified for a number of high-risk wood-boring pests that are specifically targeted by the Cooperative Agricultural Pest Survey (CAPS), a collaborative effort of PPQ and state agencies and university specialists dedicated to detecting and monitoring populations of invasive plant pests. Specifically, since 2014, pests with new attractants include several long-horned beetles: the black fir sawyer beetle (*Monochamus urussovii*), the Japanese pine sawyer (*Monochamus saltuarius*), the grape borer (*Xylotrechus pyrrhoderus*) and *Xylotrechus rufilius*. Also, our collaborators recently published research on a male-produced pheromone component for the citrus longhorned beetle, a close Southeast Asian relative of Asian longhorned beetle that is just as damaging and has become established in Europe. The Otis lab has also let studies that recently identified an attractant for polyphagous shot hole borer. This pest is a small ambrosia beetle that has taken a foothold in southern California, where it threatens a large number of tree species including avocado. The attractant is being formulated commercially into lures that are being used for monitoring the pest. A pheromone has also been identified for this beetle and may provide a mechanism for enhanced lures or other management options in the future.



Improving treatment options for Asian longhorned beetle eradication

The Asian longhorned beetle (ALB) is an invasive wood-borer that kills maple, elm, birch, and willow as well as additional deciduous trees. These pests can hitch-hike from Asia in wood packing materials (crates, pallets, etc.) made from fresh wood, and ALB has been found several times in North America, including current infestations in NY, MA, and OH. APHIS PPQ and cooperating state agencies are working together to eradicate in all three states and need effective, functional tools for suppressing the beetles. These programs fell all trees that are known to be infested and then destroy the wood so that it can be safely moved or disposed. Other potentially infested wood in the area of an infestation can be generated by tree care, storm activity or other program practices, and this

wood must also be destroyed. The usual practice of chipping or grinding the wood is effective, but the current protocol, which requires chips of one inch or less in each of two dimensions, is difficult or costly to achieve in some cases. The PPQ CPHST Otis Lab on Cape Cod investigated the potential for ALB and other wood boring insects to survive wood processing using a variety of common equipment and configurations. Risk of insect survival, within all chips regardless of their size, was shown to be non-existent for the two types of wood chippers most commonly used by contractors. In addition to destroying infested materials, programs will protect trees surrounding sites of known ALB infestation by treating them with systemic insecticides. When applied annually for 3 years, this strategy is essentially 100% effective. However, due to the broad areas where infestations exist, treatment activities have been hampered by the industry standard of applying these chemical treatments only in the spring. A four-year research study of this issue was recently conducted by the Otis Lab, and fall applications were found to be just as viable as ones conducted in the spring. This will allow ALB eradication programs to treat additional trees each year and speed up eradication activities. These findings should improve the logistics and cost-effectiveness of ALB eradication efforts.



Slowing the spread of the devastating citrus greening disease through effective biological control of Asian citrus psyllid.

The Asian citrus psyllid (ACP) has invaded citrus-growing areas in the U.S. over the past decade and is an insect vector of the bacterium that causes citrus greening disease or Huanglongbing (HLB). A key component to an HLB management program is aggressive control of insect vector ACP, and a key strategy being used for ACP is biological control using *Tamarixia radiata*, a species specific ectoparasitoid wasp that kills the nymphs of ACP. The biocontrol agent was initially evaluated and permitted for release in Florida in 2000. The Florida Department of Agriculture and Consumer Services now manage two mass-rearing facilities with a combined production of over 350,000 wasps per month for release in orchard hotspots. More recently, new strains that were collected from areas of Pakistan with similar climatic conditions to that of the US were imported after satisfying APHIS PPQ permitting requirements for field release in Texas and California. In FY15, the PPQ CPHST Mission Lab continued work to refine and develop rearing technology and produced over 904,914 *T. radiata* insects for the biological control of ACP, bringing cumulative total releases in Texas to over 2.1 million since 2011. Releases were made where plant tissue tests positive for HLB and in urban areas where ACP levels are high. Since these biological control releases began, ACP populations have **declined by 85%** in the urban environment indicating that this work is having an impact. Our field cage insectary system to rear *Tamarixia* was developed and found to produce an average of 12,000 parasitoids per tree. In FY15, fifty-three field insectary cages were installed that has greatly increased production capabilities allowing production of an additional 636,000 beneficial insects for south Texas bringing the cumulative released total in the state to over 1,188,000 using the field insectary cage approach. The field cage insectary technology was transferred to researchers in Florida, the Puerto Rican Department of Agriculture and to the California citrus industry as an additional approach to increase production capacity in the U.S. and enhance biological control efforts in citrus producing states.

In California the transferred technology found a partner with industry. PPQ program entomologists developed methods that dramatically increased wasp quality and reduced wasp mortality to 2-3 % and improved rearing efficiency by an average of 400 *Tamarixia* more per cage. This has resulted in a 30-40% increase in *Tamarixia* production. Coupled with an increase in insectary space and ongoing improvements to the program California is on track to produce over 3 million *Tamarixia* in 2016. Surveys of more than 130 sites in 8 California counties

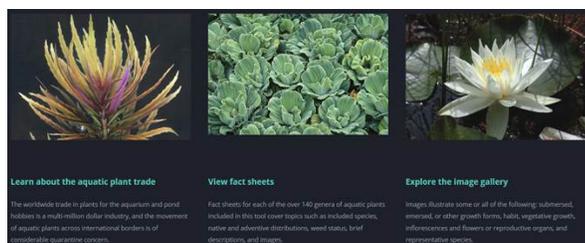
show establishment has occurred at 92% of the sites including recoveries at several sites distant from releases locations indicating extensive dispersal. Population trends of ACP show an overall decrease at monitoring sites and coupled with data from intensive life table studies, *Tamarixia* and other native natural enemies are having an impact reducing populations by as much as 99% in some cases.

A new parasitoid, *Diaphorencyrtus aligarhensis* was approved for release in California. In season establishment has been documented at several sites with evidence of dispersal from release sites of several miles, suggesting that the new parasitoid will widely establish on its own. To date in 2015, over 100,000 were released in urban areas of Southern California and although this parasitoid is more difficult to rear than *Tamarixia*, releases of > 200,000 are planned for 2016.



Spatial Point Pattern Analysis of Asian Citrus Psyllid Samples: Potential for Predicting Infected Citrus Host Locations

Intensive sampling and molecular diagnostic testing for citrus greening disease or Huanglongbing (HLB) in the Asian citrus psyllids (ACP) collected in Texas and California provided an opportunity to analyze spatial patterns and to locate early infections of HLB. ACP is a known insect vector of HLB, which is considered one of the most devastating citrus diseases because there is no cure for the disease. The quantitative Polymerase Chain Reaction (PCR) protocol used to test for the presence of HLB has very high sensitivity and specificity, and the PCR test provides a continuous measure of the amount bacteria present by recording a numerical value (Ct-value) indicating the presence of HLB in the sample. We impose a *regulatory threshold* on Ct-values, below which we can confirm the presence of HLB without question. However, HLB cannot be reliably confirmed above this regulatory threshold with the current molecular techniques and if not a true negative the result is recorded as inconclusive. Taking advantage of large amounts of diagnostic data and GPS location data associated with the samples, we started analyzing the spatial pattern of the Ct-values across the landscape to determine if there is an underlying biological process, such as clustering of samples around a known positive tree. This type of analysis would allow us to derive information from these inconclusive Ct-values. Currently, the results indicate clustering of Ct-values of psyllid samples in some areas and not just a random distribution. The work focuses on the full range of Ct-values, and how we may be able to utilize data from large scale survey efforts to predict locations that have HLB-infected plants. This information is targeting our plant tissue surveys for early HLB detection, saving state and federal resources and aiding in the fight against HLB.



Keeping web-based pest identification resources for PPQ and its external partners on the cutting edge.

Efficient and accurate pest identification is essential to our nation's efforts to safeguard our natural and agricultural resources. The APHIS PPQ Identification Technology Program (ITP) strives to keep PPQ's digital identification resources current through the delivery of a variety of products that support screening and identification of invasive insects, mites, snails and slugs, diseases, and weeds. ITP recognizes and values the importance of keeping these resources updated, both in terms of content and to keep up with the latest technologies. All of ITP's identification tool releases (<http://idtools.org>) in FY2015 were updates to previous versions. Most updates added additional content, and many enhanced the usability of the tools, adding responsive design to many websites, allowing greater ease of use on a variety of devices. Two tools, [Diabrotica ID](#) and [Flat Mites of the World](#), were updated with newly published names and taxonomic changes that were discovered during the research performed for the tools. [Longicorn ID](#) and [Grasshoppers of the Western U.S.](#) each had significant content updates, adding new fact sheets and new taxa to the keys, as well as other supporting materials. [Symptoms of Palm Diseases and Disorders](#) was updated with new ranges for a couple of diseases. [Antkey](#) was updated with new drawing and images as well as some nomenclatural changes. And last but not least, two of ITP's classic and most popular tools, [Aquarium and Pond Plants of the World](#) and [Federal Noxious Weed Disseminals](#) were both brought in to ITP's database, which will allow repurposing and sharing of data. Further, these two websites were overhauled to include ITP's latest tool features, like searchable fact sheets, a sortable image gallery, and hyperlinked glossary terms, as well as more modern web design and navigation. In addition to ensuring existing products are as up to date as possible, ITP also focused energy on several new product types. ITP produced a second suite of screening aids to support the APHIS Cooperative Agricultural Pest Survey (CAPS) community. The first suite for lepidopteran pests was delivered in FY2014, and the second set for beetles was delivered in FY2015. Each screening aid focuses on one CAPS target pest or pest group and includes detailed instructions and visuals on sorting, levels 1 and 2 screening, and comparisons with non-targets. ITP's screening aids are standardized to be clear, thorough, and user-friendly, and they have received positive feedback from the CAPS community. Another major accomplishment for ITP in FY2015 was the release of [imageID](#), a searchable online collection of high-quality images of plant pest taxa of concern to APHIS PPQ. This collection is tailored specifically for PPQ's identifiers, with images that help them recognize, learn, and compare the morphology and diagnostic characters of pest organisms. [imageID](#) was released on December 10, 2014 with over 38,000 images. By September 30, 2015, [imageID](#) contained over 60,000 images to support identifiers at ports-of-entry.



Technical materials provided by PPQ assist stakeholders to conduct agricultural pest surveys for exotic plant pests and weeds.

The Cooperative Agricultural Pest Survey (CAPS) program conducts surveys targeted at exotic plant pests, diseases, and weeds identified as threats to U.S. agriculture and/or the environment. These activities are accomplished primarily with USDA APHIS funding provided through cooperative agreements with state departments of agriculture, universities, and other entities. These survey specialists utilize CAPS commodity survey manuals and other CAPS documents to ensure that the proper methods are used to detect plant pest of regulatory concern. The PPQ CPHST Ft. Collins laboratory provides scientific support for these surveys by developing and maintaining prioritized pest lists, preparing pest datasheets and manuals, and by developing approved survey and diagnostic methods. Since 2006, CPHST has developed 14 survey manuals to support CAPS surveys. These manuals bundle pests by commodity host, pest taxon, or by pathway of the pest. By bundling the pests into one survey, resources can be better used and pests can be detected earlier. In 2015, datasheets for six of the nine pest targets were delivered to the CAPS stakeholders: *Aspidiotus rigidus* (False coconut scale), *Conogethes punctiferalis* (Castor capsule borer), *Fusarium oxysporum* f.sp. *cubense* tropical race 4 (Panama Disease TR4), *Hemileia vastatrix* (Coffee leaf rust), *Neofusicoccum mangiferae* (Mango fruit rot), and *Paratachardina pseudolobata* (Lobate lac scale). Datasheets include information on the biology, damage, distribution, host range, survey methodology, and diagnostics/identification of the pest. The introduction to the manual contains information on the background of the survey, survey planning, trapping, and sample submission. The combined manual (introduction and datasheets) provides a complete package to assist CAPS stakeholders in their survey efforts. The PPQ CPHST Ft. Collins Lab also developed the Tropical Crops Commodity-based Survey manual for the CAPS program currently being finalized. The purpose of this manual is to provide additional pest targets for tropical states and territories which have had difficulty finding relevant CAPS Priority Pests in the past. The crops of importance to these areas (avocado, banana, coconut, coffee, mango, taro, etc.) are more tropical in nature, and these regions have specific pests that may not be of concern to the continental United States. This manual consists of pests which may impact the following tropical regions: American Samoa, Guam, Hawaii, Puerto Rico, and the U.S. Virgin Islands. To create the pest list for this manual, PPQ CPHST received and evaluated pest suggestions from stakeholders in these geographic areas. Surveys for pests in the Tropical Crops Commodity-based Survey will begin in the 2016 survey season.



Meeting the nations plant health needs through advanced molecular diagnostics workshops.

Since 2004, the APHIS PPQ S&T CPHST Laboratory in Beltsville, MD has collaborated with the NIFA National Plant Diagnostic Network ([NPDN](#)) to provide hands-on advanced molecular diagnostic workshops at the Beltsville lab on PPQ approved and validated testing protocols for pathogens of regulatory significance. Both the

CPHST and NPDN groups have obtained funding, even securing Farm Bill funds, to provide workshop participants with travel reimbursement since the training is provided free of charge to participants. The Beltsville lab members are responsible for developing workshop content, producing training materials (from reagents to handouts), on-site coordination and delivery of hands-on laboratory training. These workshops not only increased the capacity in the US, for molecular diagnostics but equally important prepare U.S. diagnosticians to provide on demand surge capacity in the event of an unexpected plant pathogen outbreak or a national agricultural emergency. These workshops have also strengthened U.S. diagnostician's confidence in their ability to learn new technologies and apply them as needed to protect the nation's resources. Over the 12 years, 14 topic areas have been covered in 63 workshops attended by 436 NPDN and collaborating diagnosticians. The focus of the workshops was on plant pathogens that are known to affect a significant number of important ornamental crops, specialty crops and forest ecosystems and are of regulatory concern for the U.S. The 14 topic area workshops presented by the CPHST Beltsville Lab included *Phytophthora ramorum* the causal agent of Sudden Oak Death (SOD), Ramorum blight and Sudden Larch Blight detection; soybean rust (*Phakopsora pachyrhizi* and *P. meibomia*); *Ralstonia solanacearum* R3B2; citrus greening-HLB (*Candidatus Liberibacter asiaticus*, *Candidatus Liberibacter africanus*, and *Candidatus Liberibacter americanus*); potato cyst nematode (*Globodera rostochiensis*; *Plum pox virus*; *Phytophthora kernoviae* with *P. ramorum*; potato wart (*Synchytrium endobioticum*); *Phytophthora* 101 with focus on *P. ramorum* and *P. kernoviae*; Bioinformatics part I; Bioinformatics part II; citrus diseases which included Citrus Leprosis Virus, Sweet Orange Scab (*Elsinoë australis*) and Citrus Black Spot (*Guignardia citricarpa*); Bioinformatics complete (part I & II); and phytoplasma featuring apple proliferation. Most of the trainings presented were for immunological and molecular methods including conventional PCR and real time PCR. In addition to the NPDN diagnosticians trained in attendance at these workshops are diagnosticians from state and federal labs. Through the year's members of CPHST-Beltsville Laboratory that participated as instructors have expressed their appreciation to work with outstanding groups of participants who share common interests and goals to safeguard American agriculture. In 2015, training was provide to 65 diagnosticians from the NPDN, state departments of agriculture and universities. Workshops provided molecular diagnostics training for *Phytophthora ramorum*, *Phytophthora kernoviae*, *Plum pox virus*, *Citrus Huanglongbing* and *Phytoplasma*.



Facilitating safe trade by providing international training and capacity building in pest risk assessment concepts and methodologies.

The CPHST Plant Epidemiology and Risk Analysis Laboratory (PERAL) is PPQ's primary unit producing pest risk analyses (PRA). They contribute significantly to the promotion of international dialogue and increased capacity for science-based management of phytosanitary issues through its Risk Analysis Mentoring Program for visiting scientists. In addition, PERAL provides basic PRA training workshops in order to improve the understanding of PRA concepts and methodologies, improve PRA products developed by participating countries, and increase networking with current trading partners as well as cooperation in developing PRAs. To the extent that PPQ's approach to PRA takes hold throughout the world, it helps the agency harmonize with trading partners, give and get faster access approval, and avoid misunderstandings and disputes; all of these can facilitate safe trade. In FY2015 PERAL conducted several capacity building activities:

Plant Health Systems Analysis. Raleigh, NC. International plant protection practitioners.

The Plant Health Systems Analysis (PHSA) course is designed to familiarize participants with the approaches, programs and policies used by APHIS to support the U.S. Plant Health Safeguarding System. In the current PHSA

course, participants spend one week in Raleigh, NC and one week in Riverdale, MD, during which time they learn the components of the U.S. plant health system. Lectures and exercises are delivered by PPQ subject matter experts. The overall objective of PHSA is to use one model plant health system (the U.S. model) to illustrate and facilitate discussion of the importance of each model component to the protection of plant resources and improve the system in the countries represented. The PHSA course benefits PPQ through improved harmonization of plant health issues between countries, leading to greater cooperation in protecting the plant resources of all countries, and giving participants increased capacity to protect the phytosanitary status of their own countries.

Risk Analysis Mentoring Program. Raleigh NC. International plant protection practitioners. During 2015, we had two visitors from India in the Risk Analysis Mentoring Program (RAMP). RAMP is designed for practitioners that already understand and have practiced the fundamentals of PRA. RAMP allows these professionals to visit PERAL and work on a project of their choosing or of national interest with our analysts and resources. RAMP participants learn by doing. RAMP visits typically last two weeks or more, with some participants staying as long as six months. We discuss potential projects and the student's objectives in advance to be sure we can provide the best possible experience. RAMP participants agree to share literature from their agency or country and to present a seminar to our staff. Since 2006, RAMP has hosted visitors from Argentina, Belize, Bolivia, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Ghana, Guatemala, Honduras, Indonesia, Jamaica, Japan, Kenya, Korea, Madagascar, Malaysia, Mexico, Nicaragua, Nigeria, Panama, Paraguay, Peru, Senegal, South Africa, Thailand, Uruguay, United States (several states), Vietnam, and Zambia. RAMP improves the understanding of PRA concepts and methodologies, improves PRA products developed by participating countries, and increases networking with current trading partners, as well as cooperation in the development of PRAs.

Risk Analysis 101. Pest risk analysis is an essential tool that helps countries prioritize their resources and proactively protect their plant resources from the risks posed by pests. This training course is geared toward helping trainees understand and use PRA in an operational context. It provides foundational information about risk analysis in general, but focuses on the application of PRA concepts and practices from a policy and field perspective. This course, or versions of it, were delivered three times in FY15:

- **RA 101** in Frederick, MD. More than 30 people attended, including both PPQ and Customs and Border Protection employees.
- **Pest Risk Analysis Workshop** in Kuala Lumpur, Malaysia. A five day workshop for 36 participants: 28 from Malaysia, 4 from the Philippines, and 4 from Vietnam.
- **Quarantine and Pest Risk Analysis Applied to Fruit Flies in the Balkans and the Eastern Mediterranean** in Bucharest, Romania. Specialists involved in fruit fly activities or quarantine services from eleven Eastern European countries. International Atomic Energy Agency.

Weed Risk Assessment 101. For about 30 participants, including PPQ employees, other Federal employees, cooperators, academics, state regulatory officials, industry representatives, and international plant protection officials. Raleigh, NC. In this course participants learn to conduct and interpret weed risk assessments (WRA) using the PPQ WRA model. The model uses information about the biology, behavior elsewhere, and distribution of a species to evaluate its risk potential. In addition to describing and characterizing risk, the WRA process also evaluates the impact of uncertainty on the results and uses a simple climate matching tool to determine the potential area of the United States suitable for species establishment. During the training, participants work together in groups to develop and complete an assessment.

2.5. VETERINARY SERVICES (VS)

http://www.aphis.usda.gov/animal_health/index.shtml

2.5.1. Mission Statement

As the recognized animal health leader and trusted partner, Veterinary Services safeguards the health of animals, people, and the environment. VS's authorities derive from the Animal Health Protection Act and the Virus Serum Toxin Act. VS integrates One Health principles with USDA business objectives by contributing leadership, expertise, infrastructure, networks, and systems to collaborate effectively with local, State, Tribal, national, and international partners. Its comprehensive and integrated on-farm surveillance activities provide VS the capability to achieve national goals for animal disease prevention, detection, and early response.

2.5.2. Nature and Structure of Program

In FY 2013, VS was organized into policy and permitting staffs, a field force, and three science centers, described below:

The National Veterinary Services Laboratories (NVSL)

The mission of NVSL is to safeguard U.S. animal health and contribute to public health by ensuring that timely and accurate diagnostic laboratory support is provided directly or by its coordination of the nationwide animal-health diagnostic system. NVSL accomplishes its mission through:

- Performing diagnostic laboratory testing for Veterinary Services' program diseases and for suspected outbreaks of foreign animal diseases;
- Serving as the U.S. national and international reference laboratory for animal disease diagnosis by providing unique veterinary diagnostic capabilities, providing other diagnostic laboratories with animal disease information, technical guidance, reagents and reference materials;
- Providing national leadership in coordination of the National Animal Health Laboratory Network (NAHLN) and emergency laboratory response by training State, University and foreign laboratory personnel, providing proficiency testing, and developing improved diagnostic technologies;
- Preparing for and responding to animal health emergencies and emerging threats to animal agriculture including threats to the poultry and aquaculture industries by being able to conduct and/or support diagnostic testing in an outbreak environment.

Among other potential TT activities, NVSL develops and validates assays, and manufactures and distributes over 500 biological reagents to support veterinary diagnostics, many of which are not available from any other source.

Before a test is utilized by Veterinary Services for disease control or surveillance, it must be validated for that purpose. Samples for test validation for program diseases such as brucellosis and tuberculosis are in serum and tissue banks generated and maintained at the NVSL. These samples are made available to commercial kit manufacturers for their initial validation, and additional test validation is conducted at the NVSL before the results are submitted to the USAHA Scientific Advisory Committees. This is in addition to any testing for licensure required by the Center for Veterinary Biologics.

The NVSL is also involved in the development and validation of assays used to detect diseases that are foreign to the United States. Some of these assays are utilized in the reference laboratory as confirmatory tests, while others are deployed to the NAHLN laboratories and utilized in surveillance programs.

Identification, feasibility testing, development, optimization and validation of new assays and/or technologies are all accomplished within the NVSL. The NVSL staff collaborates with, and provides scientific advice to other Federal and State Government agencies that are also developing new assays and technologies, and NVSL

scientists partner with other reference laboratories around the world to obtain diagnostic specimens from naturally infected animals. These collaborative efforts result in enhanced expertise at the NVSL and in reference collections that are available for assay development and validation.

Centers for Epidemiology and Animal Health (CEAH)

The mission of CEAH, with a view to the future, is to explore and analyze animal health and related agricultural issues to facilitate informed decision-making in government and industry. CEAH also partners with the World Organization of Animal Health (OIE) and its member countries to improve international disease surveillance capabilities and analytic methods supporting trade decisions. CEAH has a multidisciplinary staff that includes agricultural economists, spatial analysts, GIS and computer specialists, veterinary epidemiologists, technical writers/editors, and data managers.

CEAH collaborates with university partners on analysis methods and tools. In some cases the products produced are commercialized by the academic partners.

Center for Veterinary Biologics (CVB)

The mission of the CVB is to implement the provisions of the Virus-Serum-Toxin Act (VST) to assure that pure, safe, potent and effective veterinary biologics are available for the diagnosis, prevention, and treatment of animal diseases. This mission mandates the use of sound scientific technology to:

- Ensure that biologics are free of disease producing agents, especially foreign animal diseases
- Develop appropriate standards and procedures for product release
- Issue licenses and permits
- Monitor and inspect products and facilities
- Control field tests and release of veterinary biologics

CVB-developed methods and biological standards are applied equally to all products, but by the same token can be adopted whole by the regulated commercial manufacturers, becoming part of their manufacturing and release process.

2.5.3. Current Technology Transfer Goals, Objectives and Measures of Success

APHIS-VS transfers technology primarily to State animal health agencies, animal owners, and their associations. Recent examples have included:

1. Information technology - Development of and training on Mobile Information Management systems for recording animal health information in the field for incorporation not only with VS supported data bases but other industry databases as well – utilized by industry, state/federal animal health.
2. Animal disease surveillance - Development of and training in methodologies/software for outbreak surveillance (outbreak surveillance toolbox) – utilized by state/federal animal health
3. Geospatial analysis – Development of and training in a process to integrate spatial/geophysical features of the environment and county level land use policies to determine suitable sites for carcass disposal– utilized by industry, state/federal animal/public health.
4. Diagnostic assays – Training (courses and one-on-one) in diagnosis of high consequence diseases from foot and mouth disease to spring viremia of carp.
5. Diagnostic protocols and reagents – Protocols and reagents for assays and assay validation of Avian Influenza and Porcine Epidemic Diarrhea Viruses were provided to APHIS-equivalent laboratories in Mexico and the Dominican Republic.

3.0 Agricultural Research Service (ARS)

<http://www.ars.usda.gov>

3.1. Mission Statement

ARS conducts research to develop and transfer solutions to agricultural problems of high national priority and provides information access and dissemination to:

- ensure high-quality, safe food, and other agricultural products;
- assess the nutritional needs of Americans;
- sustain a competitive agricultural economy;
- enhance U.S. natural resources and the environment; and
- provide economic opportunities for rural citizens, communities, and society as a whole.

3.2. Nature and Structure of Research Program

ARS is USDA's principal intramural scientific research agency. Agency goals are to find solutions to agricultural problems that affect Americans every day, from field to table, such as (a) protecting crops and livestock from pests and diseases, (b) improving the quality and safety of agricultural products, (c) determining the best nutrition for people from infancy to old age, (d) sustaining our soil and other natural resources, (e) ensuring profitability for farmers and processors, (f) keeping costs down for consumers, and (g) supporting the growth and development of Rural America.

ARS employs approximately 2000 scientists and post docs, as well as, approximately 6,000 other employees to conduct 750 research projects at over 90 locations. The research projects are within 17 National Programs (Table 1). The Office of National Programs in Beltsville, MD plans the scope and objectives of Agency's research projects, while five Area Directors implement research projects at the locations in their geographic areas.

Table 1. Research program management of ARS, showing 17 National Programs.

Animal Production & Protection	Natural Resources & Sustainable Ag Systems	Crop Production & Protection	Nutrition, Food Safety & Quality
Food Animal Production	Water Availability & Watershed Management	Plant Genetic Resources, Genomics & Genetic Improvement	Human Nutrition
Animal Health	Climate Change, Soils, and Emissions	Crop Production	Food Safety
Veterinary, Medical, & Urban Entomology	Pasture, Forage & Range Land Systems	Plant Diseases	Quality and Utilization of Agricultural Products
Aquaculture	Biorefining	Crop Protection & Quarantine	
	Agricultural & Industrial Byproduct		
	Agricultural System Competitiveness & Sustainability		

ARS conducts a series of reviews designed to ensure the relevance and quality of its research work and maintain the highest possible standards for its scientists. Customer input helps keep the research focused on the needs of the American food and agricultural system. Plans for each of the active research projects undergo a thorough independent external prospective peer review managed by the Office of Scientific Quality Review (OSQR). All ARS employees, including the scientific workforce, are subject to annual performance reviews, and all research

scientists and engineers have technology transfer as a performance element in their annual performance appraisal. Research scientists undergo a rigorous peer review (Research Position Evaluation System-RPES) on a 3 to 5-year cycle. These processes ensure the continuing high quality output of the ARS research addressing the needs of U.S. agriculture.

3.3. ARS Approach and Plans for Conducting Technology Transfer

Because of the delegations of authority by the Secretary, ARS's Office of Technology Transfer (OTT) is assigned the responsibility for obtaining patent protection for intellectual property (IP), developing strategic partnerships with outside organizations, licensing ARS technologies to the private sector and academia, and performing other activities that effectively transfer ARS research outcomes and technologies to the marketplace. USDA's Office of the General Counsel provides legal guidance to OTT in regard to intellectual property as needed.

The ARS technology transfer program has centralized policy and approval procedures that are managed by OTT. Research agreement negotiation and implementation is decentralized and managed by the ARS Area Offices. The Area Office Technology Transfer Staff serve as liaisons with scientists, ARS managers, OTT, university partners, and the private sector.

To facilitate technology transfer, OTT is organized into three sections. The *Administrative and Partnership Section* conducts day-to-day operations, coordinates technology transfer policy development, interacts with the Office of National Programs on agreement policy and review, and coordinates the activities between the partnership, patenting, and licensing sections. This Section maintains strong stakeholder relationships at the local, regional, and national levels, ensuring the adoption of research results. This Section is also responsible for coordinating and managing both agreements and the Agricultural Research Partnerships (ARP) Network. The *Patenting Section* provides strategic guidance to scientists regarding patent protection for their research results. The Section is also responsible for receiving invention reports, convening three National Patent Committees (Mechanical and Measurement, Life Sciences, and Chemistry), preparing and prosecuting patent applications, and reviewing patent legal work performed by cooperator and ARS contract law firm. The *Licensing Section* manages invention licensing from all the intramural scientists in every USDA agency, including the review of license applications and the negotiation and monitoring of license agreements to assure compliance with agreement terms. This Section also collects and disburses license revenues, manages international patent filings, and provides expert advice on all matters related to USDA invention licensing.

Technology transfer is accomplished through many mechanisms, such as:

- developing written information for customers and stakeholders, including scientific publications, publications in trade journals, and reports to stakeholders;
- releasing plant germplasm to the public;
- transferring research materials to scientists outside of ARS;
- entering into formal partnership agreements, such as CRADAs, and other cooperative agreements;
- licensing IP (patents, Plant Variety Protections Certificates, and biological materials);
- participation in meetings with industry organizations and universities, workshops and field days; and distributing information to the public via the ARS Information Staff, the National Agricultural Library, and other sources.

Because the ARS mission is to transfer technologies for broad public use by the most effective mechanism, ARS pursues patents and licensing principally when they facilitate technology transfer to the marketplace. This is usually the case when complementary investment by the private sector is necessary to commercialize a product, and patent protection is required to protect this investment. By ARS policy, patents are not filed on inventions that are considered to be only research tools. The purpose of this policy is to encourage scientific research. In licensing practices, ARS continues to reserve the right to allow use of any IP protected technology for research purposes (non-commercial). Judicious use of intellectual property rights (IPR) is an important cornerstone of the patent

committees. IPR is used as an incentive for commercialization and full realization of the research impact of USDA technologies.

Meaningful performance metrics in technology transfer are often difficult for research agencies to formulate. ARS is continuing to work on defining better metrics for technology transfer within USDA. For example, for ARS, successful outcomes may include improved agricultural practices, scientific information that enhances U.S. competitiveness, increased awareness about pathogens to help prevent human and animal diseases, or findings that help corporations and universities make informed decisions in allocating their research resources. Many of these outcomes do not require patenting or subsequent licensing for implementation. Additionally, ARS uses its ARP Network to match technical expertise of ARS researchers with firms who can capitalize on the ARS research capacities, facilities and research outcomes.

Licensing policies also promote small business success with licensing fees in the early years, but with annual maintenance fees and royalties that escalate in subsequent years, sometimes after the first commercial sale of the product. Licensing further enhances commercialization by encouraging broadest utilization of a federal invention. ARS also incentivizes scientists on the reporting of inventions, patenting, and licensing by providing 25% of the license revenues to inventors (this is a higher percentage than that required by statute, $\geq 15\%$). Thus, there are policies in place that incentivize commercialization, minimize transaction costs, and yet provide fair and equitable compensation for those who create federal innovations. Development and expansion of the ARP Network further enhances the adoption of research outcomes.

These are all parts of a robust and effective technology transfer program that consists of a variety of mechanisms and programs to complement the research conducted by the agencies.

3.4. Agricultural Research Partnerships (ARP) Network Program

ARS founded the ARP Network in an effort to expand the impact of ARS research by enhancing the likelihood that these outcomes are adopted. Although replete with scientific expertise, the ARS research program does not have the resources or the authority to provide ARS commercial partners with business mentoring, marketing, manufacturing, and fiscal resources needed for the success of their businesses. Consequently, the Network was established to provide these complementary assets. By combining ARS research expertise with complementary capabilities and talents of partnering organizations, the ARP Network helps stimulate economic growth through technological advancements. The ARP Network matches business needs with ARS innovations and research capabilities and provides business assistant services to help companies and startups solve agricultural problems, develop products and create new jobs.

The ARP Network includes the important parties in an innovation ecosystem and has members spanning the U.S. with a shared vision to grow and sustain a competitive agricultural economy. Members include ARS and stakeholders interested in agriculture-based economic development including, but not limited to rural agribusiness; urban, community and/or economic development groups; organizations that support farmers, growers and/or food processors; and capital programs for business attraction and acceleration. Membership in the ARP Network is formalized through Non-Funded Cooperative Agreements.

3.5. Agricultural Technology Innovation Partnership (ATIP) Foundation

The nine founding members of the ARP Network established the ATIP Foundation in 2011 to provide a unifying entity independent of ARS with the flexibility to engage other organizations that have a vested interest in seeing USDA research outcomes adopted by the private sector (<http://atipfoundation.com>). Foundation objectives are: (1) Expedite the transition of USDA technologies from USDA labs into the commercial sector; (2) Increase the use of agriculture technology discoveries that meet the needs of emerging markets (3) Seek funding to support the technology needs of the Agricultural industry and efforts to adopt and commercialize new technologies; (4) Develop industry access to utilize USDA research and research facilities; (5) Create sustainable communities by

promoting regional innovation clusters, supported by USDA research outcomes; (6) Co-host regional events with USDA, showcasing technologies and facilitating adoption of research outcomes; and (7) provide for the development of skilled workers needed to sustain the growth of the industry.

The Foundation's interface with the USDA is through the USDA Liaison Committee (LC). The LC is an internal USDA committee and not a part of the Foundation. The LC serves three primary purposes: (1) to ensure the independence of USDA-ARS research activities; (2) maintain mission relevance; and (3) align the purpose of research and mission with the work of the ATIP Foundation. The USDA Liaison Committee will receive and the USDA Liaison Committee will review and approve internal USDA and external Foundation requests to fund USDA research to determine whether those requests fit the USDA mission and research priorities.

The ATIP Foundation established two Public-Private Partnerships with ARS: *Resilient Economic Agricultural Practices* and *Branded Food Products Database for Public Health Public-Private Partnership*.

Resilient Economic Agricultural Practices Public-Private Partnership

This project was initially funded through a federal grant and expired in FY2013. At the request of ARS, a new funding mechanism was established by the ATIP Foundation to ensure uninterrupted continuation of this project in data collection and development of guidelines and tools needed to assess long-term effects of food, animal feed, fiber, and biofuels production on soil health. The new public-private partnership capitalizes on federal scientific research on soil health through cost sharing with private sector firms and organizations that have an interest in continuation of this research. Through this public-private partnership, funds are available for on-going research at university and ARS locations in Ames, IA; Morris, MN; St. Paul, MN; Lincoln, NE; Brookings, SD; University Park, PA; Akron, CO; and Florence, SC. The REAPnet database was developed which was closely aligned with the ARS Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network (GRACenet) database. The database application is a data discovery tool that provides site-specific projects information that, once peer-reviewed, will become publically available.

At November 2014 Tri-Society (American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America) Annual Meeting in Long Beach, CA, REAP scientists reported results of multi-location studies that included a 239 site-year yield dataset. In addition, a broad range of environmental issues (e.g., soil organic carbon, microbial communities, cover crops, etc.) related to corn stover management was discussed.

Branded Food Products Database for Public Health Public-Private Partnership Accomplishments

In FY 2013, ARS, the ATIP Foundation, and the International Life Science Institute North America (ILSI North America) established a public-private partnership to enhance the public's health through increased knowledge of the nutritional content of the nation's food supply. This will be accomplished by obtaining comprehensive food composition data from the food industry and making it available to government, industry, the scientific community and the general public through an enhanced USDA National Nutrient Database, developed and maintained by the ARS Nutrient Data Laboratory in Beltsville, MD.

In FY2015, the public-private partnership successfully beta tested a branded food products database. Five food manufacturers participated in a beta-test by providing product label data and nutrition information on 245 products through a GS1 certified data pool provider, FSEnet. These data were then passed to ARS for incorporation into the USDA National Nutrient Database.

3.6. Technology Transfer Highlights

- 59 new CRADAs were executed and the scope of research was expanded through amending 76 active CRADAs. The current 211 active CRADAs are valued at more than \$113,074,045 over the course of their life

(up to 5 years) with more than \$24,982,824 in funds going directly to ARS researcher projects. Approximately 53% percent of the newly executed CRADAs were with small businesses. A new type of research agreement (Material Transfer Research Agreement, MTRA) was developed in FY2013 to fit the needs of specific research projects (refer to President Initiative USDA 13). Some collaborators that would have entered into a CRADA prior to the advent of this new agreement, now may find an equally viable option in entering into and MTRA. There were 102 new MTRAs. Refer to Table 1 in Section 3.8 and figures 1, 2 and 3 in Section 3.12.

- 193 invention disclosures were received; 110 patent applications were filed; and 84 patents and PVP certificates were obtained. There was 90% increase over last year in the number of invention disclosures. Judicious use of intellectual property rights (IPR) is an important cornerstone of the patent committees. IPR is used as an incentive for commercialization and full realization of the research impact of USDA technologies. While the year in which a patent issues is the not the year in which the patent is filed, over time the ratio of the number of patent application filed over the number of patents issued does represent a trend of the percentage of patents that are issued. Refer to Table 2 in Section 3.8 and Figures 4, 5 and 6 in Section 3.12.
- 35 new licenses were executed. This was an increase of ~20% over last year. Of the new licenses agreements that were executed, 46% were with small businesses and 26% with universities. The number of income bearing licenses, as well as the earned royalty income, has steadily increased over the last five years. The total royalty income (\$5,066,988) was the highest in the last 5 years. 68% of the active licenses were granted exclusively. Most of the \$3,509,904 in earned royalty income (ERI) came from a few licenses, for the median ERI was \$3,525. In addition to the new licenses, 5 license amendments were executed. Refer to Tables 3, 4 and 5 in Section 3.8 Figure 7, 8 and 9 in Section 3.12.
- Developed and implemented the first edition of the ARP Network Newsletter highlighting CRADA and licensing opportunities and other information. In addition, participated in ARP Network members' events in Colorado, Oklahoma, and Connecticut. Connected 33 companies with ARS researchers and directly marketed 37 technologies for licensing using the ARP Network and other venues.
- In FY2015, USDA-ARS laboratories won 6 Federal Laboratory Consortium (FLC) National Excellence in Technology Transfer awards and 11 FLC Regional Excellence in Technology Transfer awards. Refer to Section 3.11.
- To further improve the changes that research outcomes will be adopted, a technology transfer strategy session was implemented in FY2015 for each of the inventions reviewed by the patent committee. After the patent committee, a conference call for each invention disclosure is held with the researcher, Patent Advisor, Licensing Specialist, and Technology Transfer Coordinator to discuss the strategy for moving forward. If the decision was not to pursue patent protection, the discussion focused on what other mechanisms could be used to get the research results adopted (i.e., trade journal article, workshops, etc.) or what other data was needed (i.e., research partnerships). If the decision was to pursue patent protection for the invention, the discussion focused on what claims are needed in the patent application to get the widest adoption and the ensuing licensing strategy (i.e., exclusive license needed, targeted market sector, etc.).
- Held a technology transfer workshop with the field technology transfer professionals. Some of the outcomes of the workshop included: 1) a plan for increasing the number of invention disclosures by harvesting inventions from manuscripts submitted for publication; In FY2015, 25 invention disclosures were submitted after reviewing manuscripts; 2) a plan for training researchers on developing technology transfer strategies for their research outcomes before the research is completed through uniform AgLearn e-learning and site visits by field technology transfer professionals and OTT-HQ staff. In FY 2015, OTT-HQ visited three field

locations for training; and 3) a plan for targeted marketing new technologies once a patent application has been filed through the ARP Network. In FY2015, 37 technologies were marketed through the ARP Network.

- The OTT website (<http://www.ars.usda.gov/Business>) was updated with more content and information. Some of the new additions include information on the use of the ARS Utilization Centers for the commercial scale-up of lab methods; patents applications filed and patents issued; informational videos; new technology transfer PowerPoint training series; new updated agreement templates; redesign of licensing page; additional items in the news and events paper; and updated list of available technologies for licensing. USDA facilities and available technologies were also submitted to data.gov
- For the National 75th Anniversary celebration for the four USDA Utilization Centers, OTT developed a document listing each of the pilot plant's specialized facilities and research expertise for the commercial scale-up of laboratory-level technologies, as well as past accomplishments. This information was developed into a series of uniform posters that have been placed on the OTT website (<http://www.ars.usda.gov/business/Docs.htm?docid=25285>). In FY2016, a webinar will be held through the ARP Network to make industry aware of these unique facilities.
- An SBIR-Technology Transfer Program, a new collaboration between the USDA's National Institute of Food and Agriculture (NIFA) Small Business Innovation Research Program (SBIR) and ARS, was established in FY 2014. This program encourages SBIR applicants to work with ARS researchers and/or license ARS technologies. The relevant language in the SBIR Request for Applications states: "Additional factors that will be considered in the review process include whether an application involves a CRADA with a USDA laboratory, or a license to a USDA technology...A list of available technologies for licensing and CRADAs that may be considered as projects under the SBIR program can be found at the USDA Office of Technology Transfer (OTT) website." In FY 2015, four CRADA projects were submitted for SBIR funding, three of which were awarded. Typically, 10-15% of USDA-SBIR proposals are funded. The higher success rate of CRADA-SBIR proposals (~75%) is likely due to the ARS selection process in identifying and research plan review process for solving agricultural problems of high national priority.
- OTT piloted a NSF I-Corps™ program for USDA-ARS. The ARS Innovation Corps (I-Corps@ARS) pilot was a set of activities and programs that prepared ARS scientists to extend their focus beyond the laboratory and broadened the impact of select ARS research projects. Combining experience and guidance from established entrepreneurs with a targeted curriculum, NSF I-Corps™, on which I-Corps@ARS was based, taught the teams to identify the real problems facing stakeholders and to develop valuable products and/or market opportunities that can emerge from their own research. In addition, I-Corps ARS offered entrepreneurship training which helped the participants to be more innovative and impactful in their research programs. Each USDA-ARS team was composed of one scientist, one post-doctoral fellow and one technology transfer professional. This model was an adaptation of NSF I-Corps for participation of intramural scientists.
- OTT represented USDA in the USPTO-Smithsonian 2015 Innovation Festival. The Innovation Festival is a family oriented, educational opportunity for the public, to meet and interact with innovative corporations, academic institutions, federal government agencies, and independent inventors from across the nation. The Festival features breakthrough patented American technology. At this year's Festival, OTT highlighted the breeding research that resulted in patented and licensed ornamental-culinary pepper cultivars. This year's Festival was held at the National Museum of American History with an estimated attendance of over 30,000.
- OTT professional staff played a very active role in the Federal Laboratory Consortium both at the national and regional levels (e.g. coordinator of the Mid-Atlantic region, member of the national executive board, trainers, tech transfer award reviewers, and meeting speakers). This collective effort of ARS technology transfer professionals was recognized in FY2015 with a Silver President's Volunteer Service Award.

- OTT took the lead in planning and holding a Forum on Mapping, Satellite and Sensor Technologies for the Mid-Atlantic region. The Forum highlighted on-going research and commercial opportunities from seven Federal agencies (U.S. National Geospatial-Intelligence Agency, National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, U.S. Geological Survey, National Institute of Standards and Technology, U.S. Naval Research Laboratory, and National Aeronautics and Space Administration) and three universities (University of Maryland, Washington College, and Salisbury University). Topics included: 1) Impact of climate change on the costal environment; 2) Sustainable urban, agriculture, and natural environments; 3) Measurements, standards and analysis; and 4) Technology applications. The Forum drew some 85 participants. Currently, new research collaborations among the different Federal labs and universities are being created. A second Forum is being planned for FY2016 to identify commercial partners for outcomes of this new research collaborations. The goal of the Forums are to more effectively leverage Federal and university research activities for commercialization.
- OTT represented the Department for the White House Office of Science and Technology Policy's Lab-to-Market, Maker Faire and Intellectual Property Enforcement Committees.
- OTT participated in Inter-agency Working Group on Technology Transfer.
- OTT staff served as reviewers and judges for Invest Maryland Challenge, i6 Challenge (a Dept. of Commerce Grant Program), University of Maryland Technology/Invention of the Year, Maryland Economic Development Association, Patents for Humanity (run by the USPTO) and Tibbetts Awards (SBA).

3.7. Response to Presidential Memorandum on Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Business

In the USDA's implementation plan for the Presidential Memorandum, ARS described 13 initiatives to promote technology transfer and commercialization. These initiatives and their implementation are described below. The following initiatives were completed in: FY 2013: USDA 1, USDA 8, USDA 9, and USDA 13; FY 2014: USDA 3, USDA 12; and FY 2015: USDA 2, USDA 4, USDA 5, USDA 7, USDA 8, USDA 9, and USDA 10.

USDA 1: New metrics proposed for standard annual reporting in addition to those required by Circular A-11 instructions on annual reporting of technology transfer

This initiative was completed in FY2013 and the new metrics are now a standard component of the metric tables.

USDA 2: Update Policy and Procedure (P&P) 141.2 "Technology Transfer in ARS"

An update is necessary to reflect statutory changes since 2000, and to reflect changes in structure and operation of the National Patent Committees, and to include licensing of biological materials and use of the ARP network. A Technology Transfer Process Working Group with representatives from the core functions involved in the technology transfer process was established. As a result of this group, changes were made in the invention disclosure review process, as well as the development of an outline for determining a strategic and tactic technology transfer plans for research projects. Based upon these changes, a new P&P was written in FY 2015 and presently going through the approval process.

USDA 3: Expand Agricultural Research Partnership (ARP) Network efforts to extend the impact of ARS research

The ATIP Network was redesigned and renamed the Agricultural Research Partnerships (ARP) Network. The mission of the new ARP Network is to extend the impact of ARS research by supporting a sustainable and competitive agricultural economy. To further this mission, the ARP Network will assist ARS in creating new

partnerships and in supporting existing partnerships to advance ARS research and development (R&D) and subsequent utilization, including commercialization. This expanded mission required a broader membership base. The membership base was increased to include any organization interested in agriculture-based economic development. The ARP Network includes all players in an innovation ecosystem and has members spanning the U.S. with a shared vision to grow and sustain a competitive agricultural economy. Members include ARS and stakeholders interested in agriculture-based economic development such as, but not limited rural agribusiness; urban, community and/or economic development groups; organizations that support farmers, agritourism and/or food processors; and capital programs for business attraction and acceleration. Membership in the ARP Network is formalized through non-funded Trust agreements executed by the Office of Technology Transfer. There are currently 33 ARP Network members. This new network has a web formation in that not only all the members are connected to ARS, but they can connect to each other. We will continue to add members as appropriate.

USDA 4: Expand outreach efforts in technology transfer to scientists in ARS

OTT worked with Office of National Programs to connect ARS scientists' research capabilities and technologies with a number of different companies. This was done through the ARP Network, responding to public solicitations, responding to industry scouting, and through webinars conducted by Federal Laboratory Consortium. This outreach effort is now an ongoing activity in OTT.

OTT began in FY 2014 the development of standard technology transfer PowerPoint training modules for ARS employees. In FY 2015, the modules were completed (Tech Transfer: Introduction, Tech Transfer: Agreements, Tech Transfer: Patenting and Tech Transfer: Licensing). The PowerPoint modules were converted and posted onto AgLearn for e-training.

USDA 5: Encourage other S&T agencies to adopt OTT's approach to technology transfer

In the past, OTT has provided technology transfer services (policy advice, agreement review, patenting / licensing services, etc.) to the USDA-Animal and Plant Health Inspection Service (APHIS) Wildlife Services, USDA Forest Service (FS), Department of Interior's Bureau of Reclamation (BoR). In FY 2015, these services were expanded through interagency agreements to include APHIS's Wildlife Services, Plant Protection and Quarantine, and Veterinary Services), as well as the FS's Forest Products Laboratory. In addition, the BoR agreement was modified to include the Department of Interior's (DoI) U.S. Fish and Wildlife Service.

USDA has a role in helping to develop Federal government technology transfer policy through OTT's active participation on the Interagency Working Group on Technology Transfer and the White House to Lab-to-Market Working Group. Through these ongoing activities, OTT is taking an active role in promoting activities which support the enhanced adoption of research outcomes.

USDA 6: Explore expanded use of Enhanced Use Lease (EUL) authority as technology transfer tool to promote longer term relationships with key customer groups

Under the 2008 Farm Bill, the Secretary was given the authority to establish a pilot project at the Beltsville Agricultural Research Center (BARC) to lease non-excess property to any private or public entities. The EUL Project was used as a technology transfer tool designed to provide longer term public-private partnerships than can be done through existing technology transfer partnership instruments. The pilot authority was used to develop a process to identify underutilized laboratory resources that could be used by the private sector to commercialize ARS research outcomes. Prospective lessees needed to establish either a licensing partnership or research collaboration with ARS. In exchange, EUL terms provide the lessee 20 years of use of the facility to develop its business. EUL authority proved to be a very successful strategy to leverage resources for entrepreneurial activities. USDA's first lessee (Plant Sensory Systems) was a small business that in FY 2013 was awarded a \$1.8 million ARPA-E grant (Better Biofuel Feedstock from Beets) based on the success of the research project

conducted using BARC laboratory facilities. Access to these facilities was essential, because this small business did not have sufficient capital to build the facilities needed for this research project.

This pilot authority for BARC was reauthorized in 2014 Farm Bill. Discussion began in FY2015 to identify a partner to establish an accelerator on the BARC campus for agriculture businesses that utilize ARS technologies and/or research expertise.

USDA 7: Beginning in FY 2012 / 2013, roll out a nationwide series of regional forums to identify issues and deliver solutions

The goal of the regional forums is to provide technology-based solutions to regional agricultural problems for farmers and businesses. A multistep approach was developed for the regional forums: (1) a series of regional listening sessions comprised of businessmen, farmers, economic development organizations, regulatory and extension personnel are held to identify a broad list of regional issues; (2) from the list of issues, those with an existing research-based solution, or a researchable issues that could be addressed by ARS, local universities, cooperative extension, state agencies or agricultural businesses are selected as potential topics for a forum; and (3) finally, a forum is convened as a roundtable discussion on the potential solution(s) and their implementation. Participants in the forum may include farmers, growers, agri-business professionals, university and ARS researchers, extension service personnel, rural development personnel, NIST Regional Manufacturing Extension Partnership (MEP) staff, funding and regulatory agency personnel, as well as ARS technology transfers professionals. Holding regional listening session – forums is now an ongoing activity in OTT. In addition, the listening session – forum approach has been implemented within Mid-Atlantic region of the Federal Laboratory Consortium.

USDA 8: Provide opportunities for applicants to the USDA Small Business Innovation Research (SBIR) program to partner with ARS scientists to further develop science necessary for business success

An SBIR-Technology Transfer Program, a new collaboration between the USDA's National Institute of Food and Agriculture (NIFA) Small Business Innovation Research Program (SBIR) and ARS, was established in FY 2014. This program encourages SBIR applicants to work with ARS researchers and/or license ARS technologies. The relevant language in the SBIR Request for Applications states: "Additional factors that will be considered in the review process include whether an application involves a CRADA with a USDA laboratory, or a license to a USDA technology... A list of available technologies for licensing and CRADAs that may be considered as projects under the SBIR program can be found at the USDA Office of Technology Transfer (OTT) website." This program is now an ongoing activity of OTT and NIFA." In FY 2015, four CRADA projects were submitted for SBIR funding, three of which were awarded. Typically, 10-15% of USDA-SBIR proposals are funded. The higher success rate of CRADA-SBIR proposals (~75%) is likely due to the ARS selection process in identifying and research plan review process for solving agricultural problems of high national priority.

USDA 9: Provide Cooperative Research and Development Agreement (CRADA) partners opportunity to link to local Manufacturing Extension Partnership (MEP) resources to assist in commercialization efforts

When appropriate, ARS CRADA partners are provided a contact in their regional National Institute of Standards and Technology's Hollings Manufacturing Extension Partnership (MEP) office to provide manufacturing assistance. OTT works with MEP headquarters to identify those contacts. When a particular ARS Regional Forums (see USDA 7 initiative) has a manufacturing component, the regional MEP field staff is invited to provide an overview of the resources they have available to assist in manufacturing. Some MEP offices are part of ARS's ARP Network.

USDA 10: Work with regional incubators and economic development organizations to identify opportunities for ARS scientists and ARS commercial partners

This initiative directly addresses Section 4 of the Presidential Memorandum in establishing joint partnerships with university research parks, incubators, and other state / community economic development organizations. Since we have not yet been able to identify a project for the specific use of the University of Mississippi incubator's facilities, we expanded this initiative to include other incubators and economic development organizations. This expansion occurred through the Agricultural Research Partnerships (ARP) Network (see USDA 3 and section 3.4). Network members now include any organization interested in agriculture-based economic development such as, but not limited to: rural agribusiness, urban, community and/or economic development groups; organizations that support farmers, agritourism and/or food processors; and capital programs for business attraction and acceleration. Many economic development entities are members of our APR network, e.g., Montgomery County Department of Economic Development, Maryland Technology Development Corporation, Center for Innovative Food Technology, Innovate Mississippi, Nebraska Department of Economic Development, and California Association for Local Economic Development.

USDA 11: Establishment of the “Branded Food Products Database for Public Health” Public-Private Partnership

In FY 2013, ARS, the ATIP Foundation, and the International Life Science Institute North America (ILSI North America) established a public-private partnership to enhance the public's health through increased knowledge of the nutritional content of the nation's food supply. This will be accomplished by obtaining comprehensive food composition data from the food industry and making it available to government, industry, the scientific community and the general public through an enhanced USDA National Nutrient Database, developed and maintained by the ARS Nutrient Data Laboratory in Beltsville, MD.

In FY2015, the public-private partnership successfully beta tested a branded food products database. Five food manufacturers participated in a beta-test by providing product label data and nutrition information on 245 products through a GS1 certified data pool provider, FSEnet. These data were then passed to ARS for incorporation into the USDA National Nutrient Database.

USDA 12: Evaluate various options for reducing license negotiation transaction costs

Several proposals for establishing standard pre-commercialization license terms for all CRADA Subject Inventions were reviewed. Possible benefits included: creating business certainty for CRADA partners; providing an additional incentive to enter into a CRADA; and reducing transaction costs for both the CRADA partner and USDA. This initiative is now completed with the pre-negotiated license language as an option in the CRADA template to be used in situations where a CRADA partner has indicated that they would like to lock in the royalty rate before proceeding with the CRADA. In 2015, when appropriate, OTT has used pre-negotiated licensing terms to a CRADA partner.

USDA 13: Develop Material Transfer Research Agreement (MTRA) as a new instrument to promote development and commercialization of materials from USDA

USDA scientists create new materials that may have value in further research and development with the private sector. Material Transfer Agreements (MTA), widely used by USDA, only allow for the transfer of materials, but not engagement in joint research between the provider and the recipient of the materials. In order to enable some collaborative research with the material, in FY 2012 by combining the Material Transfer Agreement and the Trust

Fund Cooperative Agreements authorities the MTRA was created. MTRAs are now reported as a metric in the Collaborative Relationships for Research and Development Table.

3.8. Metric Tables

TABLE 1. Collaborative Relationships for Research and Development.

*ND- no data available.

Agricultural Research Service (ARS)	FY 2011	FY 2012	FY 2013	FY2014	FY2015
Total number active CRADAs	275	243	230	214	211
Active traditional CRADAs	190	180	182	160	151
Active non-traditional CRADAs	85	63	48	54	60
Active CRADAs with small businesses	ND	ND	116	96	98
Number newly executed CRADAs, total	78	53	62	43	59
Newly executed amendments ¹	91	82	86	72	76
Newly executed traditional CRADAs	57	39	41	29	44
Newly executed non-traditional CRADAs	21	14	21	14	15
Newly executed CRADAs with small businesses	ND	20	21	10	31
Total number active MTRAs²	ND	12	100	188	212
Newly executed MTRAs	ND	12	86	105	102
Total number of active other agreements³	13,007	13,835	12,717	12,953	12,375
Newly executed other agreements	1,525	1,119	1,776	1,808	1,862
Number newly executed MTAs	1038	970	991	906	743
Newly executed outgoing MTAs	672	661	647	506	513
Total number of publications⁴	11,260	8,695	8,295	8,385	8,233
Peer-Reviewed Scientific manuscripts	5,279	5,027	4,922	5,209	4,871
Trade Journal manuscripts	83	86	93	85	76
Abstracts	3,773	3,582	3,280	3091	3,286

1. Amendments extend existing CRADAs for additional years to a maximum of 5 years, and/or change Statements of Work, and/or change funding levels.
2. Material Transfer Research Agreements. Involves collaborative research on a specific material.
3. Includes mostly Trust Fund Cooperative Agreements, Reimbursable Agreements, Non-Assistance Cooperative Agreements and Non-Funded Cooperative Agreements.
4. Number of manuscripts approved for submission to journal or magazine.

TABLE 2. Invention Disclosure and Patenting

ND- no data available.

Agricultural Research Service (ARS)	FY 2011	FY 2012	FY 2013 ⁴	FY 2014	FY 2015
Total number new invention disclosures¹	126	137	165	101	193 ⁵
University co-owned	22	66	46	37	40
Non-University co-owned	ND	ND	ND	ND	27
Based upon scientific discipline					
Biological Materials	ND	ND	ND	ND	32
Life science	61	59	74	39	64
Chemical	36	53	49	32	48
Mechanical & measurement	28	14	19	9	18
Plant patents ³	7	17	12	4	3
Plant variety protection ³	ND	ND	11	17	28
Total number patent applications filed²	110	108	144	110	110
University co-owned	ND	ND	36	34	25
Non-University co-owned	ND	ND	ND	ND	26
Based upon scientific discipline					
Life science	ND	ND	62	47	47
Chemical	ND	ND	44	25	38
Mechanical & measurement	ND	ND	13	17	15
Plant patents	ND	ND	14	6	4
Plant variety protection	ND	ND	11	6	6
Total number patents issued²	46	60	60	78	84
University co-owned	ND	ND	17	23	12
Non-University co-owned	ND	ND	ND	ND	20
Based upon scientific discipline					
Life science	ND	ND	17	36	33
Chemical	ND	ND	25	21	20
Mechanical & measurement	ND	ND	11	11	10
Plant patents	ND	ND	7	10	15
Plant variety protection	ND	ND	ND	ND	6

1. Inventions arising at the federal lab. For FY 2013 and 2014 also includes the plant protected through Plant Variety Protection.
2. Includes U.S. patent applications, foreign patent applications filed on cases for which no U.S. application was filed, divisional applications, continuation-in-part applications, provisional applications, and Plant Variety Protection.
3. Plants may be protected in one of two ways based upon their mode of reproduction- patent (vegetatively reproduced) through the USPTO or variety protection (seed reproduced) through USDA-AMS.
4. FY 2013 numbers were revised (higher) in FY 2014.
5. FY 2015 includes the addition of Biological Material Invention Disclosures.

TABLE 3. Profile of Active Licenses

*ND- no data available.

Agricultural Research Service (ARS)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Total number active licenses	337	363	380	392	404
Executed to small businesses ¹	ND	118	137	150	147
Executed to startup businesses ²	ND	ND	11	12	12
Executed to universities	ND	142	169	168	175
Amended in FY	ND	ND	ND	10	5
Invention licenses³	301	321	331	341	339
Executed to small businesses	ND	ND	113	125	112
Executed to startup businesses	ND	ND	11	12	12
Executed to universities	ND	ND	162	160	166
Other IP Licenses⁴	36	42	49	51	65
Executed to small business	ND	ND	24	25	35
Executed to startup businesses	ND	ND	0	0	0
Executed to universities	ND	ND	7	8	9
Total number newly executed licenses	33	31	23	28	35
Executed to small businesses	ND	15	9	15	16
Executed to startup businesses	ND	ND	0	1	0
Executed to universities	ND	12	10	10	9
Invention licenses			17	26	20
Executed to small businesses	ND	ND	5	14	5
Executed to startup businesses	ND	ND	0	1	0
Executed to universities	ND	ND	10	10	8
Other IP Licenses			6	2	15
Executed to small businesses	ND	ND	4	1	11
Executed to startup businesses	ND	ND	0	0	0
Executed to universities	ND	ND	0	0	1

1. A small business, together with its affiliates, must not have more than 500 employees.

2. For the purpose of this report, a startup company is a privately-held, U.S., for-profit company operating for less than 5 years and actively seeking financing to commercialize a federal scientific work product.

3. Invention licenses refer to patents and plant variety protection certifications.

4. Other IP licenses refer to biological materials licenses.

TABLE 4. Characteristics of Income Bearing Licenses

Agricultural Research Service (ARS)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Total number of income bearing licenses	335	360	378	390	402
Exclusive	239	259	273	278	274
Partially exclusive	16	14	13	15	11
Non-exclusive	80	87	92	97	117
Invention licenses¹	299	318	329	339	337
Exclusive	234	252	265	269	266
Partially exclusive	16	14	13	15	11
Non-exclusive	49	52	51	55	60
Other IP Licenses²	36	42	49	51	65
Exclusive	5	7	8	9	8
Partially exclusive	0	0	0	0	0
Non-exclusive	31	35	41	42	57
Total number royalty bearing licenses	130	128	134	131	139
Invention licenses	119	114	115	117	121
Other IP licenses	11	14	19	14	18

1. Invention licenses refer to patents and plant variety protection certifications.

2. Other IP licenses refer to biological materials licenses.

TABLE 5. Income from Licensing

*ND- no data available.

Agricultural Research Service (ARS)	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Total income all active licenses	\$3,989,228	\$3,806,164	\$4,385,952	\$4,927,938	\$5,066,988
Invention licenses ¹	\$3,854,820	\$3,670,692	\$4,053,931	\$4,733,200	\$4,842,256
Other IP licenses ²	ND	ND	\$332,021	\$194,738	\$224,732
Total earned royalty income (ERI)	\$3,136,813	\$3,059,989	\$3,353,876	\$3,610,774	\$3,509,904
Median ERI	\$4,748	\$5,000	\$3,609	\$3,232	\$3,525
Minimum ERI	\$6	\$44	\$5	\$32	\$13
Maximum ERI	\$630,847	\$757,219	\$856,987	\$575,753	\$728,017
ERI from top 1% of licenses	NP ³				
ERI from top 5% of licenses	\$1,932,197	\$1,752,367	\$1,969,155	\$2,048,317	\$1,756,460
ERI from top 20% of licenses	\$2,672,414	\$2,604,008	\$2,892,796	\$3,103,143	\$2,856,924
ERI distributed					
Inventors	\$1,391,111	\$1,206,713	\$1,192,808	\$1,305,695	\$1,632,130
Funds to be used for salaries	ND	ND	ND	\$2,812,269	\$2,819,906
Patent filing preparation, fees, & annuity payments paid ⁴	ND	ND	ND	\$809,974	\$621,701

1. Invention licenses refer to patents and plant variety protection certifications.

2. Other IP licenses refer to biological materials licenses.

3. Not presented, represents one license.

4. Approximately 40% is reimbursed when licensed.

TABLE 6. Licensing Management: Elapsed Execution Time and Termination

Agricultural Research Service (ARS)	FY 2011 ¹	FY 2012 ²	FY 2013 ³	FY 2014 ⁴	FY 2015 ⁵
All licenses					
- average (months)	5.9	5.8	3.5	5.9	2.8
- median (months)	3.3	4.2	2.3	5.8	2.5
- minimum (months)	0.6	0.3	0.4	0.9	0.5
- maximum (months)	18.2	19.7	12.5	21.5	10.0
Licenses terminated for cause	0	0	0	0	0

- ¹ During FY 2011, USDA received 29 new invention license applications, for which 4 new licenses were granted, 21 license agreements are currently in negotiation, 0 applications were withdrawn by the applicants, and 4 applications are on hold by request of the applicant. The FY 2011 data is based upon 13 licenses granted to commercial licensees and does not include licenses executed with universities for co-owned inventions. In accordance with 35 USC 202(e), such licenses are granted for the purpose of consolidating rights in the invention, and therefore license applications are not required.
- ² During FY 2012, USDA received 16 new invention license applications, for which 7 new licenses were granted, 9 license agreements are currently in negotiation, 0 applications were withdrawn by the applicants, and 0 applications are on hold by request of the applicant. The FY 2012 data is based upon 18 licenses granted to commercial licensees and does not include licenses executed with universities for co-owned inventions. In accordance with 35 USC 202(e), such licenses are granted for the purpose of consolidating rights in the invention, and therefore license applications are not required.
- ³ During FY 2013, USDA received 28 new invention license applications, for which 8 new licenses were granted, 15 license agreements are currently in negotiation, 3 applications were withdrawn by the applicants, and 2 applications are on hold by request of the applicant. The FY 2012 data is based upon 18 licenses granted to commercial licensees and does not include licenses executed with universities for co-owned inventions. In accordance with 35 USC 202(e), such licenses are granted for the purpose of consolidating rights in the invention, and therefore license applications are not required.
- ⁴ During FY 2014, USDA received 15 new invention license applications, for which 8 new licenses were granted, 5 license agreements are currently in negotiation, 2 applications were withdrawn by the applicants, and 0 applications are on hold by request of the applicant. The FY 2014 data is based upon 17 licenses granted to commercial licensees and does not include licenses executed with universities for co-owned inventions. In accordance with 35 USC 202(e), such licenses are granted for the purpose of consolidating rights in the invention, and therefore license applications are not required.
- ⁵ During FY 2015, USDA received 42 new invention license applications, for which 21 new licenses were granted, 18 license agreements are currently in negotiation, 2 applications were withdrawn by the applicants, and 1 application is on hold by request of the applicant. The FY 2015 data is based upon 26 licenses granted to commercial licensees and does not include licenses executed with universities for co-owned inventions. In accordance with 35 USC 202(e), such licenses are granted for the purpose of consolidating rights in the invention, and therefore license applications are not required.

3.9. Downstream Outcomes



NUTRITION, FOOD SAFETY, QUALITY

National Program:

- **Human Nutrition, NP 107**
- **Food Safety, NP 108**
- **Quality and Utilization of Agricultural Products, NP 306**

Survey.

Every 5 years USDA's Food Safety Inspection Service (FSIS) assesses the background levels of persistent organic pollutants—including dioxins, furans, polychlorinated biphenyls, and polybrominated diphenyl ethers—in U.S. beef, pork, turkey, and chicken. Data derived from this assessment are used to determine whether background levels of these contaminants are increasing or decreasing in food animals. ARS researchers in Fargo, North Dakota, collected over 500 samples of fat from U.S. slaughter facilities for 13 months and then analyzed the samples for dioxins and dioxin-like compounds. Study results indicated that levels of dioxin and dioxin-like compounds have remained consistently low in the U.S. meat supply and are continually decreasing. The data are being disseminated by U.S. regulatory officials as evidence that the quality of the U.S. meat supply is increasing as the level of dioxin-like persistent organic pollutants declines. (Project No. 544232000-013-00D)

Food portion sizes for children are predicted by parental characteristics.

In the first study to examine parental behavioral influences on children's food portion sizes, ARS-supported scientists examined the feeding habits of 145 mostly Hispanic and African-American parents of preschoolers. The marked increase in obesity among young children has not been explained well despite intensive research, much of which has focused on child behaviors. During three at-home meals, the researchers measured and analyzed how much food parents and children were served and consumed. The amounts parents served themselves was a significant predictor of how much food the children were given, which in turn, was highly correlated with the amounts they ate. African-American parents served more food to themselves and to their children than Hispanic parents, and employed parents served larger meals than those who were unemployed. Body mass index, the standard measure of obesity, was not predictive of meal size. These results suggest that educating parents about appropriate portion sizes for children and how parental choices at the dinner table may affect eating habits in children. This information could support efforts to improve U.S. nutrition for children and adults. (Project No. 6250-51000-053-00D)

The current standard for calorie intake in children is set too high.

Current Dietary Reference Intake (DRI) standards are based on previous studies that included only two 3-year-olds and two 4-year-olds and did not address how substantial differences in physical activity level might affect energy needs. ARS-funded researchers in Houston, Texas, determined that DRI standards overestimate the calories required to meet the energy needs of preschool children. The researchers included 97 children in a study of total energy expenditure, short-term metabolic needs, and long-term metabolic needs. Results indicated that the current DRI for energy overestimates caloric need, and that physical activity has a large role in determining that need and can sometimes increase caloric demand by almost 600 calories per day. This research will support nutritionists who provide guidance on appropriate caloric intake levels for children, and may help stem the increase in childhood obesity over the last 30 years. (Project No. 6250-51000-053-00D)

Children suffering from severe acute malnutrition improve more quickly with amino acid supplements.

In many developing countries, malnutrition of young children remains a major cause of stunting and may result in permanent deficits that prevent people from reaching their full physical and mental potential. Aid programs often provide special foods that induce acute recovery of growth, but that is often not maintained over the long term. ARS supported scientists studied 22 children from the West Indies who lagged behind their peers in growth by more than 20 percent. The children in the study ranged in age from 4 to 31 months. A mixture of aromatic amino acids (AAA) not normally used to treat malnutrition was compared with the same amount of a standard, single amino acid, and was found to increase whole-body protein synthesis and provided better amino acid balance during catch-up growth. These results can be used by government agencies to administer more effective nutrition support to the most vulnerable children by including AAA in nutritional rehabilitation regimens. (Project No. 6250-51000-052-00D)

Multiple detrimental effects of maternal obesity on placenta and fetus documented.

ARS-supported scientists have shown that maternal obesity can damage the placenta by increasing inflammation, oxidative stress, and other toxic responses caused by elevated fat levels. Even though the placenta is the biological interface between mother and developing baby, there has been limited interest in its biology because it is expelled after birth. In this study, placental tissue in women who were obese and of healthy weight was assessed for activity changes in 288 genes. The scientific team also characterized the set of all RNA molecules in the placental tissue that translate the genetic material coded by DNA into protein production. Although guidelines exist for weight gain during pregnancy, many women are overweight or obese before conception and many gain far more than recommended during pregnancy. This cutting-edge information is an essential part of identifying metabolic pathways regulating placental physiology and how this may go awry in the presence of obesity or other diseases. (Project No. 6251-51000-007-00D)

Regulation of milk production in humans. ARS-funded scientists provided the first documentation that a number of women struggle to successfully breastfeed their infants, particularly mothers who are obese, teenage, or with premature infants. The researchers developed a method for isolating and measuring the messenger RNA that help regulate milk production and traced the changes in gene expression over the first 42 days of lactation in normal women. The primary trigger for the start of lactation in humans is incompletely understood, but one of the factors is the withdrawal of progesterone (a hormone made in the placenta during pregnancy) once the placenta is removed from the mother after giving birth. This suggests it may be possible to develop therapeutic approaches for blocking the action of progesterone, which could increase the success rates of breastfeeding. Supporting efforts to provide mothers and infants with all of the benefits of breastfeeding enhances childhood nutrition and health. (Project No. 6250-51000-054-20S)

Physical activity benefits elderly adults at high risk for impaired mobility.

Sarcopenia is the loss of skeletal muscle mass in the elderly, and it contributes to declines in physical capacity and performance with advancing age. The economic impact of sarcopenia has been estimated at \$18.5 billion annually. ARS-funded researchers in Boston, Massachusetts, have determined that structured physical activity is a feasible and effective intervention to reduce the burden of disability among vulnerable older persons in late life. Men and women (aged 70-89 years) who were able to walk and volunteered for the study were assigned to

participate either in moderately intense physical activity that included aerobic, resistance, and flexibility training activities or in a health education program that included workshops on topics relevant to older adults and upper extremity stretching exercises. Thirty percent of the participants engaging in the physical activity program exhibited major mobility impairments, whereas 36 percent of participants in the health education program exhibited major mobility impairments. Notably, a subgroup with lower physical function at the beginning of the study received considerable benefit from the physical activity intervention. These results support USDA's goal of improving health and safety for citizens of all ages. (Project No. 1950-51000-068-00D)

Worksite weight-loss interventions.

Obesity is a serious health crisis in the United States, contributing to increasing health care costs, which in turn, negatively affect the Nation's competitiveness. Effective, sustainable weight control programs for employees are urgently needed. After completing a pilot study of a new worksite weight loss intervention, ARS-funded researchers in Boston, Massachusetts, reported an average participant weight loss of 8 percent over 6 months with no significant weight regain among participants 12 months after the start of the intervention. In this study, the worksite intervention had a dropout rate of only 11 percent, which indicates that in addition to the other positive results, participants found the program to be acceptable. Workplace intervention may be an important tool in addressing the national obesity epidemic because it has the potential to be more effective in retaining program participants and preventing weight regain, both of which are significant factors in the ineffectiveness of comparable programs. (Project No. 1950-51000-071-00D)

Dietary intake of vegetables and fruit can be estimated by a noninvasive skin test. Increasing the consumption of fruits and vegetables is a primary recommendation of nutritionists, yet few ways exist to accurately measure changes in intake of these foods. Carotenoid concentrations (chemicals similar to vitamin A) in the blood are considered the best marker of consumption of fruit and vegetable intake by humans, but blood collection is invasive and not practical for large-scale studies. This method was recently utilized in a human study that fed varying levels of vegetables and fruits for 28 weeks. The laser method accurately detected changes in the consumption of carotenoid-containing foods, and the values obtained by the laser correlated well with plasma carotenoid concentrations. This method will make determination of dietary intake of fruits and vegetables much easier to assess and may become a valuable tool for both researchers and clinicians. (Project No. 5450-51000-049-00D)

Cooking of food produces advanced glycation end products but does not adversely affect health.

When food is heated to high temperatures, the browning reaction generates advanced glycation end products (AGEs). Published studies on AGEs have been highly controversial, but many have associated them with several chronic diseases, especially cardiovascular disease. ARS scientists addressed this question in a new study of healthy, middle-aged adults who were given diets for 6 weeks prepared at either high or mild temperatures. The distinguishing features of this study were provision of all foods that were the same in both diets, providing identical calories, and well controlled heating of foods. A number of risk factors for heart disease, including functional tests of the blood vessels, plus multiple serum and urinary proteins that indicate inflammation, were measured. No adverse effects of the high AGE diet were observed for any indicators. This is the first fully controlled study to examine this question and clearly indicates that cooking food at usual temperatures does not have detrimental effects on the cardiovascular system. (Project No. 1235-51530-009-00D)

New analytical method for nitrosamines and risk assessment by USDA.

Nitrosamine levels in fried bacon were a major concern 30 years ago before steps were taken to reduce their formation, however, nitrosamines levels have not been monitored since the 1990s. The USDA Office of Inspector General (OIG) requested the Food Safety Inspection Service (FSIS) to conduct a survey of nitrosamine formation from cooked bacon and an accompanying risk assessment to check if the situation had changed. The previous analytical methods used for nitrosamines were unwieldy and used archaic specialized equipment that was unavailable. At the request of the Food Safety Inspection Service (FSIS), ARS scientists in Wyndmoor, Pennsylvania developed and validated a new sensitive, rapid, and easy test for assessing nitrosamine levels in fried bacon. An innovative new approach detected as little as 0.1 ng/g levels of the nitrosamines of concern in the

complex samples. FSIS regulators performed a risk assessment using the survey results and demonstrated that frying bacon did not generate levels of nitrosamines that posed a health risk. As a result of this work, nitrosamines in fried bacon do not need to be routinely monitored. Testing and survey methods will be readily available to FSIS and others if another survey is needed. ARS' research also helped close out the longest OIG audit in FSIS. (Project No. 1935-42000-056-00D)

Impact of tetracycline on *Salmonella*.

Multi-drug resistant (MDR) *Salmonella*, a bacterium that can cause foodborne illness, is an important food safety concern. The development of antibiotic resistance to tetracycline, which is a commonly used antibiotic in both humans and animals, is very common. ARS scientists in Ames, Iowa, examined the impact of tetracycline on the virulence of MDR *Salmonella typhimurium* and found that tetracycline promoted the ability of some MDR *Salmonella* to invade host cells. This suggests that tetracycline may play a role in increasing the virulence of MDR *Salmonella*, and highlights the need to develop alternative treatments for *Salmonella* and other bacterial diseases. (Project No. 3625-32000-101-00D)

***Salmonella enteritidis* contamination of eggs from hens housed in conventional or enriched cages.**

Many human foodborne illnesses result from eating eggs contaminated by *Salmonella enteritidis*, which is transmitted to eggs by infected chickens. ARS researchers in Athens, Georgia, determined that housing experimentally infected hens in conventional or enriched cages (larger cages with perches and other enhancements) did not affect how often eggs became internally contaminated with *Salmonella*. These results demonstrate that housing egg-laying hens in enriched cages may not reduce the production of eggs contaminated by *S. enteritidis* and that other options should be considered to reduce foodborne illness from contaminated eggs. (Project No. 661232420-001-00D)

***Salmonella* behavior on chicken during cold storage.**

Refrigerated chicken sold in stores is usually contaminated with low levels of *Salmonella*, a pathogen that can cause foodborne illness unless it is destroyed by cooking. When consumers store chicken in refrigerators that are too warm, *Salmonella* populations can multiply. ARS researchers in Princess Anne, Maryland, conducted studies that assessed the growth of *Salmonella* on chicken meat in cold storage. No *Salmonella* growth was observed on chicken stored at 26 to 50 degrees F, but at 54 to 61 degrees F, *Salmonella* growth was highest on dark meat, intermediate on skin, and lowest on white meat. The researchers used these findings to develop and validate a computer model that predicts *Salmonella* growth and survival on chicken stored at temperatures between 26 to 61 degrees F. The new model will help the chicken industry, regulatory agencies, and consumers better predict and manage the risk of developing foodborne illness from consuming chicken contaminated with *Salmonella*. (Project No. 1935-42000064-00D)

Genomic differences in transient and persistent strains of *Salmonella* Kentucky on a dairy farm.

There can be considerable variation both within and between different types of *Salmonella*. There is also significant variation in the pathogen's ability to colonize hosts and in the severity of illness associated with contamination or infection. Two types of *Salmonella* Kentucky were isolated from a dairy herd 6 years apart. While one strain was isolated transiently in the herd, the other was associated with long-term asymptomatic infection. Whole-genome sequencing revealed the two types had genetic differences that are linked to the ability to colonize the bovine intestine and in the ability to repress virulence. Repressing virulence reduces the host immune response to the bacteria and increases the pathogen's potential for successful long-term colonization. These findings will help scientists elucidate the genetic factors affecting pathogen colonization and virulence expression, and support the development of strategies to disrupt or prevent infection of foodborne pathogens in production animals. (Project No. 1245-32000-091-00D)

Rapid in-field detection of *E. coli* that produce Shiga toxin.

Escherichia coli (*E. coli*), a pathogen that produces Shiga toxin, is a significant contamination risk to the food supply. ARS researchers in Riverside, California, and California Polytechnic University collaborators designed and evaluated field methods that can be used to rapidly detect *E. coli* within 5 to 10 minutes. When fully

optimized, the detection procedure could be used directly in the field or wherever necessary for rapid, real-time detection of *E. coli*, which will enable food safety managers to quickly eliminate Shiga toxin from the target area and restore baseline conditions needed for safe food production. (Project No. 5310-32000-003-00D)

***E. coli* O157:H7 strains from contaminated raw beef trim during “high event periods.”**

The U.S. beef processing industry has developed and implemented effective antimicrobial interventions that have dramatically reduced the incidence of beef trim contamination by *E. coli* O157:H7, a pathogen that can cause severe foodborne illness. However, individual processing plants still experience sporadic peaks in contamination rates where clusters of multiple finished product contamination occur in a short time frame. These peaks have been referred to as “high event periods” (HEP) of contamination. ARS scientists in Clay Center, Nebraska, determined that each HEP is linked to one type of *E. coli* O157:H7 isolate that is responsible for most, if not all, of the contamination. This is in contrast to the range of different strains identified on the hides of cattle entering processing plants and poses a potential challenge to the current model for finished product contamination during beef processing. In addition, it was found that a high proportion of HEP are caused by strain types associated with human illness. This research indicates that beef processing plants will need additional support in developing tools and techniques to control HEP. (Project No. 5438-42000-014-00D)

Determining set-back distances between feedlots and leafy greens to reduce pathogen contamination.

Experts suspect that cattle may have been the source of *E. coli* O157:H7 pathogens responsible for recent outbreaks of foodborne illness linked to spinach and lettuce consumption. These outbreaks underline the importance of determining how much distance is needed between animal production facilities and crop fields to reduce the risk of *E. coli* O157:H7 transmission and associated outbreaks of foodborne illness. Current guidelines for leafy green growers recommend maintaining a provisional distance of 400 feet between concentrated animal feeding operations and leafy green crop fields. ARS scientists in Clay Center, Nebraska, evaluated how *E. coli* O157:H7 contamination of leafy green produce crops was affected by the proximity of a beef cattle feedlot. Low levels of *E. coli* O157:H7 were recovered in leafy greens at all setback distances in the study, including a 600-foot setback. These results suggest that the current leafy green field distance guidelines of 400 feet may not be sufficient to mitigate the migration of *E. coli* O157:H7 from concentrated animal feeding operations into nearby crop fields. This information is critical for understanding the risks associated with growing leafy greens in close proximity to cattle production, and for determining safe distances between cattle feedlots and produce. (Project No. 5438-32000-030-00D)

Role of plant cultivation conditions on *E. coli* internalization.

Hydroponic farming practices have increased in recent years, but little is known about how hydroponic production affects *E. coli* uptake into the internal vascular system of fresh produce. ARS scientists in Beltsville, Maryland, grew spinach in hydroponic systems and in soil contaminated with *E. coli* O157:H7 and then measured *E. coli* uptake in plant roots, stems, and leaves at set intervals during production. Their results indicated that *E. coli* O157:H7 could enter hydroponically-grown spinach plants through the root system and migrate to the stems and leaves. When the root system in hydroponically-grown spinach was wounded, *E. coli* O157:H7 internalization and migration to the edible portions of the plant increased. However, plants grown in *E. coli*-contaminated soils had greater levels of *E. coli* internalization than plants grown hydroponically, and *E. coli* uptake was not affected by *E. coli* O157:H7 Curli expression—a type of bacterial structure that is found on the surface of *E. coli*—or by spinach cultivar. This work shows it is possible for *E. coli* to internally contaminate hydroponically-grown produce, even though overall contamination levels may be lower than plants grown in soil. (Project No. 1245-32420-005-00D)

AflaGoggles for screening aflatoxin contamination in maize.

Aflatoxins are a potent toxin that can infect corn and other important food crops, but detecting aflatoxin contamination in harvested grain can be difficult, especially in countries that lack high-tech monitoring tools. ARS scientists in New Orleans, Louisiana, developed special goggles based on hyperspectral technology—which detects light waves in the visible and non-visible part of the light spectrum—that inspectors can use to identify aflatoxin-contaminated grain that needs to be removed from the rest of the grain. A licensing agreement for the

technology was signed with Mississippi State University and Secure Food Solutions, a company based in Tennessee, and a U.S. Patent was issued to “Method and Detection System for Detection of Aflatoxin in Corn with Fluorescence Spectra” (Patent Number 8,563,934). If the prototype goggle that was developed is successful, they will provide African farmers with a rapid and inexpensive method for detecting aflatoxin in their corn crops, which will significantly increase the safety of their food supply. (Project No. 6435-42000-021-00D)

Cure for perennial aflatoxin problems in Kenya.

Fungal infections of food crops can result in the production of aflatoxins, which is a carcinogen that also causes other serious acute and chronic illness in human and animals. Food crops—particularly maize—have been most severely contaminated in Kenya, where illness and death from aflatoxin exposure has been documented for decades. ARS researchers in Tucson, Arizona, collaborators at the International Institute of Tropical Agriculture, and Government of Kenya researchers partnered to use *Aspergillus flavus* fungi in the development of a biocontrol product that protects food crops from aflatoxin contamination. They tested the resulting biocontrol in selected Kenya counties and determined that the product was highly effective at preventing aflatoxin contamination of maize in these target counties. Findings also indicated that Kenyans are frequently exposed to very high aflatoxin concentrations (more than 50 times the concentrations allowed in U.S. pet food), which has resulted in an ongoing human health crisis. Developing an aflatoxin biocontrol for area-wide use in Kenya will substantially reduce the human health risk associated with aflatoxin exposure and will provide useful lessons for the development and use of next-generation biocontrol products in the United States. (Project No. 5347-42000-020-00D)

Elevated CO₂ reduces maize defenses to *Fusarium verticillioides* infection.

High temperatures and drought associated with climate change can support growth of the fungus *Fusarium verticillioides*, which increases fumonisin contamination and the development of mycotoxins in corn crops. However, there is limited information about how elevated carbon dioxide (CO₂) will affect fungal disease and mycotoxin contamination. ARS scientists in Peoria, Illinois, and Gainesville, Florida, have shown when corn is grown in elevated CO₂ levels, plant defenses are weakened. *F. verticillioides* infections are able to increase as a result, but there is also a relative decrease in the production of mycotoxin. These findings provide a clearer understanding of how elevated CO₂ levels will affect plant-mycotoxin interactions and supports the development of cost-effective agricultural practices that minimize potential economic losses in the face of future climate change. These findings also provide information about the physiological conditions associated with reduced mycotoxin production during the host plant-pathogen interactions, which will assist in identifying host plant traits and genes that modulate mycotoxin formation and developing novel approaches for reducing mycotoxin contamination in corn. (Project No. 3620-42000042-00D)

Chlorine by-product formation in wash water and fresh-cut produce.

Chlorine (sodium hypochlorite) is commonly used as a sanitizer by the food industry and citric acid is often used to adjust its pH and increase its efficacy. However, adding citric acid can also result in the formation of chlorine by-products that are a potential health risk. ARS researchers in Wyndmoor, Pennsylvania, studied the formation of the chlorine by-product trichloromethane in water and fresh-cut produce and assessed how the by-product was affected by citric acid. Results showed that citric acid reacted with chlorine and produced significant amounts of trichloromethane in chlorinated water, but not in chlorine dioxide solution. Higher amounts of trichloromethane were produced in the chlorine solution used for washing cut-lettuce than in the solution used for diced onions, and trichloromethane levels in the final products (cut vegetables) were much lower than levels in the water. These results indicate that citric acid should be replaced with other pH adjusters to reduce the formation of trichloromethane in wash water. These findings can be used by the produce industry to minimize the formation of chlorine by-products in water and fresh produce, and reduce potential health risks associated with food processing. (Project No. 1935-41000-092-00D)

Improved capacities for estimating microbial water quality.

Modeling microbial water quality is based on estimating the survival rate of livestock waste microorganisms after they have been deposited on land via excretion. ARS scientists in Beltsville, Maryland, have created the world's

largest database on how long *E. coli* pathogens in soils and in animal waste survive after they have been deposited on land. The scientists used predictive microbiology to simulate how temperature affected *E. coli* survival in different types of animal waste and manures. These results will contribute to improving the accuracy of microbial water quality models used to assess and predict microbial loads in recreational and irrigation water sources, and directly address issues included in the Produce Rule under the FDA Food Safety Modernization Act. (Project No. 1245-12630-008-00D)

Identification of *Campylobacter* flagellar capping protein as a potential vaccine candidate.

Vaccination is a potential method to prevent and control foodborne pathogens in animals, including *Campylobacter jejuni*. ARS researchers in Athens, Georgia, screened a number of *C. jejuni* proteins against blood serum from infected broilers and breeder chickens and observed that the pathogen's flagellar capping protein reacted strongly to pathogen antibodies in the serum. Since this protein is very similar among *Campylobacter* species, it could serve as a potential candidate for a vaccine that could reduce infection in chickens and increase the safety of the food supply. (Project No. 6612-32000-060-00D)

Gut microbiota affects vaccine responses.

The role of the human biome—all the microorganisms that live in the human body—in maintaining human health is receiving a great deal of scientific attention. Research by ARS scientists and colleagues indicate that the composition of the microbial community inhabiting the human intestine is likely to have a profound influence on both infant and adult health. ARS scientists in Davis, California, worked with World Health Organization and other collaborators to conduct a study among healthy Bangladeshi infants up to 15 weeks of age to determine whether intestinal microorganisms are associated with standard vaccine responses. Based on DNA obtained from feces, the scientists determined that a high abundance of certain types of intestinal bacteria was associated with stronger responses to several vaccines, including oral polio vaccine, tetanus toxoid vaccine, and tuberculosis vaccine. Multiple measures of vaccine response were affected, including antibody response, hypersensitivity skin test response, and T-cell proliferative response. These findings suggest that interventions that use live bacteria or appropriate foods to promote a healthy microbial community in the gut may improve the efficacy of vaccination programs and could have positive effects on childhood health. (Project No. 5306-51530-022-00D)

Changes in gut bacteria are associated with alterations in liver and kidney function.

ARS researchers have discovered weight loss and exercise in sedentary, obese insulin-resistant women leads to novel patterns of plasma metabolites that indicate better metabolic health. Research in recent years has shown that metabolic products from bacteria in the large intestine are absorbed into the bloodstream and may influence metabolism at distant sites in the body. Although the bacteria in the large intestine are readily influenced by diet, it remains largely unknown how such changes affect a person's overall health. But in this study, in addition to finding that exercise and diet resulted in novel plasma metabolite patterns, the ARS scientists also determined that blood metabolites that had originated from colon bacteria indicated better insulin resistance and better efficiency of mitochondria, the cell organs responsible for energy metabolism. With the majority of Americans being overweight or obese, the incidence of type 2 diabetes has more than doubled and has become a leading cause of disability and health care costs, and insulin resistance is the classic diagnostic feature of type 2 diabetes. These results indicate the need to consider both bacterial and organ metabolism to develop a comprehensive understanding of how diet helps to normalize insulin metabolism. (Project No. 5306-51530-019-00D)

Commercial application for *Vibrio* predatory bacteria.

The bacterium *Vibrio* is the primary cause of shellfish associated bacterial illness and death in the United States. While evaluating the effects of pH, temperature, and algae diet on *Vibrio* levels in shellfish, ARS researchers in Dover, Delaware, and University of Delaware collaborators discovered a group of naturally occurring predatory bacteria that substantially reduce *Vibrio* levels in seawater and shellfish. ARS researchers are collaborating with the U.S. Food and Drug Administration and industry partners to assess the use of these *Vibrio* predators for eliminating or significantly reducing vibrio levels in market shellfish. As part of this effort, a pilot-scale, portable processing facility is being evaluated to determine the effectiveness of *Vibrio* predatory bacteria in eliminating *Vibrio* in oysters. If this process is successful, it could result in the direct application of a technology developed

by ARS to manage the most significant pathogens in oysters and clams associated with foodborne illness and enhance shellfish safety worldwide. (Project No. 1935-42000-065-00D)

Organic milk is more abundant in healthy omega-3 fatty acids than conventional milk.

Scientific evidence shows that omega-3 and other fatty acids in dairy products are advantageous to human health. ARS researchers in Wyndmoor, Pennsylvania, investigated milk from two adjacent dairy farms, one producing conventional milk, the other organic milk from pasture-fed cows. Linolenic acid, an omega-3 fatty acid associated with benefiting the brain and a healthy heart, was significantly higher in the organic milk throughout the year. Americans may benefit from consuming dairy foods with higher levels of healthy fatty acids as part of a balanced diet. (Project No. 1935-41000-091-00D)

Native Texas shrub produces potent mosquito repellents with a longer-lasting effect than DEET.

Mosquitoes serve as carriers of human diseases such as malaria, dengue, and yellow fever. An ARS scientist in Oxford, Mississippi, synthesized an analog of a natural chromene compound that is more repellent than DEET with a longer duration of action. The compound was isolated from *Amyris texana*, a plant native to Texas. A patent for the compound has been filed. In follow-up studies, several chromene derivatives were further synthesized and shown to be even more potent mosquito repellents with longer action than DEET. This study reveals the potential use of chromene analogs and their action as mosquito repellents, and as superior substitutes for DEET. (Project No. 6408-41000-008-00D)

Native cedar wood oil is a highly effective repellent to several insect pests.

The oil from the American native cedar tree *Juniperus virginiana* is an effective repellent to several species of ants and houseflies, two cockroach species, and a tick species. ARS scientists in Peoria, Illinois, developed a method to extract cedar wood oil (CWO), a safe, natural, native, renewable and underutilized agricultural resource, and demonstrated its potential use as an insect control agent. In outdoor tests, several species of ants were repelled by smearing CWO on a pole leading to a sugarwater solution. In laboratory tests, invasive, imported red fire ants were repelled by CWO separating them from food. Blacklegged tick nymphs were killed by CWO, and more than 90 percent of adult houseflies died after contact with CWO. The crude carbon dioxide-derived CWO extract showed some repellence toward both German and American cockroaches. (Project No. 3620-41000-150-00D)

Vegetable oil estolides are high-performing, fuel-saving, renewable lubricants.

Renewable, bio-based lubricants are in great demand. Estolides are fluids made from renewable animal- and vegetable-based oils. Combining estolides with alcohol results in a lubricant that performs better at colder temperatures, reduces friction and wear, and lowers fuel consumption. ARS scientists in Peoria, Illinois, refined and improved the estolide properties and solved largescale batch-production challenges such as incomplete fatty acid conversion. This new technology was transferred to an industrial partner for commercialization. (Project No. 3620-41000-158-00D)

Safe, chemical-free method for cotton defoliation and desiccation.

Recent studies have demonstrated that prolonged exposure to certain chemicals used in cotton pre-harvesting may be associated with an elevated risk for Parkinson disease. Several regulatory agencies are examining a potential ban on the use of these chemicals. ARS engineers in Lubbock, Texas, have discovered a new, safe, chemical-free method to defoliate and desiccate cotton. The new technology has been patented. It offers a safe, valuable, alternative to using hazardous harvest-aid chemicals and has garnered interest and financial support from a major stakeholder in the cotton industry. (Project No. 6208-21410-007-00D)

Calcium sprays make red and blue fruits and vegetables even more colorful and healthier.

Anthocyanins, the compounds that cause the red and blue coloration of fruits and vegetables, are also recognized as having antiinflammatory and anti-carcinogenic activity, and the potential to prevent cardiovascular disease, control obesity, and alleviate diabetes. ARS scientists in Beltsville, Maryland, identified the genes that control anthocyanin accumulation in strawberries. Further research found that strawberry plants sprayed with calcium

boosted expression of the anthocyanin regulator genes and made the fruit even redder. Strawberry is an economically important crop, and these results may help plant breeders and growers enhance the color and health benefits of the fruit. (Project No. 1245-43000-012-00D)

Calcium in guayule production improves rubber yields.

Guayule is a woody desert crop native to the United States that is being used to produce natural rubber and bioenergy. ARS scientists in Albany, California, developed a tissue culture-media protocol using calcium nitrate to grow plants with more and longer shoots. Information from this research will be useful in establishing guayule seedlings in greenhouses and in eventual field production, and should lead to more abundant natural rubber production. (Project No. 5325-21410-020-00D)

Non-destructive, rapid detection and removal of fly-larvae-infested olives saves money.

Olive-fly infestation decreases fruit yield, decreases the value of olive oil, makes it unsuitable for virgin oil production, and may result in the rejection of entire lots of olives for food consumption purposes. Detecting and removing infested olives before they are used in food or oil production improves fruit quality and saves growers and processors millions of dollars. ARS researchers in Albany, California, have developed a non-destructive method of using X-rays to rapidly detect infestation of olive-fly larvae on fruit in high-speed processing systems. Combined with near infrared spectroscopy, the two technologies allow real-time removal of infested olives from processing lines, and higher quality and marketability of American olive products. (Project No. 5325-44000-010-00D)

Determining peach and tomato maturity and quality with non-destructive light scattering.

Non-destructive light wavelengths can be used to assess the maturity of horticultural products and help producers deliver superior, consistent products to the market to meet or exceed consumer expectations. ARS researchers in East Lansing, Michigan, measured the spectral-scattering of peaches and tomatoes harvested at different maturities. These data were combined with destructive measurements of maturity (color, firmness, and soluble solids content) to develop calibration models that predict maturity and quality grades. Good predictions (around 90%) of firmness and soluble solids content were achieved for these fruits. (Project No. 3635-43640-001-00D)

The environment selectively affects sorghum quality factors.

Sorghum, the ancient, gluten-free grain, is known for its dietary health benefits in combating cancer, diabetes, and cholesterol. It consists of starches, proteins, and fats, which along with grain hardness, influences the products that can be produced from it. ARS researchers in Manhattan, Kansas, along with collaborators at Texas A&M University, discovered that sorghum protein content and quality were more influenced by genetics; whereas kernel hardness, starch content, starch graininess, and fat content were influenced by the environment. This research will help identify grain quality traits that can be iNP. (Project No. 5430-44000-023-00D)



ANIMAL PRODUCTION AND PROTECTION

National Programs:

- **Animal Health, NP 103**
- **Food Animal Production, NP 101**
- **Aquaculture, NP 106**
- **Veterinary, Medical, and Urban Entomology, NP 104**

Cytokines as an alternative to antibiotics to prevent and combat infectious disease.

The use of cytokines, small proteins that are important in cell signaling and that affect the behavior of other cells, to stimulate the immune system as alternatives to antibiotics is a promising area for biotherapeutic use to prevent and combat infectious disease. ARS scientists in Ames, Iowa, investigated the potential value of using the granulocyte colony stimulating factor (G-CSF) as a potential alternative to antibiotics in food animal production for controlling pathogenic bacteria in which neutrophils (white blood cells that are the first line of defense against bacterial infections) can provide protection. G-CSF enhances the production and release of neutrophils from bone marrow and is already licensed for use in humans. A limitation of cytokines is their short half-life, which may limit their usefulness as a one-time injectable in production animal medicine. The scientists found that the administration of recombinant G-CSF induced a transient increase in neutrophils (neutrophilia) in pigs, however, delivery of porcine G-CSF inserted in a replication defective adenovirus (Ad5) vector significantly increased the effect of neutrophilia. Pigs given one injection of the Ad5-G-CSF had a neutrophilia that peaked between 3 to 11 days post-treatment and neutrophil counts remained elevated for more than 2 weeks. Neutrophils from Ad5-G-CSF treated pigs were fully functional based on laboratory tests, demonstrating that G-CSF may be an effective alternative to antibiotics for treating bacterial pathogens susceptible to neutrophils. (Project No. 3625-32000-108-00D)

Vaccinating against intestinal parasites.

Controlling parasites in production animals is difficult because parasites produce proteins that alter and suppress the host's immune responses, which improves the odds for parasite's survival. ARS scientists in Beltsville, Maryland, used a recombinant protein against the parasite *Ostertagia* to vaccinate a group of animals which then developed a high degree of protection against parasite infection and damage. Future studies on larger number of animals are being planned, and additional potential vaccine candidates have also been identified. Since some medications are becoming increasingly ineffective at controlling parasites, developing vaccines will provide producers with another option for protecting livestock health. (Project No.1245-32000-096-00D)

Amino acid changes in a viral protein determine the evolution of swine influenza A H3N2 viruses.

Swine influenza A virus is an endemic and economically important pathogen in pigs with the potential to infect other host species, including humans. Pigs may also become infected with human influenza A viruses. The viral hemagglutinin (HA) protein binds viruses to cells and is the primary target of protective immune responses and the major component in swine influenza A vaccines. However, as a result of genetic mutations known as antigenic drift, vaccine virus strains must be regularly updated to reflect currently circulating strains. Characterizing how different virus strains in pigs are to the seasonal influenza virus strains in humans is important in assessing the relative risk of interspecies transmission. ARS scientists in Ames, Iowa, found that two primary swine influenza virus strains are currently circulating in the U.S. pig population, but with enough diversity between the HA proteins to suggest updates in vaccine strains are needed. The scientists identified specific changes in the HA protein that are likely responsible for differences between the two viruses. The differences between current seasonal influenza H3N2 strains in humans and those endemic in swine is enough that population immunity is unlikely to prevent the introduction of human viruses into pigs and vice versa, reinforcing the need to continuously monitor and prepare for influenza A viruses in both species. (Project No. 3625-32000-108-00D)

Potential virulence factor of Asian highly pathogenic porcine reproductive and respiratory syndrome virus.

Asian highly pathogenic porcine reproductive and respiratory syndrome virus (HP-PRRSV) is not currently known to infect U.S. livestock, but it nevertheless poses a serious potential threat to the nation's swine and agricultural economy. HP-PRRSV causes more severe disease than PRRSV strains circulating in the United States, but it is not known why. ARS scientists in Ames, Iowa, in collaboration with scientists at the University of Denver, examined the activity of a small part of a viral protein called a protease, which is an enzyme that breaks down proteins. The scientists found that the HP-PRRSV region of this protease was 40 times more capable of breaking apart specific types of a cellular protein called ubiquitin than a U.S. strain of PRRSV that causes only mild disease in pigs. Ubiquitin has been implicated in the regulation of many cellular processes, including immune response controls. The actions of this small part of the viral protein of HP-PRRSV may correlate with the increased disease and may serve as a target in vaccine development. (Project No. 3625-32000-108-00D)

Virulence genes associated with *Haemophilus parasuis* infection.

Haemophilus parasuis causes Glasser's disease in pigs, and results in chronic debilitation and death. There is currently no effective vaccine for the disease, which costs the swine industry millions annually. ARS scientists in Ames, Iowa, who had previously identified 10 strains of *H. parasuis* with differing levels of virulence, recently sequenced these 10 strains and identified genes in some strains that may be associated with virulence and disease. These discoveries can help support the development of vaccines that may be effective against this costly pathogen. (Project No. 3625-32000109-00D)

Improving the reproductively competent pool of females in swine.

Although significant advancements have been made in swine production, better reproduction processes, specifically the identification of newborn females that will be reproductively competent in adulthood, have lagged behind. Previous reports have indicated that a newborn piglet's environment can affect its growth, body composition, and reproductive potential as an adult female pig. In an experiment funded by the National Pork Board, ARS scientists in Clay Center, Nebraska, in collaboration with scientists at Iowa State University and Murphy Brown LLC, identified three criteria that collectively could be used to determine a delay in puberty, increased puberty failure, and detrimental changes in the uterus. Incorporation of measurements for these criteria in the production setting could be used for early selection of female pigs destined for the breeding herd. (Project No. 5438-31000-091-00D)

Defining genetic determinants to select for superior resistance to Marek's disease in poultry.

Marek's disease is an extremely contagious viral disease that is capable of causing major losses of chicken, one of the largest agricultural animal commodities in the United States. The disease is currently controlled through vaccines and biosecurity, but enhancing genetic resistance to it would be a more effective mode of disease control. ARS scientists in East Lansing, Michigan, in collaboration with scientists at Purdue University,

demonstrated that a subset of previously identified genetic markers of Marek's disease. Measuring the marker-gene association had higher accuracy (61 percent improvement) in identifying birds with superior genetic resistance compared with current state-of-the-art methods. If confirmed in commercial poultry lines, this approach could efficiently select for elite, healthy poultry to generate more economical poultry products for U.S. producers and consumers. The model may also have application in addressing genetic resistance to other infectious pathogens. (Project No. 3635-31320-009-00D)

A much more productive wool ewe.

Maximizing the number of successful pregnancies and the live birth of healthy offspring is important for sheep farmers. Over a lifetime, ewes that lamb for the first time at 1 year of age are more productive than ewes that lamb for the first time at age 2, but wool producers are reluctant to adopt this strategy because of the low rate of pregnancy in wool-type ewes younger than 1 year. ARS researchers in Dubois, Idaho, with cooperators at Virginia Tech University, developed a genetic-based measurement to establish the rate of pregnancy in a wool breed and identified rams with specific genetic backgrounds that yield a greater number of daughters that lambed as 1-year-olds compared with the flock average. These measurements will enable wool sheep producers to select specific rams for breeding and improve overall production efficiency by the gain of an additional year of productivity in a greater number of ewes. (Project No. 5364-31000011-00D)

The sheep genome illuminates the biology of the rumen.

Sheep (*Ovis aries*), which are a major source of meat, milk, and fiber (wool), have a specialized digestive organ called the rumen that carries out the initial digestion of plant material. An ARS scientist in Pullman, Washington, participated in the International Sheep Genomics Consortium that included participants from a number of laboratories from around the world. The consortium assembled the sheep genome for the first time and used a large amount of gene expression data from 40 different tissues to show where different genes are located on the chromosomes and where these genes are active. This information was used to investigate several unique *Ovis aries* traits, including assessing how sheep process low quality forage into high-quality animal protein. The project provides a reference sheep genome assembly that will form the basis of future research into all aspects of sheep biology, including susceptibility to infectious disease, which will benefit U.S. sheep producers. (Project No. 5348-32000-031-00D)

First validated genetic marker test for post-infection control of ovine progressive pneumonia virus.

Ovine progressive pneumonia virus is a small ruminant virus that causes long-term and progressively worsening pneumonia and mastitis in domestic sheep. Some sheep have genetic traits that provide protection from more serious infections, but no tests have been available to identify animals with this more robust immune response. ARS scientists in Pullman, Washington, and Dubois, Idaho, in collaboration with Washington State University, demonstrated that sheep with two copies of a small deletion near the ZNF389 gene were able to control viral replication, which lessened the severity of their infection. This result was observed in multiple sheep flocks under widely differing management and viral load conditions and is the first validated genetic marker test for postinfection control of ovine progressive pneumonia virus. Results from this study will help animal breeders develop varieties of sheep that are more resilient to viral infection. (Project No. 534832000-031-00D) 348-32000-031-00D)

Selection to reduce ovine progressive pneumonia.

Ovine progressive pneumonia, a viral disease, is one of the most costly sheep diseases in North America and management schemes to minimize and eliminate the prevalence of this disease are labor-intensive and expensive. ARS researchers in Clay Center, Nebraska, demonstrated that sheep with an unfavorable form of the gene associated with susceptibility to ovine progressive pneumonia had a much higher rate of infection compared with sheep that lacked that form of the gene. The scientists developed technology to identify animals with the high-risk gene so that sheep producers can now selectively breed and generate flocks that are genetically less susceptible to ovine progressive pneumonia. This should enhance the health of sheep flocks and increase economic profits for producers. (Project No. 5438-31000-09000D)

Old tool finds new use in reducing nitrogen emissions from dairy farms.

Nitrogen is a key component of protein in the diet ration for dairy cattle. Maximum absorption of protein in the gut is crucial to avoiding the excretion of excessive nitrogen-containing compounds that may constitute greenhouse gases, affect air quality, and ultimately, human health and natural ecosystems. ARS scientists in Madison, Wisconsin, studied the use of milk urea nitrogen, a common tool applied to monitor feed efficiency in dairy herds, to evaluate the relationships between the amount of protein fed to lactating cows, nitrogen compounds in milk, and excreted nitrogen on dairy farms. A high correlation was found between milk urea nitrogen values and excreted nitrogen values. The findings demonstrated that monitoring of milk urea nitrogen on dairy farms can be used to optimize protein use in dietary rations that will reduce feed costs for dairy cows and negative effects to the environment. (Project No. 3655-31000-023-00D)

Yeast supplementation improves the well-being of stressed calves.

Management livestock management practices do not always provide optimal protection from disease. One of the most stressful times in the life cycle of a calf is removal from its mother and shipment to a feedlot where it mingles with other unfamiliar calves, and the resulting stress increases the incidence of disease. Identification of feed supplements to ensure health, growth, and overall well-being is of benefit to livestock producers. ARS scientists in Lubbock, Texas, with colleagues at the University of Nebraska, determined that feeding a yeast supplement to calves that fail to grow or develop normally as a consequence of disease improved both the calves' health and growth. Yeast may prove to be a beneficial, antibiotic free supplement for the livestock industry to manage calves with the highest risk for becoming ill. (Project No. 6208-32000-007-00D)

Feeding a by-product of ethanol to cattle maintains nutrient value and reduces production cost.

Dietary fiber in diets given to cattle in feedlots promotes good digestion; however, fiber is the costly portion of the diet. ARS researchers in Clay Center, Nebraska, determined that adding an ethanol by-product, wet distillers grains with solubles, and reducing the amount of fiber before cattle go to market, increases the retention of nutrients. These studies demonstrate that wet distillers grains with solubles can be used to reduce the cost of feed and production expenses, and improves the types of nutrients available to cattle. (Project No.5438-31000-092-00D)

Improved computer-assisted modeling of genetic traits to enhance milk production efficiency.

Milk production, one of the largest agricultural animal-based commodities in the United States, is dependent on successful pregnancies and calving. Fertility rates in Holstein cattle, the primary dairy breed in the United States, had been declining until recently; this has increased the cost of milk. To improve the prediction of fertility in dairy cattle, ARS scientists in Beltsville, Maryland, have developed computer models from extensive data sets going back to the 1960s that go beyond the previous single-trait, single-breed model to incorporate multiple traits, multiple breeds, inclusive of crossbreds and purebreds, and environment to more accurately predict the effect of genetic backgrounds associated with fertility. The new model correlated well with the previous model for Holsteins. Data were combined and implemented by ARS and the Council on Dairy Cattle Breeding in December 2013 to improve genetic evaluations for fertility. The past model reversed the fertility drop, and the inclusion of the new model is expected to improve the accuracy of predictions of genetic merit for fertility traits and allow breeders to make faster progress. (Project No. 1245 -3100-101-00D)

Identification of biomarkers for early diagnosis of *Mycobacterium bovis*.

Mycobacterium bovis is the primary pathogen that causes bovine tuberculosis in cattle, a disease that can also be transmitted to humans. Though a program to eradicate bovine tuberculosis began in 1917, eradication efforts are still continuing. Diagnosing bovine tuberculosis remains problematic, especially in the early stages of the disease, but recent work by ARS scientists in Ames, Iowa, resulted in the identification of several potential biomarkers in the blood of infected cattle that may enable more accurate diagnosis. The development of effective blood tests for bovine tuberculosis will make disease detection easier and may support its eventual eradication. (Project No.3625-32000-10400D)

Mutations conferring heat tolerance in cattle identified.

With global climate change and increasing demands for animal protein worldwide, there is a need to understand and accelerate the adaptation of agricultural animals to the environment. Cattle breeds in subtropical and tropical regions maintain a stable internal deep body temperature that is indicative of a genetic predisposition toward heat tolerance, however, variations in heat tolerance are evident among different tropical breeds. ARS scientists in Beltsville, Maryland, in collaboration with scientists at U.S. and foreign universities, identified distinct mutations in genes regulating skin formation, hair growth, and cooler body temperature that are inherited in heat-tolerant breeds. Results from the study are being used by producers to guide future breeding decisions, and by researchers to better understand the biological processes involved in adaptation to climate change. (Project No. 1245 -3100-104-00D)

Enhancement of the beef carcass grading camera system to predict meat tenderness.

Variation in the tenderness of beef results in consumer dissatisfaction; therefore, companies want technology to identify carcasses that excel in tenderness. ARS scientists in Clay Center, Nebraska, worked with the instrument manufacturer and the beef industry to develop a robust regression equation for the system, which has obtained approval from USDA's Agricultural Marketing Service to predict tenderness at the time of beef carcass grading. The technology gives the beef industry a way to measure USDA quality grade, yield based on grade, and tenderness with the same instrument; application has been instituted in one packing plant, and other plants are considering it. This new system is expected to offer consumers a better way to select higher-quality meat. (Project No. 543831430-005-00D)

New processing method to improve nutritional value of ethanol production co-products.

The primary method for producing fuel ethanol from grains results in a co-product known as distiller's dried grains with solubles (DDGS), which is a low-value ingredient for animal feeds. The standard method results in distiller's grains of high fiber and low protein digestibility, and only a single product being produced. These problems reduce the total revenue from ethanol production and limit the use of the co-product in animal feeds. To improve the value of this co-product, ARS scientists in Aberdeen, Idaho, determined the fate of many nutrients during traditional processing and devised a new method to recover multiple co-products, including a high-protein feed ingredient, a high-ash fraction for mineral supplementation, an oil fraction, and a glycerol fraction. Greater value of co-products from ethanol production increases the value generated by using renewable energy and provides valuable nutrients for animal production. (Project No. 366-21310-004-00D)

Development of a vaccination platform to protect catfish against *Enteric septicemia*. *Enteric septicemia* is the most devastating disease affecting the catfish industry. The development of a new vaccine and feed-based delivery platform has resulted in providing exceptional protection against enteric septicemia of catfish with dramatic increases in production efficiency and economic returns. Mississippi State University scientists working in collaboration with ARS scientists developed a mechanized vaccine delivery system that consistently delivered target-immunizing doses in experimental pond trials. The vaccine delivery system was used in commercial field trials during the 2013 production season with excellent results; 2014 production season trials are ongoing. This vaccine will support catfish producers in efforts to control diseases and manage production costs. (Project No. 6402-31320-002-00D)

Effective vaccine candidates to prevent *Aeromonas* disease in catfish. From 2009 to the present, outbreaks of motile aeromonad septicemia (MAS) in market-size catfish have occurred in western Alabama and eastern Mississippi with losses estimated to be greater than \$12 million. Currently, there are no methods available, such as vaccination, to prevent MAS, but they are urgently needed. ARS scientists in Auburn, Alabama, identified secreted extracellular proteins of the bacterium that trigger protective immune responses. Their results show that catfish immunized with the extracellular proteins are resistant to infection and that this immunity persisted for at least 7 weeks. This research provides the foundation for developing an effective vaccine to prevent MAS disease and may help catfish producers contain production losses. Project No. 6420-32000-024-00D)

Improvement of catfish growth.

Producers and processors of farm-raised catfish would like to improve catfish growth. ARS scientists at the Warmwater Aquaculture Research Unit in Stoneville, Mississippi, have conducted a selective breeding program over several catfish generations to improve this trait, and showed that catfish in the breeding program were more than 25 percent larger at harvest than catfish that were not in the breeding program. These efforts are part of a long-term breeding program to improve channel catfish germplasm for release to the United States catfish industry. (Project No. 6402-31000-009-00D)

Method to produce a protein concentrate from barley is commercialized for aquaculture.

Feeds costs are a significant production item in commercial aquaculture. Barley that is too high in protein to be used for malting has the potential to be developed as a protein-based fish feed. A method was developed and patented by ARS scientists in Aberdeen, Idaho, for producing a protein concentrate that can be incorporated into aquaculture feeds. Feeding studies with rainbow trout and Atlantic salmon demonstrated the concentrate is highly digestible and supports rapid fish growth, reducing the need for more expensive ingredients such as fishmeal. A pilot plant for barley concentrate production has been built and is delivering the product to commercial farms in Idaho. Two more plants are in development. (Project No. 5366-21310-004-00D)

The development of a new tool to speed genetic improvement in rainbow trout. Technology to use genomic information for improving selective breeding in dairy cattle and poultry has not yet been developed for rainbow trout. ARS researchers at the National Center for Cool and Cold Water Aquaculture in Leetown, West Virginia, worked with international partners to develop a commercially available genetic marker tool (SNP chip) for rainbow trout. By incorporating genome information, this tool improves performance prediction accuracy for individual fish versus traditional family-based estimates. Commercial producers will find this information useful and it will likely accelerate genetic improvements in trout. (Project No. 1930-31000-009-00D)

Atlantic salmon evaluated and selected for multiple traits.

Commercial salmon producers in the United States use stocks that are not many generations removed from wild, unselected stocks. Because salmon are an endangered species, producers are legally required to culture certified stocks of North American salmon. ARS researchers at the National Cold Water Marine Aquaculture Center in Franklin, Maine, in collaboration with industry, generated a broodstock of fish with North American origin and compared the growth of 4-year classes of salmon from their breeding program with a control line of fish in commercial sea cages. Salmon that were selected for greater growth, resistance to sea lice, and better fillet color, averaged approximately 90 percent larger than the control fish. Using improved salmon germplasm is increasing the cost-effectiveness, profitability, and sustainability of cold water marine aquaculture in the United States and providing a quality seafood product to consumers. (Project No. 1915-31000-003000D)

Scaling up recirculating aquaculture systems for Atlantic salmon.

Although production of Atlantic salmon in land-based recirculating water systems offers an environmentally sustainable approach to meeting domestic demands for seafood, some offflavors can develop in such systems, and harvest strategies must be developed that ensure the product quality that consumers expect. Researchers at the Conservation Fund's Freshwater Institute in Shepherdstown, West Virginia, working with an ARS researcher in Oxford, Mississippi, determined that concerns about off-flavor in 4-kg Atlantic salmon can be eliminated with a purging step in which fish are transferred to tank systems pre-disinfected with hydrogen peroxide and that do not contain hard-to-clean locations, such as aeration media, during the final 6-10 days of fish rearing. Compounds associated with off-flavor were consistently reduced to levels that are below human tasting limits. These standard operating practices maximize product quality for Atlantic salmon and other species that have been cultured in water recirculating systems. (Project No. 193031320-001-00D and 6408-41000-009-00D)

Improving water quality and lowering the price of diets for hybrid striped bass.

Temperature and ammonia levels (ammonia is a waste product secreted by fish) often increase dramatically in ponds during summer production of hybrid striped bass in the southern United States. Extended periods of high ammonia result in fish stress, disease, mortality, and significant loss of feeding days as producers attempt to

reduce ammonia to manageable levels by reducing feeding or using lower protein diets. Along with participants from the Trout-Grains Project, ARS scientists in Stuttgart, Arkansas, and Hagerman, Idaho; and U.S. Fish and Wildlife Service scientists in Bozeman, Montana, demonstrated better growth and nutrient retention by hybrid striped bass fed a 35 percent protein diet supplemented with limiting amino acids compared with fish fed a higher protein diet. Overall protein levels were decreased, whereas dietary nutrient retention increased, thereby lowering feed costs to producers and reducing negative environmental effects on water quality. (Project No. 6225-31630-06-00D)

Minimal impacts of oyster aquaculture to eelgrass at the landscape scale.

Submerged aquatic vegetation such as eelgrass provides valuable habitat for fish and invertebrates in estuaries, particularly for juvenile salmon on the west coast of the United States. ARS researchers in Newport, Oregon, used layers of geographic information on tidal heights, cumulative wave stress, salinity, distance to the river mouth, and distance to the nearest channel to quantify the distributions of eelgrass and bivalve aquaculture in Willapa Bay, Washington. The effect of bivalve aquaculture on eelgrass at the landscape scale was measured over a period of 5 years. Although oyster harvest methods had demonstrable effects on eelgrass over time at the individual bed scale, oyster aquaculture reduced eelgrass cover by less than 1 percent in any given year over the entire estuary. This information promotes sustainable shellfish culture and is enabling managers and regulators to evaluate the potential effects of existing and expanded oyster aquaculture on estuarine habitat. (Project No. 5358-63000-003-00D)

Mosquitoes can “taste” repellents such as DEET.

Mosquitoes transmit a variety of human pathogens, including the malaria parasite and the viruses that cause yellow fever, Dengue fever, and West Nile virus. Understanding more about why particular substances attract or repel mosquitoes could help identify new chemicals that alter mosquito behavior. ARS scientists in Beltsville, Maryland, discovered a taste receptor on the mouthparts of the yellow fever mosquito that is sensitive to the insect repellent DEET and were able to identify the specific hairs at the tip of the mosquito’s mouthparts responsible for repellent detection. This fundamental research finding provides a new method for screening and identifying novel chemicals and repellents that disrupt mosquito feeding behavior, which in turn could reduce the frequency with which mosquitoes transmit pathogens that cause human illness. (Project No.1245-32000-007-00D)

U.S. mosquitoes to transmit Rift Valley fever virus.

Rift Valley fever is a potentially fatal viral disease that infects humans and is transmitted by mosquitoes. The virus can also negatively impact livestock health. Though largely restricted to the African continent, experts are concerned that the Rift Valley virus could be introduced and established in the United States. In laboratory studies, ARS scientists in Gainesville, Florida, evaluated eight species of mosquitoes commonly found in the United States for their ability to transmit the Rift Valley fever virus. They found that some species of mosquitoes have a greater ability to transmit the virus than other species, a finding that has a direct impact on the risk assessment of disease transmission to humans and livestock. These results will allow mosquito control assets to target the mosquito species most likely to be involved in disease transmission if Rift valley fever is ever found in the United States. (Project No.6615-32000-045-00D)

Development of a Rift Valley fever virus challenge model to evaluate vaccines in sheep and goats.

Rift Valley fever virus (RVFV) is transmitted by mosquitoes and causes severe to fatal disease in ruminants and humans which can be preventable by vaccination. Ruminants are known to amplify RVFV and are a potential source of infection for humans. Availability of a challenge model is a pre-requisite for vaccine efficacy trials. Several modes of inoculation were tested by ARS scientists in Manhattan, Kansas, in collaboration with scientists with the Canadian Food Inspection Agency. Differences in development of infections in sheep and goats were observed between animals inoculated with RVFV produced in mosquito cells compared to mammalian cells. Only RVFV produced in mosquito cells led to development of virus in the blood (viremia) in all inoculated animals. The insect cell produced RVFV appeared to be more infectious with earlier onset of viremia, especially in sheep, and may also more closely represent a field situation. These findings were used to develop a challenge

protocol suitable for evaluating the efficacy of RVF vaccines in sheep and goats. (Project No. 5430-32000-00500D)

Improved uniforms to protect U.S. military personnel from mosquitoes.

Throughout much of the world, mosquitoes transmit a wide variety of disease causing agents. U.S. deployed military personnel must rely upon synthetic insecticide sprays to kill blood feeding pests, and/or topical repellents for personal protection. ARS scientists in Gainesville, Florida, are working with the Department of Defense to test the useful life of U.S. Marine Corp and Navy military uniforms impregnated with the insecticide permethrin. The scientists demonstrated that after 50 washings, the treated uniforms still retained their ability to repel biting mosquitoes. This information is essential to protecting U.S. deployed troops from arthropod-borne diseases. (Project No.6615-32000045-00D)

Occurrence of cattle fever ticks in white-tailed deer.

Texas cattle fever is a devastating protozoan disease of domestic cattle transmitted by certain types of ticks, termed cattle fever ticks. By 1961, an eradication effort effectively eliminated the ticks and the disease causing pathogen from Texas and the southeastern United States, though a quarantine area along the Texas-Mexico border that is still maintained by Federal personnel as part of the Cattle Fever Tick Eradication Program. Originally, the cattle tick and its parasite was thought to infest only cattle. However, recent evidence has shown that white-tailed deer can also serve as hosts for these ticks. ARS researchers in Kerrville, Texas, in collaboration with scientists from Northern Arizona University, examined the genetic relationships between ticks collected from cattle and ticks collected from deer. They found these ticks to be genetically similar, which explains why tick populations have persisted over time in the quarantine zone. Molecular techniques were also used to determine the invasive potential of ticks into major cattle producing areas in the United States. This information will be useful to scientists and government agencies charged with maintaining tick eradication quarantine areas and maintaining disease free zones in the United States. (Project No.6205-32000-034-00D)

Reducing the risk of indigenous ticks transmitting equine piroplasmiasis.

Equine piroplasmiasis was eradicated from the United States in the late 1980s. However, a recent outbreak in Texas caused significant economic loss to the equine industry and suggested that some ticks indigenous to the United States could play a role in transmission. ARS scientists in Pullman, Washington, in collaboration with Texas A&M University, collected and colonized ticks from horses at the Outbreak Ranch. The scientists demonstrated that these indigenous ticks were able to acquire and transmit the parasite to uninfected horses. These results confirm introduction of infected horses into the United States with competent indigenous vectors can result in dissemination of the parasite and thus disease to the nation's equine population. (Project No.5348-32000-034-00D)

Virus for fire ant control.

The southern United States has become home to the red imported fire ant, an aggressive and stinging invasive species whose presence costs over \$5 billion annually in livestock and crop losses, pest control, and medical treatment. ARS researchers in Gainesville, Florida, in cooperation with colleagues in Arizona, California, and Illinois, demonstrated that a newly-discovered ant virus only harms fire ants, and does not have a negative impact on other ants that are considered non-target organisms. This research will support the development of a new tool for fire ant control, which could significantly reduce the economic losses associated with the insect and help protect human and livestock health. (Project No.6615-32000-044-00D)

Genetics of screwworm control. Infestations with immature screwworms (maggots) devastated the United States livestock industry until a sterile male release technique eradicated screwworms in the 1960s. Sterile insect techniques are still currently used to prevent re-entry of screwworms into the United States. This method requires the mass production, sterilization, and release of millions of sterilized, adult males at a cost of millions of dollars, annually. ARS scientists in Kerrville, Texas, in collaboration with scientists at North Carolina State University, used genetic techniques to produce male only screwworms, making the rearing and release program more efficient and affordable. Maintaining an effective barrier against screwworms re-entering the United States ensures

benefits exceeding \$1.5 billion annually for North American livestock producers. (Project No.6205-32000-035-00D)

Rearing of immature screwworms.

The current sterile insect technique used to prevent the re-establishment of screwworms in North America requires the mass production of millions of screwworms. Immature screwworms are raised on maggot food that contains a cellulose fiber bulking agent, but the cellulose fiber additive increases the production of problematic ammonia in the facility. ARS scientists in Kerrville, Texas, and their collaborators in Panama found that ammonia emissions were reduced when the common chemical potassium permanganate was added to the immature screwworm diet. The potassium permanganate also acted as a beneficial anti-microbial agent, which eliminated the need for dietary formaldehyde additives that had been used to prevent bacterial contamination. Reduced ammonia levels in the mass-rearing facilities have improved working conditions for employees and have also improved screwworm quality. This research has resulted in a more cost-effective method of rearing screwworms, which ultimately increases the protection of livestock health and benefits U.S. livestock producers by preventing the re-introduction of this harmful insect pest. (Project No.6205-32000-035-00D)

Reliable molecular method to distinguish immature screwworms from other immature flies.

The screwworm is a devastating insect pest of cattle that has been successfully eradicated in the United States, and the rapid and reliable identification of screwworm larvae (maggots) is essential in preventing its reintroduction. However, it is very difficult to distinguish between the different species of fly maggots in their early stages of development. ARS scientists in Kerrville, Texas, collaborated with scientists in Lincoln, Nebraska, to develop a molecular technique for confirming the identity of screwworm maggots in the first few stages of their development. Using this technique, the researchers were able to distinguish between screwworm larvae and the larvae of other closely-related flies that often infest livestock wounds. This molecular approach provides important tools for the screwworm eradication and exclusion program when rapid identification and verification of suspicious larval samples is needed. The technique will eliminate the unnecessary treatment of outbreaks that are not linked to screwworms, which will save thousands of dollars each month. In the case of a real screwworm outbreak, the reliable identification will ensure a rapid response that contains and eliminates the potentially deadly pest and prevent millions of dollars in livestock production losses. The molecular technique developed by ARS scientists will ensure that United States and other North American livestock producers continue to reap the significant benefits (more than \$1.5 billion annually) resulting from screwworm eradication. (Project No.6205-32000-035-00D)

Identifying biting midges genes involved in feeding, reproduction and viral infection.

Certain types of biting midges (often referred to as “no-see-ums” or “punkies”) can transmit numerous viruses that cause disease in livestock and wildlife. One of the most serious infections is Bluetongue virus, which is a devastating disease of sheep, cattle, and goats. Because the virus can spread across international borders, U.S. cattle and sheep producers lose \$125 million annually from lost trade and expenses associated with certifying their animals are virus-free. ARS scientists in Manhattan, Kansas, in collaboration with the Clemson University Genomics Institute, have catalogued genes involved in midge feeding and reproduction and have identified genetic traits of virus-infected midges. This research contributes to developing new control strategies for biting midges, and to a better understanding of how to block virus transmissions from infected midges. The information generated by this research will be of value to scientists, livestock producers, and regulatory personnel interested in mitigating the impact of midge-borne diseases. (Project No.5430-32000-003-00D)



ENVIRONMENTAL STEWARDSHIP

National Programs:

- **Agricultural System Competitiveness and Sustainability, NP 216**
- **Water Availability and Watershed Management, NP 211**
- **Climate Change, Soils, and Emissions, NP 212**
- **Pasture, Forage and Rangeland Systems, NP 215**
- **Bio-refining, NP 213**
- **Agricultural and Industrial Products, NP 214**

Operational implementation of a global root zone soil moisture monitoring system.

Soil moisture is a key component of Earth's water cycle that is essential for plant life, affecting global energy flux, and influencing weather and climate. Monitoring the availability of soil moisture in the rooting zone is critical for forecasting variations in agricultural productivity which can affect global food prices and food availability. ARS scientists in Beltsville, Maryland, designed a system to globally estimate the availability of soil moisture in the rooting zone, and produced new worldwide soil moisture maps that reveal how the wetness of the land fluctuates seasonally and with changes in weather. These maps are being given to the public to support a wide range of agricultural and hydrologic applications, from advancing climate models and weather forecasts to improving flood warning systems. USDA Foreign Agricultural Service analysts implemented this system in April 2014 to improve their operational forecasts of global agricultural yield and productivity. These forecasts are critically important to commodity markets, and to decision-makers who must depend on crop production information to plan for disasters such as drought, which can lead to food deficits in countries that may require food assistance. (Project No. 1245-13610-028-00D)

Mitigating phosphorus loss to ensure the availability of safe drinking water.

The midwestern United States has some of the most productive agricultural soils in the world, but because of its climate much of this region would be unable to support agriculture without drainage; high water tables would both damage crops and prevent the access of machinery in the fields at critical times. While drainage is designed to remove excess water as quickly as possible, it can also provide a conduit for the rapid loss of agrochemicals, particularly phosphorus that can subsequently degrade the quality of key drinking water supplies. ARS scientists in West Lafayette, Indiana, used a combination of field and modeling investigations to provide information on how to mitigate phosphorus losses from tile drained croplands in conservation tillage. As researchers, policy-makers, and farmers search for ways to reduce phosphorus loadings to surface waters such as Lake Erie, these studies highlight the importance of treating both surface runoff and tile drainage to minimize harmful algal blooms. (Project No. 3604-13000-011-00D)

Publication of a 50+ year data record for the Upper Washita River Watershed.

Sustainable agricultural systems can vary significantly because the combined factors of weather, water, topography, soils, vegetation, space, and time differ from site to site and in turn significantly affect management decisions. Nevertheless, site-specific, long-term studies can help producers develop general principles to manage sustainable systems and anticipate the risks and possible outcomes of various scenarios associated with climate changes, market swings, and policy shifts. ARS researchers in El Reno, Oklahoma, with their collaborators from the U.S. Geological Survey and USDA Natural Resources Conservation Service, published a collection of data and research papers describing long-term research (1961 to present) in Oklahoma's Upper Washita River basin. This living history of research is presented to encourage scientists from different institutions and disciplines to collaborate on studies of complex, interactive processes and systems. These processes and systems include increasing resilience to current and future climate pressures; watershed-scale studies on contaminant sources, fates, and transport; hydrologic cycles, including their links through space and time; and developing decision-making protocols that consider how individual farm management can affect watershed-scale outcomes, and vice versa. As climate patterns shift, information from this long-term study will help producers in similar regions develop more cost-effective management decisions for optimizing water use and maximizing crop production. (Project No. 6218-1300011-00D)

U.S. grassland mortality increased following early 21st-century drought.

In order to manage current and future rangelands effectively, ranchers and land managers in the southwest United States need information about how shifting climate patterns affect the establishment and growth of vegetation in a healthy ecosystem. ARS researchers in Tucson, Arizona, conducted a site study in six USDA experimental grasslands in Arizona, Colorado, New Mexico, Oklahoma, and Utah that measured surface soil moisture and precipitation and compared these measurements with satellite estimates of above-ground plant production. In this study—the first report of how U.S. grasslands may respond to the regional drying and warming predicted with climate change—the researchers found that the early 21st-century drought was followed by a drastic decline in grassland growth, and that native grasses were displaced by less-nutritious and more fire-prone invasive grasses. These findings suggest that changing vegetation patterns can serve as an early indicator of climate change and provide ranchers with new information for managing grasslands to lower fire risk, minimize forage loss, and protect ecosystems in the face of climate change. These regional-scale field studies can significantly support future grassland research, management, and policy and help identify cost-effective decisions that protect rangeland ecosystems for livestock production and recreation. (Project No. 5342-13610-011-00D)

A new model, iSnobal, for managing snowmelt in the western United States.

Water supplies from western mountainous watersheds are in extremely high demand for agricultural production, clean electricity, and domestic uses. To optimize water supply management, traditional methods of stream flow forecasting must be improved. ARS scientists in Boise, Idaho, developed a new more sophisticated model, iSnobal, which goes beyond simple empirical relationships, but has not been used for management purposes due to its high computational demands and the expertise required to simulate snow accumulation and melt patterns over large areas. Over the past year, ARS scientists successfully integrated the iSnobal model into the U.S. Bureau of Reclamation's forecasting procedures for the 2,500 square mile Boise River Basin in Idaho. Also, weekly updates of snow cover density over a large region of the southern Sierra Nevada Mountains are now being provided for NASA's Alpine Snow Observatory program. This represents a major change in the commitment of western water managers toward using more sophisticated process-based modeling in their future river forecasting programs. (Project No. 5362-13610-010-00D)

Controlling atrazine losses in agricultural watersheds underlain by restrictive layer (clay pan) soils.

Atrazine is one of the most prevalent soil applied herbicides used in corn cultivation. Its widespread use has led to significant contamination of surface and ground water resources across the U.S. Corn Belt. Restricted layer (clay pan) soils in northeastern Missouri are particularly vulnerable to the transport of both soil and atrazine in surface runoff. To find ways of controlling atrazine losses in these landscapes, a team of ARS scientists in Columbia Missouri, assembled 15 years of data from the 28 square mile Goodwater Creek Experimental Watershed. Researchers from this team isolated and confirmed the identity of an atrazine degrading compound

(DIBOA-Glc) from eastern gamagrass that could lead to the development of a commercial product to enhance atrazine degradation in soils. The team also found that a commercially available tillage implement (a rotary harrow) substantially reduced atrazine loss, but did not significantly increase erosion compared to no-till. This research provides key information on atrazine movement, particularly in restricted drainage soils, thus providing mechanisms to help farmers both enhance atrazine degradation and prevent its loss in runoff, while simultaneously maintaining the erosion control benefits of reduced tillage. These findings have the potential to greatly improve the region's most persistent water quality problems, improving the sustainability of crop production while maintaining or increasing farmer profitability. (Project No. 3622-12130-005-00D)

Elevated carbon dioxide (CO₂) further lengthens growing season under warming conditions.

Rangeland forage levels are changing because of climate warming, and more information is needed about these dynamics so that management practices can be adjusted appropriately. In collaboration with Colorado State University researchers, ARS scientists in Fort Collins, Colorado, used a Free-Air CO₂ Enrichment (FACE) system to study how elevated carbon dioxide (CO₂) and temperature affected the growing season for temperate grasses. FACE uses outdoor heaters and pipes in experimental fields to elevate air temperature and CO₂ levels. Warming led to a longer growing season, because leaves emerged earlier in some plants and other plants died later in the season. Elevated CO₂ levels also reduced plant water demand—a response that extended the growing season, but did not change the reproductive season—which in turn increased plant life span. These results will improve the accuracy of models used to simulate plant growth and watershed changes under current and projected elevated CO₂ concentrations and warming. The improved models, in turn, will help producers, rangeland managers, and others to generate appropriate management practices that incorporate ecosystem shifts associated with climate change. (Project No. 5402-13660-008-00D)

Cropping system impacts on nutrient concentrations in soil water.

When fertilizers are applied to Midwestern row crops, some of the phosphorus and nitrate is lost from the soil and pollutes nearby waterways. Sometimes these nutrients are eventually transported to large estuaries or lakes, where they help create oxygen-deficient “dead zones,” so their loss from fields has both environmental and economic costs. Since nitrate losses beneath perennial crops such as alfalfa are known to be small, an ARS scientist in Ames, Iowa conducted an investigation to see if nutrient losses associated with annual row crops in the Midwest could be reduced through changes in cropping systems. The scientist collaborated with Iowa State University researchers in an 8-year study to compare nutrient concentrations in soil water beneath different cropping rotations. Their results indicated that growing alfalfa and corn (an annual crop) in rotation can reduce phosphorus losses, and that 4-year rotations are the most feasible management option for farms that integrate crop and livestock production. These findings, which can be used to help moderate nitrogen and phosphorus losses from crop fields and optimize management practices, will benefit agricultural and conservation communities alike. (Project No. 3625-13000-01000D)

Multiple combined best management practices reduce sediments and increase lake water clarity.

As ARS scientists in Oxford, Mississippi, identify agricultural best management practices (BMPs) that improve water quality, they need to determine how effective these practices are within an entire watershed. To answer these questions, they conducted a study that measured water clarity, total suspended sediment, and total dissolved solids in Beasley Lake—a Conservation Evaluation Assessment Project watershed in the Mississippi Delta—from 1996 to 2009. Their results indicated that a variety of BMPs in the watershed over the 14-year project resulted in improved water clarity and reduced levels of suspended sediments and dissolved solids, most notably during the spring. All helped to regenerate a healthy and sustainable lake ecosystem. These findings will guide regulatory agencies, farming stakeholders, and other groups in selecting effective conservation practices that improve and sustain lake and floodplain water quality and enhance the overall environment. (Project No. 640813660-007-00D)

Climate impacts on agricultural crops assessed for the Midwest.

Regional baseline assessments of crop vulnerability to regional climate changes are needed to provide a foundation for developing adaptation strategies. As part of the Midwest Climate Change Hub activities hosted by

ARS in Ames, Iowa, climate impacts on annual grain crops, specialty crops, and perennial crops were evaluated across the Midwest. Soil water availability was found to be the most significant factor affecting production in the Midwest. Additionally, the findings showed that within season weather effects on annual production depend on when stress is imposed. Corn and soybean are more tolerant of stress conditions during the vegetative stage than the reproductive stage. Vegetables are affected throughout their growth cycle by weather variations that affect insect pest populations and plant diseases. Perennial crops are affected early in the growing season by below normal temperatures, and late in the growing season by temperature and water stress. These findings indicate that practices that increase soil water storage capacity can help cropping systems become more resilient to climate-related variables during the growing season, and provide guidance for strategies to develop climate smart crop varieties and management systems. (Project No.3625-11610-001-00D)

Determination of the “upper lethal growing season average air temperature” for wheat.

Adapting wheat production to conditions associated with climate change will require determining how higher air temperatures affect wheat and incorporating this knowledge into growth models. ARS scientists in Maricopa, Arizona, in collaboration with scientists at the University of Arizona in Tucson, conducted a “Hot Serial Cereal Experiment.” On six planting dates for the experimental wheat crops, infrared heaters were deployed above some of the plots to provide additional warming. Results showed that yields decreased as season average air temperatures increased above 15°C, and that crops failed once temperatures reached 32°C. These results provide much needed information on the environmental limits for wheat production and will serve as a benchmark for researchers developing new varieties and new management strategies for adapting wheat to the higher air temperature resulting from global change. This research also provides more realistic projections of future climate change effects on wheat, and data for the Agricultural Modeling Intercomparison and Improvement Project. (Project No. 5347-11000-01000D)

Corn stover harvest effects on nutrient concentrations in central Iowa.

Proponents of cellulosic biofuel need to understand how soil nutrient levels will be affected by removing corn stover for use as feedstock for cellulosic biofuel. More than 500 site-years of corn plant samples were collected by ARS scientists in Ames, Iowa, who divided plant samples into different parts (stems, leaves, and grain). All samples were analyzed to determine nutrient concentrations. The results showed that compared to harvesting only the grain, harvesting corn stover increased nitrogen, phosphorus, and potassium loss by 14, 1.4, and 16 pounds per ton, respectively. The losses of nitrogen and phosphorus are not considered enough to change current nitrogen and phosphorus fertilization practices for stover harvest rates of one ton/acre. However, the potassium loss is sufficiently high to warrant routine soil testing and plant analysis to monitor available potassium levels. This information provides guidelines for the acquisition of sufficient feedstock supplies to operate emerging cellulosic biofuel investments in a sustainable manner. (Project No.3625-12000-013-00D)

Conservation farming mitigates erosion impacts from extreme rainfall events.

Although conservation farming practices have substantially reduced erosion and sediment loss, these benefits may be threatened by more frequent high intensity rainfall events. ARS scientists in Tifton, Georgia, evaluated runoff and sediment loss from conventionally tilled (CT) and conservation strip tilled (ST) fields in a Southern Atlantic Coastal Plain landscape during a 10 year rotational cotton peanut production with a rye winter cover crop. Over the 10 years, the mean annual amount of solid material transported by runoff was 87 percent higher in CT fields than in ST fields. Total runoff from ST fields was 41 percent less than total runoff from the CT fields. The maximum rate of annual soil erosion that still enables continued crop production, known as the soil tolerance value, was exceeded in 3 out of 10 years by CT, but was never exceeded by ST. Extreme rainfall events accounted for 61 to 72 percent of the CT system sediment load and 73 to 84 percent of the ST system sediment load. These results demonstrate that ST management is less susceptible to sediment loss from extreme events than CT systems, and that ST systems are still more effective at reducing sediment loss in this landscape than CT systems. More specifically, the results point to the continued use of cover crops and strip tillage as essential best management practices as the frequency of high intensity rainfall events increases. (Project No. 6602-11130-003-00D)

Inoculation with arbuscular mycorrhizal (AM) fungi increases sweet potato yields.

Alternative crop nutrient management strategies are needed to increase production, cut production costs, and reduce the loss of agrochemicals to the environment. Plants and arbuscular mycorrhizal (AM) fungi often have a mutually beneficial relationship; the host plant supports AM colonies, and the fungi improve the plant's uptake of nutrients and water. ARS researchers in Wyndmoor, Pennsylvania, found that sweet potato yields increased 10 percent after an AM fungus product was placed directly into the planting hole in the field, or when the plants were first grown in an AM-amended potting mix in a greenhouse. Amending soils with this type of AM product could benefit vegetable producers by enhancing plant nutrient uptake, reducing the need for fertilizer applications, increasing yields, reducing the risk of fertilizer losses to the environment, and reducing farm input costs. (Project No. 193512000-011-00D)

No-till management improves crop yields, reduces environmental risk, and lowers production costs.

Crop producers are looking for ways to streamline management, reduce inputs, increase cost-effectiveness, and enhance their overall environmental sustainability. ARS scientists in Brookings, South Dakota, compared a no-till production system to a conventional tillage-based system for 6 years and found that no-till production required 20 to 30 percent less water, seed, fertilizer, and herbicide—and produced yields that were 6 percent higher than the conventional system. These results suggest that no-till corn production offers options for farmers to use crop inputs more efficiently, which helps boost profits, reduce environmental impacts, and improve overall production sustainability. (Project No. 5447-12620-003-00D)

Biochar amended soils can reduce pathogen leaching from livestock into groundwater.

Pathogens can pose a public health risk when they leach into groundwater. ARS researchers in Bowling Green, Kentucky, investigated whether amending different types of soils with biochar altered soil textures and surface properties and if these changes affected the transport of two pathogenic bacteria through the soil. They found sandy soils amended with biochar retained the largest amount of pathogens. Biochars have already been proposed as a tool for sequestering carbon from the atmosphere and reducing the loss of agrochemicals from the soil. This work suggests that biochar may also reduce pathogen leaching into groundwater. (Project No. 6445-12630-004-00D)

Improving soils with “designer” biochars.

Biochars can be added to soils to improve soil quality and crop yields, but yield improvements are not always consistent, perhaps because specific soil deficits are not always improved by biochar amendments. ARS researchers in Florence, South Carolina, and St. Paul, Minnesota, devised guidelines for producing different types of biochars with unique chemical and physical properties suitable for remedying specific soil deficiencies. Results showed that designer biochars were effective at improving soil moisture retention, increasing carbon sequestration, and reducing plant nutrient leaching. Developing guidelines for designer biochars will help U.S. producers use biochars more effectively, increase crop yields, and provide widespread support for management practices that improve soil quality. (Project No. 6657-12130-002-00D)

New use for animal waste: biochar. Livestock manure management is often an environmental and economic concern for animal producers. One management option is to convert manures to biochar that can be used for amending soils and improving soil quality, but the processing necessary for wet animal manures requires a high energy input. ARS scientists in Florence, South Carolina, demonstrated that swine manure solids could be blended with plastic mulch wastes to produce both biochar and a combustible gas with heating values higher than natural gas. These efforts demonstrate that pyrolysis technology has the potential to manage two significant agricultural wastes—plastic mulch film and swine solids—while producing biochar and energy. (Project No. 6657-13630005-00D)

Manure applications benefit soil carbon dynamics in irrigated corn fields.

Soils store more than three-quarters of the earth's terrestrial carbon, and small changes in agricultural management practices can result in large carbon transfers between the soil and the atmosphere. Because of this, farmers who want to increase soil carbon storage need more information about how storage is affected by field

management practices. ARS researchers in Kimberly, Idaho, determined the total carbon budget in an irrigated corn field, including organic and inorganic carbon inputs from the atmosphere, irrigation water, and nutrient amendments (including low-carbon fertilizer or high-carbon dairy manure). Outputs included gas emissions, crop biomass removal, irrigation runoff, and deep percolation. Results showed that although soil carbon gas emissions were 18 percent greater from manure-treated plots, these plots had a net carbon increase at the end of the season, while the plots treated with commercial fertilizer had a net carbon loss. The indirect effect of manure on soil properties, such as aggregate stability, was an important factor that promoted soil retention of manure-supplied carbon. These findings indicate that applying manure fertilizer to irrigated corn could be a promising management strategy for increasing soil carbon storage and improving soil quality. (Project No. 5368-12000-010-00D)

New amendment to reduce ammonia emissions and phosphorus runoff in poultry manure.

Two of the biggest sources of pollution from animal manure are excessive ammonia emissions and phosphorus runoff. ARS researchers in Fayetteville, Arkansas, have developed a new manure amendment that greatly reduces both ammonia volatilization and soluble phosphorous levels in manure. An acidified waste product used in forming aluminum sulfate (alum) is alum mud. This waste product is currently placed in landfills at a cost of more than \$30 per wet ton. However, when mixed with bauxite and sulfuric acid, it forms a new manure amendment that works as well as alum in reducing ammonia volatilization and reducing soluble phosphorus, but at half the cost. A patent application covering this technology was submitted to the U.S. Patent Office. If 20 percent of the poultry producers used this technology, it is estimated that \$40 million in savings could be achieved each year while also reducing ammonia emissions and phosphorus runoff from poultry farms. (Project No. 6226-63000-003-00D)

Phosphate amendments can reduce the uptake of lead from contaminated soils.

Lead-contaminated soils are a serious hazard to livestock and human health. ARS scientists in Beltsville, Maryland, conducted a 16-year field trial to determine the long-term potential of different soil amendments for reducing lead levels in contaminated soils. These evaluations confirmed phosphate and biosolid compost treatments both significantly reduced the uptake of lead by chemically binding the lead to other compounds. These findings suggest that phosphate amendments can significantly reduce the risk of lead ingestion and can do so much more cost-effectively than managing lead contaminated soils with soil removal and replacement. (Project No. 1245-12000-04000D)

Identifying areas that can reduce phosphorus loss on dairy farms.

Loss of phosphorus from runoff on dairy farms can pollute local waters, and it is difficult to identify the areas on a particular site that are most responsible for these losses. ARS scientists in Madison, Wisconsin, monitored phosphorus runoff from cattle pastures and extensively surveyed four pasture-based dairy farms over a multi-year period. Data on runoff and farm management were combined with topographical information to develop advanced computer models to quantify phosphorus loss from a particular site. The research demonstrated that surveys such as this, in combination with new advanced models, can reliably and quickly determine phosphorus loss from runoff and identify those areas in the greatest need of alternative management. (Project No. 3655-12630-003-00D)

Early warning of unintended discharge from holding ponds.

Unintentional discharge from feedlot runoff holding ponds can potentially contaminate soil and groundwater. Working with the Nebraska's Cattleman's Association, Nebraska's Department of Environmental Quality, and Agra Tek LLC, ARS scientists in Clay Center, Nebraska, developed an automated resistivity array that can be used as an early warning system of these emissions. The technology allows sub-surface observations and greatly expands the surface area monitored compared with traditional monitoring. The system can notify land managers via modem or cell phones when a spill occurs, improving response and clean-up times. (Project No. 5438-41630-001-00D)

Better computer tools to estimate ammonia emissions from beef cattle feed-yards.

Ammonia losses from cattle feed yards represents both an air pollutant and a loss of nitrogen that could be recycled as a soil amendment. Ammonia emissions will be regulated by the U.S. Environmental Protection Agency in the near future, however, the EPA currently lacks an effective model to determine ammonia emissions or estimate management strategies on ammonia fluxes from agricultural operations. ARS scientists in Bushland, Texas, and State College, Pennsylvania, have improved the Integrated Farm Systems Model to estimate feed-yard ammonia emissions. This model is more accurate than current EPA emission models and has the potential to be adapted by regulators, consultants, and producers to better estimate ammonia emissions and determine the effectiveness of different ammonia management strategies to minimize ammonia losses in feed yards. (Project No. 6209-31630-003-00D)

Vaccine trials to reduce risk of *Salmonella* in swine.

Salmonella is a leading cause of bacterial foodborne disease. In the United States, more than 50 percent of the swine farms experience *Salmonella* contamination. On-farm interventions are needed to reduce the levels of *Salmonella* in swine production and limit the potential risk of foodborne disease in humans. A rationally attenuated *Salmonella typhimurium* vaccine has been developed by ARS researchers in Ames, Iowa, and is currently undergoing efficacy trials. To date, vaccine trial analysis indicates that swine vaccination reduces disease severity and gastrointestinal colonization due to challenges with both wild type *S. typhimurium* and *S. choleraesuis*. One advantage of the vaccine is that it still allows the use of an industrial test, *Salmonella* lipopolysaccharide, which is used in Europe to monitor *Salmonella* status at the herd level. Consequently, the new vaccine can still be used to differentiate infected from vaccinated animals. (Project No.3625-31000-004-00D)

Tools and techniques for multi-scale inventory, monitoring, and assessment of western range lands.

Standardized approaches are needed to monitor range lands that enable agencies to share data and address policy needs. ARS scientists in Las Cruces, New Mexico, led in the implementation of ARS developed core land monitoring indicators, field methods, and sample design techniques within the Bureau of Land Management (BLM), which included its national guidance for monitoring solar and oil/gas development impacts and sage grouse habitat. In addition, ARS led in the integration of BLM's monitoring efforts with existing USDA Natural Resources Conservation Service's National Resources Inventory private land monitoring program. ARS scientists at the Jornada Experimental Range also created Web-based tools for monitoring data analysis and reporting, mobile and tablet-based data collection applications, and extensive training modules that are deployed with other U.S. agencies and international partners. The inventory, monitoring, and assessment techniques and tools developed at the Jornada Experimental Range are providing managers and policy-makers with information needed to manage resources at local to national scales. (Project No. 6235-11210-007-00D)

Winter grazing of rangelands reduces wildfire risk and severity of wildfires.

Though wildfire prevention and response costs U.S. taxpayers more than \$3 billion annually, in 2012, a record was set in eastern Oregon for the amount of rangeland burned by wildfire. Much of the area being burned is prime habitat for sage-grouse, and the fires have created severe hardship for ranchers in the region because of the loss of palatable forage. Research by ARS scientists in Burns, Oregon, demonstrated that winter grazing by livestock altered the abundance and moisture content of fuel for wildfires, and could help reduce the period of wildfire risk from 3 months to less than 1 month. This information will assist private and public land managers in developing strategies to reduce wildfire risk on rangelands, which will benefit livestock production and help preserve essential habitat for sage-grouse and other wildlife. (Project No. 5360-21630-001-00D)

Patch burning improves production and conservation benefits in semiarid rangelands.

In the moderately arid regions of the eastern Great Plains, integrating the management of grazing and fire can be an important strategy for adjusting livestock grazing distributions, improving forage quality, and enhancing ecosystem conservation. ARS researchers in Fort Collins, Colorado, and Cheyenne, Wyoming, conducted October burns on three replicated pastures for 4 years and burned 25 percent of the pasture area each year to determine how forage and livestock production would be affected. Forage production was not affected by burning, but early-season forage quality was enhanced after the burning, and cattle spent more time grazing in

recently burned areas during periods of rapid plant growth. The burns also substantially reduced dead biomass and litter. Livestock gains were similar between cattle that grazed in the burned pastures and cattle that grazed in traditionally managed pastures where burning was not conducted. However, habitats for the Mountain Plover, a grassland bird species of concern, was significantly enhanced in pastures where burning had occurred. These findings indicate that combining the management of fire and grazing to improve wildlife habitat can be consistent with, and even complementary to, livestock production goals in semiarid rangelands of the western Great Plains. (Project No. 5409-21610-001-00D)

Resilience of semiarid rangelands to summer fire and post-fire grazing utilization.

Resource managers need information about the seasonal effects of fire during summer—when most wildfires occur—because understanding how plants respond to grazing after a summer fire can help reduce the ecological and economic risks associated with wildfire. ARS researchers in Miles City, Montana, determined that summer fires had no first-year effect on any plant productivity and that grazing after fire had no effect on total above-ground productivity. Their findings indicated that fire and grazing increased grass productivity 16 percent, and reduced forbs by 51 percent, annual grasses by 49 percent, and litter by 46 percent. They also determined that during the first growing season after summer fire, livestock could consume up to 50 percent of the available forage without harming the productivity of semiarid rangeland plant communities. Restricting livestock grazing the year after summer fire did not increase plant productivity or shift species composition. These observations were all consistent among dry, wet, and nearaverage years, indicating that plant responses are species-specific and not significantly affected by precipitation patterns. Resource managers are using these results in post-fire grazing management decisions, particularly for federally managed lands that required 1 to 3 years of livestock removal following fire, which benefits livestock producers and facilitates cost-effective grazing on Federal lands. (Project No. 5434-21630-00300D)

Rapid method for characterizing tannins improves nitrogen use efficiency on dairy farms.

Condensed tannins, a component in many plants, have been shown to improve nitrogen use efficiency at different steps in milk production, including silage production, rumen efficiency, and manure chemistry. Condensed tannins are often difficult to characterize because of their complex chemical structure, and current chemical analysis methods are cumbersome and time-consuming. ARS scientists in Madison, Wisconsin, have developed a rapid characterization method for condensed tannins based on nuclear magnetic resonance spectroscopic analysis. This method can determine the chemical components that make up individual tannins, the ratios of different tannin components, and the size of the individual purified tannins. This information is critical to accurately characterize tannins used in protein precipitation, protein degradation, and enzyme inhibition studies. The method can be used not only in dairy related research and production, but in any discipline or industry where tannins have an important function. A more comprehensive understanding of how condensed tannins work will enable farmers to develop farm/feed management processes and support cost-effective and environmentally beneficial animal production strategies. (Project No. 3655-21000-055-00D)

Improved breeding strategies to aid organic small ruminant production.

In the United States, the greatest barriers to the organic production of small ruminant livestock, such as sheep and goats, are gastrointestinal parasite infections that can result in reduced weight gains and death. ARS scientists in Booneville, Arkansas, are leading research in a multi-institutional, multi-disciplinary team funded by NIFA's Organic Agriculture Research and Extension Initiative and the Small Business Innovation Research program, and have developed selection tools to aid in the control of gastrointestinal nematodes for organic production of small ruminants. Other project collaborators include researchers from Louisiana State University, Virginia Tech, Fort Valley State University, and the University of Arkansas and farmers. This research demonstrated that breeding for parasite resistance in sheep can eliminate the need for most deworming and reduce mortality and morbidity, especially when coupled with good livestock nutrition and pasture management. The research has resulted in farmer-friendly publications available through the National Center for Appropriate Technology and the Web site of the American Consortium for Small Ruminant Parasite Control that will benefit organic producers interested in ruminant production. (Project No. 6227-21310-009-00D)

A mineral seed treatment suitable for organic alfalfa production systems.

The most common fungicide used on alfalfa seed does not protect against all soilborne diseases and cannot be used in organic production systems. ARS researchers in St. Paul, Minnesota, determined that a novel mineral seed treatment using aluminosilicate (natural zeolite)—which is allowed under the National Organic Plan (NOP) Rule 205.203(d)(2)—gave significantly greater control of major alfalfa seedling diseases than the existing Apron XL seed treatment. The mineral treatment significantly controlled multiple strains of the pathogen responsible for Aphanomyces root rot (for which Apron XL is ineffective), and in the field protected a greater percentage of plants than the Apron XL treatment. An added benefit is that aluminosilicate did not harm the soil bacteria needed by alfalfa to fix nitrogen. This research indicates that the aluminosilicate mineral seed treatment is a promising new means of controlling seedling diseases in conventional and organic alfalfa production systems. (Project No. 3640-12210-002-00D)

Recycling nutrients from dairy storage lagoons may provide new source of supplemental fertilizers.

Dairy producers often use lagoons to store livestock manure, but the manure nutrients can leach out and contaminate the surrounding soil. ARS scientists in Prosser, Washington, conducted laboratory, greenhouse, and field studies and determined that these nutrients could be recovered from animal manure anaerobic digestion systems and supply additional nitrogen, phosphorus and potassium for potato, sweet corn, wheat and bean production. Using anaerobic digestion systems to recover nutrients from manure would provide another source of fertilizer and offset fertilizer costs in specialty crop production. (Project No: 5354-21660-003-00D)

Monitoring environmental stress in wheat to improve precision agriculture.

One goal of precision agriculture is to manage within-field variability of yield quantity and quality. It has been possible for years to map the variability of yield quantity, but tools to map yield quality are still needed. ARS researchers in Pendleton, Oregon, have developed a real-time, on-combine system that can be used in the field to measure yield quality at the grain protein level. Producers can use this system to identify specific regions within fields where environmental stress is affecting grain yield quality, which will help improve precision agricultural management strategies that increase yield quantity and quality. (Project No. 5356-21610-002-00D)

Land use practices and stream and river water quality. Assessing how land use alters water quality of nearby streams and rivers is an important aspect of pollution monitoring and natural resource stewardship. Tools are needed that can quantify how land use alters stream and river water quality over long time periods. ARS scientists in Corvallis, Oregon, collected data over an 8-year period to define 56 land use patterns of crops, forests, and urban development that represented 99 percent of the Willamette River Basin of western Oregon. The data collected were incorporated into the Soil and Water Assessment Tool model. In validation tests, the model showed an increased capability to predict how land management altered nutrient and sediment load in streams and rivers. Researchers will now be able to determine the environmental consequences of changing land use patterns. (Project No. 5358-21410-003-00D)

New farm-scale gasifier unit can increase sustainability by creating value-added products.

Finding new uses for agricultural byproducts can help increase the economic resilience of individual farms. ARS scientists in Corvallis, Oregon, worked with a private non-profit group to develop and test a farm-scale gasification unit that can convert residues from seed cleaning into value-added products. This public-private collaboration demonstrated that the unit could convert over 400 pounds of feedstock per hour into syngas and organic carbon-rich biochar that could improve the organic content of acidic soils in eastern Washington State. This work led to the formation of a company that will make the technology available to farmers and other owners of seed cleaning mills. (Project No. 5358-21410-003-00D)

Increasing the efficiency of nitrogen applications in deficit irrigation.

When water is limited, nitrogen requirements to maximize crop production changes which makes it economically important to know the appropriate amount of nitrogen to apply. ARS researchers in Fort Collins, Colorado, updated the ARS Root Zone Water Quality Model 2 (RZWQM2) to determine the optimal amounts of nitrogen to be applied to match seven different levels of available soil moisture. Validation of this model with field data

indicated that RZWQM2 could be used to optimize nitrogen application rates to different levels of available soil moisture for corn producers in Colorado. (Project No. 5402-61660-007-00D)

Increasing rotational diversity can benefit sugarbeet.

Sugarbeet is susceptible to numerous diseases, insects, and weed infestations. ARS scientists in Sidney, Montana, and sugar industry researchers demonstrated that switching from a 2- to a 3-year rotation can reduce the risk of pest infestations and can help spread economic risk. In addition, adding an annual legume as a rotational crop can increase soil levels of organically fixed nitrogen and reduce fertilizer application costs. This practice can lead to reduced pest pressures and higher profits for sugarbeet growers in Montana. (Project No. 5436-13210-006-00D)

Bacteria may help prevent sugarbeet disease.

Leaf spot disease is a fungus that affects sugarbeet production in Montana. ARS researchers in Sidney, Montana, tested various bacteria found in dryland fields and discovered that one bacterium, *Pantoea agglomerans*, can attack the leaf spot disease fungus by degrading its cell walls. In greenhouse trials, adding this bacterium to sugarbeet infected with leaf spot fungal spores reduced the incidence of leaf spot disease, which suggests that the bacterium could become an ecological replacement to fungicides typically used to fight this disease. (Project No. 5436-13210-006-00D)

Management practices to improve production in dryland malt barley.

Soil degradation reduces production levels and can limit available soil nutrients. Conventional tillage with malt barley fallow rotation has reduced soil quality and annual grain yield by contributing to the loss of soil organic matter. ARS scientists in Sidney, Montana, have identified a robust management practice that includes a no-till barley pea rotation that can minimize soil degradation. Implementation of this practice can reduce the need for nitrogen fertilization by 54 percent, and nitrogen losses through leaching, volatilization, and denitrification by 125 percent. At the same time, this practice was found to increase soil carbon storage by 11 percent and enhance malt barley yield and quality as much as 44 percent compared with traditional tillage practices. Implementation of this practice by producers can reduce chemical input and energy needs, enhance soil quality, and sustain dryland malt barley yield and quality. (Project No. 5436-13210-006-00D)

Minimal tillage can increase soil carbon sequestration in the southeastern United States.

The ability of soil to sequester carbon can improve long-term soil health while acting to mitigate greenhouse gas emissions. Conservation systems that utilize minimal soil disturbance combined with high-residue cover crops enhance carbon sequestration, but no tool is available to determine carbon sequestration amounts across specific conservation systems. ARS scientists in Auburn, Alabama, compared numerous conservation tillage systems and winter cover crops to derive a means to quantify and compare how much carbon each system sequestered. They determined that cover crops added an average of 2,500 kilograms of carbon per hectare, while corn residue only added 1,340 kilograms of carbon per hectare to the soil each year. The scientists concluded that a number of winter cover crops have significant potential to sequester additional carbon. The findings demonstrate that the use of conservation systems that include cover crops can improve soil health and could offset CO₂ emissions across degraded coast plain soils for the southeastern United States. (Project No. 6420-12610-005-00D)

Novel microbial oil has antibacterial activity.

Antimicrobial resistance, a major health concern, has decreased the effectiveness of therapeutic drugs to treat and prevent infectious disease. As a result, antibiotic alternatives are needed to maintain the health and welfare of animals. ARS scientists in Peoria, Illinois, collaborated with a scientist from Rangsit University in Thailand to test a novel oil produced by the fungus *Aureobasidium pullulans* for antibacterial activity. The oil, known as one of the liamocins, was produced through bioconversion of a variety of sugars and lignocellulosic feedstocks and was found to preferentially inhibit the growth of strains of the pathogenic bacteria *Streptococcus*. The antibacterial oil can improve animal health in the dairy, swine, and aquaculture industries, and can support the biorefining industry by providing a new a high-value bioproduct. (Project No. 2008 3620-41000-135-00D)

Changing landfills into biorefineries.

To provide sufficient quantities of biomass sources between growing seasons, ARS researchers in Albany, California, developed a large pilot scale biorefinery located at the Salinas, California, Crazy Horse Landfill that converts rural and urban solid waste into ethanol, biogas, compost, and value-added recyclables. Each ton of food processing waste at the landfill currently can be converted into 65 gallons of ethanol. If the same biomass source is converted to liquefied natural biogas, which has the same burn rate as 100 percent ethanol, it yields 108 gallons of transportation fuel, which can be used to power diesel turbines. Together, ARS and the city of Salinas are creating an “energy park” that converts both agricultural biomass and curb collected garbage into bioenergy in the same biorefinery, which demonstrates the facility’s remarkable flexibility in handling and processing different feedstock supplies. (Project No. 5325-41000-049-00D)

Sustainable biodiesel additives improves cold weather flow.

The cold flow properties of fatty acid methyl esters (biodiesel) are relatively poor and detract from commercial viability of biodiesel as a fuel source during cold weather. Synthetic cold flow improver (CFI) additives made from soybean, canola, and palm oils have been shown to increase the ability of biodiesel to flow at low temperatures. ARS scientists in Peoria, Illinois, and Wyndmoor, Pennsylvania, collaborated on the synthesis and testing of CFI additives obtained from non-food resources such as waste cooking oil. Results from the research benefits farmers who supply seed oils for biodiesel conversion by making the fuel more flowable and marketable during cooler seasons. Biodiesel fuel producers, distributors, and consumers will also benefit from better flowability and performance in cold weather. (Project No. 5010-41000-148-00D)

Novel yeast strains reduce the price of biomass conversion to ethanol.

Traditional yeasts convert sugars in cereal grains to ethanol, but these yeasts cannot use the sugar xylose, which is the second most abundant sugar in corn stover, switchgrass, and lignocellulose feedstocks. In addition, the process of converting sugars to ethanol results in toxic conditions that inhibit all yeast fermenting activities. *Saccharomyces stipitis* is a native pentose-sugar fermenting yeast that ARS scientists in Peoria, Illinois, cultured in an ethanol-challenged continuous culture system to force the development of robust yeast isolates. These isolates were able to overcome toxic conditions and produced ethanol using either highly acid- or base-pretreated corn stover or switchgrass. The novel yeast isolates reduced growth lag time, significantly enhanced fermentation rates, improved ethanol tolerance and yield, and rapidly and economically generated recoverable ethanol at acidic pH levels (which potentially inhibit ethanol fermentation). Compared with parent yeasts, these new yeast isolates reduce ethanol selling costs by \$0.31/gallon, an accomplishment that advances national efforts to develop renewable fuel systems to stimulate the rural economy, preserve the environment, and reduce dependence on foreign oil. (Project No. 362041000-147-00D)

Cost-effective process technology for butanol production from corn stover.

Butanol is an advanced biofuel that packs 30 percent more energy than ethanol on a per gallon basis. It is produced via fermentation of sugars; however, butanol should be removed as it is produced during fermentation because above a certain concentration, butanol inhibits its own production. Thus the key to producing butanol economically from corn stover is a threestep process: 1) convert pretreated corn stover to sugars using enzymes; 2) ferment the sugars to butanol; and 3) recover butanol as it is generated. ARS scientists in Peoria, Illinois, developed this novel three-step process by pretreating the corn stover with a dilute acid coupled with vacuum distillation to allow for continuous butanol recovery. The production cost for butanol from corn stover by this process was estimated to be at \$3.42/gallon, whereas from corn it was \$4.39/gallon. This newly developed fermentation/recovery process offers a new, costeffective method of producing butanol. (Project No. 3620-41000-149-00D)

Identifying ethanol-tolerant proteins in bacteria that convert feedstocks to ethanol.

Lactic acid bacteria are used in the industrial fermentation of agricultural biomass to biofuels such as ethanol, but these bacteria are sensitive to the elevated concentrations of ethanol generated during the conversion process. ARS scientists in Peoria, Illinois, examined a strain of lactic acid bacteria to identify proteins that confer ethanol tolerance to the bacterium. Twenty proteins that varied in response to elevated ethanol concentrations were

identified. These results provide information on the production and regulation of the proteins involved in ethanol tolerance and will be useful in efforts to genetically improve microbial strains that can more efficiently and completely convert agricultural biomass to biofuels and bioproducts. (Project No. 3620-41000-135-00D)



CROP PRODUCTION AND PROTECTION

National Programs:

- **Plant Diseases, NP 303**
- **Crop Production, NP 305**
- **Plant Genetic Resources, Genomics and Genetic Improvement, NP 301**
- **Crop Protection and Quarantine, NP 304**

Conventionally bred sweet orange-like hybrid and new rootstocks with tolerance to citrus greening entered large-scale grower trials.

Citrus greening or huanglongbing (HLB) is the most serious threat to citrus production worldwide and has reduced Florida citrus production by 50 percent. No inherent genetic protection for citrus trees has been available for U.S. citrus growers. However, in 2014, ARS researchers in Fort Pierce, Florida, released a new hybrid sweet orange with high quality fruit that displays excellent tolerance to HLB disease. These trees have been propagated at a commercial nursery and were placed in 2015 in replicated plantings on six grower sites with other advanced sweet orange-like selections. Nine new citrus rootstocks have also been developed that display much higher sweet orange fruit productivity and tree health in field trials in areas that have been severely affected by HLB. These rootstocks have been entered into the Florida clean budwood program and are being propagated for entry into large-scale grower trials. Release of the tolerant hybrid and rootstocks offers a new option for citrus growers for production management in the presence of citrus greening. (Project No. 6618-21000-014-00D)

Genetic inheritance of cooking time in beans.

Dry beans are a nutrient-dense, low-cost food and an excellent cost effective food choice for consumers. In spite of this value, bean consumption is limited—especially in developing countries—because of their long cooking times and the high amount of fuel needed for cooking. To develop bean varieties that cook more quickly, plant breeders need information about how genetic traits affect cooking time and how metabolic activity affects those traits. ARS scientists in East Lansing, Michigan, evaluated a group of 240 Andean bean lines for genetic differences in cooking time. The average cooking time was 38 minutes, ranging from 19 to 87 minutes. Genetic

elements associated with cooking time were detected on chromosomes 2 and 10, with evidence suggesting that enzymes coded on chromosome 2 (pectin methyltransferases) may influence cooking time. In each of the four market classes evaluated (yellow, cranberry, light red kidney, and red mottled), the genotypes that required the shortest cooking time also retained a higher percentage of protein and iron, indicating that these bean varieties might potentially provide the most benefit to consumers in terms of convenience and added nutrition. (Project No. 3635-21430-010-00D)

Soybean genes that retard cyst nematode development.

Soybean cyst nematodes attack the roots of soybean plants and cause approximately \$1-2 billion in damage each year to the U.S. soybean industry. Genetic resistance combined with crop rotations is the most sustainable way to manage this pest, but the pathogen changes so rapidly that this is a challenging strategy. Toward providing a longer-term source of genetic resistance, ARS researchers in Beltsville, Maryland, designed and evaluated multiple DNA constructs to provide resistance to both soybean cyst and root-knot nematodes. The DNA segments successfully decreased galls formed by root-knot nematode and cysts formed by the soybean cyst nematode by approximately 70-90 percent. This new strategy using several gene constructs can now be exploited by soybean breeders to combat nematodes that lower soybean yields, and could be adopted for use with other crop species. The technology has been patented and transferred to industry partners, and products are being developed for commercialization. (Project No. 1245-21220-23200D)

Genes for better frost tolerance.

It is known that variation in the ability of winter wheat to survive the winter months in the field is associated with differences in the vernalization 1 (VRN1) and frost resistance 2 (FR2) genes, but knowledge of how specific forms of the genes influence winter hardiness and possible interactions among them is lacking. ARS researchers in Pullman, Washington, assayed variation in the composition of the genes and the number of copies at the FR2 and VRN1 loci in a large set of winter and spring wheat genotypes from around the world representing a broad range of freezing tolerance. Results indicate that selection of wheat varieties with a specific form of the FR2 gene (the FR-A2-T allele) and three copies of the recessive *vrn-A1* allele would be a good strategy for improving frost tolerance in winter wheat. These findings provide wheat breeders with valuable new molecular tools for improving winter survival in wheat. (Project No. 5348-21000-03000D)

Saving energy and reducing ginning costs by improving ginning efficiency.

Cotton cultivars differ in how strongly fibers are attached to the seed, and cultivars with less fiber-seed attachment force can be ginned faster with less energy and fiber damage. ARS cotton breeders and engineers in Stoneville, Mississippi, determined that percent fuzz was correlated with ginning efficiency and that selecting for genotypes with low fuzz percentage resulted in genotypes with better ginning efficiency. This finding will help cotton breeders develop cotton cultivars that gin faster with lower ginning energy requirements and high fiber quality. (Project No. 6402-21000-051-00D)

Successful preservation of oaks under genebank conditions.

Oaks, key tree species for many temperate and aridland forests, furnish highly valuable wood for construction, furniture, and other uses. Endangered oak species require protection in genebanks, but until now, that has been problematic because acorns did not survive under conventional ultra-cold genebank storage conditions. ARS researchers in Fort Collins, Colorado, and their collaborators developed methods for successfully preserving under ultra-cold conditions embryos dissected from acorns of more than 20 oak species. This breakthrough will enable ARS and other genebanks to effectively protect the gene pool of endangered, highly valuable oak species. (Project No. 5402-21000014-00D)

Next-generation sequencing of organellar genomes in cranberry to enhance breeding efficiency.

ARS scientists in Madison, Wisconsin, used molecular methods and computer-based approaches to reconstruct the cranberry plastid and mitochondrial genetic codes. These cellular organelles are involved in energy formation (photosynthesis) and utilization (respiration). This organelle sequence enables the study of photosynthesis and respiration in cranberry; key processes in the formation of fruit and ultimately cranberry yield. The genetic codes

of cranberry organelles deciphered through this research are the first and only codes available in the entire cranberry family, which comprise thousands of species without previous information. Ultimately, the genetic information about energy production/utilization systems in cranberry can be used by plant breeders to breed more energy-efficient cranberries and sister species such as blueberry and lingonberry. (Project No. 3655-21220-00300D)

Identifying cacao varieties from a sample of only one bean.

Cacao, the source of cocoa, is grown primarily on small farms primarily in West Africa. Production and marketing of specialty, high-value cocoa can provide economic opportunities for growers in the developing world and greater profits for the cocoa/chocolate industry. But to realize those benefits, the varietal identity for high-value cacao, some of which is rather rare, must be authenticated. ARS researchers in Beltsville, Maryland, developed a new method of DNA testing that can identify a cacao variety from a single bean. This new testing method can more efficiently identify high-value cacao for on-farm protection and propagation, and also can authenticate commercial sources for this increasingly high-value product. (Project No. 1245-21000-267-00D)

Physiological traits and metabolites of cacao seedlings influenced by potassium in sand-culture.

An inadequate supply of soil potassium where cacao is grown greatly affects cacao yield potentials. ARS scientists in Beltsville, Maryland, evaluated the effects of diverse levels of potassium on growth and physiology traits and metabolites of cacao genotypes. The study revealed that potassium played a critical role in growth and development, and significantly improved physiological traits (chlorophyll b and a/b ratio) and the levels fructose, glucose, myoinositol, raffinose, and starch in cacao leaves. The sand-culture method adapted is useful in identification of potassium-efficient cacao genotypes for cacao improvement programs that have a limiting soil potassium supply. Knowledge of potassium use in cacao will help cacao farmers develop suitable crop and fertilization management practices to improve cacao sustainability and yield. (Project No. 124521000-278-00D)

Producing “clean” berry crops free of targeted pathogens.

To be competitive and profitable, berry producers require clean plants (i.e., those with no viruses) that establish quickly and have higher yields and fruit quality than diseased plants. ARS scientists in Corvallis, Oregon, with collaborators at the University of Idaho evaluated strawberry, blackberry, raspberry, elderberry, grape, and blueberry and eliminated viruses from multiple cultivars and advanced selections as part of the National Clean Plant Network with funding from USDA-APHIS. These resulting “clean” plants are the starting material for certification programs that monitor and regulate the large-scale production of these crops. The testing and cleanup that occurred through this effort is also facilitating the export of more than 50 million berry plants for planting in other countries. (Project No. 5358-21220-002-00D)

A rotating cross-arm trellis system for blackberry production.

Blackberry production in the U.S. Midwest is limited by low winter temperatures that kill the fruit buds and vines. ARS researchers in Kearneysville, West Virginia, developed a rotating, cross-arm trellis system that allows the vines to be rotated to the ground and covered with a protective, floating row cover as needed to protect dormant vines from extreme temperatures. This new production system reduces the risks of crop failure and major crop losses from extreme and untimely cold temperatures. In January-February 2014, much of the Midwest experienced temperatures colder than -20°C , which killed blackberry plants grown in conventional systems with no winter protection, leaving less than 10 percent of a normal crop to be harvested. In contrast, growers who used the rotating, cross-arm trellis and winter protection system saw little winter damage and harvested 80 percent of a normal crop in 2014. Since 2010, 120 hectares of new blackberry plantings on 40 farms (1 to 10 hectares in size) from Pennsylvania to Iowa have been established using the rotating, cross-arm trellis system. In 2014 alone, these new plantings are expected to generate \$60,000 per hectare. (Project No. 1931-21000-018-00D)

Profitable practices for organic production of highbush blueberries identified.

ARS scientists in Corvallis, Oregon, conducted a long-term field study in collaboration with Oregon State University to evaluate management practices for organic production of highbush blueberry. The cultivars included ‘Duke’ (early-season) and ‘Liberty’ (mid- to late-season), and the practices included flat or raised

planting beds, two fertilizers (feather meal and fish emulsion fertilizer applied at low and high rates), and three different types of mulch (sawdust, yard debris compost covered with sawdust, and weed mat). The greatest growth and yield were found when plants were grown on raised beds, fertilized with a low rate of fish emulsion or a high rate of feather meal, and mulched with either compost plus sawdust or weed mat. The use of raised beds and weed mat is becoming popular for organic blueberry production in the Pacific Northwest, in part as a result of this study. Both practices increase growth and early production of the crop and the later improves weed control and increases economic returns. (Project No. 535821000-042-00D)

What's really in your black raspberry supplements?

Controls are needed to ensure that dietary supplements already in the marketplace meet a certain minimum quality and that they contain their labeled contents (i.e., black raspberry supplements contain a minimum anthocyanin concentration). All available black raspberry products marketed as supplements were purchased for this work. Each was analyzed for authenticity and anthocyanin concentration by ARS researchers in Parma, Idaho. Seven out of 19 samples did not contain any black raspberry fruit, and 3 out of those 7 had no detectable anthocyanin. This shows that food sources remain a more reliable method of obtaining dietary phenolics than dietary supplements. (Project No. 5358-21000-047-00D)

Intelligent spraying system for nursery and orchard applications.

The use of conventional spray applications to achieve effective pest control in floral, nursery, and fruit crop production requires excessive amounts of pesticides. ARS researchers in Wooster, Ohio, invented an automated, variable rate, air-assisted precision sprayer that minimizes human involvement in determining the amount of spray needed for application. This intelligent spraying system characterizes the presence, size, shape, and foliage density of target trees and applies the optimum amount of pesticide. Field experiments have shown that the intelligent sprayer reduces the variation in spray deposition due to changes in tree structure and species, and increases the uniformity of spray deposition on targets at different growth stages. The pest control efficacies of the new sprayer provide an environmentally responsible approach. The new sprayer also reduces average pesticide use by up to 68 percent, with an annual average cost savings of \$230 per acre. (Project No. 3607-21620-008-00D)

Adapted varieties save wheat production in acid soils with aluminum toxicity.

ARS scientists in Pullman, Washington, have determined that low soil pH and aluminum toxicity may be responsible for yield losses of up to 90 percent in over 50,000 acres of wheat in Washington, and Idaho. Producers can attempt to mitigate these conditions by growing triticale or heavily liming the soil, but neither option is cost-effective. In collaboration with scientists at Washington State University, ARS researchers evaluated wheat varieties adapted to these soil conditions, and identified several aluminum-tolerant varieties that gave significantly improved yields. These findings provide wheat growers in this region with cost-effective alternatives for improving their production. (Project No. 5348-22000-016-00D)

Sugar and cane yields optimized with variable-rate application of fertilizer.

Sugarcane crops must receive proper levels of nitrogen and potassium for profitable yields. ARS scientists in Houma, Louisiana, conducted studies to determine whether variable-rate application of nitrogen and potassium could help optimize sugarcane yields while also increasing production efficiency. Results from 2 years of field trials suggest that variable-rate application of both may offer Louisiana sugarcane producers a viable method for decreasing costs while increasing production efficiency. In the study, nitrogen rates were decreased by up to 25 percent. Data from these studies were used to reformulate Louisiana State University AgCenter fertilizer recommendations. Many growers have adopted these recommendations and have already realized greater cane and sugar yields. (Project No. 6410-12210-002-00D)

Increasing access to new genetic resources to protect sugarcane.

Sugarcane producers and industry need access to new genetic crop diversity to thwart numerous endemic and invasive pests, diversify onto marginal land, and adapt to climatic change. However, sugarcane germplasm imports to the United States have been restricted to "seed cane," or cane pieces, which has limited U.S. access to

genetic diversity. ARS scientists in Houma, Louisiana, and at Canal Point, Florida, working with university and international sugarcane researchers, determined the risk of importing pathogens on true seed (termed “fuzz”), which was previously unknown. All test results were negative, and no seedling from parents infected with known pathogens was found to be infected. These results contributed to a decision made by APHIS that fuzz can now be imported into the United States under approved protocols. The result is that major new genetic diversity can now be provided to all sugarcane breeding projects in the United States which will help can producers manage disease, respond to climate challenges, and protect profits. (Project No. 6410-22000-016-00D)

Grapevine yield estimation automated.

Worldwide, grapes are the most planted fruit crop and rank third in tonnage produced. It is important to estimate yield in vineyards to allow for contract negotiation, harvest logistics, and marketing projections. ARS scientists in Prosser, Washington, developed a trellis tension monitoring system that is as good as or better than the current labor-intensive method used to estimate crop yields. This system monitors the tension in the trellis wire as the fruit increases in size. Fruit yields can be estimated before veraison (the onset of ripening) to within 20 percent of actual yields. This information is being used to optimize processing capacity and predict labor needs. (Project No. 5358-21000-047-00D)

Cover crops and no-till systems benefit soils without negatively affecting wine-grape production in an irrigated vineyard.

ARS researchers in Davis, California, evaluated the effects of cover crops and no-till practices on winegrape production in Lodi, California, in the Central Valley, where diminished air quality from particulates could mandate the use of no-till soil management practices. Over 3 years, soil nutrient availability, vine nutrition, growth, and yield characteristics of *Vitis vinifera* cv. merlot, grown under regulated deficit irrigation, were not affected by cover crops and no-till systems. Importantly, wine-grape yields from the zones of the vineyard where cover crops and no-till practices had occurred were similar to those of conventional management consisting of weed cover in winter followed by repeated tillage between April and September. The outcomes indicate that growers can use cover crops and/or no-till practices to reduce erosion and air particulates, and improve soil infiltration with no effect on yield and nutrition in irrigated, mature vineyards. (Project No. 5306-21220-005-00D)

Early detection of grapevine trunk diseases.

Detection of wood-canker pathogens of grapevines (aka trunk diseases) is limited to the late stage of infection, when disease symptoms have become obvious and the opportunity for disease prevention is lost. Non-destructive detection would benefit from identification of grape genes expressed in symptomless leaves at the early stage of infection. In an effort to develop an early detection tool, ARS researchers in Davis, California, demonstrated proof of concept that the early stage of infection is detectable by sampling symptomless grape leaves for grape genes that are expressed before the fungus spreads through the stem. A detection tool for this early stage of infection will allow quick removal of infected plants and control of the disease in both nurseries and commercial vineyards. This is critical for growers who would otherwise bear the cost of unknowingly farming diseased grapevines doomed to a lifetime of low productivity. (Project No. 5306-21220-006-00D)

Crop adaptation to extreme environments.

Acidic soils constitute 40 percent of arable land in the tropics and subtropics. Aluminum (Al) toxicity in acidic soil stunts and damages root growth resulting in significant reductions in crop yields due to nutritional deficiencies and drought stress. Rice is the most Al-tolerant of the major cereal crops. ARS and university scientists in Ithaca, New York, showed that rice tolerance to Al is due in part to a novel transporter gene (OsNRAT1) that promotes Al sequestration into the root cell vacuole. OsNRAT1 is sufficient for promoting Al transport in diverse systems from plants to yeast. This knowledge may allow the growing of target crops with Al tolerance in acidic soils using conventional breeding or transgenic approaches. (Project No. 1907-21000-036-00D)

Effect of climate change on crop nutritional quality.

Producers and nutritionists are concerned about how climate change might affect the nutritional qualities of food crops. ARS researchers in Aberdeen, Idaho, and Urbana, Illinois, and multinational collaborators determined how climate change could affect the nutritional qualities of several staple crops, including wheat, rice, maize, sorghum, and soybean. They grew these crops to maturity under varying levels of atmospheric carbon dioxide, which are expected to become elevated because of climate change. In the first assessment of its kind, seed nutrient content of zinc, iron, and protein nutrition was evaluated. Scientists also measured seed phytic acid content, which is critically important for determining iron and zinc bioavailability. Study results indicated that although seed phytic acid was not largely altered by elevated carbon dioxide levels, seed zinc, iron, and protein levels declined. Iron and zinc deficiencies are significant global public health challenges that impair the health of an estimated two billion people worldwide. These findings, which were published in the journal *Nature*, provide important new information for understanding how climate change could affect the nutritional quality of crops. (Project No. 5366-21000-030-00D)

Gasified rice hull biochar is a source of phosphorus and potassium for container-grown plants.

Worldwide phosphorus supplies are becoming limited and, as a result, phosphorus fertilizer prices are rapidly increasing. Phosphorus is also implicated in surface water impairment when it is leached from crop production sites into surface water systems. ARS researchers in Wooster, Ohio, documented that gasified rice hull biochar (GRHB), a waste byproduct of rice processing, could be used as a source of phosphorus in production of ornamental crops in containers. GRHB was incorporated into typical greenhouse container substrates at 5 percent or 10 percent by volume. Plants received no other source of phosphorus, yet grew vigorously. ARS research documented the changes in substrate chemical and physical properties as a result of GRHB amendment, as well as plant response. Greenhouse and nursery producers can use this research to grow crops by using a recycled form of phosphorus, without reliance on traditional phosphorus fertilizer supplies. (Project No. 3607-21000-01400D)

An airborne two-camera imaging system for agricultural remote sensing.

Recent advances in imaging technologies have made consumer-grade digital cameras an attractive option for remote sensing due to their low cost, compact size, and user-friendliness. ARS researchers in College Station, Texas, assembled and evaluated an airborne multispectral imaging system on the basis of two identical consumer-grade Canon cameras. One camera captures normal color images, whereas the other obtains near-infrared images with filtering techniques. The color camera is also equipped with a GPS receiver to allow images to be geo-tagged. A remote control is used to trigger both cameras simultaneously. Geo-tagged images from the system can be viewed on any image viewer and on Google Earth for quick assessment before digital image analysis. The imaging system was tested under various flight and land cover conditions; optimal camera settings were determined for airborne image acquisition. Analysis of example images established that this system has good potential for crop condition assessment, pest detection, precision aerial application, and other agricultural applications. (Project No. 6202-22000-03200D)

Better integrated management of pecan foliar and fruit diseases, with emphasis on pecan scab.

Fungicide resistance is a looming issue for pecan growers. Recent work by ARS scientists in Byron, Georgia, identified a novel biorational compound with activity against pecan scab. The compound, trans-cinnamic acid, is produced by symbiotic bacteria from the gut of entomopathogenic nematodes. Isolation of the compound and in vitro testing showed it to be 100 percent efficacious in reducing scab. (Project No. 6606-21220-012-00D)

New discovery of the genetic factors that confer Ug99 wheat stem rust resistance.

Ug99 wheat stem rust has not yet been found in the United States, but it is spreading overseas and is considered a potential threat to up to 90 percent of the world's wheat. Durable resistance to wheat stem rust in adult wheat plants is highly desired to protect wheat production from major stem rust losses. ARS scientists in St. Paul, Minnesota, identified and determined that a combination of genetic factors can confer adult resistance to wheat stem rust in wheat varieties adapted for the United States. These results can be used by wheat breeders to develop new wheat varieties with even more effective genetic resistance to Ug99 and other wheat stem rusts. (Project No. 3640-21220-02100D)

National Sclerotinia Initiative develops effective screening tools for sunflower.

The sclerotinia diseases are some of the most important diseases of sunflower in the Northern Great Plains. ARS scientists in Fargo, North Dakota, together with Sclerotinia Initiative-funded collaborators, have developed a standardized regional approach to identify significant differences in the susceptibility of sunflower hybrids to sclerotinia. Building on that successful result, the researchers have developed field-scale inoculation procedures and misting systems that have enabled U.S. sunflower breeders to identify sunflower hybrids with resistance to sclerotinia. The system has been effectively implemented to assess sclerotinia resistance of newly released commercial hybrids at five regional “common garden” nurseries, providing growers with site-specific and overall performance characteristics of individual sunflower hybrids, and facilitating the release of new oilseed sunflower genetic lines with improved head rot resistance. The standardized assessments have significantly increased the number of hybrids identified with improved levels of sclerotinia resistance for U.S. sunflower growers whose 2012 crop production was valued at \$727.8 million. (Project No. 5442-21220-028-00D)

Remediating boll weevil pheromone trap detection failures.

Boll weevil eradication programs rely on pheromone traps to detect incipient weevil populations and to flag the need for insecticide treatments. Nevertheless, substantial weevil infestations have been detected in cotton fields even though surrounding pheromone traps failed to detect the weevils. ARS researchers in College Station, Texas, in collaboration with the Texas Boll Weevil Eradication Foundation (TBWEF) and the National Cotton Council, investigated the quality of pheromone lures used by TBWEF and determined that some weevil populations produce a unique blend of pheromone and no longer responded to the commercial pheromone formulation. As a result of this research, TBWEF adopted a stringent quality testing program and a shorter replacement interval for lures in potentially infested areas. After implementing the change, boll weevils were eradicated from the targeted zone within 3 years, which eliminated the need for insecticide applications and reduced annual grower assessments by \$9 million. (Project No. 6202-22000-029-00D)

The citrus pathogen *Xylella fastidiosa* cannot be transmitted to seedlings through infected seed.

Citrus variegated chlorosis, which is caused by *Xylella fastidiosa*, is an important bacterial disease of citrus in South America and a potential threat to citrus producers in the United States. ARS researchers in Beltsville, Maryland, collaborated with citrus researchers and Fundecitrus of Sao Paulo, Brazil, to determine if chlorosis can be transmitted by seed. Researchers at Fundecitrus extracted seeds from healthy and diseased sweet orange fruit and sent the seeds to Beltsville, where ARS researchers determined that the *Xylella fastidiosa* pathogen is not transmitted to seedlings through infected seed. The results provide new information on how citrus diseases are transmitted and help the citrus fruit producers involved in international trade manage threats posed by plant disease. (Project No. 1245-22000-281-00D)

Controlling the Asian citrus psyllid, the insect vector of citrus greening disease.

Citrus greening is now found in all citrus growing regions of Florida, and is responsible for a decrease in marketable fruit by more than 50 percent. ARS scientists in Fort Pierce, Florida, are targeting their research to disrupt transmission of the disease by the Asian citrus psyllid, a small insect that sucks the plant’s juices. In 2014, they identified natural products with potential to block the ability of the psyllid to feed. A promising strategy is the application of non-transgeneic RNAi to inhibit transmission of the disease and the viability of the psyllid. The scientists developed delivery systems for the RNAi for root drench, foliar spray, and trunk injection. Results show evidence of psyllid mortality within 2 to 4 weeks after root drench and trunk injection. These results can be integrated into multi-pronged methods for the industry to combat the psyllid to avoid transmission of the citrus greening disease. (Project No. 6618-22320-001-00D)

Establishing the host status of litchi and rambutan for the West Indian fruit fly.

The host status of litchi and rambutan for the West Indian fruit fly was unknown. An extensive survey of mature fruit collected from the field (3,732 litchi and 5,534 rambutan fruits) by ARS researchers in Mayaguez, Puerto Rico, yielded no tephritid fruit fly larvae or pupae. Exposing ripe litchi and rambutan fruit to 12-day-old females did not result in viable fruit fly larvae. This is a robust indication that litchi and rambutan fruit exported from

Puerto Rico do not pose a risk of transporting the West Indian fruit fly to trade destination countries. As a result of this research, USDA-APHIS has changed its policies on the eligibility of exporting rambutan from Puerto Rico, thus benefitting fruit growers there. (Project No. 6635-21000-050-00D)

Post-harvest treatment of spotted wing drosophila flies protects export markets for small fruits and berries.

Spotted wing drosophila (SWD) is a serious threat to the production and trade of economically key specialty crops in the United States, including table grape, stone fruit, blueberry, sweet cherry, blackberry, raspberry, and strawberry. This insect is regulated as a quarantine pest in certain countries that import fresh fruits from California. ARS researchers in Parlier, California, developed a suite of post-harvest treatments, including fumigation with phosphine, to control SWD in these commodities. These treatments including phosphine have directly resulted in the retention or expansion of export markets valued at more than \$300 million annually. (Project No. 5302-43000-037-00D)

Asian citrus psyllid abundance declines with elevation.

The Asian citrus psyllid (ACP) transmits huanglongbing, or citrus greening, the most devastating disease of citrus in the world. Anecdotal reports indicate that ACP becomes less abundant as elevation increases. ARS researchers in Mayaguez, Puerto Rico, tested that hypothesis by monitoring ACP populations in citrus orchards at 17 different elevation sites (between 10 and 880 meters above sea level). No ACP was detected above 600 meters. Results provided strong evidence that ACP abundance declines with elevation. Identifying the factors affecting the geographical and ecological distribution of psyllid populations could help develop management strategies for the insect and the disease it spreads. (Project No. 6635-21000-055-00D)

A Universal Plant Virus Microarray (UVPM) for the detection & identification of all known plant viruses.

ARS scientists in Beltsville, Maryland, have built upon existing disease classification systems to develop a Universal Plant Virus Microarray (UVPM) that recognizes all known plant viruses. This virus detection microarray contains DNA material collected from 9,556 individual virus-specific probes, and was validated for at least 44 plant virus genera and taxonomic groups representing at least 15 virus families. In addition, the correct genus was identified for two recently-described viruses not represented by species-specific probes. This new assay will be especially valuable for detecting viruses in imported plants to the United States. (Project No. 1230-22000-032-00D)

Plumbing systems identified as a common source for fungi that infect humans.

Life-threatening infections caused by *Fusarium* fungi have increased dramatically during the last 30 years. ARS researchers in Peoria, Illinois, and their collaborators applied genetic analyses to examine the occurrence of a *Fusarium* species that is often a primary cause of those infections. They found that plumbing systems are a common source for that species. This finding can help minimize the risks from such fungal infections by contributing to more effective infection-control programs in hospitals and other settings that house individuals at risk for fungal infections. (Project No. 3620-22410-016-00D).

Identification of fungicide resistance in the sugarbeet pathogen powdery mildew.

In the western United States, sugarbeet yields can be reduced by fungal infections of powdery mildew. The quinone outside inhibitor (QoI) class of fungicides is typically used to control powdery mildew, but in some experimental plots near Parma, Idaho, researchers noted a reduction in its efficacy. ARS scientists in Fargo, North Dakota, and industry plant pathologists made the first-ever determination of QoI resistance in powdery mildew in the United States. They also identified a specific gene mutation in all QoI-resistant strains of the fungus, a discovery that provides the foundation for using molecular-based techniques to identify QoI-resistance. These findings will enhance efforts to manage fungicide resistance in sugarbeet production and support efforts to optimize fungicide rotations for effective disease control. (Project No. 5442-22000-047-00D)

Discovery of a major group of beneficial nematodes.

Although many nematodes cause significant crop losses, other species feeding on fungi or other microorganisms are beneficial to agriculture. One major agricultural problem is that the beneficial species of nematodes that

might be used as biological control are often unknown. ARS scientists in Beltsville, Maryland, in collaboration with scientists from England, described six new species of nematodes (called *Rugoster* species) associated with rice, weeds, and forests in Nigeria, Ivory Coast, India, and Australia. They also developed a new diagnostic key for identifying these nematodes and related species. This key can help scientists advance the use of beneficial nematodes in agricultural soils. (Project No. 1245-22000-275-00D)

Protecting wheat from cereal cyst nematodes.

Cyst nematodes are among several types of plant-parasitic nematodes that reduce yields in dryland wheat fields in the Pacific Northwest and cause over \$50 million in annual losses. There are no chemical controls or resistant varieties to control this emerging pathogen. ARS scientists at Pullman, Washington, screened locally adapted germplasm and varieties for resistance in infested fields, and optimized a greenhouse screening technique for resistance. Using these new methods, they were able to successfully identify resistant wheat varieties that can be immediately grown by producers to avoid nematode losses. Wheat breeders can now use these new screening methods to develop improved varieties with even better nematode protection. (Project No. 5348-22000-016-00D)

New technology provides nematode resistance in potatoes.

Potato cyst nematodes (PCNs) are devastating pests impacting the U.S. potato production which is valued at \$4 billion. Methods for effective PCN control are limited and often rely on toxic chemicals so there is a major need to develop new methods to protect potatoes from these nematodes. ARS researchers in Ithaca, New York, have identified genes critical for nematode infection. They have employed a plant mediated RNAi technology to silence these nematode genes, which resulted in the development of a nematode resistant potato cultivar. This technology, which was patented, provides a valuable new tool for plant researchers working to protect potato growers and the industry from costly nematode losses. (Project No. 1907-22000-021-00D)

Methyl bromide alternative developed for walnut planting.

Just before walnut orchards are planted, soil fumigation with methyl bromide has been used to reduce walnut diseases caused by soil parasites and pathogens. The phase-out of methyl bromide has created a need for alternative fumigants. In an 8-year (ongoing) walnut replant trial in the San Joaquin Valley, University of California and ARS scientists determined that 1,3-dichloropropene and 1,3-dichloropropene plus chloropicrin were effective methyl bromide alternatives through the time period monitored which included 1 year of harvestable yield. First year yield was roughly doubled by optimized combinations of the alternatives. Also, the trial identified two rootstocks that perform better in a replanted orchard than the current commercial standard. The data from the trial will help walnut orchard managers to optimize their replanting decisions in the absence of methyl bromide. (Project No. 0500-00044-030-00D)

Mobility of immature, invasive brown marmorated stink bug affects their dispersal capacity.

Understanding the dispersal biology of brown marmorated stink bug (BMSB) at all life stages is critical for the development of site and crop-specific monitoring and management programs. Laboratory trials conducted by ARS scientists in Kearneysville, West Virginia, demonstrated that immature BMSB (i.e., those in the second through fifth nymphal stages or instars) have strong walking capacity on horizontal and vertical surfaces. Furthermore, mark-release-recapture studies demonstrate that BMSB nymphs can be successfully recaptured by pyramid traps baited with pheromone-based stimuli. Strong dispersal capacity of nymphs, coupled with their response to olfactory stimuli, yielded a recapture rate of up to 60 percent within 12 hours, during which insects walked farther than 20 meters on grassy ground. The results of this study indicate that BMSB nymphs have strong dispersal capacity, and that seasonal movement patterns of BMSB nymphal populations are an important component of a site-specific management program. (Project No. 1931-21000-019-00D)

New introductions of the brown marmorated stink bug and progress in developing an improved lure for monitoring the insect.

The brown marmorated stink bug is an invasive insect pest that causes damage in a wide variety of U.S. fruit and vegetable crops. Scientists previously thought the occurrence of the bug was due to a single introduction into the United States. However, ARS researchers in Newark, Delaware, and Montpellier, France, used genetic tools to

show that brown marmorated stink bug populations in California, Oregon, and Washington were different from populations in the Northeast, which indicated that local populations resulted from different introductions. This research demonstrates the continued need for inspecting imported products for invasive pests. These new detections, as well as treatment schedules, will be aided by work of ARS researchers in Beltsville, Maryland, and Kearneysville, West Virginia, to develop an effective chemical lure. (Project Nos. 1245-22000-272-00D and 1926-22000-026-00D)

No-till systems are helping producers restore soil health.

Weed control is a major component of any crop production system. ARS scientists in Brookings, South Dakota, found that no-till production aids weed management because no-till leaves weed seeds on the soil surface, where their viability is rapidly reduced. Acting on these research results, no-till producers using rotations comprised of a diversity of crops are managing weeds with 50 percent less inputs compared with conventional systems involving tillage, and 1- or 2-crop rotations. In some diverse rotations, no-till producers have eliminated the need for in-crop herbicides in 75 percent of their crops, which reduces production costs and pesticide use. (Project No. 5447-21220-005-00D)

Herbicide rotations found to be a poor strategy for preventing herbicide resistance in agricultural weeds.

Weeds are evolving to become more herbicide-resistant, a trend that is threatening crop production and raising food costs. An analysis by ARS researchers in Urbana, Illinois, of over 500 site-years of empirical data provided compelling evidence that herbicide rotation management—a strategy that is commonly recommended to growers to delay or prevent herbicide resistance-- is not only ineffective, but may actually exacerbate the problem. In contrast, this work highlights the importance of using single applications of chemically complex herbicides as a short-term method to forestall herbicide resistance while highly diversified weed management practices are established for long-term sustainable management. This finding provides new information that can be used by producers and custom applicators in designing the chemical control component of weed management programs. (Project No. 3611-12220-008-00D)

Method developed to remotely identify herbicide-resistant Palmer amaranth.

Palmer amaranth is a troublesome agronomic weed in the southern United States, and several populations have evolved resistance to the herbicide glyphosate. ARS researchers in Stoneville, Mississippi, developed methods to identify glyphosate-resistant and glyphosate-sensitive Palmer amaranth plants based on their spectral images from photographs. Glyphosate-sensitive plants have higher light reflectance in the visible light region and lower light reflectance in the infrared region of the light spectrum, which is invisible to the human eye. Fourteen wavebands of the photospectrum provided a classification system that could identify glyphosate-sensitive and -resistant plants with an accuracy rate of 94 percent for greenhouse-grown plants and 96 percent for field-grown plants. These results demonstrate that researchers can use hyperspectral imaging to identify glyphosate-resistant Palmer amaranth plants remotely without incurring the expense of using glyphosate. (Project No. 6402-21000-050-00D)

Herbicide options for weed control in edamame.

The nutraceutical food known as edamame, which is vegetable soybean, has become popular with Americans, but much of the product consumed in the United States is imported. U.S. vegetable farmers are reluctant to cultivate edamame because weed competition can severely lower crop yields and there are few herbicides registered for weed control. In fact, 4 years ago only a single herbicide was registered for edamame use. However, based in part on the work of ARS researchers in Urbana, Illinois, seven herbicides representing six modes of action are now available for use by farmers to grow edamame. This work supports U. S. growers who are looking for new options for producing marketable crop commodities. (Project No. 0500-00007-091-00D)

Protection and preservation of bee germplasm.

A decline in the numbers of managed honey bee colonies worldwide as well as in the populations of many indigenous bee pollinators has created an urgent need for germplasm preservation methods for honey bees and solitary bees. ARS researchers in Fargo, North Dakota, in collaboration with researchers at North Dakota State University, have developed a technique for the cryopreservation of honey bee sperm that yields 100 percent

survival of the sperm after thawing. This technique will enable the conservation of not only honey bee genetic diversity, but also that of other bee pollinators, and will be used by customers and stakeholders in the honey bee and solitary bee industry to maintain genetic diversity and preserve species. (Project No. 5442-21220-027-00D)

Honey bee protein supplements not as good as natural pollen.

In addition to the parasites and pathogens that attack honey bees, poor nutrition adds to honey bee stress and is thought to be a contributing factor to colony decline. When pollen, a source of honey bee nutrition, cannot be collected due to the absence of flowering plants, beekeepers will often feed their honey bee colonies a protein supplement. ARS scientists in Tucson, Arizona, demonstrated that these supplements have less protein than pollen and that honey bees do not digest them well. Furthermore, bees in colonies fed protein supplements experienced a higher incidence of disease and queen loss and, overall, had higher mortality than colonies that consumed pollen. These findings underscore the need to supply bees with pollen. This information will be used by beekeepers and extension agents working with honey bees to ensure colonies are receiving proper nutrition. (Project No. 5342-21000-018-00D)

Chemicals and pathogens that affect honey bees.

The honey bee is a beneficial insect because it pollinates crops with an added value of more than \$15 billion, and produces honey for human consumption. The health of honey bee colonies is jeopardized by numerous parasites and pathogens, and by insecticides and herbicides the bees come in contact with during foraging. ARS scientists in Beltsville, Maryland, found that diverse chemicals applied to agricultural crops accumulated in beeswax, honey, and in the bees themselves, and levels of one fungicide in particular (chlorothalonil) were shown to be correlated with lack of overall colony health, including susceptibility to the fungus *Nosema ceranae*. These results provide new information that can be assessed by beekeepers, extension agents, agrochemical companies, and regulatory officials interested in honey bee health. (Project No. 1245-21000-277-00D)

Evaluation of honey production by mite-resistant honey bees.

Among the parasites that attack honey bees, the *Varroa* mite is considered the most damaging and the biggest threat to bee colony survival. In Montana, Russian honey bees, which are resistant to *Varroa*, were evaluated over a 2-year period for honey production and mite infestation, and compared with non-resistant honey bee lines. The ARS scientists in Baton Rouge, Louisiana, who oversaw the study, reported that although the Russian bees produced less honey per colony (127 pounds) in the second year of the study than the non-resistant honey bees (162 pounds), they still produced more honey than the 60 to 90 pounds per colony reported nationally in the last few years. Importantly, Russian bees had fewer mites compared with the colony-threatening levels of mites found in the non-resistant honey bees. This research also shows that mite-resistant honey bees function well under commercial honey-producing conditions. (Project No. 6413-21000-014-00D)

Nest attractant developed for the blue orchard bee.

The blue orchard bee is a bee species native to North America that can be used as a pollinator of several commercial crops, including almonds, a multi-billion dollar industry. ARS scientists in Logan, Utah, and Fargo, North Dakota, in collaboration with a pollination company in California identified a chemical that attracted blue orchard bees to artificial nesting materials, which led to better nest establishment and better management of bee colonies. A patent has been filed for the chemical attractant and the information from the finding can now be evaluated by researchers who use native bees in almond pollination. (Project No. 5428-21000-015-00D)

Greenhouse tomatoes benefit from bumble bee pollination.

The bumble bee is a solitary bee species native to the United States. ARS scientists in Logan, Utah, evaluated the ability of different species of bumble bees to pollinate tomatoes grown in greenhouses. They discovered that not only were all species equally effective pollinators, but that tomato plants pollinated by bumble bees produced tomatoes that were 13 percent larger than plants with no access to the bees. This information will allow bumble bee producers to better focus their efforts and greenhouse tomato producers to consider the benefits of using bumble bees as pollinators. (Project No. 5428-21000-015-00D)

Female alkali bees must eat pollen.

The alkali bee is a ground-nesting solitary bee native to the western United States, and is a pollinator of alfalfa. ARS scientists in Logan, Utah, in collaboration with scientists in Washington State, showed that female alkali bees ate pollen at the end of each day, after they had collected nectar and pollen for rearing their offspring. The researchers extended this study to show that a species of mason bee needed to eat pollen to develop mature eggs. This information is useful to individuals and organizations that rear solitary bees for pollination services. (Project No. 5428-21000-015-00D)

Analysis of bacteria associated with honey bee pollen and nectar collectors.

The honey bee is an important insect pollinator of many agricultural crops. In an effort to improve honey bee nutrition, ARS scientists in Tucson, Arizona, catalogued the bacteria found in foraging honey bees that collected pollen and nectar. Genetic analyses of these bacteria are ongoing and will provide essential information to scientists researching honey bee nutrition. (Project No. 5324-21000-017-00D)



PLANT GERMPLASM AND CULTIVAR RELEASES

ARS scientists have a long and successful history of genetic improvement of plants. For some crops, ARS conducts cultivar development programs and releases finished cultivars. For other crops, ARS researchers produce superior breeding lines that are released and used by public and private plant breeders to create new cultivars. ARS also distributes unimproved plant genetic resources (germplasm).

New cultivars and enhanced germplasm.

ARS released 50 new cultivars and breeding lines. These releases included the following crops: peanut, pea, potato, carrot, lettuce, mustard greens, cucumber, watermelon, raspberry, blackberry, blueberry, apricot, plum, apple root stocks, hops, soybean, wheat, triticale, barley, sorghum, oil sunflower, pearl millet, cotton, pennycress, prairie clover, Bermuda grass, meadow fescue, and bluebunch wheatgrass.

Release of new apple rootstock with tolerance to apple replant disease.

Diseases affecting U.S. apple crops have been affecting yields and profits. ARS and Cornell University researchers in Geneva, New York, have developed and released a new apple rootstock, named G.814, a dwarfing, productive, early bearing, and highly yield-efficient tree. It is the most recent product from a series of disease-resistant and productive apple rootstocks developed by the Geneva breeding program. This rootstock is resistant to fire blight and crown rot, two serious diseases that infect apple trees with serious economic consequences. Most importantly, G.814 has shown tolerance to the apple replant disease complex. This rootstock was tested for 15 years to evaluate rootstock productivity levels and compared with standard cultivars. On the basis of preliminary trials in the United States, G.814 will increase production of larger, high-quality fruit in marginal replanted orchard land, which will help apple producers increase yields and profits. (Project No. 1910-21000-026-00D)

EPA amends the registration of ‘HoneySweet’ biotech plum, thus clearing the way for a public release.

Sharka disease, which is caused by the plum pox virus, has devastated stone fruit production (plum, peach, cherry, and almond) in Europe and periodically threatens the United States. There is no known source of natural genetic resistance to Sharka. When outbreaks are discovered in North America diseased trees are eradicated by removal at great cost. ARS scientists in Kearneysville, West Virginia, have developed a biotech plum called ‘HoneySweet’ that is resistant to Sharka. EPA approved an amendment to the registration of ‘HoneySweet’ that will require ARS, but not nurserymen or ‘HoneySweet’ growers, to be responsible for registering, keeping records, and reporting production of ‘HoneySweet’ to the EPA. This agreement provides a way forward for ARS to officially release C5 ‘HoneySweet’ plum as an option for plum growers facing a severe outbreak of Sharka disease. (Project No. 1931-21000-023-00D)

New soybean cultivar JTN-5110 has resistance to multiple pathogens.

In the United States, combined soybean yield losses from the soybean cyst nematode (SCN) and several damaging fungal diseases (charcoal rot, stem canker, sudden death syndrome, and Frogeye leaf spot) are estimated to be nearly \$1 billion. Although soybean cultivars with SCN resistance have stabilized some yield losses, nematode populations have evolved that are now able to infest the resistant cultivars. ARS researchers in Jackson, Tennessee, developed and released a new soybean line, JTN-5110, that yields from 62 to 66 bushels/acre and has resistance to SCN and the fungal diseases. Growers have been anticipating a cultivar with these combined traits and are adopting the new release for more effective SCN management. This release also is being used by soybean breeders as an excellent parent material in developing more desirable cultivars. (Project No. 6402-21220-011-00D)

The release of ‘Huckleberry Gold’, a new nematode-resistant potato cultivar.

The potato cyst nematode (PCN) is increasingly responsible for economic losses in the U.S. potato industry, and the most effective and environmentally sound approach for controlling the PCN is improving host resistance. ARS researchers in Ithaca, New York, in collaboration with potato breeders at Aberdeen, Idaho, have developed Huckleberry Gold, a specialty market potato cultivar with resistance to PCN and potato virus X. Potato producers can use this new resistant cultivar to reduce losses associated with the PCN and support eradication efforts in the United States. (Project No. 1907-22000-021-00D)

Sorghum multi-seeded mutants increase seed yield.

ARS researchers in Lubbock, Texas, and Ithaca, New York, identified multi-seeded mutants and related genes with more primary and secondary flowering branches. These have been incorporated into higher yielding sorghum germplasm lines. These discoveries are now enabling public and private sector sorghum breeders to exploit the germplasm lines and related molecular markers to develop new varieties with substantially increased sorghum yields. (Project No. 6208-21000-01700D)

New yield genes from a soybean wild relative found in the USDA soybean collection. The narrow genetic base of the soybean crop limits progress in developing higher yielding varieties. ARS scientists in Urbana, Illinois, discovered and transferred into cultivated soybean unique yield genes from *Glycine tomentella* (a very distant, perennial relative of soybean). These two species are so genetically different that direct progeny from these crosses are sterile, and special procedures, including several backcrosses to the soybean parent, were needed to produce fertile progeny. Each new plant from these crosses is likely to have a different complement of *G. tomentella* chromosomes and could be genetically quite different. In tests at seven locations across four states, 10 lines were identified that yielded significantly more than the commercial soybean parent—as much as by 7 bushels/acre. This is the first report of soybean lines derived from perennial *G. tomentella*. Increasing yield is the most important objective for soybean breeders, and the genes to increase yield that were transferred from *G. tomentella* are now available to soybean breeders for the first time. (Project No. 3611-21000-026-00D)

New Hessian fly resistance gene identified in wheat.

Hessian fly populations have become virulent to most resistant wheat varieties grown in the southeastern United States. ARS researchers in West Lafayette, Indiana, worked with collaborators at Purdue University to identify a

new resistance gene called H33 and moved it from a wheat relative into cultivated bread wheat. The H33 gene was shown to provide effective protection of wheat against Hessian fly attack in the southeastern United States. Molecular markers were identified to aid in moving this resistance gene into wheat cultivars through marker-assisted selection. Knowledge from this study will help wheat breeders prevent yield loss due to Hessian fly attack. (Project No. 3602-22000-018-00D)

A new common bean with tolerance to low soil fertility.

Inadequate soil fertility, high costs of fertilizers, and root rots are common crop production constraints worldwide. TARS-LFR1, a multiple disease-resistant common bean with superior performance in low-nitrogen soils and with root rot resistance was developed via collaboration among researchers with ARS in Mayagüez, Puerto Rico, the University of Puerto Rico, and Cornell University. In addition to root rot, this germplasm has resistance to common bacterial blight and Bean common mosaic virus, and it yields well in association with rhizobia through biological nitrogen fixation. This combination of traits will be valuable for plant breeders who seek to target low-input and organic production systems, in which little to no fertilizer is applied. (Project No. 6635-21000-054-00D)

New switchgrass hybrid expands opportunities in northern climates and marginal environments.

Switchgrass is one of the leading candidates for bioenergy feedstock production, especially in marginal environments where field crops are neither profitable nor sustainable. However, many of those marginal lands are in the more northern USDA Hardiness Zones 3 and 4 where switchgrass is not as productive as it is in the more southern Hardiness Zones 5 and 6. Recent field experiments by ARS scientists in Madison, Wisconsin, demonstrated that biomass yields in Zones 3 and 4 can be increased and competitive to those grown in Zones 5 and 6 through directed selection and breeding for high biomass yield and winter survival following harsh winters. The greatest gains in biomass yield, up to a 50 percent increase, were achieved with hybrid switchgrass that combined the high yield of a southern strain with the winter hardiness of a northern strain. This research provides the first documentation that high-yielding switchgrass strains can be productive in Hardiness Zones 3 and 4. (Project No. 3655-21000-05600D)

New sand bluestem forage variety released for the arid Southern Plains Region.

Under field conditions, soil moisture is often inadequate for the satisfactory establishment of native grass seedlings. These dry soil conditions limit a range land manager's ability to reestablish native grasses after a disturbance, such as drought or energy exploration. ARS scientists in Woodward, Oklahoma, in cooperation with the NRCS in Knox City, Texas, and Manhattan, Kansas, have developed a variety of sand bluestem (a native, perennial, warm season bunch grass) that has superior field emergence and plant density when planted in dry soil conditions. The new variety, named "Centennial," was developed using traditional breeding techniques, and is expected to help increase establishment success with its improved seed germination under dry soil conditions. This variety has demonstrated increased emergence and 17 percent higher plant density compared to other varieties, providing range land managers another viable option when attempting to establish native grasses on disturbed lands. (Project No. 6216-21630-010-00D)

Unenhanced plant germplasm distribution.

The National Genetic Resources Program (NGRP) is responsible for acquiring, characterizing, preserving, documenting and distributing to scientist, germplasm of all life forms important for food and agricultural Production. In CY 2014, 255,402 plants or seeds were distributed. The table below lists the number of distributions from the NGRP repositories in the Germplasm Resources Information Network (GRIN) to different organizational categories for CY 2014.

Organization Categories Key: FCOM=Foreign commercial company, FGEN=Foreign genebank/resources unit, FIND=Foreign individual no affiliation, FPRU=Foreign non-commercial organization, INT=CGIAR International Agr. Res. Center, STA=U.S. state agencies and all universities, UARS=Agricultural Research Service, UCOM=U.S. commercial company, UFED=U.S. Federal agency (not ARS or AID), UNID=U.S. individual no affiliation, and UPRU=U.S. non-profit organization.

Annual Reporting on Technology Transfer in USDA, FY 2015

Repositories Key: COR=Natl. Germplasm Repository- Corvallis, COT=Cotton Collection, DAV=Natl. Germplasm Repository- Davis, GEN=Natl. Germplasm Repository- Geneva, GSOR=Rice Genetic Stock Center, GSPI=Pea Genetic Stock Collection, HILO=Natl. Germplasm Repository- Hilo, MAY=Natl. Germplasm Repository- Mayaguez, MIA=Natl. Germplasm Repository- Miami, NC7=North Central Regional PI Station, NE9=Northeast Regional PI Station, NR6=Potato Germplasm Introduction Station, NSGC=National Small Grains Collection, NSSL=National Center for Genetic Resources Preservation, NTSL=Forest Service National Seed Lab, OPGC=Ornamental Plant Germplasm Center, PARL=National Arid Land Plant Genetic Resources Unit, RIV=Natl. Germplasm Repository- Riverside, S9=Southern Regional PI Station, SOY=Soybean Collection, and W6=Western Regional PI Station.

SITE	UARS	UFED	STA	UCOM	UPRU	UIND	UAID	INT	FGEN	FCOM	FPRU	FIND	Totals
COR	760	26	1141	1023	194	3456	0	0	326	147	423	74	7570
COT	0	0	59	10	5	28	0	0	0	0	0	1	103
DAV	231	5	1023	1070	270	4971	0	0	138	9	128	30	7875
GEN	2005	18	637	591	262	2565	0	0	0	4	99	90	6271
GSOR	1777	1	3895	223	250	49	0	0	3	104	5331	5	11638
GSPI	13	0	64	4	0	8	0	0	5	7	185	26	312
HILO	63	0	28	29	12	82	0	0	0	22	0	0	236
MAY	25	16	57	42	42	147	0	0	81	0	1	6	417
MIA	77	0	205	41	19	64	0	0	0	0	22	0	428
NC7	2390	8	10319	8460	982	1862	0	349	83	6904	11274	132	42763
NE9	70	5	2123	1254	198	316	0	0	0	1493	634	48	6141
NR6	1651	13	1342	1812	138	365	0	0	1	30	178	29	5559
NSGC	15338	5	21691	3032	148	1202	0	44	1014	729	21507	121	64831
NSSL	97	0	56	7	4	5	0	0	3	33	13	27	245
NTSL	865	1	0	0	0	0	0	0	0	0	0	0	866
OPGC	9	0	140	73	23	141	0	0	0	135	37	3	561
PARL	18	0	208	291	117	239	0	0	22	19	43	2	959
RIV	123	0	110	2	30	37	0	0	32	3	170	27	534
S9	3228	5	16374	3843	339	818	0	1	1223	4932	3982	139	34884
SOY	4118	2	13858	8083	270	262	0	0	1684	241	746	0	29264
W6	3125	67	9163	1931	1012	3914	0	2044	1318	599	10001	771	33945



NATIONAL AGRICULTURAL LIBRARY

The National Agricultural Library (NAL) is one of the largest and most accessible agricultural research libraries in the world. NAL provides services directly to the staff of USDA and to the public, primarily via the NAL Web site, <http://www.nal.usda.gov>. NAL was formed with USDA in 1862 and was named in 1962 a national library by Congress, as “the primary agricultural information resource of the United States.” NAL is the premier library for collecting, managing, and disseminating agricultural knowledge. The Library is the repository of the Nation’s agricultural heritage, the provider of world class information, and the wellspring for generating new fundamental knowledge and advancing scientific discovery. It is a priceless national resource that, through its services, programs, information products, and Web-based tools and technologies, serves anyone who needs agricultural information. The Library’s vision is "advancing access to global information for agriculture."

PubAg.

PubAg is a portal to USDA-authored and other highly relevant agricultural research. At launch in 2014, PubAg delivered over 41,892 full-text journal articles by USDA staff and included nearly 1,011,937 citations. NAL is adding about 20,000 citations each month. PubAg also provides access to 340,000 peer reviewed, agriculture-related scientific articles, published primarily between 2002 and 2012. Each article citation in PubAg includes an abstract, NAL Thesaurus subject terms, and a link to the article if available from the publisher. PubAg can be found at <http://PubAg.nal.usda.gov>.

DigiTop.

NAL obtained contributions from across USDA to purchase licensed full text databases to support research and scientific discovery. Just over two years ago, NAL launched a new component of DigiTop, called Navigator, that enables cross searching of multiple bibliographic databases. This system includes AGRICOLA, AGRIS, BIOSIS, CAB Abstracts, Fish, Fisheries & Aquatic Biodiversity Worldwide, Food Science and Technology Abstracts, GEOBASE, GeoRef, MEDLINE, Wildlife & Ecology Studies Worldwide, Scopus, and Zoological Record. The Navigator service allows researchers to access nearly 79 million records at once and is updated weekly.

Automated indexing.

NAL is continuously improving full scale production—automated indexing/text analytics software to generate the AGRICOLA Index of agricultural literature. This application combines semantic analysis, machine learning, and human constructed rules to automatically assign NAL Thesaurus subject terms to journal article citations. This metadata facilitates effective literature classification, management, search, and retrieval.

Digitization of NAL collections.

NAL is in the midst of a large scale digitization project to digitize agricultural literature and provide online access to the general public. Important and distinctive items were selected from the NAL collection, with an initial focus on USDA issued publications and nursery and seed trade catalogs. Publications are accessible at <https://archive.org/details/usdanationalagriculturalibrary>.

i5K Workspace at NAL.

NAL launched the i5K (insect 5,000 genome) Workspace (<https://i5k.nal.usda.gov/>) to meet the initiatives needs for genome hosting and other bioinformatics services. The Workspace currently hosts 35 genomes with several more in the pipeline. Approximately 200 researchers are involved in community annotation. Content is accessible via organism pages, genome browsers, and a completely updated and improved BLAST search engine, implemented via the open source Tripal framework, a Web interface for the underlying Chado database schema.

VIVO.

NAL launched VIVO, a Web application used internally by USDA scientists since 2012, to allow for better national networking across disciplines and locations. USDA VIVO will be a "one-stop shop" for Federal agriculture expertise and research outcomes. This efficient networking tool enables scientists to more easily locate others with a particular expertise that may contribute to a project's success. VIVO also makes it possible to quickly identify scientific expertise to address and rapidly mobilize a response on emerging agricultural issues, such as specific plant and animal diseases or pests.

3.10. Outreach Activities: Workshops, Field Days & Forums



Arizona:

Arid-Land Agricultural Research Center

- Arid-Land Agricultural Research Center and the University of Arizona, Maricopa Agricultural Center in Maricopa co-hosted Farm Day, a community outreach event. ARS research in entomology, plant science and water management was featured using interactive displays and hands-on activities. Approximately 350 people attended from the city of Maricopa and surrounding communities, including stakeholders. (10/25/14)
- A tour of the center, the center's greenhouses and field plots were given by a scientist to visiting researcher from Rubber Technology Center, India. (10/8/14)

Carl Hayden Bee Research Lab

- Presented research on photoperiodic control of *Lygus* diapause. Approximately 500 industry, federal, and state university personnel associated with cotton were in attendance. (1/5-7/15).
- Scientists presented their research on the effects of honey bee nutrition on colony health at a commercial beekeepers meeting, research conference, and Carl Hayden Bee Research Center Laboratory Open House. Approximately 400 industry and research personnel from the American Honey Producers, American Beekeeping Federation, Apiary Inspectors of America, and American Bee Research Conference participated in the various events. (1/7,8,20-22/15)

Pest Management and Biocontrol Research Unit

- Presented research on photoperiodic control of *Lygus* diapause. Approximately 500 industry, federal, and state university personnel associated with cotton were in attendance. (1/5-7/15).
- Dr. James Hagler provided hands-on training on Insect Immunomarking. Pennsylvania State University is using the procedure Dr. Hagler developed to track insect dispersal patterns in an agroecosystem. Ohio State University plans to use the method to track bed bug dispersal patterns in urban landscapes. (3/2-6/15, 7/21-22/15)

Plant Physiology and Genetics Unit

- Participated in the 5th AgMIP Global meeting to promote collaborative research on potential impacts of climate change on agriculture. Approximately 300 international scientists with expertise in economics, climatology, data

management and crop production participated. (2/25-28/15)

- Presented the approach used by the Agricultural Model Intercomparison and Improvement Project (AgMIP) for documenting field research at the "Improving Semantics in Agriculture" Workshop held at the Food and Agriculture Organization of the United Nations, Rome, Italy to assess opportunities for improved management of data from agricultural research and development efforts. Approximately 60 researchers, which included development specialists from diverse institutions in Europe, South America and Africa, and information management specialists attended. (7/2-3/15)
- Presented work on guayule production and breeding in Arizona during the 2015 School of Plant Sciences Research Retreat. University professors, directors, and researchers were in attendance.
- Experimental data on the response of wheat to a wide range of temperatures obtained by varying planting date and infrared heating were furnished to wheat growth modelers for the purpose of testing the high temperature aspects of their models. This information has been distributed widely to University of Arizona and other academic researchers. (3/25/15, 5/1/15, 8/4/15)
- Presented/discussed with Microsoft Computational Research Laboratory, Cambridge, UK, the effects of elevated CO₂ on cotton, wheat and sorghum, resulting from free-air CO₂ enrichment (FACE) experiments. The data will be used in validation test of crop growth models used to predict likely effects of global change on future crop productivity. (1/28/15)
- In an effort to improve the response of wheat growth models to high CO₂ concentrations, such as anticipated in the future, as well as drought and low nitrogen, ARS scientists from the Plant Physiology and Genetics Research unit and the University of Arizona furnished a wheat dataset from wheat that had been grown at elevated CO₂ concentrations and at ample and limited supplies of water and nitrogen. University of Bonn, Germany received the information and will distribute the data to at least eight other scientists at institutions around the world. (5/7/15)

Southwest Watershed Research Center

- In an effort to improve the response of wheat growth models to high CO₂ concentrations, such as anticipated in the future, as well as drought and low nitrogen, ARS scientists from the Plant Physiology and Genetics Research unit and the University of Arizona furnished a wheat dataset from wheat that had been grown at elevated CO₂ concentrations and at ample and limited supplies of water and nitrogen. University of Bonn, Germany received the information and will distribute the data to at least eight other scientists at institutions around the world. (5/7/15)
- Dave Goodrich, Mark Nearing, and unit staff presented a two-day workshop to 30 participants including action agencies, consultants, and students on the Automated Geospatial Watershed Assessment (AGWA) tool and the Rangeland Hydrology and Erosion Model (RHEM). (3/18-19/15)

Water Management and Conservation Research Unit

- Two scientists met with a Cotton Incorporated representative to discuss research on mitigation of nitrous oxide emissions from cotton and guayule, and high throughput cotton phenotyping plans for 2015. (12/2/14)
- Scientists in the Plant Physiology & Genetics Research Unit and the Water Management & Conservation Research Unit; in collaboration with the University of Arizona, Kansas State University, and private industry; conducted a four-day workshop to introduce researchers to basic principles of field-based high throughput phenotyping. Approximately 50 grad students, researchers and private company personnel participated.
- Provided an update of nitrogen budgets for surface and sprinkler irrigation management approaches for southwest cotton. Data was presented to 120 industry consultants and cotton producers from Arizona, California, Idaho, and Utah. (3/5/15)
- Participated in the Pakistan Water Dialogue. The Dialogue is an initiative led by USDA Foreign Agricultural Service (FAS) and the Pakistan office of the International Water Management Institute (IWMI). The scientist provided information on technology for hydraulic modeling of surface irrigation systems, as well as conducting a one day training workshop on the use of the WinSRFR software to staff of the IWMI and various Pakistani irrigation management organizations. Participated in a debriefing meeting with US Embassy staff (USAID/ASSIST/State Department) to discuss USDA activities in Pakistan related to improved irrigation water management. (2/10-13/15)
- Presented a seminar titled: "Current developments in the hydraulic analysis of surface irrigation systems," at the University of Arizona, Agricultural and Biosystems Department, Tucson AZ. The meeting provided an overview of surface irrigation software and allowed discussion of components currently under development that will enhance analytical capabilities for practical and research users. (10/13/14)

- Scientists presented information on the design of a drip irrigation system and how it is operated and managed to grow crops. Interested farmers are planning to develop a 20-acre organic vegetable farm in urban South Phoenix area. County Extension personnel and private farmers participated. (6/30/15)

Water Management and Conservation Research Unit/ Plant Physiology and Genetic Research Unit

- One scientist from the Plant Physiology and Genetics Unit and two scientists from the Water Management and Conservation Unit presented approaches for field-based phenotyping at a workshop at Texas A&M University located in College Station, Texas. Approximately 200 researchers, graduate students and private company personnel attended the event and webinar broadcast. (10/17-18/14)
- Scientists and engineers from USDA-ARS, University of Arizona Yuma Center of Excellence for Desert Agriculture and nMode Solutions of Tucson evaluated the potential technologies to scan plant roots in situ using magnetic resonance imaging. ARS scientists described research on imaging roots of cotton, melon, and sorghum. (9/17/14)

Arkansas:

Dale Bumpers National Rice Research Center

- Dale Bumpers National Rice Research Center, co-hosted with the USA Rice Federation, a tour of the facilities and an overview of research conducted at the center to a delegation from The Philippines, including their Deputy Secretary of Agriculture and will include visits with state government representative and tours of local rice mills and rice farming operations. (6/22/2015)

Delta Watershed Research Unit

- ARS Delta Watershed Research Unit in Jonesboro, AR hosted a meeting with colleagues from the University of Arkansas to discuss edge of field data collection strategies and challenges. (3/5-6/2015)

Brazil:

Animal Genomics and Improvement Laboratory

- Presented (by invitation) a talk on Animal Genomics and Improvement Laboratory research at the 52nd meeting of the Brazilian Society for Animal Science in Belo Horizonte (7/20-23/2015)
- Presented (by invitation) a talk on Animal Genomics and Improvement Laboratory programs to staff of the Holstein Association of Minas Gerais State (7/22/2015)

California:

Exotic and Invasive Weed Research Unit

- Organized a three-part aquatic weed management workshop for natural resource agency personnel seeking CEU credits. An overview of aquatic weed management technology was presented to approximately 520 registered attendees of the California Weed Science Society. CWSS is predominantly for agricultural practitioners, applicators, and crop consultants. (1/21/15)
- Discussed plans by the State of California, Division of Boating and Waterways (CDBW), to control aquatic weeds growing in the bays of a residential boating-oriented development and throughout the Sacramento-San Joaquin Delta. Presented research information to 200 boaters/residents on biocontrol of aquatic weeds, and discussed the role of the new USDA-ARS Area-Wide Project on Aquatic Weeds and Mosquitos in the Delta to improve control outcomes. (2/25/15)
- Reported on the objectives, goals, and progress of the USDA-ARS Areawide Pest Management Program for improved adaptive management of invasive water hyacinth, Brazilian waterweed and arundo for protection of water resources in the drought-stricken Sacramento-San Joaquin Delta. The Delta Plan Interagency Implementation Committee (DPIIC) is a California state executive committee, responsible for the implementation of the Delta Plan, a 50-year plan to achieve co-equal goals to efficiently use the water resources of the Delta and to restore Delta ecosystems. (5/11/15)

- Provided biological life cycle information on the arundo wasp *Tetramesa romana*, a biological control agent of *Arundo donax*, a major invasive grass weed that consumes water in the drought-stricken Sacramento River Valley, and delivered arundo plants with shoot tip galls containing the wasps to three field sites along tributaries of the Sacramento River in Glenn and Butte Counties, CA. The scientist met with landowners and CSU-Chico faculty to coordinate monitoring and further wasp releases. (6/11-26/15)
- Presented on the ecology and management of flowering rush. Accompanied tribal and state / county natural resource agency personnel on a field trip to examine flowering rush infestations and discuss what might be done to manage this species before it expands too much. Approximately 50 riparian users and riverfront users, as well as natural resource agency and tribal management personnel were in attendance. (7/28/15)

Foodborne Toxin Detection and Prevention Research Unit

- Presented a status report on development of a plant volatile-based attractant and proposed research for use of the attractant in pistachio orchards to board members of CPRB, growers, and other researchers. (1/22/15)

Healthy Processed Foods Research Unit

- Demonstrated novel uses for food waste, and showcased commercialized products developed by ARS researched that solve this important global issue. Gorge Delights Just Fruit Bars, NewGem Foods Fruit and Vegetable Wraps, Whole Vine Products Wine Grape Flours and Oils, Whole Vine Products Cookies and T8 Veggie Chips were highlighted, as were nonfood, biodegradable utensils and plates. "Waste to Worth: Food Processing Solutions" was presented for 19,000 registered individuals at this annual event, held in Arlington, Virginia. (2/19-20/15)

Foodborne Toxin Detection and Prevention and Healthy Processed Foods Research and Crops, Diseases, Pests and Genetics Research Unit

- Reported on research to sterilize navel orangeworm (NOW) using x-rays and determination of required doses and experience with NOW including rearing issues inherent to this particular insect. Representatives from California Pistachio Research Board, Almond Board of California, Western Agricultural Processors Association, California Cotton Ginners and Growers Association, ARS, APHIS, Setton Pistachio, and Wonderful Orchards (formerly Paramount Farming) were in attendance. (6/30/15)

Crops Pathology and Genetics Research Unit

- Presented at the Global Alliance for Climate-Smart Agriculture session of the USDA Agricultural Outlook Forum. ARS efforts that were profiled include: GRACEnet, the USDA Climate Hubs and content from the publication "Climate-Smart Agriculture Global Research Agenda: Scientific Basis for Action." Climate-Smart Agriculture technologies from USDA included the Climate Change Response Framework run by the USDA-FS Northeastern Institute for Applied Climate Science and their partners, USDA NRCS COMET-FARM to which USDA-ARS contributes data for this tool's development. Audience included the press, personnel from USDA agencies, NOAA and other US federal and state agencies, representatives from Embassies, commodity groups and agriculture industry representing national and international efforts. Approx. 150 people attended the session; >1000 people participated in the Forum. (2/19-20/15)

Commodity Protection and Quality Research Unit

- Scientist presented research and methods for managing navel orangeworm (NOW) infestation at the South SJV Almond Symposium, alongside UC Cooperative Extension agents and County Ag Commissioner to an audience of individual growers, farming company personnel and university extension specialists. (5/28/15)

Crop Diseases, Pests and Genetics Research Unit

- Central San Joaquin Valley table grape growers and the California Table Grape Commission were shown new advanced table grape selections from the ARS breeding program in Parlier, CA. Both newly harvested selections,

and some held in storage for two months, were on display for tasting and evaluation at the research meeting. The meeting's purpose was to provide growers with the opportunity to sample and comment on new advanced table grape selections relative to existing commercial varieties. (10/2/14)

Water Management Research Unit

- Scientists from the Water Management Research Unit co-organized and presented at the 2014 Pomegranate Field Day held at University of California Kearney Ag Center. Research findings on water and nitrogen use, and tree growth parameters were reported to approximately 40 individual growers, farming company personnel, and university extension specialists. Event participants toured the research orchard. (10/2/14)
- Approximately eight growers from Maine toured the San Joaquin Valley and visited the SJVASC to learn water management practices and instrumentation for irrigation and crop water use. (2/18/15)

Colorado:

Central Great Plains Research Station

- The Annual Spring Field Day is a combined effort with Colorado State University. Scientists present relevant information to customers attending the event. Farmers come from Kansas, Wyoming and Nebraska, lunch is sponsored by the local Ag-industry. There were 102 attendees. Stakeholders praise ARS for the event and the ideas and discussion that occur during the day. These discussions have tremendous value to ARS as a feedback mechanism with several customers/farmers who we serve.

Water Management Research Unit

- The Water Management Research Unit along with Colorado State University collaborators held a joint field day at the USDA Limited Irrigation Research Farm. Sixty-three stakeholders attended representing water conservation districts, university cooperative extension, academic researcher, state and federal agencies and private industry.

Denmark:

Animal Genomics and Improvement Laboratory

- Presented (by invitation) presentation on gut health of ruminants and Animal Genomics and Improvement Laboratory research at the 8th International Conference on Farm Animal Endocrinology (8/27/15)

Florida:

Animal Genomics and Improvement Laboratory

- Presented papers on Animal Genomics and Improvement Laboratory research at the 2015 Interbull annual meeting in Orlando (7/9-12/2015)
- Presented talks and posters on Animal Genomics and Improvement Laboratory research at the 2015 joint annual meeting of the American Dairy Science Association and the American Society for Animal Science in Orlando (7/12-16/2015)

Georgia:

Crop Genetics and Breeding Research Unit

- Hosted a delegation of women scientists from Pakistan, as part of the Department of State's International Visitor Leadership Program. The delegation consists of eight female scientists from various agricultural disciplines, including aquaculture, plant breeding, weed science, and agronomy. (12/3/2014)

Southeast Poultry Research Laboratory

- ARS Southeast Poultry Research Laboratory hosted a training with (APHIS) USDA, and provides field veterinarians with current information on foreign animal diseases and preparedness for infectious disease outbreaks. (2/18-

19/2015)

- Hosted the 9th International Symposium on Avian Influenza. The conference is held every 6 years in the USA and has 254 participants from 35 countries. (4/12-15/2015)

Southeast Fruit and Tree Nut Laboratory

- ARS Southeastern Fruit and Tree Nut Laboratory in Byron, GA, hosted a Pecan Field Day for about 350 attendees from southeastern states. ARS pecan researchers highlighted aspects of ongoing research activities and information of relevance to pecan farmers of southeastern United States. (9/3/2015)

Hawaii:

Daniel K. Inouye U.S. Pacific Basin Agricultural Research Center

- Presentation of recent research on microbial biological control of coffee berry borer to research and extension scientists and coffee growers.

Tropical Crop and Commodity Protection Research and Tropical Plant Genetic Resources and Disease Research Units

- Hosted a visit of Japanese nationals representing a government ministry, a university, a non-profit organization and a private farm. Presented research approaches to pest management including development of GE papaya and its coexistence with non GE Papaya, irradiation treatment of fruit to enable shipment out of state and country, development of pest attractants, research to improve the sterile insect technique, and the methods used to communicate with U.S. stakeholders to best serve their needs.
- The flat bark beetle *Cathartus quadricollis* is a predator of the coffee berry borer, a worldwide pest of coffee and a new pest in Hawaii. This predator can be raised on a cracked corn-cornmeal diet, and a raise and release program was started by providing farmers with a predator starter kit. Distributed >200 kits to coffee farmers.

Tropical Plant Genetic Resource and Disease Research Unit

- Spoke about the zero waste research project including increasing biomass and lipid production of algae and its potential use as fish feed to the owners of Big Island Biodiesel and state government personnel. (10/2/14)
- Lectured on techniques for controlling plant-parasitic nematode pests in nursery and floriculture operations in a presentation titled "Management of Plant-parasitic Nematodes in Nursery Production" to local growers of nursery and floriculture crops. (10/3/14)
- Gave a tour of the research projects, field and facilities and overview of the National Plant Germplasm system to a professor and 15 students from the University of Hawaii at Hilo, College of Agriculture, Forestry and Natural Resources Agribusiness class (02/09/15).
- Provided an overview of Rapid Ohio Death research going on at DKI-PBARC to US Forestry, homeowners and land management representatives. (1/13/15)
- Provided an overview of the CBB research going on at DKI-PBARC and the implementation of the Area-Wide IPM Program to coffee growers and industry representatives. (1/30/15)
- A small group of quarantine treatment researchers from tropical regions of 5 continents discussed taxonomy, trade, market access, treatment responses, and future collaborations proposed treatment approaches to control Oriental Fruit Fly (12/15/14)

Tropical Crops and Commodity Protection Research Unit

- Presented a webinar talk "Phytosanitary Irradiation for Control of Quarantine Insect Pests" to Department of Energy, Department of Homeland Security, USDA APHIS and industry representatives as part of an Alternative Technologies for Radioactive Sources Working Group meeting. The group is exploring electronic alternatives to cesium-137 and cobalt-60 research and blood irradiators. Follett discussed his plans to build a cabinet style x-ray irradiator to treat fruit for quarantine insect control and market access. (7/7/15)
- Presented research on improving the post-processing color, flavor and shelf-life of roasted macadamia kernels. About 150 growers and processors attended. (6/20/15)
- Released version 0.6 of MED-FOES (MEDfly, Outbreak and Extirpation Simulation). The new version includes a spatial component, and is available online for use by regulators and program managers around the world.

Idaho:

Small Grains and Potato Germplasm Research

- Presented at the Oat Rust Forum 2015 on the development of a molecular marker platform that would be capable of diagnosing oat lines for the crown rust resistance genes that they carry. Approximately 25 breeders, growers and industry representatives attended. (02/17/15)

Illinois:

National Center for Agricultural Utilization Research, Crop Bioprotection Research Unit

- Summary information on field work related to evaluation of low lignin sorghum lines for insect damage distributed as a handout at Central Illinois Irrigated Growers Association, Irrigation Clinic at Havana, IL. 2/5/15
- Identified and developed an attractant that is being used by farmers, land managers, and city arborists, to survey for the presence of an invasive ambrosia beetle (Polyphagous Shot Hole Borer) which is causing severe damage to avocado and urban trees in southern California. The attractant was developed with a commercial collaborator.

National Center for Agricultural Utilization Research, Bio-oils Research Unit

- Participated in the STLE Annual Meeting in Dallas, TX and presented three papers (authored by Bantchev et. al., Harry-O'Kuru et. al.); attended the STLE Fellows Committee meeting; and taught several modules of the "Biofuels and Biolubricants" course. 5/17-21/15

National Center for Agricultural Utilization Research, Mycotoxin Prevention and Applied Microbiology Research Unit

- Presentations at the 2015 Corn Dry Milling Conference including the impacts of climate change on physiology, promising applications of nanotechnology, and free vs. total toxin levels in corn. 5/14/15

Indiana:

National Soil Erosion Research Laboratory Unit

- Conducted a training workshop on Water Erosion Prediction Project (WEPP) model at the 10th Federal Interagency Sedimentation Conference at Reno, NV. 4/23/15

Iowa:

Agroecosystems Management Research Unit

- Gave invited presentation "Saturating Riparian Buffers in Tile Drained Landscapes for Nitrate Removal" at 2015 Waseca County Farmer Forum. Farmers and state agency personnel attended. 3/11/15
- Gave presentation "Field-edge practices to reduce nitrate losses to surface waters from tile-drained fields," at 2015 Summer Education Week for American Society of Farm Managers and Rural Appraisers, Omaha, NE. 7/21/15
- Presented at the Minnesota Crop Production Retailers CPM Short Courses and Trade Show, Minneapolis, MN, on using cover crops to reduce nutrient losses and to improve soil health to crop consultants and agricultural business people over two sessions. 12/10/14
- Participated in the Iowa Independent Crop Consultants Annual Meeting in Ames, IA, and presented an overview of how various soil and crop management strategies affect phosphorus, potassium, and sulfur cycling in soil and losses of these nutrients from the plant root zone. Attended by 60 Certified Crop Consultants. 2/18/15
- Participated in the North Central Industry-Extension Soil Fertility Conference in Des Moines, IA, and provided an update on current research addressing potassium availability in upper Midwest soils. Attended by 150 fertilizer industry representatives, Cooperative Extension personnel, and independent consultants from the U.S. and Canada. 11/19-20/14
- Held a two-day training session on the Agricultural Conservation Planning Framework at Mankato, MN, which was attended by 24 individuals affiliated with state and federal agencies, county government, universities, and engineering consulting firms. This software enables spatial analyses to identify where various types of conservation

practices can be placed in a watershed for water quality improvement. 8/13-14/15

Corn Insect and Crop Genetics Research Unit

- Presented research to the Iowa State University CALS Deans and Center Directors in Ames, IA. Information on crop genomics, genomic databases, and Bt-corn risk assessment and resistance management was exchanged. 5/8/15

NADC, Infectious Bacterial Diseases Research Unit

- Research Update on Brucellosis Studies at NADC. National Academy of Science. Jackson, WY. 9/15/15

NADC, Ruminant Disease and Immunology Research Center

- Gave invited plenary talk and attended the combined meeting of the 17th Latin-American Buiatrics Conference and the 11th Brazilian Buiatrics Conference 2015 in Sao Paulo, Brazil. Spoke on impact of pestivirus variability on design and implementation of control programs to an audience that included veterinary consultants, researchers, diagnosticians and producers. 7/22-24/15

Plant Introduction Research Unit

- Germplasm Enhancement of Maize (GEM) Project staff hosted the annual GEM field day at the Plant Introduction Research Unit in Ames, IA. The field plots demonstrate maize germplasm enhancement products (populations, lines and hybrids), breeding processes and technologies, and some important historical lines. 9/22-23/15

Soil, Water, and Air Resources Research Unit

- Presented on limitations to agricultural use of Humic products at the annual meeting of the Humic Products Trade Association in New Orleans, LA. 12/02/14
- Presented findings on deep-pit foaming to Iowa Pork Producers Associations at Iowa Pork Congress to producer groups. Information is being used to target control strategies and used to inform producers of the dangers of foaming pits along with strategies to mitigate dangers of foaming pits. 1/28/15
- Presented information from feeding trials to a representative of Iowa Nutrient Applicators Association and ISU Agriculture Engineering group and ARS scientists on the topic of hydrogen sulfide emissions associated with pumping of manure from swine buildings. Discussed potential causes and changes in diets with high rates of sulfur inclusion from DDGS. 6/3/15

Kansas:

Grain Quality and Structure Research Unit

- The USDA Regional Performance Nursery consists of two nurseries: the Northern Regional Performance Nursery (NRPN) and the Southern Regional Performance Nursery (SRPN). These nurseries provide critical information to breeders on the end-use quality of experimental breeding lines and aids in the selection and screening process of variety release to the general public.
- The Annual Sorghum Improvement Conference of North America brings together stakeholders, customers and scientists across broad disciplines within the sorghum industry. The conference includes scientific presentations, tours of field plots, and informal discussions. The venue brings together scientists, producers and sorghum industry personnel to discuss the needs of the sorghum community.

Soil and Water Management Research Unit

- The Ogallala Aquifer Program in an ARS led federal-state research-education consortium seeking solutions to problems arising from decreases in water availability from the aquifer. Approximately 80 participating scientists and 40 visitors/stakeholders attended part or all of the workshop. Visitors and stakeholders provided input on critical research needs that the program should be addressing. Participating scientists discussed future research plans, resulting in submission of proposed work plans for FY2016 and 2017.
- The Wheat Field Day was held in conjunction with Texas A&M AgriLife Research and Extension Service. More than 150 stakeholders, extension agents, industry and cooperators attended the event. Information was provided on new and emerging wheat varieties, and better management practices for wheat production on the Southern High Plains.

Kentucky:

Food Animal Environmental Systems Research Unit

- Presented at symposia targeting produce safety industry, researchers and extension agents

Food-Animal Production Systems Research Unit

- Presenter at the Larkspur/Tall Fescue Workshop hosted by the Meat Animal Research Center at Clay Center. Title was “The Impact of Fescue Toxicosis on Cattle Production.” 9/15/15
- Presenter at the Kentucky Small Ruminant Conference held in Russellville, KY. Spoke on the impacts of fescue toxicosis on sheep and goats. 2/7/15.

Louisiana:

Commodity Utilization Research Unit

- ARS SRRC Commodity Utilization Research Unit, hosted the director, staff and students of the Institute of Subtropical Forestry (ISF), Hangzhou, China summarizing recent research results in the shared field of tung tree genetics and biochemistry. Also, discussion on the results recently generated by collaborators in (ISF) studying roles of genes from tung tree -to engineer in the creation of transgenic plants with increased resistance of fungal pathogens. (10/17-24/2014)

Honey Bee Breeding, Genetics and Physiology Research Unit

- Honey Bee Breeding, Genetics and Physiology Research Unit, hosted three representatives of the French National Institute for Agricultural Research (INRA) and the French technical and scientific institute of beekeeping and pollination (ITSAP). The objectives of the visit are to exchange information about techniques related to selecting honey bees for resistance to Varroa mites. (6/1-6/2015)

Sugarcane Research Unit

- Sugarcane Research Unit, co-hosted the annual USDA-LSU AgCenter Sugarcane Field Day at the Ardoyne Research Farm in Schriever, LA. Approximately 100 people attend, including local farmers, and extension/sugar industry personnel. (6/5/2015)

Maryland:

Animal Genomics and Improvement Laboratory

- Presented (by invitation) a talk on Animal Genomics and Improvement Laboratory research at the 2015 ARS Big Data Workshop in Beltsville (7/16-17/2015)
- Presented (by invitation) seminar on Animal Genomics and Improvement Laboratory Research at a seminar for the Department of Animal and Avian Sciences (4/28/15)

Environmental Microbial and Food Safety Laboratory

- EMFSL hosted the annually recurring field trip for Food Quality Control (NFSC 431) class from the Nutrition and Food Science Department at the University of Maryland, College Park (03/06/2015)
- EMFSL hosted a visit by the Technical Adviser for Japan Association for Techno-innovation of Agriculture, Forestry and Fisheries; Executive Director of Japan Bakery Institute, and Researcher from National Food Research Institute Tsukuba (03/10/2015)
- EMFSL hosted the annually recurring visit to BARC for approximately 40 members of the National Science Teachers Association participating in FDA-sponsored professional development program (07/22/2015).
- EMFSL was included on the agenda for Dr. Deirdra Chester and Dr. Jodi Williams, NIFA national program leaders for Applied Nutrition Research and for Food Safety, during their visit to BARC and BHNRC (09/09/2015).
- EMFSL hosted the annually recurring field trip for Food Quality Control (NFSC 431) class from the Nutrition and Food Science Department at the University of Maryland, College Park (03/06/2015).

- EMFSL hosted a visit by the Technical Adviser for Japan Association for Techno-innovation of Agriculture, Forestry and Fisheries; Executive Director of Japan Bakery Institute, and Researcher from National Food Research Institute Tsukuba (03/10/2015).
- EMFSL was included on agenda for three PCAST staff visiting multiple labs at ARS Beltsville (08/26/2015).
- EMFSL was included on the agenda for Dr. Deirdra Chester and Dr. Jodi Williams, NIFA national program leaders for Applied Nutrition Research and for Food Safety, during their visit to BARC and BHNRC (09/09/2015).

Floral and Nursery Plant Research Unit

- On April 2, 2015, USNA participated in a BARC-hosted field tour of the Lower Chesapeake LTAR that showcased field plots, measurement devices, modeling, and pollution mitigation. Attendees included ARS and non-ARS LTAR scientists, ARS administrators, NRCS policy makers, and producers
- The USNA hosted a booth at MANTS January 14-16, 2015, where we highlighted the impact of our research and collections on the nursery industry. The show was attended by over 11,000 paid registrants from 44 states and 13 countries representing green industry professionals.

Invasive Insect Biocontrol and Behavior Laboratory

- Hosted participants in the Brown Marmorated Stink Bug (BMSB) Working Group meeting, for tour of laboratory and field research related to BMSB biological and behavioral control of this invasive pest and related stink bugs and squash bugs (6/11/2015)

Genetic Improvement of Fruits and Vegetables Laboratory

- Chaired the 2015 International meeting of the North American Strawberry Growers Association and the North American Strawberry Symposium, a unique meeting bringing together scientists, growers, and industry members. ARS support for these events builds trust and facilitates communication as well as two-way support between ARS and industry from around the world. (February 3-6, 2015, Ventura, CA)

Soybean Genomics and Improvement Laboratory

- Hosted a visit by women agricultural scientists from Pakistan sponsored by the U.S. Department of State, Bureau of Educational and Cultural Affairs, as part of a three-week study project titled “Women in Agriculture: Developing the Next Generation of Leaders.” (12/8/15)
- Hosted a meeting and led a tour of the Electron and Confocal Microscopy Unit for the President’s Council of Advisors for Science and Technology (8/26/15)
- Led a tour of the Electron and Confocal Microscopy Unit for young girls sponsored by the White House Council of Women and Girls Champions of Change (9/15/15)
- A joint Symposium with UMD was held at the Ag Library. The symposium was directed to Organic Production; Food, health and Ecosystems; held Nov 13, 2014

Michigan:

Sugarbeet and Bean Research Unit

- Presented field research progress to over 150 growers and industry personnel at the Saginaw Valley Research and Extension Center’s field day in Richville, Michigan. Disease nursery operations as well as examples of dry bean and sugar beet germplasm in the germplasm enhancement and genetic analysis pipelines were presented. 8/26/15
- Gave a presentation on the latest research progress on spectral imaging technology for quality inspection of pickling vegetables to about 50 pickling growers and processors at the Midwest Pickle Association’s annual meeting in Grand Rapids, Michigan. 12/9/14

Minnesota:

Cereal Disease Laboratory Research Unit

- Provided Ug99 race group molecular diagnostic and genotyping services for over 500 samples from 10 countries: Azerbaijan, Eritrea, Ethiopia, Iran, Iraq, Kenya, Lebanon, Nepal, Tanzania, and Uganda. 2015

- Coordinated the launch meeting of the rust component of the USAID funded project “Seed multiplication and delivery of high-yielding rust resistant bread and durum wheat varieties to Ethiopian farmers” at St. Paul, MN. 2/18-24/15
- Evaluated entries from the eastern (31 lines) and southern (30) soft red winter wheat nurseries, southern (42) and northern hard red (41) winter wheat nurseries, and hard red spring wheat (33) nursery; Gulf Atlantic (44) SUNWHT test (79) and Mason-Dixon (79) nurseries for leaf rust resistance in seedling tests. Seedling genes were postulated in breeding lines based on leaf rust infection types. Data was communicated directly to nursery organizers and wheat breeders. 2015
- Present the seminar “Contribution of environment and pathogen race to effectiveness of adult plant resistance to wheat stem rust” at the Borlaug Global Rust Initiative (BGRI) Technical Workshop, Sydney, Australia. Coordinated and led a satellite meeting at the BGRI Technical Workshop with collaborators of the “Seed multiplication and delivery of high-yielding rust resistant bread and durum wheat varieties to Ethiopian farmers” USAID project. 9/20/15

Plant Science Research Unit

- Presentations were made at the Idaho Hay and Forage Conference in Burley, Idaho to approximately 200 producers and industry representatives on strategies to reduce the impact of foliar and root diseases on alfalfa production (2/27/2015).
- Presentations were made at the Industry Extension Forage Advisory Council in LaCrosse, WI to alfalfa and forage seed industry and extension educators on new races of alfalfa pathogens identified in the Midwest and strategies to reduce damage from the diseases. 3/13/15

Soil and Water Management Research

- Participated in the North Central Extension Research Activity (NCERA-217) annual meeting describing the concept of landscape storage of water for reuse in irrigation and by providing training on alternative tile drainage inlet designs to ≈65 resource, regulatory, university, and industry personnel from multiple states (4/14/2015).

Soil Management Research Unit

- Demonstrated nutritional value and ecosystem services of hulled wheats to university students and farmers at the Agro-ecology Summit near Windom, Minnesota. Provided practical information and guidelines on their inclusion in current and future crop rotations and their potential environmental benefits as efficient nutrient users and recyclers. 8/14/15
- Organized the annual field day at the North Central Soil Conservation Research Lab for the local farming community. Solicited contributions for presentations and demonstrations on new management practices and the use of airborne digital imagery in agricultural research and practical field monitoring and data collection (~80 farmers/attendees). The Morris Sun and Tribune published an article in the August 1 issue covering the event: <http://www.morrissuntribune.com/news/3808728-healthy-soils-healthy-world-ars-scientists-share-research-field-day> 7/23/15
- Co-hosted 10 students from Australian universities with the University of Minnesota-Morris in Morris, Minnesota. This tour and information exchange was part of the GO Minnesota: Innovations in Environmental Sustainability 2015, which is a summer sustainability program for international students. 7/16/15
- Hosted three farmers and three renewable energy/ag researchers from Sweden at the North Central Soil Conservation Research Laboratory in Morris, Minnesota. The international visitors were interested in reducing fossil energy use in agriculture and improving both carbon and environmental footprints of their agricultural systems. 3/18/15

Mississippi:

Cotton Ginning Research Unit

- Cotton Ginning Research Unit and the Office of Technology Transfer hosted the Stoneville Ginners School sponsored by the National Cotton Ginners Association. Over 20 instructors from industry, other ARS locations, and universities are expecting to teach over 100 students from across the cotton growing belt about the proper operation and management of cotton ginning. (6/9-11/2015) hosted a visit and tour for the U.S. Army Corps of Engineers Research and Development Center, Vicksburg, MS to discuss possible collaborative research on biological control

of aquatic weeds. (3/13/2014)

- Cotton Ginning Research Unit, co-hosted a meeting with Delta Council for the Southern Cotton Ginners Association, speaking to producers and ginners on the latest research in cotton ginning. (7/23/2015)

Crop Genetics Research Unit

- Crop Genetics Research Unit, hosted the Southern Soybean Breeders Tour 2015. This is an opportunity for private and public soybean breeders to view the Uniform Soybean Tests –Southern States trials located at Stoneville. It was attended by 82 visitors, including 2 scientists from Uruguay and two from Paraguay. (8/26-27/2015)

National Sedimentation Unit

- National Sedimentation Laboratory, hosted guests from Bosnia Hercegovina as part of the Cochran Fellows Program. (8/7/2015)

Thad Cochran Southern Horticultural Laboratory

- ARS Thad Cochran Southern Horticultural Laboratory in Poplarville, MS, and Mississippi State University co-hosted Muscadine Field Day. The annual event showcases the muscadine grape, a native U.S. grape with economic potential for small farmers. More than 130 people attended the event (8/29/2015)
- Thad Cochran Southern Horticultural Laboratory, hosted Poplarville's Annual Blueberry Jubilee. Approximately 300 people tour the research facilities during the Blueberry Jubilee. (6/13/2015)
- Thad Cochran Southern Horticultural Laboratory, co-hosted with Mississippi State University Cooperative Extension Service an inaugural honey bee pest management workshop. Over 100 local beekeepers attended and learned about current control strategies for Varroa mites and small-hive beetles. (9/26/2015).
- Hosted a research exchange meeting with numerous University colleagues on determining the impact of southern row crop pesticides on honey bee health. Over 30 attendees with discuss on-going projects as well as plans for future work. (3/10-11/2015)

Watershed Physical Processes Research Unit

- Watershed Physical Processes Research Unit, hosted the S1048 Regional Project Meeting at the National Sedimentation Laboratory in Oxford, Mississippi. The project focuses on the "Assessment of the Carbon Sequestration Potential of Common Agricultural Systems on Benchmark Soils across the Southern Region Climate Gradient. (4/28-29/2015)
- Watershed Physical Processes Research Unit, hosted RUSLE2 training sessions and work with collaborators at Pontificia Universidad Catolica de Valparaiso to adapt the RUSLE2 computer model to work with Chilean conditions at Vina del Mar, Chile. (5/10-17/2015)

Missouri:

Cropping Systems and Water Quality Research Unit

- Presentation to the Missouri Department of Natural Resources (MDNR) on the APEX and modeling expertise available at the University and within ARS, and to the Soil and Water Conservation Commission. 2/11/15.
- Presented "Cover Crop Effects on Nutrient Cycling and Fertilizer Recommendations" 44th NC Extension-Industry Soil Fertility Conference. Des Moines, IA. 11/19/15.
- Presented "Technology Trends in Precision Agriculture" at the Red River Valley Research Corridor Precision Ag Summit, in Jamestown, ND. 1/19/15
- Presented at the Soil Biology and Soil Health in Hundley-Whaley Research Center Field Day and Missouri Soil Health Exposition in Albany, MO.
- Soil Health and the Role of Soil Biology. USDA Cochran Fellowship Program: High-Value Horticultural Production/CAFNR International Program (15 fellows from Turjikistan and Turkmenisan). Columbia, MO.
- Presented "Cover Crops and Nitrogen Credits." MU Crop Injury Clinic. Columbia, MO. 7/29/15.

Montana:

Fort Keogh Livestock & Range Research Laboratory

- Southeastern Montana Livestock Association's semiannual meeting was attended by ranchers and industry leaders. Discussion surrounding evaluation management schemes to promote cow lifetime productivity.
- Montana Stock Grower Association meeting was attended by over 180 industry leaders, ranchers and agency personnel. Discussions on research productivity and future planning.
- Scientists and technicians from Fort Keogh met with scientists from all over the continent and shared research perspectives and findings. Audience consisted of researchers, agency employees, and graduate students

Northern Plains Agricultural Research Laboratory

- Discussions of the ARS Fall Focus Group included research on cover crops and economic impacts associated with cover crops.
- The National Grasshopper Board meeting included ARS and University researchers, state entomologists, state plant health directors and plant regulatory officials. Scientists shared research results on microbial control and grazing and fire management of grasshoppers and Mormon crickets.
- Scientists participated in weed management training for private pesticide applicators. The event was part of the Glendive AgriTrade Exhibition. The training provides researchers, ranchers and farmers with the latest information on weeds and pesticide research for safely managing weeds and insect pests.
- ARS research scientists were invited to speak at the Montana Farm Bureau Conference. The statewide conference had approximately 200 Bureau members, farmers, ranchers and researchers in attendance. Presentations on microbial products to replace environmentally-unfriendly chemicals, future of biological alternatives, new bio-based jet fuel, and Jet fuel from oilseeds were given.
- ARS Field Day "Drone 101 Workshop" and Research Talks featured two local flyers, one long-time hobbyist and a recent recipient of a federal Aviation Administration exemption allowing him to fly commercially, acquainted tour goers with basics of their quadcopter and fixed wing machines including flight demonstrations and discussion. Presentations on wheat stem saw-fly, Canada thistle biocontrol research, and nitrogen rate impacts on greenhouse gas emissions under wheat-pea rotations.

Nebraska:

U.S. Meat Animal Research Center

- As part of the Nebraska Sheep & Goat Producers Association Annual Meeting and Conference, producers visited USMARC to hear about research related to Ovine Progressive pneumonia and sheep production systems. The event concluded with a tour of USMARC.
- As part of the annual conference for the National Swine Improvement Federation Symposium, USMARC hosted more than 80 swine producers, researchers and industry leaders. Topics included an overview of swine genomics, assessment of functional genetic variants, swine nutrition, gilt development, sow metabolomics, and swine fetal development.
- USMARC hosted a pre-conference tour for the 68th Annual American Meat Science Association Reciprocal Meat Conference attendees. USMARC showcased research findings and facilities to current and future leaders in the meat science community. Impacts from this event include future collaborations with university faculty and meat science professionals.
- Members of the Beef, Sheep, and Swine Focus Group met with ARS Scientists at USMARC to discuss industry research.

Grain, Forage, and Bioenergy Research Unit

- Scientists from Lincoln led the Vermeer-Cen USA Bioenergy Field Day in Pella, IA for certified crop advisors, extension agents and farmers. Discussions were held on the use of native perennial grasses for biomass production and potential bioenergy markets.
- The Hard Winter Wheat Breeders Field Day was organized by scientists from both Lincoln and Manhattan. Discussions of wheat breeding trials, disease resistance, and quality attributes of advanced wheat breeding lines from both public and private programs were held.

- The Winter Wheat Field Day was held at the University of Nebraska. Over sixty wheat growers and scientists attended the event. Wheat producers were able to view new wheat cultivars that might be adapted to their production environments and evaluate their disease responses.

New Mexico:

Range Management Unit Jornada Experimental Range

- The Range Management Unit hosted a field day for K-12 students to expose them to agriculture, ecology, botany, and zoology. Over two-thousand students were involved.

New York:

Grape Genetics Research Unit

- Gave two tours of the grape germplasm to the Fingerlakes Community College "Introduction to Viticulture and Enology" classes. Around 30 undergraduate students in total (9/14 and 9/17, 2015, Geneva, NY).

Plant Genetic Resources Unit

- Apple collection tour to Professor Tom Drennen, Chair Economics and Environmental Studies classes, Hobart and William Smith Colleges with 57 students, 4 TAs, and 4 professors (9/30/2015, Geneva, NY)
- Gave two tours of the grape germplasm to the Fingerlakes Community College "Introduction to Viticulture and Enology" classes. Around 30 undergraduate students in total (9/14 and 9/17, 2015, Geneva, NY).
- Hosted Cornell University course PLBR 4060 - Methods of Plant Breeding Laboratory. Helped teach students and scholars about Malus collection (9/19/2015, Geneva, NY)
- Tour of the Malus collection to 20 students, TAs, and Professor Melissa Luckow "Plants and People" class (9/22/2015, Geneva, NY)
- Tour of the Malus collection to 21 apple growers, researchers, and extension agents from China and Cornell University (9/22/2015, Geneva, NY)
- Malus collection open house with 6 stakeholders (9/23/2015, Geneva, NY)
- Apple collection to Professor Elizabeth Newell "Organisms and Populations" class with 20+ students and 3 professors (9/25/2015, Geneva, NY)
- Northern Organic Vegetable Improvement Collaborative (NOVIC) outreach to Northeast Organic Farming Association (NOFA)-NY 33rd Annual Winter Conference. This conference was attended by ~1,100 growers, educators, students, researchers and entrepreneurs. We provided educational material on seed saving and promoted NOVIC's activities to develop new varieties of vegetables that are adapted to organic conditions in northern climates (1/23 - 1/25/2015, Saratoga Springs, NY).
- Northern Organic Vegetable Improvement Collaborative (NOVIC) outreach to Maine Organic Farmers and Gardeners Association (MOFGA) at the 38th Annual Common Ground Country Fair. The fair was attended by over 50,000 people and emphasized workshops and conferences about farming, gardening and environmentally conscious practices. We provided free vegetable seed samples, educational material on seed saving, demonstrations of seed processing, hands-on seed cleaning, and promoted NOVIC's activities to develop new varieties of vegetables that are adapted to organic conditions in northern climates (9/25 - 9/27/2015, Unity, Maine).
- Gave tour to the Malus collection to Professor Maryann Herman class with 8 students (4/7/2015, Geneva, NY)
- Tour of the Malus collection to 9 cider grower and makers (5/8/2015, Geneva, NY)
- Tour of the Apple collection and discussion (8/9/2015, Geneva, NY)
- Tour of the Vitis collection to 50 participants of the North American Grape Breeder meeting (8/27/2015, Geneva, NY)
- Tour of the Apple collection and discussion (10/10/2015, Geneva, NY)
- Tour of the Apple collection to 57 participants of the Great Lake Fruit Growers Meeting (11/10/2015, Geneva, NY)

USDA-ARS Robert W. Holley Center for Agriculture and Health

- Provided training in various aspects of insect pathology and microbial biocontrol and collaborated on research aimed

at biological control of thrips and wood-boring beetles

- Taught basic biology, ecology, and taxonomy of insects to grade school- and high school-aged students. Instructed students in techniques for collection and preservation of insects and directed exhibition of student insect collections at County and State Fairs
- On August 11, 12, and 13th, 2015, employees at the ARS Robert W. Holley Center in Ithaca, NY participated in the Empire Farm Days event held in Seneca Falls, NY as part of an outreach activity. ARS scientists displayed and explained the research that is performed at the Robert W. Holley Center and provided informational handouts to help the public learn more about agricultural research at the USDA-ARS.
- On February 26, 27, and 28th, 2015, employees at the ARS Robert W. Holley Center in Ithaca, NY participated in the New York State Farm Show held in Syracuse, NY as part of an outreach activity. The annual NYS Farm Show is one of the largest agriculture shows in the Northeast, attracting over 25,000 people and 400 vendors. ARS scientists explained their research projects and provided informational handouts regarding agricultural research at the USDA-ARS to the public.

North Dakota:

Northern Great Plains Research Laboratory

- The Northern Great Plains Research Laboratory scientists partnered with NRCS, the Area 4 Soil Conservation District Research Farm, North Dakota State University, and Bismarck State College to host an expanded program, "Farming for the Bottom Line." The day-long program featured USDA and non-Agency experts focused on assisting family farmers reduce costs and optimize yields with reduced long-term environmental impact, and improve marketing expertise. More than 250 farmers and students attended the program held at the Bismarck State College National Energy Center Auditorium.
- The Northern Great Plains Research Laboratory in Mandan, ND welcomed the public to their 17th annual Friends & Neighbors Day. The afternoon event featured presentations, exhibits, and demonstrations by the ARS scientific and technical staff, exhibits of antique and modern farm equipment, children's educational activities, an all-afternoon barbecue, and tours of ARS research. There were also exhibits and presentations by NRCS, FSA, APHIS, Forest Service, Rural Development, and numerous non-USDA agencies and organizations. More than 750 people from family farms, ranches, and the community attended this annual civic event.

Sunflower and Plant Biology Research Unit)

- This forum made of USDA-ARS personnel and their North Dakota State University partners presented talks and posters to about 70 stakeholders, farmers, and university personnel. This annual forum transfers technology between scientists, stakeholders, partners, and farmers to improve the production of sunflower in the U.S.

The Red River Agricultural Research Center

- The Red River Agricultural Research Center (RRVARC) Research Partners' Annual Meeting with representatives from all of the major agriculture sectors in ND and the upper mid-West States. Presentations were given by commodity/industry representatives on research needs and included, Mike Davis, President - American Malting Barley Assoc.; Barry Coleman, Executive Director - Northern Canola Growers Association; Steve Edwardson, Executive Director - ND Barley Council; Neal Fisher, Administrator - North Dakota Wheat Commission; Chuck Gunnerson, President - Northern Plains Potato Growers Association; John Sandbakken, Executive Director - National Sunflower Association; Joel Tenney, Executive Vice President, - ICA Trinova, LLC; Mike Metzger, Research Agronomist, Minn-Dak Farmers Cooperative; Stan Wolf, 1st Past President - ND Weed Control Association; Tom Lilja, Executive Vice President, ND Corn Growers Association; and Richard Vierling, Director of Research, National Corn Growers Association. Research Leaders from the five USDA-RRVARC Management Units also provided highlighted accomplishments from each of their respective commodity-specific responsibilities. Commodity and industry representatives expressed sincere appreciation for the many accomplishments of USDA researchers at Fargo & throughout the entire country, and discussed coordinating efforts to sustain USDA research through delegation visits with USDA leadership in Beltsville, MD and with Congress in Washington, DC.

Ohio:

Application Technology Research Unit

- Presented a talk on managing the greenhouse environment at Barco Sons, Inc., Medina, OH. (12/5/14)
- Stakeholder Liaison Conference at Toledo Botanical Gardens in Toledo, Ohio regarding current and future research programs involving growing substrates, plant nutrition (including silicon), energy-efficient production methods, container weed control, biochar and steel slag amendments, and Virtual Grower. (3/11/15)
- Virtual Grower 3.1, a decision-support software program, was developed and released. (203 downloads since software was made available 7/10/15)
- Presented intelligent spray technology to improve pesticide application efficiency, reduce pesticide use and safeguard the environment at the 18th World Congress of International Commission of Agricultural and Biosystems Engineering (CIGR) in Beijing, China, (9/16-19/2014)
- Presentation titled "Optimization of pesticide spray application rates to match sprayer and crop parameters" in Columbus, OH 1/7-9/15
- Presented to over 40 greenhouse growers, farm managers, sprayer manufacturer reps, students and researchers. 1/22/15

Corn, Soybean and Wheat Quality Research Unit

- Participated at Wheat Growers board meeting, held at Delaware, Ohio, by presenting new data on viruses in Ohio wheat conveying and discussing important next steps to assess their impact on production leading; ongoing project with wheat growers. Meeting attended by approximately 15 Ohio wheat growers. 9/14
- Provided training workshop on Methods for diagnosis of Maize Lethal Necrosis causing viruses in seed during visit to Rwanda Agriculture Board Seed Laboratory. Attended by 4 Rwanda Agriculture Board and One Acre Fund researchers. 7/26/14 to 8/5/2014
- Participated in surveying maize crops for virus disease in all maize growing areas of Rwanda. Taught techniques for collecting, storing and stabilizing plant samples for virus diagnosis and the use of tissue blot immunoassays for virus diagnosis in maize to 20 researchers at the Rwanda Agricultural Board. 1/26-30/15
- Participated in the Ohio Wheat Workshop in Plain City, Ohio), and discussed efforts to overcome the quality and yield challenges in Ohio wheat production. Developed an action plan for increased wheat production and quality in Ohio. Attended by over 40 wheat growers, breeders, grower organizations and traders. 6/11/15
- Gave presentation on Flour yield traits and extended uses of eastern soft wheat at the American Bakers' Association Meeting in Columbus, Ohio. 11/6/14

Soil Drainage Research Unit

- Presented a webinar on application of ground penetrating radar for agriculture. Attended by 50 local, state, and federal agency staff; industry personnel, and university researchers. A recording of the webinar is maintained and remains available at: www.ag-geophysics.org. 9/30/14
- Presented poster titled "Quantifying the impacts of agricultural management on water quality: Edge-of-field monitoring and modeling" at SERA-46/Hypoxia Task Force Meeting, held in Columbus, Ohio. Attended by approximately 100 state and federal agencies, non-government organizations, watershed stakeholders, and policy makers. 5/19/15
- Presented an illustrated lecture titled "Agricultural Drainage - Pros and Cons", at a Western Lake Erie Basin Drainage Conference held in Maumee Bay State Park, Oregon, OH, arranged by The Nature Conservancy. Attended by approximately 75 local elected officials, especially County Engineers and Drainage Commissioners. 8/20/15
- Presented "Influence of grass filter strips on the structure and function of agricultural headwater streams in central Ohio" at the Deeply Rooted in Restoration, the 2014 Natural Areas Conference, held in Dayton, Ohio. Attended by 60 watershed managers, Natural Resource Conservation Service personnel, state natural resources staff, university faculty and students, non-profit organizations involved with management of natural areas, and consultants. (10/16/14)
- Presented "Influence of grass filter strips on the structure and function of agricultural headwater streams in central Ohio" at the Deeply Rooted in Restoration, the 2014 Natural Areas Conference, held in Dayton, Ohio. Attended by 60 watershed managers, Natural Resource Conservation Service personnel, state natural resources staff, university faculty and students, non-profit organizations involved with management of natural areas, and consultants.

(10/16/14)

Oregon:

Eastern Oregon Agricultural Research Unit

- Organized a cooperative program between ARS scientists and OSU extension agents to develop land management plans and address issues in sagebrush steppe animal and plant populations with college and high school student groups. (11/12/14)
- Updated group of 30 Natural Resource Conservation Service managers on recent findings for managing medusahead in sagebrush rangelands. (10/28/14)
- Provided scientific basis for managing sage-grouse populations and the State and Transition Models for Sagebrush Steppe approved for the Candidate Conservation Agreement with Assurances adopted by the US Fish and Wildlife Service. (12/15/14)
- Provided 80+ western rangeland management professionals and stakeholders with research findings for managing annual grass infested rangelands threatening large tracts of sage-grouse habitat in the west. (1/13/15)
- Provided scientific background and research findings to Oregon Sage-Con Habitat Quantification Committee for greater sage-grouse. Their research is the basis for developing a quantification tool for Oregon guidelines. (1/16/15)
- Showcased scientists' research and provided numerous copies of ARS Manager Decision Guidelines (print and video) to 800 + rangeland science professionals and university students. (2/2-4/15)
- Provided research on rangeland weed management and restoration for 20+ ranchers, agency personnel, non-profit organizations and members of advisory council. (2/19/15)

Range and Meadow Forage Management Research Unit

- University students participated in activities and learning events on the rangeland with the goal of gaining field experience in rangeland ecosystems. Scientists instructed on systems approach to Sage-grouse management including state and transition habitat model, Ecologically-based invasive plant management (EBIPM), Seed technology to enhance restoration, and Western Juniper management and fire ecology. Students teamed in a rangeland management competition for improving sage-grouse habitat. Shasta College advisor said, the “event may have been the MOST worthwhile hands-on workshop I have attended.” (4/23-26/15)
- ARS scientists and technicians hosted over 60 elementary school students from Harney County, Oregon including students from the county’s rural one room schools to learn about basic plant physiology and plants in the ecosystem. This annual field trip was the subject of an ARS award winning video several years ago - “Making the Science Connection”, a step by step guide for ARS stations and scientists hosting educational field trips. (5/7/15)
- Presented research on sage-grouse habitat management adopted by land managers on over 1.2 million acres of sagebrush rangeland. Students from Evergreen State College and University of Idaho were provided with on overview of rangeland management research. (5/14,20/15)
- Presented systems approach to Sage-grouse management including State and Transition Habitat Model Western Juniper management and fire ecology, and ecologically-based invasive plant management (EBIPM)s event to members of the board of The Nature Conservancy, and college students completing a rangeland management plan as part of a course in collaborative design. (6/5,11/15)
- ARS scientists and technicians presented information and led field tours on interactions between fire and grazing and juniper encroachment, collaborative partnerships in resource management, seed technology in rangeland restoration techniques, and interactions between annual grasses and fire in sage-grouse habitat. Field Days were organized for Pacific Northwest Section Society for Range Management professionals that will implement research findings in sagebrush steppe rangeland management, and the International Rangeland Seminar for the US Forest Service. (6/15-16/15, 8/7/15)
- Conducted a 4 day camp for high school students interested in exploring the rangeland science field and career opportunities available with college degrees. This was the 5th annual range camp conducted by Burns USDA-ARS and it has proven to be a very valuable outreach program. The top camper attends the High School Youth Forum at the annual conference of the Society for Range Management. (6/17-20/15)
- Provided the scientific information on Juniper management and fire ecology, and fuels management with annual grasses for decision making on rangeland fire policy and resources in eastern Oregon. Participants included agency personnel with fire responsibilities, private land owners and environmental groups. (8/26/15)

Horticultural Crops Research Unit

- Presented research on the cold hardiness of lesser-known wine grape cultivars at the BC Wine Grape Council Annual Enology & Viticulture Conference and Tradeshow in Penticton, British Columbia, Canada. Approximately 300 growers, winemakers and related industry personnel attended the two day conference (07/20/15).
- Presented at the Northwest's premier wine community trade show and educational event on their current winegrape research and overview of wine style metabolites. Approximately 300 growers, winemakers, and additional private company personnel attended this session on farming for wine styles (02/25/15).
- Had a demonstration booth where individuals could run a LAMP assay (nucleic acid amplification technique) to quantify the amount of *Erysiphe necator* inoculum present in air samples. The detection technique is used to adjust the timing of fungicides applications for the management of grape powdery mildew. (2/24/15)
- Presented information on Grapevine Red Blotch Virus and other important viruses of grapevine that occur in Oregon. Participants included 120 growers, and 40 board meeting attendees who will use the information to develop an RFA. (7/28/15, 8/12,20,25/15)
- Delivered several workshop modules managing nutrition and viruses, and bacterial and fungal diseases of grapes as part of the Oregon Wine Research Institute's vineyard management workshop in Grants Pass, OR. (7/28/15)
- Co-presented with an OSU colleague an overview of water use and how to monitor water stress in grapevines in dry-farmed vineyards, to approximately 120 growers and viticulture professionals.
- Presented a summary of recent findings regarding Nitrogen, Phosphorus, and Potassium thresholds for Pinot noir nutrient status, and practical methods to track and manage grapevine nutrition. (3/10/15)
- Described ongoing research on Blueberry Fruit Drop Virus, Blueberry Scorch Virus and Blueberry Shock Virus and Raspberry Bushy Dwarf Virus to growers and consultants in Lynden, WA. (8/13/15)
- Provided update on progress of berry breeding program in the Pacific Northwest, and shared information on new selection development, naming, grower trials, and discarded selections. Presentations were made to Washington State University, AgCanada, Washington Red Raspberry Commission, Washington Blueberry Commission, and commercial nurseries. (10/21-22, 11/18/2014)
- Provided tours of the breeding plots and discussed performance of various selections and cultivars to determine which varieties were best suited for particular farm conditions. Information was provided to commercial berry growers and nurserymen at numerous events throughout the year and to interested public in conjunction with Blueberry/Caneberry Field Day, International Trials Conference, Oregon Blueberry School, Oregon State University Strawberry Field Day. (3/16-17, 5/19-20, 6/2,9,10,16,23,30, 7/1,7,8,14,21, 8/10,11,31/15)
- Presented Information about cultivars developed and grown in the Pacific Northwest. Discussion included the blooming tendency of strawberry species, and the future of raspberry and blackberry breeding with an emphasis on what traits were going to be given priority. Numerous commercial growers, nurserymen and private company personnel were the recipients of this information. (1/29/15, 2/17/15, 2/26-27/15, 8/26/15)
- Presented samples of new USDA cultivars or selections prepared as individually quick frozen fruit by OSU Department of Food Science to help a Japanese ice cream company and their major Oregon supplier determine whether these new genotypes would work in their product formulation. (4/20/15)
- Convened the NCC 212 Small Fruit Research Meeting. Scientists from industry, universities, and the USDA gathered in Corvallis to discuss research results and progress. (10/28/14)
- Presented information on breeding for resistance to Blueberry shock virus to 30 researchers, commissioners, and representative of the commercial blueberry industry.
- Presented information about day-neutral strawberry selections and cultivars at the Oregon Strawberry Commission Plasticulture Workshop and Demonstration in Forest Grove, OR, and served as information source during on-farm demonstrations in Hillsboro, OR. (8/18/15)
- Scientists displayed thawed, frozen samples of advanced selections and new releases of blueberry, strawberry, red raspberry, black raspberry, and blackberry so that the industry had the opportunity to evaluate, including tasting, these genotypes. Evaluations were conducted throughout the year at many industry meetings and field days including Oregon Blueberry Conference, and Northwest Food Processors Association Meeting. Several hundred people representing the processed food industry and berry growers participated.(12/15,19/14, 1/16,21/15)

Forage Seed and Cereal Research Unit

- Presented on the development of new hop varieties; molecular and traditional breeding tools; disease control measures to mitigate damage from hop powdery mildew, including emergent, virulent strains of the pathogen; and technologies associated with IPM. Numerous growers, brewers and private company personnel attended the events. (10/29/14, 1/9, 21, 22/15, 6/18/15).

Annual Reporting on Technology Transfer in USDA, FY 2015

- Provided information on cover crops and benefits to soil health to industry, growers, and representatives from Oregon State University, USDA, NRCS, and OSU extension. (4/30/15)
- University, USDA, growers, NRCS, and Extension Personnel met to discuss potential novel approaches for slug control using RNAi technology. (5/5/15)
- Presented the benefits of biochar-based amendments and proposed future collaborations to the Southern Umpqua Rural Community Program Meeting and industry stakeholders. (6/16,18/15)

National Clonal Germplasm Repository

- Scientists of the National Clonal Germplasm Repository provided guidance on cranberry germplasm preservation and research to 6 scientists from other government research agencies. (4/28/15)
- Site tours of the National Clonal Germplasm Repository in Corvallis, OR were provided to members of the university community, national and international researchers, and interested public and industry representatives throughout the year. Tour highlights include Humulus (Hop) genetic resources, germplasm preservation, the use of tissue culture techniques, and cryopreservation as a pathogen control measures. (2/24/15, 5/21/15, 7/28/15)

Soil and Water Conservation Research Unit

- Presented a breakout session at the Direct Seed and Oilseed Conference in Kennewick, WA on collecting and deciphering precision crop data to make management decisions. Participants included over 60 growers. (1/20/15)

Pennsylvania:

Bio-based and Other Animal Co-Products Laboratory

- Hosted ASTM International's D31 Committee meeting on Leather on April 22, 2015. The area of interest of the Committee is to establish the standard methods for the assessment of materials used to produce leather and of the ability of the resultant leather to meet end-use performance requirements. (4/22/2015)
- RS scientists produced samples of biobased detergent (called sophorolipids) by fermentation using renewable agricultural feedstocks; the collaborating laboratory (Marmara University, Turkey) tested ARS materials to inhibit animal hides-degrading bacteria. One manuscript has been prepared for submission to peer-review journal, in which the antimicrobial activity of the materials against hides-degrading bacteria was affirmed.

Eastern Regional Research Center

- Hosted the annual ALCA Research Liaison Committee (RLC) meeting with stakeholders /participants from DC, Delaware, Maine, Michigan, Minnesota, Ohio, Pennsylvania, Wisconsin, South Dakota and Maryland. The relevance of ERRC research to industry needs was discussed. This meeting provided an opportunity for the stakeholders and customers to maintain an awareness of ongoing hides and leather research, to foster research collaborations, and to assist the USDA and other public research institutions in establishing research priorities. (4/23/2015)
- The Center hosted 125 attendees including the Deputy Undersecretary for Research, Education and Economics, Administrator of ARS, Headquarters' personnel, state and local politicians, major stakeholders, customers, collaborators and worldwide known national and international scientists and local media. Highlights of the research accomplishments of ERRC scientists were presented and a tour of the Center included demonstrations of projects showcasing the state of the art instrumentation and the facility. Providing insight into solutions to some of the agricultural problems facing the U.S. today and tomorrow with fundamental, applied, and developmental research being highlighted.

Molecular Characterization for Foodborne Pathogens

- Co-hosted with E. coli Reference Center at the Pennsylvania State University an international workshop bringing together researchers from ARS, academia, the Centers for Disease Control and Prevention, the Food and Drug Administration, and E. coli experts from various institutions worldwide working on molecular serotyping of E. coli, methods for characterizing and determining E. coli pathotypes, and whole genome sequencing and bioinformatic analyses for genotyping and outbreak surveillance.

Sustainable Biofuels and Co-Products Laboratory

- All collaborators and stakeholders on this large BRDI grant were invited to discuss research progress and future direction for the project. The FarmBio3 project will demonstrate whether a fast-pyrolysis method of processing biofuel from common agricultural feedstocks can be employed at an efficient and useful scale in farms and villages—one that will be affordable and easy for growers to use, and provide biorefineries with a steady supply.

South Carolina:

Coastal Plain Soil, Water and Plant Research Center,

- ARS Coastal Plains Soil, Water, and Plant Research Center in Florence, SC, participated in Clemson University's Pee Dee Research and Education Center Field Day with research in cotton breeding and soil management. Attendance at this year's event was about 240 people including farmers, industry personnel, and extension specialists. (9/10/2015)

South Dakota:

North Central Agricultural Research Laboratory

- The 21st annual field day of the North Central Agricultural Research Laboratory in Brookings, SD was held June 16, 2015. Attendance was recorded at 62 non-NCARL visitors plus about 30 employees. Attendees included agricultural producers, crop consultants, extension professionals, educators, and the general public. The topic was "Measuring Success: Beyond another Bushel" and included presentations and discussion on the value of soil health and increasing soil biology, developing resilient crop production systems, the value of including pollinator-friendly crops, and managing weed resistance. As an outcome of the meeting, agricultural professionals and the general public have an improved understanding of new land management practices, the impact of agricultural management on food production, and the mission of ARS and NCARL.

Spain:

Animal Genomics and Improvement Laboratory

- Presented (by invitation) talks on Animal Genomics and Improvement Laboratory research at the ANEMBE (National Association of Bovine Medicine Specialists of Spain) Bovine Medicine International Congress XX in Burgos (5/6-8/2015)

Tennessee:

Floral and Nursery Plants Research Unit

- On June 17, 2015, FNPRU staff co-hosted with TSU a field day for industry partners, nursery growers, and the general public. Over 150 attendees participated in workshops and listened to speakers on topics related to pest control, best nursery practices, plant production, and propagation techniques. Follow-up evaluations revealed that 100% of respondents "learned something new" and 95% plan to "adopt or use some of the information" they learned.

Texas:

Cotton Production and Processing Research Unit

- The National Cotton Ginners Association's Gin School provided levels I-III and continuing education. The classes on gin and equipment safety, hydraulics, electricity, equipment settings and repair, seed cotton machinery unloading and handling systems. The continuing education focused on OSHA regulations and safety management practices.

Cropping Systems Research Laboratory

- The 2015 meeting and Field day included a Field tour and research updates with Executive officers of US Sorghum Checkoff Program and National Sorghum Producers (NSP). Promote and strengthen research agreements and cooperation of ARS scientists with the primary commodity organization representing the US sorghum industry.

Grazinglands Research Laboratory

- The Grazinglands Research Laboratory Field Day 2015 on October 15, was attended by about 250 people. About one third of attendees were producers, one third were families (primarily home schooled), and numerous cooperators and community members. Congressman Lucas and several of his staff members and two staff members from Senator Langford's office attended.

Utah:

Forage and Range Research Laboratory

- Met with seed company representatives, USU extension and range management professional societies to inform them of newly available seed materials, current research, and identify new target areas. (10/22/14)
- Trade Show booth display of information on genetically improved plant materials releases (grasses, legumes, and forbs). Of the 150 attendees, approximately 20 ranchers and general public picked up samples of grass, legume, and forage kochia seed and received information on establishing grasses, legumes, and shrubs on range and pasturelands. (2/6-7/15)
- Provided information on improved plant materials and enhanced management practices for rangelands, pastures, and turf in the western U.S to approximately 150 producers, federal agents, and private company representatives. (11/6-8, 12/3-5/14)
- Presented information, brochures, and sample seeds of FRRL releases for improvement of irrigated and non-irrigated pastures. There were approximately 350 attendees including ranchers, seed company representatives, Utah Farm Bureau, and NGOs.
- Winter Seed School for western alfalfa seed growers and Inaugural Bee Workshop for beekeepers (1/25-27/15)
- Presented seminar on the rehabilitation of big sagebrush sites in northern Utah at the 2015 Society for Rangeland Management-Northern Utah Chapter Annual Tour in Cedar Fort UT and Birdseye UT. The field day featured information on improving rangeland health through novel management practices and FRRL plant materials. (6/2/15)
- Presented the genetic nature of economically important traits; and demonstrations of novel plant materials with improved yield and quality for pastures, improved stand establishment, and persistence for enhanced rangeland productivity. Discussed new germplasm releases and associated management technologies related to reductions in financial inputs and higher yield and quality. Approximately 30 Western Region Farm Bureau presidents and administrators from CO, WY, UT, NV, and ID were in attendance. (7/28/15)

Washington:

Animal Diseases Research Unit

- Featured speaker to American Goat Federation and American Sheep Industry. He provided information on research unit results to these stakeholder groups. (1/28/15)

Grain Legume Genetics and Physiology Research Unit

- Scientists met at Washington State University with approximately 20 members of a trade delegation from India and representatives for the U.S. edible legume industry. The scientists presented visual samples of elite ARS chickpea breeding lines and new varieties and discussed seed quality traits of special importance to consumers in India. (10/15/14)
- Presented at the Washington State Weed Conference on the biology, identification, and management of nightshade species in crop rotations. Approximately 50 growers and private company personnel attended. (11/6/14)
- Presented on rattail fescue and other problem weeds management in mint. Approximately 200 growers, researchers, and private company personnel attended the events. (12/2/14, 1/20/15)
- Presented at the Annual Meeting of the Western Pea and Lentil Growers Association. Topics presented include updates on grain legume breeding, endemic and emerging diseases of grain legumes, and strategies for controlling weeds. Approximately 200 growers and industry personnel were in attendance. (12/2/15)
- Scientists presented on research to manage grass weeds in grass seed production. Approximately 50 producers, researchers, and seed company personnel attended. (12/10/14)
- Hosted field managers, seed treatment technicians, and business managers of Pacific Northwest Growers Cooperative. Results of 2014 yield trials were presented to the audience and they had the chance to look at seed samples of elite varieties of pea, lentil, and chickpea developed by the research unit. (12/19/15)

- Presented on cool season food legume breeding efforts; advances in pea, lentil, and chickpea variety development; and on the recent discovery of an emerging disease of chickpea. Events include the annual research review of the USA Dry Pea and Lentil Council Research, annual meeting of Blue Mountain Seed Co., USA Dry Pea and Lentil Council Variety Release Committee. The meetings were attended by numerous industry personnel, and university and federal scientists. (2/5,19/15, 3/12/15)
- Presented at the Washington State Mint Convention, Pasco, WA on status and management of herbicide resistant weeds in processed vegetable production areas of Washington State. Approximately 100 producers, researchers, and crop consultants attended. (12/11-12/14)
- Presented a research summary at the Washington Hop Commission and Hop Research Council grower meeting in Yakima, WA on weed management in hops and efficacy of hop bine desiccants. Approximately 120 growers, buyers, researchers, and crop consultants attended. (8/5/15)

Northwest Sustainable Agroecosystems

- Presented information on weed-suppressive bacteria, registration by EPA, and NEPA information available to hasten the use of these bioherbicides on federal lands. Communication to over 200 producers, growers, ranchers, and land managers from state and county agencies, and federal organizations.(1/7/15, 1/11/15, 1/22/15)
- Presented a seminar on weed-suppressive bacteria applied in winter wheat rotation. Washington Grain Alliance /Commission leaders, administrator, Washington growers, WSU scientists (100 participants) were involved. (2/19/15)
- Discussed establishing grower test plots for cover crops in the low rainfall region and methods of data collection. (2/14/15)
- Reviewed winter canola fertility requirements for the spring with a growers group. (2/24/15)
- Presented two training seminars on 1) soil science and 2) weed-suppressive bacteria. Discussed soil factors involved in vegetation establishment in rangeland to reduce soil and organic matter loss and application of weed-suppressive bacteria as a means to reduce annual grass weeds. Met with land managers to discuss restoration plans that include bacteria; to compile a list of field restorations efforts to test the weed-suppressive bacteria; and to develop interagency collaborations. Information presented to Land Managers from BLM, FWS, NPS, and USFWS at various events. (2/24/15, 3/4/15, 3/11-12/15, 3/24/15)
- Presented on the proper techniques to use microbial products in production systems to improve soil quality and net farm profit. Approximately 14 producers, scientists, land manager, and land owners attended. (10/1-2/15)
- Organized and presented research on winter canola varieties, fertility, and rooting patterns at annual Field Day. Growers, crop consultants, ag chemical dealers, scientists, and extension educators attended. (6/4/15)
- Provided information on the influence of tall standing stripper header stubble on soil moisture and temperature and wind velocity to 50 attendees including growers, conservation district representatives, equipment dealers, and scientists. (6/23/15)
- Presented information on nitrogen loss from farmland by wind erosion to concerned growers at a Field Day in Lind, WA. (6/11/15)

Wheat Health, Genetics, and Quality Research Unit

- Provided laboratory tour, discussed lab operations, wheat quality research, genetic potential of varieties grown in this area, and new varieties with Washington Grain Alliance, Washington State University, Korean Trade Team, and various Japanese companies. (10/3/14, 10/27/14, 5/5/15, 6/29/15, 7/7/15, 7/27/15)

Vegetable and Forage Crop Production Research Unit

- Presented at the McGregor Grower Meeting in Quincy, WA on the incidence and management of herbicide resistant weeds in vegetable cropping systems. Approximately 175 growers, private company personnel, crop consultants, and researchers attended. (2/11/14)

Fruit and Vegetable Research Unit

- Provided information in oral presentations and posters on research results on chemical lures for detection of spotted wing Drosophila and management of cherry fruit fly. The audience of 100 was primarily cherry growers and packers, as well as other researchers. (11/13/14)
- Scientists provided information on the biology, ecology, and management of potato psyllid as a vector of the pathogen causing zebra chip disease of potato. Audiences were comprised of approximately 150 growers and

- commercial pest managers, and 1800 grower and industry representatives. (11/13/14, 1/8/15, 1/29/15)
- Presented research results describing the phytonutrient content of advanced breeding lines from the TriState breeding program to growers and industry at the annual Oregon/Washington Potato Conference. (1/27/15)
- Methods and technologies for attracting and trapping insect pests were presented to approximately 200 grape growers and representatives of the wine industry at the Wine Grape Growers Annual Conference. (02/13/15)
- Presented research findings on pear psyllid endosymbionts, insecticide resistance, and mating disruption. Approximately 100 growers and industry representatives from Washington, Oregon, and California were present. (2/18/15)
- Presented research on phytonutrient content of baby potatoes and potato cyst nematode to over 100 growers and industry members at the Idaho Potato Conference. (1/22/15)
- Presented the biology, pest status, and management of stinging wasps to a group of approximately 100 personnel responsible for property management and pest control in Jacksonville, FL. (3/26/15)
- Presented the risk of zebra chip disease pathogen spreading through export potatoes. POTATO EXPO is the largest conference and trade show for the potato industry held in North America every year. Approximately 1800 potato producers, processors, researchers, and key industry stakeholders attended. (01/8/15)

Physiology and Pathology of Tree Fruits Research Unit

- Presented on apple fruit postharvest biology and technologies to manage fruit ripening and minimize fruit physiological disorders during storage to approximately 100 university chemistry instructors. (10/10/14)
- Presented at the Washington Tree Fruit Research Commission Apple Crop Production Research Review, the Pace International Postharvest Academy, and the AgroFresh Inc. Crunch Clinic on postharvest management of apple fruit to prevent physiological disorders and extend market quality life. Attendees included over 250 growers, researchers, extension, and private company personnel. (1/28/15, 3/25/15, 5/6/15)
- Presented on the management of orchard soil microbiology resources as a means to manage diseases and to limit re-infestation of soils by plant pathogens and parasites. Research, extension, and private company personnel attended the presentations. (12/3/14)
- Presented research on elucidation of apple rootstock genes and metabolism related to disease resistance to an audience of growers, research, extension and private company personnel. (1/30/15)
- Presented on the development of non-fumigant alternatives for the management of soil-borne diseases in strawberry and tree fruit production systems. Approximately 300 growers and private company personnel attended. (2/4/15)
- Delivered presentations summarizing field trials on the use of Brassica seed meal amendments and anaerobic soil disinfestation as alternatives to soil fumigation for the control of strawberry soil-borne diseases. Growers and industry representatives were in attendance. (8/12/15)

West Virginia:

Appalachian Fruit Research Station

- Open House presented research results and projects related to tree fruit and small fruit production to the general public October 8-9.
- Participated in the 6th Jefferson county Science Olympiad with a presentation on the brown marmorated stinkbug October 19-23

Wisconsin:

Environmentally Integrated Dairy Management Research Unit

- Low-disturbance manure application methods in a corn silage-rye cover crop system and Winter manure phosphorous loss at the WI Crop Management Conference, Madison, WI. 1/15
- Wisconsin Environmental Health Network Symposium, UW-Madison School of Medicine and Public Health (2/26/15)
- Maintained website for public downloading of APLE P runoff model. Model was downloaded 70 times in FY15. Initiated new website for public downloading of new APLE-Lots barnyard P runoff model. Model was downloaded 4 times in FY15.
- Application of Dairy Slurry on Alfalfa Fields, Midwest Forage Association, Wisconsin Custom Operators, and Professional Nutrient Applicators Association of Wisconsin, Wisconsin Dells, WI (1/21

U.S. Dairy Forage Research Unit

- Received official approval from the Association of Official Analytical Chemists International (AOAC) for a starch assay, “AOAC Official Method 2014.10 Dietary Starch in Animal Feeds and Pet Food,” to be used by feed analysis laboratories. It was also posted on the AOAC web site. 4/30/15
- Created and distributed a new computer simulation model, APLE-Lots, to augment the previously created Annual Phosphorus Loss Estimator (APLE) which has gained widespread use among scientists, conservationists, and others working to reduce phosphorus runoff from agricultural systems. While the original model simulates dissolved and sediment-bound phosphorus loss in surface water from cropped fields and pastures, the new APLE-Lots does the same for phosphorus loss from outdoor cattle lots. 5/2015
- Presented talks (“Measures of nitrogen use efficiency and environmental impacts of dairy production systems,” “Effects of manure on legume productivity and persistence,” and “Low-disturbance manure application methods in a corn silage-rye cover crop system”) to 300 crop consultants, animal nutritionists, fertilizer dealers, researchers, Extension educators and producers at the Wisconsin Crop Management Conference. 1/14/15
- Organized and presented research information at a seminar series for about 300 dairy and forage producers and industry representatives at World Dairy Expo. Also created an educational display, “You don’t have to choose between saving the earth and saving money: Economic and environmental sustainability go hand in hand,” for the 77,000 visitors from 44 states and 94 countries who attended the show. 10/4/15
- Gave a presentation, “Best Practices for Using Coproducts in Dairy Diets,” to about 300 ethanol industry personnel, animal nutritionists and researchers at the Distillers Grains Symposium. 5/13/15

Vegetable Crops Research Unit

- National Fry Processor Trial Field day in East Grand Forks, MN. 10/1/14
- UW Extension and WPVGA Grower Education Conference in Stevens Point, WI. 2/3-5/15
- California Carrot Symposium in Bakersfield, CA. 3/10/15
- Wisconsin Cranberry School sponsored by the University of Wisconsin-Extension and the Wisconsin State Cranberry Growers Association. Establishing a marker assisted selection (MAS) program for cranberry

3.11. Technology Transfer Award Winners

FY 2015 ARS Technology Transfer Award

Scientist: Dr. Timothy Leeds and Dr. Gregory Wiens

Lab: National Center for Cool and Cold Water Aquaculture, Northeast Area, Kearneysville, West Virginia

Title: The ARS-Fp-R Team for the development and release of the ARS-Fp-R line of rainbow trout.

FY 2015 Federal Laboratories Consortium (FLC) Awards

Name: Dr. Sevim Erhan, Eastern Regional Research Center, Wyndmoor, Pennsylvania

Award: Laboratory Director of the Year Award

Lab: Apple Rootstock Breeding Laboratory

Title: New Productive, Disease Resistant Apple Trees

Award: National Excellence in Technology Transfer

Lab: Coastal Plains Soil, Water and Plant Research Center

Title: Quick Wash Process for Removing and Recovering Phosphorus from Wastes

Award: National Excellence in Technology Transfer

Lab: Environmental Microbial and Food Safety Laboratory

Title: Online Imaging for Real-Time Wholesomeness Inspection in Poultry Processing

Award: National Excellence in Technology Transfer

Lab: Genetic Improvement of Fruits and Vegetables Laboratory

Name: 'Flavorfest' Strawberry Cultivar

Award: National Excellence in Technology Transfer

Lab: National Center for Cool and Cold Water Aquaculture

Name: Development and Release of a Disease- Resistant Rainbow Trout Line

Award: National Excellence in Technology Transfer

Lab: Foodborne Toxin Detection and Prevention Research Unit

Name: Improved Detection of Shiga Toxin through Monoclonal Antibodies

Award: Far-West Region, Excellence in Technology Transfer

Lab: Bioproducts Research Unit

Name: Encapsulation of Beneficial Soil Microbes in Starch-Gypsum Matrix for Use in Agriculture

Award: Far-West Region, Excellence in Technology Transfer

Lab: Soil and Water Management Research Unit

Name: Waveguide-On-Access-Tube (WOAT) Time Domain Reflectometry (TDR) System

Award: Mid-Continent Region, Excellence in Technology Transfer

Lab: Bio-oils Research Unit

Name: Commercialization of Estolides as a Biobased Engine Oil

Award: Mid-West Region, Excellence in Technology Transfer

Lab: Cotton Chemistry and Utilization Research Unit

Name: Cotton Nonwoven Fabrics for Disposable Diapers

Award: Southeast Region, Excellence in Technology Transfer

Lab: Quality & Safety Assessment Research Unit

Name: Microwave Moisture Sensor for In-Shell Peanut Kernel Moisture Measurement

Award: Southeast Region, Excellence in Technology Transfer

Lab: Crop Production Systems Research Unit

Name: Herbicide Resistance in Weeds Monitoring and Reporting System

Award: Southeast Region, Honorable Mention

Lab: Environmental Microbial and Food Safety Laboratory

Name: Online Imaging for Real-time Wholesomeness Inspection in Poultry Processing

Award: Mid-Atlantic Region, Excellence in Technology Transfer

Lab: Genetic Improvement of Fruits and Vegetables Laboratory

Name: "Flavorfest" Strawberry Cultivar

Award: Mid-Atlantic Region, Excellence in Technology Transfer

Lab: Invasive Insects Biocontrol and Behavior Laboratory

Name: Reduced Risk Vector Control Insecticides

Award: Mid-Atlantic Region, Excellence in Technology Transfer

Group: ARS Office of Technology Transfer, University of Maryland Extension, and Montgomery County Department of Economic Development

Name: The High Tunnel Forum

Award: Mid-Atlantic Region, Educational Institution and Federal Laboratory Partnership Award

3.12. Selected Metric Charts.

Figure 1. Number of new and active CRADAs. Part of the trend in the decreasing number of CRADAs may be due to the fact that we have a new mechanism (Material Transfer Research Agreement, MTRA) for collaborative research that was previous carried out under a CRADA.

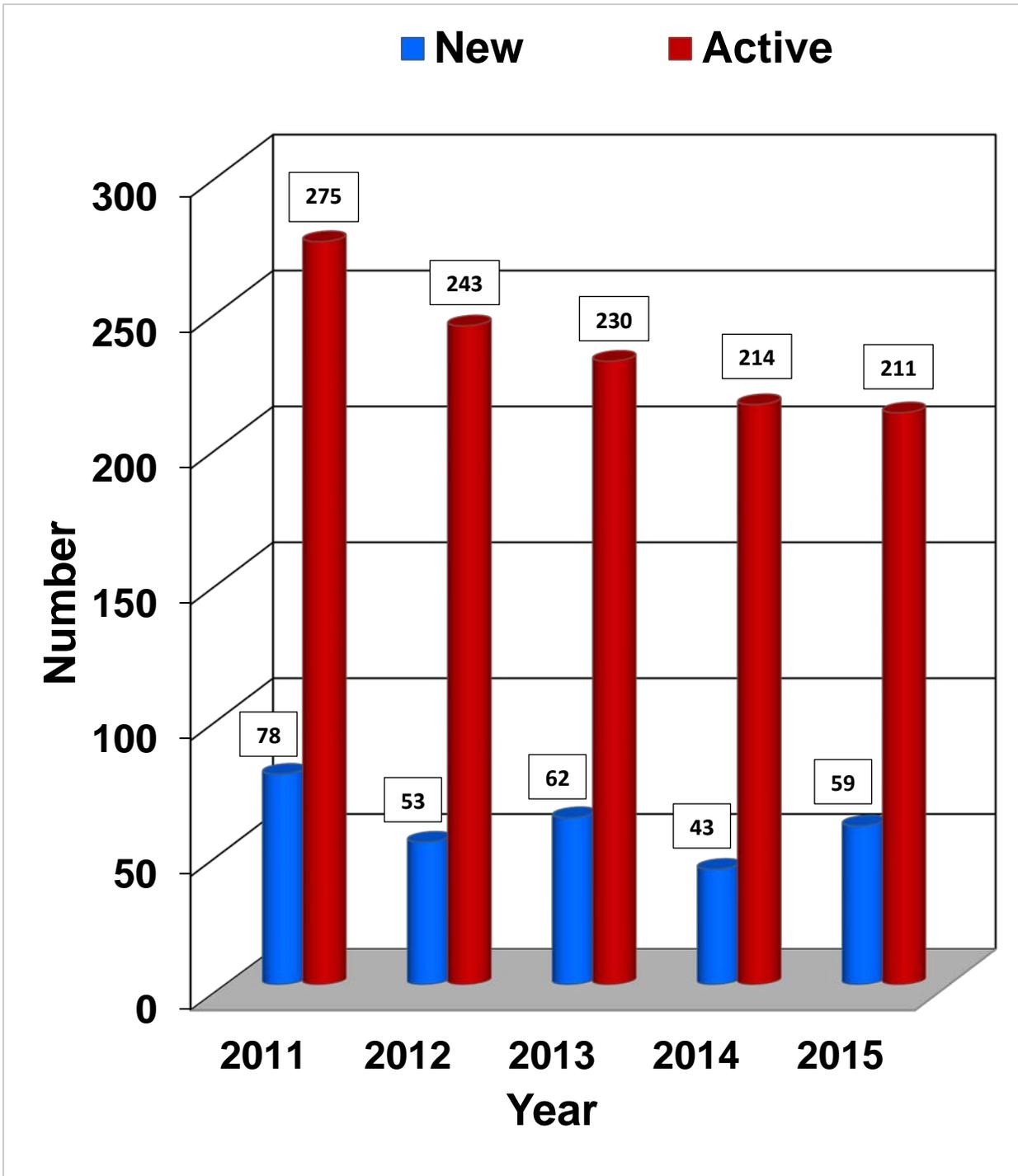


Figure 2. Number of collaborative research agreements executed by type in FY 2015.

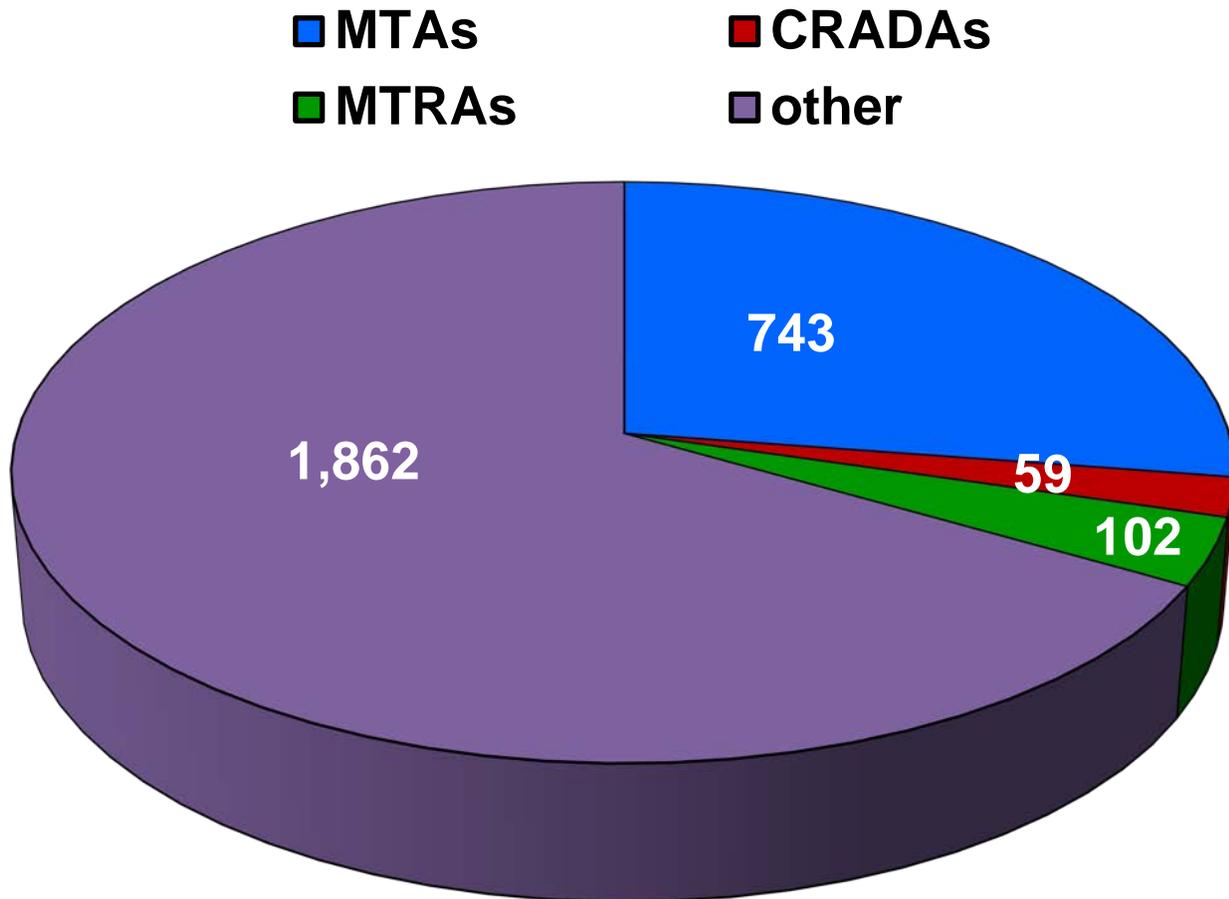


Figure 3. Number of new and active Trust Fund Cooperative Agreements, Reimbursable Agreements, Specific Cooperative Agreements and Non-Funded Cooperative Agreements.

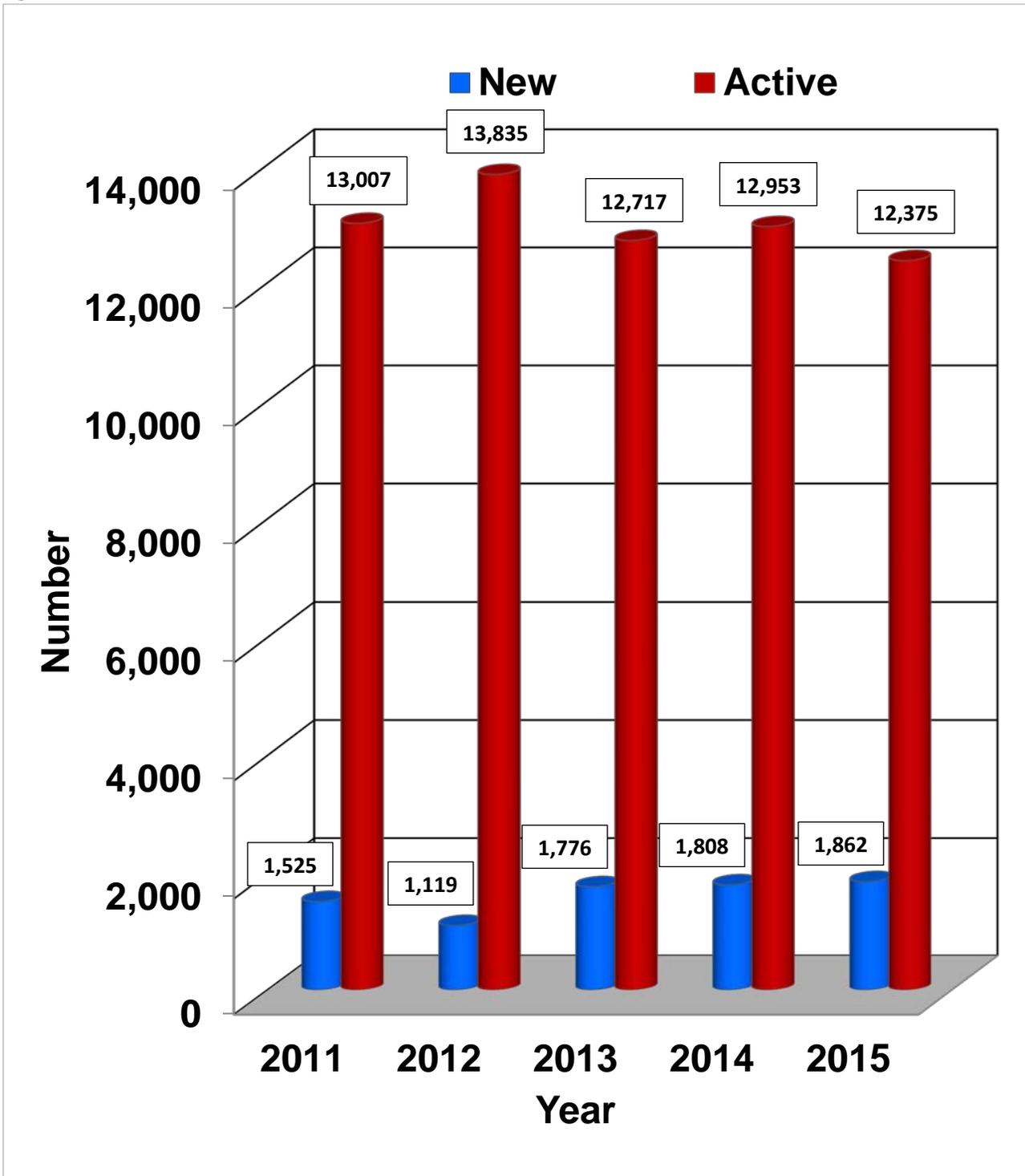


Figure 4. Number of invention disclosures, patent applications filed and patents issued. The year in which a patent issues is not the year in which the patent is filed. The increase in the number of invention disclosure in FY2015 was the result of adding biological materials disclosures for the first time.

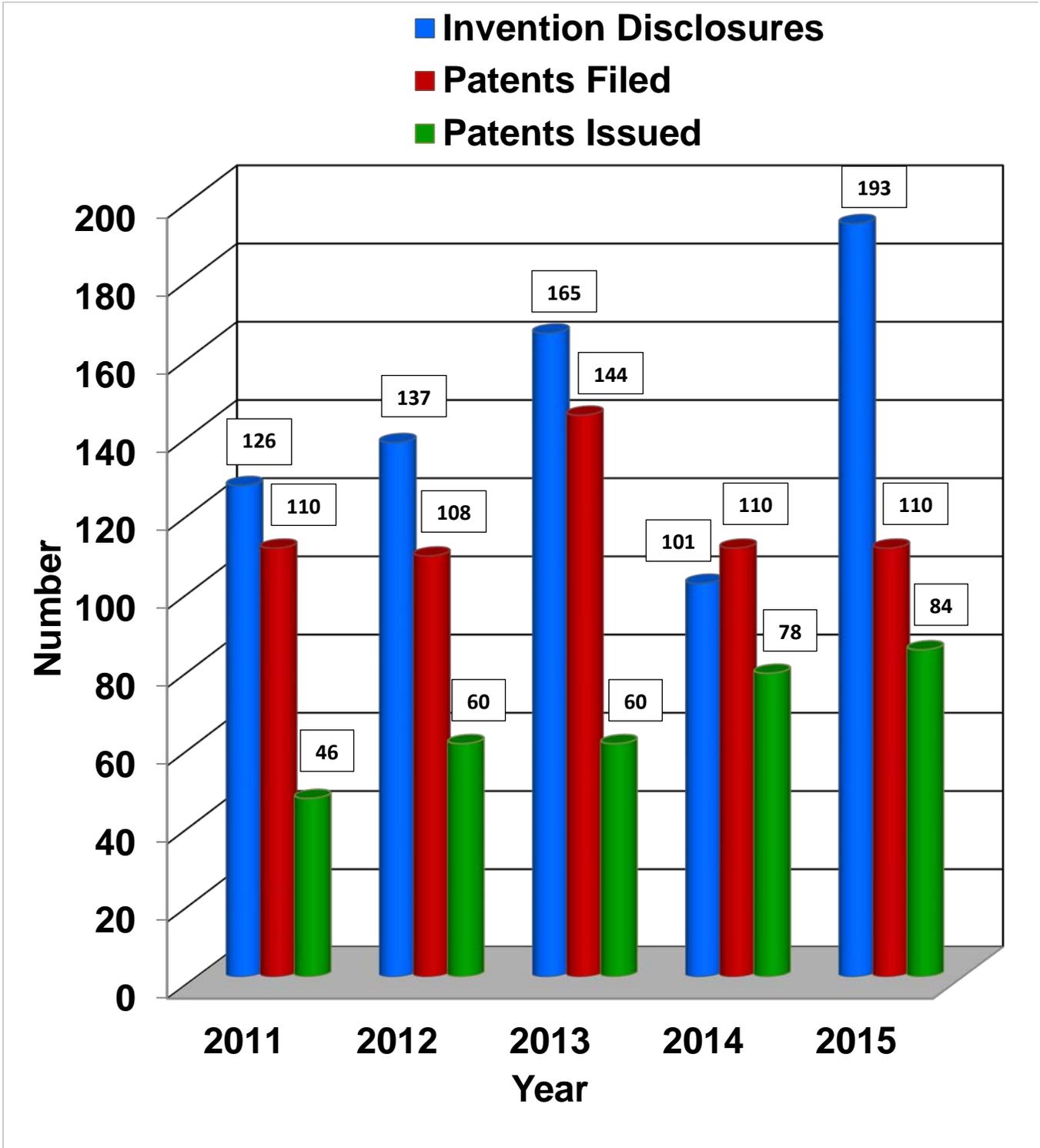


Figure 5. The ratio of patents issued over patent applications per year. While the year in which a patent issues is not the year in which the patent is filed, the ratio does represent a trend. The current goal is “judicious” patenting to increase the percentage of patents that are issued.

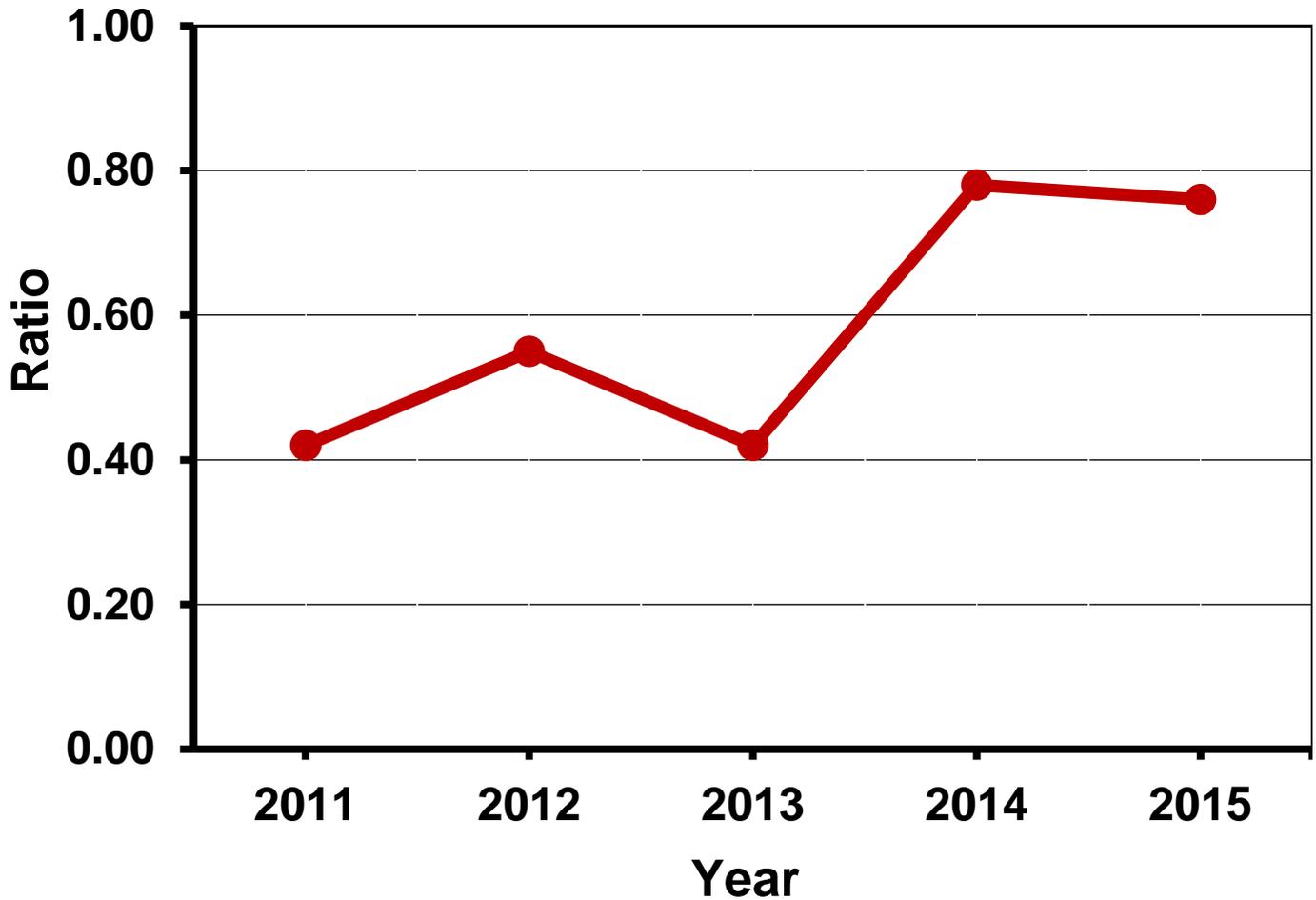


Figure 6. Number of patents issued in FY 2015 by scientific discipline.

- **Life Science**
- **Chemical**
- **Mechanical & Measurements**
- **Plants**

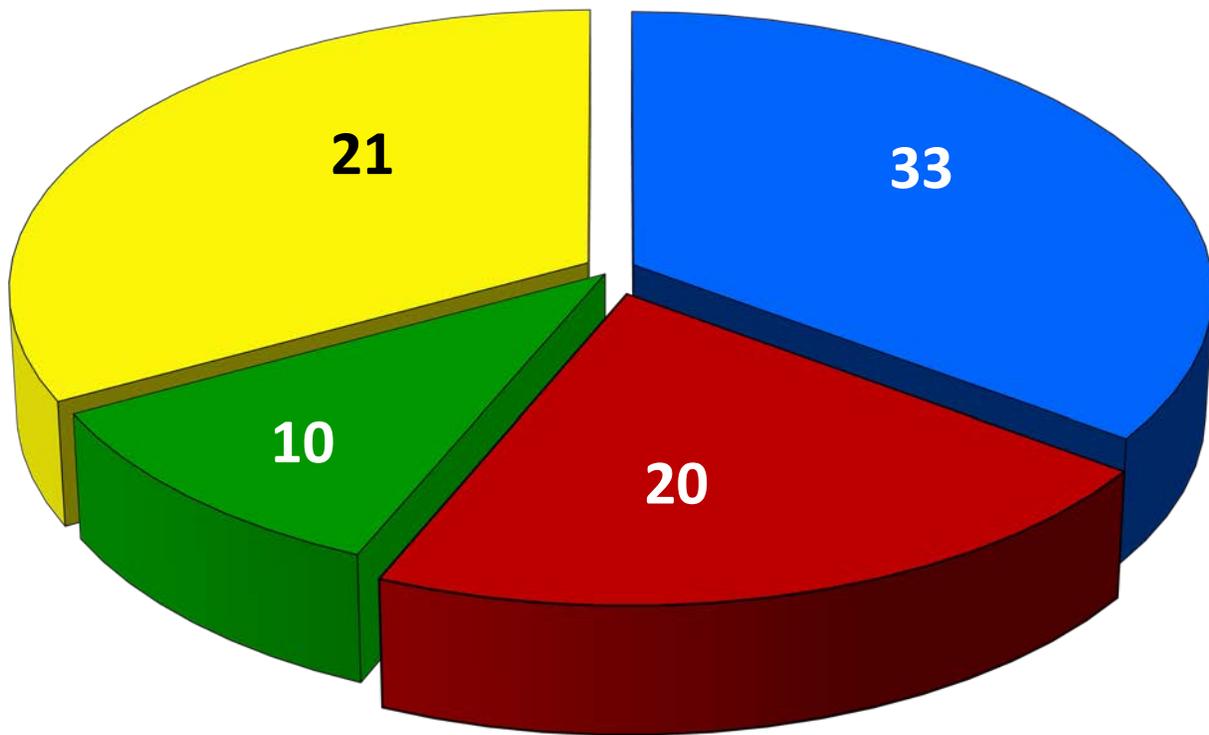


Figure 7. Number of license types per year.

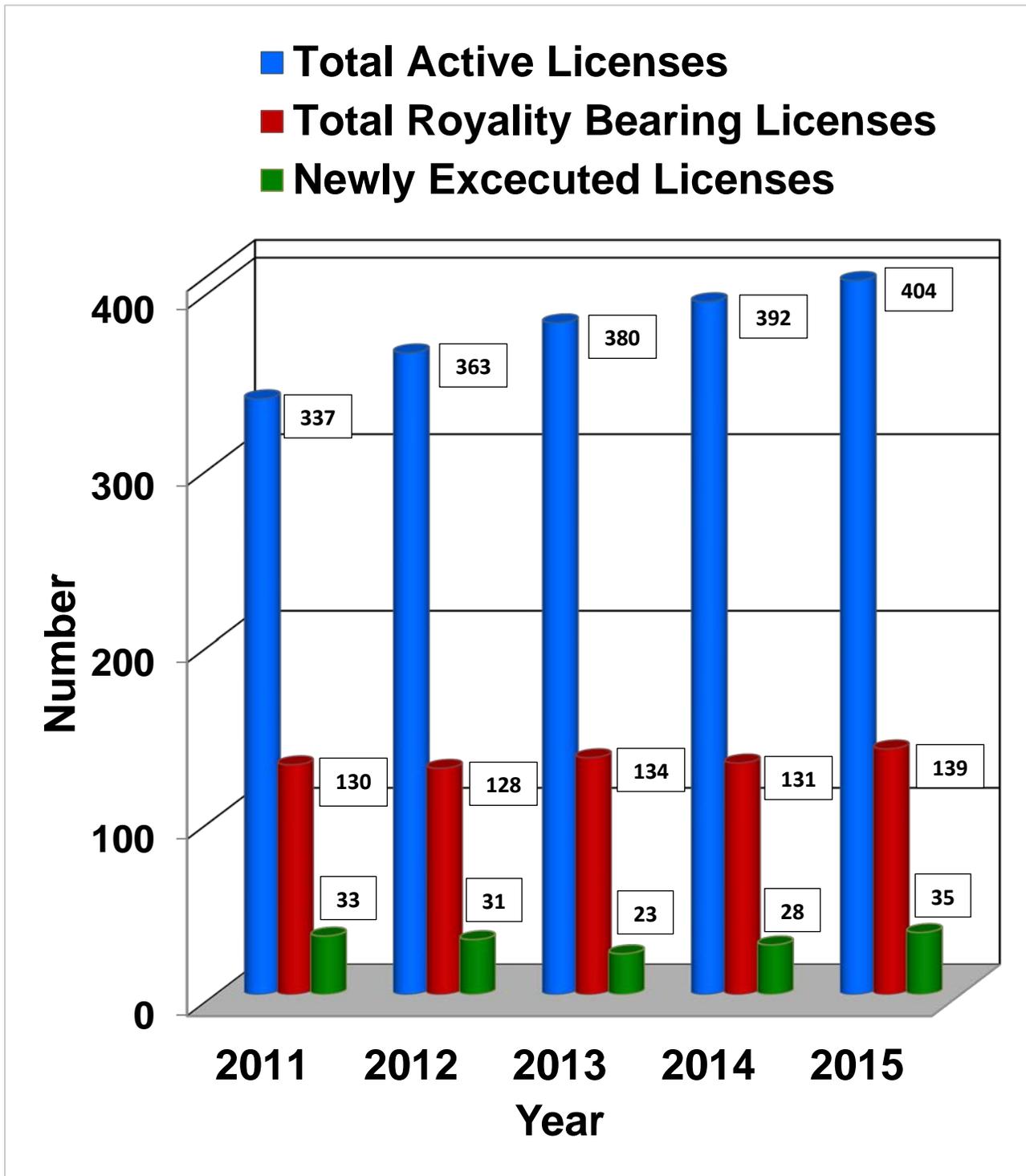


Figure 8. Earned license royalty income (ERI) over time.

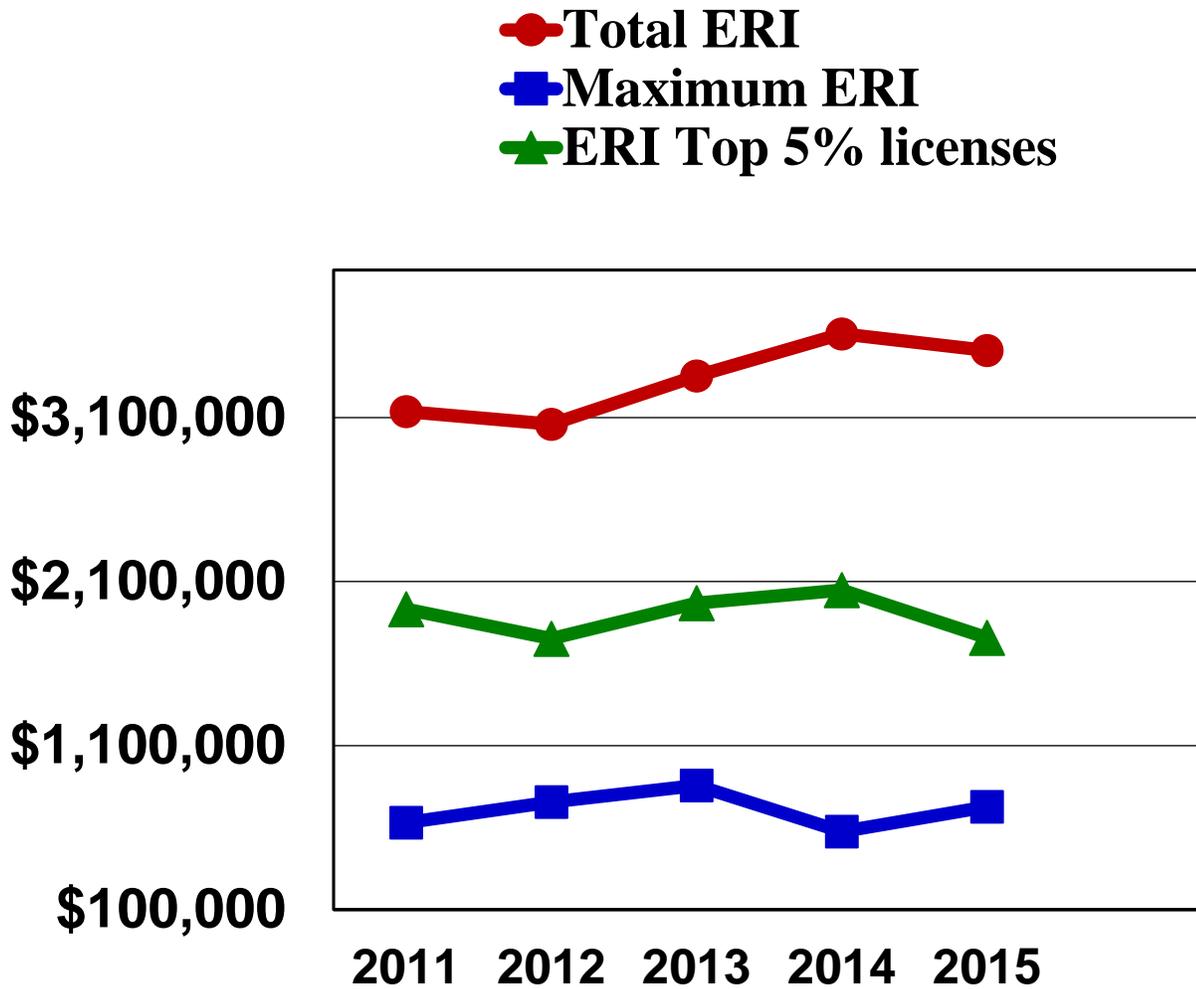


Figure 9. The number of new licenses executed in FY 2015 by business type.

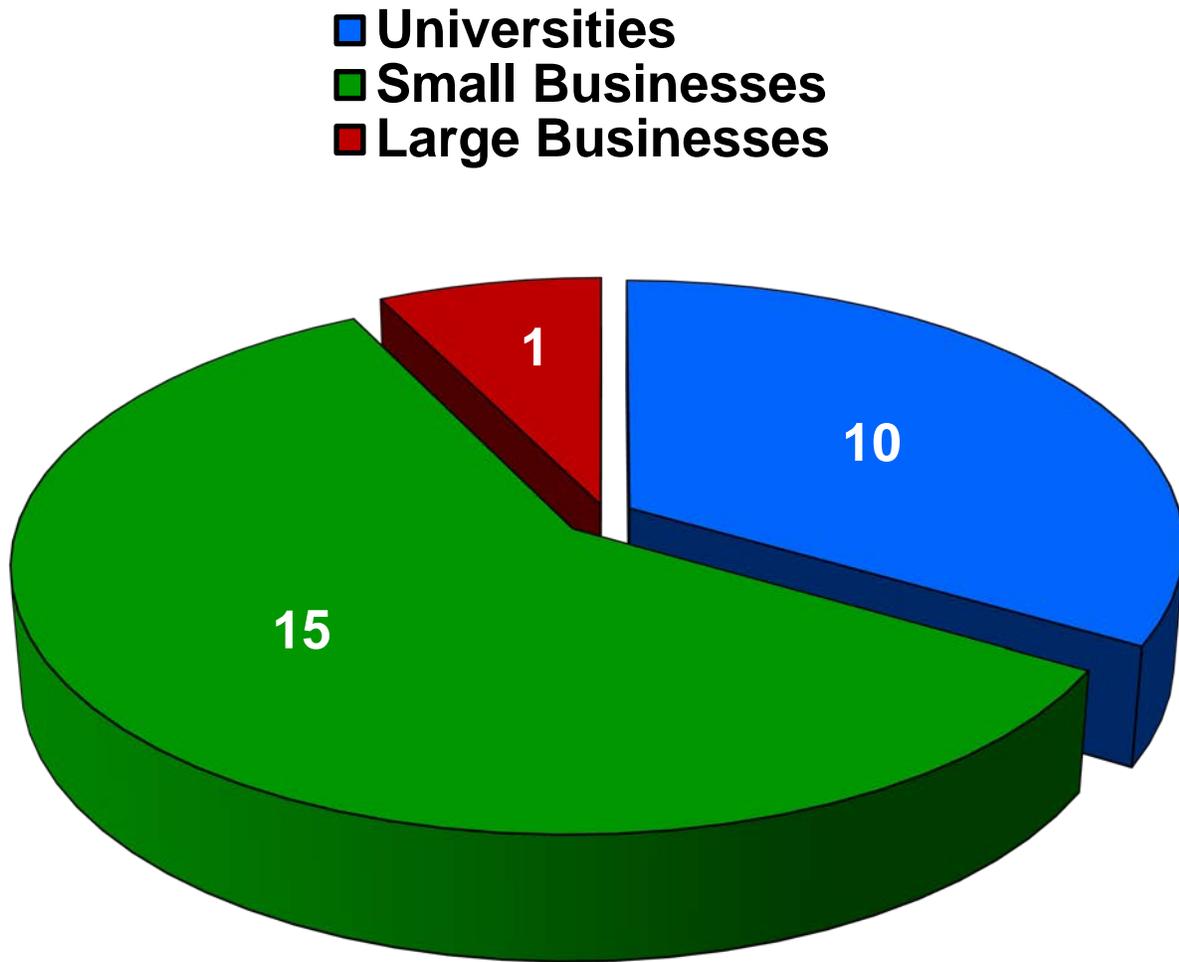
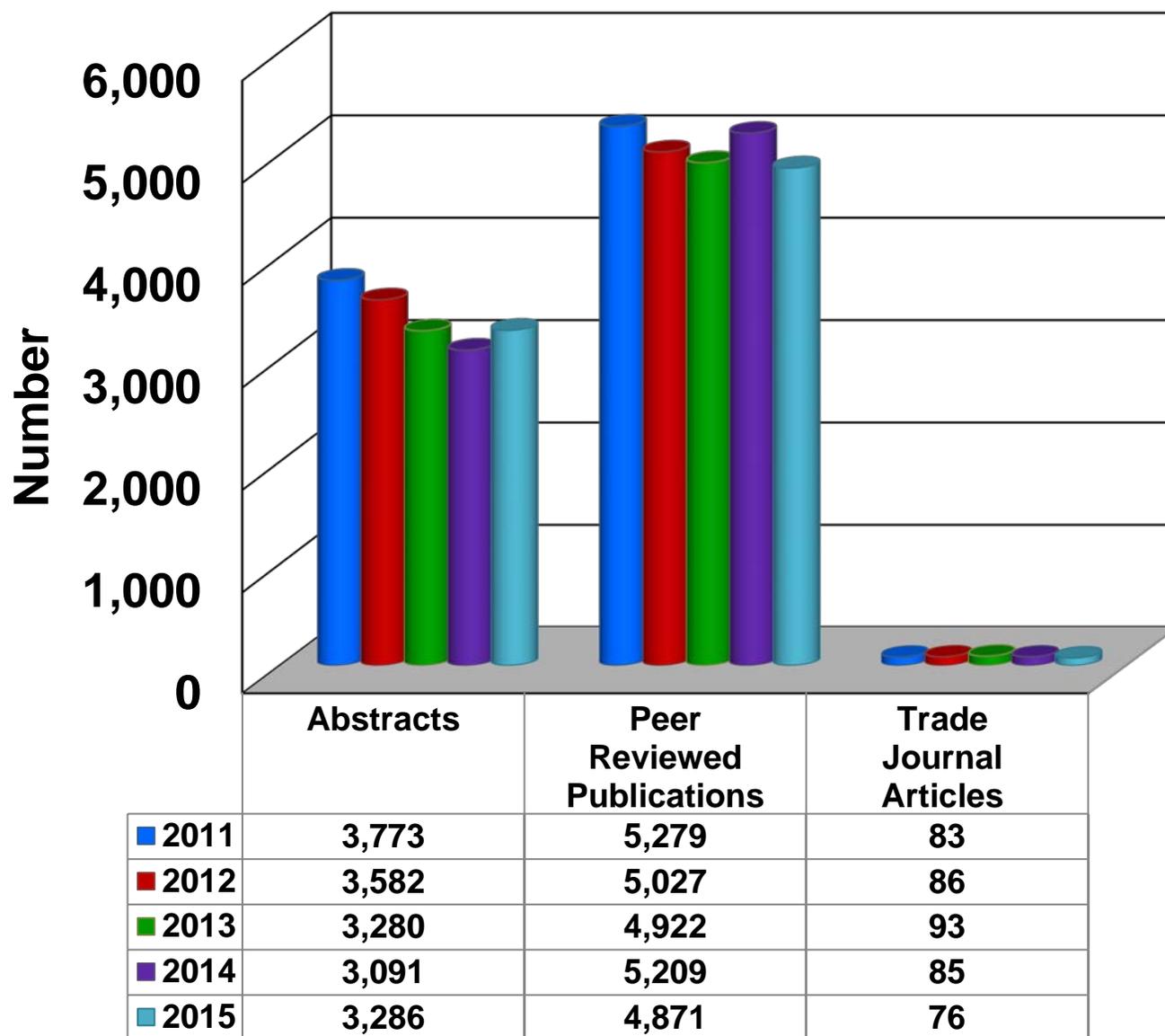


Figure 10. Number of ARS-approved manuscripts per year.

4.0. Economic Research Service (ERS)

<http://www.ers.usda.gov/>

4.1. Mission Statement

The ERS mission is to anticipate economic and policy issues related to agriculture, food, the environment, and rural development, and conduct economic research that broadly and specifically informs public program and policy decisions.

4.2. Nature and Structure of Research Program

ERS follows the general USDA definition of technology transfer as the adoption of research outcomes for public benefit. ERS conducts relevant and objective economic research and policy analyses that inform program and policy decisions. ERS designs its research to demonstrate to its customers the consequences of taking alternative policy or programmatic pathways. Our data and market analysis program provides crucial market and trade outlook information to help farmers and agricultural companies run successful businesses and support jobs. ERS is also the primary source of statistical indicators that, among other things, gauge the health of the farm sector (including farm income estimates and projections), assess the current and expected performance of the agricultural sector (including trade), and provide measures of food insecurity here and abroad. ERS is one of the 14 officially designated (by OMB) federal statistical agencies.

ERS disseminates its research findings, market information, and statistical indicators in a variety of outlets including:

- Its website (www.ers.usda.gov/);
- Its online magazine, *Amber Waves*;
- Outlook reports for specific commodity sectors
- ERS research and information reports; and
- Refereed journal articles, which assure the professional credibility of findings.

The ERS is located in Washington, DC, and has about 250 federal researchers working on socioeconomic research. Additionally, ERS seeks out academic and private sector collaborators through contracting and cooperative agreements to leverage external expertise to complement the knowledge of our intramural research staff.

4.3. Current Technology Transfer Goals, Objectives, and Measures of Success (Metrics)

ERS uses a web-centric approach to communication with customers. Our goal is to convey clear, objective, and transparent research, data, and analysis to decision makers, policy officials, industry, non-governmental organizations, and the general public. All ERS research, data, and other information disseminated by the agency are available through the ERS website. ERS measures customer satisfaction with the ERS website using a survey based on American Customer Satisfaction Index (ACSI). The measure tracks satisfaction of Web site users and provides a basis for comparison with similar government and private-sector Web sites. The target for this measure is at or above the average rating for government websites in the Information/News category.

4.4. Strengthening Current Activities

ERS continues to enhance and update its website. ERS research, analysis and data will be easier to find, and dynamically displayed in multiple locations. The website features more intuitive navigation for customers to enhance information delivery to customers. The website also features an enhanced experience for mobile users.

4.5. ERS response to Presidential Memorandum on Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses

In the USDA's implementation plan for the Presidential Memorandum, ERS described one initiative to promote technology transfer and commercialization. The initiative and its implementation in FY 2014 are described below.

USDA 29: ERS is making wider use of social media and new technologies (such as mobile phone applications) to widen and expand the reach of our information services to the general public.

ERS is implementing wider use of social media and new technologies (such as mobile phone applications and open data methodologies) to widen and expand the reach of our information services to the general public. ERS has been a leading innovator in support of the Administration's Digital Strategy and Open Data initiatives, providing a wealth of products—including data and resources—designed to enhance delivery of information and services. In FY 2015, ERS used several new tools designed to help consumers more easily access critical programs and stimulate further innovation:

- **Responsive Design:** ERS has been working to optimize the website for mobile users, including developing a digital “eZine,” built with Responsive Design principles to automatically render on multiple devices/screen sizes, providing efficiencies in design/production (versus developing multiple style sheets for individual devices/platforms).
- **Web content APIs** (Application Programming Interface), offering digital professionals a machine-readable option for accessing publications, charts, and other website content. This allows external customers to integrate ERS information into their own website content.
- **APIs for select data and geospatial/mapping applications**, enabling researchers and developers to build applications using ERS data and process for additional insights.
- **Data Visualization:** New tools and technologies have been adopted to present data in a series of active online charts that allow users to interact with ERS data and design charts that reflect different views of data for an enhanced user experience.

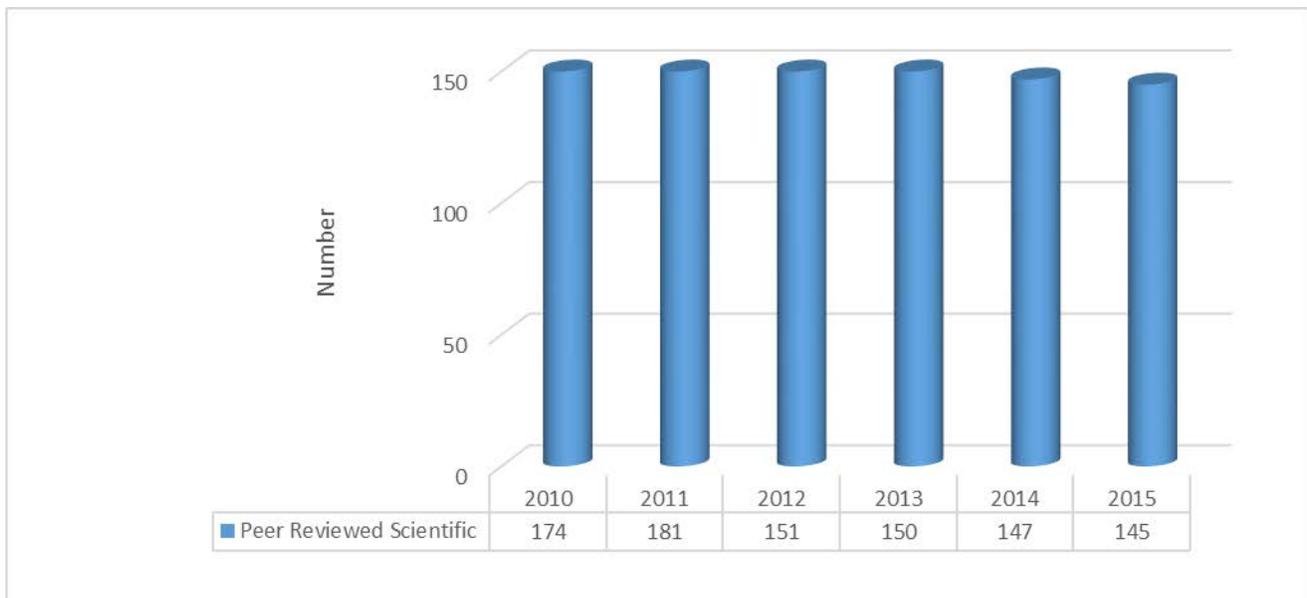
The new products and tools extend and expand access to ERS research findings, market outlook, and data—making the Agency's information more readily available to the general public. These items were a first among USDA (and many government agencies), enabling USDA to meet its 12-month Digital Government Strategy goals to ensure high-value services and systems are available anywhere, any time, and on any device. The work also supports the President's Management Agenda to improve efficiency, share data with entrepreneurs and businesses, and stimulate job growth.

4.6. Downstream Outcomes

- ERS's Twitter feed continues to expand our reach: with over 22,000 followers signed up for our tweets in fiscal 2015--up from over 16,000 followers in 2014 and from 13,000 in 2013.
- Policy makers and the public are being provided with easily accessible data on rural areas through the ERS Atlas of Rural and Small-town America (<http://www.ers.usda.gov/data-products/atlas-of-rural-and-small-town-america.aspx>). The online mapping tool provides county-level information on over 60 statistical indicators on the people, jobs, agriculture, and county characteristics in nonmetropolitan America. The Atlas helps State and local decisionmakers pinpoint the needs of particular areas, recognize their diversity, and develop strategies to build on their assets by using location-based data on population, age structure, race and ethnicity, income, employment, agricultural well-being, and other measures. In FY 2015 the Atlas was updated to feature information on Veterans, education, and income from the American Community Survey, as well as current population and migration estimates from the Census Bureau..

- Local officials throughout the country can now easily gauge the characteristics of their food environment and target actions that alleviate problems with the availability of healthy food options for the people in their counties or State using the ERS Food Environment Atlas (<http://www.ers.usda.gov/data-products/food-environment-atlas.aspx>). The Atlas maps 168 different factors that contribute to U.S. counties' and States' food environments – from the number of fast food outlets per capita, to average food prices for various products, and the rate of diabetes. Because ERS determined the location and derived the characteristics of the nation's food deserts – places where grocery stores do not exist or are not easy to get to -- national, State and local governments can target food access investments so that the 23 million people with low access will have better choices and better access to healthy, affordable food.

4.7. Publications



5.0. Foreign Agricultural Service (FAS)

<http://www.fas.usda.gov/>

5.1. Mission Statement

The Foreign Agricultural Service (FAS) links U.S. agriculture to the world to enhance export opportunities and global food security.

5.2. Nature and Structure of Program

FAS Washington, D.C. staff and a global network of 96 offices with Foreign Service Officers and locally engaged staff cover over 160 countries. FAS supports U.S. foreign policy, identifies problems, provides practical solutions, and works to advance global food security and opportunities for U.S. agriculture. Within USDA, FAS serves as the principle coordinator of international activities, drawing on the broad expertise of USDA and U.S. agricultural organizations.

Trade Policy

FAS expands and maintains access to foreign markets for U.S. agricultural products by providing expertise in international trade policy negotiations and enforcement, and in working to reduce or eliminate technical barriers to trade and sanitary and phytosanitary trade restrictions. FAS works closely with other USDA agencies, federal and state governments, the U.S. agricultural industry, foreign governments, and international organizations to help ensure a level playing field for U.S. agricultural products in the international marketplace.

Market Development and Export Assistance

FAS partners with more than 75 cooperator groups, representing a cross-section of the U.S. food and agricultural industry, and manages a toolkit of market development programs to help U.S. exporters develop and maintain markets for hundreds of U.S. products. FAS also supports U.S. agricultural exporters through export credit guarantee programs and other types of assistance.

Data and Analysis

FAS's network of global contacts and long-standing relationships with international groups contribute to the agency's unique market intelligence capacity for all major agricultural commodities. FAS collects data and its analysts generate objective intelligence on foreign market opportunities, prepare agricultural production forecasts, assess marketing opportunities for U.S. exports, and both identify and monitor changes in policies affecting U.S. agricultural exports and imports. Agricultural markets and key private sector constituents rely on FAS data and analyses to develop and implement domestic and international programs and make business decisions.

Capacity Building and Development

FAS leads USDA's efforts to help developing countries and emerging market economies improve their agriculture and food systems and build their agricultural development and trade capacities. FAS administers international fellowships and other agricultural science and trade technical assistance, including non-emergency food assistance programs to help meet recipients' nutritional needs and support agricultural development and education.

5.3. Response to Presidential Memorandum on Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses

USDA 31: Engage in consultation with the Agricultural Research Partnerships Network to assist in establishing U.S. commercial partners with foreign entities.

In 2015 FAS provided updated talking points to the ARS/Office of Technology Transfer to disseminate information about FAS to ARP Network members that were interested in establishing commercial partners with

foreign entities. In addition, FAS continued direct consultations with the Center for Innovation (Arlington, TX) about concepts for potential collaboration on international capacity building for transfer and commercialization of USDA technologies.

5.4. Downstream Outcomes

Food For Progress.

The Food for Progress Program (FFPr) helps recipient countries to modernize and strengthen their agricultural sectors. U.S. agricultural commodities donated to recipient countries are sold on the local market and the proceeds are used to support agricultural, economic, or infrastructure development programs. In some cases, FFPr activities help accelerate the transfer and commercialization of U.S. technology in partner countries. For example, in FY 2015 TechnoServe (TNS) was awarded \$35.98 million to develop the cashew value chain in Benin. Through this project, TNS will transfer a focused set of market-engagement skills to cashew producers that will help them improve their management practices and enable them to successfully engage in markets. Working with local agencies, TNS will recruit and train field agents the Skills for Marketing and Rural Transformation (SMART) Skills and Farmbook curricula adapted from Catholic Relief Services' current toolkit. At the village level, these field agents will mobilize existing or aspirant cashew producers into training groups in multiple communities. Field agents will train these producer groups on the SMART Skills package and a subset of farmers on Farmbook principles. In addition, TNS will train cashew farmers on improved post-harvest handling techniques and inventory control technologies.

Norman E. Borlaug International Agricultural Science and Technology Fellows Program.

In 2015, the Norman E. Borlaug International Agricultural Science and Technology Fellowship Program (BFP) supported 45 Fellows to help transfer new science and agricultural technologies to eligible developing countries. Since the program's inception in 2004, BFP has provided training to more than 750 Fellows from 64 countries and facilitated ongoing relationships between Fellows and their U.S. mentors to promote the adoption or commercialization of U.S. technologies in their respective countries. For example, this year FAS learned that the citrus industry in the Rio Grande Valley of Texas was positively impacted as a result of training a Moroccan Fellow at Texas A & M University (TAMU) at Kingsville, an Hispanic Serving Institution. In 2011, Mr. Lhou Beniken conducted research there on improved irrigation and water management techniques for citrus orchards. His mentor, Dr. G. Rasmussen, visited Mr. Beniken at the National Agricultural Research Institute in Morocco and saw firsthand the success in orchards utilizing an improved border flood technique instead of conventional flood irrigation. This method utilizes 36 percent less water while still meeting the water needs of citrus trees. Dr. Rasmussen, along with other TAMU-Kingsville colleagues, brought this technique back to Texas, where it was introduced to the citrus industry through field demonstrations and farmer trainings. Many orchards in the Rio Grande Valley adopted this improved method and have seen measurable success. The reciprocal visit of a host university mentor to the Fellow's home country to see their research application is a unique feature of the BFP and leads to many examples of two-way knowledge sharing and learning. Dr. Abdul Islam, a 2010 Borlaug Fellow from the Indian Council of Agricultural Research (ICAR), conducted climate change research at Colorado State University (CSU) under the Global Research Alliance Initiative. After his time in the United States under the BFP, he continued to collaborate with his mentors at CSU and USDA's Agricultural Research Service (ARS) facility in Fort Collins, Colorado. The focus was on generation of climate change scenarios, using the projection model learned during his Fellowship, to evaluate corn cultivars for adaptation to climate warming. Realizing the importance of the project, ICAR initiated a program on Integrated Agricultural Systems Analysis for preparing an adaptation strategy, with suggested policy interventions. Dr. Islam is coordinating those research activities and was recently promoted to Principal Scientist at ICAR in New Delhi. He has published four scientific journal articles about the research at CSU, has applied climate change models for two case studies in India, and has presented his findings at four seminars. These exemplary Fellows, their U.S. mentors, and other BFP participants are continuing to learn, disseminate, and apply U.S. technologies to improve agricultural sciences, trade, and food security throughout the developing world.

Global Partnership for Pesticide Standards.

With funding provided by the FAS Emerging Markets Program, the U.S. Department of State, and the U.S. Agency for International Development, and with technical cooperation from the IR-4 Project, crop protection industries, and the Food and Agriculture Organization of the United Nations (FAO), FAS continued to lead a global partnership for transferring and commercializing U.S. crop protection technologies to partner countries in a manner that is concurrently helping to establish Codex standards for innovative pesticide-crop combinations and, ultimately, share costs of generating the data that leads to such standards. Codex standards are international food standards, guidelines, and codes of practice contribute to the safety, quality, and fairness of this international food trade. Currently, USDA's National Institute of Food and Agriculture spends approximately \$17 million each year on IR-4 to conduct pesticide residue field trials for U.S. specialty crops, which prioritizes low-risk pest control solutions. The IR-4 Project is highly successful in generating data for review and acceptance by the U.S. Environmental Protection Agency. Thus, the pace of the registration and commercialization of new pesticides for use by U.S. growers far exceeds the pace of Codex and most U.S. trading partners. As a result, many chemicals approved for use by U.S. growers are not yet approved abroad, often creating situations where affected U.S. products are banned from their intended foreign markets. Conversely, many specialty crops grown in tropical countries also do not have sufficient, legally allowed pest control tools available to growers, nor do they have internationally recognized trade standards for the products that are registered. The lack of low-risk specialty crop pesticides and international residue standards is a critical barrier for crop production and trade. The FAS-led global partnership is working with stakeholders in partner countries in Africa, Asia, and the Western Hemisphere to fill the gaps. In short, through policy dialogue, technical training and cooperative research, the global partnership is enabling coordination among the United States and 20 other countries to conduct field trials on pesticides and crops and then jointly submit the data packages to Codex. From 2014-15, the partnership successfully completed field and laboratory studies in 10 countries, initiated studies in 5 countries, and provided training to 5 additional countries that planned to initiate studies. Additionally, FAS coordinated the nomination process between the United States, partner countries and FAO for the scheduling of residue data review for establishment of Codex standards by 2017. In addition to ongoing technology transfer activities in 2015, FAS and the IR-4 Project hosted a global meeting to identify future projects that will support new pesticide standards and plan ongoing global coordination of that work. In 2016, FAS and the IR-4 Project plan to expand this partnership to more countries and build upon the project in countries that have been successful partners. By transferring these policy concepts and technical skills to foreign partners, the global partnership for pesticide standards continued complementing the IR-4 Project by supplementing US-generated data or completely shifting to a partner country the responsibilities for generating pesticide data from field trials. In addition to economizing U.S. resources for development and commercialization of pesticides, this global partnership continued to promote common standards among the United States and our agricultural trading partners and, overall, provide modern pest control tools that may be safely used by growers world-wide.

6.0. Forest Service (FS)

<http://www.fs.fed.us/>

6.1. Mission Statement

The overall mission of the FS is to “sustain the health, diversity, and productivity of the nation’s forests and grasslands to meet the needs of present and future generations.” Established in 1905, FS is an agency of the U.S. Department of Agriculture that directly manages 193 million acres of public land in national forests and grasslands and works with state forestry agencies and other partners to assist in managing 491 million acres of state and private forest lands. Gifford Pinchot, the first Chief of the Forest Service, summed up the mission of the Forest Service —“to provide the greatest amount of good for the greatest amount of people in the long run.” FS is composed of four deputy areas: National Forest System (NFS), Research and Development (R&D), State and Private Forestry (S&PF), and Business Operations.

The R&D mission is to “develop and deliver knowledge and innovative technology to improve the health and use of the Nation’s forests and grasslands – both public and private.” R&D provides this information to landowners, managers, policymakers, and the American people to help inform their decisions and actions.

6.2. Nature and Structure of Research Program

The FS R&D mission area develops and delivers the scientific information and technology needed to manage, protect, use, and sustain the natural resources of forests and rangelands. Research is conducted by more than 550 scientists and several hundred technical and support staff. The FS R&D deputy area includes five research stations (Northern, Pacific Northwest, Pacific Southwest, Rocky Mountain, and Southern), the Forest Products Laboratory, the International Institute of Tropical Forestry in Puerto Rico, and two Technology and Development Centers run by NFS located in Missoula, Montana and San Dimas, California.

Ninety-two research work units are located at 67 sites throughout the United States. The system provides sites for long-term science and management studies of major vegetation types found on the 193 million acres of public land administered by the Forest Service.



The research program is organized among seven Strategic Program Areas: wildland fire and fuels; resource management and use; wildlife and fish; recreation; water, air, and soil; inventory and monitoring; and invasive species.

FS R&D maintains a vital network of 80 Experimental Forests and Ranges, 29 of which were established in the 1930s. Long-term records from some of these forests can provide unprecedented insights into global climate change, watershed function, disturbance recovery and many other areas. Major research themes at the Experimental Forests and Ranges include developing systems for management and restoration of forests, range lands, and watersheds; investigating forest and stream ecosystems; characterizing plant and animal communities; observing and interpreting long-term environmental change and many other themes.



FS R&D is currently placing special emphasis on climate change, biomass to energy, watershed restoration, urban natural resource stewardship, and nanotechnology. FS R&D seeks to achieve excellence in conducting high-quality research on relevant topics in natural resource sciences.

6.3. Current Technology Transfer Goals, Objectives, and Measures of Success (Metrics)

The FS uses many means of technology transfer, including marketing efforts at tradeshow and with universities; patents; webinars; workshops; social media posts; conservation education and citizen science; public outreach; and publications both electronic and paper. Many metrics associated with these efforts are currently being tracked, and FS plans to track new metrics such as social media, web hits and citation indexes within the next five years.

One measure of success currently used by FS R&D is the Customer Satisfaction Survey sent out every three years to the various individuals and groups who use our research information and products. The survey uses econometric models developed collaboratively with FS R&D staff and customized for our products and services. The results are presented as a score based on the American Customer Satisfaction Index methodology, which enables users to compare the scores of other Federal R&D agencies. The three main components measured were relevant activities in each area that drive customer satisfaction, satisfaction itself, and desirable customer behaviors and outcomes. The FY 2015 survey scored 76 percent. This represents a 3 point decline from the

previous measure in 2012, but still above the baseline score of 72 from the initial survey in 2006. The FY 2015 score is also above the Federal average of 64. Results from this survey will be incorporated into FS R&D program planning to show where we excel, how we can improve and to ensure that the work we do is relevant to customers' needs. This survey is also required to meet Agency and Department goals. The survey will be repeated in 2018.

The principal contact for technology transfer via patents and licensing within the FS is the Patent Program reporting to the Washington Office and located at the Forest Products Laboratory in Madison, Wisconsin. The FS Patent Program receives and tracks all invention disclosures, providing guidance to scientists regarding all aspects of intellectual property protection. The Patent Program directs prior art searches and prepares FS invention disclosures for review by the FS Patent Review Committee (PRC), a multidisciplinary committee with members from R&D, NFS, and S&PF. The Patent Program also oversees contract law firms drafting patent applications, and files and prosecutes applications in the U. S. Patent and Trademark Office. Draft patent licenses are prepared by the FS Patent Program and reviewed by ARS OTT Licensing Specialists. CRADAs and other technology transfer agreements for the FS are handled by the FS Grants and Agreements Specialists, with patent marketing responsibilities falling to the FS Patent Program.

The PRC meets bimonthly to evaluate and decide whether to file patent applications on FS invention disclosures. The criteria used by the committee include the invention's relationship to the overall mission of the Forest Service, its potential to further national forest resource goals and objectives, the advancement of the state of the art, and economic concerns such as market potential, costs of production, and licensability. Once the decision to patent an invention has been made, the FS Patent Program handles filing and prosecuting patent applications, and/or working with the joint owner (such as CRADA cooperator or university) to pursue patent protection.

The Forest Service is the only land management agency within USDA and is responsible for managing 193 million acres. Forest Service R&D provides high-quality scientific information and applications that help land managers restore and maintain healthy forests and grasslands for community protection; multiple environmental and social benefits, such as clean air and clean and abundant water; a great array of recreational opportunities; and a wide range of ecosystem services.

The following table illustrates trends in FS R&D performance outcomes, the average of these years will be used as a baseline for the period from 2013-2017.

Performance measure	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Customer satisfaction index score - (60,000 - 80,000 customers surveyed every three years)	75	75	79	79	79	76

6.4. FS response to Presidential Memorandum on Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses

In the USDA's implementation plan for the Presidential Memorandum, FS described six initiatives to promote technology transfer and commercialization. The initiatives and their FY 2015 updates are described below.

USDA 14: Accountability of Scientists and Engineers in Technology Transfer Accomplishments

In 2012 the annual performance standards for scientist evaluations were revised to include technology transfer elements. In FY 2014, two new performance metrics were employed to measure the number of technology

transfer units performed at each station. These new Performance Accountability Measures are Science Delivery Products and Science Delivery Activities. Science Delivery Products are products developed to enhance the usefulness of scientific information, including synthesized information from a wide range of disciplines that are delivered to clients in clear and accessible formats. Science Delivery Products include non-refereed publications, software, web and multimedia products. Science Delivery Activities are activities undertaken to enhance the usefulness of scientific information that are delivered to clients in clear and accessible form. In FY 2014 FS R&D produced 429 Science Delivery Products and in FY 2015 produced 442. In 2014 FS R&D produced 1,224 Science Delivery Activities and in 2015, FS R&D produced 2,514 Science Delivery Activities.

USDA 15: New uniform metrics for Forest Service Outcomes

A major review of all performance metrics was conducted in FY 2014 that resulted in ten new performance metrics, five existing metrics were revised, three metrics were retired, and ten existing metrics were not changed. There were no additional changes to metrics during FY 2015.

The fourth “Chief’s Science Delivery Award” was presented in February 2015 for a FS employee’s work in the area of natural resource management in the United States with global applications.

Forest Service is currently reporting the number of citations of Station scientist’s publications as indices of the impact of Forest Service science. These indices are the average number of times FS scientists’ papers are cited in the Science Citation Index during the previous 10-year period beginning two years after publication. These include the average annual number of high impact papers (papers cited more than 20 times) and the average annual number of very high impact papers (papers cited more than 50 times). As reported in the Web of Science, over the period from 2006 through October 2015, publications authored by FS R&D scientists were cited in peer reviewed scientific journals an average of 14,634 times per year for a total of 146,337 citations over the ten year period. There were 1,945 high impact papers and 596 very high impact papers for that ten year period ending in 2015. This was a 7% increase in citations for the 10 year period ending with 2015 compared to the 10 year period ending with 2014. The number of high impact papers increased by 7% and very high impact papers increased by 11% in FY 2015 compared to FY 2014.

FY 2015 marked the sixth year of operation for the Forest Service Research Data Archive (<http://www.fs.usda.gov/rds/archive>). We added 63 research data sets to our catalog in FY 2015, and now offer 200 research data sets to the public and global science community. The catalog is also searchable via science.gov. The Archive provides data repository services to the Joint Fire Science Program (<http://www.firescience.gov>); 48 of the data sets in our catalog came through that channel. Over 2,500 people downloaded a data publication in FY 2015 (> 70 percent increase relative to FY 2014). According to results from Google Scholar, there were 41 citations of our data publications in FY2015; this is a substantial increase over the 2 citations in FY2013 and the 4 citations in FY2014. Through FY2015, citations have appeared in the scientific literature (37), in dissertations (8), and in popular media (2).

USDA 16: New metrics on research outcomes related to intellectual property (patents)

FS R&D developed and implemented the Research Information Tracking System (RITS), which became the official FS reporting vehicle for all science publications in FY 2010. RITS improves the quality and consistency of data, provides transparency to the public, and reduces the need for burdensome data calls. The newest version of RITS incorporates patent data which is connected to related publications on specific technology focus areas. Patent data in RITS has now been updated to include the last 20 years of information. Going forward, patent data will be entered in RITS annually. Additional updates to improve the patent portion of RITS are planned for future releases.

Facilitating Adoption Through Partnerships

As part of the USDA, the Forest Service Patent Program has enjoyed a close working relationship with Agricultural Research Service (ARS) and the Office of Technology Transfer (OTT) for many years. This partnership has grown and expanded to include FS access to the Agriculture Research Information System (ARIS) database for patent and license tracking, inclusion in OTT teleconferences, and ARS Licensing Associates assisting the FS Patent Program with license negotiations.

USDA 17: Explore additional ways FS and ARS can work together on intellectual property and related matters

Cooperative Research and Development Agreements (CRADAs) are widely used within the FS to enable researchers to work with university partners and industry leaders and are drafted by the FS Grants and Agreements Specialists. Recognizing efficiencies that could be gained by having standardized agreement language and procedures, FS has used ARS as a CRADA resource in FY 2014 and FY 2015 to assist with CRADA questions. Further collaboration on various technology transfer agreements, such as Material Transfer Agreements (MTAs) and CRADAs is planned for the next FY, as are collaborations involving jointly owned inventions and patent prosecution matters.

USDA 18: Enhance education and extension outreach efforts

Natural Inquirer is a science education journal for middle school students. The expanded *Natural Inquirer* products include science journals for upper elementary students, scientist cards for middle and high school students, Readers for K-2, and a nonformal activity guide for middle school students. All of these products are based directly on Forest Service scientists and their research. In FY 15, 60,658 *Natural Inquirers*, 11,888 *Investigators*, 7,060 Readers, and 48,000 *NSI: Nature Science Investigators* were distributed to classrooms, homeschools, and conferences. Social media followers increased by over 25 percent, and the *Natural Inquirer* Web site had over 58,000 unique visitors. Some noteworthy distribution points include the World Special Olympics, the White House Tribal Youth Initiative, the World Forestry Congress, the White House Maker Faire, the Council of Scientific Society Presidents, the National Science Teachers Association, the Ecological Society of America annual conference, and the Earth Day Network's Toolkit for Climate Change Education. All work is accomplished in cooperation with the *Natural Inquirer's* non-profit partner, the Cradle of Forestry in America Interpretive Association. <http://naturalinquirer.org>.

USDA 19: Enhance FS interactions with entrepreneurship activities at educational institutions

During FY 2015 more than \$42 million in grants and cooperative agreements were provided to educational institutions, with almost \$1 million going to minority colleges and universities: \$732,904 went to Historically Black Colleges and Universities, \$262,720 went to Hispanic Serving Institutions, \$30,000 went to Tribal Colleges and Universities. Land Grant Colleges received \$14.8 million: \$13.7 million went to 1862 schools, \$672,904 went to 1890 schools, and \$30,000 went to 1994 schools. Non-academic institutions received \$14 million in grants and agreements. A total of 892 grants and agreements were made in FY 2015.

6.5. Metric Tables.

TABLE 1. Collaborative Relationships for Research and Development.

*ND-no data available.

Forest Service (FS)	FY 2011	FY 2012	FY 2013	FY2014	FY2015
Total number active CRADAs	9	22	20	44	79
Active traditional CRADAs	9	22	20	24	26
Active non-traditional CRADAs	0	0	0	20	53
Active CRADAs with small businesses	0	0	0	0	ND
Number newly executed CRADAs	6	3	10	16	20
Newly executed amendments ¹	N/A	N/A	6	N/A	13
Newly executed traditional CRADAs	6	3	10	9	7
Newly executed non-traditional CRADAs	0	0	0	7	13
Newly executed CRADAs with small businesses	0	0	0	0	ND
Total number active MTRAs²	0	0	0	0	4
Newly executed MTRAs	0	0	0	0	4
Total number of active other agreements³	1,636	807	3,179	2,550	1,083
Newly executed other agreements	1,038	63	1,380	701	261
Number newly executed MTAs	ND	ND	8	7	3
Newly executed outgoing MTAs	ND	ND	8	7	3
Total number of publications	4,261	3,699	3,460	2,083	2,013
Peer-Reviewed Scientific Publications ⁴	3,083	3,049	3,014	1,285	1,151
Trade Journal Publications ⁵	1,178	650	446	798	862
Abstracts ⁶	N/A	N/A	N/A	N/A	N/A

1. Amendments extend existing CRADAs for additional years to a maximum of five years, and/or change Statements of Work, and/or change funding levels.
2. Material Transfer Research Agreements. Involves collaborative research on a specific material.
3. Includes mostly Trust Fund Cooperative Agreements, Reimbursable Agreements, Material Transfer Research Agreements, Specific Cooperative Agreements and Non-Funded Cooperative Agreements, Challenge Cost-Share Agreements, Collections Agreements, Cooperative Agreements, Inter-agency & Intra-agency Agreements, Joint Venture Agreements, Participating Agreements, Research Cost-Reimbursable Agreements, Research Joint Venture Agreements.
4. In 2014 the definition of this metric and the means of accounting for publications was changed and these factors can explain the large reduction in number of publication accomplishments for 2014 and beyond compared to FY2013 and earlier. This category is considered "Formally Refereed Publications" and is defined as "Documents, usually in journal or similar quality outlet, that are the result of material support from FS R&D, and on which the decision to publish is based on the results of a formal peer review and independent editorial decision."
5. The definition for this metric changed in FY14 to "Informally Refereed Publications" and is defined as "scientific papers or similar documents that are the result of material support from R&D, and on which the decision to publish is made after peer reviews that are not independently commissioned (reviewers are selected

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by author or line officer). In past years, these publications may have been counted as journal publications, but from FY2014 onward the new definition applies.

6. The Forest Service does not count Abstracts as accomplishments.

TABLE 2. Invention Disclosure and Patenting

*ND-no data available.

Forest Service (FS)	FY 2011	FY 2012	FY 2013	FY2014	FY2015
Total number new invention disclosures¹	31	23	24	13	24
University co-owned	ND	ND	7	4	2
Based upon scientific discipline					
Life science	ND	ND	3	4	6
Chemical	ND	ND	8	4	6
Mechanical & measurement	ND	ND	13	5	12
Plant patents			0	0	0
Total number patent applications filed²	13	13	13	9	12
University co-owned	ND	ND	9	6	7
Based upon scientific discipline					
Life science	ND	ND	0	5	2
Chemical	ND	ND	8	4	7
Mechanical & measurement	ND	ND	5	0	3
Plant patents	ND	ND	0	0	0
Total number patents issued	3	8	4	4	9
University co-owned	ND	ND	1	1	4
Based upon scientific discipline					
Life science	ND	ND	1	4	3
Chemical	ND	ND	0	0	3
Mechanical & measurement	ND	ND	3	0	3
Plant patents	ND	ND	0	0	0

1. Inventions arising at the federal lab.

2. Includes U.S. patent applications, foreign patent applications filed on cases for which no U.S. application was filed, divisional applications, continuation-in-part applications, and provisional applications.

TABLE 3. Profile of Active Licenses

*ND-no data available.

Forest Service (FS)	FY 2011	FY 2012	FY 2013	FY2014	FY2015
Total number active licenses	20	20	19	21	19
Executed to small businesses ¹	ND	ND	1	3	2
Executed to startup businesses ²	ND	ND	2	1	1
Executed to universities	ND	ND	14	17	16
Invention licenses³	20	20	19	21	19
Executed to small businesses	ND	ND	1	3	2
Executed to startup businesses	ND	ND	2	1	1
Executed to universities	ND	ND	14	17	16
Other IP Licenses⁴			0	0	0
Executed to small business	ND	ND	0	0	0
Executed to startup businesses	ND	ND	0	0	0
Executed to universities	ND	ND	0	0	0
Total number newly executed licenses	2	3	2	2	0
Executed to small businesses	ND	ND	0	0	0
Executed to startup businesses	ND	ND	1	0	0
Executed to universities	ND	ND	1	2	0
Invention licenses	20	20	19	21	19
Executed to small businesses	ND	ND	1	3	2
Executed to startup businesses	ND	ND	2	1	1
Executed to universities	ND	ND	14	17	16
Other IP Licenses	0	0	0	0	0
Executed to small businesses	ND	ND	0	0	0
Executed to startup businesses	ND	ND	0	0	0
Executed to universities	ND	ND	0	0	0

1. A small business, together with its affiliates, must not have more than 500 employees.

2. For the purpose of this report, a startup company is a privately-held, U.S., for-profit company operating for less than five years and actively seeking financing to commercialize a federal scientific work product.

3. Invention licenses refer to licenses resulting from a patent.

4. Other IP licenses included biological materials licenses and plant variety protection licenses.

TABLE 4. Characteristics of Income Bearing Licenses

Forest Service (FS)	FY 2011	FY 2012	FY 2013	FY2014	FY2015
Total number of income bearing licenses	18	18	18	21	19
Exclusive	17	17	17	20	18
Partially exclusive	0	0	0	0	0
Non-exclusive	1	1	1	1	1
Invention licenses¹	18	18	18	21	19
Exclusive	17	17	17	20	18
Partially exclusive	0	0	0	0	0

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Non-exclusive	1	1	0	1	1
Other IP Licenses²	0	0	0	0	0
Exclusive	0	0	0	0	0
Partially exclusive	0	0	0	0	0
Non-exclusive	0	0	0	0	0
Total number royalty bearing licenses	18	18	18	21	19
Invention licenses	18	18	18	21	19
Material transfer licenses	0	0		0	0

1. Invention licenses refer to licenses resulting from a patent.

2. Other IP licenses included biological materials licenses and plant variety protection licenses.

TABLE 5. Income from Licensing (\$ reported in thousands)

*ND-no data available.

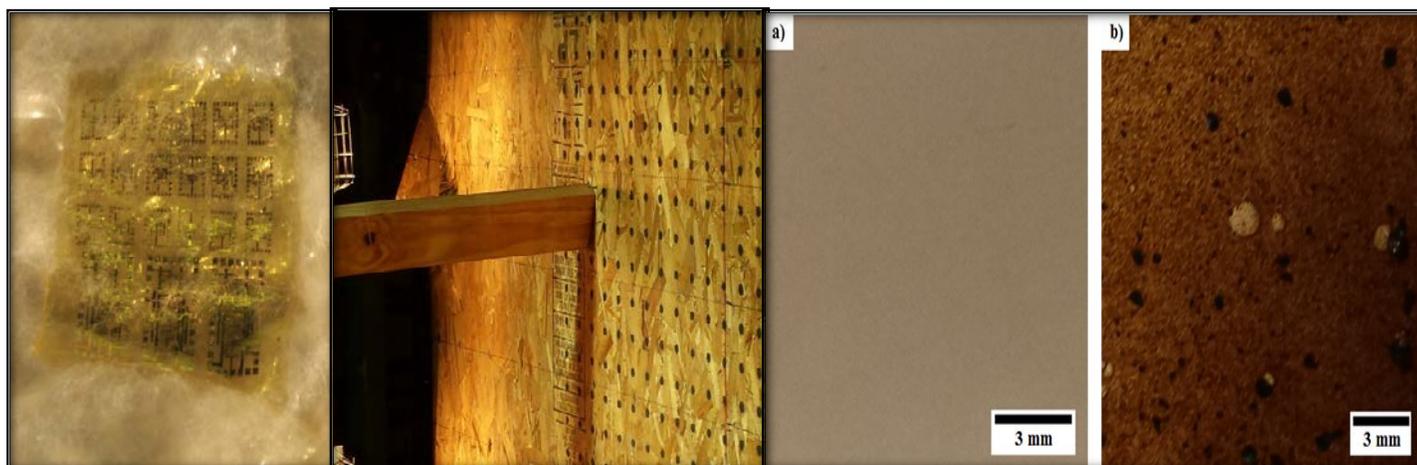
Forest Service (FS)	FY 2011	FY 2012	FY 2013	FY2014	FY2015
Total income all active licenses	\$5,920	\$12,733	\$3,763	\$2,230	\$2,878
Invention licenses	\$5,920	\$12,733	\$3,763	\$2,230	\$2,878
Biological materials licenses	0	0	0	0	0
Total earned royalty income (ERI)	\$810	\$658	\$1,763	\$230	\$878
Median ERI	\$212	\$329	\$340	\$230	\$439
Minimum ERI	\$187	\$312	\$256	\$230	\$256
Maximum ERI	\$411	\$346	\$827	\$230	\$623
ERI from top 1% of licenses	\$411	\$346	\$827	\$230	\$623
ERI from top 5% of licenses	\$411	\$346	\$827	\$230	\$623
ERI from top 20% of licenses	\$411	\$346	\$827	\$230	\$623
Total income distributed	\$5,810	\$0	\$10,788	\$2,230	\$2,878
Inventors	\$5,810	\$0	\$10,788	\$2,230	\$2,878
Salaries of some technology transfer staff	\$194,496	\$194,496	\$194,496	\$194,496	\$194,496
Patent filing preparation, fees, & annuity payments	ND	\$46,445	\$15,144	\$15,600	\$13,500
Other technology transfer expenses (plaques)	\$800	\$926	\$665	\$910	\$1,158

1. Not presented, represents one license.

2. Invention licenses refer to licenses resulting from a patent.

3. Other IP licenses included biological materials licenses and plant variety protection licenses.

6.6. Downstream Outcomes



FOREST PRODUCTS LABORATORY

Biodegradable Computer Chips Made from Wood

The current consumable materials used in the electronics industry are neither recyclable nor sustainable. To reduce the use of expensive materials for electronics and to better protect the environment, recyclable and sustainable materials need to be designed and implemented in electronic products that are massively produced. Cellulose nanofibrillated fiber (CNF) materials, due to their renewability and biocompostability, appear to be one of the best candidates for such purposes, as proved by recent preliminary research. CNFs, which are generated from abundant, environmentally friendly natural plant resources, display numerous interesting properties, such as outstanding mechanical strength, negligible light scattering, and low thermal expansion. CNFs have previously been used in a broad range of fields, such as special printing, packaging, medical carriers, filtration, polymeric reinforcement, energy storage, and electronics or display substrates. Researchers have demonstrated that CNF films have the potential to serve as substrates for portable green electronics substrates due to their good mechanical properties, low thermal expansion, flexibility, and biodegradability.

Forest Products Laboratory, Madison, WI, Zhiyong Cai, 608-231-9446

High Performance Cellulose Nanocrystal Polyolefin Composites

More than 50 million tons of plastic resins are used annually in the United States to manufacture products for a variety of end uses, including packaging, building materials, vehicles, furniture and furnishings, and electronics and electrical devices. The addition of biorenewable cellulose nanocrystals to these polymers could open a vast new market for forest based materials. Researchers have produced nanocellulose – polypropylene and polyethylene composites exhibited the greatest improvement ever reported for such composites.

Forest Products Laboratory, Madison, WI, Gregory Schueneman, 608-231-9412

Affordable Tornado Safe Rooms

Forest Service research is making tornado safety more affordable. The FPL is developing a tornado safe room from commodity wood products that can be built by a do-it-yourself homeowner. Impact and wind pressure testing have proven the structural performance of this design. Estimates of material costs are under \$4000 for an 8'x8' room. This is significantly less than conventional steel or concrete safe rooms of the same size, making this design affordable for a higher percentage of the population.

Forest Products Laboratory, Madison, WI, Bob Falk, 608-231-9255



INTERNATIONAL INSTITUTE OF TROPICAL FORESTRY

The International Institute of Tropical Forestry uses a variety of technological transfer of information tools to communicate to the public the results of our research activity, which is focused on the conservation of tropical forests at a time of unprecedented environmental change. The technology transfer tools range from the publication of peer reviewed scientific articles, delivery of materials aimed at communities and non-governmental organization, engaging the public through public meetings, individual consultations, and social media. The number of available scientific articles on tropical forest conservation now totals over 2,700 (available through electronic and paper media). We routinely deliver over 10,000 documents per year to the public. Conduct over 500 public education programs, and reach about 200,000 people with the conservation message of the Forest Service. Social media reaches as many people and more countries than our traditional technology transfer methods. For example, our web page was visited by some 5,000 people during the last five months and we have 2,184 twitter followers from 78 countries. Between January and October, 2015 we had 18,585 profile visits and 1,072,300 impressions or 1,859 per month, and our popular albums attract some 500 views. Our public is predominantly Hispanic, located throughout Latin America, the Caribbean, and mainland United States. *International Institute of Tropical Forestry, San Juan, PR, Ariel Lugo, alugo@fs.fed.us, 787-766-5335*



NATIONAL AGROFORESTRY CENTER

AgBufferBuilder Tool

Mike Dosskey, Forest Service Researcher at the [USDA National Agroforestry Center](#), created [AgBufferBuilder](#), a GIS-based computer program for designing water quality buffers around agricultural fields. Created with others at the University of Kentucky and the US Forest Service, the program designs vegetative filter strips around agricultural fields utilizing terrain analysis to account for non-uniform runoff. In 2015, significant advances were made to accelerate the use of this tool. The tool is now hosted on the National Agroforestry Center [website](#), with detailed supporting information including a user's guide and test data sets. This information has been downloaded over 100 times since February 2015. In July 2015, Dosskey and others also published a peer-reviewed [article](#) in the Journal of Soil and Water Conservation that describes the tool. A chapter, titled Application of Geographical Information System and Terrain Analysis for Designing Filter Strips, was also included in a book edited by T. Mueller and G. Sassenrath called GIS Applications in Agriculture, Volume 4, Conservation Planning. In addition, Dosskey presented a webinar describing the tool to the Ohio Watershed Network on September 2, 2015 that is archived [online](#).

National Agroforestry Center, Mike Dosskey, 402-437-5178 ext 4025

Island Agroforestry

In partnership with NRCS, University of Hawaii Extension, US Forest Service in Puerto Rico, non-profits, and other partners, the [USDA National Agroforestry Center](#) published Working Trees for Islands in both [English](#) and [Spanish](#) in FY2015. The six page brochure describes how agroforestry provides food for growing populations and protects island natural resources in the Pacific and Caribbean. It also describes island agroforestry systems including homegardens, multistory agroforestry, coastal forests and windbreaks, silvopasture, green manure, and cut and carry systems. This brochure was downloaded over 1500 times and approximately 14,000 copies of the Spanish-language brochure were distributed during the year. These outreach efforts are complemented by the upcoming release of a new research report titled Agroforestry and Climate Change: Reducing Threats and Enhancing Resiliency in Agricultural Landscapes, which includes sections on human dimensions of island agroforestry and the particular threats and opportunities for agroforestry in the Islands. Additional technology transfer efforts will result from this research report.

National Agroforestry Center, Kate MacFarland, 402-437-5178 ext 4012

Agroforestry for Pollinators

In 2015 the [USDA National Agroforestry Center](#) (NAC) developed a number of publications that highlight the role agroforestry can play in supporting pollinators. [How can agroforestry help pollinators?](#) is a two-page color information sheet that highlights opportunities to recognize, protect, and enhance pollinator habitat on farms. [Working Trees for Pollinators](#) is a six page color brochure that illustrates some of the most important pollinators for food production and their habitat needs. It also illustrates how agroforestry practices can be adjusted to meet not only the needs of pollinators, but also of producers. NAC received requests for over 2,000 copies of this brochure in the first two weeks of its publication. NAC also published an issue of its newsletter, [Inside Agroforestry](#), titled [Learn How You Can Use Agroforestry Help Pollinators](#), with articles written by a range of Federal, university, non-profit, and other partners. The social media campaign carried out in association with this newsletter and pollinator week generated 135 tweets. In addition to its 5,500 print circulation, the newsletter has been downloaded nearly 10,000 times. [Technical publications](#) on agroforestry and pollinators, also written in partnership with Xerces are also available through NAC.

National Agroforestry Center, Gary Bentrup, 402-437-5178 ext 4018



NORTHERN RESEARCH STATION

Maps Locate the Wildland-Urban Interface across the United States

Exciting new U.S. Forest Service research products provide visually-appealing, high-resolution maps of wildland-urban interface (WUI) areas across the United States. A user-friendly book displays state maps that are easy to understand. The underlying data sets are also available on-line for those who want to do fine-grained analysis of WUI locations at the state or local level.

Wildland-urban interface (WUI) areas, where houses and other development meet or mix with undeveloped natural areas, are places of transition, change, and great fire danger. Wildland fires have recently been in the news for burning down rural towns, second homes, and businesses in many states, especially the drought-stricken West. The fires create smoke that endangers wildlife and causes visibility and health problems for people living miles away. New development and roads in the WUI also introduce or spread invasive plants and animals to natural areas. Knowledge of WUI locations is extremely useful for policy makers, land managers, fire managers, and others. Northern Research Station scientists have studied the WUI in the United States for more than 10 years, developed and refined a scientifically based definition of the WUI and created maps that show past, present, and projected future WUI locations. A new user-friendly atlas and related data files provide valuable information for anyone who wants to learn about WUI locations at the local, state, or national scale. The atlas has recently attracted media attention from local, national, and international outlets including the cover of USA Today. The website was featured in a USDA news release, and the WUI map was accessed over 100,000 times in the two weeks following the release.

Web Link: <http://www.nrs.fs.fed.us/data/WUI/>

Northern Research Station (NRS), Newtown Square, PA; Cherie Fisher, 847-866-9311

Biocontrol Agent for the Invasive Ailanthus Tree Is Being Tested

Scientists from the Northern Research Station are studying a native fungus and find that it kills ailanthus (tree-of-heaven) while sparing native tree species. Inoculations in research trials have begun in Ohio and appear to be successful.

Ailanthus (tree-of-heaven), a nonnative invasive tree from Asia, is a prolific seeder and sprouter that is difficult to control with herbicides or cutting and is increasing in northeastern forests. However, there may be an alternative biocontrol in the near future. In 2002, Penn State researchers isolated the fungus *Verticillium nonalfalfae* from dead and dying ailanthus trees within forested areas of Pennsylvania. After rigorous testing and numerous trials, this soil-borne fungus was found to be very specific and deadly to ailanthus. In 2012, the fungus was isolated in Ohio by Northern Research Station (NRS) scientists who began greenhouse tests in 2013 to verify that native tree species in Ohio are not susceptible. After two growing seasons, no signs of wilt have been observed in seedlings from native Ohio sources of ash, beech, elm, and oak (black, chestnut, northern red oak, and white).

Ailanthus has the potential to replace oak and other native tree species. This would have a devastating effect on many wildlife species. This research is important to private landowners, as well as the Wayne National Forest in Ohio. Aerial surveys conducted of the area, in conjunction with the Ohio Division of Forestry in 2011 show large numbers of ailanthus on the Marietta Unit of the Wayne, as well as over 78,000 acres of private lands within the Marietta Unit.

In May 2015, fungal inoculations began in research plots in Ohio forests with trials testing the effectiveness of the fungus in killing ailanthus and also monitoring subsequent regeneration following eradication of ailanthus. Within 2 weeks of stem-inoculations with fungal spores, ailanthus trees began yellowing, wilting, and losing leaves; disease symptoms progressed and trees began to die over the summer.

Web Link: http://www.nrs.fs.fed.us/disturbance/invasive_species/ailanthus_and_Vn/

Northern Research Station (NRS), Newtown Square, PA; Joanne Rebbeck, 740-368-0054

Green Patterns for Vacant Lots in Baltimore

In 2013, Baltimore had 14,000 vacant lots and 16,000 abandoned houses, many of which are slated for demolition. Although these vacant properties often create problems, they also offer opportunities to create greener neighborhoods and improve residents' quality of life. The Green Pattern Book and Green Registry, co-developed by Northern Research Station scientists, are tools to help Baltimore's communities transform vacant urban land into usable green space.

The solution for Baltimore's chronic urban blight – 14,000 vacant lots and 16,000 abandoned structures – includes a vision for a citywide program to transform many blighted areas into an integrated network of green spaces. Transforming the vacant land into parks, forests, or gardens could help grow the City to be resilient, sustainable, and competitive in the 21st century. The Green Pattern Book is a tool that provides eight potential patterns by which city agencies, NGOs, community-based organizations, and individual residents can green vacant lots and partner with each other to achieve more livable Baltimore neighborhoods. Created by the Baltimore Office of Sustainability in partnership with the Northern Research Station, the book includes patterns ranging from urban agriculture, to forest, to stormwater management. The Green Registry is a publicly accessible, on-line interactive mapping tool that allows users to register and map their own greening activities. Created in partnership with the Baltimore Neighborhood Indicators Alliance (BNIA), this tool will inform policymaking and individual greening efforts and enhance the connectivity of Baltimore's environmental stewardship network. These two efforts are essential components to Forest Service leadership in Baltimore's Urban Waters Program: (1) Green Pattern Book, (2) Local Projects, (3) Monitoring and Modeling, and (4) Mapping.

Web Link: <http://www.nrs.fs.fed.us/baltimore/green/>

Northern Research Station (NRS), Newtown Square, PA; Morgan Grove, 802-238-4328



PACIFIC NORTHWEST RESEARCH STATION

New mapping of landscape sensitivities to changes in peak and low streamflow helps national forests plan ahead

A changing climate over the coming decades poses serious challenges to the Pacific Northwest's streamflow. How can predictions of future flows be used to guide intelligent choices about infrastructure and restoration investments in the present? New analyses demonstrate that impacts of climate change on streamflows will not be uniformly distributed across the landscape but are strongly controlled by both hydrologic regimes (i.e., rain versus snow) and the underlying geological setting (deep groundwater versus shallow runoff dominated landscapes). Watersheds that provide much of Oregon and Washington's summertime flow, such as the Cascade Range, may continue to have water as climate warms, but paradoxically, also are most sensitive to reduced stream flows under climate change.

The information in these analyses is being incorporated into forest planning efforts around the region. The Blue Mountain Adaptation Partnership used this analysis as a cornerstone of their hydrologic assessment that incorporates climate change into the forest plans for the Malheur, Umatilla, and Wallow-Whitman National Forests. These analyses are also being used to provide the fundamental hydrologic assessment in the on-going South Central Oregon Adaptation Partnership. This effort involves a collaborative assessment of climate change vulnerabilities for a consortium that includes the Deschutes, Ochoco, and Fremont-Winema National Forests, the Crooked River Grasslands, and Crater Lake National Park. Results from these analyses were also featured prominently in the Climate Change Toolkit developed by the Pacific Northwest Region to provide state-of-science tools for resource managers to address climate change vulnerabilities.

Partners: Oregon State University, USDA Forest Service Pacific Northwest Region

Contact: Gordon Grant; ggrant@fs.fed.us, Pacific Northwest Research Station

Research findings help guide the next generation of wood energy systems in southeast Alaska

Wood pellets are an emerging renewable energy source in Alaska, yet currently pellets must be imported from Washington. A local production facility could greatly facilitate the use of pellets, while using resources from southeast Alaska. Potential pellet producers need information on local system operations and project economics, including return on investment.

Scientists with the Pacific Northwest Research Station conducted a case study that examined two pellet burners at different scales of operation and different energy needs. They found that two Alaska Native organizations in Juneau who use wood pellets realized financial and environmental benefits. Favorable economic conditions were realized over a range of operating conditions, despite having to import pellets from Washington. Locally produced wood pellets would likely provide greater energy cost savings while creating local jobs. Because the wood pellets

(a carbon neutral fuel) were used instead of heating oil, additional environmental benefits have been realized. Within the past year, a third wood pellet burner has been installed in Juneau, helping to create infrastructure needed to use pellets more effectively. Findings from this case study will benefit both Sealaska Corporation and the Tlingit-Haida Regional Housing Authority as they attempt to develop a regional demand for wood pellets, while more efficiently using their pellet resources.

Partners: Sealaska Corporation, Tlingit-Haida Regional Housing Authority, USDA Forest Service Alaska Regional State & Private Forestry

Contact: David Nicholls, dlnicholls@fs.fed.us, Pacific Northwest Research Station

National forests and communities test new approach for wildfire risk mitigation

A new assessment approach that couples biophysical and social dimensions of risk can potentially improve wildfire community protection planning by informing sources of risk to the wildland-urban interface.

The Forest Service's State and Private Forestry Washington Office and Pacific Northwest Region have funded pilot studies to apply this approach in more than 120 communities in the western United States. Results from these pilot studies can potentially help funding allocation that targets specific communities for risk reduction activities, and improve community wildfire protection planning process as case studies are implemented. The outputs from this study are being distributed through a new interactive geospatial web portal that allows communities to interact with social and biophysical assessment data and strategize potential mitigation activities.

This work contributes a landscape science foundation for an "all lands-all hands" risk management approach consistent with the broad goals of the new federal wildland fire cohesive strategy. The work also has led to new science to analyze and understand wildfire risk transmission between federal, state, and private lands.

Partners: Portland State University, Oregon State University, USDA Forest Service Washington Office State and Private Forestry, Rocky Mountain Research Station

Contact: Alan Ager, aager@fs.fed.us, Jeff Kline, jkline@fs.fed.us, Pacific Northwest Research Station

National Forest and communities test new approach for wildfire risk mitigation

Scientists developed an assessment approach and planning framework to address gaps in local planning and broad-scale prioritization of federal and state assistance to mitigate wildfire risk on federal lands near high-risk communities. This work explicitly incorporates social science information pertaining to mitigation potential among private landowners and information on risk transmission to identify the sources of wildfire exposure to communities.

Partners: Portland State University, Oregon State University, USDA Forest Service Washington Office State and Private Forestry, Rocky Mountain Research Station

Contact: Alan Ager, aager@fs.fed.us, Jeff Kline, jkline@fs.fed.us, Pacific Northwest Research Station



PACIFIC SOUTHWEST RESEARCH STATION

New method using LiDAR provides more accurate mapping of snags in forests

In recent years, recognition of the essential roles standing dead trees (snags) play in forest ecosystems has significantly increased. Snags provide key habitat components for many threatened and forest health indicator species while also serving as key indicators of forest biodiversity. As the recognition of the importance of snags has become more apparent, numerous certification programs and forest management regulatory bodies have developed minimum snag stocking requirements to help ensure that biodiversity is maintained or restored over time. These most often require a certain density or volume of snags to be maintained over time in order to provide continuous habitat support and ecosystem sustainability. Unfortunately, both the development and compliance assessment of snag stocking guidelines is inherently difficult due to the naturally irregular and sparse distribution of snags across the landscape. Most standard sampling designs are not efficient for rare events such as snags and thus require complex, intensive, and expensive sampling procedures to produce sufficiently accurate estimates. This has led to the exploration of utilizing remote sensing technologies to better estimate snag densities and distributions across the landscape.

Forest Service researchers explored and successfully developed a new method that uses LiDAR (Light Detection and Ranging, which is a remote sensing method used to examine the surface of the Earth) data to identify, map, and measure the majority of individual snags across the landscape. The method helps overcome the inherent difficulties associated with estimating and monitoring snags, while also providing snag stem maps that can be used to explore the spatial distribution of snags across the landscape. The method is semi-automated, can be implemented wherever airborne LiDAR data are available, and should bring more clarity to snag stocking guidelines.

Pacific Southwest Research Station, Brian Wing, brianwing@fs.fed.us

Model serves as tool to improve environmental responsibility through social media

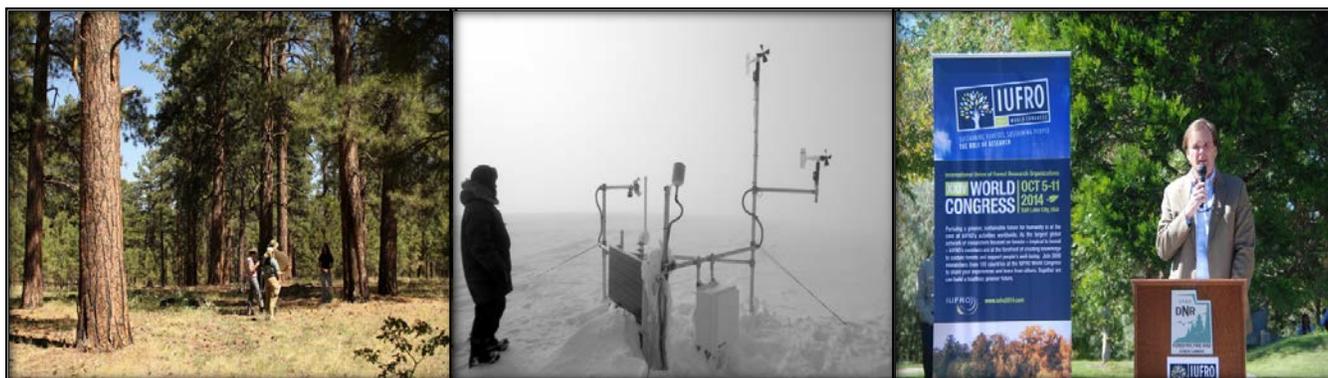
Web 2.0 and social media have considerable potential for facilitating connections to nature and spurring proenvironmental action. The Technologies for Proenvironmental Action Model (TPAM) is a conceptual framework that explains how different functions of Web 2.0 and social media (i.e., informational, relational, and experiential) can generate and/or facilitate personal, social, and contextual pathways to environmentally responsible behaviors, especially among youth. For example, the relational function of social networking sites may be particularly effective in communicating social norms supportive of environmentally responsible behavior. Visitors to a site may report their own actions through stories and first-hand accounts, thereby encouraging others to take similar measures. Making use of this model and the underlying principles may enhance social media outreach and engagement efforts within the agency, helping to focus efforts to those approaches with greater anticipated effectiveness.

Pacific Southwest Research Station, Pat Winter, pwinter@fs.fed.us

New approach to forest restoration garners broad support

A "variable density thinning" study on the Stanislaus-Tuolumne Experimental Forest proved not only to be a valuable opportunity for learning about the ecological outcomes of thinning and prescribed fire treatments, but also a catalyst for consensus building. This new thinning approach is designed to restore the variability that was historically found in these forests and has gained the support of both environmental groups and the timber industry. Forest Service scientists were invited by the Yosemite Stanislaus Solutions collaborative group to give several presentations and tours of the study area. The group is interested in facilitating the wider-application of treatments to prevent future catastrophic wildfires.

Pacific Southwest Research Station, Eric Knapp, eknapp@fs.fed.us; Malcolm North, mnorth@fs.fed.us



ROCKY MOUNTAIN RESEARCH STATION

The Silalirijit projects: Linking traditional ecological knowledge with technology-based climate modeling

Through efforts of the Rocky Mountain Research Station and collaborators, a multicultural and multidisciplinary team of physical and social scientists, the Silalirijit collaborative, are exchanging skills and knowledge all with the common purpose of understanding the weather in the Arctic. "Silalirijit" (pronounced see-lah-LEE-ree-yeet) is an Inuktitut word that means "those who work with or think about weather." Projects are focused on high-latitude North America in general, but in particular, the Kangiqtugaapik (Clyde River), Baffin Island, Nunavut, Canada and Lower Yukon River Basin, Alaska. Silalirijit projects step outside the bounds of traditional scientific research by using a combination of facilitated dialogue and collection of snow, ice, and water data. They combine qualitative and quantitative methods into a transformative process of mutual discovery between scientists and communities. To support collection of weather data for the projects, RMRS scientist Kelly Elder designed a state-of-the-art weather station network for the Clyde River area on Baffin Island. This area is used heavily by the community for recreation and hunting. Scientists with the Silalirijit collaborative are also working with First Nation students to teach them to compare, contrast, and integrate indigenous observations and knowledge with western scientific methods. Indigenous knowledge captures ecological changes over time in unique and alternate ways from conventional western science. The students' work involves observations of changes that affect the lives and activities of Baffin Island and lower Yukon communities where citizens are particularly interested and concerned about changing sea ice, snowpack, water resources, and water quality. Results of the Silalirijit projects will facilitate the development of adaptive strategies through community participation and form a new, relational way of viewing the environment. These collaborations create a more holistic view of climate change effects on human populations by addressing the year-round relationship between the local populations and the climate and hydrologic cycles in the arctic region. Through the Silalirijit collaboration, a broader Nunavut Climate Change Partnership has been established, that is multi-faceted, bringing scientists, planners, communities

and decision-makers together from across Nunavut to build the capacity for climate change adaptation. An extended meteorological station network adopted by local hunters and recreationists has proven useful for traditional activities as well as search and rescue operations.

Rocky Mountain Research Station, Fort Collins, CO, 970-498-1100

Management-focused videos on forest restoration

Ponderosa pine and dry mixed-conifer forests in the Southwest United States are experiencing, or have become increasingly susceptible to large-scale severe wildfire, insect, and disease episodes resulting in altered plant and animal demographics, reduced productivity and biodiversity, and impaired ecosystem processes and functions. Science-basis and management recommendations for enhancing the resiliency of frequent-fire forests are outlined in “Restoring composition and structure in Southwestern frequent-fire forests: A science-based framework for improving ecosystem resiliency” (RMRS-GTR-310, http://www.fs.fed.us/rm/pubs/rmrs_gtr310.html). In June 2014, over a dozen scientists and managers from the Rocky Mountain Research Station, Forest Service Southwest Region, and Northern Arizona University convened for several days on the Kaibab National Forest in Arizona to bring to life lessons from RMRS-GTR-310: Restoring composition and structure in Southwestern frequent-fire forests. The restoration framework presents forest ecology of frequent-fire forests, describes reference conditions, and outlines management strategies that can improve the resiliency of ponderosa pine and dry mixed-conifer forests. Central to this approach are six key elements that characterized historical composition and structure of vegetation in frequent-fire forests: (1) species composition; (2) groups of trees; (3) scattered individual trees; (4) grass-forb-shrub interspaces; (5) snags, logs, and woody debris; and (6) variation in the arrangements of these elements in space and time.

The result of this technology transfer effort was six management-focused videos that extend the reach, impact, and application of the science-based restoration framework. This project successfully (1) involved a scientist-manager partnership in the interpretation and communication of peer-reviewed ecological research, (2) presented science and management implications in a novel and engaging manner, and (3) resulted in tangible technology transfer products.

The videos series complements the restoration framework by providing additional interpretation of key concepts by the author team and using live footage to illustrate components of frequent fire forests (*e.g.*, tree groups, variability over space and time, etc.). The 8-12 minute videos were posted on the Forest Service YouTube channel in mid-April 2015 (available online at <https://www.youtube.com/playlist?list=PLNsZX2SBTIVkiwgIy0BpqG9CfLLorBcjs>). Titles of the videos are as follows:

- The Impetus for Ecological Restoration
- Expected Benefits and Outcomes of Restoration
- Key Elements of Southwestern Frequent Fire Forests
- Considerations for Implementation of the Management Framework
- Ecological Restoration over Space and Time
- Putting it all Together: The Bluewater Case Study

The video series has received 1,970 views to date and positive reviews from managers. A silviculturist from the Southwest Region emailed the GTR-310 author team with the following message: “I just wanted to say great job on the 6 Youtube videos you all did. The information is well presented and the videos are great for anyone with little or lots of knowledge about the GTR-310. I’ll encourage our IDT to watch the videos.”

Rocky Mountain Research Station, Fort Collins, CO, 970-498-1100

IUFRO

The Rocky Mountain Research Station provided regional support and scientific knowledge for the 2014 International Union of Forest Research Organizations World Congress, held in Salt Lake City, Utah, 5-11 October. This meeting was held in conjunction with the 2014 Society of American Foresters and Canadian

Institute of Forestry's Annual Conferences – with a total of 3500 people from 100 countries participating. 17 RMRS employees provided hands-on assistance at the meeting, supporting the 27 In-Congress Tours (which focused on science delivery), communications efforts, and general operational support. 25 RMRS scientists were accepted into the IUFRO scientific program and shared their scientific expertise with other leading global experts. RMRS led an outstanding team of communication and outreach professionals who managed on-site communications for the 2014 IUFRO World Congress. An emphasis for the 2014 Congress was to leverage the power of social media. Generating content thru blogs and sharing thru the various social media outlets (Facebook, Twitter, YouTube) during Congress week was truly the foundation for the successful outreach, inclusion and communication effort.

The Team was broken into work groups focused on media coordination, image coordination, social media (Facebook, Twitter, Blogs, YouTube videos), and Newsletter/Website Management. Liaisons from IUFRO, SAF/CIF and Community outreach were also part of the overall team. Media outreach results as of Saturday, October 11th, the last day of the Congress:

On social media across the globe -- The #iufro2014 hashtag seen by over 561,000 twitter accounts over 3.6 million times; 55 blogs with over 50,000 views; outreach to 18,000 Facebook users and 5 daily newsletters published for the 2500 congress attendees. The on-line conversation continues through <http://blog.iufro2014.com> and www.iufro.org.

In the greater Salt Lake Community -- 300+ citizens at the Utah Film Center, over 100 residents at the Poetry Slam and book reading, and outreach to 100 community locales (in Spanish and English) learning about the importance of forests and sharing the best available science.

In the press – Over 110 reporters from all over the world received IUFRO press materials leading up to and during the Congress. Interviews were conducted by The Salt Lake Tribune, Deseret News, KSL TV, “Primetime Live,” ABC 4 Utah, and CBS KUTV2. Traditional print and TV media highlighted forests in our lives and the learning and networking of over 3,000+ researchers, managers and policy-makers from over 100 countries in Salt Lake City.

Through images and video – Over 1,000 photos from Congress events, plenary sessions, field trips and exhibits were cataloged, tagged, and stored. On YouTube – 17 videos of keynote presentations and 16 exclusive video interviews with leading IUFRO presenters are posted. The closing ceremony featured select images in a slide show and a large selection of Congress photos are available on Flickr.

Rocky Mountain Research Station, Fort Collins, CO, 970-498-1100



SOUTHERN RESEARCH STATION

Moving fire ecology into the 21st Century: using high-resolution infrared thermography to explore mechanisms linking fuels, fire and plant diversity in longleaf pine.

Infrared thermography allows Forest Service scientists to explore how fire maintains high diversity in longleaf pine. Southern Research Station (SRS) Research Ecologist, Joe O'Brien and others at the Center for Forest Disturbance Science (CFDS) have developed new techniques that are enabling the testing of hypotheses that could explain the links among canopy structure, fuels, and fire behavior and fire effects. Specifically, CFDS is exploring how variation in fire energy release driven by cones and woody fuels might create the conditions for plant community assembly to be driven by neutral processes thus allowing a diversity of plant species to coexist in a very uniform environment. The infrared thermography platform developed by CFDS allows the capturing of high resolution data on fire behavior used to explain patterns in plant demography in longleaf stands at Eglin Air Force Base. The results of the study are being incorporated into models that will link stand structure, fire behavior and plant community dynamics. The model will eventually allow land managers to explore how various management activities could affect both fire behavior and plant diversity.

Southern Research Station, Dr. Joseph J. O'Brien, jjobrien@fs.fed.us

Redbay trees may hold the key to their own survival against laurel wilt disease

Laurel wilt disease is caused by a fungus carried on beetles that reproduce in the bark of redbay and other tree species. The disease is decimating the ecologically important redbay tree species in the coastal southeast, radiating out from the point of introduction of this invasive beetle species, Savannah, Georgia. Some natural resistance has been observed among trees surviving outbreaks. These survivors hold promise as starting material to breed resistant redbay trees for deployment in effected areas.

Researchers with the Southern Research Station Forest Genetics Research Work Unit are conducting research to determine if genetic markers within the redbay genome can be associated with resistance and therefore be selected for when breeding resistant trees. An initial screen of 100 genetic loci in just seven individuals from along the southeast coast revealed a large amount of genetic diversity. About half of the genetic marker locations studied were found to contain between four and eight variations across this small set of redbay trees. This kind of population diversity makes it easier to discover resistance associated with locations within the genome, as well as, gives redbay a better chance for success once breeding for resistance begins. Portions of the redbay genome responsible for resistance to laurel wilt disease will accelerate breeding of resistant trees.

Southern Research Station, Dana Nelson or Kathy Smith, dananelson@fs.fed.us

Monitoring Forest Dynamics

The dynamics of forested ecosystems are of increasing interest as urban areas expand and the world's population continues to grow. USDA Forest Service researchers and their partners explore how forests change and how those

changes can be monitored. The continuous forest monitoring database, collected and maintained by the Forest Inventory and Analysis Program, is of special interest because the data arise from a simple, but elegant sample design and constitute observations that are thoroughly dispersed over the landscape and through time. The knowledge that we can gain from this and other data sets can be enhanced by how we think about how sample observations relate to the dynamic forested ecosystems that they monitor. When we recognize and treat time as a basic and integral observational element, our understanding of the underlying ecosystem is exponentially enhanced. To date, many publications have resulted from this research. Development of improved estimation methods for the data obtained by the FIA Program is expected to increase our level of understanding of the changes in the Nation's forests that are occurring through time.

This research seeks to understand the dynamics of forested ecosystems in the United States through the improved analysis of continuous forest inventory designs, considering time in ways not previously considered.

Southern Research Station, Francis A. Roesch, froesch@fs.fed.us

Filling a Gap: Biomass Modeling of Small Trees

Tree biomass in southern forests has great potential to produce bioenergy and store atmospheric carbon. Biomass models of commercial-sized trees are available for most important timber species, but not for the smallest trees, especially for non-commercial species. New models help to fill the gap for small diameter pines and hardwoods.

The accurate prediction of tree biomass is a critical need for large-scale efforts to develop bioenergy resources and support carbon sequestration of the forests in the southern United States. In recent years, biomass models for the primary commercial species have been developed, especially for merchantable-sized trees. However, small-diameter trees, especially those of less commercially valuable species, are rarely included in these models, even though they can contribute large quantities of biomass. Funded by a grant from the federal government, new predictive models are based on samples of small-sized loblolly pine, hardwoods, and woody shrubs destructively sampled in parts of Arkansas, Louisiana, and Mississippi, dried, and then weighed. The regression models have the promise of giving managers and landowners a better sense for the ecosystem services their maturing forests offer.

Southern Research Station, Don C. Bragg, dbragg@fs.fed.us

Assessing Emerging Drought Threats to National Forests and Grasslands

National Forests and Grasslands provide numerous benefits to the American people, from recreation opportunities to supplies of clean water and air. These important ecosystem functions are increasingly threatened by drought due to global climate change, but the effects of drought on natural resources are difficult to assess and quantify nationally. Scientists estimated regional impacts of drought on watershed water yield and ecosystem productivity across the conterminous United States using a large-scale Water Supply Stress Index (WaSSI) simulation model.

The WaSSI model simulates water and carbon cycles in watersheds across the lower 48 United States and Mexico, enabling researchers to project likely impacts of future climate change on ecosystem productivity and water supply. Scientists with the Southern Research Station Eastern Forest Environmental Threat Assessment Center used WaSSI to estimate how water yield and carbon sequestration in the National Forest and Grassland System were impacted by periodic droughts across the United States over the past 60 years. They then examined drought trends and chose five extreme drought years to estimate the 'worst cases' of drought impacts on water yield and ecosystem productivity in the future. This benchmark study provides a reference point to assess drought impacts for each of the 170 NFs and can help land managers better optimize limited resources during watershed restoration efforts in response to climate and land use changes. Ongoing study results highlight the importance of understanding drought stress on forest and grassland ecosystems and the need to better quantify stress under a changing climate.

Southern Research Station, Ge Sun, gesun@fs.fed.us



TECHNOLOGY AND DEVELOPMENT CENTERS

Preserving Traditional Skills Through The National Technology and Development Program

The Forest Service National Technology and Development Program (T&D) works to preserve and teach traditional skills for future generations. Effective wilderness and backcountry management require traditional skills, such as the safe and proper use of crosscut saws, axes, nonmotorized rigging, and horse and mule packing. These skills helped to build America, and they are fundamental to the Forest Service heritage. Today, Forest Service employees and volunteers use these skills to work effectively in remote locations and logistically difficult situations.

During 2015, T&D presented traditional skills management tools at the International Seminar on Protected Area Management. The seminar is a partnership between the Forest Service International Programs, the University of Montana, and the University of Idaho. Resource conservation professionals from 21 different countries participated, acquiring hands-on experience at the Magruder Ranger Station on the Bitterroot National Forest. Participants had a strong interest in traditional skills because many of them also manage remote areas and face challenging logistics.

Current T&D projects related to traditional skills include the DVD “Leave No Trace for Stock Users,” The Equine Safety and Etiquette Training Course, the publications “Forest Service Ax Manual” and “Rigging for Backcountry Trail Use,” and the development of a traditional skills teaching cadre.

For additional information about this project, please contact Bob Beckley, email: rbeckley@fs.fed.us, phone: 406-329-3996.

Wireless Signaling Data Used to Estimate Monthly Visitors to Federal Lands

This project uses cellular wireless technology to provide a reliable system for counting visitors to Federal Lands Management Agency (FLMA) lands throughout the country. FLMAs currently determine visitor numbers by using traffic counters or by performing counts manually. This technology is a statistically sound visitor surveillance system that enables cellular devices to provide vehicle location coordinates nationwide. Wireless cellular data eliminates most of the labor and time costs associated with conventional traffic counters.

For additional information about this project, please contact Vincent Barandino, Jr., email: vbarandino@fs.fed.us, phone: 909-929-7049.

Using ArcGIS Online and the Collector Application for Incident Management Teams

The National Technology and Development Program led an interagency pilot test to assess the use of ArcGIS Online (AGOL) and the Collector application for Incident Management Team fire operations. The Fire and Aviation Management’s Interagency Wildland Mobile Technology Working Group sanctioned this pilot. The pilot test showed that AGOL and Collector can enhance current fire mapping procedures, reduce the quantity of printed maps, and provide offline data collection. Using this application enables real-time information transfer of

fire spatial data during incidents, results in rapid turnaround of mapping products and fireline intelligence, and improves the situational awareness of fire personnel.

For additional information about this project, please contact Tyler Hackney, email: thackney@fs.fed.us, phone: 406-329-3919.

Above and Beyond Ecosystems (The Northern and Pacific Northwest Regions)

For the first part of this project, the San Dimas Technology and Development Center (SDTDC) conducted an exhaustive review of techniques and literature associated with soil science, and had extensive communication with subject matter experts. Soil science can address potential site changes that may affect desired vegetation resulting from management activities and ecosystem processes, such as climate change. To address management effects or climate change, the Forest Service needs dynamic datasets that complement our legacy inventories to identify and track possible changes in growth potential. The Internet has new sources of information available that offer finer resolution mapping of seasonal precipitation patterns and temperature changes that influence desired vegetation. Online resources are available through partner agencies, including the Natural Resources Conservation Service Snow Telemetry (SNOTEL) Network, the National Oceanic and Atmospheric Administration's National Climatic Data Center, the National Aeronautics and Space Administration, and the U.S. Geological Survey's physiographic data. Other resources include university affiliates, such as Oregon State's PRISM Climate Group and the University of Arizona's Jemez Mountains Critical Zone Observatory. The Forest Service needs the product of this new framework to direct analysis that can answer critical questions on soil and vegetation production potential at multiple levels (forest plan, watershed assessment, and/or project plans).

For the second part of the project, SDTDC used statistical modeling to evaluate long-term climate change on forest greenness. We worked closely with specialist D. Maliha Nash at the U.S. Environmental Protection Agency (EPA), National Exposure Research Laboratory, Office of Research and Development, Environmental Science Division, Landscape Ecology Branch in Las Vegas, NV. The cooperative work between SDTDC and the EPA resulted in the use of the Normalized Difference Vegetation Index (NDVI) method to track climate signature change on national forests. This NDVI method, derived from the Advanced Very High Resolution Radiometer, can be used as a means of monitoring vegetation. The NDVI data represents 1 kilometer squared per pixel.

For additional information about this project, please contact Mohammad Nash, email: mohammadnash@fs.fed.us, phone: 909-929-7070.

The Emergency Medical Short-Haul Program

The Forest Service rolled out its Emergency Medical Short-Haul Program in 2015. The Emergency Medical Short-Haul Program is a medical air evacuation mission in which helicopters contracted by the Forest Service transport one or more persons suspended on a fixed line beneath the helicopter. The goal is to provide emergency response to seriously injured individuals by transporting them from an area with limited or no access to a location where another type of medical transportation is available.

Two helitack programs (Wenatchee in the Pacific Northwest Region and Teton in the Intermountain Region) added short-haul capability during 2015. The regions plan to add two more programs during 2016. Although no one required an operational short-haul mission this year, the helitack programs successfully implemented the additional capability.

Missoula Technology and Development Center (MTDC) equipment specialists helped to research, analyze, and test commercially available short-haul equipment during 2014 and 2015. MTDC equipment specialists also participated in several followups and program reviews throughout the 2015 field season. The National Park Service and other non-federal programs currently use some of the equipment MTDC reviewed.

For additional information about this project, please contact Kevin Brown, email: kkbrown@fs.fed.us, phone: 406-329-3958.

Stabilization and Rehabilitation Measures for Low-Volume Forest Roads

The report “Stabilization and Rehabilitation Measures for Low-Volume Roads” provides guidance and techniques for many types of repairs and improvements made to forest roads. This information is valuable to Forest Service and other Federal, State, and local land management agency road managers, transportation engineers, equipment operators, resource specialists, field personnel, and anyone else involved in the rehabilitation and stabilization of low-volume roads.

For additional information about this project, please contact Vincent Barandino, Jr., email: vbarandino@fs.fed.us, phone: 909-929-7049.

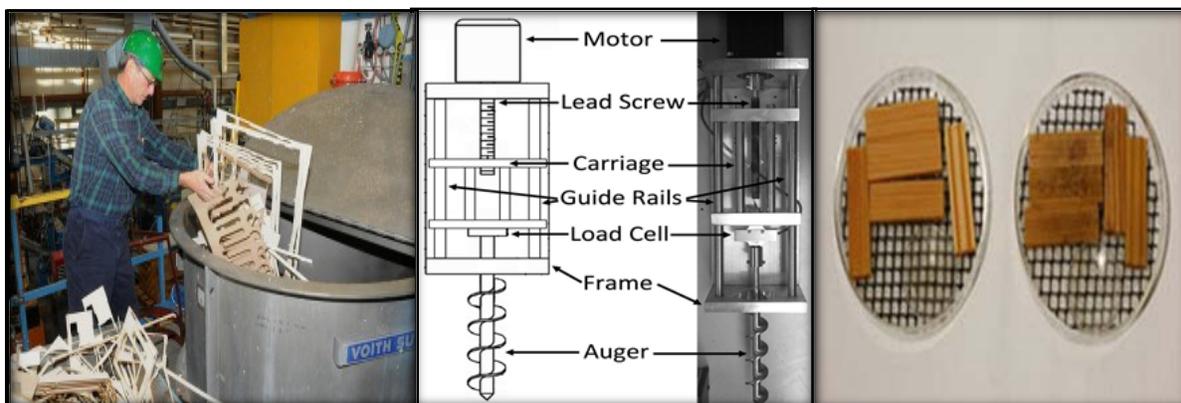
Preventing Resource Damage and Extending Off-Highway Vehicle Use Opportunities Through Remote Sensing Technology

This project combines two recently completed projects—remote soil-sensing technology and a simplified field-based soil moisture/strength relationship determination process—and implements the combined system as a remote wet weather management system to enable Federal Land Management Agency (FLMA) managers to make trail/road closure decisions in response to changing ground conditions. Managers can make decisions quickly and easily based on scientific, repeatable data. FLMA across the country manage thousands of miles of native-surfaced roads and trails that are subject to resource damage from motorized vehicle use during overly wet conditions. In order to protect the native-surfaced travel routes, maximize the public’s motorized access to public lands, and protect hydrologic resources, Federal land managers must be able to legally open and close these native-surfaced travel routes during the appropriate times and conditions.

Currently, Federal land managers typically use one of two methods to legally open and close these native-surfaced motorized routes: a fixed-date method or a precipitation-quantity method. Both these methods are problematic. The fixed-date method (i.e., opening and closing a road or trail on particular dates each year) can lead to resource damage during periods of heavy precipitation when the roads or trails are open, and can limit public access opportunities during drier periods when roads or trails are closed. Precipitation-based methodologies are more responsive to user access needs and desires, and can better protect natural resources. However, they require a burdensome and time-consuming administrative process of creating and terminating official closure orders. Federal courts require this time-consuming process because they are unwilling to allow FLMA to base rapid programmatic closure orders on the nonscientific basis of a manager’s experience, or “gut feeling.”

The work plan combines a recently developed and fully functional soil moisture/condition remote sensing system (“Monitoring Soil Conditions in OHV Parks,” San Dimas Technology and Development Center, 2010, and “Wet Weather Management of OHV Trails,” California Off-Highway Motor Vehicle Recreation Division and Forest Service Pacific Southwest Region, 2014) to create an easy-to-use wet weather management information system that is useful to FLMA trail and road managers. Proposed installation and implementation sites include the Tahoe National Forest, the Miami Off-Highway Vehicle Basin on the Sierra National Forest, and the Bureau of Land Management’s Ivanpah Dry Lake. (Although this pilot remote soil-sensing project is proposed for motorized routes, the technology/system can also be used for nonmotorized trails through sensitive habitats. This technology can communicate through cellular or satellite networks, so communication issues would not limit the location of a remote soil-sensing station.)

For additional information about this project, please contact Mohammad Nash, email: mohammadnash@fs.fed.us, phone: 909-929-7070.



WASHINGTON OFFICE

Science Education Journals

Natural Inquirer is a science education journal for middle school students. The expanded *Natural Inquirer* products include science journals for upper elementary students, scientist cards for middle and high school students, Readers for K-2, and a nonformal activity guide for middle school students. All of these products are based directly on Forest Service scientists and their research. In FY 15, 60,658 *Natural Inquirers*, 11,888 *Investigators*, 7,060 Readers, and 48,000 *NSI: Nature Science Investigators* were distributed to classrooms, homeschools, and conferences. Social media followers increased by over 25 percent, and the *Natural Inquirer* Web site had over 58,000 unique visitors. Some noteworthy distribution points include the World Special Olympics, the White House Tribal Youth Initiative, the World Forestry Congress, the White House Maker Faire, the Council of Scientific Society Presidents, the National Science Teachers Association, the Ecological Society of America annual conference, and the Earth Day Network's Toolkit for Climate Change Education. All work is accomplished in cooperation with the *Natural Inquirer's* non-profit partner, the Cradle of Forestry in America Interpretive Association. <http://naturalinquirer.org>.

WO R&D KMC, Barbara McDonald, Ph.D., Education Program Manager, 706-559-4224

Forest Service Research Data Archive

FY 2015 marked the sixth year of operation for the Forest Service Research Data Archive (<http://www.fs.usda.gov/rds/archive>). We added 63 research data sets to our catalog in FY 2015, and now offer 200 research data sets to the public and global science community. The catalog is also searchable via science.gov. The Archive provides data repository services to the Joint Fire Science Program (<http://www.firescience.gov>); 48 of the data sets in our catalog came through that channel. Over 2,500 people downloaded a data publication in FY 2015 (> 70 percent increase relative to FY 2014). According to results from Google Scholar, there were 41 citations of our data publications in FY2015; this is a substantial increase over the 2 citations in FY2013 and the 4 citations in FY2014. Through FY2015, citations have appeared in the scientific literature (37), in dissertations (8), and in popular media (2).

National Research Data Archivist, David J. Rugg, FS R&D, 608-231-9234

Forest Service eResearch - Advertising Forest Service R&D among Other Federal Research Agencies

Forest Service R&D, through efforts spearheaded by USDA, has joined with other research agencies in USDA and other Federal Government research organizations to improve the transparency of their activities and demonstrate the impact of federal science investments on the economy and society. Three systems show the results of those collaborations, all based on data research stations already report.

- 1) [VIVO](#) is a web tool for sharing information about researchers and institutions to support collaboration and discovery. Search USDA's version of this NIH-funded tool to find researchers, publications, and problem areas from the Agricultural Research Service, Economic Research Service, National

Agricultural Statistics Service, and the National Institute of Food and Agriculture as well as the Forest Service. Some really cool visualization tools come with the package.

- 2) [STAR METRICS](#) (Science and Technology for America's Reinvestment: Measuring the Effect of Research on Innovation, Competitiveness and Science) attempts to document the outcomes of science investments. This solution displays R&D's problem areas and funding among current studies funded by NSF, EPA, NIH, ARS and NIFA. Powerful query and visualization tools let you slice and dice federal research like you've not seen before.
- 3) [PatentsView](#) is a visualization tool for patent information that now includes all the patents issued to USDA inventors including those in the Forest Service. Find the innovative ideas Forest Service research has made available to create jobs and launch businesses.

In addition, Research and Development websites delivered to the public, abstracts of its scholarly papers over a million times in FY2015, describing some forty five thousand full text publications freely offered online.

Program Manager – Internet Communications, John Pye, jpve@fs.fed.us, 919- 549-4013

National Urban Forest Technology & Science Delivery Team

The Forest Service has a long history - well over three decades - of delivering urban forestry research, technology, and information to a broad set of partners, stakeholders, and customers. In recognition of growing demand for science information on urban natural resources stewardship and the value of sharing Forest Service knowledge and tools, the Forest Service established the *National Urban Forest Technology and Science Delivery Team* in 2013. The team represents a shared commitment across Forest Service mission areas to deliver quality urban natural resources science, technology, and information to improve urban forests and advance urban sustainability and community resilience. In FY2015 the science delivery team met monthly to implement an action plan to ensure that the Forest Service is timely, relevant, and coordinated in sharing urban forestry science and program information with stakeholders and the broader American public. The action plan serves as an internal road-map, setting forth a suite of near-term actions to reshape and redefine current Forest Service communication efforts and to create a clear, comprehensive, contemporary information delivery system for urban forestry research and technology into the future. Two important products of this team include:

- (1) *Urban Forest Connections webinar series*: This monthly seminar series brings urban environmental experts together across sectors and institutions to discuss the latest science, practice, and policy on urban forestry and the environment. The National Science Delivery Team has provided 13 webinars to date, creating a forum for sharing the latest knowledge, ideas, and tools among a growing community of academics, practitioners, and decision-makers. Between 80-215 professionals attend each webinar, and over 900 people request webinar notifications and announcements via email. [www.fs.fed.us/research/urban-webinars]
- (2) *Focused science synthesis and delivery*: The team is embarking on a series of urban forestry “deep dives” that will serve as rapid, state-of-the-science activities to inform key partners, shape new directions in research and decision-making, coordinate Forest Service messages, and increase visibility of the Forest Service’s emphasis on urban natural resources stewardship.

Urban Research, Elizabeth Larry, elbLarry@fs.fed.us, 202-213-5107

Patented Forest Service Technologies:

Fiber Loading Improvements in Papermaking

Traditional methods of making paper consume large amounts of energy and require a lot of space. A better understanding of sheet dewatering is needed to cost-effectively increase solids before drying without compromising sheet structure. This invention improves the press dewatering process during papermaking.

A patent covering this invention issued as U.S. Pat. No. 8,808,503 on August 19, 2014.

This invention is owned exclusively by the USDA Forest Service. Industrial cooperators and/or licensees to utilize and/or further develop this technology are being sought.

Patent Program, Janet Stockhausen, Patent Advisor, jstockhausen@fs.fed.us, 608-231-9202

Sugar Transport Sequences, Yeast Strains having Improved Sugar Uptake, and Methods of Use

This invention (U.S. Pat. No. 8,916,367 Issued 12/23/2014), presents a method to produce ethanol based on biomass, especially woody biomass. This invention increases the efficiency of yeast-catalyzed conversion of sugars to ethanol by enhancing the uptake of sugars by the yeast, and provides a way to promote xylose utilization by yeast in the fermentation of mixed hemicellulosic sugars by using sugar transport proteins that had a high affinity or specificity for xylose.

Industrial applications of this invention include sustainable and efficient production of bio-based ethanol fuels. This invention is jointly owned by USDA Forest Service and Wisconsin Alumni Research Foundation (WARF), the licensing arm of the University of Wisconsin. WARF has licensed it to a start-up company for further development and commercialization.

Patent Program, Janet Stockhausen, Patent Advisor, jstockhausen@fs.fed.us, 608-231-9202

Engineered Molded Fiberboard Panels and Methods of Making and Using the Same

This invention uses a broad spectrum of virgin cellulosic fibrous raw materials such as wood and plant fibers and recycled cellulose fibrous materials such as paper, agriculture waste, corrugated cardboard, and newspaper to form a sheet using wet process manufacturing methods. The shapes produced create a three dimensional, light weight, flexible material that is strong and durable. For indoor use, this product is environmentally friendly and does not off-gas toxins into the environment, ensuring a safe environment for manufacturing personnel and the consumer.

U.S. Pat. No. 8,936,699 issued on January 20, 2015 and was jointly invented by a Forest Products Laboratory engineer in collaboration with Noble Environmental Technologies (NET) under a Cooperative Research and Development Agreement. NET has exclusively licensed the worldwide rights for this patent and is actively commercializing it.

For more information, see <http://ecorglobal.com/> or contact:

Patent Program, Janet Stockhausen, Patent Advisor, jstockhausen@fs.fed.us, 608-231-9202

Recursive Hexapod System and Method for Multiaxial Mechanical Testing

This invention describes a materials testing machine for testing and characterizing materials under multiaxial conditions, and more particularly for determining reaction forces and displacement behavior. The system is reconfigurable and modular, and can apply the widest possible range of three translations and three rotations about a frame of reference attached at the center of the specimen. This system's advantages over current material testing systems include allowing precise control of the specimen's path and loading profile, cameras allowing three dimensional determination of displacement and strain, and the ability to rapidly and precisely load, grip, move, and release the specimens. The invention has broad applicability for testing the characteristics of a wide range of specimens, with the flexibility of utilizing various computing systems to analyze results.

This invention is jointly owned by the USDA Forest Service and the U.S. Navy (Naval Research Laboratory, Washington DC). A patent covering this machine was issued on March 17, 2015, (U.S. Pat. No. 8,978,480). Industrial cooperators and/or licensees to further develop this technology are being sought.

Patent Program, Janet Stockhausen, Patent Advisor, jstockhausen@fs.fed.us, 608-231-9202

Essential Oils Inhibit Mold on Wood

Traditional methods of treating mold have utilized chemical fungicides. Due to the toxicity of the chemicals, these treatments are poorly suited for indoor use. Natural, low toxicity means of inhibiting mold growth therefore have strong commercial appeal. This invention describes a method of protecting wood from mold with an essential oil, specifically thyme, which can be applied through various surface treatments. The essential oil may be applied in an undiluted or diluted form. Commercial applications may include dimensional lumber, oriented

strandboard, engineered composites, drywall, and ceiling tiles. The invention has appeal for safely and effectively controlling growth of mold on wood or wood products using natural products.

U.S. Patent No. 8,986,757 issued March 24, 2015 and is owned by USDA Forest Service. Industrial cooperators and/or licensees to further develop this technology are being sought.

Patent Program, Janet Stockhausen, Patent Advisor, jstockhausen@fs.fed.us, 608-231-9202

Enhance Enzymatic Hydrolysis of Lignocelluloses by Modifying Lignin Properties and Hydrolysis Environment

This invention reduces non-specific enzymatic binding of an enzyme to lignin which can enhance the enzymatic processing of lignocellulosic materials thereby providing economic and process advantages to any process that converts the lignocellulosic biomass into a product using an enzyme, such as biofuel production.

U.S. Patent No. 9,074,231 is solely owned by the USDA Forest Service Forest Service and issued on July 7, 2015. Industrial cooperators and/or licensees to further develop this invention are being sought.

Patent Program, Janet Stockhausen, Patent Advisor, jstockhausen@fs.fed.us, 608-231-9202

Sulfite Pretreatment for Biorefining Biomass

Lignocellulose represents a potentially valuable resource for the production of biofuel and biochemicals. However, one barrier to the production of fuels (such as ethanol) and chemicals from biomass is that the sugars necessary for chemical and biological conversion (such as fermentation) are trapped inside the lignocellulose. This invention helps overcome the key impediments in cellulose bioconversion, which are the physical and chemical barriers posed by plant cell walls that limit hydrolytic enzymes' access to the biomass. This technology is now being piloted for production of jet fuel by the Northwest Advanced Renewables Alliance (NARA), a 5-year, \$40 million grant involving 15 partners including USDA Forest Service. Led by Washington State University, NARA develops wood-based alternatives to petroleum-based fuels and chemicals.

U.S. Patent No.: 9,090,915 issued on July 28, 2015. It is jointly owned by USDA Forest Service and Wisconsin Alumni Research Foundation (WARF), the patenting and licensing arm of the University of Wisconsin-Madison. Industrial cooperators and/or licensees to further develop this technology are being sought.

Patent Program, Janet Stockhausen, Patent Advisor, jstockhausen@fs.fed.us, 608-231-9202

Device and Method For Measuring The Rheological Properties Of A Yield Stress Fluid

This invention discloses a system for measuring the yield stress of a fluid, such as biomass material. Rising oil prices and the finite nature of fossil fuels have led to an increased demand for alternative fuel sources, such as conversion of biomass into biofuel.

The conversion process typically involves the flow of the biomass through a series of chemical, thermal, and mechanical treatments. Currently, however, generating the flow of the biomass through the series of treatments is difficult and expensive, often requiring significant amounts of auxiliary materials and energy. To properly design the industrial processes and equipment, accurate measurements of the rheological properties of the biomass flow through the treatments is necessary. The most important rheological parameter is yield stress, i.e. the amount of stress that must be exceeded to make the fluid flow. Measurements currently being used are limited to low solids concentrations, very slow measurement times, and are expensive. This invention measures rheological properties of fluids requiring high stress or special handling, is simple to operate, operates quickly, and is inexpensive to manufacture.

This invention is co-owned by Wisconsin Alumni Research Foundation (WARF), the patenting and licensing arm of UW-Madison, and USDA. Industrial cooperators and/or licensees to further develop this technology are being sought. U.S. Patent 9,116,092 issued on 8/25/15.

Patent Program, Janet Stockhausen, Patent Advisor, jstockhausen@fs.fed.us, 608-231-9202

Methods of Monitoring and Controlling the Walnut Twig Beetle

This invention discloses a system for exposing the walnut twig beetle *Pityophthorus juglandis* and/or treating surfaces with semiochemicals produced by the beetle. A fungus lives in symbiosis with the beetle and the fungi are introduced into the phloem when the beetles bore through the bark. The beetle and fungus are associated with thousand cankers disease, a disease of national significance that threatens economically valuable black walnut trees and kills the tree within a few years. Currently, few products exist for detecting and/or combating thousand cankers disease and none have demonstrated any significant effectiveness.

This invention is co-owned with Contech Enterprises, Inc., University of California-Davis, and the USDA. Industrial cooperators and/or licensees to further develop this technology are being sought. U.S. Patent 9,137,990 issued on 9/22/15.

Patent Program, Janet Stockhausen, Patent Advisor, jstockhausen@fs.fed.us, 608-231-9202



FSIS is responsible for the safety of meat, poultry and processed egg products.

The free Food Keeper phone app can help keep consumers safe from food-borne disease and reduce food waste.

FSIS laboratories apply research advances to efficiently monitor potential chemical and microbiological hazards in meat, poultry and egg products.

7.0. USDA Food Safety & Inspection Program

<http://www.fsis.usda.gov>

7.1. Mission Statement

The Food Safety and Inspection Service (FSIS) is the public health agency in the U.S. Department of Agriculture responsible for ensuring that the nation's commercial supply of meat, poultry, and egg products is safe, wholesome, and correctly labeled and packaged.

7.2. Nature and Structure of the Program

FSIS applies the latest advances in food safety technologies to reduce foodborne diseases and monitors chemical and microbial hazards in meat, poultry, and egg products. FSIS also facilitates the application of food safety technologies to food production. In addition, the agency conducts outreach to consumers with food safety messages throughout the year.

The FSIS Research Priorities Review Panel routinely identifies and prioritizes research that assists the agency in its mission to protect public health. The list of current FSIS research priorities include:

- Developing analytical methods to increase the efficiency of laboratory analyses
- Identifying and understanding emerging chemical and microbial hazards
- Identifying and evaluating hazard mitigation techniques, e.g. pathogen interventions for food processing establishments
- Improving the transfer of food safety knowledge to consumers.

Although not a research agency, FSIS addresses its scientific information and data needs through partnerships with a variety of federal agencies, universities and industry. The agency prioritizes and communicates its needs to our partners and stakeholders during meetings with agency leadership and scientists, seminars at universities and scientific conferences, and postings on the FSIS website. In FY 2015, the FSIS Research Priorities page on the FSIS website was accessed on more than 4,000 occasions. Moreover, about 50% of users navigated to associated

pages for additional information on the FSIS Research Priorities and associated studies. Nearly 25% of new visitors subsequently returned to these pages. During FY 2015, FSIS added one new research priority (Identify unique attributes of pathogen outbreak strains that may increase the probability of food-borne illness) and 8 new associated study suggestions.

7.3. Activities in FY2015

FSIS Uses Science-Based Food Safety Information to Educate Consumers

FSIS plans, coordinates, conducts, and updates consumer food safety education campaigns and related outreach activities. FSIS originated and continues to promote the Food Safe Families campaign, an advertising, partnerships, public relations, digital and social media campaign based on the latest food safety research with consumers. FSIS used the results of the International Food Information Council's Food and Health Survey and an observational study conducted by Kansas State University to formulate messaging and establish communications priorities for this campaign.

FSIS collaborates with the Centers for Disease Control and Prevention, the Food and Drug Administration, and the Ad Council to develop Public Service Announcements (PSAs) for the advertising portion of this campaign. The *Food Safe Families* campaign features PSAs that promote four safe food handling behaviors to consumers: *Clean/Separate/Cook/Chill*. The PSAs inform consumers about simple steps to protect their families from foodborne illness. *Food Safe Families* PSAs were facilitated by the receipt of more than \$125 million in complimentary advertising from the National Ad Council resulting in roughly 8.6 billion views.

FSIS prepared fact sheets, brochures, video news releases, webcasts, public service announcements, press releases, blogs and other documents in support of agency's food safety programs and initiatives. These resources were designed to engage stakeholders, including the media and organizations that serve individuals at a greater risk of food poisoning (i.e., older adults, pregnant women, children under five years, and those with a compromised immune system).

Key components of FSIS' consumer education program include the USDA Meat and Poultry Hotline, the USDA Food Safety Discovery Zone traveling exhibit, and the FSIS web-based virtual representative initiative "Ask Karen." The USDA Meat and Poultry Hotline operated throughout the year, including the hotline's busiest time of year, the November–December holiday season. The Hotline operated from 8:00 am until 2:00 pm on Thanksgiving Day answering consumer food safety questions, which focused on turkey preparation, storage, and handling. The Hotline responded to nearly 74,000 inquiries (calls, webmail, and chats) in 2015 and received 1,769,716 views of *Ask Karen* questions. During FY2015, the USDA Food Safety Discovery Zone attended 17 outreach events in 7 states, reaching approximately 1,712,868 consumers with food safety messages. FSIS also developed consumer food safety content for the mobile "Ask Karen" app supported by iPhone and Android systems.

The completion and launch of the FoodKeeper app in April 2015 was a significant accomplishment. This app was developed by FSIS, Cornell University and the Food Marketing Institute and offers users valuable storage advice for more than 400 food and beverage items, including various types of baby food, dairy products and eggs, meat, poultry, produce, seafood, and more.

With the app users can:

- Find storage timelines for the refrigerator, freezer, and pantry stored products;
- Get cooking tips for cooking methods of meat, poultry and seafood products;
- Note in the devices' calendar when products were purchased and receive notifications when they are nearing the end of their recommended storage date;
- Search the app with swipe gestures or voice control; and,

- Submit a question to USDA using the ‘Ask Karen’ feature of the app. ‘Ask Karen’ is USDA’s 24/7 virtual representative. The system provides information about preventing foodborne illness, safe food handling and storage, and safe preparation of meat, poultry, and egg products.

The app is available for [Android](#) smartphones and tablets, and [iOS](#) products. The app supports the Secretary’s goal to reduce food waste by providing consumers with information about safe handling and storage times for hundreds of food items. The app was downloaded more than 84,000 times between launch and September 30. This success is due in large part to marketing to national news, technology, and food outlets. The app was mentioned by more than 200 media outlets, including Univision, Food Safety Magazine, Oprah.com, the Associated Press, Time Magazine, Food and Wine, LifeHacker, Salon, BBC World Service, Wegman’s, Fast Company Magazine, Consumer Reports, Real Simple, Every Day with Rachael Ray, Woman’s Day, and People Magazine.

Social media also is an integral part of the agency’s educational outreach. The Agency uses YouTube, Twitter, and Facebook to communicate to customers, stakeholders and consumers throughout the year. The [@USDAFoodSafety](#) Twitter account and the FoodSafety.gov Facebook account continued to see growth throughout the year due to the ongoing strategy of using non-traditional topics to communicate food safety messages. Twitter engagement was up more than 93% and Facebook engagement was up 192%. FSIS used pop culture topics like Star Wars Day (#Maythe4thBeWithYou) and #TheDress to promote food safety messages to audiences engaged in discussion about those trending topics. FSIS has also seen considerable success on social media related to seasonal campaigns. The biggest success in 2015 was the #GrillingLikeaPRO campaign. This campaign was launched in July to promote food thermometer use at the grill during the Fourth of July holiday weekend. Followers were encouraged to post pictures of them using a food thermometer with the hashtag, #GrillingLikeaPRO. The hashtag itself was used by more than 1,000 accounts and received more than 5.5 million unique impressions. Many government, nonprofit, and private business accounts participated in the campaign by promoting our food safety messages. Examples of major participants included nine Congressmen, the American Public Health Association, Johnsonville Sausage, Tyson Foods, the Department of Health and Human Services, Kaiser Permanente, and the County of Los Angeles.

Transferring Analytical Methods Development Research and New Technologies to FSIS Laboratories for Monitoring Hazards in Meat, Poultry, Catfish and Processed Egg Products

FSIS laboratories deploy new technologies to better monitor hazards in meat, poultry, and egg products and to minimize human exposure to foodborne hazards. In FY2015, FSIS validated and adopted four new laboratory methods. These methods improve the agency’s ability to monitor potentially hazardous concentrations of chemicals (e.g., antibiotics, pesticides, environmental contaminants, growth promoters) and microbial pathogens in food. These new FSIS methods include:

- A multi-residue method to detect pesticides in FSIS regulated products increases the efficiency of analysis to assure that FSIS regulated products do not contain unsafe levels of pesticides. The new method was developed by the USDA Agricultural Research Service and successfully validated and implemented in FSIS laboratories. This method is suitable for screening a variety of pesticides in bovine, caprine, equine, ovine, porcine, poultry and catfish muscle. This method provides data that are useful for FSIS and U.S. Environmental Protection Agency consumer pesticide exposure and risk assessments.
- A chemistry method to quantify the macrolide antibiotic veterinary drug Tilmicosin will be used by FSIS to assure that FSIS regulated products do not contain unsafe levels of veterinary drugs. This method is suitable for the quantification of Tilmicosin in beef liver, kidney and muscle tissue. The U.S. Food and Drug Administration will use the data generated by this method to ensure that veterinary drugs are being properly used in food animals and that the levels of these drugs in foods do not present a public health concern to consumers.

- The new document entitled *Quantitative Analysis of Bacteria in Foods as Sanitary Indicators* may be used as a means of evaluating the degree of sanitation during production. FSIS laboratory methods are used to detect and, when desired, quantify selected microorganisms in meat, poultry, catfish and pasteurized egg products.
- Improved method for the *Detection, Isolation and Identification of Escherichia coli O157:H7 from Meat Products and Carcass and Environmental Sponges* offers an alternative confirmatory test for Shiga toxin gene. The method is used for the analysis of raw and ready-to-eat meat products, and laboratory environmental sponge samples for *Escherichia coli* O157:H7.

Adoption of Whole Genome Sequencing for the Routine Characterization of Pathogens

Whole Genome Sequencing (WGS) is a rapidly evolving and powerful characterization technology that promises an in-depth discrimination between closely related bacterial isolates. In FY 2015, FSIS deployed four whole genome sequencers. This added more discriminatory power to the Agency's investigative process by permitting 'real-time' sequencing of outbreak related pathogen isolates. To further strengthen FSIS' WGS capability and to develop a shared understanding among federal public health partners on the rapidly evolving WGS issues, FSIS partnered with the Centers for Disease Control and Prevention, the U.S. Food and Drug Administration, the National Center for Biotechnology Information /Institutes of Health to formalize the relationship into an interagency collaboration called Gen-FS.

When WGS is fully implemented in FSIS, the agency will be able to provide the WGS data to establishments to assist them in developing effective Hazard Analysis Critical Control Point (HACCP) systems for taking effective corrective actions and for performing adequate reassessments. The WGS data will also be used by FSIS to explore/identify environmental harborage and recurrences of pathogens in FSIS-regulated establishments.

Facilitating the Application of New Food Safety Technologies to Food Production

FSIS encourages continued improvement and innovation in food safety technologies. During FY 2015, FSIS evaluated new technologies aimed at enhancing food safety, including new commercial pathogen interventions, process innovations, and new ingredient usages proposed by industry. If the evaluation indicates that the agency has no safety concerns with the proposal, the agency issues a "no objection" letter, which facilitates the adoption of new technologies for production of FSIS regulated products with enhanced safety. In FY2015, FSIS evaluated 135 new technology submissions. Of these submissions, FSIS issued 83 "no objection" letters. Of those 83 "no objection letters, 35 related to new ingredients, 22 to *Salmonella* Initiative Programs (SIP) and 9 were related to egg products. These no objection letters facilitate the adoption of food ingredients to enhance the safety of FSIS regulated products.

Adoption of New Technologies to Facilitate Information Transfer to FSIS Inspectors and Industry

FSIS is expanding its reach into ever more sophisticated technologies as new platforms for training. FSIS has begun developing 3-D, virtual reality instruction for food safety inspectors and other audiences to orient them to authentic slaughterhouse operations. Users will watch the video segments using virtual reality goggles. FSIS used video recording equipment similar to the Google Maps camera-on-wheels to shoot meat and poultry processing scenes in various establishments and is now editing the footage into learner-activated, instructional vignettes narrated by experts. Watching the scenes using virtual reality goggles will give users the next-best experience to being in a processing plant so they better understand the environment and enhance their preparation for the job.

FSIS also launched an online IPP (Inspection Program Personnel) Help 'button,' available via a desktop icon that opens a menu of IPP-related topics. Initial content for the Help button supports inspectors in using the Public Health Information System (PHIS) to record results of their inspection tasks. The Help 'button,' which was launched in January 2015 and updated throughout the year, features simulations of PHIS features. Users click the desktop IPP Help icon to open a PHIS menu, and then click a menu topic such as Inspection Verification, Lab

Sampling, and Animal Disposition. Each topic offers “watch me” live-screen demonstrations and “try me” interactive animations that teach the user how to use each PHIS feature. Since the IPP Help button’s launch, the number of “hits” to the site has ranged from 4,000 to 11,000 per month.

Another distance learning accomplishment during FY 2015 was the launch of the second online course in a planned, three-course curriculum about Export Certification. Using animated characters and voices, the course teaches IPP to certify meat, poultry, and egg products according to the requirements of foreign countries who rely on FSIS to attest to the safety and wholesomeness of the foods being exported. Users can access the course 24/7 on AgLearn, USDA’s automated course management system.

In addition, FSIS continued to produce industry guidebooks and other publications throughout the year to help small processing plants comply with FSIS regulations. Titles released during FY15 include a revised version of *Introduction to the Microbiology of Food Processing* guidebook and language translations of *FSIS Food Safety and Food Defense Information for In-Commerce Firms* into Spanish and Korean.

Facilitating the Application of Food Safety Research Findings to Produce Safe Food and Compliance with FSIS Guidance and Regulations

In FY 15, FSIS released seven guidance documents to assist industry with identifying and applying relevant scientific findings to produce safe meat, poultry, and egg products, including:

1. *FSIS Compliance Guideline HACCP Systems Validation*, to help very small meat and poultry plants meet initial validation requirements.
2. *Modernization of Poultry Slaughter Inspection Microbiological Sampling of Raw Poultry* Helps small and very small poultry slaughter establishments comply with new microbiological sampling and analysis requirements.
3. *Best Practices Guidance for Controlling Listeria monocytogenes (Lm) in Retail Delicatessens*. Provides actions for deli retailers to decrease the potential for *Listeria monocytogenes* growth or cross-contamination in the deli area.
4. *FSIS Compliance Guideline for Validating Cooking Instructions for Mechanically Tenderized Beef Products* helps establishments ensure that labels contain validated cooking instructions for any raw or partially cooked, needle- or blade-tenderized beef products destined for households, hotels, restaurants, and similar institutions.

The other FY 2015 issued guidelines focused on record keeping, regulatory compliance and data management.

Risk Assessments Used to Develop Targeted Food Safety Education Messages

In FY15, FSIS broadened the use of quantitative food safety risk assessments to inform emergency response decisions and develop targeted food safety outreach and education efforts. In general, FSIS’s regulatory risk assessments are developed to evaluate the public health impact of industry guidance options, hazard prevalence targets, and other major policies. Risk assessments also have utility beyond policy development:

- **Risk Assessments Tailored to Guide Emergency Response:** In 2010, FSIS led the development, in collaboration with USDA’s Animal and Plant Health Inspection Service (APHIS) and the U.S. Food and Drug Administration (FDA), of a quantitative risk assessment to evaluate the public health risk should highly pathogenic avian influenza (HPAI) affect poultry flocks in the U.S. This risk assessment was used to guide national emergency response planning, with APHIS furthering the use of this risk assessment through collaboration with academia and industry to develop tailored risk assessments that incorporated industry data to better inform decisions regarding the movement of shell eggs and poultry during an HPAI outbreak. In FY15, discussions with APHIS, FDA and academia led to sharing FSIS’s pasteurized shell egg quantitative risk assessment to be tailored to support industry emergency response decisions for the movement of shell eggs to mitigate HPAI risks.

- Risk Assessments Used to Develop Targeted Food Safety Education Messages: Discussions among federal partners, academia and industry led to collaboration with the Partnership for Food Safety and Education to use the 2003 FDA/FSIS *Listeria* risk assessment for ready-to-eat foods to guide the development of targeted consumer outreach and messaging regarding refrigeration as part of the “Go 40 or BELOW campaign” to mitigate the risk of listeriosis. This unique collaboration between academia, industry, and government led to the use of existing food safety risk assessment to guide the development of a targeted national consumer education campaign informed by quantitative risk assessments.

These technology transfer efforts ensure greater use of regulatory risk assessments to support both public and private sectors efforts to mitigate the risk of foodborne illness in the U.S.

8.0. Grain Inspection, Packers and Stockyards Administration (GIPSA)

<http://www.gipsa.usda.gov/>

8.1. Mission Statement

To facilitate the marketing of livestock, poultry, meat, cereals, oilseeds, and related agricultural products, and promote fair and competitive trading practices for the overall benefit of consumers and American agriculture.

8.2. Strategic Plan

GIPSA's Strategic Plan serves to ensure fair and transparent markets free from deceptive and fraudulent practices, combined with recognized and reliable descriptors of crop quality and value, to promote economic health and prosperity in American agriculture. U.S. farmers produce a wide variety of agricultural products, and the vast American infrastructure permits these products to be processed and distributed throughout the United States and international markets effectively and efficiently. The markets serviced by GIPSA represent a total economic value of approximately \$170 billion annually with exports contributing over \$28.7 billion to the U.S. economy.

8.3. Nature and Structure of Research Programs

GIPSA maintains a strong presence, domestically and internationally, in the development, evaluation, and implementation of practical grain quality assessment and inspection methods. Our laboratories work with the latest technologies, and through these technologies and our ongoing efforts, we are helping to improve the quality of U.S. grain available to the global market. To enhance marketing of grain into the future, we are also conducting internal research and participating in development and collaborative efforts with other governmental entities, laboratories, and private business. The research and analysis we conduct is in response to clear and widespread market needs. In general, GIPSA research is highly "applied" in that GIPSA's successful projects result in direct and immediate use by the US grain industry. GIPSA also develops written information for customers and stakeholders, including scientific publications, publications in trade journals, and reports to stakeholders.

As agricultural crops evolve and varieties with enhanced traits are developed, reliable tests must be developed to detect and quantify the quality traits important to the market. GIPSA conducts a research program to assess the performance of rapid test kits that are designed for detecting and/or quantifying the presence of mycotoxins in grain or for detecting the presence of specific biotechnology-derived traits in grain to allow test kit manufacturers to make verified claims regarding their products. GIPSA research results in new applications of existing technologies, such as near-infrared spectroscopy and nuclear magnetic resonance, and improvements in those technologies to meet identified market needs for grain quality assessments.

8.4. Current Technology Transfer Goals, Objectives, and Measures of Success (Metrics)

8.4.1. Current Technology Transfer Initiatives

Moisture measurement remains one of the most important official and commercial grain inspection activities because of moisture content's impact on end-use value (dry matter content) and storability.

GIPSA research, in collaboration with ARS, resulted in the Very High Frequency (VHF) Unified Grain Moisture Algorithm (UGMA)—an approach to grain moisture measurement that improves grain moisture measurement by (1) yielding improved accuracy, (2) permitting multiple manufacturers to design moisture meters that can use common calibrations and give equivalent results, and (3) reducing the cost of on-going calibration maintenance. GIPSA has worked closely with manufacturers for approximately 10 years to develop instruments that could use GIPSA's UGMA technology successfully. GIPSA made the UGMA freely available as a public algorithm to facilitate adoption by multiple manufacturers.

Two manufacturers developed and commercialized UGMA-compatible instruments and other manufacturers have expressed interest in developing such instruments. The UGMA technology was implemented for corn, soybeans, sunflower, and sorghum on September 10, 2012, and for all 60 other grains and commodities under GIPSA's jurisdiction on May 1, 2013. UGMA-compatible moisture meters continue to provide effective grain moisture measurements for the entire U.S. grain industry and, eventually, for the global grain industry.

Visually identifying quality factors within grain and other commodities requires clear light that appropriately illuminates the product being graded. GIPSA has identified a need for light emitting diode (LED) lights as an alternative to fluorescent lights currently required for use within the Official inspection system. GIPSA is working to identify the specifications for LED lights that equate to the requirements established for grading, and is currently working with a manufacturer who may be able to provide a commercial product that meets these specifications.

GIPSA works with manufacturers of rapid test kits used to detect mycotoxins and approved genetic events in grain to certify the test kits. GIPSA also approves the use of mycotoxin test kits for use within the Official inspection system. GIPSA provides a monthly update of all approved rapid test kits on its public website. GIPSA has approved 45 rapid test kits for detection of aflatoxin, deoxynivalenol, and fumonisin. GIPSA has approved ten rapid test kits for detection of specific approved genetic events in corn, soybeans and maize.

8.4.2. CRADA Activities

GIPSA does not have any active CRADAs at the present time.

8.4.3. Measures of Success

GIPSA measures its success in terms of the percentage of market needs, which are grain and commodity quality factors, which are addressed through the Official inspection system. GIPSA currently provides tests that address 98% of current market needs as identified by the grain exporting industry. GIPSA is in the process of reviewing all market needs in order to ensure that emerging quality factors critical to marketing grain are addressed. Another metric used is the number of quality and weight complaints we receive from our customers each fiscal year. GIPSA has received no complaints that indicate any issue with the method used to assess any quality factors during FY 2015.

8.5. Downstream Outcomes

- **Harmonizing Biotech Reference Methods.** There is a need for highly specific and accurate tests for the various genetically-engineered (GE) crops grown in the United States. GIPSA has developed intra-laboratory validated real-time polymerase chain reaction (PCR) methods and has evaluated the accuracy, reliability, and proficiency of publicly available methods used to detect and identify GE grains and oilseeds. GIPSA participated on a scientific panel of experts engaging U.S. stakeholders and influencing outcomes on issues related to testing of GE traits in grains with the goal of developing global scientific consensus regarding the analysis of transgenic events. GIPSA continues to collaborate with international organizations such as Codex Alimentarius, International Organization for Standardization, American Association of Cereal Chemists, American Oil Chemists' Society, Institute for Reference Materials and Measurements, and the Canadian Grain Commission to harmonize testing technologies for GE grains and oilseeds.
- **Export Wheat and Corn Quality Surveys.** GIPSA coordinates with representatives of U.S. Wheat Associates and the U.S. Grains Council to conduct export wheat and corn surveys. GIPSA assisted with the wheat survey by collecting samples, providing inspection results, and performing additional tests for

pesticide residues and heavy metals. GIPSA has assisted with the wheat survey for over 30 years, and 2012 was the first year of the corn survey. The two market development organizations use the data to advise importers worldwide on what is available for sale, the cost, and the advantages that U.S. wheat and corn have over the competition.

8.6. Outreach Activities

8.6.1. Domestic Outreach

- GIPSA collaborated with external manufacturers of GIPSA approved moisture meters to conduct a seminar on how UGMA-compatible moisture meters measure moisture in grain for grain elevators operators located in Minnesota, South Dakota and North Dakota in Fargo, ND.

8.6.2. International Outreach

- A GIPSA scientist attended the International Food Safety Training Laboratory, which is a part of the Joint Institute for Food Safety and Applied Nutrition (JIFSAN). JIFSAN is a joint collaboration between the U.S. Food and Drug Administration and the University of Maryland and helps provide the scientific basis for ensuring a safe, wholesome food supply as well as provide the infrastructure for contributions to food safety programs and international food standards. The purpose of the training was to educate international scientists involved in food safety on mycotoxin testing methods in food.
- GIPSA collaborated with a manufacturer of inspection equipment to present a seminar on U.S. grain grading procedures for Mexican grain graders at the FIGAP conference in Guadalajara, Mexico. Ensuring that it is clear how equipment is used for Official inspection within the U.S. can alleviate grading discrepancies due to different approaches taken in another country.
- GIPSA collaborated with instrument manufacturers to present a seminar regarding how UGMA-compatible moisture meters approved for use within the Official inspection system do so for members of the Canadian Grain Commission (CGC). The CGC recently adopted UGMA-compatible moisture meters for use within Canada as well.
- A GIPSA scientist served as a member (alternate delegate) of the U.S. delegation to the Codex Committee on Methods of Analysis and Sampling meeting held in Budapest, Hungary. The U.S. delegation actively participates in continuing discussions on uncertainty of sampling, conformity assessment, and processes for resolution of disputes.
- In FY 2015, GIPSA responded to customers' needs for technical assistance in foreign markets. Exporters, importers, and end-users of U.S. grains and oilseeds, as well as other USDA agencies, USDA cooperator organizations, and other governments, occasionally ask for our personnel to provide expertise. These activities include representing the Agency at grain marketing and grain grading seminars, meeting with foreign governments and grain industry representatives to resolve grain quality and weight discrepancies, helping other countries develop domestic grain and commodity standards and marketing infrastructures, assisting importers with quality specifications, and training local inspectors in U.S. inspection methods and procedures. Such activities typically have been funded through various programs administered by the Foreign Agricultural Service (FAS), Farm Service Agency (FSA), or directly by GIPSA. These types of outreach activities serve to strengthen the U.S. reputation for being a reliable supplier of high-quality grain, to reinforce the integrity of GIPSA as an independent quality inspection authority, and to minimize discrepancies in inspection results between GIPSA and the importer.
- GIPSA personnel frequently meet with delegations visiting from other countries to brief them on the U.S. grain marketing system, our national inspection and weighing system, U.S. grain standards, and our mission. Many of these delegations are sponsored by USDA Cooperator organizations like U.S. Wheat

Associates and U.S. Grains Council, which arrange visits to grain production areas, GIPSA field offices, onsite laboratories at export grain elevators, and our National Grain Center in Kansas City, Missouri. At the National Grain Center, delegations sometimes receive technical training on analytical testing procedures and grain inspection methods and procedures.

- Briefings are tailored to address each group's interests and concerns. Presentations include explanations of the various services available from GIPSA, our use of the latest technology to provide grain traders with accurate and reliable inspection and weighing information and, for importers or potential importers new to the U.S. grain market, information on contracting for the quality they desire. These briefings foster a better understanding of the entire U.S. grain marketing system and serve to enhance purchasers' confidence in U.S. grain. Ultimately, these efforts help move our nation's harvest to end-users around the globe. During 2015, GIPSA personnel met with 74 teams from 43 countries.

8.7. Publications

8.7.1. Book Chapters

None

8.7.2. Peer reviewed-publications

None

8.7.3. Internet Publications

- The GIPSA Performance Verified Mycotoxin Rapid Test Kits matrix is located on GIPSA's website at www.gipsa.usda.gov. The matrix is updated on a monthly basis.
- The GIPSA Performance Verified Biotech Rapid Test Kits matrix is located on GIPSA's website at www.gipsa.usda.gov. The matrix is updated as new tests are approved.

9.0. National Institute of Food and Agriculture (NIFA)

<http://www.nifa.usda.gov/>

9.1. Mission and Vision Statement

NIFA's mission is to "Invest in and advance agricultural research, education, and extension to solve societal challenges." NIFA approaches its mission with the following vision, "Catalyze transformative discoveries, education, and engagement to address agricultural challenges."

9.2. Nature and Structure of Research Program

NIFA's two key mechanisms for accomplishing its mission are:

- National program leadership. NIFA helps states identify and meet research, extension, and education priorities in areas of public concern that affect agricultural producers, small business owners, youth and families, and others.
- Federal assistance. NIFA provides annual capacity grants to land-grant universities and competitively granted funds to researchers in land-grant universities, other universities, and other partner organizations.

NIFA collaborates or has formal working partnerships with many institutions and individuals. Our key partners are the institutions of higher learning making up the Land-Grant University System. However, we also partner with other federal agencies, within and beyond USDA; non-profit associations; professional societies; commodity groups and grower associations; multistate research committees; private industry; citizen groups; foundations; regional centers; the military; task forces; and other groups.

NIFA and its partners focus on critical issues affecting people's daily lives and the nation's future. The advanced research and educational technologies NIFA supports empower people and communities to solve problems and improve their lives on the local level.

Among the many programs NIFA leads, many are currently focusing efforts on the following societal challenges:

- Advance our ability to provide global food security and fight hunger
- Create a resilient and environmentally sustainable agricultural system responsive to climate change
- Enable U.S. energy independence through the development of sustainable bioenergy feedstocks and value-added bio-based industrial products
- Combat childhood obesity by ensuring the availability of affordable, nutritious food and providing individuals and families science-based nutritional guidance
- Reduce the incidence of food-borne illness and provide a safer food supply

NIFA does this not only through their research and higher education programs, but also through an extensive network of state, regional, and county extension offices in every U.S. state and territory. These offices have educators and other staff who respond to public inquiries and conduct informal, noncredit workshops and other educational events. Extension education for all citizens is also provided nationally online through eXtension.org.

Moreover, with support from more than 500,000 volunteers, 4-H - USDA's 111-year-old youth development program administered through NIFA - engages more than 6 million young people every year and teaches them life skills through hands-on learning and leadership activities.

9.3. Current Technology Transfer Goals, Objectives, and Measures of Success (Metrics)

Applicants or recipients of NIFA grants that support basic research and integrated projects are encouraged to explore potential commercialization through the Small Business Innovation Research (SBIR) program. Conversely, small business owners or other grant recipients are encouraged to use NIFA-funded basic research programs to enhance innovation and competitiveness in their commercial operations.

Each land-grant university funded by NIFA has a university technology transfer office to promote, support and improve technology transfer from academic and nonprofit institutions. They often manage and license innovations derived from research at their universities (including research funded by NIFA) and are a good source to link small businesses with university faculty. Moreover, the Cooperative Extension System Offices are a nationwide, non-credit educational network. These offices are staffed by one or more experts who provide useful, practical, and research-based information to agricultural producers, small business owners, youth, consumers, and others in rural areas and communities of all sizes.

9.4. Strengthening Current Activities and New Initiatives

NIFA plans to promote SBIR funding opportunities to USDA intramural research CRADA partners through a partnership between NIFA's SBIR national program leaders and the Agricultural Research Service (ARS) Office of Technology Transfer (OTT).

Through a partnership with ARS, NIFA informs those who have applied to the NIFA SBIR program of potential partnership possibilities and benefits with ARS scientists. Notification to the SBIR applicant are made after NIFA SBIR program managers have completed disposition of SBIR applications.

- Joint intellectual property potential (ARS can file patent applications for CRADA partners and only charges the partner for filing fees, patent application and prosecution completed by registered USDA patent agents provided free of charge saving small businesses substantial costs)
- CRADA partners can work with ARS to utilize the benefits of the ATIP Foundation

Partner with ARS for their joint ARS / ATIP "Forum" series

- NIFA's relationship with the Cooperative Extension System and the Regional Rural Development Centers enables improved coordination and partnership with ARS intramural research to improve technology transfer that is relevant to stakeholders. This increases the likelihood of success of technology transfer by the agricultural sector partners of USDA.
- Partner with ARS on forums on bioenergy feed stock development
- Partner with ARS, Rural Development, and ATIP Foundation to coordinate economic development funding from public and private sources. In FY 2014 the ARS OTT held a series of listening sessions in cooperation with USDA RD and in those sessions the SBIR program was one program within USDA that was highlighted. In FY 2015 the ARS OTT will hold joint forums with USDA RD and the SBIR program and these forums will be focused on rural states that are a priority for both USDA RD and SBIR.

9.5. Response to Presidential Memorandum on Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Business

USDA 27: New Metrics (beginning FY 2014) on NIFA outcomes:

Efforts to develop procedures for requesting information from NIFA awardees are in progress. Information will be collected on: 1) number of new jobs created by a small business as the result of receiving SBIR grant funds; 2) increase in sales of technology or services developed by a small business as the result of receiving SBIR grant funds; and 3) sale to other businesses of licenses to technology developed by a small business as the result of

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receiving SBIR grant funds.

The data on the patents issued based upon Competitive NIFA Funding has been collected for FY2015 and is now being reported (see Table 1).

Table 1. Patents Issued in FY2015 based upon Competitive NIFA Funding.

Institution Name	Award Number	Patent Number	Issue Date	Invention Description
BOISE STATE UNIVERSITY	2009-65119-05977	8,911,748	12/16/2014	Cholera Toxin Chimera and Its Use as a Staph Vaccine
DIVISION OF AGRICULTURE	2007-35603-17744	9,005,601	4/14/2015	Bacterial Isolates for Improved Health of Poultry
EASTERN MICHIGAN UNIVERSITY	2012-67021-19958	8,952,093	2/10/2015	Bio-Based Polyurethane Dispersion Compositions And Method
IOWA CORN PROMOTION BOARD	2013-31200-06031, 2014-31100-06031, 2015-31100-06031	9,120,806	9/1/2015	Dianhydrosugar Production Process
LOUISIANA STATE UNIV A&M COL BATON ROUGE	2007-35204-05420, 2009-35204-05200	8,877,211	11/4/2014	Bovine Herpes Virus Vaccine with Multiple Mutations
MICHIGAN STATE UNIVERSITY	2001-35504-10668	8,968,515	3/3/2015	Methods For Pretreating Biomass
MICHIGAN STATE UNIVERSITY	2006-35504-17364	8,894,725	11/25/2014	Process for Producing Mixed Esters of Fatty Acids as Biofuels
NORTH DAKOTA STATE UNIVERSITY	2012-31100-06031, 2013-31100-06031, 2014-31100-06031, 2015-31100-06031	9,096,773	8/4/2015	Highly Functional Epoxidized Resins and Coatings
OHIO STATE UNIVERSITY	2001-35504-10668	8,961,915	2/24/2015	Wet Scrubbers for Ammonia Capture
PENNSYLVANIA STATE UNIVERSITY	2008-38814-04727	9,003,983	4/14/2015	Row Crop Sidedress Applicator and Cover Crop Seeder
PENNSYLVANIA STATE UNIVERSITY	2013-31200-06031, 2014-31100-06031, 2015-31100-06031	9,119,862	9/1/2015	Anti-leukemic Property of Cyclopentenone Prostaglandin Metabolite of Omega-3 Fatty Acid
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN	2012-31100-06031, 2013-31100-06031, 2014-31100-06031, 2015-31100-06031	9,080,187	7/14/2015	Methods and Compositions for Producing Solvents
UNIVERSITY OF MASSACHUSETTS AMHERST	2013-31100-06031, 2012-31100-06031	9,040,109	5/26/2015	Enzymatically cross-linked biopolymer interfacial complexes for improved lipid particle stability
UNIVERSITY OF WISCONSIN-MADISON	2014-31100-06031, 2015-31100-06031	9,063,073	6/23/2015	SOLID WORKING ELECTRODE WITH REPLACEABLE TIP

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UNIVERSITY OF WISCONSIN-MADISON	2012-31100-06031, 2013-31100-06031, 2014-31100-06031, 2015-31100-06031	9,080,212	7/14/2015	METHODS AND COMPOSITIONS FOR IMPROVED FERTILIZATION AND EMBRYONIC SURVIVAL
THE SAMUEL ROBERTS NOBLE FOUNDATION	2006-35300-17143	9,121,031	9/1/2015	Methods and Composition for Regulating production of proanthocyanidins
OREGON STATE UNIVERSITY	2005-35319-15280	9,018,002	4/28/2-15	Method to Trigger RNA Interference
UNIVERSITY OF WISCONSIN	09-CRHF-0-6055	8,871,494	10/28/2014	Overproduction of Secondary metabolites by Over-Expression of the VEA Gene
UNIVERSITY OF MINNESOTA	2011-67009-20062	International Patent Application No. PCT/US2015/020599	3/14/2015	Compositions Including Ligninsulfonate, Compositions Including Un-alkylated Lignin, and Methods of Forming
UNIVERSITY OF MINNESOTA	2011-67009-20062	Provisional Patent Application No. 62/215,017	9/6/2015	Compositions Including Ligninsulfonate, Compositions Including Un-alkylated Lignin, and Methods of Forming

USDA 28: Partner with ARS and the Animal and Plant Health Inspection Service (APHIS) at USDA on the National Plant Diagnostic Network, and the National Animal Health Laboratory Network

There are two goals for NIFA in this area.

- 3) Develop competitive funding opportunities to include ARS scientists in the development of diagnostic assays and validation protocols that are needed to support APHIS regulatory surveillance efforts for foreign and emerging plant and animal diseases.
- 4) Coordinate APHIS regulatory and ARS research efforts with relevant components of the Cooperative Extension Service in order to better identify producer needs and the transfer of relevant technology. Plans for FY 2016 are still being developed.

9.6. Downstream Outcomes

Forest Concepts is located in Auburn, WA and has successfully commercialized several different SBIR awards. Their most notable achievement was the development of WoodStraw™. This product is made from low grade waste wood veneer or from beetle-killed dead trees and it resembles oversized pencils. WoodStraw™ is an erosion control material that is a replacement for grass straw. Grass straw is light weight and can easily be blown away in high winds and also contains weed seeds. By contrast, WoodStraw™ is much heavier and thus more permanent and contains no weed seeds. It can be spread by hand, straw blower or helicopter. It can easily be baled and thus transported by truck to where it is needed. Compared to grass straw, WoodStraw™ provides superior performance in watersheds, forest lands and road construction sites. In initial field trials, WoodStraw™ reduced erosion by more than 98%. It has proven especially effective in reducing erosion in areas that have been impacted by forest fires. WoodStraw™ has been sold in many western states with total sales of well over \$1 million. The development of WoodStraw™ has improved the sustainability of independent veneer mills by

providing a value-added outlet for low grade veneer. It has also provided a value-added use for trees killed by bark beetles. It also offers a sustainable, ecologically compatible year-around erosion control product at a competitive price.

The Nitrate Elimination Company (NECi) is located in the Upper Peninsula region of Michigan, which is a very rural, economically depressed area. They employ 10 people and whenever possible they subcontract work to local businesses. Nitrate is an essential nutrient for plant growth but at high concentrations in drinking water it can be a serious health problem for humans and livestock and at high concentrations in forage it can also pose serious problems for livestock. The traditional method for measuring nitrate makes use of cadmium chemistry but cadmium is a heavy metal that can easily become toxic in the environment. NECi has received several grants from the SBIR program. They have developed a new type of nitrate test kit based on the use of the enzyme nitrate reductase that can be used either to measure nitrate levels in water or in forage. With SBIR support they have also developed an enzyme-based test kit for phosphate. Compared to the cadmium-based test kits, the NECi test kits are more environmentally friendly, cost competitive, just as sensitive, and more selective with fewer substances interfering with the tests. A few years ago a severe drought in much of the country resulted in a large increase in demand for the forage test kits as farmers had to determine if they could safely feed their forage to livestock. USGS has certified the nitrate test kits as an approved method for measuring nitrate in soil and water and more recently EPA has approved their nitrate test kits, which will open up new markets worldwide. The phosphate test kits will be commercialized later this year along with a new photometer they have developed that is needed to measure phosphate levels. Sales have increase slowly but are now more than \$250,000/year and expected to grow significantly in the next few years.

Sporting collars equipped with GPS tracking devices, grazing beef cattle in Oklahoma are part of a sweeping five-year study led by **Kansas State University** to better understand beef production vulnerability across the southern Great Plains in the face of climate change. The goal is to increase the resiliency of beef cattle operations on grazing lands and wheat pasture so producers can better sustain future productivity through potential climate changes. As part of the work, researchers are also looking for the best ways to reduce beef production's environmental footprint. That includes finding the most efficient ways to use water, best grazing practices, best forages and improving soil and water quality.

Between 15-18 billion apples are harvested every year in Washington state for fresh market consumption, but often farmers can't find enough people to pick the fruit. Many agencies have tried to create a device that will help with the picking process – a machine that is both gentle enough and picks fast enough to make it economically viable for commercial use – but have been unable to do so. Engineers and scientists at **Washington State University Tri-Cities** and the **WSU Center for Precision and Automatic Agricultural Systems (CPAAS)** are creating a practically adoptable robot that will pick apples as efficiently as people with the help of a \$548,000 AFRI grant, part of NIFA's National Robotics Initiative.

Strawberry production in the United States is valued at more than \$2 billion. Growers, however, face high production costs, particularly for managing pests, including diseases, insects, mites, nematodes, and weeds. Producers can now receive help from the **University of Florida** in the form of an online tool, the Strawberry Advisory System. The online tool communicates with farmers to alert them of factors that indicate a perfect environment for disease. Once alerted, farmers can spray their crops and log the information online to track each spray. This tool helps farmers spend less money on fungicides and spray less often, while achieving better results with what and when they spray.

Iowa State University veterinary researchers have developed a new means of delivering pain medication to nursing piglets through the mother sow's milk. This new method could help pork producers reduce the stress and pain experienced by piglets that are castrated or have their tails removed without the need to inject each piglet with medicine. The researchers tracked the level of medication in blood samples and used a thermography camera to measure changes in skin temperature on the piglets' heads after they underwent castration and tail removal. The

piglets that received pain medication through the mother's milk maintained a more consistent, higher surface skin temperature, which the scientists say is suggestive those piglets were under less stress.

Researchers from the **University of Maryland** are testing a cutting-edge approach for eradicating the most ancient disease known to mankind, influenza. The research team used advanced genome editing technologies and deleted receptors in the pigs' genetic codes to block the virus's entry and inserted what are called "decoy" genes to prevent the virus from replicating. This technology has the potential to develop flu resistance in pigs and prevent the flu from spreading to other pigs and to humans, who can and do contract the virus from swine.

The **University of California-Davis**-led Triticaceae Coordinated Agriculture Project (T-CAP) and Wheat CAP, and the **University of Minnesota**-led Barley CAP have used knowledge gained from the genomes of these crops to develop improved varieties. Approximately 20 percent of the harvested wheat acreage—worth approximately \$3.5 billion—and four percent of the harvested barley acreage in the United States come from wheat and barley varieties developed by these projects. These new varieties have traits that include improved disease resistance, nutritional value, yield, drought tolerance, and adaptability to a changing environment. The T-CAP team also created a toolbox to provide plant breeders with additional information so they can develop improved wheat and barley lines. Project investigators have mentored 108 undergraduate students, 136 graduate students, and 25 postdoctoral researchers.

Digital Tools Helps Farmers Adapt to Climate, Weather Changes

Weather and climate patterns are a driving force behind the success or failure of Corn Belt cropping systems. "Useful to Usable" (U2U) is a collaboration among nine North Central universities led by **Purdue University** designed to improve the resilience and profitability of U.S. farms in the Corn Belt amid a variable climate. The U2U initiative has launched several new decision support tools in the past two years to help farmers and agricultural advisors manage increasingly variable weather and climate conditions. For example, "[Corn Split N](#)" combines historical weather data and fieldwork conditions with economic considerations to determine the feasibility and profitability of completing a post-planting nitrogen application for corn production.

A team of **University of Wisconsin** researchers explored insect pest resistance in two types of genetically modified poplar trees that had been altered to improve their use as a biofuel feedstock. Poplar tree species and hybrids have been identified as one of the nation's most promising woody feedstocks for the production of cellulosic ethanol. This research explored whether particular genetic modifications might have the undesirable side effect of reducing poplar's natural resistance to pest insects, leading to crop loss or additional need for pesticide—which proved not to be the case. These genetic modifications may be used to enhance hybrid poplar as a biofuel crop without substantially affecting pest resistance.

Since the tobacco quota buyout of 2005, farmers in Virginia have experienced a loss of income and cropland. With funding from NIFA's 1890 Capacity Building Grants Program, researchers at **Virginia State University** have developed varieties of vegetable soybean (edamame) that can provide a profitable option for former tobacco farmers and a new use for the farmland. Edamame is an ideal substitute for tobacco because it can be grown using the same methods as grain-type soybean, but marketed as a high-value vegetable crop. The research team is identifying varieties that can be grown year-round, providing a fresh supply during the times of the year when supply is low and demand is high.

Texas A&M University researchers have discovered that bioenergy sorghum not only serves as a viable fuel source, but also acts as a greenhouse gas sink. Researchers made this discovery while measuring greenhouse gases from biofuel production lab experiments. Analyzing the effects of crop rotation, nitrogen fertilization, and residue management were their main objectives. The research helped quantify the carbon footprint of a bioenergy cropping system and has significant implications for net greenhouse gas emissions, soil organic carbon sequestration, and life-cycle analyses.

University of Illinois scientists have evidence that lifelong exposure to genistein, a bioactive component in soy foods, protects against colon cancer by repressing an internal signal that leads to accelerated growth of cells, polyps, and, eventually, malignant tumors. In healthy humans, the cells lining the gut turn over and are completely replaced on a weekly basis. However, in 90 percent of colon cancer patients, a growth-promoting signal is always on, leading to uncontrolled growth and malignancies. The scientists noticed a change in the expression of three genes that control this growth-promoting signal, suggesting that soy-rich diets can slow or protect against the development of colon cancer.

Medical professionals highly recommended pregnant or nursing women consume 8 to 12 ounces of fish per week. There are, however, concerns about the accumulation of mercury in some species of fish, and ingesting the same may affect babies who are vulnerable to mercury contamination. A new mobile app developed by **Purdue University** provides mothers with information about which commercial fish species are best to eat and recommended amounts. Recommendations are based on Purdue research about the amounts of healthy fats, trace elements, and heavy metals in fish. Researchers say the best choices are salmon, rainbow trout, whitefish, herring, and sardines, all of which are high in health fats and low in mercury content.

University of Missouri researchers have found that eating breakfast, particularly meals rich in protein, increases young adults' levels of a brain chemical associated with feelings of reward, which may reduce food cravings and over-eating later in the day. The researchers studied the effects of different breakfasts on participants' levels of dopamine in the brain. Understanding the brain chemical and its role in food cravings could lead to improvements in obesity prevention and treatment. The research showed that people experience a dramatic decline in cravings for sweet foods when they eat breakfast. Additionally, breakfasts high in protein also reduced cravings for high-fat foods.

Human noroviruses cause more than five million cases of foodborne disease every year, more than any other pathogen including *Escherichia coli* and *Salmonella*. A team of researchers led by **North Carolina State University** have discovered how noroviruses contaminate fresh produce, such as lettuce and kale. The research team has developed surface sanitizers that reduce norovirus on food service worker gloves and food processing surfaces. Other promising approaches for the inactivation of noroviruses include gamma irradiation, high intensity pulsed light, copper surfaces, and nanomaterials. The project's education component is also training and placing food safety virologists, armed with the skills to tackle future food safety challenges, in academia and industry.

Up to 90 percent of people in the United States have been taught to rinse their raw chicken and turkey, and many recipes call for the practice. But a NIFA-funded project at **Drexel University** shows that washing raw poultry actually increases the chance of spreading bacteria around the kitchen. Instead of getting rid of bacteria, it increases the chance that rinsing will spray these harmful germs onto other surfaces in the kitchen. With NIFA's funding, the team also developed a public service campaign to inform people of the only tried and true method of killing bacteria: proper cooking techniques.

The invention of non-stick pans was a welcome relief for households and restaurants, and now using nanotechnology, scientists have created a new surface that promises to repel bacteria and lessen the chance for contamination. Developed by researchers at **Cornell University** and Rensselaer Polytechnic Institute, the new technology uses an electrochemical process to create nanoscale pores that change the electrical charge and surface energy of a metal surface, which in turn exerts a repulsive force on bacterial cells and prevents attachment and biofilm formation. When this process was applied to aluminum, it created a surface called alumina, which proved effective in preventing *Escherichia coli* and *Listeria* from attaching to the surface. Alumina could provide a low-cost solution to bacterial contamination in the biomedical and food processing industries.

The **University of Missouri's** 4-H Living Interactive Family Education Program promotes child-centered family visits between incarcerated parents, their children, and children's caregivers who raise them. These comprehensive visiting sessions consist of pre-approved, hands-on 4-H club activities and projects designed to promote citizenship, positive leadership, and healthy living. Evaluations have consistently shown that the program helps

children learn how to be leaders and make healthy lifestyle choices, which helps keep them out of juvenile and adult criminal justice systems. The program also creates an estimated taxpayer savings of \$16,690 in juvenile delinquency costs and \$40,195 in adult crime costs per child in the program. The program is now being replicated in several other states.

Blackfeet Community College in Montana used a NIFA research grant to teach students how to establish and monitor water quality in key Blackfeet waterways. Students learned to collect samples and analyze for benzene, toluene, ethyl benzene, and xylene. By establishing a baseline for water quality on these rivers, the Blackfeet reservation will now be able to detect changes in water quality caused by hydraulic fracturing near the reservation. This project taught students field research techniques and how to calibrate and read data from hydrocarbon analyzer sensors. In the future, the college hopes to find the source of contamination of the northernmost watershed of the Blackfeet Tribe, which had the highest concentration of hydrocarbons.

Livestock production in the United States is a complex operation. Veterinary services are critical to ensuring the health and well-being of livestock. Many rural areas, however, face a shortage of veterinarians. A contributing factor is the high student debt incurred by these professionals, leading them to take higher paying jobs in urban areas. To help address this shortage, since 2010, NIFA's Veterinary Medicine Loan Repayment Program has made loan repayment awards to 286 veterinarians who have committed to working in a shortage area. Many recipients have been able to start large-animal care facilities in rural areas and acquire necessary equipment they would not have been able to purchase until after paying off their student debt.

Orange County, California is home to 155,210 children who are food insecure, more than 21 percent of the population. **California State University-Fullerton**, a Hispanic-serving Institution, created a community-based Urban Agriculture Research Experience (U-ACRE) program to engage students to expand their interest in gardening and improve their access to food. The project is also training the next generation of food, agriculture, natural resources, and human scientists. U-ACRE gives hands-on, community-based research experience to undergraduate students who help local communities develop sustainable urban agriculture to achieve food security and provide families healthier food options.

Much of Arkansas's population is economically vulnerable, with many counties having poverty rates in excess of 25 percent. Arkansas consumers may not have the knowledge and skills they need to build financial security. The University of Arkansas Cooperative Extension Service offers research-based educational programs in personal finance, giving Arkansans the knowledge and skills they need to build financial security. More than 20,000 individuals have participated in personal finance programs with \$73,928 reported dollars saved and debt reduced. Participants developed skills such as creating a spending plan, checking a credit report, shopping smartly, and, setting financial goals. These individuals gained the knowledge needed to increase financial security and build wealth.

Agricultural Research Service and collaborating university scientists recently completed an SCRI project that provides food safety advances for fresh-cut leafy greens. Their groundbreaking research is used by FDA and the industry to reset food safety standards. They are the first to show that the industry-standard "Control Limit" chlorine concentration does not prevent pathogen cross-contamination, and that rewashing of contaminated product is an ineffective "Corrective Action" to rectify process failures. This work overturned historical industry practices by documenting the risks associated with operating practices previously considered safe. They also determined the necessary and sufficient sanitizer concentration to prevent pathogen cross-contamination and spread. These results are now incorporated into an interagency and industry task force document supporting Food Safety Modernization Act implementation. Canadian researchers have used our findings to develop mathematical models to predict contamination, and the US Department of Homeland Security has incorporated these results into anti-terrorism programs. The project also identified a cost-effective mechanism to improve cold chain integrity and fully implement food safety preventive controls during retail display. Open refrigerated display cases typically have significant temperature nonuniformity, presenting technical challenges for maintaining temperature below 5 °C at the front, without freezing damage at the rear. Their research found that retrofitting open cases

with doors achieved Food Code compliance, with nearly-uniform product temperatures below 5 °C throughout the case. Moreover, energy costs were 69% less than for open cases, allowing retrofit cost recovery in less than two years. Reduced costs for product rotation and savings from reduced spoilage are also expected. Based on outreach to retailers detailing these results, use of doors on fresh-cut produce retail cases has substantially increased in the last two years.

Pennsylvania State University and collaborating institutions studied the role of native pollinators in Pennsylvania apple orchards as part of an SCRI project began in 2010. They established 200+ acres of pollinator plantings with fruit growers, and evaluated the pollinator communities in these plantings for 4 years to evaluate effectiveness on conserving or enhancing the fruit pollinator community of 50-60 species. This led to the NE IPM pollinator guide for apple pollinators. Results of 4 years of apple orchard evaluations indicate that the pollination needs of most apple orchards in Pennsylvania are met by native pollinators in the diverse adjacent landscape and the cost of renting honey bees is not necessary. The savings to growers at a previously recommended rate of 2 hives/acre is over \$200/acre. Over half PA apple growers no longer rent honey bees for pollination and suffer no loss in yield or quality. Many of these growers have smaller acreages, so Penn State estimate that of the State's 22,000 acres of apples, approximately 5,500 acres were not renting honey bees (11,000 fewer honey bee hives with a potential savings in rentals of \$1.1 million by relying on wild bees). Penn State believes that their research and outreach will at least double this acreage and potential savings to growers. They are currently researching whether the pollination potential by wild bees holds true for Pennsylvania cherry orchards as well.

Low nutrient availability limits growth rates on many forest plantations in the southeastern United States. **North Carolina State University's** nutrition research on southern pine plantations including weed control and tillage has established prescriptive fertilization rates. Over 1.5 million acres of southern pine plantations are now fertilized annually. One year of fertilization results in the production of at least an additional 30 million tons of southern pine wood. This translates into an additional revenue of \$316 M (Based on 2014 Southeastern Average Stumpage Prices for Pine Pulpwood of \$10.54/ton). Diagnostic tools, prescriptions, and response information are now available and play a key role in the adoption of and wise use of fertilizers as a silvicultural tool.

The Japanese recently introduced a program called the Wood Use Point Program (WUPP) that provided up to 600,000 yen (~\$6,000) in direct subsidies to home builders who used local wood rather than imported wood to build their houses. An economic analysis by **CINTRAFOR (University of Washington)** found that excluding US Douglas-fir wood products from the WUPP could cost US forest products manufacturers and exporters between \$30 million and \$40 million in lost exports during the implementation of the WUPP program. However, in order to comply with WTO trade regulations, they provided a mechanism whereby imported wood could be classified as "local wood" if it met three criteria: 1) it was legally harvested, 2) the forest inventory of the wood was increasing over time, and 3) the imported wood contributed to the economic well-being of rural, fishing and mountain communities. With McIntire-Stennis funds, support of the US Embassy in Tokyo, and the Japan Director of the Tokyo Office of the Softwood Export Council, CINTRAFOR researched and developed a report demonstrating that US Douglas-fir wood products met the three criteria developed for gaining recognition as "local wood" in Japan. Following the meeting of the Corporation for the WUPP Fund, it was determined that US Douglas-fir wood products did meet the criteria laid out in the WUPP program and as a result, US Douglas-fir was formally recognized as a "local wood" within the WUPP program. The US was the only country that gained the "local wood" designation for their wood being imported into Japan. As a result, the US was able to save a \$30M Douglas-fir export and the US wood exporters are able to not only maintain their access to the Japanese market but they have an opportunity to expand exports at the expense of other competitors.

University of Missouri researchers received support from the Farm Business Management and Benchmarking Competitive Grant program to improve farm management knowledge and skills of agricultural producers and establish and maintain a national, publicly available farm financial management database. The cooperation and sharing of ideas have been key to the collaborative efforts within this grant. Continual communication including an online meeting and a face-to-face dialogue were completed to aid in the collaborative process. The concerted

effort to increase the size of the database has been through a variety of promotional and recruitment methods to farm producers. Methods have included displays at farm shows, informative pamphlets, community seminars, commodity workshops, and comprehensive training of new FINPACK analysts. Consequently, seven collaborators reported an increase in producers within the national database (although not all collaborators reported as records were still in process). Over 60 new farms have been added to the program which provides more data to the FINBIN. This increase in producers includes younger individuals and producers in geographical areas and production sectors that were not previously included. The expansion of collaborators within more states has allowed for 10 states to submit data to FINBIN thus increasing the scope of the potential analysis. The National Database is open to all farms through the FINBIN website to benchmark whole farm metrics and enterprise costs and returns. Over 30,000 summary and benchmark reports are generated annually.

The field production component of three major fruiting vegetables (tomato, watermelon, melon) represents over 470,000 acres of production with a farm-gate income of over \$3.47 billion in the U.S. These industries face major challenges due to the loss of methyl bromide and lack of efficacy or regulatory constraints with available soil fumigants. Additionally, growers seek efficient use of water, nutrients, and land resources for decreased environmental impact. There also are new opportunities in organic and specialty markets that growers seek to capitalize on. Grafting provides adaptability and solutions to address these challenges and opportunities. Grafting is the practice of joining a cutting (scion or top) possessing desirable market and horticultural characters to a rootstock that can provide increased resistance/tolerance to soilborne diseases (e.g. bacterial wilt of tomato; Fusarium wilt of watermelon), nematodes and/or abiotic stress, in addition to increased yield or enhanced fruit quality. Combining the independent benefits of the scion and the rootstock greatly reduces the interval between the discovery of important traits and their delivery to farms advancing economic benefits for multiple stakeholders. Scientists from **North Carolina State University** have formed the USDA-SCRI Grafting team and 42 private partners advanced the productivity and profitability of U.S. fruiting vegetable enterprises by integrating grafting technologies into fruiting vegetable production systems through a participatory, global and dynamic process. New business have emerged and growers are now able to manage serious soilborne diseases or gain crop yield and quality advantages by using grafted vegetable plants. Vegetable grafting is becoming an IPM tool nationally recognized among stakeholders as well as the general public. This project resulted in the creation of over 100 new jobs.

National 4-H staff is active on the White House Maker initiative and fostering making and inventing in 4-H. Several states have been developing maker experiences in 4-H clubs, afterschool programs and camps, including military 4-H partnership programs. About 150 4-H professionals attended a technology workshop presented by 4-H STEM NPL called “Changing Realities” using robotics, augmented reality and virtual reality applications in January 2015. The NPL co-coordinated a USDA booth at the National Maker Faire held at UDC. The NPL worked with a team of five 4-H educators to develop a “Making and Tinkering” workshop presented to 50 4-H professionals at their national conference in Oct. 2015. With assistance from 4-H Headquarters, National 4-H Council hosted the second National Youth Maker Summit in November 2015 which was attended by 80 4-H members, staff and volunteers from across the country. The 4-H staff coordinated National 4-H GIS/GPS Leadership team composed of teens and adults. The team developed an online GIS 4-H history map where local clubs can map their 4-H historic places of interest. They are also creating apps to support the history map.

The Western IPM Center promotes IPM adoption is through support of the Climate and Weather- Based Decision-Support Tools Signature Program, led by **Oregon State University**. This project helped create and continues to improve and expand the www.uspest.org website, which provides growers across the country up-to-date weather and pest-development information. The system provides daily and hourly weather-driven models serving many IPM, regulatory, and plant biosecurity uses for the full U.S. and specializes in IPM needs for the West. With more than 24,000 weather stations in the network, the ability to create virtual weather stations in other locations and more than 100 degree-day or hourly weather-driven pest-development models, growers can time their pest-management activities accurately and efficiently. Used thousands of times a day, www.uspest.org gives growers the data they need to practice integrated pest management. The Western IPM Center is funded through

NIFA's Crop Protection and Pest Management Program.

The Western IPM Center Crop-Pest Loss and Impact Assessment Signature Program is led by Peter Ellsworth at the **University of Arizona**. The project has used a detailed annual survey of cotton pest managers to document significant reductions in pesticide use and growers' pest-management costs since the mid-1990s. Examples: the number of sprays growers made dropped from around 12 per year to about two; the amount of pesticide active ingredient used dropped from four pounds per acre to one. Today, an average of 20 percent of the cotton acreage in Arizona is never sprayed for insect pests because growers successfully manage pests through other means. Through IPM adoption, from 1996 to 2014 Arizona cotton growers cumulatively saved \$451 million and prevented more than 21 million pounds of insecticide active ingredient from reaching the environment. The Western IPM Center is funded through NIFA's Crop Protection and Pest Management Program.

Honey bee pollination is crucial to ensuring sustainable food supplies worldwide, yet honey bee abundance is decreasing worldwide due to several pests and microbial diseases. American foulbrood is one of the most prevalent and serious bacterial diseases affecting honey bees. Antibiotics can cure the active infections initially, but bees frequently move between other bee hives and carry spores with them, thus re-infecting colonies. Colonies that are afflicted with American foulbrood and equipment must be incinerated making it a costly disease. **University of Nevada in Las Vegas** researchers received an AFRI grant to develop a novel means of controlling American foulbrood by using its own biology against itself. They identified several of the bacterium's bio-molecules and successfully used these compounds to cause bacterial spores to germinate out of context, thus making them vulnerable to other viral phages which attack the bacterium. Specifically these phages were found to produce lytic enzymes that break open the bacterium's cell walls. The researchers identified phage with high host specificity to the American foulbrood bacterium with broad efficacy and developed a method of using phage to treat active infections. Laboratory and field trials have shown significantly reduced levels of the disease and have increased overall health of colonies. This phage has been submitted for patent. As a whole, the researchers have developed a novel approach to protect bees and remove infectious spores from the hive without the risk of resistance posed by current antibiotic treatments or contamination of the hive and its products.

North Carolina State University (NCSU) is leading a CAP project (NoroCORE), the purpose of which is to reduce the burden of human illnesses caused by foodborne viruses, through research, education and extension activities. Noroviruses are the leading cause of foodborne disease, responsible for over 5 million cases per year in the U.S. There are a number of technology transfer activities associated with this project, and a few are described below.

- Researchers are improving methods to detect and diagnose noroviruses. Several participating institutions have identified specific molecules to be used to facilitate virus capture and detection. Specifically, Baylor College of Medicine team members have produced monoclonal antibodies, single chain antibodies, and phage-displayed peptides; Arizona State University researchers have developed synbodies; NCSU, nucleic acid aptamers; and Georgia State University, synthetic glycans. Several companies have expressed interest in developing rapid diagnostic tests using these molecules. Intellectual property documents and/or materials transfer agreements have been filed and many of these reagents are being shared with commercial sources and collaborators.
- The Illinois Institute of Technology Institute for Food Safety and Health (IFSH) team continues to work with food and equipment manufacturers to validate commercially relevant methods to inactivate noroviruses in the food supply. For example, with Campden BRI, they are evaluating pulsed light technology, and Nestle Switzerland has approached IFSH to form a public-private partnership to facilitate the evaluation of processing technologies. NCSU is working with a variety of small and large companies in the sanitation and hygiene sector to evaluate the anti-noroviral efficacy of sanitizers and disinfectants relevant to the food sector.

- Strong extension activities are in place to aid the retail and institutional food sectors in managing the foodborne norovirus problem. For instance, the NoroCORE team has developed fact sheets for educating food service employees on preventing contamination, and guidelines for clean-up of human bodily fluid contamination events for small, independent restaurants. Fact sheets and a social media campaign have been developed focusing on educating consumers so they can better prepare themselves to prevent norovirus infection.

The **University of Nebraska** is leading a CAP project is to reduce foodborne illnesses from Shiga Toxin Producing *E. coli* (STEC) through research, education and extension activities. Shiga toxin-producing *Escherichia coli* (STEC) are major pathogens of humans, most commonly acquired through the consumption of contaminated food or water, with about 29% of the cases in the U.S. attributable to beef. There are a number of tech transfer activities, I am providing a few examples:

- A spiral plating culture method using modified Possé agar to quantify non-O157 STEC in cattle feces was developed and validated in samples from naturally infected feedlot cattle. The spiral plating method was able to determine the concentration of “top 6” non-O157 STEC. It has the advantage that it can quantify STEC and not just organisms identified to the serogroup level.
- The efficacy of an air-assisted electrostatic spraying system (ESS) and/or the Sprayed Lethality in Container (SLIC®) method to deliver antimicrobials onto the surface of beef subprimals to reduce levels of STEC was found to be effective for reducing low levels of STEC on the surface of beef subprimals. Use of ESS will be of particular benefit to the industry because it allows for more uniform coverage with an antimicrobial and requires far less volume of an antimicrobial than other delivery methods such as spraying or dipping. Moreover, it will appreciably reduce the volume of water that processors use to harvest and further processing carcasses and cuts of meat.
- The effects of post-fermentation heating to control STEC within a non-dried sausage were determined. While application of heat may improve safety, it may cause untoward effects on the quality and sensory attributes of dry-fermented sausage. Fermentation alone delivered a 0.33- to 1.58-log CFU/g reduction in pathogen numbers while fermentation to ca. pH 4.6 followed by post-fermentation heating between 100° to 130°F and holding for 0.5 to 12.5 h generated reductions from around 1.0 to 6.7 log CFU/g. Likewise, fermentation to ca. pH 5.2 followed by post-fermentation heating between 100° and 130°F and holding for 1 to 12.5 h generated reductions from 0.3 to 6.7 log CFU/g. These data will be useful for manufacturers of dry-fermented sausages to validate/achieve the required reduction of STEC while producing a high-quality, safe product.
- The effect of pH and water activity (aw) on the efficacy of high pressure processing (HPP) for inactivation of non-O157 STEC in acidulated beef sausages and beef summer sausage was determined. Traditionally, manufacturers of fermented dry and semi-dry sausages have used thermal processing subsequent to fermentation as a means to meet USDA FSIS performance standard for *E. coli* O157:H7. However, this alters the product characteristics (flavor, texture, etc.). The use of high pressure processing (HPP) as an alternative can help processors achieve the performance standard and maintain the product quality. The developed and validated models can be used to design the HPP process based on the product pH and water activity (aw). This model can also be used in developing and/or modifying the food safety and HACCP plans.

The Solanaceae Coordinated Agricultural Project (SolCAP) has been transformative for the potato breeding and genetics community. In the US most potato breeding programs have used and continue to use the SNP array technology designed and developed by SolCAP collaborators. The genome-wide markers are now a standard that have been integrated into further USDA grants beyond SolCAP because of the reliability of genome-wide SNP markers and that they provide visualization of all 5 genotypic classes of the SNP markers in tetraploid

potatoes.

- The SolCAP SNP array technology has become the worldwide standard used in South American, Europe, Africa, China and New Zealand.
- A second version of the potato SNP array is now being used that has 5000 additional SNPs. The third iteration is being designed between US and European scientists. Neogen, a private sector cooperator is helping in the design and manufacture of the SNP array.
- Many of the papers presented in the 2015 breeding and genetics section of the national potato research meeting (Potato Association of America) and 2014 European Association of Potato Research use the SNP array and SNP genetic markers.
- The International Potato Center is using the SNP array to fingerprint their collection of 5,000 potato varieties. This process is helping removal of duplicates and to better classify the germplasm.
- The US Potato Genebank is using the SNP array to understand the genetic structure of their collections and to better manage their collection and curation of the germplasm.
- The software Tetraploid Map, developed in Scotland, has been modified to use genome-wide SNP markers.

9.7. Outreach Activities

- In FY 2016 the SBIR program will participate with the USDA Office of Technology Transfer to offer a webinar entitled “Partnership Pays: Building a Research Partnership with U.S. Department of Agriculture (USDA) Agricultural Research Service to Enhance Your USDA SBIR Proposal” in an effort to encourage more small business firms to enter into CRADA agreements with ARS prior to submitting proposals to the SBIR program.
- A number of NIFA’s National Program Leaders attended National SBIR Conferences in Washington, DC and Austin, TX, with formal presentations on the USDA SBIR program and met one-on-one with 25 or more small business entrepreneurs at each conference. In addition, the USDA SBIR program participated in webinars for Arizona Arkansas and Southern California.
- In FY15 the USDA SBIR program staff participated in conjunction with the SBA in 4 SBIR Road Tours and also attended 4 regional SBIR events to conduct outreach to potential small businesses found in underrepresented states. In each case a presentation was made on the USDA SBIR program. The tours provided outreach to approximately 2000 attendees in total, provided on average 20-30 one-on-one meetings with small business entrepreneurs at each meeting, and covered the following states, KY, TN, GA, SC, LA, MS, OK, KS, MO, IN, IL, IA, NE, SD, MT, WA, OR, ID, ND, and WVTX. In FY 2016 the USDA SBIR program will participate in National SBIR Conferences in Washington DC and Austin, TX and in several SBA Road Tours and State meetings, primarily in rural states.

10.0. The Natural Resources Conservation Service (NRCS)

<http://www.nrcs.usda.gov>

10.1. Mission Statement

The Natural Resources Conservation Service (NRCS) is not generally considered a research agency—the thrust of its mission is to help private landowners address natural resource concerns on their lands. NRCS conservation experts help landowners develop conservation plans and often provide opportunities for financial assistance to implement conservation practices. To carry out this mission on a broad scale (NRCS’s annual budget is approximately \$4 billion), NRCS has become perhaps the country’s premier agency for transfer of natural resources conservation approaches and technology. NRCS maintains approximately [160 National Conservation Practice Standards](#). These standards and supporting documents are NRCS’s principle vehicle for transferring the latest science and technology directly to America’s farmers and ranchers.

10.2. Nature and Structure of Programs

Once resource needs on private farms and ranches have been identified, the agency works closely with the Agricultural Research Service and numerous universities to develop and fine tune the science and technologies needed to help farmers conserve, protect, and enhance, their natural resources. NRCS also conducts conservation field trials to strengthen NRCS technology when formal research is not available. As appropriate, these trials are conducted on working farms and ranches, in cooperation with other agencies and organizations. A field trial is a study designed to examine the adequacy or adaptability of a conservation practice, technology, procedure, or material. It may also be used to introduce promising conservation practices or technologies into areas where they are not now accepted as a solution to a local soil, water, or related natural resource problem or condition. Field trials can be useful to transfer technology, to update the local technical guide, or to show the need for formal research.

10.3. Soils Research and Technology Transfer

The NRCS Soil Science Division is authorized by the Secretary to conduct research on the use and behavior of soils to facilitate soil classifications and distribution of information through the Web Soil Survey and other vehicles of data dissemination. Below are some current research and technology transfer efforts that are currently underway.

Rapid Assessment of U.S. Soil Carbon for Climate Change and Conservation Planning

Soils are the largest global storehouse of terrestrial carbon and have potential for mitigation of anthropogenic atmospheric carbon dioxide. Additionally, many other important processes, including water infiltration, nutrient cycling and loss, and soil erodibility, are strongly influenced by the amount of carbon in soils. To aid land managers, policy makers, and conservationists to make sound recommendations for management options to increase the amount of carbon in soils, scientists with the NRCS Soil Science Division, in cooperation with scientists from multiple universities, completed a nationwide inventory of soil carbon. This inventory from 6,000 sites provides a statistically reliable estimate of the amount of carbon in U.S. soils for global carbon accounting and will be used to enhance model-based conservation planning.

National Wetland Condition Assessment Hydric Soil Analysis

The nation’s wetlands are important landscape components and perform important ecosystem services including flood mitigation, regulation of carbon and nutrient dynamics, and sediment and contaminant sequestration. Many of these important wetland functions are mediated by hydric soils in the wetland. Soil Science Division soil scientists are cooperating with the U.S. Environmental Protection Agency in a nationwide project during FY 2016 to evaluate the condition of the nation’s wetlands. The project entails field evaluations and soil sampling at 1,000 wetland sites. NRCS scientists will conduct quantitative determinations on the approximately 5000 samples. This

soil data forms is essential for a comprehensive assessment of the condition of US wetlands.

Ground Penetrating Radar Evaluations of Soil Water Movement

Water movement into and through soils is a major driver of a multitude of important ecosystem services including soil water storage for plant growth, aquifer recharge, stream discharge, mineral weathering, nutrient cycling, and transport of natural and anthropogenic materials. Thus, understanding and predicting this process is critical for maintaining and enhancing long term sustainability of ecosystems including those used for agriculture and forest production. Soil Scientists from the Soil Science Division are cooperating with scientists at Penn State University to evaluate ground penetrating radar as a rapid and non-destructive method to document water movement through soils in a National Science Foundation-funded Shale Hills Critical Zone Observatory site. Project results will improve the ability to predict and manage soil water relationships.

Phosphorus Behavior in Soils

Phosphorus is a leading cause of water quality decline in the US, which leads to algal blooms and hypoxia in surface waters. To protect the nation's waters, practices to minimize phosphorus losses and runoff from agricultural lands must be applied effectively and efficiently. Soil Scientists in the Soil Science Division are cooperating with scientists at the University of Nebraska – Lincoln to evaluate phosphorus retention in and release from sediment derived from soils across the nation with a wide range in properties. Results will be extrapolated to all soils in the nation through the Soil Survey Geographic (SSURGO) Database to inform phosphorus management related decision-making at the watershed, farm and field scale and will provide valuable input to developers of field-level models that simulate water, soil and nutrient movement from agricultural lands.

National Ecological Observatory Network (NEON)

The National Ecological Observatory Network (NEON) is designed to gather and synthesize data on the impacts of climate change, land use change and invasive species on natural resources and biodiversity. Data will be collected from 47 terrestrial sites across the U.S. (including Alaska, Hawaii and Puerto Rico) using instrument measurements and field sampling. The sites have been strategically selected to represent regional biomes. NEON will combine site-based data with remotely sensed data and existing continental-scale data sets (e.g. satellite data) to provide a range of scaled data products that can be used to describe changes in the nation's ecosystem through space and time. The Soil Science Division is collaborating with NEON to characterize soils at each of the 47 sites across the US and partner with NEON to develop a research and develop agenda to understand the dynamics soil plays in the ecological environment.

2012 National Resources Inventory Release

The latest updated database from the National Resources Inventory (NRI) Program was released in September 2015 with the posting of the 2012 NRI Summary Report on the NRI Website. This database contains 30 years of data on over 800,000 points across the nation include information on land cover/use, erosion, wetlands, soil characteristics, and conservation practices.

USDA Greenhouse Gas Inventory Support

The National Resources Inventory (NRI) provides the statistical foundation for the USDA Greenhouse Gas Inventory. Beyond providing the NRI database for the inventory, support work in 2015 included collaboration on improving methods for reconciling NRI data with data from the Forest Service and the beginning of discussions on how to incorporate NRI Grazing Lands on-site data and the Conservation Effects Assessment Program farmer survey to further improve estimates.

10.4. Soil Health

NRCS launched its Soil Health Initiative in 2012 to refocus agency efforts on improving the physical, chemical and biological components of soil on private lands. Since that time, NRCS's soil health activities have expanded greatly and interest in soil health has spread rapidly to partners and stakeholder groups. The potential for the

adoption of soil health practices to have positive impacts on climate change—both adaptation and mitigation—has contributed to the energy around soil health.

NRCS established a Soil Health Division that now has upwards of 20 staff members. In Fiscal Year 2015, NRCS performed soil health related outreach and tech transfer to over 7,900 people through presentations, workshops and demonstrations. NRCS's Science of Soil Health videos, available on YouTube, have been viewed over 150,000 times. Forty soil health webinars are posted on the NRCS Science and Technology Training Library open to the general public. Each NRCS state has held multiple trainings on soil health for state staff, ensuring that the latest planning and science information is transmitted to the field level.

10.5. Ecological Site Description and Forage Suitability Groups

Tables for use in Ecological Site Description (ESD) development work were constructed from NRI rangeland on-site data collected over 2004 to 2013 on non-Federal and BLM managed rangelands. Sets of thirteen tables summarize field data within each observed ecological site and are organized by MLRA. A webinar has been presented to provide guidance for using these tables. The tables and recorded webinar are posted at:

http://www.nrisurvey.org/nrcs/range/ESD_tables/esd_tables.htm.

Similar sets of tables constructed from NRI pastureland on-site data collected over 2009-2011 and 2013-2014 are being finalized for use in Forage Suitability Group (FSG) development.

10.6. GeoObserver for Dams and DamWatch

Since the establishment of the Federal Guidelines for Dam Safety in 1979, NRCS has led the USDA effort in participating with federal and state agencies to promote dam safety. NRCS assisted dams currently number over 29,000, representing one third of the over 87,000 dams on the National Inventory of Dams (NID). Within this total, NRCS helped project sponsors build approximately 11,900 project dams through one of four programs: Public Law 83-566, Public Law 78-534, Pilot Watershed Program authorized under the Department of Agriculture Appropriation Act of 1954, and the Resource Conservation and Development (RC&D) Program authorized by the Agriculture and Food Act of 1981.

To assist NRCS personnel and project sponsors in monitoring the safety of NRCS assisted dams, the Conservation Engineering Division (CED) recently deployed two geospatial applications. First, in 2014, CED rolled out *GeoObserver for Dams* provided guidance on the use *GeoObserver for Dams* to provide an ongoing and an up-to-date inventory of NRCS dams. During FY 2015, the States used the application to update NID data associated with the over 29,000 NRCS assisted dams. In 2015, CED used information in *GeoObserver for Dams* to complete agency input for the congressional biennial report for dam safety.

In June 2015, Secretary of Agriculture Tom Vilsack and NRCS Chief Jason Weller announced the rollout of a second geospatial tool called *DamWatch*. This tool monitors, in real-time, the status of dams affected by storms and other events. NRCS uses *DamWatch* to monitor potential dam safety concerns on the approximately 11,900 project dams. To help optimize the use of *DamWatch*, CED conducted eight *DamWatch* training webinars for NRCS administrators, NRCS users, NRCS sponsors, and Dam Safety officials in FY 2015. After deployment, CED and the States had the opportunity to monitor rainfall activity at dams from numerous storm events that occurred across the country. CED continues to work very closely with the *DamWatch* developers, USEngineering Solutions of Hartford, CT, to update the application to optimize the experience of NRCS and sponsor users.

10.7. National Technology Support Centers

NRCS has three National Technology Support Centers—Greensboro, NC, Fort Worth, TX, and Portland, OR—that have two primary functions: to provide direct assistance and technology transfer (including collaboration with others for technical training) to NRCS States and the Pacific Basin and Caribbean Areas, and to acquire and/or

develop new science and technology in order to provide cutting-edge technological support. These Centers are also charged with developing and maintaining national technical standards and other technological procedures and references.

In effect, the NTSCs are a critical vehicle for technology transfer from NRCS scientists down to State, Area and Field offices. Conservation implementation partners, such as conservation districts and state departments of agriculture, frequently participate in NTSC training sessions alongside NRCS employees. Thirteen thousand individuals participated in over 200 training sessions in Fiscal Year 2015.

10.8. Science and Technology Training Library

NRCS's National Technology Support Centers work with partners including the Forest Service, land-grant universities, and the Extension service to make available to conservation planners and natural resource managers up-to-date training webinars on a wide diversity of topics (including forestry, climate change, bioenergy, wildlife, soil health, conservation planning, organic agriculture, etc.). Some of the webinars are developed by NRCS staff, others by partners. These webinars may be viewed live or on-demand. In Fiscal Year 2015, these webinars were viewed by over 30,000 individuals, including both NRCS and non-NRCS participants.

10.9. Conservation Innovation Grants (CIG)

Another important vehicle for development of conservation technology that NRCS will then transfer to farmers and ranchers is Conservation Innovation Grants

(<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/>)

CIG, a component of NRCS's Environmental Quality Incentives Program (EQIP), is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging Federal investment in environmental enhancement and protection, in conjunction with agricultural production. Under CIG, EQIP funds are used to award competitive grants to non-Federal governmental or nongovernmental organizations, Tribes, or individuals.

CIG enables NRCS to work with other public and private entities to accelerate technology transfer and adoption of promising technologies and approaches to address some of the Nation's most pressing natural resource concerns. CIG will benefit agricultural producers by providing more options for environmental enhancement and compliance with Federal, State, and local regulations. NRCS administers CIG. Much of what NRCS learns from CIG is incorporated into conservation practice standards, used by the field conservationists and technicians to address resource concerns on private farms and ranches.

Since CIG's inception in 2004, NRCS has awarded over 600 national-level CIG grants. There is also a State-level component that NRCS State offices may use to award smaller grants for State-specific resource concerns.

A sample of project results is provided below. Lists and brief summaries of funded projects are available on the CIG Web site (<http://www.nrcs.usda.gov/technical/cig/index.html>).

Solar Irrigation Pumps

Water quantity is a significant issue in many parts of the country, particularly in the arid Southwest. Many producers on Navajo Nation work their land beyond the reach of the energy grid, so they must choose from diesel-generated power or renewable energy options for irrigation. Tó Łání Enterprises (TLE) received a 2012 CIG award to conduct a three-year national pilot project to demonstrate the environmental, agricultural, economic and sociocultural effectiveness and benefits of solar energy systems for pumping irrigation water. The project was designed to encourage and facilitate adoption of such systems among Navajo, Hopi and other tribal conservation districts, farmers and ranchers in the arid and semiarid Southwest. Although demonstration sites were only recently completed (August 2013), results have been

so promising that the solar powered system has already been adopted by many Navajo farmers.

A First-of-its-Kind Carbon Markets Transaction

Environmental markets have the potential to generate new revenue streams for agricultural producers while enhancing natural resource conservation. Ducks Unlimited used a 2011 CIG award to develop a protocol for measuring and quantifying the amount of carbon stored by avoiding the conversion of grasslands to cropland. This protocol was then approved by the American Carbon Registry and used by private landowners to generate carbon credits on ranch lands in North Dakota. In 2014, General Motors became the first entity to purchase these credits as part of its corporate sustainability initiative. This success is being used as a model for future environmental markets to enhance conservation of our natural resources.

Temperature Credit Trading for Salmon Habitat

Using a 2011 CIG award, The Freshwater Trust worked with Willamette Partnership and a number of other organizations, agencies and regulators to develop the standards, calculation methodologies, verification and validation procedures, and state policies necessary to allow for the trading of ecosystem services credits for water temperature in Oregon.

Through the project, the city of Medford, Oregon worked with farmers, ranchers and other private landowners to shade the Rogue River in order to meet its regulatory compliance requirements for salmon habitat under a Total Maximum Daily Load. Incentivizing landowners to take action on a voluntary basis cost approximately half of what it would have cost to build and operate chillers to cool the effluent from Medford's wastewater treatment plant. President Obama, in remarks at a White House Summit on Conservation, mentioned this project as an example of a progressive, forward thinking conservation effort. It was the first time a standing President addressed the issue of emerging markets for ecosystem services, and the first time a President mentioned a CIG project.

Developing an Air Quality Tool for Livestock Operations

For several years, NRCS has funded efforts by a consortium of universities working to develop a National Air Quality Site Assessment Tool (NAQSAT) for livestock and poultry operations. The first CIG funding this effort was awarded in 2007. After many years of development, refinement and testing, the NAQSAT will soon be accepted as NRCS' official Air Quality Site Assessment Tool, pending review and approval. The present online version can be found at <http://naqsat.tamu.edu>.

Generating Greenhouse Gas Credits Through Nutrient Management on Cropland

In 2011, NRCS awarded a CIG grant to the Delta Institute to develop a protocol that would allow farmers to generate greenhouse gas reduction credits arising from voluntary implementation of more efficient nitrogen fertilizer management techniques. The Delta Institute engaged a variety of partners in the project, including American Farmland Trust, Conservation Technology Information Center, Environmental Defense Fund and agricultural retailers. The end result was a methodology approved by the American Carbon Registry that allows for the generation of carbon credits (converted nitrogen oxide credits) on cropland. In a first-of-its-kind transaction, the Climate Trust purchased credits developed using the methodology in early 2014, providing a new income stream for those farmers generating the credits. This demonstrates how improving nitrogen management can be used to generate marketable credits that improve the environment and provide additional income for producers.

Rebuilding Pollinator Habitat

People depend on pollinators for about 30 percent of their food supply; however, habitat for pollinators has declined in recent years. A 2009 CIG award to the Xerces Society developed new NRCS guidelines for improving native bee habitat. The project demonstrated that establishing native pollinator habitat in previously abandoned agricultural areas significantly increased native bee populations. The project was carried out in California where most of the nation's fruit and vegetable crops are located. The guidelines developed led to publication of an NRCS bee habitat improvement reference guide. NRCS is now providing funding to establish bee habitat on previously unused farm areas on hundreds of thousands of acres across the nation.

Saving Water with Online Irrigation Technology

Growers using traditional cranberry irrigation systems have to turn their systems on and off manually; wasting time, money and water. With support from a 2005 CIG award, the Cape Cod Cranberry Growers Association worked with growers to install automated sprinkler systems that conserve water and reduce costs. These systems have sensors among the cranberry vines that monitor temperature and other weather conditions. A grower can monitor and control the systems online. Growers using these systems can save more than 9,000 gallons of water per acre on a frost night. During the study period, the systems reduced water application times by two hours per application. For a typical growing season, 280,000 gallons of water per acre can be conserved by using this system.

A Tool for Tailoring Cover Crops for Water Quality and Weather Resilience

Cover crops can dramatically reduce nutrient losses to surface and ground water, provide nutrients for the next crop and enhance water infiltration, all of which improve resilience to extreme weather. Through a CIG award and other contributions, the Midwest Cover Crops Council developed a Cover Crop Decision Tool that incorporated expert knowledge across several states into a decision support system for farmers. As a result of this project, producers throughout the Midwest United States can evaluate their options and receive cover crop recommendations, such as species and seeding rates, tailored to their local conditions, soils and management goals. This not only helps farmers be profitable, but also contributes public value through benefits to the environment.

Taking Adaptive Nutrient Management To the Next Level

Nutrients are essential for food production, but loss of excess nutrients can degrade water quality. With support from a 2004 CIG award, the Iowa Soybean Association, in partnership with the Environmental Defense Fund, worked directly with producers to evaluate an adaptive nutrient management process for refining nutrient management on their farms. Results from this project showed that 80 percent of farmers participating changed their nutrient management practices within two years. The greater nutrient use efficiency made possible through adaptive nutrient management not only allowed producers to reduce their fertilizer inputs and associated costs, but also reduced the risk of nutrient loss to the environment. These results led NRCS to include adaptive nutrient management in its revised Conservation Practice Standard 590, Nutrient Management. NRCS then developed and provided guidelines and training to field staff on implementing adaptive nutrient management and is currently providing financial and technical support to increase adoption of this practice nationwide.

A Cloud-based Tool for Nitrogen Management

Nitrogen is required for plant growth, but loss of excess nitrogen can contribute to water quality impairments and greenhouse gas emissions. Determining the right rate to apply is difficult, because weather influences how much nitrogen is needed. With funding from a CIG and others, Cornell University developed and tested a publicly available, cloud-based nitrogen recommendation tool, Adapt-N, on farms over three years. The tool models local weather, soil and management to provide better nitrogen recommendations. Results showed that Adapt-N saved producers \$30 an acre and decreased nitrogen inputs by 44 pounds an acre, without decreasing yield. The model has been successfully tested throughout the Northeast United States and is now being evaluated in the Midwest.

10.10. Publications

The Kellogg Soil Survey Laboratory Research scientists published 11 articles in refereed journals and delivered more than 20 presentations at scientific meetings.

11.0. Rural Development (RD)

<http://www.rd.usda.gov/>

11.1. Mission Statement

USDA Rural Development (RD) is committed to helping improve the economy and quality of life in rural America. RD provides loan and grant financing as well as technical assistance to develop housing, community facilities, businesses, infrastructure, and renewable energy ventures in rural areas. In addition to providing direct loan and grant assistance, USDA Rural Development also partners with private sector lenders and development organizations to carry out local community development projects. Rural Development's more than 40 financial assistance programs, in addition to its ability to leverage private sector resources, give USDA the flexibility to invest in a wide range of projects that are reinvigorating rural towns and bringing new job opportunities for local residents.

With a total portfolio of more than \$210 billion and investments upwards of \$38 billion in 2015 alone, Rural Development is making lasting investments in rural communities. The mission area has a tremendous set of business, utilities, housing and community development programs designed to ensure that rural Americans have access to safe, affordable homes and community facilities, jobs and business capital, and the benefits of drinking water, broadband, electricity and other essential services.

11.2. Nature and Structure of Program

RD is a program-oriented organization that provides a vast array of grant, loan, loan guarantee and technical assistance programs to rural Americans. RD financial programs support such essential public facilities and services as water and sewer systems, housing, health clinics, emergency service facilities and electric and telephone service. We promote economic development by supporting loans to businesses through banks and community-managed lending pools. We offer technical assistance and information to help agricultural and other cooperatives get started and improve the effectiveness of their member services. And we provide technical assistance to help communities undertake community empowerment programs.

Rural Development achieves its mission by helping rural individuals, communities and businesses obtain the financial and technical assistance needed to address their diverse and unique needs. Rural Development works to make sure that rural citizens can participate fully in the global economy and plays a lead role in improving the economic climate of rural areas through creating and preserving business opportunities and jobs. Through our partnerships with other public and private sector businesses, our programs help close the opportunity gaps between under-served rural and productive metropolitan areas.

Although RD does not have a formal technology transfer program in place, the agency does oversee the Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program (Section 9003), which assists in the development, construction, and retrofitting of new and emerging technologies for the development of advanced biofuels, renewable chemicals, and biobased product manufacturing by providing loan guarantees for up to \$250 million.

The purpose of the program is to assist in the development of new and emerging technologies for the development of advanced biofuels, renewable chemicals, and biobased product manufacturing. This is achieved through guarantees for loans made to fund the development, construction, and retrofitting of commercial scale biorefineries using eligible technology and of biobased product manufacturing facilities that use technologically new commercial scale processing and manufacturing equipment and required facilities to convert renewable chemicals and other biobased outputs of biorefineries into end-user products on a commercial scale. RD's Rural Business-Cooperative Service has the responsibility for administering the program.

RD's renewable energy programs help increase American energy independence by increasing the private sector supply of renewable energy and decreasing the demand for energy through energy efficiency improvements. Over time, these investments can also help lower the cost of energy costs for small businesses and agricultural producers.

RD also oversees the Alternative Technology Transfer for Rural Areas (ATTRA) project carried out by the National Center for Appropriate Technology (NCAT). The ATTRA project works to provide information to farmers and other rural users on a variety of sustainable agricultural practices that include both cropping and livestock operations. Additionally, ATTRA encourages agricultural producers to adopt sustainable agricultural practices which allow them to maintain or improve profits, produce high quality food and reduce adverse impacts to the environment.

Work for the ATTRA project takes place at all seven NCAT office locations. The ATTRA project is staffed by more than 20 NCAT agricultural specialists with diverse backgrounds in livestock, horticulture, soils, organic farming, integrated pest management, and other sustainable agriculture specialties. The ATTRA project supports a nationally recognized, virtual resource center (www.attra.org) that is accessible by farmers, ranchers, market gardeners, Extension agents, researchers, educators, farm organizations, and others involved in agriculture, especially those who are economically disadvantaged or belong to traditionally underserved communities. ATTRA provides technical assistance through publications and/or customized resource packets.

ATTRA receives funding through the annual appropriations bill which directs Rural Development to administer the funding through a cooperative agreement. The annual funding for ATTRA is administered by Rural Business-Cooperative Service.

11.3. Current Technology Transfer Goals, Objectives, and Measures of Success (Metrics)

While RD did not have any specific goals related to technology transfer, RD programs support entrepreneurs and rural businesses implement technology through an array of loan, loan guarantee, grant and technical assistance programs. RD works to support technology transfer by creating linkages and supporting partnerships and collaborations with other Federal agencies, universities, and other organizations that can improve access and deployment of proven technology in rural areas. For example, through various programs, RD investments are supporting advanced manufacturing, business incubators, renewable energy systems and energy efficiency improvements. Examples of how producers and small businesses are using RD programs to implement technology advances include: lighting, refrigeration, high efficiency heating, ventilation and air conditioning systems, cooling or refrigeration units, electric, solar or gravity pumps for sprinkler pivots, and replacement of energy-inefficient equipment. Additionally, RD funds are being used to support new technology in the processing and marketing of value added food products that are contributing to the development of a more robust local and regional food system.

11.4. Strengthening Current Activities

Through a diverse portfolio of programs and network of State offices, RD achieves its mission by helping rural individuals, communities and businesses obtain the financial and technical assistance needed to address their diverse and unique needs. Rural Development works to make sure that rural citizens can participate fully in the global economy and plays a lead role in improving the economic climate of rural areas through creating and preserving business opportunities and jobs. Through our partnerships with other public and private sector businesses, our programs help close the opportunity gaps between under-served rural and productive metropolitan areas.

RD continues to enhance its Web presence to make information and programs more accessible to the public as well as concentrate outreach efforts to ensure that businesses and communities in greatest need have access to the necessary resources to be competitive.