**National Program 216- Agricultural System Competitiveness and Sustainability**
**National Program Annual Report for FY2015**

***Vision**: Integrated solutions solving problems of productivity, profitability, efficiency, and natural resource stewardship.*

***Mission***

This interdisciplinary research program integrates information and technology to develop new practices and dynamic systems that optimally enhance productivity, profitability, energy efficiency, and natural resource stewardship for different kinds and sizes of American farms. New configurations of practices are identified that utilize on-farm resources and natural ecosystem processes to reduce the need for purchased inputs and reduce production costs and risks. Precision management, automation, and decision support technologies are used to increase production efficiencies and enhance environmental benefits. Strategies are developed for sustainable production of bio-based energy products from farms. Production systems incorporate consumer preference and supply chain economic information to expand market opportunities for agricultural and other value-added bio-based products. Diverse improved agricultural systems will support the long-term financial viability, competitiveness, and sustainability of farms and rural communities, and increase food and fiber security for the U.S. and the world.

***Introduction***

Fiscal year 2015 research supported the 2013-2017 Action Plan for National Program (NP) 216. The Action Plan and the projects were developed from comprehensive stakeholder input gleaned from the national stakeholder workshops. These efforts are documented online at: http://www.ars.usda.gov/research/programs/programs.htm?NP_CODE=216 and include workshop documents, strategic vision, the action plan, and accomplishment and external assessment reports.

The goal of NP216 is to conduct research that addresses the challenges described above, and specifically to provide farmers with management practices, decision aids, and information needed to move farming systems toward greater sustainability. The program has four components:

1. *Food, feed, fiber, and feedstock production systems.*
   - Research addresses systems producing food (e.g. wheat, rice, peanut, vegetables, fruit), feed (e.g. soybean, corn, alfalfa), fiber (e.g. cotton), and feedstock (e.g. crop residue, oilseed, perennial biofuel crops), and is designed to understand the underlying agroecological principles for developing technologies and production strategies for generating food, feed, fiber, and feedstock.
2. *Production system economics*
   - Research addresses the profitability of agricultural production systems, and is designed to understand the economic factors affecting production system profitability and to develop strategies for profitable food, feed, fiber, and feedstock production.
3. *Production system effects on natural resource*

- Research addresses soil, water, and air resources associated with production systems, and is designed to understand the physical, chemical, and biological processes in production systems and develop strategies for meeting air, water, and soil quality expectations of society.

4. *Integration of sustainability goals*
   - Research addresses problems related to synthesizing data needed to assess sustainability at the farm/regional/or larger scales. This synthesis is necessary to insure that progress is being made in all sustainability goals. Research is designed to develop and use databases, analytical tools for processing datasets, statistical methods, assessment tools, and models to synthesize results and compare systems at various scales.

Specific research topics include production systems for commodity and specialty crops; integrated crop – livestock systems; organic production systems; micro- and macroeconomic implications for these systems; and production *system* effects on air, water, and soil quality.

## *News for NP216 During 2015*

Many of the NP216 projects include significant domestic and international collaborations including government, industry and academia. These collaborations provide opportunities to leverage funding and scientific expertise for USDA-ARS research and accelerates dissemination of ARS research results, thus enhancing the impact of ARS research programs. During 2015, NP216 scientists participated in research collaborations with scientists from Australia, Brazil, Canada, China, France, Germany, Nigeria, Portugal, and South Korea.

During FY215, 55 full-time scientists working at 17 research units across the U.S. actively engaged in 18 ARS-led and 56 collaborative research projects. The gross fiscal year 2015 appropriated funding for NP216 was $22 million.

## Personnel News for NP216

New additions to the NP216 team during 2015 included:

- **Dr. Charles Walthall** became the National Program Leader (NPL) for NP216 at the start of FY2015. Dr. Walthall was previously the NPL for NP212 Climate Change, Soils and Emissions.
- **Dr. John Henning** of the Forage Seed and Cereal Research Lab in Corvallis, Oregon was added part time to the NP216 project "Improvement of Biotic and Abiotic Stress Tolerance in Cool Season Grasses." His area of research and expertise is in quantitative genetics, genetic marker development, and bioinformatics. Dr. Henning is providing bioinformatics support to the project team.
- **Dr. Qiuxiang Tang** is a visiting scientist from China working in the Genetics and Sustainable Agriculture Research Lab, Mississippi State, Mississippi for one year.
- The Crop Systems and Global Change Laboratory in Beltsville Maryland had two visiting scientists in 2015: **Dr. Bruno Condori** of the International Potato Center, Bolivia, is working on potato model development, and **Dr. Marite Navarro**, from SENAMHI (National

Meteorological and Hydrological Department), Peru, is working on the development of a maize model.

- **Dr. Jose Franco** joined the Northern Great Plains Research Laboratory at Mandan, North Dakota as a post-doc. Dr. Franco received his Ph.D. from Texas A&M University and is working on exploiting diversity in cover crop systems for multiple ecosystem services.
- **Dr. Victoria Ackroyd** has joined the Sustainable Agricultural Systems Lab, Beltsville, Maryland as a post-doc with a Ph.D. from Michigan State. Dr. Ackroyd is working on nitrogen use efficiency in corn production systems, as well as organizing the establishment of the Northeast Cover Crop Council.
- **Dr. Claire Phillips** is a post-doc working in the Forage Seed and Cereal Research Lab, Corvallis, Oregon on multiple aspects of soil chemistry, nutrient analyses, and biochar. Dr. Phillips was formerly with Oregon State University.
- **Dr. Rachel Okrent** is a post-doc working in the Forage Seed and Cereal Research Lab, Corvallis, Oregon. Dr. Okrent is working to characterize the genetic underpinnings of formylamiono xyvinylglycine (FVG) production.
- **Dr. Christian Dold**, University of Bonn, has joined the of the National Laboratory for Agriculture and the Environment, Ames Iowa, as an Oak Ridge Institute for Science and Education (ORISE) postdoctoral research associate. Dr. Dold's field of expertise is plant physiology, and he has been working on corn-soybean response to weather variation.
- **Dr. Lina Sarunaite** worked with the Soil Dynamics Research Lab, Auburn, Alabama as a visiting scholar to foster the exchange of ideas between the Baltic States and the U.S. and to stimulate international collaboration and research efforts. The research focused on crop growth and weed management systems.
- **Dr. Dara Boardman** also worked as a post-doc with the Soil Dynamics Research Lab, Auburn, Alabama during 2015 on cover crop management**.** .

The following scientists contributing to NP216 retired from ARS during FY15:

- **Dr. Steve Griffith** retired from the Forage Seed and Cereal Research Unit in Corvallis, Oregon in January 2015.
- The Agricultural Systems Research Unit in Sidney Montana had three retirements during 2015: **Drs. Ashok Alva, Thecan Caesar, and Robert Lartey**.

The distinguished record of service of these scientists is recognized world-wide and they will be missed by NP216, ARS and the scientific community. Our best wishes go out to them.

**The following scientists in NP216 received prominent awards during FY215:**

- **Dr. Steven Mirsky**, of the Beltsville, Maryland Sustainable Agricultural Systems Laboratory received Outstanding Researcher Award from the Northeast Weed Science Society.
- **Brian David,** a Ph.D. student at the University of Maryland working with **Dr. Steven Mirsky** of the Beltsville, Maryland Sustainable Agricultural Systems Lab received 1st place for an oral presentation in soil fertility at the 2015 The American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America (Tri-Society) meeting.

- **Dr. Jeffrey W. White** of the U.S. Arid-Land Agricultural Research Center, Maricopa, Arizona received the L.R. Ahuja Ag Systems Modeling Award of the Soil Science Society of America at the 2015 Tri-Society Meeting.
- **Dr. Jerry Hatfield** of the National Laboratory for Agriculture and the Environment, Ames Iowa, received the ASA President's Award for outstanding influence on agronomy and the impact of future science.

Our congratulations and thanks go to these scientists for their outstanding work.

**Additional Personnel News of Note:**

- **Dr. Bruce A. Kimball**, a distinguished ARS retired collaborator, continues working on infrared heating to simulate global warming and on plant growth modeling at the US Arid-Land Agricultural Research Center, Maricopa, AZ.

The quality and impact of NP216 research was evidenced during FY215 by the following:

- Over 84 refereed journal articles published;
- A new invention disclosure filed;
- One current cooperative research and development agreement with stakeholders, and one new material transfer agreement;
- Administration or development of four web sites for academia or stakeholders.

## Selected Research Results for FY215

This section presents significant and high impact research results that address specific components of the FY2013 – 2017 action plan for NP216.

### Action Plan Component 1. Enhancing the Yield of Food, Feed, Fiber, and Feedstock Production Systems

**Yield consequences and nitrogen (N) requirements for wheat across tillage systems in Alabama.** Alabama wheat farmers are changing to no-tillage (NT) and non-inversion tillage (where the plough does not completely invert the soil) conservation systems, and are increasing N fertilizer rates to ensure maximal yields. However, ARS scientists in Auburn, along with Auburn University collaborators, questioned the yield consequences of these conservation practices and the need for additional nitrogen with these tillage systems for all regions of Alabama, and have conducted experiments to test these practices. The results showed that non-inversion tillage on the sandy loam soils of central and southern Alabama produced greater (~+13%) yields, while NT on the silt loam soils in northern Alabama produced equivalent yields to conventional tillage operations requiring multiple passes. Fall N application was imperative for successful wheat production on central and southern Alabama soils, while northern Alabama soils were less responsive to applied N. These results, which were used to construct a self-study exam sent to 14,000 certified crop advisors (CCA), indicate that conservation tillage techniques can exceed or meet conventional tillage yields depending on location; can save time, fuel, and labor while promoting soil health; and can be used successfully without increases to current N recommendations for wheat across Alabama.

### Action Plan Component 2. Enhancing Production System Economics Viability

**Canola yield estimates using remote sensing.** Above-ground biomass is an important parameter used to estimate crop yield from remote sensing data. However, the reflectance from bright yellow canola flowers creates errors when estimating canola biomass. ARS scientists in Pendleton, Oregon, have developed a novel spectral index that is strongly related to canola flower density. Using the new index to correct for the effects of yellow flower reflectance, reliable estimates of canola plant biomass and yield were achieved. The new spectral index also performed well as an estimator of oilseed yield based on the premise that yield is directly proportional to flower and seed pod numbers. The index makes reliable estimates of canola yield possible using remote sensing and thus provides a means for private firms and government agencies to monitor crop conditions and estimate crop yields at county and state levels. Crushing plants could also use the method to more efficiently find and procure oilseed, minimizing storage and transportation costs.

### Action Plan Component 3. Production System Effects On Natural Resources

**Runoff curve numbers for no-till cropping systems are smaller than curve numbers for tillage cropping systems.** The runoff curve number (CN) is a widely used, efficient method for estimating the amount of runoff for water quantity and quality model projections. The CN method was empirically developed using runoff data collected from small catchments and

hillslope plots prior to the advent and widespread adoption of NT systems. Unfortunately, little work has gone into validating CNs for NT cropping. Using 1972 to 2010 rainfall-runoff data from a watershed near Athens, Georgia, ARS scientists derived CNs when conventional tillage (CT) and NT management were used. Results showed that CNs for NT cropping systems are smaller than CNs currently used for comparable tilled watersheds in the southeastern U.S. The NT CNs provide more realistic representation of landscape characteristics for hydrologic modeling of water quantity and quality, where the use of the CN method is widespread. Users of CNs such as NRCS, EPA, and state and local agencies are now able to more accurately evaluate water quantity and quality consequences of land management when seeking to foster the implementation, and assessment of practices that reduce the effects of agriculture on the environment.

## Action Plan Component 4. Integration of Sustainability Goals

**An improved cover crop selection tool.** Producers grow cover crops for benefits such as improved soil health, nutrient management and erosion control. However, selecting a cover crop to meet specific producer needs has been challenging because of the many options available. ARS researchers in Mandan, North Dakota developed an updated Cover Crop Chart (CCC) to help producers select cover crops that will meet specific production and natural resource goals. The chart categorizes 57 cover crops based on the plant type and general growth characteristics, and provides basic descriptive information. The CCC is available online and is being used by producers and conservation agencies to help assess and select cover crops that will meet producer needs. Cover crop use is expected to increase and to be more effective at meeting producer goals because of the greater ease of decision-making with the CCC.

### *Plans for FY2016*

During FY2016, scientists in NP216 will further advance research on the NP216 Action Plan components, the Agricultural Modeling Intercomparison and Improvement Project (AgMIP), the ARS Big Data initiative, the ARS Long Term Agroecosystem Research network (LTAR) and the USDA Climate Hubs. New projects will be added to NP216 from other ARS national programs due to their systems nature. A fifth research component for the action plan has been added and accomplishments will be added during 2016. The new component addresses a research approach focusing on the interaction of Genetics with Environment and Management (GxExM).