National Program 216- Agricultural System Competitiveness and Sustainability
National Program Annual Report: FY2014

Introduction

FY2014 was a year of start-up activities for five-year research projects supporting the new 2013 Action Plan for 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.

Background

Increasing demands are being placed on agriculture. The public demands a safe, affordable supply of high quality, nutritious food, a healthy environment, a growing economy that provides a comfortable standard of living for its citizens, and increased use of renewable sources of energy. Agriculture must meet these demands using an area of land that has not changed appreciably over the last 100 years and a workforce that has decreased from nearly 50% to less than 4% of the population over that same period.

Agricultural production over the past decades has become much more productive and efficient. These improvements have been accomplished through:

- increased use of conservation tillage practices
- expanded use of irrigation
- increased use of fertilizer and improvements in nutrient management
- development and deployment of pesticides to reduce losses associated with weeds, insects, disease, and other pests
- genetic improvements (including genetically modified organisms, GMO’s) for crop management, improved traits, and increased yields
- improvements in equipment
- advances in crop processing and storage
- an infrastructure that facilitates timely distribution and export of agricultural products.

Similar advances will be needed in the future to meet societal demands, and modern agriculture must confront a number of major challenges. The U.S. and global populations are growing rapidly, and agricultural productivity must increase to meet their food and fiber needs. The portion of populations involved in agricultural production is small and declining, as a majority of people live in urban areas. Large segments of the population are thus unfamiliar with what agriculture provides and how it is provided. Housing and infrastructure needed to support a growing population and migration of people from rural to urban areas has resulted in urban encroachment into productive agricultural areas and increased conflict between urban and rural life styles (e.g. odor and dust issues, increased traffic, and land use changes). There is increasing competition for other resources essential to agriculture. In many U.S. regions, water supplies will likely not meet future demand for human consumption, agriculture, and environmental stewardship. Agriculture is a major energy consumer, and there are calls to increase use of agricultural land to produce feedstocks or biofuels that reduce dependence on foreign energy.

Finally, agriculture will be required to reduce greenhouse gas emissions and sequester carbon to help mitigate climate change, and develop or shift practices to adapt to climate change.

The goal of the NP216 National Program is to conduct research that addresses the challenges described above, and specifically to provide farmers with management practices, decision aides, and information needed to move farming systems along a trajectory toward greater sustainability. The program has four problem areas:

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.

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Personnel news in NP216

The following scientists retired from the ranks of NP216 in FY 2014:

- John Halloran, of the New England Plant, Soil, and Water Laboratory, Orono, ME.

- **Robert Lartey** of the Northern Plains Agricultural Research Laboratory, Sidney, MT.

The distinguished record of service of these scientists is recognized world-wide, and they will be missed in NP216.

The following scientists in NP 216 received prominent awards in FY 2014:

- **Sharon Papiernik** of the North Central Agricultural Research Laboratory, Brookings, SD**,** and **Scott Yates** of the Contaminant Fate and Transport Research Unit, Riverside, CA and, were recipients of an Outstanding Partnership Award for the ASTM Film Permeability Inter-laboratory Study (Round Robin) from the Federal Laboratory Consortium for Technology Transfer.
- **Upendra Sainju** of the Northern Plains Agricultural Research Laboratory, Sidney, MT, was named as a Fellow of the Soil Science Society of America

The quality and impact of NP 216 research was further evidenced in FY 2014 by the following:

- Over 60 refereed journal articles published
- One current cooperative research and development agreements with stakeholders, and three new material transfer agreements
- 32 new technologies developed, and one new invention disclosure filed
- Administration or development of seven web sites for academia or stakeholders.

In 2014 NP 216 scientists participated in research collaborations with scientists in: Australia, Brazil, Canada, China, France, Germany, Nigeria, Portugal, and South Korea.

Selected Accomplishments for FY 2014

This section summarizes significant and high impact research results that address specific components of the FY2013 – 2017 action plan for NP216. Many of the programs summarized for FY 2014 include significant domestic and international collaborations with both industry and academia. These collaborations provide extraordinary opportunities to leverage funding and scientific expertise for USDA-ARS research by rapidly disseminating technology, which enhances the impact of ARS research programs.

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

Increasing rotational diversity can benefit sugarbeet. Sugarbeet is susceptible to numerous diseases, insects and weed infestations. ARS scientists in Sidney, MT, in conjunction with 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, if an annual legume is included as a rotational crop, it can also add additional organically fixed nitrogen to the soil, reducing fertilizer application costs. This practice can lead to reduced pest pressures and greater economic return for sugarbeet growers in Montana.

Bacteria may help prevent sugarbeet disease. Leaf spot disease is a fungus that affects sugarbeet production in Montana. ARS researchers in Sidney, MT 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, addition of this bacterium to sugarbeet infected with leaf spot fungal spores reduced the incidence of leaf spot disease. This bacterium could be useful as an ecological replacement to fungicides typically used to fight this disease.

Management practices to improve sustainable production of dryland malt barley. Conventional tillage with malt-barley-fallow rotation has reduced soil quality and annual grain yield by enhancing the loss of soil organic matter. ARS scientists in Sidney, MT 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%, and can reduce nitrogen losses through leaching, volatilization and denitrification by 125%. At the same time, this practice was found to increase soil carbon storage by 11% and enhance malt barley yield and quality from 24% to 44% over that of traditional tillage practices. Implementation of this practice by producers offers a notable step towards sustainability via reduced chemical input and energy needs, enhance soil quality, and sustain dryland malt barley yield and quality.

Component 2. Enhancing Production System Economics Viability

New farm-scale gasifier unit can increase sustainability by creating value-added products. Finding new uses for farm by-products can help increase economic resilience of farms. ARS scientists at Corvallis OR, working with a private non-profit group, developed and tested 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 farm biomass (at over 400 pounds of feedstock per hour) to produce syngas and organic carbon-rich biochar that could be useful as a soil amendment to 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.

Assessing environmental stress in wheat to improve precision agriculture. Managing within-field variability of yield quantity and quality is a goal of precision agriculture. Mapping variability of yield quantity has been possible for years, however tools to map spatial yield quality are still needed. Researchers at ARS in Pendleton, OR have developed an on-combine, multi-sensor system that can measure yield quality expressed as grain protein levels, in the field in real time. As such this system can be immediately utilized by producers to effectively identify specific regions within fields where grain yield quality is being impacted by environmental stress. Such information will enable farmers and land owners to determine how to better increase yield quantity and quality production efficiency with precision agricultural methods.

Increasing the efficiency of nitrogen applications in deficit irrigation. If water is limiting, nitrogen requirements to maximize crop production will change. It is thus economically important to apply the appropriate amount of nitrogen (N) under conditions of limited water. ARS researchers at Ft. Collins, CO updated the Root Zone Water Quality Model 2 (RZWQM2) to determine the optimal amounts of N to be applied to each of seven different levels of available soil moisture. Validation of the results with field data indicated that use of decision support systems such as RZWQM2 can be used to reduce nitrogen application based on soil moisture, and still maintain yield goals of corn producers in Colorado.

Component 3. Production System Effects On Natural Resources

Linking land-use practices to 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 to quantify how land use alters stream and river water quality over long time periods. ARS scientists at Corvallis, OR collected data over an 8-year period to define 56 land-use patterns of crops, forests and urban development that represented 99% of the area in the Willamette River Basin of western Oregon. These data were used to estimate land use impacts on water quality using the Soil and Water Assessment Tool (SWAT). Analysis of the SWAT results over the 8-year period revealed that the model was able to predict how land management altered nutrient and sediment load of streams and rivers. When used with SWAT, data of different land-use patterns can now be used to project the potential environmental consequences of land use patterns changing in response to market forces, policies and climate.

Conservation tillage can increase soil carbon sequestration of the Southeastern U.S. The ability of soil to sequester carbon (C) can improve long-term soil health while mitigating greenhouse gas emissions. Conservation systems that utilize minimal soil disturbance combined with high-residue cover crops enhance C sequestration, but tools are lacking to determine C sequestration amounts across conservation systems of southeastern US cropping systems. ARS scientists in Auburn, AL 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 kg C per hectare while corn residue only added 1,340 kg C per hectare to the soil each year. They also concluded that a number of winter cover crops have significant potential to sequester additional C. Thus, the use of conservation systems that include cover crops offer an option to improve both soil health, and potentially offset CO_2 emissions across degraded coast plain soils for the southeastern U.S.

Component 4. Integration of Sustainability Goals

Recycling nutrients from dairy storage lagoons may provide new source of supplemental fertilizers. Storage lagoons in dairy production can be a significant source of nutrient contamination of surrounding soils. Removal and processing of excess nutrients could be a means to supply additional nutrients to other crops. ARS scientists in Prosser, WA, conducted laboratory, greenhouse and field studies and determined that nutrients could be recovered from anaerobic digestion (AD) systems of animal manure to supply additional nitrogen, phosphorus and potassium for potato, sweet corn, wheat and bean production. The use of recovered nutrients from manure through AD would provide another source of fertilizer and offset fertilizer costs in specialty crop production.

Future Activities for NP216

An additional research component is being added to NP216 during 2015 for the addition of selected projects previously conducted under the Climate Change, Soils and Air Emissions Program (NP212).