2009 ANNUAL REPORT
NATIONAL PROGRAM - 216
AGRICULTURAL SYSTEM COMPETITIVENESS AND SUSTAINABILITY

As the world's population continues to grow, water resources become scarce, and energy use climbs, even greater demands will be placed on agricultural producers to provide dependable supplies of products for consumers from a shrinking earth resource base. American farms generate more than $200 billion in goods and services on 442 million acres. Profitable farms are the basis of vibrant rural economies. Consumers benefit from agricultural production that provides an abundant choice of safe products at relatively low costs. However, many farms have suffered from commodity prices that have, until recently, remained relatively unchanged for decades, while the costs of fuel and other purchased inputs continue to rise. In addition, much of agricultural production happens in a global market, so there is increasing competition from overseas where production costs are comparatively low. Also, continued advancement of conservation goals is needed to enhance the natural resource base upon which the nation not only depends for food, feed, fiber, and renewable energy, but also for abundant and high quality supplies of fresh water, clean air, and healthy ecosystems. The challenges producers face regarding productivity, profitability, and natural resource stewardship across the country are complex, so solutions to these challenges are equally complex.

The USDA-ARS projects contributing to the Agricultural System Competitiveness and Sustainability National Program (NP 216) use an interdisciplinary systems research approach to bring together the diverse expertise needed to understand how different kinds and sizes of farms function, and how changing or introducing new technology will affect their economic and environmental sustainability. Whether the ARS scientist teams and their university and industry cooperators are in the Pacific Northwest, Southwest, Great Plains, Midwest, Southeast, or New England, they use their collective talents to find the best place-specific combinations of practices to help producers achieve their production goals.

The Agricultural System Competitiveness and Sustainability National Program contributes to USDA-ARS Strategic Plan Goal 2: Enhance the Competitiveness and Sustainability of Rural and Farm Economies, Objective 2.1: Expand domestic market opportunities, and Objective 2.2: Increase the efficiency of domestic agricultural production and marketing systems; and Strategic Plan Goal 6: Protect and Enhance the Nation's Natural Resource Base and Environment.

Agronomic Crop Production Systems

The Agronomic Crop Production Systems component addresses challenges in agricultural systems dominated by the commodities including corn, soybean, cotton, peanut, cereal grains, and turf and herbage seed crops. The value of U.S. crop output in 2002 was 2.6 times higher than in 1948, while the inputs required to achieve this output have declined. However, the profitability of many farms producing major commodity crops is declining because of escalating costs of energy, fertilizers, and other purchased inputs. Loss of crop rotation diversity in production systems has also resulted in emerging problems with herbicide resistant weeds, particularly in the southeastern region. Research is needed to develop production strategies and technologies that increase productivity and reduce production costs and the risk of economic loss, all while maintaining or even enhancing natural resource quality.

In addition, the United States has embarked on an ambitious program to replace a significant portion of petroleum-based transportation fuels with bio-based fuels from agricultural sources. Producers, government agencies, energy companies, and policy makers need to know how best to produce biomass and dedicated energy crops in different agricultural regions of the country, and what the likely impacts would be of an expanding bio-economy on whole-farm economic return and natural resource quality. A new generation of production systems and technologies is needed to sustainably produce feedstocks to support emerging bioeconomies in ways that do not disrupt the integrity of existing farms and markets or degrade the quality of natural resources.

Selected Accomplishments

Conservation tillage in peanut and cotton systems and optimal peanut varieties for biodiesel production. ARS scientists showed that the use of conservation tillage in peanut/cotton rotation systems, while having no adverse impacts on crop yield or quality, resulted in lower production costs, lower emissions, and water savings of 20% versus conventional tillage. Peanut oil could be an excellent feedstock for biodiesel production, but no data currently exist about which cultivars might be best suited for this market. ARS scientists evaluated the economic and agronomic performance (under both low and high input management strategies) and biodiesel engine performance of over 40 different cultivars. Five peanut cultivars exhibited both superior production performance and oil characteristics, and would help to enable on-farm biodiesel production. (216-1A and 1B & 307-2B; PM 2.2.1 & 2.1.1)

Benefits of conservation practices for producers in the Upper Midwest. ARS scientists showed that the use of conservation practices such as multi-crop rotations (four year corn-soybean-wheat/alfalfa-alfalfa), reduced tillage, and reduced inputs (no pesticides in organic systems) in the upper Midwest improved soil fertility (including nitrogen availability and carbon content), corn mineral nutrient composition, and in many cases overall yields. This research should enable greater use of conservation practices by upper Midwest farmers. Doing so would increase the economic sustainability of their farming systems and result in significant environmental benefits. (216-4A and 4D; PM 2.2.1)

Increasing productivity of potato systems. Potato yield in the Northeast has remained stagnant for over 50 years, despite increased inputs of pesticides, nutrients, and water. Additionally, numerous soil-borne diseases are a persistent problem in potato production. ARS research showed that when soil quality was improved by increasing organic matter, potato plants developed more leaf area with greater and longer lasting photosynthetic potential, thereby increasing yield by as much as 50%. Several rotation crops with the potential to reduce soil-borne diseases when managed as full season, green manure, or fall cover crops were evaluated. Canola and rapeseed rotations reduced certain soil-borne diseases by 30-80% through a combination of effects, to include decreased disease incidence and severity of symptoms. This provides growers with new technology and specific rotation guidance that makes them more competitive in the global economy. (216- 2A/ 216- 1B/ 216-2B/ 216- 4A; PM 2.2.1)

Specialty Crop and Organic Production Systems

The Specialty Crop and Organic Production Systems component is focused on solving problems related to the production of high-value specialty crop and value-added organic agricultural products. The value of U.S. specialty crops is greater than the combined value of corn, soybean, wheat, cotton, and rice crops. At the same time, organic production now captures more than 3% of the U.S. food market, and is growing at a rate of 10% annually. The production of high-value specialty and organic crops often requires cost-intensive practices to achieve profitable production levels for products that must be of sufficient quality to meet high market and consumer preference standards. Producers wishing to produce high-value specialty and organic crops may face significant barriers to the development and marketing of new products grown in their region. Alternative management strategies are needed that utilize an understanding of the agro-ecological and biophysical processes innate to plants, soils, invertebrates, and microbes that naturally regulate pest problems and soil fertility, to reduce or replace reliance on the use of synthetic pesticide and fertilizer production inputs. Also, an understanding of marketing supply chains from field-to-table must be considered and integrated with production, handling, and processing information to increase the portion of product value received by producers.

Selected Accomplishments

Organic cropping systems mitigate global climate change. Agriculture can contribute to or mitigate global climate change. Researchers at ARS in Beltsville, Maryland estimated the global warming potential of no-till, chisel till and organic cropping systems at the long-term Beltsville Farming Systems Project. Organic cropping systems resulted in greater increases in soil carbon and lower energy use compared to conventional no-tillage and chisel-tillage crop management systems. Despite relatively low crop yields in organic systems, the ratio of global warming potential per unit of crop yield was also significantly higher in conventional no-tillage and chisel-tillage than in organic systems. Practices common in organic systems, including incorporating legume cover crops and animal manures into soil, can help reduce global climate change compared to conventional systems, primarily by increasing the amount of carbon in the soil. These results will benefit policy makers, farmers, and others interested in reducing the impact of agriculture on global climate change. (216-4D; PM 2.2.1)

Novel cover crop mixtures of legumes and cereals enhance sustainability. Cover crop mixtures of legumes and cereals combine the nutrient scavenging abilities of cereals with the nitrogen fixing ability of the legumes. Such mixes can reduce losses of nitrogen to ground and surface water, and reduce the need for expensive supplemental nitrogen fertilizers. Novel mixtures of legumes and cereal were evaluated by ARS scientists for biomass production, nitrogen content and weed suppression in on-farm trials in Salinas and Hollister, California over several years. Mixtures of 90 percent legumes (faba beans or peas) and 10 percent cereals (rye or oats) were evaluated. This research provides farmers with critical information that will help them choose more cost effective cover crop mixtures, and improve weed and soil fertility management in vegetable rotations. (202 -1A/ 202-1B; PM 6.1.2)

White mustard seed meal suppresses weeds in organic onions. Weeds are the primary limitation and expense ($800-$6,000/acre) to organic onion production. ARS scientists at

Prosser, WA found that mustard (*Sinapis alba*) seed meal, applied at 1 to 2 tons/acre after the 2 leaf stage of onion growth, controlled annual weeds without significant injury to onions. Mustard seed containing high levels of sinalbin suppressed weeds much better than seed meal derived from seed lines bred for low glucosinolate levels. Mustard seed meal may be useful to producers of organic crops for weed suppression, while helping to reduce the excessive costs of hand weeding, which can range from $800 to $6,000 per acre. (304-2B; PM 2.2.3)

Blueberry production improved with effective irrigation management. Blueberry is sensitive to drought so supplemental irrigation is essential and can improve yields by 25 to 40 percent. Although blueberry is the most widely distributed crop in the U.S., over 40% of lowbush blueberries produced in North America are grown in Maine, an area in which water resources are critical to salmon. In order to determine the proper amount of irrigation needed to boost yield and yet conserve water resources, ARS scientists combined meteorological data with several years of field measurements to calculate crop coefficients for irrigated blueberry. Crop coefficients allow water use of blueberries to be compared to other reference crops. These data allow growers to specifically determine crop water use for blueberries from readily available weather data, and substantially increase their ability to improve water use efficiency for irrigated blueberry production. 216 2 A 2008/ 216 2 B 2008/ 216 4 A 2008

Integrated Whole Farm Production Systems

The Action Plan component Integrated Whole Farm Production Systems addresses problems associated with the integration of specialized crop and livestock enterprises, as well as diversified agroforestry systems. Agricultural producers face increasing pressures to become more efficient because of increasing energy and nutrient input costs. Increased profitability has been achieved by some producers through specialized production and acreage consolidation into large farm units. Integrating crop and livestock production elements is an alternative strategy that reduces risks of economic loss, diversifies income, and enhances environmental benefits.

Selected Accomplishments

Incorporating perennials in corn-soybean cropping systems. Combining annual and perennial crop species in rotational cropping systems – termed “living mulch” cropping systems – could enable the production of both food and bioenergy on the same land and thereby minimize the displacement of food crops by cellulosic energy crop production. Concurrent management of food/feed crops such as corn or soybeans with perennial crops (forages) requires that forages be suppressed during row-crop production. ARS scientists investigated combinations of reed canarygrass or orchardgrass with leguminous forages such as alfalfa, kura clover, and birdsfoot trefoil, in a corn-soybean-forage rotation. The cover crops were managed by harvesting four times during the forage year and by suppressing with a 10 inch glyphosate band over the row during the corn and soybean years. They found that a combination of alfalfa, kura clover, and reed canarygrass resulted in the highest forage yields and lowest weed densities. They also found that seeding an unadapted alfalfa in the spring of the forage year supplemented yield and suppressed weeds in the former crop row. As a result, producers can produce both food and bioenergy crops on the same land, diversify their cropping systems, obtain high yields of forages for livestock or bioenergy, eliminate the lower yields usually encountered in the first (establishment) year for perennials, and improve ecosystem function of corn production systems. (216-1A & 307- 2B; PM 2.2.1 & 2.1.1)

Integrated dryland production systems enhance long-term production. Diversified, intensified cropping systems are replacing wheat-summer fallow systems in the Northern Great Plains. The inclusion of annual cool-season forages in diversified cropping systems decreases pesticide use and increases the productivity of pea and spring wheat. Spring wheat grown every third or fourth year in diversified cropping systems has been shown to have higher yields and quality, and fewer weeds and weed seed production compared to spring wheat grown continuously or planted every other year. Field pea grown every third or fourth year in diversified systems has higher yields and fewer weeds compared to pea grown every other year. Field pea produced in alternate year rotations has improved yield compared to field pea following broadleaf crops in stacked rotations. This research provides options for producers to more intensively manage their production systems with less dependence on pesticides and greater yield and economical productivity. (216 -1A; PM 2.2.1)

Water-stressed sugarcane promotes Mexican rice borer reproduction. The Mexican rice borer has been spreading northward from Mexico and Texas, and invasion of Louisiana sugarcane and rice has begun. ARS researchers at Weslaco TX have shown that the rice borer prefers laying eggs on drought-stressed sugarcane plants over well-watered sugarcane. Preference was linked to increased numbers of dry leaves, where eggs are mostly laid, and to enhanced nutritional status of the plant based on accumulations of free amino acids essential to insect growth and development. A study of the important characteristics of sugarcane leaves that cue Mexican rice borers toward drought-stressed plants led to the development of a technique of mulching with dry sugarcane leaves to trap Mexican rice borer eggs and neonates. Drought-tolerant varieties may also have potential for suppressing the pest. Better understanding of the relationship of the Mexican rice borer and water-stressed sugarcane plants is important to controlling this pest. (216-2A; PM 2.2.1)

Integrated Technology and Information Systems

The Integrated Technology and Information Systems component focuses on research to develop and apply technologies that can be used to understand and increase production system economic and environmental sustainability. ARS customers want not only the latest information and best technology that research can provide; they also want to know how these innovations can best be incorporated into their unique operations. Also, it is important to know whether the use of new technology will increase farmer ability to compete in the marketplace or to deliver their services. Understanding the system level impacts of implementing new technologies will help increase adoption and reduce uncertainty and risk. Recognizing that users are the ultimate system integrators, customer participation in the entire research process becomes a necessity for the successful transfer and adoption of emerging technologies.

Selected Accomplishments

Corn-soybean tillage economics. While no-till and minimum tillage systems could provide environmental benefits, use of these practices for corn and soybean production in the northern Corn Belt has been limited because farmers believe they are less profitable than conventional tillage practices. In a 7-year field study in Morris, MN, ARS scientists compared the economics of eight different tillage practices. Switching from moldboard plow tillage to a minimum tillage fall residue management system increased average net returns by as much as $37/acre. Furthermore, all but one of the minimum tillage and no-till systems evaluated were less risky than the two conventional tillage systems commonly used. This research could enable greater adoption of minimum tillage and no-till systems in the northern Corn Belt. (NP 216-1A; PM 2.2.1)

Economic modeling tool for farmers. Often, the most expensive resource for an agricultural enterprise is the land. Allocating this valuable resource between different uses (enterprises) has substantial impacts on both profitability and sustainability, and finding the optimal allocation scenario can be difficult. ARS scientists developed a computerized model – the Land Allocation Model (LAM) – for producers to evaluate how land allocation decisions, environmental factors (such as residue quantity and quality, rainfall variability, number of operations, energy requirements, and degree of industrialization), economic factors (e.g., price coefficient of variation), and producer preferences impact net return per acre. The LAM tool utilizes information that is easily available to producers, and it allows producers to optimize land allocation between their enterprises for optimal profitability and sustainability. (NP 216, Component 3A)

Social and political factors influence agricultural systems. If agriculture is to be sustainable, it is critical to understand how it is affected by social and political factors. A panel of experts was surveyed to identify the most important social and political influences on U.S. agriculture. Although the panelists often had contrasting views about the importance of some factors, there was strong agreement that globalization and low margins requiring increased scale and efficiency were the two most important factors affecting agriculture. This research provides agricultural scientists with a better understanding of the social and political effects on agriculture resulting in the development of agricultural systems more likely to be accepted and used by farmers. This research also provides information needed by social scientists and policy makers to develop policies that lead to more sustainable agricultural systems. (NP216, Component 1A 2008)