

**FY 2010 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, ever-greater demands will be placed on agricultural producers to provide dependable supplies of products for consumers from a shrinking resource base. American farms generate more than \$170 billion of the gross domestic market on 442 million acres of land. Profitable farms are the basis of vibrant rural economies. The public benefits from agricultural production that provides consumers 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 depends not only 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-Agricultural Research Service (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 performance. 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 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.

**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**

**More environmental benefits from adopting cover crops.** When swine manure is applied to agricultural fields, plant nutrients and organic matter are added that reduce the need for purchased nutrients that require energy to produce and import. The most commonly used manure management practice in the Midwest involves autumn application of liquid swine manure to land where corn will be grown the next growing season. ARS researchers in Ames, IA conducted experiments to evaluate the effects of integrating a rye/oat cover crop with autumn-applied liquid swine manure injection on retention of manure nitrogen in an otherwise conventional corn-soybean cropping system. The autumn-planted rye/oat cover crop reduced soil inorganic nitrogen losses after liquid swine manure injection, soil nitrogen content was stable within a month after application, and that it persisted into the following spring. Low-disturbance injection of swine manure into a standing cover crop was important to minimize both damage to the cover and loss of phosphorus to surface runoff, while providing optimum phosphorus availability to corn. Even though dissolved phosphorus losses were greater in both the autumn and spring following low-disturbance injection, application method had no effect on total phosphorus lost in runoff in either season. The cover crop also provides a way to maintain soil carbon after both corn silage and soybean harvest. Without the cover crop, soil carbon decreased by 6% for a corn silage-soybean rotation relative to corn grain-soybean rotation. These findings are important to add to the already demonstrated benefits of using cover crops, and will help to increase grower confidence in using this conservation practice. The information is useful to producers and will impact nutrient management decisions in farming systems that utilize manure, and provide documentation useful for Cooperative Extension and for the development of USDA-Natural Resources Conservation Service (NRCS) conservation guides in support of USDA conservation program payments.

**Helping the navy reach a biofuel target in Hawaii.** A public and private partnership led by USDA in Hawaii has been designed to establish the commercial production of advanced biofuels for use by the Navy. The USDA's ARS and NRCS, the Department of the Navy's Office of Naval Research (ONR), and the University of Hawaii have formed a research and development partnership with Hawaiian Commercial & Sugar (HC&S) Company on Maui to develop

sustainable opportunities for producing advanced biofuels and renewable electricity from sugarcane and other biomass crops. ARS researchers from Temple, TX, Parlier, CA, and Hilo, HI have begun developing an analytical framework to assess the natural resources base in Hawaii so that dependable supplies of biomass can be delivered to biorefineries that produce fuels for the Navy. The effective use of water is of primary concern. An initial water use model for the island of Maui has been completed. More refined measurements of water sources, transportation routes, and use across the island are being developed. The information will help HC&S develop optimal strategies for growing sugarcane and other kinds of biomass crops given different amounts of available water, while at the same time protecting the quality of air, water, soil, and other natural resources.

**Conquering invasive jointed goatgrass in the Pacific Northwest.** Effective long-term control strategies are needed to reduce the negative impact of jointed goatgrass on 5 million acres of winter wheat in the Pacific Northwest. ARS Scientists in Pullman, WA conducted a six-year, three-state study to identify the most effective practices that can be combined for an Integrated Weed Management (IWM) control system for jointed goatgrass. Fields with the lowest weed densities were achieved by using a combination of a one-time burn of the stubble after wheat harvest to destroy as many goatgrass seeds as possible, growing an alternative rotation crop such as winter canola or lentil beans for three years, and planting winter wheat varieties that have the highest grain yield and quality. Adoption of the IWM system by wheat growers would reduce jointed goatgrass competition and infestations, decrease the need for farm chemical inputs, and improve overall sustainability by increasing farm profitability and environmental quality.

**Helping the Colville Tribal Nation produce its own biodiesel.** Research by an ARS agronomist working in Pullman, WA showed that planting winter canola earlier allowed young canola shoots to become established and better survive the winter than typical times for planting. Canola also represents an alternative winter rotation crop to suppress annual weeds that are hard to control in wheat. This increase in establishment success means that farmers can use winter canola to help fend off weeds in their wheat fields that are planted the next season, and also reduce the amount of soil erosion during the winter and spring when fields would otherwise be bare and exposed to rain and melting snow. The Colville Confederated Tribes are working with ARS and Washington State University to find ways to take advantage of winter canola on tribal lands so they can extract canola seed oil to make biodiesel for their fleet of school buses and logging trucks. They also plan to sell the crushed seeds to local farmers as a livestock feed supplement. In the future, as much as 20,000 acres of winter canola could be grown on Colville tribal lands. This acreage could support production of enough oilseeds for 2 million gallons of canola-based biodiesel and 6,500 tons of high-protein canola meal every year. These activities have the potential for generating annual gross revenue of \$8.8 million for the tribe and the surrounding community. The ARS research results have also been used by the USDA's Risk Management Agency as the basis for extending crop insurance for canola in two Washington State counties where the Tribe will obtain the needed canola seeds for biodiesel production. This research supports the EPA's in-progress review of the use of canola oil for biodiesel production to see if it meets requirements for greenhouse gas reduction under the Renewable Fuel Standard. Under the Standard, one million gallons of biodiesel must be

produced by 2022 to meet the legislated requirements, and a significant portion of the biodiesel will come from this region.

**A package of practices to reduce sugarbeet production costs in the Northern Great Plains.**

Sugarbeet growers in the Northern Great Plains must find ways to reduce the cost of energy, labor and time invested in farming to remain profitable. Conventional deep tillage with a chisel plow is a major expense. No-till or 10-cm deep strip tillage could substantially reduce costs, but how these practices influence resulting crop yield and quality is not known. ARS scientists at Sidney, MT compared the three tillage practices in a four-year study on an irrigated research farm near Williston, ND. Strip tillage had no significant effect on root yield, sucrose content, or sucrose yield, and unlike no-till, final sugar beet population emergence was not reduced compared to conventional tillage. With placement of nitrogen fertilizer in the strip tillage zone, standard application amounts did not adversely affect yield. This is important because the added time and expense that would otherwise be required to develop new fertilizer recommendations for strip tillage before adoption are not required. Farmers could reduce tillage costs from \$100-150 per acre using strip tillage, with no reduction in sugar production.

**Long-term soil aggregation in semi-arid dryland systems is aided by no-till wheat-lentil rotations.**

Soil aggregate formation and stability are key indicators of soil health. Soil health, in turn, is a key factor in sustaining crop yields and quality, increasing soil water storage and reducing erosion, particularly in semi-arid regions like the Northern Great Plains. Soil aggregation is significantly impacted by common farming practices, including tillage and the types and sequences of crops grown, but until recently those effects have been not been quantified. ARS researchers at Sidney, MT developed a set of biological markers specifically to study the long-term tillage and cropping effects on soil aggregation and aggregate stability in dryland areas of semi-arid eastern Montana. In this study, researchers used those markers to compare soil aggregation levels in long-term spring-wheat systems using varied tillage and alternating crops, along with continuous wheat and wheat-fallow. Results have conclusively shown that: 1) aggregate stability improved over 12 years of no-till continuous spring wheat systems compared to wheat-fallow rotation with the values approaching those of samples from nearby perennial grass fields, and 2) long-term, continuous wheat-lentil rotations did not differ in aggregate stability compared to a wheat-fallow rotation. However, leaving lentil residues on the soil surface to control erosion was shown to minimize nitrogen (N) mineralization, thus making more N available to the subsequent crop, and reducing economic and environmental risks to the region's producers. Consequently, leaving moderate amounts of lentil residue on the soil surface in no-till wheat-lentil rotations was found to be a better alternative than fallow or tilled lentil-wheat systems for farmers in eastern Montana interested in the long-term sustainability of their operations. As a result of these and related studies, these practices have been adopted on about 25,000 acres planted in MT, ID, ND, NE, MN, and CO, with an estimated 35,000 total acres expected in 2011.

**Ozark and Ouachita small farm biofuel production.** Many landowners in the Southeastern U.S. do not have large farms, so ARS scientists at the Dale Bumpers Small Farms Research Center in Booneville, AR are working with local farmers to evaluate hazelnut trees and other potential

bioenergy crops—production systems that might someday be used for small-scale on-farm biofuel production. Hazelnuts have the potential to produce 125 gallons of oil per acre, more than twice the amount produced by soybeans. While the trees are becoming established, the scientists are also looking at other crops like winter canola, which can be planted between the rows and could yield almost 80 gallons of oil per acre. The canola would also provide soil cover and help prevent erosion during the winter. New systems like these can help small scale farmers participate in the biofuel economy and contribute to energy security in rural areas.

**Twin row peanut production possible in high residue conservation systems.** Traditional peanut production includes multiple conventional tillage operations to prepare a seedbed, but these methods worsen the already-poor soil structure and low organic matter content typical of many southeastern production areas. The belowground fruiting habit of peanut also requires a tillage operation to facilitate harvest. Strip tillage that disrupts up to 1/3 of the row is beneficial, but would further reduction of the strip tillage zone still allow a twin row configuration? ARS researchers in Auburn, AL, in conjunction with Auburn University scientists, found that twin row peanut produced in narrow strip tillage systems gave yields equivalent to peanut produced in wider strip tillage systems across southern Alabama and northern Florida. Peanut grades, a measure of peanut quality, were also equivalent across strip tillage systems and row configurations. Twin-row peanut produced in narrow strip tillage systems will minimize surface soil disturbance and offset the effects of typical intense tillage operations required in peanut production. This information will benefit growers that include peanut in their crop rotations, while simultaneously improving soil quality with conservation tillage practices on degraded soils utilized across the Southeast.

**Long-term use of poultry litter and conservation tillage.** Using conservation tillage practices and animal manures as fertilizers can make significant contributions to sustainable food production, but their interactions need to be studied over long periods of time to test for possible negative impacts. Scientists from ARS's J. Phil Campbell, Sr. Natural Resource Conservation Center, Watkinsville, GA, and the University of Georgia, Athens examined 14 years of research in crop productivity, soil quality, and water quality associated with the use of conservation tillage and poultry litter in cotton and corn production. Yields of cotton and corn increased on average 10-27% with no-till and 32-42% with a combination of no-till and poultry litter, but soil nutrient accumulation, particularly phosphorus and zinc, reached excessive levels from long-term use of poultry litter. Rainfall infiltration and drainage increased in conservation tillage plots but runoff decreased. Fecal indicator bacteria and hormones were detected in drainage and runoff but were not great enough to pose an environmental risk. These results can be used by State Cooperative Extension Systems, NRCS, and other state and federal agencies to guide producers in management of systems using conservation tillage and organic fertilizers such as poultry litter.

### **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**

**Feather meal and feather meal-poultry litter blends show potential as side-dress fertilizers to improve nitrogen use efficiency in organic systems.** Improving nitrogen use efficiency in corn production will provide economic benefits to farmers and environmental benefits to society. Researchers at ARS in Beltsville, MD showed that the N release characteristics of locally available sources of Organic Materials Review Institute (OMRI)-approved N (raw poultry litter, pelletized poultry litter, feather meal, and a pelletized blend of feather meal and poultry litter) could serve as viable sources of supplemental N for organic and other grain production. The rate of N release of each material was relatively fast, suggesting that applying them to corn at the V5 growth stage (sidedress) could result in significant improvements in N use efficiency compared to pre-plant applications (the industry standard). Results showed that the feather meal and the feather meal-poultry litter blend were more nutrient-dense than the raw and pelleted poultry litter and therefore less costly to transport per unit of available N. This information will benefit producers, extension educators, nutrient management plan designers, and others interested in improved soil fertility and nutrient management in organic and other grain cropping systems.

**Weed seed persistence is similarly short for organic and conventional cropping systems.** Crop yield loss from competition with weeds is particularly troublesome for organic farmers because herbicides are not used to control weeds. Some have speculated that organic systems may be more resilient to spikes in weed seed production because weed seed in soil should be less persistent in the high organic matter soils with high microbial activity that are characteristic of organic farms, compared to seed in conventionally managed soils. Comparison of weed seed persistence in soils of two long-term cropping systems (organic and conventional) in experiments conducted by ARS-Beltsville, and Rodale Institute, Kutztown, PA, showed that persistence of weed seed populations was relatively short (half-life of approximately one year)

and that there were only small differences (a couple of months) in half-life between organic and conventional systems. In addition, seed half-life correlated poorly with various measures of soil microbial activity and organic matter content. Results suggest that more precise mechanistic hypotheses will be needed for defining factors responsible for weed seed longevity in soil.

**Rotation crops may reduce disease and pests.** Verticillium wilt is a persistent soilborne disease that becomes particularly important after many years of potato production. ARS scientists at Orono, ME evaluated potential disease-suppressive rotation crops for their ability to suppress wilt problems in a severely infested potato field. Results showed that biofumigation crops, such as mustard green manures, could reduce wilt by about 25%, but that multiple years of disease-suppressive crop cultivation were needed to maintain low disease levels. This research provides growers with specific information on rotations useful for naturally controlling this important disease, as well as how to best integrate these rotations into their production system.

Corky ringspot disease (CRS) of potato is caused by tobacco rattle virus (TRV), and makes tubers unmarketable. CRS is present in approximately 5% of the potato acreage of the Columbia River Basin, and soil fumigation, costing \$200/acre, is currently the only method of control. Researchers at the Vegetable and Forage Crops unit in Prosser, WA completed research demonstrating that growing weed-free alfalfa cleanses CRS from soil. Weed hosts of TRV and its nematode vector were identified, and when the weeds are present in the crop rotation, they prevent the cleansing of TRV from the nematode population. Growers can utilize this information to lessen the need for costly soil fumigation, saving the potato industry approximately \$1.5 million dollars annually.

The potato cyst nematode, *Globodera pallida* (PCN), a restricted pest in the U.S. was first reported in Idaho in 2006, and the federal government and Idaho State Department of Agriculture hope to eradicate it from infested fields. Eradicating PCN will require depriving the nematodes of their hosts (potatoes, tomatoes, and various weeds) over a protracted time period. The host status of PCN found in Idaho has not been documented and is unknown. ARS scientists conducted host suitability tests on common weeds found in the Pacific Northwest potato production region. Reproduction of PCN occurred on hairy nightshade (*Solanum physalifolium*) biotypes from Idaho and Washington, while other nightshade types from ID and WA were relatively poor hosts of PCN. PCN did not produce new cysts on redroot pigweed (*Amaranthus retroflexus*), kochia (*Kochia scoparia*), and common lambsquarters (*Chenopodium album*). Control of hairy nightshade during the eradication of potato cyst nematode from infested fields will increase the likelihood of success.

**In Organic Cover Crops, More Seeds Mean Fewer Weeds.** Farmers cultivating organic produce often use winter cover crops to add soil organic matter, improve nutrient cycling, and suppress weeds. Now these producers can optimize cover crop use by refining seeding strategies, thanks to work by ARS scientists. In moderate climates, suppressing weeds in winter cover crops is important because weeds that grow throughout the year produce seed that can increase

weeding costs in subsequent vegetable crops. An ARS horticulturist in Salinas, CA conducted studies comparing winter cover crop planting protocols in organic systems along California's central coast. Examining how seeding rates and planting patterns affected cover crop performance, the scientist found that planting rye at higher seeding rates consistently improved early-to midseason rye biomass production and weed suppression. There was no consistent crop improvement from grid planting. In addition, planting patterns had no effect on cover crop yield or weed suppression. These findings suggest that increased seeding rates could provide organic producers with a cost-effective weed control strategy. However, planting in a grid pattern would probably not consistently boost the benefits of cover crops—and since it would require two passes through the field, grid planting would likely double dust production, fuel use, planting time and labor.

**New roller concepts result in two U.S. patents.** High residue cover crops have been adopted across portions of the Southeast, and the cover crop is crushed with rollers before planting subsequent summer row crops such as cotton. Vegetable growers are beginning to adopt high residue cover crops, but since many vegetables are produced on raised beds, roller designs must differ from those used with traditional row crops. ARS researchers at Auburn, AL have been awarded patents for two innovative crimper designs that can manage cover crops used with vegetable crops. The first patent is a roller/crimper for elevated bed culture, and the second is a smooth roller/crimper with a crimping bar that has a spring-adjustable crimping force. The smooth roller/crimper was further tested with different herbicide application methods and rates. Results indicated that applying herbicide every fourth crimp was as successful as continuous spray in terminating rye one week after rolling. By eliminating the continuous spray, an 80% reduction was achieved in the amount of herbicide used. Proper roller management can reduce herbicide use in summer row crops as well. When black oat, rye, and wheat winter cover crops were flattened with a straight-blade mechanical roller-crimper alone, rolling followed by herbicide applied at rates less than half the standard use can reliably terminate mature cereal winter cover crops, thus maintaining the cotton population and protecting growth. Rolling mature winter cereal cover crops will likely conserve more soil moisture compared to standing covers; however, rolling immature cereal cover crops provides no benefit. Reduced chemical application combined with rolling can provide both monetary and environmental benefits.

### **Integrated Whole Farm Production Systems**

This component 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. Some producers have achieved increased profitability through specialized production and acreage consolidation into large farm units. Integrating crop and livestock production elements is an alternative strategy that may reduce risks of economic loss, diversify income, and enhance environmental benefits.

## Selected Accomplishments

**Sheep grazing to control weeds and increase nutrient cycling in soils.** Wheat and livestock producers are looking for ways to reduce herbicide and feed costs, respectively. The largest use of glyphosate herbicides in Montana is for control of volunteer wheat during fallow periods. In collaboration with Montana State University, ARS scientists at Sidney, MT conducted a five-year study to evaluate and compare the effects of sheep grazing with chemical fallow and tilled fallow management systems on soil properties, weed community, and spring wheat yields. Grazing slightly reduced soil carbon and available nitrogen, phosphorus, and potassium contents, along with pH, cation exchange capacity, and electrical conductivity by reducing the amount of crop residue returned to the soil compared with tilled and no-tilled treatments. Grazing, however, also increased soil calcium, magnesium, and sodium contents. Grazing had no effect on wheat grain and biomass yields, but reduced the need for herbicides by reducing populations of some problem weed species. The study demonstrated that properly timed sheep grazing can be an effective way to economically control volunteer wheat and other weeds and sustain crop yields by reducing selection pressure for weed resistance to glyphosate, decreasing potential leaching of nitrates, and increasing nutrient cycling in soils.

**Annual forages identified as profitable alternatives to summer fallow in semi-arid dryland farming operations.** Economic forces are driving the replacement of wheat-summer fallow cropping systems by diversified, continuous cropping systems in dryland crop production areas of the semi-arid Northern Great Plains, but results are quite variable and growers lack direction. ARS scientists at Sidney, MT have determined that annual spring-seeded forage crops use less water than cereal grains, including durum, and may be a suitable replacement option to summer fallow. A five year experiment compared yield, quality, and water and nitrogen use of durum-fallow rotations with two-year rotations of continuous durum and three annual forages: forage barley, forage barley interseeded with field pea, and foxtail millet. Averaged over years, preplant soil water and residual nitrogen content were greater for durum following fallow than for durum following annual forages, resulting in reduced total fertilizer N requirement and greater yield, water use, grain N accumulation and nitrogen recovery index (NRI) following fallow. In addition, replacing summer fallow with annual forages reduced durum grain yield by 10.8 bushel per acre. But while those factors appear to favor the wheat-fallow system, forage yields of nearly 2.5 tons per acre produced a higher annualized return over the five-year study period for all three wheat-forage rotations, greatly reduced herbicide use and substantially lowered total fertilization costs, despite reduced wheat yields. Under the study, the annualized net returns in the three annual forage-durum systems were \$51 acre<sup>-1</sup>, \$31 and \$14 acre<sup>-1</sup> greater than for fallow-durum, respectively. This information will be useful in making cropping system decisions in the Northern Great Plains.

**Tillage requirements for vegetables following winter grazing.** Winter annual grazing combined with vegetable production can improve profitability and sustainability of southeastern farming operations. However, soil compaction following winter grazing is a prevalent problem and negatively impacts subsequent yields. Previous tillage work has focused on alleviating soil compaction prior to planting traditional summer row crops; therefore, limited information

exists on tillage requirements for vegetables that minimize soil compaction. Based on this information, ARS and university scientists located in Auburn, AL, examined tillage requirements for sweet corn, field peas, and watermelons following winter annual grazing. Researchers demonstrated that sweet corn responded to a combination of surface and deep tillage, while field peas required only surface tillage to maximize yields. Watermelon responded to deep tillage alone. These results correspond to typical rooting depths associated with these vegetables. Southeastern vegetable growers that incorporate winter grazing into their operations for diversification and additional income should be aware of potential soil compaction problems, but yields can be maintained with appropriate tillage practices.

### **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**

**Computer modeling contributes to Thai soybean production.** ARS scientists are testing the soybean model GLYCIM to improve its performance under a range of conditions around the world. In the process, they've been able to pinpoint the best agronomic practices for maximizing soybean production in Thailand. GLYCIM was designed to simulate the growth of any soybean cultivar on any soil at any location and for any time of year. ARS scientists at the Crop Systems and Global Change Laboratory in Beltsville, MD, partnered with scientists at the Asian Institute of Technology in Pathumthani, Thailand, to see how well GLYCIM estimated soybean yield potential in Thailand. The team programmed GLYCIM with data from a field study conducted in Thailand that tracked soybean growth and yield. Then they introduced new data—including four years of weather measurements, seven planting dates, three soil types and three soybean cultivars—and developed 504 cultivation and yield scenarios for two key soybean production areas in northern Thailand. GLYCIM results indicated that it is critical for farmers to use optimal planting dates to achieve high yields at these sites. Planting on May 2 and May 16 produced the greatest yields, while earlier planting resulted in yields ranging from 7 percent to 17 percent less. Yield losses in delayed planting simulations averaged around 30 percent. GLYCIM can help Thai farmers identify the best dates and soybean cultivars to obtain the highest yields, which could help increase production to meet current and future demand. Farmers in Thailand and other tropical regions could also use GLYCIM to estimate how different

management practices could be adjusted to deal with the effects of global climate change and changing weather patterns.

**Affordable, reliable remote sensing technique verified for use in computer models of agricultural systems.** Increasingly sophisticated computer models allow for assessments of the impacts of soil, water and energy conservation and new production methods on the sustainability of various cropping systems. But these assessments are only as good as the tools used to measure the many variables involved. Crop residue cover, a key indicator of soil carbon storage and soil conservation benefits, is one such variable that has previously been highly labor intensive and expensive to accurately calculate. To address that issue, ARS scientists at Sidney, MT in collaboration with researchers at the ARS Hydrology and Remote Sensing Laboratory, Beltsville, MD, examined use of the remotely-sensed cellulose absorption index (CAI) to evaluate crop residue cover and the subsequent sustainability of various cropping systems in semi-arid regions. Measurements were made in 2009 and 2010 in the Northern Great Plains (Sidney, MT and Akron, CO) and Pacific Northwest (Pendleton, OR and Pullman, WA) regions. u Scientists have determined that CAI can be used to provide reliable estimates of crop residue cover in these semi-arid dryland regions, which can, in turn, be utilized in computer models to help determine the sustainability of different cropping systems in these regions. In addition, in collaboration with scientists at the Livestock and Range Research Laboratory in Miles City, MT, the technique has also been shown to successfully assess residue cover and subsequent “fuel loads” for computer models looking at wildfire potential of rangelands. The technique also holds potential for many other computer model applications looking at carbon sequestration and to aid compliance with government farm conservation programs.