2008 ANNUAL REPORT
NATIONAL PROGRAM - 216
AGRICULTURAL SYSTEM COMPETITIVENESS AND SUSTAINABILITY

As the world 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 talent 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 that 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 emergent herbicide resistant weed problems, particularly in the southeastern region. Research is needed to develop production strategies and technologies that increase productivity and reduce production costs and risks 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.

Accomplishments

Irrigation Management System Software Improves Water Conservation, Pest Control, and Profitability. Southeastern U.S. row crop growers depend on several factors to stay in business: proper irrigation methods, good crop rotations, and effective marketing to secure the best price for their product. Years of drought and increasing urban usage of water resources are forcing most southeastern farmers to determine whether irrigation pays and which crops to produce. Irrigator Pro, an irrigation manager developed by ARS researchers at Dawson, Georgia for cotton and corn, were released as part of a collection of software called FarmSuite update 5.0. This management system, updated with new data, allows peanut, cotton and corn growers to use volumes of research data and grower experience to make daily decisions about their production, harvesting and marketing. This software program has been extensively validated with long-term controlled research studies, as well as commercial trials with cooperating farmers. Use of this software will help farmers reduce water consumption by their crops, reduce pesticide applications, and increase the yield and profitability of corn, cotton, and peanut crops. Adoption of the software by producers and crop consultants in Georgia, Florida, and Alabama has exceeded expectations.

Imported Conservation Tillage System Increases Yield and Reduces Herbicide Costs. Alternative weed control systems are needed to improve the efficiency of herbicide use and increase profitability in peanut production. ARS scientists at Watkinsville, GA and Auburn, AL in cooperation with Auburn University evaluated the weed control value of three winter cereal cover crops in a Brazilian-modeled high-residue conservation tillage system. Black oat, cereal rye, and wheat were evaluated for weed suppressive characteristics compared to a traditional winter-fallow system using three weed suppressive systems: no herbicide, low-input system, and a high-input system. The no cover crop system was effective in controlling weeds without an herbicide program, however when black oat or cereal rye was used with the low-input herbicide system, weed control was similar to the high-input system. Cereal rye and black oat provided more effective weed control than wheat in a conservation-tillage system. Yields were improved using the Brazilian cover crop management system compared to the winter-fallow system which yielded 7-26% less peanut. The Brazilian system using black oat or cereal rye cover crops has the potential to increase peanut productivity and reduce herbicide inputs for peanuts grown in the Southeast U.S. Cover crops further benefit conservation tillage systems by providing crop residues to increase soil organic matter and help control weeds, improving soil structure and increasing infiltration, protecting the soil surface, and dissipating raindrop energy and thus reducing the velocity of water that moves over the soil surface, and anchoring soil with roots.

Genetic Differences Identified for Mineral Accumulation in Straw Bioenergy Feedstocks. Switchgrass is a warm-season perennial grass with great potential as a U.S. energy crop. It is widely adapted to many regions of the U.S., produces large amounts of biomass, and serves as a useful forage grass. Potential conversion technologies to turn this grass to energy include fermentation, which is similar to that used for corn-to-ethanol, or thermochemical technologies including pyrolysis and gasification. The mineral composition of switchgrass varieties is important because certain elements like silica, potassium, and chlorine react with the metal in thermochemical reactors to form corrosive compounds and slag, which reduce the lifetime of the reactor. ARS scientists in Corvallis, Oregon in cooperation with ARS geneticists at Lincoln, Nebraska and Madison, Wisconsin determined the mineral composition of six different populations of switchgrass grown at five different locations to evaluate the potential for breeding new populations that are more suitable for thermochemical conversion. They found that mineral accumulation varied between selections and was dependent upon the location at which the grass was grown, thus suggesting factors such as conservation practices and biophysical conditions during production may affect mineral accumulation. This important new knowledge enabled the selection of appropriate genetic strains of switchgrass by breeding programs to develop improved traits that enhance switchgrass as a bioenergy feedstock in thermochemical conversion processes.

Improved Sustainability through Crop Diversification, Reduced Fallow, and Decreased Inputs. Water availability, depleted soil quality, and weed competition are major constraints to dryland crop production in the northern Great Plains region. The use of crop production systems that integrate alternative crop selection options and rotational combinations increases the diversity of farm enterprises and biological diversity of soils. ARS scientists in Sidney, Montana have developed a diversified dryland production system that utilizes spring wheat grown every third or fourth year. Wheat produced in this diversified system has greater yields and higher quality grain compared to conventional spring wheat systems that grow wheat continuously or every other year. When this kind of ecological management is combined with zero-tillage planting, the influence of weeds on yield of spring wheat, field pea, and forage barley is greatly reduced, compared to conventional management and preplant tillage systems. Early planting of herbicide-free forage barley can prevent all weed seed production. Fall-seeded, zero-till winter wheat and triticale produced without an herbicide application during the growing season provides high yields of nutritious forage without seed production. Land rolling following preplant tillage increases the emergence of small-seeded broadleaf annual weeds in annual pulse and forage crops, thus providing opportunities to increase weed seed bank depletion. These new management practices used in combined systems have reduced herbicide use, thus saving Montana producers about $2,500,000 per year on approximately 95% of the awnless forage barley, and zero-till continuous cropping practice acreage.

Management Can Influence CO_2 Emissions and Carbon Sequestration in Northern Great Plains Soils. Climate change due to increased concentration of greenhouse gases such as CO_2 in the atmosphere is a major concern. It has been estimated that agricultural practices contribute about 25% of total man-caused CO_2 emissions. Soil can act both as source or sink for atmospheric CO_2. ARS scientists in Sidney, Montana examined the effects of combinations of irrigation, tillage, cropping systems, and N fertilization practices on soil CO_2 flux, temperature, water, and soil carbon content at two sites in the northern Great Plains region. The research revealed that irrigation increased carbon dioxide emissions by 13% compared with non-irrigation, by increasing soil water content during otherwise dry periods. Tillage increased emissions by 62 to 118%, compared with no-tillage. Carbon dioxide emissions were 1.5 to 2.5-

fold greater with tilled than with non-tilled treatments following heavy rain or irrigation, and 1.5 to 2.0-fold greater with crops grown in sequence after one another, than with fallow following substantial rain. Nitrogen fertilization increased CO_2 emission by 14% compared with no nitrogen input, and cropping increased emissions by 79% compared with fallow without tillage or nitrogen fertilization. Soil carbon storage was not influenced by the different treatments. It was concluded that although soil carbon storage was not altered, management practices influenced carbon dioxide emission within a short period due to changes in soil temperature, water content, and applied nitrogen levels. Regardless of irrigation, carbon dioxide emission can be reduced from croplands to a level similar to that in grassland using no-tilled crops, whether N fertilization is used. This information can be used to help develop cropping system strategies that reduce CO_2 emissions from agriculture in the northern Great Plains region.

Self-Seeding Varieties Lower Winter Cover Crop Establishment Costs. Winter cover crops cover the soil between crop harvest and planting of summer annual grain crops the next year. Cover crops also perform important ecological services that include reducing soil erosion and nitrogen leaching, providing weed and pest suppression, and increasing soil organic matter. However, the adoption of cover crops into existing production systems has been limited. ARS scientists in Ames, Iowa used winter cereal rye, wheat, and triticale have developed a dependable way to allow winter cover crops to self-seed in a soybean-corn rotation system, and winter cereal rye grown alone in a corn silage-soybean rotation. All small grain species studied self-seeded when growing concurrently with soybean, but the soybean yield was lowered. Winter cereal rye planted after corn silage harvest produced substantial biomass, had no impact on soybean yield, and had minimal potential increased risk to corn silage yields. The results of these studies show that self-seeding winter cover crops do not require excessive seed production and thus may increase their adoption by growers if efficient seed dispersal technologies are developed so minimal purchased cover crop seed is required. Lower establishment costs may encourage conventional growers to use winter cover crops and experience the resulting environmental benefits in their fields.

Coordinated Research to Address Roundup-resistant Palmer Amaranth Pigweed in Southeast Cotton Production. A coordinated research effort was begun to address the challenges cotton growers face from Roundup-resistant pigweed on the Coastal Plains region of the southeastern United States. ARS researchers at Auburn, Alabama, Dawson, Georgia, and Tifton, Georgia in cooperation with the University of Georgia, Mississippi State University, North Carolina State University, University of Tennessee, University of Arkansas, and Cotton Incorporated have demonstrated that Palmer Amaranth populations in cotton fields can be substantially reduced by using a combination of conservation tillage when cereal rye is grown as a winter cover crop. Conservation tillage is an important management tool across the southeastern U.S. to help prevent erosion, maintain soil organic matter levels that maintain crop productivity, conserve soil moisture, and reduce the amount of fuel required to produce crops. The inclusion of the winter cover crop makes the use of conservation tillage possible. This approach to pigweed management is also being applied to peanut production where acetolactatesynthase-resistant pigweed is also a problem. In addition, ARS researchers at Tifton, Georgia are cooperating with the University of Georgia to study the biology of pigweed. One pigweed plant can produce more than 600,000 seeds. By learning more about the reproduction of pigweed, and how it disperses its seeds across farm fields, other management strategies can be developed to effectively control this pest. A Conservation Innovation Grant proposal is being prepared for submission to USDA Natural Resources Conservation Service to facilitate

demonstration of feasible technologies and conservation systems that control herbicide resistant weeds on farms across the region.

ARS and ERS Modeling Partnership for Sustainable Biofuel Feedstock Production. A joint partnership was formed among ARS scientists at Mandan, North Dakota, Corvallis, Oregon and Dawson, Georgia in cooperation with the USDA-Economic Research Service to integrate USDA Research, Education, and Economics (REE) Mission Area biophysical and economics models to estimate the amounts of feedstocks available at the farm level that could be used for bioenergy production. The purpose for the joint research project is to provide multiple-scale assessments of different agricultural production systems strategies incorporating biofuel feedstock production on natural resources quality, national commodity prices, and farm income. A short-term application of this project is using ARS long-term cropping system rotation research results in the EPIC model to project the impacts of different production systems across the Minnesota River watershed. These results are then used in PGA-BIOECON to determine the impacts of different production options on natural resources quality at the watershed-scale. These results will then be passed to USDA-ERS for analysis with their REAP model, and prices fed back down to the farm-scale for refining production options using the ARS WholeFarm model. This research is providing the first quantitative framework to determine how to sustainably incorporate biofuels production into existing agricultural systems in ways that do not disrupt food, feed, and fiber markets.

Small-scale Biofuel Production to Reduce On-farm Energy Costs. The cost and impacts of using petroleum-based fuels has triggered considerable interest in the development of sustainable, on-farm biodiesel production systems. Construction of a new peanut oil biodiesel refinery in Dawson, Georgia has been completed, and more than 500 stakeholders have already visited the new facility. ARS scientists designed the refinery and are conducting research to find optimal whole-farm systems for producing and utilizing high-oil content peanuts that can be produced for 70% lower costs than peanuts for edible consumption. The refinery will be used to conduct throughput studies to address the economic feasibility of on-farm peanut biodiesel refinement. A similar integrated research approach is being established at Akron, Colorado to utilize oil seed crops adapted to farms in the central Great Plains region. These studies aim to reduce the costs of biofuel production on the farm, which could help farmers turn peanuts into fuel to run their own farm machinery and meet growing demand in an environmentally and economically responsible way.

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 of 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.

Accomplishments

Reducing Weed Control Costs to Organic Vegetable Producers. Hand labor for weed management in high-value organic vegetable crops can cost up to $1,500 per acre. ARS scientists in Salinas, California and cooperators conducted on-farm research to evaluate the effectiveness and costs of six organic weed management tools to prepare stale seed beds in high-density vegetable production. These techniques included organic herbicides, propane flamers, and various cultivation tools. Most techniques controlled more than 70% of the weeds for less than $230 per acre. However, an organic herbicide that is widely marketed was found to be ineffective and cost $1,557 per acre to use. These findings identified effective methods to help organic producers minimize the need for hand weeding of high-value vegetable crops grown in the California Central Coastal Region.

Byproduct from Biodiesel Production Inhibits Weeds and Reduces Weeding Costs. Weed control is a major production cost for organic growers, ranging from $500 to $2,000 per acre. Organic growers can now take advantage of a low-cost biodiesel byproduct. Seed meal is a co-product remaining after pressing mustard seed to remove the oil. Seed meals are high in glucosinolates, compounds that inhibit weed germination and establishment. Mustard seed meal efficacy to suppress weeds by was tested by ARS scientists in Prosser, Washington in organic onion and peppermint fields at specific crop growth stages. The mustard seed meal was effective in controlling annual weeds for about three weeks after planting without significant injury to either crop. Application of mustard seed meal is a more cost-effective form of weed control than hand weeding, and suppresses weeds that would otherwise lower the value of peppermint and onion sent to market.

Synthetic Barrier Controls Weeds, Improves Water Management and Yields in Blackberries. By improving yield while reducing labor for weed control, synthetic weed control barriers are a promising management tool in blackberry production. Weeds are a challenge to control in brambles, particularly when organic methods are employed. ARS investigators at the Weslaco, Texas found that several synthetic barriers used in newly planted blackberries improved plant vigor, yield, and berry soluble solids, and at the same time greatly reduced hand weeding labor time compared to no weed barrier used. The crop response to the barrier was due to soil temperature fluctuations at the four-inch soil depth were moderated, providing more consistent temperatures through out a 24-hour period. Soil moisture differences to the eight-inch depth were confounded by the improved plant development where the barriers were used. After two harvest seasons in 2007 and 2008, white plastic improved yield compared to all other treatments. In a study started in 2008, an EPA approved organic herbicide showed promise for post-emergence weed control in blackberries, but when compared with white plastic weed barriers, did not improve establishment growth as seen with the synthetic barriers.

Reducing Weed Pressure and Increasing Mid-Atlantic Organic Cereal Crop Yields. ARS scientists in Beltsville, Maryland and cooperators showed that the numbers of weed seeds in the soil in spring are often correlated with weed cover percentage at maturity the same year, demonstrating that diverse rotations can reduce weed seed numbers in the soil bank and can lead to improved weed control. During favorable years, corn yield losses due to weeds were less than 5% in the longest organic rotation, a level similar to that achieved using herbicides in conventional no-till and chisel-till systems. This indicates that with good management, longer organic crop rotations can adequately control weeds, and that this strategy should be of value to conventional producers to reduce the amounts of herbicides that are required for their conditions. These results will be of great benefit to growers considering economical ways to transition from conventional to organic production systems.

Compost and Biological Amendments Improve Disease Control and Potato Productivity. Potatoes frequently suffer from numerous soilborne diseases that reduce plant growth, tuber quality, and yield. ARS scientists at Orono, Maine evaluated compost and biological amendments for their efficacy to control potato diseases on both organic and conventional farms. Compost and biological amendments were found to reduce diseases and increased potato yields by as much as 30%. Adopting these results can provide growers with more sustainable production systems having higher yields and requiring fewer chemicals for controlling diseases, or reduce risks of yield losses in organic production systems.

Increased American Food System Security. Consumer dependence on centralized and distantly produced agricultural products including fresh market produce makes large urban centers vulnerable to risks of interrupted food supplies due to health safety concerns and natural disasters. Over the past forty years, many of the small farms and the associated infrastructure needed to support locally sourced foods in the Eastern Seaboard region have been lost. To proactively reverse these trends, ARS scientists at Orono, Maine and Beltsville, Maryland and USDA-Economics Research Service and USDA-Agricultural Marketing Service, in cooperation with scientists at Massachusetts Institute of Technology, Tufts University, Iowa State University, and Pennsylvania State University, are determining how local-based production systems could be redesigned to meet a greater portion of regional food demand and diversify the food supply. This research projects was initiated to determine the biophysical capacity of local production systems to meet Eastern U.S. market demand. Economic and biophysical modeling decision tools are needed to construct an efficient regional food supply chain based on local production that deals with the challenges of rural lands lost to suburban development, rising transportation costs, and global market competition. An ARS-funded Post-doc Research Associate has been contributed by headquarters to facilitate the partnership, and research plans are being developed by the team to fund cooperator participation.

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.

Accomplishments

Integrating Cattle with Crops Improves Soil Quality and Increases Farmer Profitability. Combining winter grazing of cattle with summer crops like cotton and peanut can generate additional income for farmers, but could also cause soil compaction and reduce soil carbon amounts. ARS scientists at Watkinsville, Georgia and Auburn, Alabama, in cooperation the University of the Republic of Uruguay, grazed oat and ryegrass during the winter with stocker cattle, and then tested four tillage systems for the following cotton-peanut rotation. Soil compaction, water infiltration, and soil organic carbon were measured at the end of the three-year study. No-tillage resulted in the greatest soil compaction and least amount of water infiltration. However, non-inversion no-tillage used prior to spring planting reduced soil compaction, increased infiltration 83%, and increased soil carbon 38% near the soil surface. Combined with a $75/acre/year greater net returns due to 7% higher cotton yields, this integrated grazing and non-inversion tillage conservation system proved successful not only for improving soil quality, but also for increasing farmer profits.

Bringing Back Swath Grazing – Dynamic Farming Integrates Livestock with Crop Production in the Northern Great Plains. The practice of letting cattle graze all winter, or swath grazing, saves money and labor but can alter near-surface soil properties, resulting in either positive or negative effects on natural resources quality. ARS scientists at Mandan, North Dakota conducted field research to determine the impact of livestock presence on no-till grain and forage production. The rotation used an oat and pea mix the first year, then a triticale and clover mix, followed by drilled corn the third year. All were grown without tillage, and crop residues after harvest were left in swaths for livestock grazing during the winter. They found that the combination of no-till and annual crop rotations gave farmers higher yields, more agricultural stability, fewer crop pests, more protection against drought, less soil erosion, and more efficient use of precipitation. The need for nitrogen fertilizer could also be cut in half by planting legumes like clover and using nutrients in manure more efficiently. This integrated crop with livestock system can save more than $4,000 per 200 cows in feed cost a year, saves labor costs otherwise needed for winter feeding, and provides a profitable way to recycle manure as a soil conditioner within fields. The protein-rich forage also slightly increased weight gain in cows. Millions of acres of grazing cropland in the Northern Great Plains being ecologically degraded and under-producing could be improved using swath grazing that integrates crop, forage, and livestock systems to make them economically and environmentally sustainable.

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 research can provide, but also 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.

Accomplishments

New Spectral Index Improves Nitrogen Fertilizer Management for Wheat. ARS scientists in Pendleton, Oregon in cooperation with ARS scientists in Beltsville, Maryland developed a new spectral vegetation index that is sensitive to plant chlorophyll content. Plant chlorophyll content is a useful indicator of nitrogen fertilizer need, but is sensitive to crop cover variability across fields which is often the result of soil moisture differences. The new ARS index improves our ability to use remote sensing to precision-apply late-season nitrogen fertilizer based on crop need, regardless of how soil moisture affects crop growth. This is important for wheat grown in semiarid regions where spectral reflectance can be dominated soil moisture variability. In arid regions, nitrogen fertilizer is applied late in the growing season to boost grain quality before harvest. Precision applications of fertilizer to meet the exact crop needs of plants across variable field conditions can save costs and reduce the chance of excess fertilizer contaminating water or generating greenhouse gases. This research is a part of an expanded effort for precision application technologies applications to nitrogen fertilizer and crop residue management in wheat based production systems across the U.S. A coordinated effort among ARS systems research projects at Pendleton, Oregon, Sidney, Montana, and Hydrology-Remote Sensing Laboratory at Beltsville, Maryland is providing ground-based information to validate larger scale regional models to optimize economic and natural resources benefits. Production system information is being used to validate the Fort Collins, Colorado Root Zone Water Quality Model-2 (RZWQ2) across temporal and spatial scales. Two ARS-funded Post-doc Research Associates have been contributed by headquarters to facilitate the partnership.

New Integrated Biophysical-Economic Model Finds the Ways to Farm Profitably and Protect Natural Resources. A significant challenge we face is finding ways to meet the conflicting interests of agriculture and environmental groups. ARS scientists in Corvallis, Oregon have developed a way to choose among different agricultural production system options to meet the needs of stakeholders with different priorities. The new model called PGA-BIOECON runs on a high-speed parallel computer to simultaneously look at the tradeoffs among production efficiency, profitability, and natural resources quality objectives. Thus farmers, conservationists, and policy makers can look at what is important to them, and see how it affects the others. If a person values water quality more than farm profit, they may choose differently than a farmer would. With PGA-BIOECON, the best scientific and economic information are provided about trade-offs, so the most informed choices could be made. Answers to these kinds of questions will be very important as our country finds ways to sustainably produce more biofuels.

Integrated Microcontroller and Irrigation Scheduling Technologies Reduce Labor and Irrigation Water Use. To fully realize the benefits from irrigation, frequent and accurate updates of soil moisture conditions across a farm are needed for timing water applications. ARS researchers in Stoneville, Mississippi have developed an integrated data collection system that

can greatly reduce the amount of labor required to collect the needed soil moisture information in the field to make accurate irrigation scheduling decisions. The automated system was found to be a useful tool for production-scale soil moisture monitoring. By scheduling irrigation using the microcontrollers, water use was reduced 25% in one study. For a 12,000-acre farm, one irrigation-scheduling operator can remotely accomplish in one hour what would take a week to collect manually. Moreover, the near-continuous recordings with the automated system allow researchers to learn more about soil moisture changes through out the day so irrigation scheduling can be improved even more. Combining new monitoring technology with crop-based irrigation scheduling models will help farmers improve crop performance, reduce production costs, and conserve water resources.

Evolving Satellite Technology for Fast Ecosystem Services Assessments. ARS scientists in Corvallis, Oregon used an extensive ground-based survey of the different agricultural management practices used to grow crops across the entire Calapooia River watershed, and used the results to validate a remote sensing approach using satellite images to distinguish crops and management used by farmers. The survey incorporated input from field locations and management practices used for three years into a Geographic Information System (GIS) database. The information collected and modeled for the individual fields were used to train the classification of a series of commercially available Landsat satellite images comprising over 90% of all land use practices. These results were then used to calibrate the ARS Soil Water Assessment Tool (SWAT) computer model to assess natural resources conditions that resulted from the practices. This development will enable the use of satellite images across entire watersheds to develop recommendations for the best combination of cropping practices to optimize profitability consistent with water quality and other ecosystem services outcomes.

Holistic Approach to Improve Profitability and Conservation Planning. Farm economic returns drive land use. Using information from a program initiated by North Dakota Natural Resources Trust using a whole-farm approach while also promoting private water storage and conservation, ARS scientists at Mandan, North Dakota evaluated for five years the economic performances of four demonstration farms and compared these to other farms in North Dakota. The project began by developing actions to increase agricultural profitability through Resource Teams that assisted farmers in the whole-farm planning process. Results showed that using this approach, farm debt declined significantly for three of the four farms studied, and that all four farms had debt lower than regional averages. The study also showed that farmers can increase their conservation efforts without loss of profit. This is important because it provides a template for policymakers to use in designing future conservation programs when teams of agricultural and conservation professionals are involved who work directly with individual producers.

Assessing Farmer Risks with Changing Production Costs and Commodity Prices. Scientists at Fort Collins, Colorado used the iFARM Field Economic Assessment Tool (iFEAT) in conjunction with the whole-farm GPFARM model to perform cost-benefit analysis for alternative in-season crop management scenarios suited to the northern Great Plains region. The scenarios included crop rotations, crop insurance options, and land lease arrangements that were run for varying commodity prices. Increased net return to the producer was the objective of the analysis. Also, two crop insurance options were used, along with two crop share and land rental lease arrangements, and farmer ownership as the three land-cost alternatives. Commodity prices ranged from the 2006 average, to the much higher averages that were common in 2007 and 2008. With the lower 2006 commodity prices, the 60/40 crop-share lease with production costs split

equally between tenant and land provided the most equitable split between tenant and owner while the cash lease option produced the smallest net return to the grower. With the elevated commodity prices in 2007/2008, the cash lease option was more profitable for the tenant than the 60/40 split, even with a significantly higher rental price. Results of this kind are being prepared as a fact sheet to help farmers decide which production options are best for their conditions during these times when production costs and prices are highly volatile.

New Device Estimates Earthworm Densities across Soil Conditions. Earthworm populations are key indicators of soil quality. However, methods for estimating earthworm populations like hand sorting or chemical extraction are time consuming and laborious. In contrast, electrical extraction allows for sampling without detrimental soil disturbance or contamination. ARS scientists at Morris, Minnesota, Watkinsville, Georgia, and St. Paul, Minnesota along with cooperators from the University of Georgia improved the design of an electrical "octet" extraction device to allow for variable control of voltage, and operation with a static or dynamic electrical field for different soil conditions. Worm extraction efficiency in a forest soil was 75%-100% depending on soil conditions, earthworm species and stage of growth. Similar extraction efficiencies were found in agronomic production systems, either with or without poultry litter. The device is labor and time saving and will be useful for producers and researchers wanting to accurately assess management effects on soil quality.