USDA United States Department Of Agriculture
Agricultural Research Service

NATIONAL PROGRAM RESEARCH ACTION PLAN

NATIONAL PROGRAM - 216
AGRICULTURAL SYSTEM COMPETITIVENESS AND SUSTAINABILITY

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE

28 February 2007

VISION

Problem-solving research that helps producers and other users develop integrated solutions to solve their challenges related to agricultural system productivity, profitability, energy efficiency, and natural resource stewardship.

BACKGROUND

American farms generate more than $200-billion in goods and services on 442-million acres. Profitable farms are also the basis of vibrant rural economies. Consumers benefit from agricultural production that provides abundant choices of products at relatively low costs. However, many farms are suffering from commodity prices that have remained relatively unchanged for decades, while the costs of fuel and other purchased inputs have continued to rise. In addition, there is increasing competition from overseas markets where production costs are comparatively low. At the same time, 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 are complex, so solutions to these challenges are not simple.

The twenty-one projects in USDA-ARS National Program *Agricultural System Competitiveness and Sustainability* (NP-216) use a similar interdisciplinary systems research approach to bring together the expertise needed to understand how different kinds of farms function and how changing or introducing new technology will affect their productivity, profitability, energy efficiency, and natural resource stewardship. Whether the ARS teams of scientists and universities and industry cooperators are in the Pacific Northwest, Southwest, Great Plains, Midwest, Southeast, or New England, they use their collective scientific talent to find the best combinations of practices for different farming systems to help producers achieve their production goals. NP-216 is one of six ARS National Programs in *Natural Resources and Sustainable Agricultural Systems* that conduct research at 70 locations comprising a nation-wide network dedicated to helping farms and ranches become more profitable while enhancing the environmental goods and services derived from agricultural lands.

NP-216 Agricultural System Competitiveness and Sustainability contributes towards USDA-ARS Strategic Plan Goal 2: *Enhance the competitiveness and sustainability of rural and farm economies* Objective 2.2: *Increase the efficiency of domestic agricultural production and marketing systems*, and Objective 2.1: *Expand domestic market opportunities*; and Strategic Plan Goal 6: *Protect and Enhance the Nation's Natural Resource Base and Environment*.

APPROACH

Participants at many of the USDA-ARS Customer Workshops have expressed their desire for holistic solutions to the problems they face on their farms. Not only do they want the best production methods, improved varieties, and advanced technologies research can provide, they want to know how these innovations can be best incorporated into their operations and whether their investment will increase their ability to compete in the market. Though many of kinds of problems producers face are the same across the country, it is accepted that every farm is different, so there are no “one-size-fits-all” solutions.

All locations and projects in Agricultural *System Competitiveness and Sustainability* (NP-216) conduct systems-level research to provide integrated solutions that enhance productivity, profitability, energy efficiency, and natural resource stewardship of different kinds and sizes of American farms. To gain a deeper understanding of the complexity of factors that affect the ways farms function, NP-216 research projects require collaborations among teams of scientists with backgrounds in biological and physical science, ecology, economics and sociology, engineering, mathematics and modeling, and computer science. This interdisciplinary approach often requires partnerships with university, other state and federal agencies, and industry cooperators to bring additional talent as needed to solve the complex problems producers face.

Agricultural System Competitiveness and Sustainability research focuses on six approaches to address whole-farm competitiveness and sustainability:

- Identify new configurations of practices that utilize on-farm resources and natural ecosystem processes to reduce the need for purchased inputs and thus reduce whole-system costs and risks.
- Develop precision management, automation, and decision support technologies to increase production efficiencies, reduce costs, and limit adverse impacts or even enhance natural resources quality.
- Develop strategies for incorporating sustainable bio-based energy production into existing farm enterprises to increase income diversity and contribute to whole-farm energy self-sufficiency.
- Incorporate consumer preference and supply chain economic information to expand market opportunities and demonstrate how producers can respond to changing markets and increase economic returns.
- Provide scientific knowledge and analyses to inform policymakers seeking solutions to increase agricultural profitability, efficiency, and competitiveness.
- Use industry, Federal, State, and local partnerships to identify and solve problems, convey research results and information transfer, and advance adoption of improved practices for different kinds and sizes of farms.

Diverse and dynamic agricultural systems that can adjust to changing environmental and market conditions should increase the long-term financial viability and competitiveness of farms, enhance natural resource quality, contribute to the vibrancy of rural communities, and increase the food and fiber security for the Nation and the world.

PLANNING PROCESS AND ACTION PLAN DEVELOPMENT

The problems that American agriculture producers face are similar, but the solutions for each are unique to regional or local conditions and personal management goals of each. Therefore, research priorities for systems research are identified through dialogue with a wide range of customers and stakeholders in a number of different venues to ensure that our research and the strategies we develop are relevant and provide effective solutions to their problems and needs.

Every five years, a workshop is held that brings together a broad cross-section of customers and stakeholder from across the country to meet with ARS field scientists and leadership. The second National Program Customer Workshop was held in Atlanta in October 2006. Approximately 140 people participated in the workshop including producers, representatives from regional and national agricultural organizations, university scientists, and administrators from ARS and other Federal and state agencies.

Prior to the workshop, each NP-216 research project asked their constituents to identify the most significant challenges they face that keep them from achieving their production goals. Written input was also provided by national and regional agricultural commodity and advocacy organizations. At the Atlanta workshop, our invited customers, stakeholders, and partners provided additional input through facilitated breakout sessions that focused on research direction and priorities for NP-216 projects. Input was also provided by the Chairperson of the external expert panel that reviewed the previous five years of accomplishments for NP-207 *Integrated Agricultural Systems* (the predecessor to NP-216). After the customer and stakeholder portion of the workshop, the ARS scientists began planning research for the next five years based on all of the input that was provided. Collaborative discipline and cross-cutting research topic teams were also formed who will partner during the next five-year research program cycle.

Based on the customer and stakeholder input, the Action Plan was developed by a writing team of scientists representing the different NP-216 projects around the country. The Action Plan serves to organize, coordinate, and communicate all research activities at the National Program level across all NP-216 projects. Each research project will complete the writing of their Project Plans by February 2008. Project Plans provide detailed information about the problems important to local and national customers and stakeholders, the specific research objectives and approaches that will be taken, anticipated products or information that will be produced, the roles and responsibilities of ARS scientists and their cooperators, and timelines and milestones to measure progress. All Project Plans will be reviewed for scientific quality by an independent panel of experts outside of ARS. ARS scientists use input from the review panel to revise and improve their planned research plans as needed.

Research progress will be communicated with customers and stakeholders throughout the next five-year period. Regular communication vehicles will be developed with interested national and regional agricultural organizations. Many aspects of NP-216 research involve active participation by our customers and stakeholders. The research projects address problems important to customers and stakeholders at the local and regional level, as well as problems of national interest that require collaborations among different projects. The technologies and strategies will be developed and shared in partnerships among the different projects.

CONTRIBUTING RESEARCH UNITS

Agricultural Land and Watershed Management Research Unit – Ames, IA
National Soil Dynamic Laboratory – Auburn, AL
Crops Systems and Global Change Laboratory – Beltsville, MD
Sustainable Agricultural Systems Laboratory – Beltsville, MD
Dale Bumpers Small Farms Research Center – Booneville, AR
Forage Seed and Cereal Research Unit – Corvallis, OR
National Peanut Research Laboratory, Dawson, GA
Agricultural Systems Research Unit, Fort Collins – CO
Northern Great Plains Research Laboratory – Mandan, ND
Genetics and Precision Agriculture Research Unit – Mississippi State, MS
North Central Soil Conservation Research Lab – Morris, MN
New England Plant, Soil, and Water Laboratory – Orono, ME
Soil and Water Conservation Research Unit – Pendleton, OR
The Vegetable and Forage Crop Research Unit, Prosser – WA
Land Management and Water Conservation Research Unit – Pullman, WA
U.S. Agricultural Research Station – Salinas, California
Northern Plains Agricultural Research Laboratory – Sidney, MT
Application and Production Technology Research Unit – Stoneville, MS
J. Phil Campbell Sr., Natural Resource Conservation Center – Watkinsville, GA
Integrated Farming and Natural Resources Research Unit – Weslaco, TX

RESEARCH COMPONENTS

COMPONENT 1. AGRONOMIC CROP PRODUCTION SYSTEMS.

The Action Plan Component *Agronomic Crop Production Systems* addresses research problems in agricultural systems dominated by the commodities including corn, soybean, cotton, peanut, wheat, barley, and turf and forage seed crops. The primary focus of research in this component is on understanding the underlying agroecological principles for how farms function so that new technologies and production strategies can be developed to increase production efficiency and profitability, while enhancing natural resource quality.

Problem 1A. The value of U.S. crop output in 2002 was 2.6 times higher than that in 1948, while the total amounts of production 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. Strategies and technologies are needed to reduce production costs and risks of economic loss.

Contributing Research Locations: Ames, IA; Auburn, AL; Beltsville, MD; Dawson, GA; Fort Collins, CO; Mandan, ND; Mississippi State, MS; Morris, MN; Pendleton, OR; Pullman, WA; Sidney, MT; Stoneville, MS; and Watkinsville, GA.

Objective 1A1. Develop economic risk averting management strategies that improve soil productivity, enhance soil and water conservation and nutrient cycling, and reduce fuel and pesticide use while enhancing the natural resource base.

Anticipated Products and Potential Benefits:

- Cost efficient conservation systems for the Mid-South cotton production region that have greatly reduced input requirement.
- Economically viable management system options for cereals grown across the different Inland Pacific Northwest region precipitation zones that reduce weed competitiveness and herbicide resistance while decreasing soil erosion and needs for purchased inputs.
- Optimal management strategies for corn, cotton, peanut and soybean production systems in the Southeastern region that incorporate conservation tillage and winter cover crops into rotations to conserve water, reduce herbicide resistance, lower production risks, and improve profitability.
- Identify the most productive cropping strategies in

Examining cotton boll samples grown in ultra narrow row widths and high plant populations using conservation tillage and various cover crops.

relation to overall soil biological activity and various soil quality indicators for conservation tillage practices in both irrigated and dryland cropping rotations in the Northern Great Plains.

- Optimal production systems for the upper Midwest region that reduce negative environmental impacts compared with existing corn-soybean management practices.
- Recommendations for mid-Atlantic region organic grain farmers to select crop rotations that meet the agronomic, economic, and environmental goals based on knowledge of fundamental ecological processes underlying soil biological function and its effects on nutrient cycling and weed control.

Nuclear Magnetic Resonance is used to examine the molecular structure of extracted soil organic matter constituents.

- Diversified alternative crop rotations for the semi-arid Northern Great Plains under zero till conditions that optimize soil health, soil biological diversity, biologically-based cropland weed control, residue management, water quality, and net returns.
- Management strategies based on estimates of the relative economic risks in Upper Midwest corn-soybean production systems to help farmers evaluate new crops for diversifying rotations, or when deciding to convert to organic production.
- Decision aid for selecting optimal crop rotation sequences in Northern Great Plains semi-arid environments.
- Decision tools to assess economic and agronomic benefits and costs of adopting best management practices for conservation corn, cotton, peanut and soybean production systems in the Southeast region.
- Risk assessment framework for Midwest region corn-soybean cropping systems that incorporate cover crops as an agronomic management practice.

Objective 1A2. Develop specific conservation management practices and document their benefits on natural resource quality for agronomic crop production systems.

Anticipated Products and Potential Benefits:

- Soil management strategies for Mid-South and Southeast cotton production systems on alluvial soils that improve water and nutrient availability and reduce the time and money spent on production.
- Conservation implements and strategies for managing and terminating winter cover crops in row crop systems on Mid-South alluvial soils and Southeast crop production systems.
- Improved conservation practices that minimize weed competition, wind erosion susceptibility, and maintain profitability compared to traditional winter wheat-fallow production systems.

- Alternative conservation systems that include direct-seed organic, perennial- and annual-based no-till systems for both small and large farms.
- A method for seeding winter wheat on precise contours to prevent water erosion and reduce overlap of agrichemical and crop inputs in conventional summer fallow fields of the dryland Pacific Northwest.
- Develop new seeding technologies for improved no-till drill performance in conservation tillage systems.
- Specific soil and residue management practice recommendations for dryland production in the semi-arid Northern Great Plains to improve soil water retention, reduce compaction, reduce commercial fertilizer use, and minimize the use and negative impacts of agricultural chemicals.
- Management guidelines for limiting export of nutrient nitrogen and phosphorus and fecal indicator organisms to enhance water quality using farm ponds and other impoundment technologies in agricultural watersheds.
- Science-based estimates based on mechanistic crop and soil simulation models for production scenarios to evaluate the economic and environmental impacts for crop production systems including the effects of global climate change.

Objective 1A3. Provide science-based guidelines to help USDA-NRCS support landowner participation in USDA Farm Bill Conservation Title programs.

Anticipated Products and Potential Benefits:

ARS scientists examine a map of fiber quality data created with a geographic information system.

- Management guidelines and predictions of erosion prevention for application of small grain cover crops to corn-soybean rotations at the landscape scale in the Upper Midwest.
- Technical guidelines for western Oregon direct-seeded, high residue management grass seed production systems.
- Guidelines for enhancing wildlife habitat quality in western Oregon grass seed production landscapes.
- Guidelines for non-irrigated Pacific Northwest residue management practices for reducing soil water and wind erosion.
- Tillage guidelines that assess the conservation benefits from using reduced tillage in irrigated and rain-fed high value potato production systems.
- Guidelines for adoption of new conservation technologies into cotton production systems in the Midsouth region.
- Guidelines documenting the benefits from using cover crops to counter the effects of tillage in organic production systems.

- Guidelines for integrated production practices that can be combined to meet conservation goals for organic farmers.
- Improved coefficients for transport and management models used in the Phosphorus-index.
- Guidelines for assessing land use practices for offsite transport of microbes and nutrient conservation in forage-based animal production systems.

Problem 1B. The United States has embarked on an ambitious program to replace a significant portion of petroleum-based transportation fuels with bio-based sources from agriculture. Producers, government agencies, energy companies, and policy makers need to know how to best produce energy crops in different agricultural regions of the country and what would be the likely impacts of energy production on whole-farm economic return and natural resource quality.

Contributing Research Locations: Ames, IA; Auburn, AL; Beltsville, MD; Corvallis, OR; Dawson, GA; Fort Collins, CO; Mandan, ND; Morris, MN; Orono, ME; Pendleton, OR; Prosser, WA; Pullman, WA; Watkinsville, GA; and Weslaco, TX.

Objective 1B1. Identify optimal economic strategies for different U.S. production systems that wish to incorporate bio-based energy production without disrupting agricultural diversity and compromising natural resource quality.

Anticipated Products and Potential Benefits:

- Best management practices that balance biomass yield and soil productivity when integrating bio-based energy production into Midwest row crop agricultural systems.
- Strategy for incorporating on-farm energy production into the annual farm operation cycle of Pacific Northwest grass seed and cereal producing systems.
- Economically and environmentally optimal strategies for harvesting winter cover and cash crop biomass for biofuel production from diversified Southeast farms.
- Management guidelines for removal of crop residues for ethanol production and its impacts on carbon sequestration and soil health in irrigated potato production systems in the Pacific Northwest. Guidelines for the incorporation of ethanol producing perennial crops in irrigated production systems.
- Identification of reduced risk strategies for diversified irrigated and dryland cropping sequences that include bioenergy crops in the semiarid Northern Great Plains.

A biodiesel-powered tractor heads to a dairy barn at BARC. The center uses B20, a common biodiesel blend, in its entire fleet of over 150 diesel vehicles.

- Guidelines for removal of cereal crop residues for ethanol production and its impacts on carbon sequestration and soil health across Inland Pacific Northwest precipitation zones.
- Determine the potential for Russian thistle and other weeds for relay cropping forages or thermochemical conversion.
- Agronomic and pest management strategies for integrating biofuel, bioproduct, and other alternative crops into Pacific Northwest dryland cereal production systems.

Objective 1B2. Develop technologies to support sustainable local-based energy production to enhance rural economic development.

Anticipated Products and Potential Benefits:

- Whole-farm economic optimization tool to estimate financial and environmental costs and benefits of local-based bioenergy production.
- Mechanistic crop and soil simulation tools and databases to evaluate the economic effects, resource use, and environmental impacts of strategies for biofuel production.
- An index for determining the environmental and economic impacts of biofuel production into Northern Great Plains integrated farm systems.
- Enhanced systems models and decision aids that evaluate the potential of biomass productions for energy while maintaining soil and environmental quality.
- Adapted scalable thermochemical technology suited to on-farm or local-scale energy production from crop residues.
- Biofuel decision tool to assess the collective impacts of biofuel production on soil nutrient levels.
- Decision tool to analyze regional impacts of biobased energy production and trade-offs between economics and environmental services for semi-arid Northern Great Plains production systems.

Objective 1B3. Develop strategies for on-farm recycling of by-products from agricultural-based energy production.

Anticipated Products and Potential Benefits:

- Guidelines provided for straw ash chemical composition to facilitate government regulatory agencies allowing thermochemical byproducts to be applied to crop fields.
- Field application guidelines for ash derived from thermochemical conversion of grass and cereal straw to benefit soil fertility and agricultural sustainability.

ARS scientists have shown that straw residue doesn't have to be removed by burning but can instead remain on the field to decompose without reducing future seed yields.

- Development of integrated weed management practices for potato production systems that utilize the weed suppressive properties from Brassica seed meals and dried distillers' grains.

Resources: Accountability for research will be assigned to the lead scientist whose project is aligned with this component: Ames IA, J. Singer; Auburn AL, R. Raper; Beltsville MD, M. Cavigelli and J. Teasdale; Corvallis OR, S. Griffith; Dawson GA, M. Lamb; Fort Collins CO, L. Ahuja; Mandan ND, J. Hendrickson; Mississippi State MS, J. Jenkins; Morris MN, A. Jaradat ; Orono ME, C. Honeycutt; Pendleton OR, D. Long ; Prosser WA, H. Collins; Pullman WA, F. Young; Sidney MT, R. Evans; Stoneville MS, G. Sassenrath; Watkinsville GA, H. Schomberg; and Weslaco TX, L. Zibilske.

COMPONENT 2. SPECIALTY CROP PRODUCTION SYSTEMS.

The Action Plan Component *Specialty Crop Production Systems* is focused on problems in agricultural systems producing high value crops including potatoes and fresh market vegetables. The value of U.S. specialty crops is greater than the combined value of corn, soybean, wheat, cotton, and rice crops. The products produced must be of sufficient quality to meet high market and consumer preference standards. Producers wishing to produce high value specialty crops may face significant barriers to the development and marketing of new products.

Problem Statement 2A. High-value specialty crop production typically requires costly intensive practices to achieve profitable production of suitable market quality. Alternative management strategies are needed to reduce production costs but have neutral or positive impacts on yield, product quality, and risk of economic loss.

Collecting data on weed seedling growth between rows of a young cover crop at USDA's 17-acre certified organic research plot in Salinas, California.

Contributing Research Locations: Auburn, AL; Beltsville, MD; Orono, ME; Prosser, Salinas, CA; Sidney, MT; and Weslaco, TX.

Objective 2A1. Identify management practices to lower total production costs and maintain market quality.

Anticipated Products and Potential Benefits:

- Potato management practices that increase soil carbon sequestration and decrease greenhouse emissions from high nitrogen fertilizer inputs.
- Identification of suitable cover crops and associated management practices that are economical and enhance soil and water natural resource quality in specialty crop systems.
- Defined soil and cropping system management practices that reduce plant water stress in Northeastern potato

production systems.

- Tillage guidelines that assess the sustainability of reduced tillage in irrigated and rain-fed potato production systems.
- Management guidelines for nitrogen fertilizer application rates and timing for potato grown under reduced tillage, high residue conditions.
- Comparison of conventional and reduced tillage impacts on potato yield and quality for both processing and fresh markets.
- Improved hairy vetch cultivars with enhanced winter hardiness and earlier flowering to expand the use range of this nitrogen-fixing cover crop.
- Development of a conservation strip tillage system for Northern Great Plains sugarbeet production to substantially reduce fuel use, with recommendations for pest, fertilizer, irrigation, and harvest management.
- Guidelines for Northern Great Plains irrigated potato-sugarbeet systems based on combinations of soil and crop management practices and their impacts on soil carbon and nitrogen inputs from crop residues.
- An economic assessment of incorporating cover crops, reduced tillage, and rotation energy crops into potato production systems.
- Determination of the effects of rotation and cover crops on the yield and quality of specialty crops.
- Management strategies based on knowledge of how soil properties, plant diseases, and water availability affect the yield, quality, and profitability of potato, leafy vegetables, and other high value crop production systems.

The fungus Cercospora beticola, which causes leaf spot disease, is developing resistance to some fungicides currently used against it.

Objective 2A2. Develop ecological-based pest management strategies that enhance yields and market quality, while reducing the need for pesticides.

Anticipated Products and Potential Benefits:

- Suitable rotation crop sequences and other practices recommended that enhance biological control of specific soilborne diseases and weeds in specialty crop systems.
- Estimation of the biological efficacy of using oilseed cover crops to reduce synthetic pesticide inputs for control of plant pathogens and nematodes in potato production systems.
- Guidelines for improved control of volunteer potatoes in reduced tillage crop rotations.
- Improved tillage management techniques for sprinkler irrigated potato-sugarbeet rotations that utilize biologically based pest control and residue management strategies.

- Systems level preventative control strategies for pest and weed management in organic production systems based on understanding of the underlying ecological processes.
- Evaluation of the quality, nutrition, and safety of marketed products from diverse production conditions.

Problem Statement 2B. Profitable alternative rotation crops are needed to enhance whole-system agroecological function, increase economic return, and reduce production risks. However, market barriers often exist when introducing new crops into existing systems due to lack of supply chain infrastructure and knowledge of consumer needs and market capacity.

Contributing Research Locations: Beltsville, MD; Fort Collins, CO; Orono, ME; Prosser, WA; Salinas, CA; Sidney, MT; Weslaco, TX.

Objective 2B1. Identify whole-system management strategies based on enhanced agroecological functions when including alternative crops in rotations to reduce income variability and risk of economic loss to producers.

Inspecting leaves of red chard on an organic farm in San Juan Bautista, California.

Anticipated Products and Potential Benefits:

- Suitable alternative crops to diversify rotations that are profitable themselves or increase potato yield and quality.
- Profitable multi-cropping strategies and resource management plans for promoting organic and other small-scale direct marketing farmers in the mid-Atlantic urban corridor.
- Improved multiuse soybeans cultivars that provide better quality vegetable beans, opportunities for industrial or energy products, and greater flexibility for forage.
- New decision making technology for selecting sustainable systems that include alternative and specialty crops under limited water conditions.
- Identification of optimal rotation sequences that reduce reliance on off-farm inputs to increase the profitability of the production system.
- Economic conservation management strategies for small and limited resource vegetable farmers in the Southeast states that incorporate high residue summer and winter cover crops.

Objective 2B2. Develop production systems that meet new market opportunities and improve producer profitability and competitiveness.

Anticipated Products and Potential Benefits:

- A business plan based on production systems results and interagency partnerships to specify New England market capacity and quality requirements for regionally produced specialty crops that reduce the risk of economic loss by the Maine potato industry.
- Estimate of market competitiveness for a potential olive oil industry based on the development of new adapted genetic lines and their introduction into Texan production.
  - System options that supports local and regional rural development programs to attract value-added industries to economically depressed areas in the Northern Great Plains.
  - Production practice guidelines for specialty market potatoes with enhanced phytonutrients and other nutritional traits including glycoalkoloids and folic acid.
- Cropping systems development that supports local and regional rural development programs to attract value added industries to economically depressed areas in the Northern Great Plains.

A plot of barley interseeded with red clover. Behind it are crops of mustard, canola, and sweet corn, evaluated by ARS scientists for their effects on soilborne disease, nutrient availability, soil physical properties, and more.

Resources: Accountability for research will be assigned to the lead scientist whose project is aligned with this component: Auburn AL, R. Raper; Beltsville MD, J. Teasdale; Fort Collins CO, L. Ahuja; Orono ME, C. Honeycutt; Prosser WA, H. Collins; Salinas CA, E. Brennan; Sidney MT, R. Evans; and Weslaco TX, L. Zibilske.

COMPONENT 3. 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.

Problem 3A. Whole-farm management approaches are lacking that take advantage of the complimentary benefits that could be produced by combining complimentary production enterprises. To assist farmers wishing to transition to more integrated whole-farm systems, research is needed to determine the relative amounts of risk of economic loss and potential trade-offs between economic and environmental outcomes for multiple-enterprise agroecosystems compared to specialized production systems.

Examining a previous crop's residue that remains after seeding with a no-till drill.

Participating Research Locations: Booneville, AR; Mandan, ND; Pendleton, OR; Pullman, WA; Watkinsville, GA.

Objective 3A1. Determine the important agroecosystem properties of multiple-enterprise that can be used to optimize whole-farm economic and natural resource sustainability.

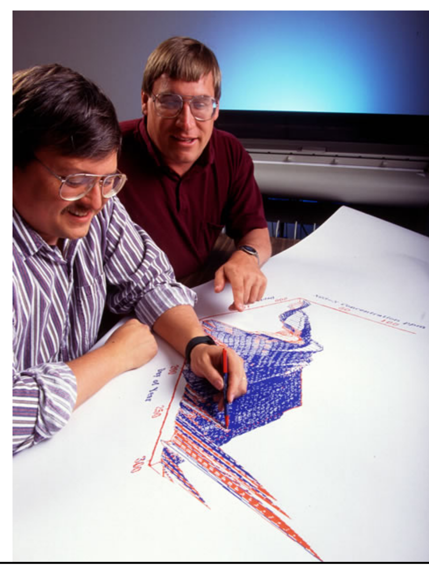
Anticipated Products and Potential Benefits:

- Assessment of the economic and environmental attributes of inland Pacific Northwest integrated crop-livestock systems.
- Assessment of economic and environmental benefits and risks associated with grazing cover crops in conservation systems in the Southern Piedmont.
- Comparative economic and environmental assessment of integrated crop-livestock and non-integrated direct-seeded organic systems and small farms.
- Quantify the effects of establishing and maintaining alley cropping, shelter belts, forest farming, and riparian buffer agroforestry practices on natural resources quality at the field and whole farm scale.
- Quantify potential economic returns and increase understanding of the market forces that affect new products derived from agroforestry systems.
- An assessment for the economic and environmental benefits and risks associated with establishing and maintaining alley cropping, shelter belt, forest farming and riparian buffer agroforestry practices for low-resource farms.
- Economic assessment for integrated crop-livestock production systems in the semi-arid northern Great Plains.

Objective 3A2. Provide science-based guidelines to help landowners make sound whole-farm resource management decisions.

Anticipated Products and Potential Benefits:

- Management guidelines for incorporating perennials into Northern Great Plains annual cropping systems.
- Management recommendations for site selection, establishment, and maintenance of alley cropping, shelter belt, forest farming and riparian buffer agroforestry practices at the field and whole-farm scales.



The Root Zone Water Quality Model (RZWQM) is used to examine nitrate distribution in a simulated soil profile. The model enables scientists to forecast potential environmental pollution, such as from excessive nitrate leaching.

- Website that allows producers to make management decisions by comparing early-season rangeland condition at reference sites with the condition of previous years to support integrated whole-farm management decisions.
- Strategies to manage integrated livestock-row crop systems in the Southern Piedmont to reduce spatial and temporal impacts on soil and water quality and increase economic stability.
- Decision aids for integrating livestock into pasture forage phase of direct-seed organic production systems and small farms.
- Management practice guidelines to reduce spatial and temporal impacts of cattle in an integrated cattle-cotton production system for the Southern Piedmont region.
- A decision aid that provides producers with information on evaluating multiple enterprise management alternatives.

Resources: Accountability for research will be assigned to the lead scientist whose project is aligned with this component: Booneville AR, D. Burner; Mandan ND, J. Hendrickson; Pendleton OR, D. Long; Pullman WA, F. Young; and Watkinsville GA, H. Schomberg.

COMPONENT 4. INTEGRATED TECHNOLOGY AND INFORMATION TO INCREASE CUSTOMER PROBLEM SOLVING CAPACITY.

This component of the Action Plan focuses on the development and use of technology to increase production system efficiency by customers and stakeholders. ARS customers not only want the latest information and best technology research can provide, but also how these innovations can be best incorporated into their operations. Also important is whether the use of new technology will increase their ability to compete in the market or deliver their services. Understanding the system level impacts of implementing new technology will help increase adoption and reduce the 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.

Inspecting the root system of a cotton plant sown into a rye cover crop.

Problem Statement 4A. Researchers and stakeholders need methods to understand the best ways new production technologies and management systems should be delivered so producers can more easily adopt them.

Contributing Research Locations: Auburn, AL; Mandan, ND; Orono, ME; Stoneville, MS; and Watkinsville, GA.

Objective 4A1. Identify the most appropriate methods for delivering new information and technologies to promote adoption by customers and stakeholders.

Anticipated Products and Potential Benefits:

- Assessment of the socio-economic factors affecting the adoption and retention of integrated agricultural systems technologies.
- Outreach methodologies and strategies that promote the adoption and retention of integrated agricultural systems technologies.

Objective 4A2. Develop customer-based indicators and metrics to determine the impact of new information and technology used by customers and stakeholders.

Anticipated Products and Potential Benefits:

- Assessment tools to measure the efficacy of outreach methods for promoting the adoption of new technologies and presentation of information to producers and customers.
- Response tools that customers and stakeholders use to provide feedback to ARS on the relative success of research adoption.
- Measurement methods and metrics of the impacts of agricultural systems research, new technologies developed, and generated agricultural knowledge on the agronomic and economic performance of producers.

ARS scientists examine the installation of a stem flow collar on a peanut stem in an irrigated test plot. Stem waterflow is monitored continuously to examine responses to irrigation, precipitation, and other environmental conditions.

Objective 4A3. Develop a set of management principles that are common to agricultural systems across production regions that reduce risks, improve competitiveness, and promote environmental stewardship.

Anticipated Products and Potential Benefits:

- Identification of key drivers of agricultural production systems, definition of their role in developing current production systems, and measures of the potential impacts of future innovations.
- Identification of the underlying principles and guidelines that should be used for developing integrated agricultural systems and their use in research and farm operation management.

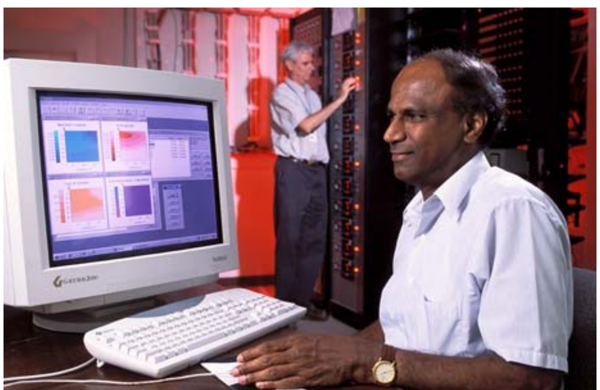
Problem Statement 4B. There is need to determine the technical limits and feasibility of integrating new technologies to ensure that their use will increase agricultural efficiency and economic competitiveness.

Contributing Research Locations: Beltsville, MD; Corvallis, OR; Dawson, GA; Fort Collins, CO; Mississippi State, MS; Pendleton, OR; Pullman, WA; Sidney, MT; and Stoneville, MS.

Objective 4B1. Improved production efficiencies through precision management, automation, and decision support technologies that reduce agricultural chemical and irrigation water use.

Anticipated Products and Potential Benefits:

- Guidelines for irrigation scheduling under conservation practices and systems.
- A high-speed digital information management system to collect, store, use, and transfer data for precision management decisions.
- An integrated system using aerial remote sensing and variable rate application technologies to relate field-crop-pest ecology for improved invertebrate pest management.
- Crop and soil simulation tools and databases for reducing purchased inputs and evaluating the economic and environmental impacts of crop production systems, including the effects global climate change.
- Enhanced whole system models and decision aids to help optimize and reduce crop production risks from limited water, nutrients, and other inputs under varying soil and weather conditions.
- Procedures for analyzing combine yield monitor and other GIS data for incorporation in precision agriculture methodology and decision-making processes to improve production input efficiency.



Data gathered in soybean growth chambers is used to develop an accurate model for simulating growth with computer models.

- An inexpensive approach to characterize the agricultural production practices used in fields across landscapes using remote sensed data.
- Enhanced models and decision aids for optimizing forage and crop residue management for livestock production under varying weather/climate and soil conditions.
- A Web-based approach to obtain and distribute weather information used in pest management decision tools.
- Improved Web-based pest management decision-support tools that include uncertainty estimates.
- Web-based self-assessment tool for developing landowner conservation plans.
- GPS-based and microprocessor-controlled technology for self-propelled sprinkler irrigation systems that allow site-specific precision applications.

- A sensor-based irrigation scheduling decision support system for enhanced, on-the-go management of self-propelled water application systems.

Objective 4B2. Increase production system competitiveness by technology that enhances farm gate product quality consistency.

Anticipated Products and Potential Benefits:

- Method for applying combine harvester yield monitors and protein sensors information to segregate grain into different quality classes at harvest.

- Improved remote sensing techniques for estimating wheat nitrogen status at mid-season and predicting expected grain protein response to late-season fertilizer applications.
- Site-specific decision aids for precision cereal production systems based on geospatial integration of terrain modeling, remote sensing, and site-specific grain yield and quality data.
- Method for segregating grain into different quality classes at harvest using information from combine harvester yield monitors and protein sensors.

A chlorophyll meter measures cotton leaf color to evaluate plant growth and nutrient uptake.

Problem Statement 4C. USDA-ARS long-term systems research experiments have produced extensive data sets for physical, chemical and biological indicators, but this information has not been available in accessible forms for use by other researchers, agencies, and non-traditional customers.

Contributing Research Locations: Beltsville, MD; Corvallis, OR; Dawson, GA; Fort Collins, Co; Morris, MN; Orono, ME; Pendleton, OR; Pullman, WA; and Watkinsville, GA.

Objective 4C1. Conduct an inventory of long-term ARS experiments and datasets that can be organized as metadata for access by other researchers, agencies, and non-traditional customers.

Anticipated Products and Potential Benefits:

- A metadatabase that provides a basic description of each long-term experiment and the types of data that have been collected in the past and that will be collected in the future.
- A schema design for incorporating long-term system experiment economic and biophysical data into the Steward's Database.

Objective 4C2. An inventory of ARS decision tools for making multi-objective assessments of the impacts from agricultural systems on field-to-landscape scales.

Anticipated Products and Potential Benefits:

- A database of ARS biophysical and economic decision and assessment tools with a description of their specifications.
- An assessment of the technical limits and applicability of economic and natural resources assessment tools for estimating agricultural production impacts.
- A component level framework for integrating and reusing economic and environmental decision tools for making multi-objective assessments and to identify knowledge gaps.

Native wetland plants have been established in a seasonal drainage next to a perennial ryegrass seed field.

Problem Statement 4D. Integrated multiple-objective economic and environmental effects assessments are needed at varying scales for agricultural systems across the United States.

Contributing Research Locations: Ames, IA; Beltsville, MD; Corvallis, OR; Fort Collins, CO.

Objective 4D1. Develop an approach to assess the economic and environmental impacts of agriculture across broad landscapes.

Anticipated Products and Potential Benefits:

- Web-based database containing experimental and model-simulation data of management effects on economic and environmental indicators.
- Science based crop and soil simulation tools that utilize databases for input management, provide assessments of economic and environmental impacts for crop production systems, and incorporate the effects of global climate change.

Objective 4D2. Develop a scalable assessment model framework to identify optimal integrated solutions that help producers meet their multiple-objective production and environmental quality goals.

Anticipated Products and Potential Benefits:

- A database of the tradeoffs to achieve the multiple goals of 13 ARS watersheds for the USDA Conservation Effects Assessment Project (CEAP).
- An index that estimates the impacts of farm production, conservation, and policy strategies on rural economies for use in the ARS Economic Bio-physical Optimization Model.

- A method to integrate simulation models and databases to provide a multi-objective assessment tool to evaluate economic and environmental sustainability on a water-shed level scale.
- A pest management component for the Economic Biophysical Optimization Model.

Resources: Accountability for research will be assigned to the lead scientist whose project is aligned with this component: Ames IA, J. Singer; Auburn AL, R. Raper; Beltsville MD, D. Timlin; Corvallis OR, S. Griffith; Dawson GA, M. Lamb; Fort Collins CO, L. Ahuja; Mandan ND, J. Hendrickson; Mississippi State MS, J. Jenkins; Morris MN, A. Jaradat; Orono ME, C. Honeycutt; Pendleton OR, D. Long; Pullman WA, F. Young; Sidney MT, R. Evans; Stoneville MS, G. Sassenrath; and Watkinsville GA, H. Schomberg.