Integrated Agricultural Systems National Program
FY2004 Annual Report

Introduction

Research in the Integrated Agricultural Systems National Program (NP-207) is unique in that the focus is on identifying linkages among different crop, livestock, and natural resource components to determine how entire agricultural systems respond to new or changing practices to optimize profit and environmental benefits. Producers desire a range of problem-solving options to choose from when making decisions for their specific operation. In this program, not only are the effects of practices on commodity production determined, but also the impacts on economic return and natural resource quality. In many cases, there is no single best solution for all producers, but multiple alternatives for producers to choose from that best meet their needs.

To better understand system effects, it is important that the results be interpreted at a scale larger than small experimental research plots. To do this, new methods and technologies are being developed to measure experimental and environmental variation across fields, farms, watersheds, or entire regions. Often systems research is coordinated with large numbers of producers, with data collected directly from their operations. Producers can be active participants in systems research, not only giving access to their farms, but also providing their perspectives and observations to help guide research questions and direction.

This annual report contains highlights of accomplishments from 44 USDA-ARS research projects in 24 states whose common purpose is to provide agricultural producers the information they need to make informed decisions when considering the best economically feasible and environmentally sound choices for their operations. The accomplishments for this year are presented under four National Program component headings: Cropping Systems, Integrated Crop and Animal Systems, Site Specific Management and Precision Agriculture, and Decision Support Systems.

Cropping Systems

It is important to understand how changing a single cropping practice can impact an entire production system. Integrated Agricultural Systems projects will often identify a problem and possible solution, and then determine what other practices need to be adjusted as well to reach a desired outcome. These kinds of research are demonstrating how agriculture can be economic and compatible with natural resources.

South Texas Conservation System being Accepted. Excessive cultivation and wind erosion in the Lower Rio Grande Valley of south Texas has caused soil organic matter to decrease from 4% at time of settlement to as low as 0.3% today. To improve soil productivity, ARS Scientists at the Kika de la Garza Subtropical Agricultural Research Center, Weslaco, TX developed an integrated conservation tillage system that trades most tillage trips over cotton and sorghum fields for a blanket of stems, leaves, and stalks.

Their research showed that when using this system, organic matter doubled in a nine-year period and soil loss to wind erosion was prevented. In fact, soils with 60% crop residue cover accumulated soil blown from nearby fields. The researchers also developed ways to effectively control weeds without extensive tillage that was critical for success. Not only were these conservation practices beneficial for protecting soil from wind erosion, farmers have accepted these practices because production costs were reduced giving them greater profits. An added benefit of this research was the conservation tillage systems were more productive during drought periods. Because of these multiple benefits, this integrated cropping system approach has been adopted on more than 100,000 acres in the Lower Rio Grande Valley of south Texas.

Other Conservation Tillage Systems are Economical. Progress from ARS research in other regions is also proving conservation tillage systems to be both effective for protecting natural resources and economical. Iowa strip tillage systems produced the greatest profit and had the lowest economic break-even point among seven common corn establishment systems (National Soil Tilth Laboratory, Ames). Annual deep tillage was shown not needed for cotton grown in soils with a hard layer underneath the surface. Even though root growth may be reduced, deep tillage once every two or three years was enough to maintain yields, saving growers the annual expense of the costly deep tillage operation (Coastal Plain Soil, Water, and Plant Conservation Research, Florence, SC). Researchers at the National Soil Dynamics Laboratory at Auburn, AL showed there are situations when not only are production costs reduced using conservation tillage, but crop productivity may immediately respond positively when conventional tillage ceases. Contrary to widespread belief, farmers do not need to wait several years for results. This should help the conservation system be more readily accepted by industry.

An Agricultural System that Benefits Wildlife. ARS scientists at the Forage Seed and Cereal Research Unit, Corvallis, OR are not only showing the benefits of direct seeding and vegetative buffers to reduce agricultural nutrient and sediment movement from fields to waterways, but also how agricultural drainages and nearby trees can benefit wildlife. Working with partners from Oregon State University Department of Fisheries and Wildlife, it was shown that native fish use seasonal streams near grass seed fields during the winter. Nutrient and sediment concentrations in these drainages were generally less than those reported to adversely affect fish health, and some fish species even used these drainages to reproduce. Also, trees naturally growing in fields along drainages where shown to provide habitat for winter songbirds. University of Massachusetts and ARS scientists in Corvallis showed seventeen-times more birds were found along forested than non-forested drainages, but only 15% of the total land cover was needed to be in trees to maximize songbird diversity. This research shows in addition to providing farmers income from their crops, the seasonal drainages and vegetation near their fields are providing valuable habitat supporting native fish and bird populations in a landscape that is significantly impacted cities and towns. Because aquatic wildlife protected under Endangered Species Act can be sensitive to high concentrations of sediment and nutrients found in field runoff, these findings will support landowner applications for conservation program payments under the USDA Farm Bill and help demonstrate compliance with provisions of the Clean Water Act.

Combinations of Practices Can Reduce Soil and Pesticide Movement to Oxbow Lakes. In another environmentally sensitive region, researchers at the National Sedimentation Laboratory (NSL) in Oxford, MS are identifying combinations of in-field and next-to-field conservation technologies to reduce pollution and enhance aquatic wildlife habitats. Over 100 kinds of vertebrates including amphibians and migrating songbirds use these agricultural landscapes. Using field research results and computer models, the NSL researchers found conservation systems that feature reduced tillage and letting weeds grow as winter cover in fields combined with placing small impoundments at the edges of fields where water from fields drains, sediment loading is reduced 90% into oxbow lakes where wildlife is sensitive to pesticide and nutrient runoff. By combining agricultural conservation practices with natural systems of drainage ditches and wetlands, landowners can not only clean agricultural runoff water before it enters rivers and lakes, but also provide habitat that serves essential functions for many vertebrates. Amphibians, possibly on worldwide decline, used pools for reproductive habitat and migrating songbirds made major use as well. These findings are being used to establish Total Maximum Daily Load target levels for sediment, assess the natural nutrient needs for fisheries production in oxbow lakes, and provide NRCS with enhanced watershed planning tools.

Integrated Crop and Animal Systems

Developing Agricultural Systems by Integrating Crop and Animal Research with Computer Decision Support. Research by scientists at the U.S. Dairy Forage Research Center, Madison, WI is showing how modifying diets of confined dairy cattle can increase milk productivity while reducing environmental impacts. When birdsfoot trefoil with optimal tannin levels was fed in place of tannin-free alfalfa, dairy cattle produced 15% more milk and excreted 20% less urinary nitrogen - a form of nitrogen readily lost to the atmosphere. The increased milk production and reduced adverse environmental consequences of dietary condensed tannins are due to improved protein utilization by dairy cattle. Using the ARS Integrated Farm System Model (Pasture Systems & Watershed Research Unit, University Park, Pennsylvania), the Madison researchers predict Wisconsin dairy farms would experience long-term profit increases of up to 12% and reduced nitrogen losses of up to 25% if dairy farms produced and fed an alfalfa with moderate tannin levels. This work demonstrates how integrated crop and animal research using computer decision support can provide a road map to develop agricultural systems that are both economic and environmental friendly.

Site Specific Management and Precision Agriculture

Crop yields can vary greatly across fields because of soils and topography variability can interact with year-to-year differences in annual precipitation amounts. When farmers manage all portions of their fields the same, some parts may receive too much fertilizer, while other parts not enough. Using real-time evaluations of soil and plant conditions at

any place across a field and then applying a practice to match the need could reduce production costs and minimize negative impacts to natural resources. From the ground, to remote controlled model airplanes and aircraft flying overhead, to satellites in space, ARS scientists are developing site-specific management strategies and technologies to increase farm profits with the least impact on natural resources.

Management Zone Strategies to Optimize Purchased Farm Inputs. At the National Soil Tilth Laboratory at Ames, IA, researchers are finding the best methods based on terrain and chemical characteristics of the soils to predict where different amounts of fertilizer can be applied to optimize corn and soybean yields. Soybean yield was affected more than corn by soil pH and field depressions that collect water. Also, poor-drained field conditions reduced yields in wet years, but not in dry years. Similarly, scientists at the Soil and Water Conservation Unit at Lincoln, NB are showing the best strategy for managing corn production during a season is to combine information based on established management zones within fields with satellite images evaluating the crop during the growing season. Doing so, precision applications were most beneficial during years with typical precipitation amounts, than during the wettest and driest years. ARS scientists at the Application and Production Technology Research Unit in Stoneville, MS collaborating with economists are showing that precision application technology may be better-suited to maximize net return than crop yield, and are determining the kinds of farming operations where this technology is best suited.

New Precision Agriculture Technologies Developed. At the Cropping Systems and Water Quality Research Unit in Columbia, MO, scientists have developed a soil strength sensor that can simultaneously take measurements at five depths while moving across a field. This technology will help identify areas within fields where costly tillage practices are most needed to overcome soil compaction that adversely affects crop yield. The Genetics and Precision Agriculture Research Unit at Mississippi State, MS developed a wireless local area network to use with variable rate farm equipment controllers. With this new wireless technology, agricultural consultants do not have to hand-deliver and directly downloaded geographic information system maps to the application equipment, saving farmers time during critical production operations.

Decision Support Systems

Desktop computers and the Internet provide farmers, conservation planners, and policy makers unprecedented access to information for making decisions. ARS scientists are taking their research results and developing computer decision aids to help agricultural specialists choose the best combinations of production practices that are economically feasible and environmentally sound.

Decision Support Tools Expanded for Farmer Use. The Integrated Farm System Model developed by the Pasture Systems & Watershed Research Unit at University Park, Pennsylvania was expanded to describe the how dairy cattle diet affects manure excretion. Also, the affects of kinds of pasture plant mixtures on pasture dry matter production was added. These additions will help dairy and beef cattle producers choose

the most efficient integrated pasture and livestock systems for their farm conditions that are also environmentally sound. Also, the National Peanut Research Laboratory in Dawson, GA has expanded the Irrigator Pro model for use with cotton and corn. It has been shown using Irrigator Pro for peanut production can increase farmer net income $130 per acre. Scientists from the Vegetable and Forage Crops Production Research Unit in Prosser, WA, the Crop Systems and Global Change Laboratory, Beltsville, MD, and cooperators from Washington State University have incorporated the Simpotato simulation model into the CropSystVB multiple year crop rotation decision aid. The model can now be used as a guideline for optimal management of water and fertilizer for potato crops to maximize the nitrogen uptake efficiency and minimize the amount of unused nitrogen by the crop that can potentially pollute water. The CropSystVB model predictions have shown that nitrogen unused by Washington potato crops can vary from 30 to 100 pounds per acre, depending on the cropping year, rate and method of nitrogen application, and water management. This research shows a great deal can be done to improve nitrogen crop use efficiency.