NP 207 FY 2002 Annual Report

Introduction

Many times the products of agricultural research provide increased knowledge of the workings of individual components in a farming or ranching system. These individual pieces of knowledge, however, are often not enough for a farm manager to make decisions. The manager must also integrate an array of other information or data, often without information on the repercussions of a decision on other farm system components, economics, and the environment. The goal of the Integrated Agricultural Systems National Program is to help producers understand and apply research-based information for the development and management of effective sustainable production systems within the context of their ecosystems and communities. Research emphases within this National Program include: Cropping Systems, Integrated Crop and Animal Systems, Site Specific Management/Precision Agriculture, and Decision Support Systems. Significant research progress for FY2002 is reported below by emphasis area.

Cropping Systems

Potato growers in the Northeast suffer substantial economic hardships from high pesticide and fertilizer requirements and climatic limitations to crop production. ARS researchers from the New England Plant, Soil, and Water Laboratory at Orono, Maine, have conducted studies to evaluate the impact of several rotation crops on soil-borne diseases of potato. Results demonstrated significantly lower disease levels when potato followed canola, barley, or sweet corn compared to other crop rotations. Farmers who use these rotation crops can reduce pesticide costs and improve profitability.

No-till farming is an established approach for reducing soil erosion. In the northern Corn Belt, cold and wet soil conditions often hinder early planting of crops, particularly in no-till production systems. Scientists from the Soil Management Research Unit at Morris, Minnesota evaluated the ability of a temperature-sensitive polymer coating to allow earlier planting of corn and soybean. This coating keeps the seed encapsulated until soil temperatures are warm enough for good germination and growth, allowing farmers to plant earlier than they could with uncoated seed. Analysis showed that the use of the polymer-coated seed increased net returns by $2.50 to $9.70 per acre. When it becomes commercially available, this seed coating will allow farmers to address one of the main drawbacks to no-till production in the northern Corn Belt.

Use of the soil fumigant methyl bromide will be banned in 2005 causing an urgent need for alternatives. Scientists from the Sustainable Agricultural Systems Laboratory at Beltsville, Maryland in collaboration with researchers at the University of Florida have evaluated a biologically-based alternative to methyl bromide application for use in tropical and subtropical areas of the U.S. A biologically-based alternative production system consisting of a nematode-resistant tomato cultivar and three nematode-resistant

cover crops produced yields equal to the conventional methyl bromide production system. The impact of this finding is that Florida vegetable growers can replace methyl bromide with an environmentally-friendly, biologically-based alternative and produce comparable yields at lower costs.

The current dryland crop rotation of winter wheat-summer fallow used in the Great Plains degrades soil quality, promotes soil erosion, and strains economic resources of producers. ARS scientists from the Central Plains Resources Management Research Unit in Akron, Colorado have developed a new 4-year crop rotation (wheat-corn-millet-fallow) that produced nearly 14 percent higher wheat yields compared to the best yields in their existing reduced till or no-till wheat-fallow rotations. In addition to producing higher wheat yields, the new rotation provides three crops per 4-year rotation as compared to the current one crop per 2-year rotation.

Integrated Crop and Animal Systems

Disposal and/or use of broiler litter is a significant issue in regions where poultry production is concentrated. Although this litter is often used as a soil amendment on cropland, the long-term soil quality benefits are not well understood. ARS scientists in Beltsville, Maryland and collaborators found that low-rate applications of broiler litter and composted broiler litter resulted in increased soil quality up to four years after application. These findings reinforce the benefits of land application of broiler litter by showing that even low application rates can have measurable soil quality benefits.

Many dairy farms must reduce phosphorus loadings to the environment to comply with nutrient management regulations. Scientists from the US Dairy Forage Research Center in Madison, Wisconsin and collaborators showed that elimination of dietary phosphorus supplements and selection of low phosphorus protein supplements dramatically reduced phosphorus excretion in manure and the amount of cropland needed for recycling manure nutrients. Reductions in dietary phosphorus also made manure nitrogen and phosphorus contents more closely match crop requirements, making it easier to utilize the manure as a crop production resource. This link between dietary practices and water quality impairment is an important consideration for whole-farm nutrient management planning and meeting environmental standards.

Site Specific Management and Precision Agriculture

Scientifically-based placement of agrochemicals across a field to match soil and plant conditions at each point can reduce production costs and negative environmental consequences. Scientists at the Agricultural Systems Research Unit in Sidney, Montana evaluated a precision, variable-rate fertilizer application strategy for sugar beet production. A small cost saving from reducing the amount of phosphorus applied, combined with a significant increase in yield and no reduction in sugar quality, resulted in an increased return of over $100/acre compared to uniformly treated areas. Application of these new information-driven technologies is important to help US agricultural enterprises remain competitive in world markets.

Defining site specific management zones within an agricultural field is a first step toward applying precision agriculture approaches for improving crop production efficiency and reducing environmental impacts. ARS scientists at a number of locations, including Ft. Collins, Colorado, Columbia, Missouri, and Ames, Iowa are investigating ways to define management zones. This year, scientists at the ARS National Soil Tilth Lab in Ames, Iowa applied a mathematical technique called cluster analysis to long-term corn yield records to divide fields into different management zones. They found that these zones were related to easily measured landscape and soil factors such as slope. Following this approach, farmers could use topography information to predict potential corn yields and then use the potential yield maps as the basis for site specific management or variable rate application of production inputs.

Decision Support Systems

Scientists from the Great Plains Systems Research Unit at Fort Collins, Colorado in collaboration with Colorado State University, other ARS Units, and local farmers and ranchers have developed a whole-farm decision support system, GPFARM (Great Plains Framework for Agricultural Resource Management). GPFARM, Public Version 2, was released in April, 2002 and on-farm testing of the model is ongoing in Colorado, Nebraska, Kansas, and Wyoming. Model evaluations have shown that GPFARM does a good job of predicting long-term crop production. Model testing using more detailed data from research plots indicates that GPFARM makes reasonable estimates of crop yields, residual soil nitrate, surface residues, and soil water content. Producers in the central Great Plains (and potentially nationwide) now have a decision aid to help them select the best strategic management scenarios for their local conditions and to test for options that are economically and environmentally sustainable.

A method for assessing reductions in grassland productivity due to drought would be useful in determining assistance levels for producers. Scientists at the Grassland, Soil and Water Research Laboratory in Temple, Texas applied the ARS-developed ALMANAC plant model, which had been previously validated with NRCS range productivity values, to 31 years of weather conditions in 20 counties in five regions in Texas. They then used this model simulation technique to derive a simple method for computing grass yields as a function of rainfall during the growing season. The model system is currently being used to assess drought impacts on range productivity in several counties in Texas.

Scientists at the Alternate Crops and Systems Laboratory in Beltsville, Maryland are developing and improving crop models that can simulate the interception of chemicals by plant canopies, water and solute uptake by plant roots, and respond to irrigation and water stress. Crop models for soybean, cotton, wheat, rice, corn and potato are under development, along with a generic user interface for use with all the models. Growers in the Mid-South testing a revised and enhanced version of the soybean simulation model GLYCIM reported that using the model to schedule irrigations increased both water use efficiency and soybean yields. The use of crop models as decision aids can reduce input usage, reduce environmental pollution, and increase profits.

Remote sensing technologies can readily provide crop production managers with real-time information for use in large-scale assessments. In south Texas the methods for evaluating cotton defoliation strategies have traditionally been based on visual observation and ground measurements. ARS scientists from the Kiki de la Garza Subtropical Agricultural Research Center in Weslaco, Texas in collaboration with Texas A&M University developed a remote sensing-based method that was able to give quantitative indications of defoliation differences. This new technique has implications for more effective and efficient evaluations of cotton harvest aids, leading to more effective defoliation and more efficient harvesting.