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Balancing the economic, environmental, and social demands of agriculture requires a high degree of management skill and knowledge because every producer faces a complex mix of choices to evaluate what will work for her or his farm. The Agricultural Research Service National Program, Integrated Agricultural Systems, is designed to facilitate the synthesis, evaluation, and transfer of information to all types of agricultural operations, to solve problems important to producers, using a systems approach.

This annual report contains highlights of accomplishments from USDA-ARS research projects in 2005. These accomplishments bring together research that has been conducted over a number of years and that often involves multidisciplinary teams of ARS scientists and cooperators.

Integrated Production Systems

Crop Rotations Can Reduce Risk to Northern Corn Belt Farmers. Farmers need assurance that using new production practices will not put them at risk of financial losses. The ARS North Central Soil Conservation Research Laboratory in Morris, Minnesota, cooperating with the Brookings, South Dakota, North Central Agricultural Research Laboratory have addressed the problem of reducing barriers to the adoption of more sustainable cropping systems by analyzing long-term crop rotation studies to evaluate the effects of government programs and crop insurance on managing economic risk. The research showed corn rotations including soybean, spring wheat, or alfalfa, instead of continuous corn production, were valuable risk management tools when government program payments and crop insurance are not available. However, when growers choose to use both government programs and crop insurance, the relative benefits of crop diversification in reducing risk are decreased. This research is helping assure Northern Corn Belt farmers who want to adopt more sustainable production practices that diverse crop rotations can reduce economic risks and complement other risk management tools including government programs and crop insurance. This research can also help policy makers find creative ways to design programs that provide economic incentives for producers to adopt conservation practices.

Many Approaches Together Used to Increase Maine Potato Profits. There are approximately 23,000 small farms in New England that benefit from research that helps producers identify optimal combinations of rotation crops and conservation practices. The New England Plant, Soil, and Water Laboratory in Orono, Maine, is showing ways to integrate soil, plant disease, and economic research to develop potato crop rotations that increase profits for growers. The right rotation not only brings growers additional income, it can also be an effective way to suppress potato diseases, enhance soil nutrient content, and boost crop productivity—all while reducing the use of chemicals. Incorporation of canola into the rotation reduces the disease caused by the *Rhizoctonia* fungus. Controlling the common weed hairy nightshade reduces a source of the fungus that causes Late Blight. Using ryegrass cover crops not only reduces soil erosion during the winter, but also helps to reduce *Rhizoctonia*. The introduction of raised planting beds seeded with green-sprouted potatoes consistently increases net income $40 per acre. From 8 years of research, the "Potato Systems Planner" decision-support software weaves together all the laboratory's research findings on possible potato crop rotations to reduce diseases and bring significant savings by growers not having to use as many pesticides and herbicides, while attaining potentially higher yields and higher quality.

Grass Seed Profits Increased Using Conservation Practices. Due to safety and health concerns, new production practices were needed for the 560,000 acres of Pacific Northwest perennial grass seed crops that were burned after harvest. The ARS Forage Seed and Cereal Research Unit, Corvallis, Oregon, completed a 10-year experiment in western Oregon that demonstrated perennial grass seed crops can be economically produced without burning by using no-till seeding in combination with chopping back all of the straw onto fields after harvest. Compared to conventional tillage establishment with straw removed by baling, the ARS conservation system reduced soil erosion 40-77%, nitrate leaching 50%, establishment costs $27-162 per acre, can increase seed yields, allow earlier spring planting times, and increase the amount of recreation time available to farmers who use them. Oregon and Washington growers are experimenting with how to best use these new practices at the farm scale on 15,000 acres. USDA-NRCS has adopted no-till seeding and full straw management as practices to help farmers qualify for USDA Farm Bill conservation program payments. This research is also helping the grass seed industry demonstrate compliance with provisions of the Clean Water and Endangered Species Acts. Farmers using these practices are reporting higher yields, increased profits, and more

flexibility in their schedules that can be used for non-farming related activities.

Conservation Tillage And Poultry Litter Reduce Drought Risk For Southeast Cotton Production. Cotton in the Southeast United States relies on timely rainfall in April and May for establishing good stands and in the summer months to sustain fruiting. Drought during these periods can be disastrous for growers. Researchers at the Phil Campbell, Sr., Natural Resource Conservation Center in Watkinsville, Georgia, showed that conservation tillage protects the soil surface, allows crop residue to accumulate on soil surfaces to build soil structure, increases rainwater infiltration, reduces evaporation, and increases the biological activity that helps improve nutrient cycling. The net effect is larger soil water reserves and greater nutrient availability, which are crucial for crop growth and sustenance during drought. Cotton growers may want to combine no-till with applications of poultry litter fertilizer to increase yields even more. Changing from conventional tillage to no-till increased yield by 33%. But changing to no-till plus poultry litter fertilizer increased yield by 42%. Average cotton yield in dry years surpassed that from conventionally tilled and fertilized cotton in 4 of the 5 years. This research applies to 5.2 million acres of cotton planted in the region.

Helping Iowa Farms to Recover Production Costs. Scientists at the ARS National Soil Tilth Laboratory in Ames, Iowa, used 10 research and demonstration sites over 3 years to evaluate the effects of four tillage systems on corn and soybean production on Iowa farms. The study was supported by the Iowa Department of Agriculture and Land Stewardship to find the best ways farmers can reduce the risk of their investment in crop production. Not only were there difference among the fall chisel, fall strip, spring tillage, and spring strip tillage systems, but these differences varied among the farm locations. The research team showed that seasonal differences in precipitation amounts and the distribution of rain across the state were the cause of the differences. The analysis from the research showed that the strip tillage systems were the best strategy to use to recover production costs and generate the greatest profit. This research is important, especially when yields may be low because of limited precipitation, to give farmers that best chance of making a profit with their crops.

Practices Developed for Production Systems

Organic Crop Production Using Conventional Tillage and Cover Crops More Effectively Minimizes Phosphorus Losses than

Chisel Tillage. Organic farmers not only are interested in producing food without synthetic pesticides and fertilizers, but also desire to use production practices that enhance water quality through improved nutrient utilization. Organic crop production often relies on substantial amounts of tillage for weed control that can also increase nutrient losses through soil erosion. Therefore, it has not been clear if phosphorus losses from organic systems using tillage to control weeds are a greater problem than conventional systems that can use either no-till or chisel tillage operations. Scientists at the Sustainable Agricultural Systems Laboratory in Beltsville, Maryland, compared an organic system that used conventional tillage with cover crops to conventional production systems that used no-till or chisel tillage practices. The researchers demonstrated that the no-till conventional system had a greater portion of large soil aggregates that were less likely to erode than soil from the other two systems. However, with a cover crop, the organic conventional tillage system had less predicted phosphorus losses than the conventional chisel tillage system. This research showed increased aggregate stability in no-till systems was more important to phosphorus loss reduction than using cover crops. The cover crop reduced the amount of predicted phosphorus loss, even though aggregate size was smaller than in the no-till system. Organic farmers who use cover crops can expect results similar to those for chisel tillage conventional producers.

Helping Small Dairy Farms Better Manage Manure. Outdoor confinement areas on small dairies are “hot spots” for concentrating nutrients from manure. Most uncollected manure accumulates in exercise lots and feeding areas, leading to excessive nutrient levels in the soil. A study of 54 dairies across Wisconsin was conducted by the U.S. Dairy Forage Center in Madison, Wisconsin, to find what kinds of dairies could benefit most by developing conservation management plants. The research showed that less manure is collected from farms with stanchions than free-stall housing. Also, small-to-medium-sized herd farms collected less manure than large herd dairies. There were differences also in the amounts of manure collected in different regions of the state, with more manure collected in the hilly southwest region and less than that collected in the undulating south central or flat northeast regions in Wisconsin. With this research, manure management plans can be developed based on knowing the relative amounts of manure produced on different kinds of dairies. Also, movable electric fence can be used to gradually move cows so that manure and urine can be more evenly distributed over field areas and the nutrients utilized by crops. Using these research findings, extension efforts can be directed towards small-to-medium-sized dairy

herds to specifically help show those dairy operations that most likely need to make greater efforts to manage manure in outside confinement areas to reduce the risk of impairing surface and ground water quality.

Small-Scale Farmers Can Receive Income from Pine Straw Without Increasing Soil Erosion. Pine straw harvesting can provide an additional income source to small farms. However, there are concerns that removal of pine straw will increase soil erosion. Experiments conducted by the ARS Dale Bumpers Small Farms Research Center, Booneville, Arkansas, showed how pine straw could be harvested without increasing soil erosion. It was demonstrated that when pine straw is harvested once every 3 years, precipitation run off, soil erosion amount, and nutrient losses were not affected. This finding benefits landowners looking for additional income sources as well as conservation planners interested in helping these farmers.

Improved Livestock Performance Can Result from Afternoon-Cut Alfalfa Hay. Cattle, sheep, and goats prefer alfalfa hay that is cut in the afternoon. However, it was not known whether this preference by these animals affected the amount of forage they will eat or the amount that will be digested. Scientists at USDA-ARS facilities in Raleigh, North Carolina, Kimberly, Idaho, and Watkinsville, Georgia worked together to compare how livestock performed in response to hay that was cut in the morning or afternoon. Both goats and cattle ate more afternoon harvested hay, than morning cut hay. Goats also digested more of the morning cut hay. Sheep did not perform differently on morning and afternoon cut hay. Knowing more about the ways to influence the culinary choices of livestock can mean healthier animals that make better weight gains and bigger profits for ranchers. Since the cost of cutting hay is the same whether cut in the afternoon or morning, this practice can lead to increased profits for some livestock, without additional production costs.

Site Specific Management and Decision Support Systems

Using Remote Sensing to Estimate Difference in Tillage Practices. To measure the large-scale effects of conservation practices such as no-till planting have within a watershed, the percentage of land area that is tilled needs to be known. One way to gather this information is to conduct a census of fields by driving and viewing each field to record the kinds of crops and amounts of tillage that are done annually across a watershed. The Forage Seed and Cereal Research Unit in Corvallis, Oregon, developed a method that is

74% accurate using Landsat satellite images to estimate differences in tillage amounts and kinds of crops grown in different small watersheds in the Willamette Valley. This new geographic information system-based method will help researchers and conservation planners use remote-sensed information so they can better understand how different kinds of farming practices affect the amounts of nutrients and sediment in streams. This will help farmers choose the best ways for them to manage their fields and reduce nutrient and sediment losses to nearby streams so that they can meet legislated water quality standards. This research supports the USDA Conservation Effects Assessment Project (CEAP) that is determining the landscape-level impacts of conservation practices on water quality and whole farm profitability.

Using GPS Technology to Map Cotton Fiber Quality Across Fields. Harvesters equipped with satellite geopositioning system (GPS) yield monitors are routinely used to map differences in cotton yield across fields. However, there has been no practical way to use this information to find out the effects of differences across fields on cotton fiber quality. The Application and Production Technology Research Unit in Stoneville, Mississippi, has designed and built a rapid sampling system that allows cotton fiber to be sampled on commercial harvesters and combined with GPS technology to map cotton fiber quality. The new harvest system retrieves seed cotton from georeferenced positions, and after ginning and quality analyses, maps fiber quality over entire fields. This new method gives farmers, researchers, and crop advisors information they can use to determine the best ways to change management practices to enhance cotton quality so premium prices can be received for cotton crops.