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DeSoto National Wildlife Refuge demonstration and education project

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DeSoto National Wildlife Refuge demonstration and education project

Abstract
Researchers evaluated and refined a low-input cropping system at DeSoto National Wildlife Refuge near Missouri Valley, Iowa. DeSoto is located within the Missouri River floodplain in Harrison and Pottawattamie Counties in Iowa and in Washington County in Nebraska. The nearly level area includes cropland, grassland, timber, marshes, and DeSoto Lake, into which three drainage ditches empty runoff. The majority of the drained acres is managed by farmers for row-crop production, primarily in corn and soybeans planted in two-year rotations.

Keywords
Extension and Outreach, Human systems, Demographics, Beginning farmer programs

Disciplines
Agricultural Education | Demography, Population, and Ecology
DeSoto National Wildlife Refuge demonstration and education project

Goals

Researchers evaluated and refined a low-input cropping system at DeSoto National Wildlife Refuge near Missouri Valley, Iowa. DeSoto is located within the Missouri River floodplain in Harrison and Pottawattamie Counties in Iowa and in Washington County in Nebraska. The nearly level area includes cropland, grassland, timber, marshes, and DeSoto Lake, into which three drainage ditches empty runoff. The majority of the drained acres is managed by farmers for row-crop production, primarily in corn and soybeans planted in two-year rotations.

The DeSoto ecosystem can be dramatically affected by crop management practices both within it and on adjacent land. In fact, contamination of DeSoto Lake by agricultural chemicals may be one cause of the occasional algal blooms that threaten the lake’s fishery. The adjacent cropland is suspected because it is linked to the refuge by the agricultural drainages. Because surface drainage is often poor, producers sometimes alter the surface topography, using techniques such as grading, to encourage runoff. Subsurface drain tile is not used in the area.

This project focused on demonstrating to local producers the benefits of a field-crop scouting and soil-testing program. Project investigators considered it vitally important to provide producers ample opportunity to evaluate these tools and to encourage long-term adoption of more such sustainable production practices in and around the refuge.

Specific objectives included (1) demonstrating integrated pest management (IPM) concepts, particularly crop scouting; (2) soil testing for phosphorus, potassium, and nitrate; (3) determining whether sweet clover contributes sufficient nitrogen for optimal corn yields; (4) monitoring surface water and groundwater for nitrate and pesticides; (5) comparing crop yields between the low-input (biological) crop rotation and the conventionally managed corn-soybean rotation; (6) establishing a parasite nursery for biological control of the alfalfa weevil; and (8) extending project results to public agencies and local producers.

Local crop growers were also surveyed about tillage practices, crop choice, yields, crop rotations, fertilizer use, knowledge of pest management, and attitudes toward issues and practices associated with sustainable agriculture.

Background

From 1960-1980, large fields of continuous corn provided food for migrating waterfowl at DeSoto. Crops other than corn also became important to the local economy. As fertilizers and pesticides received greater use in general agriculture, farmers leasing refuge cropland applied them to refuge cropland much as they did to their other fields. The planting of continuous corn on the refuge ended after 1978. Since 1979, two crop rotations have been practiced at DeSoto. The conventional crop rotation consists of alternating corn and soybeans; no insecticides are used. Herbicides are permitted for controlling weeds, although tillage and cultivation are encouraged as an alternative. Fertilizer is also restricted to amounts that are lower than those typically used on private farmland.
Biological crop rotation at the refuge consists of alternating alfalfa or sweet clover with an oat companion crop, corn, and soybeans in a three-year rotation; insecticides are not used, nor is nitrogen fertilizer permitted for growing corn because the forage legume, usually sweet clover, is expected to provide that nutrient.

The biological rotation meshes well with the refuge management objectives of (1) providing food and "loafing" sites for migratory waterfowl as well as food and cover for resident wildlife; (2) improving long-term productivity of refuge soils; (3) maximizing habitat diversity; (4) providing for public access; (5) retiring nonproductive areas from annual crop production; (6) fully implementing biological farming techniques on refuge cropland; and (7) benefitting the local economy when doing so is consistent with other objectives. DeSoto's biological cropping approach, which is currently applied to 83 percent of the refuge cropland's acres, has been used as a model for other wildlife refuges.

Approach

A crop scout monitored about 1,000 acres of row crops (about half of which was refuge cropland) weekly throughout each growing season. These acres included both biological and conventional crop rotation and private cropland near the refuge within the three drainages. In addition to corn and soybeans, alfalfa and sweet clover were scouted occasionally to collect information specific to them. The scout used Iowa State University Extension-recommended procedures, and "economic thresholds" identified fields with pest infestations sufficient to harm crop yields and cause economic loss. The crop scout also generated a weekly newsletter to provide a wide variety of individuals an opportunity to observe and evaluate the usefulness of a scouting program.

Soil sampling measured phosphorus, potassium, zinc, soil pH, and nitrate levels in corn following sweet clover; soil organic matter was also measured and compared between the biological and conventional crop rotation. Only fields within the refuge were sampled.

Researchers monitored surface and groundwater quality. Shallow groundwater was sampled at depths up to 11 feet via wells; vacuum lysimeters were used to extract water from the soil profile. The three drainages and DeSoto Lake were sampled routinely and following rainfall events. Routine sampling of the drainages was not always possible during spring and summer of 1989 and 1990 because of too little rain. Researchers had all water samples analyzed for nitrate and various herbicides; a few samples were tested for insecticides as well.

The project investigators also compared crop rotation productivity across fields containing similar soils. They used fields managed by the same producer for these comparisons; planting dates, plant populations, and hybrids/varieties were also similar in fields under comparison.

Findings

From 26-30 fields were scouted annually; approximately two-thirds of these were within the refuge. Two important scouting functions were demonstrated: (1) identification of economically threatening infestations in time to prevent economic crop losses and (2) production of information that helped avoid unnecessary pesticide use. Pests scouted included wireworm, white grub, black and dingy cutworms, European corn borer, corn rootworm, bean leaf beetle, green cloverworm, grasshopper, and spider mite. Insect pests were most active in 1988, a year of severe drought. Evidence suggests that the extended-diapause northern corn rootworm, which has adapted to survive the two-year corn-soybean rotation, may pose a threat to this locale.

Both potassium and zinc soil test levels were found to be high to very high in all fields sampled. Researchers concluded that crop yields in the area can be maintained without these nutrients added as fertilizer, although soil testing should continue to monitor soil test levels.

Phosphorus levels were usually low to very low in the fields sampled, yet soil test levels on
private cropland are much higher. Producers managing private cropland are likely applying more phosphorus than crops need, thus increasing soil test levels, whereas refuge application rates are equal to or less than crop removal rates. The alkaline soils of this region may be influencing test results. Researchers concur that a test calibrated for the soils in this region would produce more instructive results.

Sweet clover offers potential as a sole nitrogen source, although a highly variable one. Plant stand density, weather, and weed control are factors most likely to affect sweet clover's nitrogen contribution. The amount of organic matter in the conventional and biological crop rotations differed from the silty clay to the silt loam soils.

Researchers found a much greater nitrate concentration in soil pore water than in shallow groundwater, where nitrate was rarely detected in significant amounts. And the soil profile under the biological crop rotation showed less nitrate than that under the conventional one. While the potential for nitrate contamination is less under the biological rotation, denitrification (conversion of nitrate into nitrogen gas) mitigates nitrate's negative impact on groundwater quality in either system. In short, nitrogen fertilizers applied at optimal rates to soils similar to those in this study are unlikely to increase groundwater nitrate levels.

Of the seven herbicides identified in refuge shallow groundwater sampling, atrazine, cyanazine, and metolachlor were detected most frequently (though in low concentrations), coinciding with times of peak use. All but one are prohibited on the refuge. Herbicides apparently are entering refuge groundwater from nearby, privately owned croplands. The highest groundwater concentrations detected do not constitute a hazard to the refuge ecosystem, although alachlor exceeded the drinking water advisory level.

Herbicide and insecticide contamination of surface water represent the greatest hazard to the refuge's aquatic environment. Whereas the shallow groundwater sampling revealed seven herbicides, eight herbicides were detected in surface drainages and DeSoto Lake; detections were most frequent and concentrations highest following rainfall. Although some of these concentrations are potentially hazardous to some plant and animal life, concentration peaks are short-lived.

DeSoto Lake samples detected atrazine and cyanazine most frequently; in fact, the atrazine exceeded the aquatic population advisory level in 1990 and 1991 and neared the drinking water maximum-contaminant level in 1991 as well.

Although yield data collected did not account for variations such as a soil type's inherent productivity or the management practices of individual producers, average yields of field corn and soybeans over 12 years were essentially the same between biological and conventional crop rotations. Nevertheless, the 12-year average contained marked yield differences between the two systems over briefer periods; these differences were generally attributable to moisture conditions during a particular growing season.

Five parasitoid species that attack the alfalfa weevil are now established at the refuge. (Parasitoids feed on host tissues such that the host remains alive until larval development is complete.) Researchers hope that adequate levels will develop to allow a systematic program of parasitoid releases in nearby counties.

Implications

This project addressed a range of topics important to sustainable agriculture: water quality monitoring for nitrate and chemicals, crop scouting and soil testing to demonstrate the usefulness of these decision-making tools, development of an insectary for possible releases of beneficial parasites to control insects throughout the area, and evaluation of the refuge's overall cropland management plan.

Project investigators have identified certain issues for continued research. Most important of these is continuation of the crop scouting
program, which is considered the most effective tool available for encouraging pesticide use that maximizes economic benefit and minimizes hazards to the environment.

The sweet clover component of the biological crop rotation, including minimum stand density for optimal nitrogen contribution and the economic viability of such a rotation, also need more research. Calibration of the late-spring soil nitrate test for corn that follows the clover will also help. Although results indicate that sweet clover can contribute enough nitrogen for optimal corn yields, the amount actually contributed varies greatly from field to field and year to year.

Finally, researchers have only partially assessed the environmental impact of pesticide use near the refuge on aquatic populations. And the compounds monitored in this project represent the chemical technology of 20-30 years ago. The movement, concentrations, and impact of the newer, post-emergence herbicides must also be studied.

The DeSoto National Wildlife Refuge's high public visibility provided a unique opportunity to convey research results to a large and diverse audience. Information gained from this project reached over 1700 audience contacts via newsletters, personal consultations, large-group presentations, field tours, brochures, print news media, electronic news media, and poster presentations. This project was but one example of the U.S. Fish and Wildlife Service's interest in sustainable agriculture's relationship to wildlife management.