FY2004 Annual Report for Rangeland, Pasture and Forages National Program 205

Introduction

Grassland agriculture is the largest land use in the United States. Publicly and privately owned range, pasture and forage lands cover about 55% of the nation's total land area. In addition to being the foundation of an $80 billion livestock sector, these lands also provide recreational opportunities, heritage values, critical water and air sheds, and habitat for a vast array of plants and animals. Turf production, establishment, maintenance and use is a multi-billion dollar industry that touches every American's life. There is growing interest in using grasses and legumes as feedstock for bio-energy production to protect the environment and increase national security. The ARS has a long history of conducting basic and applied research to provide the knowledge, plant materials and technology needed to manage lands for these activities in a sustainable manner.

The rangelands, pasture and forages national program includes research at over 30 ARS locations to address a broad variety of national issues including profitability in a global economy, assessing and managing risk, conserving natural resources, and providing sound science for environmental protection. In addition, ARS scientists develop decision-support tools such as models, expert systems, and monitoring systems to aid the public in applying research findings to resolve real world problems.

Selected accomplishments by national program components:

Ecosystems and their sustainable management

Improved management of fires on western rangelands. Land managers need improved information on how wild and prescribed fires impact on water and soil resources critical to ecological and economic sustainability. ARS scientists at Boise, ID working with the Forest Service and Natural Resources Conservation Service collected data on fire sites in Colorado, Idaho, Montana, and Nevada. They used the data to develop and validate hydrology and erosion models now being used by the Federal land management agencies to improve wildfire risk assessment, prescribed fire planning and post-fire mitigation.

Compatibility of livestock and threatened species. The lack of basic ecological information about the sagebrush steppe limits developing and assessing of management guidelines for integrating livestock grazing and wildlife habitat conservation for species like the sage grouse. ARS scientists at Burns, OR quantified vegetation cover and composition across the region on 107 Wyoming big sagebrush sites classed as being in excellent condition. When these findings were compared to current sage grouse habitat management guidelines, they found the guidelines to be unrealistic in estimating the habitat potential of the land. They are now working with land managers to develop more realistic guidelines based on this new ecological data.

Rising carbon dioxide levels can reduce forage quality. ARS scientists at Cheyenne, WY working with Colorado State University have completed a five-year study of how increasing carbon dioxide levels affect plant species composition and forage production on the shortgrass prairie ecosystem of the Great Plains. They found changes in the plant species mix and a reduction in nitrogen concentrations within the plants. Together, these changes significantly reduce the nutritional quality of the forages for livestock. As global carbon dioxide levels continue to rise, livestock producers may reach a point where supplementation of livestock will have to be increased to maintain production. Increased supplementation will reduce profitability for the thousands of livestock producers who depend on the grasslands of the Great Plains.

Weather has greater impact than grazing intensities in the southern Great Plains. ARS scientists at Woodward, OK completed a 20-year experiment assessing the impact of livestock grazing on forage production and weed populations. They found that the commonly held belief that weeds increase and forage production declines significantly as grazing intensity increases is not valid in their region. Weather fluctuations over the years had a much more significant impact on forage production than did any reasonable levels of livestock grazing. These studies indicate that maintaining efficient grazing levels and ecological integrity are not incompatible goals.

Evaluating long-term impacts. Because of the hundreds of millions of acres of rangelands, the cost of monitoring and assessing the condition of these lands is a major concern. ARS Scientists at Las Cruces, New Mexico working with the Natural Resources Conservation Service (NRCS) compared statistical options for analyzing data collected on the Jornada Experimental Range and data from the National Resources Inventory (NRI). They found that the within-plot replication of data collection for monitoring and assessing at the landscape to regional scales could be significantly reduced from analytical protocols previously used. Applications of these findings are expected to result in savings of as much as 25% in NRCS rangeland field data collection.

Plant Resources

More accurate estimates of forage bioenergy potential. Producing liquid fuels from forage biomass offers opportunities to increase national energy independence, diversify rural economies, and reduce greenhouse gas emissions. ARS scientists at St. Paul, MN have evaluated procedures for estimating how much ethanol can be produced from biomass stocks such as alfalfa. They found that the common analytical system (detergent fiber analysis) used to estimate cellulose and other polysaccharides for livestock production is not adequate for biofuel estimates because it overestimates potential production. This information will help producers and government agencies more accurately estimate production potential from bioenergy sources and improve the analyses of investment choices.

Reducing protein loss when ensiling forage crops. Alfalfa and some grasses have significant protein loss during the ensiling process that results in economic loss because more protein supplementation can be required. There are also adverse environmental

impacts as nitrogen compounds are released into the environment. The enzyme, polyphenol oxidase (PPO), helps to reduce the breakdown of protein during ensiling. ARS scientists at Madison, WI and St. Paul, MN have worked together to clone a PPO gene from red clover and insert it into alfalfa. The modified alfalfa produced PPO. The potential of these plants to reduce protein loss under various management options is being evaluated.

Selecting the proper seed for a location. Protecting genetic biodiversity within a species is a priority to ensure we maintain sufficient genetic variability to adapt to changing environmental conditions. Bluebunch wheatgrass is a premier native grass widely used for revegetation across the western states. The commercial seed sources for this species are limited to several varieties grown in southeastern Washington. ARS scientists at Logan, Utah collected 565 plants that represented 82 locations spread across 9 states and provinces. Using multilocus DNA fingerprinting and statistical cluster analysis, they found that the Bluebunch wheatgrass samples fell into 21 geographically significant genetic groups. Seeds for most of these groups are not available from commercial sources. This information is helping land managers in identifying and evaluating new seed sources that better reflect local biodiversity needs. ARS scientists are also working with the Utah Division of Wildlife Services in cooperative collection and breeding projects to increase seed availability for some underserved locations.

Identifying superior stress-tolerant cultivars of turfgrass. The National Turfgrass Evaluation Program (NTEP) located at Beltsville, Maryland in cooperation with forty states and five Canadian provinces continued to evaluate grasses to provide information to turf managers and home owners to aid in selecting cultivars that will reduce input costs and maximize environmental benefits while meeting user objectives. This year summary reports on six key grass species were mailed to 1400 users.

More rapid screening for disease resistance in legumes. Forage and grain legume producers sustain significant losses from disease. Breeding resistant cultivars is an important way to reduce these losses, but breeding projects have required long, expensive greenhouse evaluations to identify and evaluate disease-resistance plant materials. ARS scientists at Prosser, WA, using information they gathered on the genetic basis of resistance have developed a multiplex real-time PCR assay that identifies key genes conferring resistance. This assay will greatly shorten the time and costs to breeders in selecting breeding germplasm with desirable traits and evaluating the new cultivars.

Grass cultivar releases for the Mid-West and eastern Great Plains. ARS plant breeders at Lincoln, NE released two new big bluestem cultivars, Goldmine for hardiness zone 6 and Bonanza for zone 5. In grazing trails, Bonanza and Goldmine produced respectively 50 and 18 pounds more beef per acre than older cultivars. During the period 2000-2002 when participation was below normal, Bonanza produced over 400 pounds/acre/yr of cattle gains. In an economic comparison with non-irrigated corn on marginal land during the same period, Bonanza averaged over $70 per acre more net profit.

Forage Management

Supplementing livestock diets with flaxseed to improve food quality. There is evidence that increasing certain polyunsaturated fatty acids in human diets is health promoting. ARS scientists at Mandan, ND found that they could substantially increase desirable fatty acid levels in beef by feeding cattle ground flaxseed that had been treated to reduce microbial conversion in the animal's rumen. Steers fed the protected flaxseed had significant increases in three desirable fatty acids with the largest being 283% more alpha-linolenic acid. Improving the food quality of livestock products with flaxseed supplementation could offer improved food for the nation's citizens while providing increased economic opportunities for livestock and flax producers.

Filling the gaps in the grazing system in the southern Great Plains. The traditional winter wheat-warm season perennial-grass grazing system has serious gaps in forage production in the spring and fall. ARS scientists at El Reno, OK have been evaluating alternative forages to fill these gaps. They found that adding pastures planted in tall-fescue cool-season grass infected with non-toxic endophytes to the traditional system provided producers with an additional 65 days of grazing for stocker cattle with the potential for a 145 additional pounds of gain per animal. This provides producers with additional options to increase profitability.

Improving drought management on rangelands. ARS scientists at Miles City, MT collected information on forage growth over many growing seasons with a variety of climatic conditions. They found in the northern Great Plains that perennial grass production is closely tied to the spring rains and only loosely linked to fall precipitation. About 90% of grass production happens by July1 since summer rainfall is very limited. Using this information, ranchers can determine if they are entering a period of drought and low forage production early in the summer and adjust their livestock grazing plans then instead of waiting till later in the summer when forage shortages become a crisis.

Maintaining profitability with fewer inputs. Livestock grazers in the Northeast face periods when environmental stresses lead to forage deficits that result in lower livestock production. Maintaining profitability requires that the forage deficit periods be reduced without using fertilizers, herbicides and other expensive inputs. ARS scientists at University Park, PA are evaluating the effects of increasing plant diversity by planting a mixture of plants in pastures instead of only one or two species. The hypothesis is that a mixture of plants with different growth characteristics can adapt to shifting environmental conditions better than one or two species. They found that more complex plant mixtures resulted in fewer weeds and more forage production without any reduction in dry matter intake or milk production in Holstein cows.

Increasing profitability on small farms serving niche markets. ARS researchers at Beaver, WV working with scientists from Virginia State University studied how crossbreeding and finishing options could improve the value of meat goats produced for a growing niche markets on the east coast. They found that using the recently introduced Kiko meat goat as the male sire in crosses with Spanish and Myotonic breeds produced

consistently small, lean carcass more effectively than the traditionally used Boer breeds in the finishing systems evaluated. They also found that the offspring finished faster when supplemented at a rate of 3% of body weight. However, there was incomplete consumption of the supplemental forage toward the end of the feeding trial at this supplementation level. This suggests that the maximum level of daily energy supplementation should be between 2 and 3%. This information will help producers select the best breeding and supplementation rates to enhance profitability.

Grazing management: Livestock Production and the Environment

Compatibility of livestock grazing and water quality goals. Pasturelands are considered a major source of phosphorus pollution in southern Florida. ARS scientists at Brooksville, FL examined the effect of cattle stocking rates on phosphorous loadings, forage production, animal performance, and ranch economics. When compared to the no-grazing control, they found that none of the stocking rates evaluated resulted in increased phosphorus loading but the higher stocking rates did result in increased net income.

Using livestock to manage vegetative cover. Mountain big sagebrush canopies can become too dense and suppress other vegetation important to wildlife and livestock. ARS scientists at Dubois, ID identified sheep with high preference for mountain big sagebrush and compared the impacts of their grazing on vegetation to a group of sheep identified as having a low preference. They found no significant difference in sagebrush canopy cover following grazing by either of the two groups. However the high-preference group consumed significantly more antelope bitterbrush, an important component of the sagebrush steppe. These results indicate that using grazing to control a plant species should to be carefully monitored to ensure there are no unexpected impacts on other ecosystem components beyond the targeted species.

Integrated management of weeds and other pests

Carbon dioxide levels affect cheatgrass growth. Cheatgrass (Bromus tectorum) is a serious invasive weed that fuels wildfires and degrades rangeland ecosystems. ARS scientists at Reno, NV and Beltsville, MD working with the U.S. Forest Service studied the effects of various atmospheric carbon dioxide concentrations on cheatgrass growth. Increasing carbon dioxide levels from pre-industrial levels of 270 ppm to 420 ppm resulted in an average of 70% more cheatgrass biomass at 87 days. This response to higher carbon dioxide levels may help explain the spread of cheatgrass into higher and lower elevations where it was not previously found. Knowledge of this response will also help land managers identify more effective options for rangeland restoration.

Decision support tools

Increasing sustainability in grass seed production. Stem rust is the most damaging disease in grass seed production in the Pacific Northwest. Over 400,000 pounds of fungicide at a cost of $10 million are used annually to control this disease. ARS scientists at Corvallis, OR have developed and made available to commercial seed growers a web-based decision-support tool that improves the accuracy of predicting rust epidemics. The model also provides information that improves the timing and effectiveness of fungicide application to reduce costs by increasing the effectiveness of treatments. This also helps the environment by reducing the amount of fungicide applied.