Research

Tracking beef's shrinking footprint

A study published in the December *Journal of Animal Science* found that raising a pound of beef in the United States today uses significantly fewer natural resources, including land, water, feed and fuel than in the past. "The Environmental Impact of Beef Production in the United States: 1977 compared with 2007" (*Journal of Animal Science,* Dec. 18, 2011) by Jude Capper of Washington State University, documents that each pound of beef raised in 2007 used 33% less land, 12% less water, 19% less feed and 9% less fossil fuel energy than equivalent beef production in 1977. Waste outputs were similarly reduced, shrinking the carbon footprint of beef by 16.3% in 30 years.

According to Capper's research, improvements in the way cattle are raised and fed in the United States between 1977 and 2007 yielded 13% more total beef from 30% fewer animals. Raising more beef from fewer animals maximizes natural resources while providing essential nutrients for the human diet. As the population increases, it is crucial to continue the improvements demonstrated during the past 30 years to meet demand for nutrient-rich beef while reducing resource use and mitigating environmental impact. Turning back the clock on these advancements is not the solution to feeding a world population that recently reached 7 billion and will grow to 10 billion by the year 2050, concludes the author.

"As the number of mouths to feed increases and the quality of diets in many areas around the world improves, the demand for nutrient-rich protein like beef will increase," says Capper. "At the same time, resources like land, water and fossil fuels will become increasingly scarce. These realities are like two trains speeding toward each other on the same track. If we listen to alarmists shouting at us to slow down, we could face a head-on collision of epic proportions. The only way to avoid this disaster is to accelerate the pace of progress."

Capper attributes much of the reduction in beef's environmental footprint to raising cattle on grass pasture before finishing them on an optimal balanced diet of grasses, grains and other forages in a feedyard. According to previous research conducted by Capper, each pound of grain-finished beef requires 45% less land, 76% less water and 49% less feed and at the same time generates 51% less manure and 42% fewer carbon emissions than grass-finished beef.

"As we work on solutions for the future it is important to understand how far the U.S. livestock industry has come in reducing its environmental footprint in the recent past and how this significant reduction was achieved," says Capper. "The facts are in. Improved cattle diets in the feedyard and responsible use of science-based technologies to improve the ability of cattle to convert feed to pounds of beef reduces the amount of land, water and fossil fuels it takes to raise beef. "

Capper says focusing resources to provide more nutrient-rich foods like beef, which provides more than 10% of the daily recommended value of 10 essential nutrients and vitamins for less than 10% of daily calories (based on a

2,000 calorie per day diet), is a critical success factor in meeting nutrition needs at home and abroad.

"Making the best use of resources like land, water and energy to raise nutrient-rich beef is the key to sustainability," says Capper. "The result is delicious, healthful beef you can feel good about."

This project was supported by the Beef Checkoff Program through a research grant from state beef councils in Iowa, Kansas, Nebraska, South Dakota and Washington.

Study aimed at reducing drought-stress losses to wheat

Texas AgriLife Research scientists are trying to make the best of an "extreme" situation. Drought conditions crippled wheat crops the past year. But drought is not new. It is expected to continue and needs to be dealt with, according to the group.

"Texas AgriLife Research is building a very strong team to study the drought tolerance in wheat in the Texas Panhandle, which is one of the best environments in the world to work on drought," according to Jackie Rudd, AgriLife Research wheat breeder.

During 2011, drought stress resulted in the loss of about 240 million bushels (bu.) of winter wheat in the Southern Great Plains. Texas wheat production was down 80 million bu. from the 2010 crop, Rudd said, which is "close to a $500 million hit on the Texas economy at today's wheat prices."

The team will look at different angles of drought stress in wheat with different expertise, but all with the same objective in mind: develop wheat varieties for the variable and unpredictable High Plains' environment, Rudd said.

Rudd is joining forces with Qingwu Xue, AgriLife Research crop stress physiologist; Shuyu Liu, AgriLife Research small grains geneticist; and Srirama Krishna Reddy, a postdoctoral research associate, to take drought studies from the field to genetic laboratories and back to producers with more drought-tolerant wheat varieties that can reduce those losses.

"We chose three wheat varieties (TAM 111, TAM 112 and TAM 304) that are all among the top-yielding under irrigation but they differ in their yield response to drought," Rudd said. "The next step is to determine what is going on inside the plant and use this understanding to move to the next level."

The team has already learned a lot by collecting data during two contrasting years of rainfall. 2010 was a good year for wheat yield and 2011 was one of the driest years on record, he said.

"Initially, we propose to use physiological measurements and yield parameters to evaluate the impact of specific drought-stress treatments on the phenotype and physiology of the plants in controlled greenhouse and field conditions," Xue said.

"We will then employ a systems biology approach involving state-of-the-art science using high throughput RNA sequencing, proteomic, metabolomic and hormonomic technologies to elucidate the drought tolerance mechanisms of the above mentioned varieties at molecular and whole-plant levels," Krishna Reddy said.

"We expect to identify the key genetic regulators of drought tolerance and their biochemical pathways and interactions at multiple levels," Liu said. "That will enable us to design more effective molecular markers to be used in screening breeding populations for wheat improvement."

The results will be validated under field conditions with a wide range of wheat genotypes. Then wheat breeders can apply the molecular tools to screen for and target drought-tolerance genes in various breeding programs, he said.

Rudd said the knowledge generated will help to accelerate variety development in the United States and in other similar environments throughout the world, and ultimately result in the release of drought-stress tolerant and

(Continued on page 72)

Research *(from page 71)*

high-yielding wheat varieties that benefit producers.

"Improved genetics cannot replace timely rains, but we have made significant improvements in drought tolerance through traditional plant breeding and further improvements are likely in the future," Rudd said.

"Preliminary projects supported by the Texas Wheat Producers and the federally funded Ogallala Aquifer Program have given us valuable insight into our past accomplishments and a clear direction for future research."

— by Kay Ledbetter, Texas AgriLife Extension

National Beef Tenderness Survey released

With funding from the beef checkoff, the industry has been tracking beef tenderness for 20 years, with the first benchmarking survey conducted in 1990. In more recent surveys, foodservice cuts were added and a consumer sensory panel was substituted for previously used trained sensory panels because the consumer's perception of tenderness is the ultimate determinant of a cut's success.

"Beef quality, when you think about it, means a lot of things to a lot of people, but to a consumer, quality has everything to do with consistency, flavor, tenderness and overall taste," says Molly McAdams, chair of the checkoff's Joint Product Enhancement Committee.

The 1999 survey revealed a 20% increase in tenderness as compared to 1990. The increased tenderness noted from 1990 to 1999, to a large extent, is attributable to the checkoff-funded science, which has increased the industry's understanding of beef palatability.

Results of the 2005-2006 survey showed an 18% overall increase in tenderness as compared to 1999. However, authors of the 2005-2006 survey suggested that efforts still were needed to emphasize appropriate cooking methods for the variety of available retail cuts.

The 2010-2011 survey was the fourth in the series to quantify the current status of tenderness compared to previous surveys. The final verdict? Most steaks evaluated in the 2010-2011 survey were considered tender and similar to steaks evaluated in 2005-2006. The least tender cuts continue to be from the round, suggesting the need for improved aging practices and increased consumer education focused on proper preparation and cooking to enhance consumer satisfaction.

"Information from the National Beef Tenderness Survey has been very important in setting priorities for additional research that needs to be conducted in product enhancement, to look at where there are gaps in information or lack of information in certain areas," concludes Jeff Savell, professor of animal science at Texas A&M University.

The full executive summary is available at *http://bit.ly/tsanh1*.

NMSU researchers developing drought-resistant alfalfa varieties

The development of alfalfa varieties that are more drought tolerant would be a boon to both consumers and hay producers. Alfalfa breeders at New Mexico State University (NMSU) are combining high-tech genetic analysis with traditional plant breeding practices to do just that. Ian Ray, a professor in the Department of Plant and Environmental Sciences and head of NMSU's Alfalfa Breeding and Genetics Program, and doctoral candidate Gina Babb are using DNA marker-assisted selection to search for more drought-resistant varieties.

The first phase of the project was a collaboration a decade ago between NMSU and the Samuel Roberts Noble Foundation of Ardmore, Okla. Through that partnership, researchers were able to identify DNA marker alleles that were common to alfalfa populations that produced more forage and root biomass under low-water conditions.

The current phase of the project uses DNA MAS to improve alfalfa forage production in drought-prone environments.

"The project that we have going on here involves transferring the DNA marker alleles, which we previously determined were associated with alfalfa productivity under water-deficit conditions, into different types of alfalfa that farmers grow here in the state," Ray said. "Then we evaluate the effects of those DNA markers on forage productivity."

Ray said they use DNA markers to help track and select for natural genetic differences for improved drought tolerance that are already present in alfalfa. Then, using traditional crossbreeding techniques, they transfer the DNA markers into alfalfa varieties, some of which are known to be sensitive to drought stress. The productivity of the offspring that carry the markers is then compared with their original varieties under deficit irrigation management to see if improvement in drought tolerance has occurred.

The field research is taking place at NMSU's Leyendecker Plant Science Research Center south of Las Cruces, where 32 populations of alfalfa derived through the MAS technique were planted in 800 small plots. In this study, about 260 plots are being watered on a standard 14-day interval, while the other 540 plots receive water every 28 days to simulate drought stress.

Productivity was compared by harvesting all plots on a monthly basis during April, May, June, July, August and October 2011. The forage weights for each plot were logged immediately, both electronically and manually, by Christopher Pierce, research technician for the program. Random hay samples were also collected during each harvest to determine forage moisture content, according to Pierce. This allows the harvest weights to be converted to dry tons per acre, the way farmers traditionally assess forage productivity.

Statistical analysis software programs are employed to analyze the yield date for significant differences in productivity among the different populations.

"During 2011, we've documented that we're able to improve the performance of some populations by about 15%," said Ray. "In general, we're seeing forage yield improvements of 7% to 10%, which can be attributed to specific DNA marker combinations that were previously shown to influence forage or root production."

In another part of the field, Ray identified a different MAS population that was developed from a drought-sensitive variety with a very leafy canopy composition.

"What excites us about this particular research population is that not only have we improved its ability to out-yield the original variety under limited irrigation conditions, but its nutritive value should be high, as well, because of its leafy composition," Ray said. "So in an ideal world, our goal is to capture both high yield and high nutritive value in future varieties that we'll be releasing."

Ray also emphasized that the plants in this study will be evaluated for forage yield over three years to measure how the DNA markers influence alfalfa productivity over time. After the study is completed in 2013, the root biomass of all the populations will be assessed. Ray speculates that some of the increase in forage productivity may be related to more extensive root systems that enhance the plants' effectiveness in obtaining soil moisture.

"The great thing about this MAS approach is that it helps us track specific alfalfa chromosome segments that possess one or more genes, which influence forage yield productivity during drought," Ray said. "In this way we can strategically develop new cultivars that will have improved forage yield capabilities under well-watered or drought-stress conditions."

— by Jay Rodman, NMSU Extension