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RANCH & RURAL LIVING

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DECEMBER 2013

Merry Christmas



Creating a ‘Super Juniper Eating Goat’

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Texas A&M AgriLife Research



These healthy Boer goats in Sutton County, Texas, have obviously been whittling down the juniper in their pasture. Photo by Gary Cutrer.

Driving down the road and observing the vegetation that grows in the pastures is a lesson in ecology for the astute observer (see Jake Landers’ “Reading the Landscape” each month in *Ranch & Rural Living* magazine). The natural vegetation is a product of the climate, soils, fire history and the dietary preferences of the many herbivores, from insects to domestic livestock, that depend on the vegetation for their food. The importance of dietary preferences by livestock as a factor that affects rangelands has long been recognized and as such these preferences resulted in the classification of plants by early range ecologists as decreaseers, increaseers and invader.

Decreasers are preferred plants that decline in abundance with heavy grazing; increaseers are less preferred and increase in abundance with heavy grazing; and invader are weedy species avoided by livestock that move in and dominate an area that is heavily grazed. Most of Texas, lacking an active brush control program, is dominated by woody species, mostly mesquite and juniper.

Brush tends to dominate the landscape because woody plants are suppressed by fire, which has more or less been eliminated as an ecological factor, and because most brush is less palatable to livestock and most other herbivores than other forages.

These brush species are avoided by herbivores because they wage chemical warfare to avoid being consumed. In other words, they produce chemicals that adversely affect herbivores and cause them to be avoided. To counter this chemical warfare some animals have evolved a variety of mechanisms to overcome these defenses. For instance both goats and deer can consume significant amounts of juniper, while sheep and cattle make little use of this plant. The use of goats for biological control of woody plants has long been recognized as an effective tool.

Scientists with Texas A&M AgriLife Research at San Angelo and Sonora are capitalizing on the dietary habits of goats and are trying to create a Super Juniper Eating Goat (SJEG). Juniper, or cedar as it is commonly referred to, is one of the

most problematic brush species in Texas and perhaps the entire U.S. It infests about 50 million acres in Texas, which is more area than the entire state of Nebraska, the 36th largest state in the U.S. Furthermore, various species of Juniper are found in all 50 states. A quick comparison of juniper to mesquite, the other great destroyer of rangelands, shows that: juniper has a much wider distribution, causes a greater reduction in forage production, and is more detrimental to the hydrology because of its ability to form an effective umbrella that prevents moisture from small rainfall events from ever reaching the ground. Compared to mesquite, juniper does have one redeeming virtue in that its leaves and small branches are more palatable, at least to goats, and though the quality is low, it can meet their maintenance requirements.

The difference in grazing habits of cattle, sheep and goats is an indication of the effect of genetics on diet preference. Foraging behavior is a term used by ecologists to refer to the complex decisions and behaviors that animals use to obtain their food, whether that food is a plant or an

animal. The difference among different dog breeds in foraging behavior demonstrates that animals can be selectively bred to modify their foraging behavior. Thus, some hunting dogs “naturally” point, while others retrieve, and some stock dogs head while others heel. These differences are the result of many generations of selection emphasizing different portions of a sequential set of behaviors that in coyotes and other canid predators ultimately results in killing and consuming the prey.

Over the years I have raised and trained both blue heelers and border collies. One of the smartest dogs that I ever had was a blue heeler named Gaucho. He would bark when signaled with a barely perceptible twitch of my finger. This ability allowed him to amaze people as he did arithmetic or answered questions with one or two barks for yes or no. He fell dead when shot with an



Goats readily consume juniper and at certain times of the year it may make up over 20 percent of their diet.



imaginary gun and performed many other amusing dog tricks, and, of course, he loved to work cattle. One day I happened to read an article that described how to teach a heeler to head cattle, which I thought would be a very useful ability. So I trained Gaucho to do an outrun as good as any border collie. I could put a bucket in the pasture and he would go around it to the left or right and drop when he was opposite me waiting for the command for the lift. Unfortunately, when I tried to use this new skill on cattle, Gaucho reverted to instincts, forgot everything he had learned and heeled the beast.

This led me to ponder the question: if we could modify the foraging behavior of dogs through selective breeding, why couldn't we do the same for livestock? However, there was a big obstacle that had to be overcome, namely how to determine

Highway ecology—this road in Mills County shows how on the right goats have kept juniper from invading, while on the left it is a problem plant.

which individuals ate the most of a targeted plant. When dogs were selected to modify their foraging behavior, it was obvious which ones preferred to work the head and which ones preferred the heels. Not so with goats and juniper.

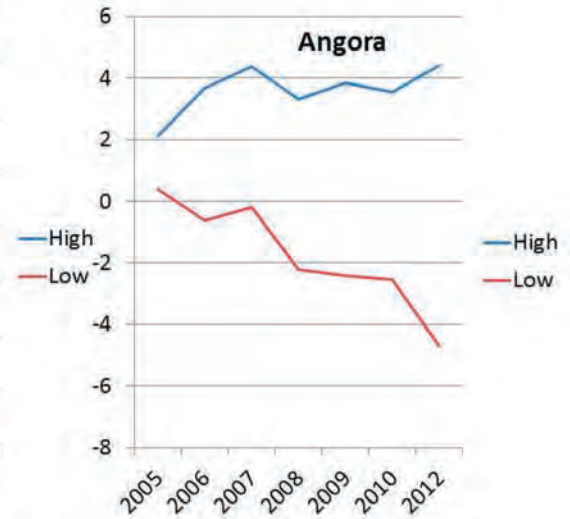
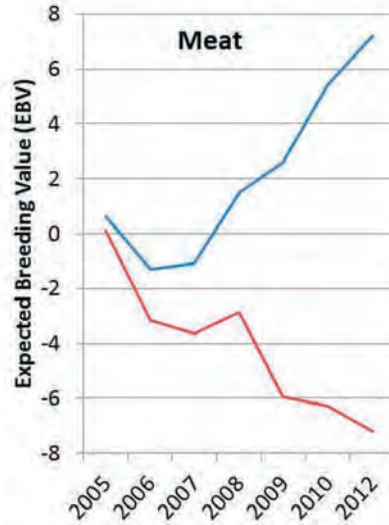
Several methods were available to determine what plants goats were consuming but they were slow, expensive and not suitable for screening large numbers of goats. We investigated a technique called near-infrared reflectance spectroscopy that had previously been used to determine the nutritional value of herbivore diets, to see if it could be used to predict what plants were being consumed. After several trials that involved

feeding goats known amounts of juniper and analyzing the feces with a spectrometer, we established that this technique could identify which goats ate the most juniper.

With a tool to predict juniper consumption we were able to apply classical animal breeding principles based on each goat's juniper consumption and the juniper consumption of other goats in its pedigree. It was decided to apply divergent selection pressure and create two lines of goats, a high juniper line and a low juniper line. This selection strategy was applied to two different breeds, Angora and meat goats, the latter being Boer x Spanish goats. Breeding groups using these criteria were established in 2005, and we have been selecting goats for these traits for the past eight years.

The results of this selection pressure

shows that we have been able to continually increase the difference in the expected breeding value (EBV) of goats for juniper between the high and low selection lines. The EBV for juniper consumption is the difference in this trait that can be attributed to genetics and can be inherited by their offspring. It is expressed as a percent deviation from the average for the population. Thus an animal with an EBV of 6 is genetically capable of consuming 6 percent more juniper than the average goat in this group of goats. Currently, the difference



Change in the genetic potential for juniper consumption (expected breeding value) by the highest and lowest 10% of goats in each selection line since 2005.

PASTURE PROBLEM SOLVED BY GOATS

ON JUNE 4th, Oliver L. Adams, County Agent for Boone County, Arkansas, stated that Mitchell Davis of Harrison had solved the problem of keeping sprouts out of his pasture. Mr. Davis' solution of the problem not only keeps the sprouts out of the pastures but also pays him a nice profit.

Mr. Davis is keeping 12 Angora goats to do the job and at the same time he is getting a cash return on the goats from the sale of mohair and natural increase in his flock. This year Mr. Davis sheared his 12 Angoras and got 60 pounds of mohair which he sold for 57 cents a pound or an average of \$2.85 per head. The natural increase of his flock was 5 kids valued at \$2.50 each.

The only expense which Mr. Davis had was the cost of a little dry hay which he had to feed the goats during the bad Winter months.

between the top and bottom 10 percent of the goats in the high and low consuming lines is about 14 percentage units for the meat goats and 9 percentage units for the Angora goats. The difference in juniper consumption estimated by the fecal analysis is greater than the differences in the EBV. Averaged over several years of samples, the top and bottom 10 percent of the of the meat goats consumed 51 and 22 percent of their diet from juniper, respectively, and the top and bottom Angora goats consumed 21 and 5 percent of their diets from juniper, respectively. This indicates that in addition to the genetic differences in juniper consumption there is an environmental effect that may be attributed to learning.

One of the difficulties of this experiment is that, like you and me, goats do not eat the

same thing every day. As we began this project we conducted other studies to determine when to collect samples that represented the true preference of a goat for juniper and to discover the underlying physiological processes that allowed some goats to consume more juniper than others. Understanding the physiological processes will hopefully provide a more efficient way to select goats for increased juniper consumption.

One of the studies followed juniper consumption in 12 nannies for two years determine how to sample goats to best represent their preference for juniper. In this study we found out that goats tend to have a fairly regular cycle that peaks about every 7 to 9 days, and that spring samples represent the average yearlong consumption of juniper better than samples at other times of the year.

Another study investigated the level of monoterpenes in the blood following a dose of these compounds. Monoterpenes are naturally occurring compounds in juniper that give it its characteristic odor, resistances to rotting, and reduce its palatability to grazing livestock. In this study we found that goats that had a high genetic potential for juniper consumption had lower levels of monoterpenes in the blood than low juniper consuming goats even though both groups were given the same dose of this compound. This indicates that for (currently) unknown reasons goats that consume more juniper are physiologically exposed to lower levels of these plant chemical defenses than goats that eat less. We are currently looking for genetic markers to identify goats that have a greater genetic potential for the consumption of juniper.

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Funding the Super Juniper Eating Goat Study

THE PROJECT presented in this article required work by many people and support by a number of different agencies.

Texas A&M AgriLife Research has provided long-term support for this research that was supplemented over time by funding from the Texas Food and Fibers Commission; and later the Texas Department of Agriculture through their Food and Fibers Research Grant Program; the National Sheep Industry Improvement Center; the USDA Cooperative State Research Service; and the United States–Israel Binational Agricultural Research and Development Fund.

Although not a complete list, people that made significant contributions to this project in alphabetical order include:

Erika A. Campbell
 Christopher J. Lupton
 Charles A. Taylor, Jr.
 Daniel F. Waldron
 John W. Walker
 Wynne Rae Whitworth



On this cattle and goat grazed pasture the hedged juniper bushes show how goats can keep juniper at a manageable level while still allowing forage for cattle.

The ultimate goal of a super juniper eating goat is to produce animals that will make better use of an abundant resource and thereby increase the number of goats that can be sustainably raised on a ranch. Over time this should also benefit the overall ecological health of the ranch as the juniper

is more heavily utilized it should be less competitive thus allowing more desirable forages to increase. Goats cannot be expected to clear a cedar break but they can be an important part of a management plan to stop the re-invasion of juniper after a pasture has been cleared using other methods. ◇

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