

## Managing Shrub-Infested, Postmined Pasturelands With Goats and Cattle Part II. Effects on Forage Biomass, Nutritive Values, and Animal Performance

*A. O. Abaye, Professor, Crop and Soil Environmental Sciences, Virginia Tech*

*D. M. Webb, Extension Agent, University of Tennessee Extension*

*Carl Zipper, Extension Specialist, Crop and Soil Environmental Sciences, Virginia Tech*

*Jean-Marie Luginbuhl, Professor, Crop Science, North Carolina State University*

*Chris Teutsch, Associate Professor, Forage Research and Extension, Southern Piedmont Agricultural Research and Extension Center*

### Introduction

Reclamation of mined lands in the Appalachian coal region has resulted in the successful establishment and utilization of pasture for beef cattle production. Maintaining desirable grasses and legumes on reclaimed, mined land requires appropriate grazing management, weed control, and proper soil fertility maintenance. The steep topography that is characteristic of the region makes management of these pastures difficult and sometimes dangerous. The low fertility of the soils — coupled with difficult topography and a proliferation of seeds by plant species used in reclamation — has resulted in an invasion of undesirable plant species that reduce forage quality and quantity, resulting in reduced cattle performance on reclaimed, coal-mined lands.

Invasive plant species (often non-native) are able to reproduce and spread over large areas due to few natural controls. When these species invade pastures, they can be problematic for livestock producers, especially when the plants possess characteristics that inhibit browsing or grazing. Such plants are also undesirable if their proliferation in the pastured areas remains unchecked, allowing the land to act as a seed source that aids the spread of these species to other areas.

Beef cattle production is a viable enterprise in the Appalachian region because cattle are often able to utilize lands altered by coal mining. Incorporating goats

into existing cattle-grazing operations in this region may serve as a possible biological control for invasive plant species in pastures.

Goats prefer to browse woody species rather than graze, and they prefer steep land compared to flat land. They tolerate plant species that contain bitter compounds, such as tannins, that are unpalatable to cattle. Therefore, the mixed grazing of goats with cattle is possible, because each species selects for its preferred diet and competition between them for forage is minimal.

Research in North Carolina has shown that mixed grazing goats with cattle has been successful in converting brush-infested pasture into a desirable mix of grasses and legumes beneficial for cattle (Luginbuhl et al. 1995; Luginbuhl et al. 2000). The total animal output for mixed grazing is generally improved over single-species grazing because both animal performance and the pasture's carrying capacity are improved. Improved total animal output from mixed grazing can be as much as 24 percent more than single-species grazing (Abaye, Allen, and Fontenot 1995).

An experiment conducted from 2006 to 2008 at the Powell River Research and Education Center near Wise, Va., explored the use of goats to control invasive plants in cattle-grazing systems. Research goals were to determine the effects of mixed grazing of goats with cattle on forage biomass, forage nutritive quality, and

[www.ext.vt.edu](http://www.ext.vt.edu)



Figure 1. Mixed grazing of cattle and goats, Powell River Research and Education Center project site, Wise County, Va.

animal performance. The three treatments included an ungrazed control, cattle grazing alone, and mixed grazing goats with cattle (figure 1).

Three replicates were used for grazed treatments and two replicates were used for the control. Replicate paddocks for grazing were 4.5 acres each, and control replicates were 0.5 acre. Three steers (615 pounds) were allocated to each grazing treatment. The stocking rate was based on 1.5 acres per steer. Mixed grazing included 15 young, intact male goats (44.7 pounds  $\pm$  SE) in addition to the cattle. The assumption was that two to three goats could be added per steer with no loss in steer performance.

Animals were rotationally grazed among paddocks by grazing one paddock for two weeks, followed by four weeks of rest. Water and trace minerals were provided by free choice at all times. Animals were weighed three times during the growing season (spring, summer, and fall). Pastures were evaluated for forage biomass, nutritive values, species diversity, and the effect of grazing on browse species during spring, summer, and fall of each grazing season. Forage biomass was determined by clipping eight 2.7-square-foot quadrants per grazing treatment and four 2.7-square-foot quadrants to a 2-inch height. Samples were dried in a forced-air oven at 221 degrees Fahrenheit for at least 48 hours.

Results are presented on a dry-weight basis. The experiment was conducted on a reclaimed, surface-mined area that had been in use for cattle grazing for more than a decade but was experiencing degraded pasture

quality due to the growth of invasive species, including autumn olive (*Elaeagnus umbellata*), *Sericea lespedeza* (*Lespedeza cuneata*), and multiflora rose (*Rosa multiflora*). We will review results of this experiment and then conclude by reviewing “lessons learned” that we hope can be helpful to livestock producers who may consider use of mixed-grazing systems.

## Forage Biomass

Forage biomass was influenced by year: It was less in 2008 than in 2006 or 2007. Grazing treatments impacted the total seasonal-forage biomass (the combined biomass of conventional pasture species and herbaceous weeds, including the invasive species). When compared to the ungrazed control and the cattle-alone grazing system, total standing-forage biomass was less in the mixed-grazing pastures over the three growing seasons (figure 2).

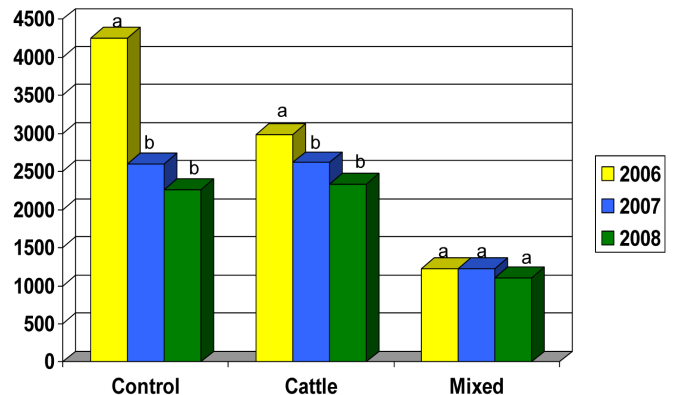


Figure 2. Influence of cattle alone and mixed grazing versus no grazing control on total forage biomass (pounds/acre) by year. Note: Values followed by the same letter are not significant at  $p = 0.05$ .

By the end of each grazing season, standing-forage biomass was always less in pastures occupied by the mixed animal species than the cattle-alone or control treatments. Forage biomass was less in the mixed-grazed pastures because it was being fully utilized by the grazing animals.

## Forage Quality

The nutritive values of pasture, *Sericea lespedeza*, autumn olive, and multiflora rose were within the acceptable range for all classes of animal production (table 1). The total digestible nutrients (TDN) and crude protein (CP) requirements for 500-pound steers gaining 1.5 to 2.2 pounds per head per day are 63 to 67.5 percent TDN and 10 to 11.5 percent CP. The requirements for young, growing goats are 65 to 68 percent TDN and 12 to 14 percent CP (NRC 2000).

All of the forages sampled generally met or exceeded these requirements, and the nutritive values of *Sericea lespedeza*, autumn olive, and multiflora rose were generally higher than that of the typical mixed pastures (clovers and cool-season grasses, such as orchardgrass, tall fescue, timothy, and lovegrass). The lower TDN (average 58.9 percent) and CP (average 10.1 percent) values of pasture species in summer in this experiment have the potential to reduce gains by steers, but the TDN and CP values of *Sericea lespedeza*, autumn olive, and multiflora rose were more than adequate to meet the nutritional requirements of the grazing animals. Various research has documented the nutritive value of weed or browse species to be higher or equivalent to those of forages commonly used for pasture (NRCS 1994; Ball, Hoveland, and Lacefield 2007).

## Animal Performance

By the end of the grazing season in 2006, total animal output from mixed grazing was 205 pounds more than from those grazed alone. In 2007, which was a drier year, total animal output from mixed grazing still had a much greater weight gain than cattle grazed alone. The weight gain for goats in 2007 was 50 percent more than 2006 results (table 2, see page 4). Treatment comparisons of the total gains by cattle-alone grazing versus mixed grazing cattle with goats showed that the output of animal product was more favorable for mixed grazing.

In 2008, both the average daily gains and total output were lower than in 2006 and 2007 (data not shown). This can be attributed to the decline in both browse species and forage biomass. The mixed grazing of goats with cattle resulted in greater meat output compared to cattle-alone grazing. The combination of goats with cattle did not have a negative effect on the performance of either animal species. In fact, in most cases, the performance of cattle grazing with goats was better than cattle grazed alone.

Our two-year research showed that mixed grazing by cattle and goats can improve the overall utilization of pasture by reducing undesirable species and increasing more-desirable species. Also, the economic value from the animal gains is an added benefit to the economically depressed, coal-mined Appalachian regions of Virginia.

**Table 1. Mean nutritive values of mixed pasture species, autumn olive, *Sericea lespedeza*, and multiflora rose over three grazing seasons, 2006-2008.**

Forage type	Nutritive values (%)			
	ADF <sup>b</sup>	NDF <sup>c</sup>	CP <sup>d</sup>	TDN <sup>e</sup>
Mixed pasture species <sup>a</sup>	34.5 <sup>a</sup>	48.1 <sup>a</sup>	10.8 <sup>d</sup>	61.8 <sup>d</sup>
Autumn olive	24.4 <sup>c</sup>	38.6 <sup>b</sup>	22.3 <sup>a</sup>	72.9 <sup>b</sup>
<i>Sericea lespedeza</i>	30.2 <sup>b</sup>	32.1 <sup>c</sup>	14.4 <sup>b</sup>	66.5 <sup>c</sup>
Multiflora rose	17.7 <sup>d</sup>	24.9 <sup>d</sup>	12.8 <sup>c</sup>	80.5 <sup>a</sup>

<sup>a</sup> Mixed pasture species = clovers and cool-season grasses, such as orchardgrass, tall fescue, timothy, and lovegrass.

<sup>b</sup> ADF = acid detergent fiber.

<sup>c</sup> NDF = neutral detergent fiber.

<sup>d</sup> CP = crude protein.

<sup>e</sup> TDN = total digestible nutrient.

Note: Values followed by different capital letters indicate significant differences within the column ( $p < 0.05$ ).

**Table 2. The influence of grazing cattle alone and cattle plus goats on animal performance for the 2006 and 2007 grazing seasons.**

Treatment	Cattle only	Cattle/goats	Goats only
<b>2006 totals</b> <sup>a, b, c</sup>			
ADG (lb/head/day)	1.43	1.32	0.15
Gains per animal	175.00	153.00	18.00
Gains by species	524.0	458.00	272.0
Treatment comparison <sup>d</sup>	524.00	729.60	—
<b>2007 totals</b>			
ADG (lb/head/day)	2.40	2.70	0.31
Gains per animal	174.70	87.60	20.60
Gains by species	524.00	562.90	308.60
Treatment comparison <sup>e</sup>	524.00	871.50	—

<sup>a</sup> Cattle-alone average daily gain (ADG) lower in 2006 than 2007 at  $p = 0.05$ .

<sup>b</sup> Cattle mixed ADG lower in 2006 than 2007 at  $p = 0.05$ .

<sup>c</sup> Goat ADG lower in 2006 than 2007 at  $p = 0.05$ .

<sup>d</sup> Cattle alone versus mixed grazing differs at  $p = 0.01$ .

<sup>e</sup> Cattle alone versus mixed grazing differs at  $p = 0.05$ .

Note: Animal performance data for 2008 not included.

## Conclusions and Recommendations

At the end of the three-year study, forage biomass was less in the mixed-grazing treatment than in the cattle-alone grazing and the ungrazed control as a result of more effective utilization by the goats and cattle together. The decline in forage biomass yield in the mixed-grazing treatment in our experiment could be attributed to the considerable preference for *Sericea lespedeza* and other weeds exhibited by the goats. A similar observation was made by Hart (2001), who stated that *Sericea lespedeza* was preferred by goats, and invasive stands of *Sericea lespedeza* could be nearly eliminated in three years. Weeds (including *Sericea lespedeza*) represented less than 30 percent of the forage biomass in the grazed treatments.

Also, the high nutritive value of invasive plant species, coupled with mixing grazing animals with differing grazing preferences, may yield a greater output per head and/or per land area. When compared to the ungrazed control, both cattle-alone grazing and mixed grazing resulted in better persistence of grass species, such as tall fescue, orchardgrass, and bluegrass, as well

as white and red clovers. *Sericea lespedeza*, a major weed species in the control treatment, became one of the more-desirable species in the mixed-grazed treatment, because goat browsing improved its palatability to cattle. The mixed-grazing treatment had a favorable effect on the quality of pasture vegetation (Abaye et al. 2011).

The nutritive values of *Sericea lespedeza*, autumn olive, and multiflora rose were generally much higher than the conventional pasture species, and goats preferred these species to the conventional pasture species preferred by cattle. As a result, goats gained weight while improving the quality of the pasture for the cattle by keeping the invasive species under control.

The combination of goats and cattle did not have a negative effect on the performance of either animal species. In fact, in most cases, the performance of cattle grazing with goats was higher than those grazed alone. Total animal gain was 34 percent higher for mixed grazing than for cattle-alone grazing in our study.

The three-year research study showed that mixed grazing of goats with cattle can improve the overall utiliza-

tion of pasture by reducing undesirable plant species and increasing more-desirable species. However, such outcomes require effective management. Managers should monitor the relative usage of pasture's conventional forage and browse vegetation components, especially in a new, mixed-grazing system's early stages, so as to ensure the right mix of goats and cattle to utilize both the browse and forage components of the pasture effectively, without overusing the forage component.

If the goal is to eradicate invasive species, the stocking rate needs to be significantly higher than the stocking rate needed to control the species. The use of mixed grazing goats with cattle showed a great potential for improving the utilization of both established and invasive plants found on reclaimed, coal-mined lands in the Appalachian region. The preference of goats for invasive plant species and the increased output per land area are attractive benefits of mixed grazing goats with cattle for livestock producers in this region.

## References

Abaye, A. O., V. G. Allen, and J. P. Fontenot. 1995. Influence of grazing cattle and sheep together and separately on animal performance and forage quality. *Journal of Animal Science* 72:1,013-22.

Abaye, A. O., D. M. Webb, C. E. Zipper, J.-M. Luginbuhl, and C. Teutsch. 2011. *Managing Shrub-Infested, Postmined Pasturelands With Goats and Cattle: I. Effect on Botanical Composition and Browse Species*. Virginia Cooperative Extension Publication CSES-4.

Ball, D. M., C. S. Hoveland, and G. D. Lacefield. 2007. *Southern Forages: Modern Concepts for Forage Crop Management*. 4th ed. Lawrenceville, Ga.: International Plant Nutrition Institute.

Hart, S. P. 2001. Recent perspectives in using goats for vegetation management in the USA. *Journal of Dairy Science* 84 Supplement:E170-76.

Luginbuhl, J.-M., J. T. Green, J. P. Mueller, and M. H. Poore. 1995. Forage needs for meat goats and sheep. In *Production and Utilization of Pastures and Forages in North Carolina*, edited by D. S. Chamblee and J. T. Green. Technical Bulletin 305. North Carolina Agricultural Research Service. Raleigh: North Carolina State University.

Luginbuhl, J.-M., J. T. Green Jr., M. H. Poore, and A. P. Conrad. 2000. Use of goats to manage vegetation in cattle pastures in the Appalachian region of North Carolina. *Sheep & Goat Research Journal* 16:124-35.

National Resources Conservation Service (NRCS). 1994. *The Use and Management of Browse in the Edwards Plateau of Texas*. USDA. Temple, Texas: NRCS.

National Research Council (NRC). 2000. *Nutrient Requirements of Beef Cattle*. 7th ed. Washington, D.C.: National Academy Press.