

## Managing Shrub-Infested, Postmined Pasturelands With Goats and Cattle Part I: Effect on Botanical Composition and Browse Species

*Ozzie Abaye, Professor, Crop and Soil Environmental Sciences, Virginia Tech*

*Matt Webb, Extension Agent, University of Tennessee Extension*

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

*J. M. Luginbuhl, Associate Professor, Forage Research and Extension, North Carolina State University*

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

### Introduction

The narrow margins of profit for most cattle and goat enterprises necessitate the development of methods to increase efficiency of forage use. The grazing behavior and diet selection of goats greatly differs from that of cattle. Goats prefer to browse woody and shrub-type species of plants, rather than low-growing traditional forages; cattle prefer to graze grasses and legume swards. This makes the co-grazing of cattle and goats an alternative, often effective, mixed-sward management technique (Abaye et al. 2011).

Here, we describe how such a mixed-grazing system affected forage quality when established in a reclaimed, mined-land site in Wise County, Va. The experiment was conducted in Virginia's coalfields, where invasive, woody weeds have proliferated and conventional pasture management techniques are hindered by the nature of the terrain. However, the techniques described have potential application in wider areas.

When established in 1989 and 1990, the pastures at the Powell River Project Research and Education Center were primarily tall fescue (*Festuca arundinacea* Schreb.), orchardgrass (*Dactylis glomerata* L.), and ladino white clover (*Trifolium repens* L.). Over the following years, however, the pastures became increasingly infested with wood vegetation, including multiflora rose (*Rosa multiflora* Thunb.), brambles (*Rubus* spp.), honeysuckle (*Lonicera japonica*), honey locust (*Gleditsia triacanthos* L.), mulberry (*Morus alba*, *Morus rubra*, *Morus nigra*), black locust (*Rob-*

*inia pseudoacacia* L.), and autumn olive (*Eleagnus umbellata* Thunb.), as well as many broadleaf weeds, such as thistle (*Cirsium* spp.; table 1).

These species have infested millions of acres of pastureland in the Appalachian regions of Virginia and adjacent states. Several of these species are especially prone to invading pastures in the coalfield region (honey locust, black locust, and autumn olive), because they are currently or have in the past been used for reclamation of coal-mined sites.

Due to the nature of the land and soil in the Appalachian coalfield and the low economic returns from cattle grazing in this landscape, restoration of pasture vegetation on these areas using conventional systems — such as herbicide and replanting — is often not a viable economic option. Low-cost, environmentally safe, and economically viable invasive brush-control techniques are needed to maintain productive and sustainable grazing systems in these landscapes.

An experiment was conducted in 2006, 2007, and 2008 at the Powell River Research and Education Center near Wise, Va., to determine the effects of an ungrazed control, cattle grazing alone, and cattle grazing with goats (mixed) on forage biomass, botanical composition, relative plant abundance, and animal performance.

Three replicates were used for grazed treatments and two replicates for the control. Replicate paddocks for grazing were 4.5 acres each, and control replicates

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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. Pastures were evaluated for forage biomass, nutritive values, species diversity, and the effect of grazing on browse species during spring (June), summer (July/August), and fall (October) of each grazing season (Abaye et al. 2011). Botanical composition of the pastures was determined by using the double DAFOR scale (Abaye, Allen, and Fontenot 1997; Brodie 1985), a method of quantitative visual assessment that includes assessing the percentage of groundcover, grass, legume, and weeds.

Because the invasive and prolific shrub autumn olive was a dominant vegetative component at the experiment's outset, additional procedures were employed to monitor how the grazing systems affected its status. The height of selected autumn olive shrubs was measured with a clinometer from a distance of 10 meters. Branch length was measured with a tape measure from the base of the branch to the end tip. Survival was measured by counting shrubs in each measurement area and visually evaluating percent leaf-out.

## Research Outcome and Summary

### Effect on Forage Species (Botanical Composition)

Generally, the effect of grazing versus control was evident (figure 1). The mixed-grazing treatment resulted in a shift in botanical composition to a species mix that is more desirable by both animal species than the control treatment, and to a species mix that is more favorable to the cattle than the cattle-alone treatment (figures 2 versus 3). When compared to an ungrazed control, both cattle-alone and mixed-grazed treatments resulted in an increase in persistence of grass species, such as tall fescue, orchardgrass, and bluegrass (tables 1 and 2).

At the end of the three-year experiment, white and red clovers disappeared from the control, and although not present in great abundance, they remained part of the pasture component in both grazing treatments. *Sericea lespedeza* became a dominant weed in the control treatment, mostly due to the lack of grazing pressure (figure 3). The grazing behavior of goats influenced the growth

pattern of *Sericea lespedeza* and other weeds from an erect, woody appearance to a shorter, leafier plant that was palatable to cattle.

The high grazing preference of goats for *Sericea lespedeza* and other weeds influenced the morphological characteristics of these plants. The growth pattern of *Sericea lespedeza* was changed from an erect, woody, less leafy plant to a shorter, more palatable, and leaf-



Figure 1. A sharp contrast in the area outside the experiment (left) versus a paddock grazed by both cattle and goats (right).



Figure 2. Selective grazing of *Sericea lespedeza* by goats resulted in a shorter, highly branched, leafy plant that was acceptable to cattle.



Figure 3. Ungrazed paddock showing the stand of *Sericea lespedeza*.

**Table 1. Effect of control, cattle alone, and mixed-grazing treatments on botanical composition, 2006. (Values followed by different letters within a row signify differences at p = 0.05.)**

Component	Control	Cattle	Mixed
Spring			
Grass	44.0A	40.2A	36.8A
Legume	18.0B	32.8A	5.2C
Weed	38.0B	27.0B	58.0A
Summer			
Grass	25.0B	48.8A	55.0A
Legume	18.0BA	27.7A	9.2B
Weed	57.0A	23.5B	35.8B
Fall			
Grass	52.0C	63.7B	76.3A
Legume	4.5B	27.5A	7.0B
Weed	43.5A	8.8B	16.7B

**Table 2. Effect of control, cattle alone, and mixed-grazing treatments on botanical composition, 2007. (Values followed by different letters within a row signify differences at p = 0.05.)**

Component	Control	Cattle	Mixed
Spring			
Grass	72.0A	72.5A	52.7B
Legume	0.5B	19.5A	16.7A
Weed	27.5A	8.0B	0.7A
Summer			
Grass	41.0B	77.3A	70.7A
Legume	0.0C	8.2B	16.5A
Weed	59.0A	14.5B	12.8B
Fall			
Grass	49.0B	83.3A	72.8A
Legume	0.0A	5.8A	5.5A
Weed	51.0A	10.9B	21.7B

ier plant due to goat grazing (figures 1 versus 2). The shorter and leafier *Sericea lespedeza* was more acceptable and thus was readily grazed by cattle (figure 1). Also, grazing of *Sericea lespedeza* opened up the sward canopy and allowed desirable grasses and legumes to increase.

In 2006 and 2007, shifts in botanical composition were observed due to treatments (tables 1 and 2). Generally, the grazing treatments experienced an increase in grass percentage compared to weeds. The increase in grass percentage after the two grazing seasons was 5 percent for the control, 43 percent for cattle alone, and 36 percent for the mixed-grazed treatments. Results are similar to Luginbuhl et al. (1999) and Luginbuhl et al. (2000), where mixed grazing cattle with goats improved grass and legume persistence and reduced weeds and brush, compared with treatments of cattle or goats grazed alone. Luginbuhl et al. (1999) reported that grass percentage increased from an initial 13 percent to 54 percent after four years of mixed grazing goats with cattle. The results indicated that grazing was essential for maintaining weeds at low levels in pasture.

By the end of the three grazing seasons, no legumes were observed in the ungrazed control treatment, while a little more than 5 percent legumes were observed in the grazed treatments. The decline in legumes in the control treatment can be attributed to a lack of grazing pressure and excessive shading by grasses, weeds, and shrubs. In the summer of 2007, the legume content was much higher in mixed grazing (16.5 percent) compared to cattle grazed alone (8.2 percent; table 2).

The higher percentage of legumes in the mixed-grazed treatment can be attributed to the goats' preference for grasses over legumes, as well as preferences for weeds and browse species. In 2008, grasses represented the dominant component of biomass for both grazing treatments (data not shown). Legume contribution as a component of biomass was lowest throughout the growing season in all treatments.

## Effect on Browse Species

Autumn olive branch and height, as well as shrub survival, was affected by goats browsing in the mixed-grazing treatment. The change in branch length due to growth was highest for cattle-alone grazing, where cattle removed herbaceous species that compete for nutrients and water, while only minimally impacting the shrub. The change in branch length was lowest for

mixed grazing where goats browsed on the autumn olive leaves, branches, and bark; the ungrazed control showed intermediate change (figure 4).

During the summer-fall period, branch lengths in the cattle-alone grazing and control treatments showed no differences from the spring period, but mixed grazing caused branch growth to slow. Goats were observed chewing the tips of branches if branch tips were slender and tender. Therefore, during the summer-fall period, goats browsing branch tips had a negative impact on branch length within the goats' reach, although higher branches were able to continue growing.

There were no data on autumn olive shrub survival in 2006 and 2008. It was assumed that goat browsing would have an effect on autumn olive growth but that it would not kill autumn olive shrubbery within the first year. However, goat browsing coupled with a late spring frost in 2007 resulted in autumn olive shrub losses (figure 5). On May 18, 2007, the control and cattle-grazing treatments showed no differences in autumn olive survival. However, only 73 percent of autumn olive shrubbery in the mixed-grazing treatment survived the first year, whereas essentially no losses were found in the control (100 percent) and cattle-grazing treatments (98.9 percent; figure 5). This was also true on September 21, 2007, when only 61 percent of autumn olive survived in the mixed-grazed treatments. There was no difference between the control (98.5 percent) and cattle alone (92.8 percent).

The effect of goat browsing on the survival of autumn olive shrub was evident. The reduction in autumn olive shrubs where goats grazed can be attributed to the browsing pattern of the goats. When browsing, goats stand on their hind legs and hold down branches with their weight for easy access to leaves and twigs (figure 6). When a goat bends down a branch, other goats in the herd may also gather around the branch for a meal. A branch can be completely defoliated within a short period. As a result of this browsing behavior, a browse line of defoliated branches may develop on the shrubbery.

In our study, we observed an average browse height of close to 7 feet. This was higher than the 5 feet reported for free-ranging goats browsing *Acacia tortilis* in Kenya (Oba and Post 1999). Browsing height is likely influenced by the size of the goat. Branches were broken and killed at times as branches became brittle from excessive browsing.

As forage became limiting at the end of the growing season, goats began to strip bark on shrubs. This bark stripping can girdle and kill the shrub. After hard browsing and branch death, the shrub would occasionally produce numerous suckers from the base of the plant. This lush growth was highly preferred and acces-

sible to goats. Another observation of the resiliency of autumn olive was that when allowed a rest period of four to six weeks, leaves would regrow to the size they were prior to browsing.

## Summary and Conclusion

Mixed grazing of goats with cattle can have positive influences on botanical composition and invasive plant species control on reclaimed, coal-mined lands in the Appalachian region. The grazing behavior of goats changed the growth pattern of *Sericea lespedeza* from an erect, woody, less leafy plant to a shorter, more succulent, leafier plant. The shorter and leafier *Sericea lespedeza* was more acceptable and thus was readily grazed by cattle.

In 2006, grazed treatments resulted in a reduction in undesirable weedy species. Furthermore, by the end of the 2008 grazing season, the grazing treatments reduced the weed percentages to less than 30 percent. By the end of the three grazing seasons, the grass component of the grazed pastures increased, while legumes (particularly clovers) declined.

The change in botanical composition of the pastures due to grazing can be attributed to the grazing pattern and diet preference of the grazing animals. The grazing behavior and diet selection of goats greatly differs from cattle. This makes the mixed grazing of cattle and goats an alternative management technique for managing diverse pasture swards. Goat browsing had a negative impact on autumn olive shrubbery. Shrub survival was less in mixed grazing (61 percent) by the end of the experiment, compared to the other treatments.

Mixed grazing goats with cattle is a viable practice on reclaimed, coal-mined lands. Mixed grazing resulted in greater utilization of pasture resources, mainly due to the different grazing habits of goats and cattle offering opportunities for complementary pasture use. Goats provided biological control for invasive plant species, such as autumn olive, while maintaining *Sericea lespedeza* in an herbaceous state and likely limiting its seed production. Therefore, goats could play a major role in low-input farm enterprises in the Appalachian coal-mining region while aiding in the control of alien invasive species that have become common throughout the area. These results suggest that goats and cattle grazing together can optimize pasture use when plant species are diverse and the appropriate mixture of cattle and goats are used.

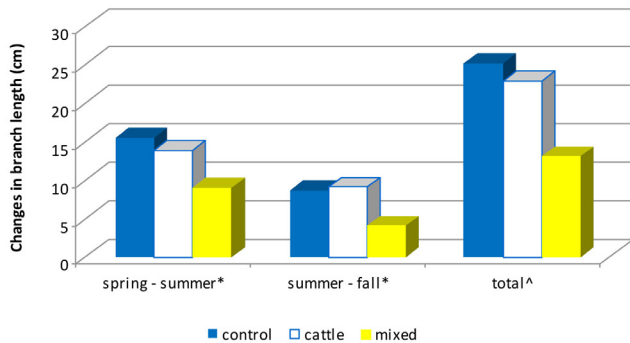


Figure 4. The influence of mixed grazing on branch length, 2006-2008. (Note: \* and ^ denote significance at  $p = 0.50$  and  $p = 0.01$ , respectively.)

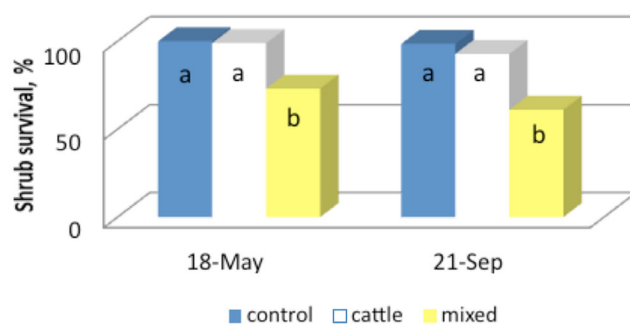


Figure 5. Autumn olive shrub survival of control, cattle grazing, and mixed grazing, 2007. (Note: Letters are significant at  $p = 0.05$ .)



Figure 6. Goats browsing autumn olive, 2007.

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