Nutritional Status of Goats Used in Controlling Forestry Underbrush Vegetation

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Abstract

The nutritional status of goats used in a forest vegetation control was evaluated by the performance of goats in two field trials conducted in 1995 and 1996. Nutritional status of the goats was determined by assessing weight gain performance and the composition of the forages consumed. Six 0.202 ha (132.68 m x 15.25 m) forest paddocks were assigned in a completely randomized block design (T x R x G) to two treatments with three replicates in a two year study to evaluate the effect of biological (goats) method in controlling forest woody vegetation or weeds. The treatments were: A -Goats stocked at the rate of 25 goats/hectare (ha); and B -Goats stocked at the rate of 40 goats/ha. Goats were conditioned for 4 weeks before being randomly assigned to treatments. Each of the experiments was planned to last for sixteen weeks. The goats were weighed, dewormed and vaccinated for the most common parasites and diseases at four-week intervals. Guard dogs (Great Pyrenees breed) were used to protect the goats from predators. No animal was lost to predators. During the first year, the goats consumed more than 60% of available forest vegetation within the first four weeks. There was minimal body weight (BW) gain for goats in both biological treatments but weight gain was not significant ($P < .05$) for either the 25 goats per ha or the 40 goats per ha. In the first year's trial, some goats in paddocks containing 40 goats per ha lost weight while goats in all treatments in second year's trial lost weight. Hence hay was supplemented (at the rate of 4.09 kg per goat per paddock per week). The loss of BW in the second year's trial indicated that the vegetation available in the paddocks was not enough to satisfy the maintenance energy requirements of the goats.

KEY WORDS: Weed control, weight gain, guard dogs, browsing.

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INTRODUCTION

Forestland accounts for a large percentage of the earth. Hence, the management of forestry understory vegetation is important in the economy of agroforestry. The forestland of Southern United States has more acreage than all the cropland and pasture land combined (Bliss, 1991). With about 73.65 million ha (182 million acres), southern forests produce tremendous quantities of woody vegetation and forest underbrush. There are several techniques that are available for brush and weed management, some are more efficient or economical while others are more environmentally acceptable. Browsing goats in the forest is one of the methods considered to be environmentally friendly in forest weed control. Pinkerton (1991) reported that

goats can provide an alternative to using herbicides for controlling competing vegetation in pine plantation having shown that goats drastically reduced vegetative regrowths.

The goat (Angora and Spanish breeds) is on of the most preferred animal species used in controlling forest underbrush probably because it is a good browser and can selectively utilize a wide variety of shrubs, woody plants, weeds, and briars (Adams et al. 1992). Angora and other goat breeds have been used economically (Harris, 1997) to improve pasture, clear reforestation areas, control leafy spurge and destroy multiflora roses, red cedars, sand burs, knapweed, hound's tongue canadian thistle, sagebrush, backbrush, giant ragweed, sunflowers, and many weeds (Goat Handbook-Angora Goats. 1993).Also, the forest vegetation could provide energy, and protein and other nutrients required in goat maintenance and production (NRC, 1985).

Normally , goats depend on forages to meet their nutritional needs. Forages commonly utilized are grasses, browse, weeds, forbs, and seasonally, small grains, hays, and silages. With rare exception, all these plants contain metabolizable crude protein, minerals and vitamins. Goats prefer to consume more browse plants than grass. Studies show that goats would normally consume about 60% browse plants and 40% grass in mixed plant populations (pinkerton and Pinkerton 1997).

Many factors may be responsible for goats' preference of browse plants. Although grasses are considered the most desirable type of vegetation for ruminant animal production, goats prefer forbs and browse plants that often contain higher levels of nutrients (Adams, et.al. 1992). For example, leguminous forbs and browse may contain as much as 25% crude protein, whereas perennial grasses seldom exceed 15% crude protein content, although the level of nutrients may vary from one part of the plant to another. Generally, leaves are more nutritious and digestible than stems and young leaves have more nutritional value than mature leaves (Huston and Ace, 1992; Pinkerton and Pinkerton, 1997). Woody stems usually, contain more fiber than leaves (Cherneyand Hall, 1995). Other factors include palatability (Cherney and Hall, 1995) and the forage quality (Linn and Martin, 1997) which decrease as the matures due changes in the chemical constitution of the plant. Changes in plant chemistry include increased fiber components and decreased protein content.

The objectives of this study were to evaluate the use of goats as a biological agent in the control of forest woody vegetation, and to establish the stocking density of goats used in controlling forest vegetation.

METHODS

The nutritional status of goats used in a forest vegetation control was evaluated by growth performance of goats. In this study, field trials were conducted over two years to compare the goats as a biological method of forestry underbrush controlling to other common methods vegetation control (such as chemical and mechanical methods). Nutritional status of the goats was determine by evaluating their growth performance and the composition of the forages consumed. Only the paddocks containing goats were used in the analysis. The study area was located on the USDA Agricultural Research Service's Dale Bumpers Family Farm Research Center, 7 miles south of Booneville, Arkansas, on State Highway 23 at 35° N, 94° W. The Center varies from about 490 to 550 feet (149.45 m to 167.75 m) in elevation; Magazine Mountain, about 20 miles (32.18 km) east by northeast of the Center has 2823 ft (861.02 m) elevation, the highest point between the Appalachians side of Highway 23, in section 13, T5N, R28W. Mean annual precipitation is 49 inches (124.45 cm), evenly distributed throughout the year, and the

mean length of freeze-free period is 231 days, from March 23 through November 9 (Nelson and Zilgitt 1969). Soils on the study area are Leadville silt loam, 1 to 3% slopes, with inclusions of Enders silt loam, 3 to 8% slopes (Garner et al. 1980).

In the first year trial conducted in 1995, six 0.202 ha (132.68 m x 15.25 m) forest paddocks were used to compare the effect of two stocking rates of mature goats in controlling brush. The goats were Spanish breeds of approximately three years old. Treatments were: A - Goats stocked at the rate of 10 animals per acre (25 animals per ha); and B -Goats stocked at the rate of 16 animals per acre (40 animals per ha). Goats were conditioned for approximately 4 weeks before being randomly assigned to treatments. The goats were kept the paddocks to browse for 15 weeks. Prior to being stocked in the paddocks, major plant species were identified, sampled and refrigerated for further analysis.

The second year (1996) trial was conducted in the same paddocks with the same experimental design as for the 1995 trial. Thus, the goats browsed on a one-year regrowth of forest woody vegetation and underbrush within the paddocks. The same number of animals was allowed to browse in the same forest paddocks in 1996 as was the case in 1995. Prior to being stocked in the paddocks, a qualitative identification of the major botanical plant species was conducted. Paddocks with goats were supplemented with hay as necessary.

All animals were weighed and vaccinated with ivomectin4 and clostridium tetani-perfringens Type D-corynebacterium pseudotuberculosis5 at four week intervals. All experimental goats were provided with trace mineral salt and water *ad libitum.* Guard dogs (Great Pyrenees) were used to protect the experimental animals from predators. All vegetation samples collected were chemically analyzed for crude protein by the K.ieldahl method (A.O.A.C., 1984), neutral detergent fiber (NDF), acid detergent fiber (ADF), Acid Detergent Lignin (ADL), cellulose and hemicellulose (Van Soest and Marcus, 1964; Goering and Van Soest, 1970). Total digestible dry matter and digestible energy were calculated (Goering and Van Soest, 1970; NRC, 1985). The experimental design used in both trials was a complete randomized design (Steel and Torrie 1980; Bender et al., 1989).

In determining the degree of forest vegetation utilization, the following browsing categories were estimated (Pearson and Martin 1991):-

> **None**: No browsed plants or plant parts
> **Light**: Difficult to find browsed plants or browsed plant parts, twigs, and stems. Browsing patchy and generally less than 35% of the plants or plant parts or twigs and stems are browsed.
> **Moderate**: Frequently find browsed plants or plant parts(twigs and/or stems) but commonly present. Generally 35 to 70 % of the plants or plant parts or twigs and/or stems are browsed
> **Heavy**: Generally more than 70% of the plants or plants parts or twigs and/or stems are browsed. Plants have a hedged appearance.

RESULTS

In the 1995 trial, more than 60% of the available underbrush forest vegetation was consumed by the goats in all the paddocks within the first four weeks. Hence, the degree of forest vegetation utilization was categorized as moderate. In order to ensure that the goats were receiving energy at the maintenance level, all animals received hay supplementation, approximately 20.45 kg per week for paddocks stocked at the rate of 25 goats per ha and 30.68

kg of hay for paddocks stocked at the rate of 40 goats per ha). The degree of vegetation utilization was categorized as 'heavy' at the end of the trial.

The goats consumed > 70 percent of available underbrush vegetation in the paddocks. Weight gain was minimal for goats in both treatments (Table 1). However, weight gain was not significant ($P < .05$) for the two treatments ha treatment (Table 2). Some goats in paddocks containing 40 goats per ha lost weight during this period. Weight gain was more than doubled for the same length of time when the animals received hay supplementation as compared to the time the animals were consuming only forest underbrush (Table 2). However, weight gain was significantly higher ($P < .05$) for goats in paddocks containing 25 goats per ha than in those paddocks with 40 goats per ha in the first four weeks apparently due to more competition for feed.

In the second year (1996) trial, the goats had consumed more than 70 percent of available underbrush by the ninth week. This degree of consumption was rated as "Heavy". Within this period, the goats in paddocks containing 25 goats per ha lost 10.55% body weight (BW) compared with a loss of 12.43 % BW for the goats in paddocks containing 40 goats per ha (Table 3). Hence, the experiment was terminated. Apparently, the 1995-1996 forest underbrush regrowth did not provide adequate dry matter to support . the animals' minimum energy requirement for maintenance throughout the span of the experiment. More plant species appeared to have been growing during the annual regrowth. This could have been due to reduced canopy and competition that followed the first-year browsing. Plant species identified included sixteen grasses, twelve sedges, twelve woody species, nineteen small herbs and twenty-one large herbs.

Nutritional composition of some of the forest vegetation preferred by the goats (Tables 4 and 5) showed wide variations in crude protein, calculated digestible dry matter (DDM) and digestible energy by species and maturity .The 1996 samples tended to contain higher crude protein, DDM and digestible energy for the same species than 1995 samples. For example, a 1996 Honeysuckle sample contained 10.10 percent crude protein (Table 4) compared to 6.86 percent for the 1995 honeysuckle sample (Table 5). Digestible energy varied from 1.05 Mcal/kg DM for winged elm to 2.88 Mcal/kg DM for shining sumac (Table 5).

DISCUSSIONS

During the two year trials, no animal was lost to predators which suggests that the Great Pyrenees dogs were very effective in deterring predators. Supplemental hay that was given to the animals in both treatments after the first four weeks of the trial, suggested that the total DM from available forest vegetation was not enough to satisfy the maintenance energy requirement of the goats. It might be advisable, therefore, to stock less than 25 goats per ha when using goats in the management woody vegetation/weeds in the forest. Crude protein levels, estimated DDM and digestible energy in the analyzed samples tended to be higher in the forest vegetation sampled in 1996 than that sampled in 1995 (Tables 4 and 5) apparently because the 1995 forest vegetation was more mature than the 1996 annual vegetation regrowths.

CONCLUSIONS

Goats effectively controlled forest woody vegetation and underbrush within the first four weeks of the trial. Higher stocking density of goats requires supplemental hay. Considering the fact that the goats in this study consumed the available vegetation before the expected expiration date of the trial, it may be recommended that less than 25 goats per ha be used in forest

underbrush management. However, recommended stocking density would depend on the type of predominant vegetation, forage density and habitat

Woody forest vegetation can provide some nutrients and have a sparing effect on traditional feed normally that would have been fed to the goats if they were not browsing in the forest. Although the nutritional composition of forest vegetation varies due to the plant species and stage of maturity, goats' energy and protein requirements can be met by consuming young plants or careful selection of plant species. For example, green briars and Cherry (Table 5) with protein content of 20.79% and 18.46% (dry matter basis) respectively, can be good source of protein for goats and can be substituted for alfalfa hay *(Medicago.s'ativa)* with protein content of 19.7% (NRC, 1981). Other woody browse plants such as cedar and shining sumac with low protein content could supply energy of maintenance for mature goats.

Table 1. Periodic Mean Weights of Goats Browsing Forest vegetation (1995 trial)

Period	Stocking Rate 25 Goats/ha	Stocking Rate 40 Goats/ha
First Day (initial Week)	33.33 ± 5.73^{b}	32.90 ± 5.231^{a}
Fourth Week	36.03 ± 5.18^{b}	32.61 ± 5.16^{a}
Eight Week*	39.51 ± 6.01^{b}	36.42 ± 6.06^{a}
Twelfth Week *	39.60 ± 5.92^{b}	36.84 ± 6.67^{a}

a,b differences in means are not significant (P<.05)

Table 2. Periodic Gain (kg) of Goats Browsing Forest Vegetation (1995 trial)

Period	Stocking Rate 25 Goats/ha (N=15)	Stocking Rate 40 Goats/ha (N=24)
Fourth Week	2.74 ± 1.64^{a}	0.40 ± 0.56^{b}
Eight Week*	6.14 ± 2.52^{a}	3.54 ± 2.14^{d}
Twelfth Week *	6.51 ± 3.88^{c}	4.01 ± 3.14^{d}

Means with superscript a,b differ significantly (P<.05)
Means with superscript b,c differ significantly (P<.05)
*All goats were supplemented with hay due to low levels of understory vegetation after the first four weeks.

Table 3. Performance of goats browsing on annual regrowth of forestry underbrush and woody vegetation (May-August, 1996)

Stocking Rate/ha	Initial weight (kg)	Weight 32 days (kg)	Weight 63 days (kg)	Weight change at 32 d	Weight Change at 63 d
25 goats Wt gain %	40.5 +/- .4	36.9 +/- 1.1	36.2 +/- 1.6	-3.6 +/- 0.9 -8.87%	-4.3 +/- 1.3 -10.55%
40 goats Wt gain %	39.5 +/- .2	35.0 +/- 0.6	34.6 +/- 1.1	-4.4 +/- 1.1 -11.28 %	-4.9 +/- 1.2 -12.43 %

Table 4. Chemical Composition of predominant Woody Vegiation-1995

SAMPLE	CP ----------	NDF ----------	ADF -----%----	ADL ----------	ASH ----------	DDM ----------	DE Mcal/kg
Smilax	9.32	61.06	46.67	24.96	.03	31.94	4.31
Ashe (Juniperus ashei)	9.90	56.50	45.02	20.71	.13	38. 83	1.59
Sparkle berry (Vaccinium aboreum)	5.99	63.55	52.95	29.16	.16	29.14	1.19
Pine (Pinus echinofa)	6.17	56.68	40.58	18.72	.48	38.71	1.59
Cedar Bark	5.24	60.05	53.96	31.87	.08	30.78	1.26
Trumpet Cedar	9.03	65.66	52.29	18.53	.33	37.20	1.52
Oak (Quercus viriginiana)	9.22	55.79	42.48	24.05	.94	44.07	1.81
Black Cherry (Prunus Serotina)	1..30	51.13	41.55	21.94	.30	60.99	2.50
Cedar	6.59	49.57	40.94	19.30	.11	48.65	1.99
Shining Sumac (Rhus copallina L.)	9.25	27.58	20.12	10.87	.08	35.44	1.45
Honeysuckle (Lonicera albiflora)	6.86	43.11	38.21	18.99	.41	40.81	1.67

Table 5. Chemical Composition of Predomnant Woody vegetation (1996 trial)

Sample	CP	NDF	ADF	ADL	ASH	DDM	DE Mcal/kg
Honeysuckle (Lonicera albiflora	10.10	51.60	45.36	24.31	2.30	40.15	1.65
Cedar Bark	5.90	62.51	50.48	31.96	1.65	27.07	1.11
Cedar Leaf	8.27	56.47	36.65	22.90	0.21	32.93	1.35
Green Briar (Smilax rotundifolia)	20.79	63.51	57.64	37.89	7.45	25.32	1.04
Black Cherry (Prunus Serotina)	18.46	27.81	32.78	16.39	0.74	61.53	2.52
Persimmon (Diospyros texana)	11.85	30.25	43.52	22.29	0.51	59.21	2.43
Shining Sumac (Rhus copallina L.)	9.98	18.12	16.93	7.68	0.64	70.34	2.88
Winged Elm (Ulmus alata)	10.29	67.17	51.95	29.06	2.89	25.59	1.05

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