TUSKEGEE UNIVERSITY

COOPERATIVE EXTENSION PROGRAM

COLLEGE OF AGRICULTURE, ENVIRONMENT AND NUTRITION SCIENCES

COOL-SEASON FORAGES FOR SUSTAINABLE GOAT PRODUCTION

On-Farm Research Highlights

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Introduction

Pasture-based goat production is becoming popular among small-scale livestock producers in Alabama. However, most Alabama goat producers do not have productive pastures, especially during the cool-season portion of the year generally from November to April. During this period, producers need to invest in supplementary feedstuffs such as hay, agricultural byproducts, or commercial feeds to sustain their goats. Sustaining goats on supplementary feeds for five to six months each year is costly because it involves 1) investment to buy feedstuffs and to develop and maintain storage facilities, 2) extra labor to feed animals, and 3) storage and feeding loss of feedstuffs. Thirty percent or higher loss of hay dry matter may occur when stored unprotected in open fields (Ball et al., 2007). Producers may make negligible or no money when production costs are high. To make pasture-based goat production sustainable, development of cool-season pastures and their sustainable management is essential (Figure 1). Nevertheless, there is not much information available on the suitable forages for developing cool-season pastures for goats. This article presents the productivity and quality of the selected cool-season forages, and goats' preference for those forages. Moreover, savings in feeding costs of goats after the development of cool-season pastures is also discussed.

Figure 1. Crimson clover-Marshall ryegrass mixed pasture in March 2012, Selma, AL.

Selected Cool-Season Forages: Productivity, Quality, and Goats' Preference

Study Methods

Studies on cool-season forages were conducted from 2011 to 2013 in the farms of two cooperator goat producers: Mr. Gregory Scott from Selma and Mr. Nimrod Stephens from Phenix City, Alabama. Each site had 'sandy' and 'loams and light clays' types of soil. Soil samples from each site were tested for necessary liming and fertilization, and lime and fertilizers were applied based on the soil test recommendations for the selected forages. Lime was applied three months before planting, and phosphorus and potassium fertilizers were applied at the time of planting. The study was set up as a randomized complete block design with three replications in each site. Each replication contained six equal strips, where the selected treatments and a control were randomly allocated. Five treatments: mixtures of Marshall ryegrass (*Lolium multiforum*) and one of the selected cool-season legumes (arrowleaf clover, *Trifolium vesiculosum*; berseem clover, *Trifolium alexandrinum*; crimson clover, *Trifolium incarnatum*; hairy vetch, *Vicia villosa*; and winter peas, *Pisum sativum*) and a control of sole Marshall

ryegrass were tested in the study. Seed rate for all grass-legume mixtures contained 60 percent grass and 40 percent legume seeds. Nitrogen fertilizer was applied only to the sole Marshall ryegrass strips in divided doses: the first application (50%) when seeds germinated well and the strips looked green, and the second application (50%) after the first grazing. In another study, a mixture of MaxQ tall fescue (*Festuca arundinacea*), chicory (*Cichorium intybus*), and crimson clover was planted in separate plots in both study sites for the demonstration purpose. However, this study was not replicated as that for legume-Marshall ryegrass mixtures.

Developed pastures were cross-fenced to create three paddocks, and watering facilities were in place to supply water in each paddock for goats. When forages were well established and reached the average canopy height of eight inches or above, forage samples were collected and analyzed for dry matter (biomass free of moisture) production per acre (productivity) and quality (crude protein, CP; acid detergent fiber, ADF). Then the pastures were grazed rotationally with goats (Figure 2). Pictures of different cool-season forages used in these studies, goats grazing on some of the selected forages, and stubbles of some of the forages after grazing have been presented in the Appendix (pages 7 to 9).

Figure 2. Goats grazing on the cool-season pastures, March 2012, Selma, AL.

Study Results

Goats readily consumed all the selected forages right from their first exposure to these forages except winter peas, which were eaten well at the subsequent exposures. Among the legume-ryegrass mixtures from Selma, crimson clover-Marshall ryegrass (3.94 ton/acre) and hairy vetch-Marshall ryegrass (3.82 ton/acre) produced the highest amount of biomass (Table 1). These combinations also showed equivalent or better quality with 15.7% and 16.3% crude protein respectively as compared to other combinations or sole ryegrass.

Table 1. Productivity and quality of different forages during the cool-season production period of 2012-2013, Selma, AL.

	Forage biomass dry matter			Forage quality	
	Grass	Legume	Total	ADF†	CP‡
Forage type	----------Ton/Acre----------			-------%--------	
Arrowleaf clover-Marshall ryegrass mixture	1.57^{ab*}	0.75^{c}	2.67^{bc}	21.9	14.7^{ab}
Berseem clover-Marshall ryegrass mixture	1.47^{ab}	0.30^{d}	2.07^{cd}	19.4	11.5^{b}
Crimson clover-Marshall ryegrass mixture	1.13^{ab}	1.97^{a}	3.94^{a}	22.8	15.7^{a}
Winter Peas-Marshall ryegrass mixture	1.18^{b}	1.22^{b}	3.30^{ab}	22.9	15.5^{a}
Marshall ryegrass	1.75^{a}	0.05^{e}	1.92^{d}	21.5	13.4^{ab}
Hairy Vetch-Marshall ryegrass mixture	1.68^{ab}	1.31^{b}	3.82^{a}	24.1	16.3^{a}

†ADF – Acid detergent fiber. ADF is the measure of fiber content in the forage biomass. Higher ADF means lower forage quality.
‡CP – Crude protein. CP is a measure of total nitrogenous compound, and eventually total protein present in the forage biomass. Higher CP means better forage quality.
*Values in a column with different superscripts are different ($p < 0.05$).

Among the legume biomass from different legume-Marshall ryegrass combinations in Phenix City, crimson clover, winter peas, and hairy vetch produced higher biomass than arrowleaf clover and berseem clover (Table 2). Forage quality of all legume-Marshall ryegrass mixtures remained higher (crude protein 14.5% or higher) than the sole Marshall ryegrass (crude protein 13.9%).

Table 2. Productivity and quality of different forages during the cool-season production period of 2012-2013, Phenix City, AL.

	Forage biomass dry matter			Forage quality	
	Grass	Legume	Total	ADF†	CP‡
Forage type	----------Ton/Acre----------			-------%-------	
Arrowleaf clover-Marshall ryegrass mixture	1.60^{ab*}	0.55^{b}	1.80	21.52	14.5^{ab}
Berseem clover- Marshall ryegrass mixture	1.64^{ab}	0.58^{b}	1.95	22.37	15.3^{ab}
Crimson clover- Marshall ryegrass mixture	1.39^{b}	1.07^{a}	2.10	21.69	16.8^{a}
Winter Peas- Marshall ryegrass mixture	1.61^{ab}	0.80^{ab}	1.87	23.25	17.0^{a}
Marshall ryegrass	1.89^{a}	---	1.96	22.17	13.9^{b}
Hairy Vetch- Marshall ryegrass mixture	1.46^{b}	0.81^{ab}	1.95	22.58	16.6^{ab}

†ADF – Acid detergent fiber. ADF is the measure of fiber content in the forage biomass. Higher ADF means lower forage quality.
‡CP – Crude protein. CP is a measure of total nitrogenous compound, and eventually total protein present in the forage biomass. Higher CP means better forage quality.
*Values in a column with different superscripts are different ($p < 0.05$).

The productivity and quality of mixed pastures containing MaxQ tall fescue, crimson clover, and chicory from the both Selma and Phenix City study sites have been presented in Table 3. However, these results were based on a smaller-plot study and conducted differently than those with legume-Marshall ryegrass mixtures. So, the results presented in Table 3 and Table 1 or Table 2 cannot be compared.

Table 3. Productivity and quality of MaxQ tall fescue-crimson clover-chicory mixed pasture during the cool-season production period of 2012-2013, Selma and Phenix City, AL.

	Forage biomass dry matter	Forage quality	
		ADF†	CP‡
Study site	----------Ton/Acre----------	----------%----------	
Selma	5.15	31.33	19.73
Phenix City	2.57	25.78	16.40

Economic Benefits of Developing Cool-Season Pastures

Study Methods

Both the cooperator producers were requested to keep records of expenses for feeding their goats on a pre-structured record-keeping format beginning October 2011. They were also interviewed for other benefits they realized after the development of winter pastures, such as labor saving, decrease in parasite problems, and improvements in goat health and performance. Partial enterprise budgeting was used to determine the savings in feeding costs because of the cool-season pastures. Savings from not having to use nitrogen fertilizer was appraised from the pasture area planted to legumes and the estimated nitrogen fixation values for these legumes (Ball et al., 2007).

Study Results

The cooperator producer in Selma was able to save $221.00 per month in feeding costs of his 40 goats after developing the cool-season pastures (Table 4). Before developing the cool-season pastures, the feeding costs per month was $301.00, which was reduced to $80.00 per month after the cool-season pastures were developed (Karki, 2013).

Table 4. Feeding costs before and after the development of cool-season pastures, October 2011 to April 2012, Selma, AL.

Before developing cool-season pastures, 2011	**Purchased feeds**		
	Hay	**Feeds**	**Total**
October	60	320	380
November	325	400	725
December	0	100	100
Sub-total	**385**	**820**	**1205†**
After developing cool-season pastures, 2012			
January	50	110	160
February	0	75	75
March	0	85	85
April	0	0	0
Sub-total	**50**	**270**	**320‡**

† Feeding costs per month before developing cool-season pastures = October-December feed cost total 1205*3/4 [because 25% of the purchased feed was saved for the rest of the season] = $904/3 = $301.00.

‡ Feeding costs per month after developing cool-season pastures = January-April feed costs total $320/4 months = $80.00
Source: Karki, 2013.

Similarly, savings in feeding costs for 35 goats was $237.50 per month for the cooperator producer from Phenix City, Alabama because of cool-season pastures development (Table 5). The monthly feeding costs before and after developing cool-season pastures were $300.00 and $62.50, respectively. There was no need to purchase hay or feeds from February to April because of abundant cool-season forages available for grazing (Karki, 2013).

Table 5. Feeding costs before and after the development of the cool-season pastures, October 2011 to April 2012, Phenix City, AL.

Before developing cool-season pastures, 2011	**Purchased feeds**		
	Hay	**Feed**	**Total**
October	300	400	700
November	200	400	600
December	100	400	500
Sub-total	**600**	**1200**	**1800†**
After developing cool-season pastures, 2012			
January	50	200	250
February	0	0	0
March	0	0	0
April	0	0	0
Sub-total	**50**	**200**	**250‡**

† Feeding costs per month before developing cool-season pastures = October-December feed cost total $1800/2 [because 50% of the purchased feed was saved for the rest of the season] = $900/3 months = $300.00
‡Feeding costs per month after developing cool-season pastures = January-April feed costs total $250/4 months = $62.50
Source: Karki, 2013.

Besides savings in feeding costs, savings in nitrogen fertilizer use was estimated to be $423.50 for Selma and $212.50 for Phenix City respectively because of planting leguminous forages in their pastures (Karki, 2013). Because legumes fix atmospheric nitrogen into the soil, there is no need to apply nitrogen fertilizers when the forage stand consists of 33 percent or more legumes. In both of the study sites, no nitrogen fertilizer was used in legume-Marshall ryegrass mixed pastures as these pastures consisted of 40 percent legumes. Moreover, cooperator producers from both sites mentioned that goats performed better and showed fewer parasitic and other health problems while they were on cool-season pastures as compared to previous years during the same time. Additionally, because of cool-season pastures development, the producers saved one hour of work per day that would otherwise have been spent on feeding and taking care of sickly goats (personal communication with the cooperator producers, June 2012).

Summary and Conclusions

Findings from these studies show that crimson clover-Marshall ryegrass and hairy vetch-Marshall ryegrass mixtures are the most productive among the selected legume-Marshall ryegrass combinations under the given soil, environmental, and management conditions. Any mixture of Marshall ryegrass and selected legumes is readily consumed by goats, except winter peas for which goats require some time to get used to. Similarly, the mixed pastures containing MaxQ tall fescue, crimson clover, and chicory were consumed very well by goats. Because of cool-season pastures, both cooperator producers were able to save $221 or higher per month in the feeding costs of their goats. There were additional savings for not having to use the commercial nitrogen fertilizer in their grass-legume mixed pastures ($423.50 for Selma and $212.50 for Phenix City) and a savings of one hour per day of labor. Goat producers in Alabama and other places with similar soil types and climatic conditions can improve their pastures, reduce the costs of production, and eventually make the pasture-based goat production more sustainable by establishing cool-season pastures and managing them well with rotational grazing.

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Appendix. Pictures: Research Highlights

Crimson clover-Marshall ryegrass pasture March 2012, Selma, AL.

Crimson clover-Marshall ryegrass stubble after grazing, April 2012, Selma, AL.

Marshall ryegrass pasture, December 2012, Phenix City, AL.

MaxQ tall fescue pasture, February 2013, Phenix City, AL.

Hairy vetch-Marshall ryegrass pasture, March 2012, Selma, AL.

Blooming hairy vetch.

Goats grazing on hairy vetch-Marshall ryegrass pasture, March 2012, Selma, AL.

Winter peas-Marshall ryegrass pasture, March2012, Selma, AL.

Winter peas-Marshall ryegrass stubble after grazing, April 2012, Selma, AL.

Arrowleaf clover-Marshall ryegrass mixed pasture, April 2012, Selma, AL.

Arrowleaf clover-Marshall ryegrass stubble after grazing, April 2012, Selma, AL.

Berseem clover

Berseem clover-Marshall ryegrass pasture, January 2013, Phenix City, AL.

Chicory, crimson clover, and MaxQ tall fescue mixed pasture with other volunteer forages, May 2013, Selma, AL.

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