# *Virginia Tech Shenandoah Valley Agricultural Research and Extension Center*

# 2009 Field Day Proceedings

## August 5, 2009

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# *Field Day Program*
## Shenandoah Valley Agricultural Research and Extension Center
### Wednesday, August 5, 2009

| | |
|---|---|
| 1:00 – 1:30 | **Registration** |
| 1:30 – 1:35 | **Welcome**, *David Fiske, Superintendent, Shenandoah Valley Agricultural Research and Extension Center* |
| 1:35 – 1:45 | Load wagons and travel to the east end of McCormick Farm Circle |
| 1:45 – 2:00 | **Forage Species Demonstration Plot** – *Jon Repair, Virginia Cooperative Extension* |
| 2:00 – 2:30 | **Forage Research Plots** - *Dr. Ozzie Abaye, Crop and Soil Environmental Science, Virginia Tech, and Christina Newman, Graduate Student, Crop and Soil Environmental Science, Virginia Tech* |
| | **Forage Chains for Year Around Grass Finishing Systems –** *Dr. Chris Teutsch, Extension Agronomist, Southern Piedmont AREC* |
| 2:30– 2:45 | Load wagons and travel to Big Meadow |
| 2:45 – 3:30 | **Overview of the Pasture-Based Beef Systems for Appalachia Project –** *Dr. William Clapham, USDA-ARS and Dr. Joe Fontenot, John W. Hancock Jr. Professor Emeritus, Department of Animal and Poultry Sciences, Virginia Tech* |
| | **SVAREC Cow / Calf Forage Systems Project** - *Dr. Terry Swecker, VA-MD Regional College of Veterinary Medicine, Virginia Tech and Dr. Ron Lewis, Department of Animal and Poultry Sciences, Virginia Tech* |
| | **Overview of Calf Creep Grazing Systems** - *Dr. Ben Tracy, Crop and Soil Environmental Science, Virginia Tech and Dr. Terry Swecker, VA-MD Regional College of Veterinary Medicine, Virginia Tech* |
| | **Using Residual Feed Intake (RFI) to Predict Animal Performance** – *Dr. Gene Felton, Department of Animal Science, West Virginia University* |
| 3:30 – 4:00 | **Poisonous Plants** – *Dr. Ozzie Abaye, Crop and Soil Environmental Science, Virginia Tech* |
| | **Botanical Composition of Pastures** – *Dr. Ozzie Abaye, Crop and Soil Environmental Science, Virginia Tech* |
| 4:00 – 4:10 | Load wagons and travel to Forestry Demonstration area |
| 4:10 – 4:40 | **Overview of Sustainable Forest Management Project at SVAREC** – *Matt Yancey, Virginia Cooperative Extension, and Dr. John Munsell, Department of Forestry, College of Natural Resources, Virginia Tech* |
| 4:40 – 4:55 | Load wagons and travel to Ram Evaluation Center |
| 4:55 – 5:30 | **Strategies to Improve Carcass Composition in Sheep** – *Dr. Scott Greiner, Department of Animal and Poultry Sciences, Virginia Tech* |

**Visual Overview of SVAREC Cow / Calf Forage Systems Paddocks -** *Dr. Terry Swecker, VA-MD Regional College of Veterinary Medicine, Virginia Tech and Dr. Ron Lewis, Department of Animal and Poultry Sciences, Virginia Tech*

5:30 – 5:40 Load wagons and travel to the McCormick Memorial

5:40 – 6:00 **Poster session and visit with sponsors –** Memorial Grounds

6:00 – 6:15 **Pasture-based Production Systems: Much More than Wholesome Beef** - *Dr. Floyd Horn, Former Administrator, USDA-ARS*

6:15 – 6:45 **Panel Discussion – Current Issues Impacting Agriculture and the Forage Livestock Industry –** Moderated by Dr. David Gerrard, Department Head, Animal and Poultry Sciences, Virginia Tech

*Jim Saunders, President, Virginia Agribusiness Council*
*Jerry Swisher, President, Virginia Forage & Grassland Council*
*Hank Maxey, Board Member, Cattlemen's Beef Promotion and Research Board*

6:45 – 7:00 **Introductions and Comments from Special Guests**

7:00 **Dinner**

# FORAGE SPECIES DEMONSTRATION PROJECT

**Jonathan P. Repair, Jason H. Carter, David A. Fiske[1]**

## Introduction

The concept and purpose of this Result Demonstration Project is to provide agricultural producers a side by side visual demonstration of both perennial grass and legume forage species and one warm season annual grass species that are conducive for growth and production in Western Virginia. Through this project producers will be able to appraise for themselves both traditionally grown forage species and new forage species, that have been developed and released in recent years. The forages in this demonstration project can be used in agricultural production systems, as mechanically harvested forages or grazed forages, while some can be utilized in both type production systems. There are a total of seventeen forage species available for observation with two different varieties of alfalfa and tall fescue.

## Demonstration Plots

Forage Species and Variety Identification in plots (from left to right):

1 / 2 / 3 / 4 / 5 / 6 / 7/ 8 / 9 /10 / 11 / 12 / 13 / 14 / 15 / 16 / 17 / 18 / 19 / 20A&B

1. Chicory
2. Timothy
3. Orchardgrass
4. Tall Fescue – Kentucky 31
5. Tall Fescue – Max Q
6. Reed Canarygrass
7. Praire Bromegrass
8. Red Clover
9. Ladino Clover
10. White Dutch Clover
11. Birdsfoot Trefoil
12. Alfalfa – Round Up Ready
13. Alfalfa – Traditional Type
14. Smooth Bromegrass
15. Bermudagrass
16. Eastern Gamagrass
17. Crabgrass
18. Caucasian Bluestem
19. Switchgrass

20A. Brown Mid Rib (BMR)
Sorghum Sudex
20B Dwarf Pearl Millet

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1 Forage Extension Agent, Virginia Cooperative Extension, Planning District 6 (VCEPD6); Livestock Extension Agent, VCEPD6; Superintendent, Virginia Tech Shenandoah Valley AREC, respectively.

**<u>Forage Specie Information</u>**

**Chicory (1)**

Use- Grazing
Time of Seeding - Spring or Fall
Ph Range – 6.0-6.5
Seeding Rate – 10-15lb. / acre

**Timothy (2)**

Use – Primarily as mechanically harvested forage. Highly acceptable by equine producers
Time of Seeding – Early Spring or Late Summer
Ph Range – 5.8-6.2
Seeding Rate – 8-10 lb/acre alone or 2-8 lb. in mixtures
Generally only one harvestable crop per year

**Orchardgrass (3)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – Early Spring or Late Summer
Ph Range – 5.8 -6.2
Seeding Rate – 8-12 lb/acre alone or 3-6 lb. in mixtures

**Tall Fescue (4) (5)**

Use – Pasture and/or Mechanically Harvested Forage / Strong late fall and winter grazing crop
Time of Seeding – Early Spring or Late Summer
Ph Range – 5.6 -6.2
Seeding Rate – 15-20 lb/acre alone or 6-12 lb. in mixtures
Kentucky 31 (4) – Can be highly infected with toxic endophyte fungus
Max Q (5) – Free of toxic endyphyte fungus

**Reed Canarygrass (6)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – Spring or Late Summer
Ph Range – 5.8 -6.2
Seeding Rate – 12-14 lb/acre alone or 6-8 lb. in mixtures
Very conducive for wet soils, however will also respond well In upland soils
Excellent nitrogen responder

**Praire Bromegrass (7)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – Early Spring or Late Summer
Ph Range – 6.0 – 7.0
Seeding Rate – 25 lb/acre drilled, 30-40 broadcast or 10-15 lb. in mixtures
Seeding Depth ¼ - ½ of an inch deep, planting depth is critical

Needs more intensive management
Excellent nitrogen responder
Does not tolerate continuous grazing
Must be allowed to reseed naturally once per year

**Red Clover (8)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – Early Spring or Late Summer
Ph Range – 5.8 -6.5
Seeding Rate – 8-10 lb/acre alone or 2-6 lb. in mixtures
Excellent response to frost seeding

**Ladino Clover (9)**

Use – Pasture
Time of Seeding – Early Spring or Late Summer (preferred)
Ph Range – 6.0 -6.5
Seeding Rate – 3-5 lb/acre alone or 1-2 lb. in mixtures
Excellent response to frost seeding
Excellent grazing tolerance
Reproducers excellent form plant runners and stolens

**White Dutch Clover (10)**

Use – Pasture in mixtures with cool season grasses
Time of Seeding – Early Spring or Late Summer
Ph Range – 5.8 -6.5
Seeding Rate – 1-2 lb. in mixtures
Excellent response to frost seeding
Establishes naturally very readily in rotational grazing systems
Not excessively tolerant to hot dry weather

**Birdsfoot Trefoil (11)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – Early Spring or Late Summer
Ph Range – 5.8 -6.5
Seeding Rate – 8-10 lb/acre alone or 4-8 lb. in mixtures
Can be difficult to establish
Best suited in combination with other cool season grasses

**Alfalfa (12) (13)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – Early Spring or Late Summer
Ph Range – 6.8 -7.0
Seeding Rate – 15-25 lb/acre alone or 10-20 lb. in mixtures
Should be planted in highly fertile and well drained soils
Needs 2-4lb/acre of boron annually
High potassium user
Grazing tolerant varieties are best used in grazing situations
Should not use in continuous grazing situations
Very drought tolerant
Round up Ready (12) allows for glyphosate to be used for grass and broadleaf weed control without injury to alfalfa.

**Smooth Bromegrass (14)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – Early Spring or fall with small grains
Ph Range – 5.8 -6.7
Seeding Rate – 10 lb. in mixtures, do not seed alone
Very drought tolerant
Prefers well drained drought tolerant soils
Excellent nitrogen responder

**Bermudagrass (15)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – April 1 –June 1
Ph Range –6.0 -6.5
Seeding Rate – 15- 20 bushels /acre as sprigs in rows or 30-40 sprigs if broadcast.
    Seed Use 5-10 lb./acre
Warm Season Grass with excellent production in summer months
Varieties that are sprigged at planting and there are seed types also available
Excellent grazing crop in summer months
Excellent hay producer
Excellent nitrogen responder

**Eastern Gamagrass(16)**

Use – Primarily Pasture also Mechanically Harvested Forage
Time of Seeding – Late Spring or November-December
Ph Range – 5.8 -6.5
Seeding Rate – 8-10 lb/acre alone
Warm Season Grass
Does well in wet highly fertile soils
Excellent nitrogen responder
Grazing and cutting height critical 6-8 inches
Best planted with corn planter at a depth of 1-1.5 inch depth

**Crabgrass (17)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – March - May
Ph Range – 5.8 -6.2
Seeding Rate – 4-6 lb/acre alone
Warm Season Annual Grass
Excellent natural re-seeder
High quality forage
Excellent nitrogen responder

**Caucasian Bluestem (18)**

Use – Primarily Pasture can be used as Mechanically Harvested Forage
Time of Seeding – Late May - August
Ph Range – 5.5 -6.2
Seeding Rate – 2-3 lb/acre alone
    Do not seed in mixtures
    Seed needs to be mixed soybean meal to allow for adequate and even flow in seeder

Adaptable to a wide range of soils
Excellent forage producer in summer months
Excellent nitrogen responder

**Switchgrass (19)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – May 15 – July 15
Ph Range – 5.5 -6.5
Seeding Rate – 6-8 lb/acre of pure live seed
- Seed must be chilled to make it more viable (live)
- Do not seed in mixtures
- Seed quality can vary

Graze or cut at 6-8 inch height
Excellent nitrogen responder
Excellent forage for summer months
Drought tolerant
Does well in less fertile soils

**Brown Mid Rib Sorghum Sudex (20A)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – May 1 – July 1
Ph Range – 5.8 -6.2
Seeding Rate – Drill at 20-25lb./acre or Broadcast at 30-35lb./acre
Excellent nitrogen responder
Drought tolerant
Prussic acid can be a concern if not grazed or harvested at the proper height
Higher digestibility than other sorgum sudex type forages
Grazing best in rotational system and it requires a high stocking rate
Excellent summer grazing crop to offset fescue toxicity

**Dwarf Pearl Millet (20B)**

Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – May 1 – July 15
Ph Range – 5.5 -6.5
Seeding Rate – 25-40 lb/acre
Re-grows after each cutting until frost
Excellent nitrogen responder
Drought tolerant
Harvest as heads emerge (30-40”)
Grazing best in rotational system and it requires a high stocking rate
Excellent summer grazing crop to offset fescue toxicity

## Project Goals

Once forage species plots are well established, there will be a plot plan and forage description available on site at all times. This will allow agricultural producers the opportunity to visit the plots at anytime of the year, to familiarize themselves with the forage species available. It is hoped that this will better help them to evaluate the forage species and to make sounder decisions when looking to select the various forage species that will be best suited for their particular farming operation.

**Acknowledgements**

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Augusta Farmers Coop

Research Assistants:

Shenandoah Valley AREC Research Assistants

Mr. Andrew Mackey
Mrs. Marnie Caldwell

Rockbridge Extension Summer Research Assistant

Mr. Donald Repair

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**Evaluation of alternative forage species to reduce risk for cow-calf production systems**

Christina Newman, Ozzie Abaye, William Clapham, Ben Tracy, William Swecker, Rory Maguire, and David Fiske

## Introduction

Tall fescue is the main cool-season forage across the Appalachian region. Adapted to the "transition zone", defined as the area between the successful zone of cultivation for cool and warm-season grasses, tall fescue is the most important forage species worldwide of the Festuca genus and the principal cool-season perennial grass in the humid areas of the USA (Moser et al., 1996). However, when deciding to use a pasture for annual production, tall fescue alone is insufficient. Classified as a cool-season perennial grass, tall fescue experiences its peak growth rate in the spring months with a secondary peak of vegetative growth in early fall (Barnes et al., 2003). There must also be alternative forage available during warmer months to reduce the need for supplement feeding and ease the risk of low production yield. In an effort to manage production effectively, mixtures of alternative forage species within a system reduce risk in pasture-based livestock production.
The overall objective of this study is to assess the buffer capacity (risk lowering ability) of various cool season and warm season annuals and perennials to complement tall fescue based pastures. More specifically, the objectives are:

1. To develop yield probability functions for tall fescue vs. warm-season species.
2. To analyze the nutrient content of various alternative forages and assess the capability of these alternative forage species to lower the risk of nutrient and yield deficiencies in the summer months of limited growth from cool-season tall fescue.

## Risk Management

The least risky and most profitable approach to intensive forage beef production is to plan for relatively poor weather conditions and low forage production (Pope et al., 1984). Forage production varies in the South and can have major impacts on net returns to intensive forage-beef producers. In an effort to minimize this variability and as a result minimize risk, alternative forages can be used to buffer situations of low forage production in traditional pasture systems. A variety of alternative forages; specifically warm-season grasses and legumes, are often used to offset the lack of adequate summer growth of tall fescue (Moser et al. 1996):
However, with multiple warm season grasses available as compliments, what is the optimal choice to reduce the risk of decreased pasture yields? This study will examine seven different forage combinations and evaluate their performance based on production yields and nutrient content to determine the most risk efficient alternatives. This study is not only focused on where production yields will be highest, but where alternative forages work with existing species in order to produce an optimum amount of pasture at a reasonable level of risk.

**Materials and Methods**

The experiments are implemented at three Virginia locations: Orange, VA, Steele's Tavern, VA and Blacksburg, VA. The seven forage treatments include endophyte-infected tall fescue (KY31 E+), endophyte free tall fescue (KY E-), Max- Q tall fescue (E++), Crabgrass in combination with endophyte-infected tall fescue (KY31 E+), Teff, Bermudagrass and Caucasian bluestem. Treatments are replicated 4 times at each location.
Treatments containing cool season grasses and warm season perennials were established in all three locations in the summer of 2008. Teff will be seeded the first week of June 2009 while crabgrass will be over-seeded into one of the tall fescue treatments after the first harvest of cool-season grasses late May. Nitrogen at 60 lbs/acre rate will be applied to all plots flowing first harvest. Forage samples will be taken for yield assessment, quality and botanical composition on a monthly basis.

**Risk Analysis**

To determine the level of risk in association with each forage treatment, each plot will be measured for dry matter yield and nutritional value. These figures will be compared to the minimum requirements of needed summer forage as determined by animal demands. The seven treatments will also be compared to one another in an effort to assess the least risky and most effective forage alternative. The treatment showing the highest ability to reduce risk of summer yield and quality loss in pasture management will be determined by this method. After this assessment, consideration must be taken by individual producers as to specific goals and needs within their pasture operation.

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Pope, C. Arden, and C. Richard Shumway. "Management of Intensive Forage-Beef Production Under Yield Uncertainty." Southern Journal of Agricultural Economics, 1984.

# Teff: Exploring its potential use for livestock in Virginia

**A. Ozzie Abaye, Katie Hurder, William Clapham, Ben Tracy, and Jim Fedders**

Having warm-season grasses in a forage system could save producers money because less hay would be fed during the hottest part of summer. The main benefit is that warm-season annual grasses are most productive during hot weather and can provide badly needed forage during times of water deficit. Teff (*Erogrostis tef* (Zucc.)) is an annual warm-season grass from Ethiopia, that has potential to help fulfill this need. Teff has several advantages that make it a viable alternative over other summer annual forages, including its ability to thrive both in moisture-stressed and waterlogged soils, and its lack of anti-quality compounds as found in sorghum-related annuals (Ketema, 1997, Ketema, et al., 1993). Teff is a bunch type grass (Figure 1). Despite its small seed size, it germinates within 3-5 days and is an aggressive competitor once established (Figure 2). In its native habitat, maximum production of Teff occurs with a growing season rainfall of 11 to 22 inches and a temperature range of 50 to 85°F. During extremely dry summers such as 2007, a crop such as Teff might make the difference between financial success or disaster.

Producer demand for suitable warm-season annual forages will likely grow in the future as our climate warms and droughts may become more common. Increased surface temperatures (IPCC, 2001) will almost certainly influence regional precipitation patterns (Jackson et al., 2001). Many climate change prediction models suggest that periodic droughts will become more common and extreme rainfall events more frequent (Frederick and Major, 1997). A combination of increased dry periods interspersed with larger individual rainfall events will result in extended periods of soil moisture deficit and greater variability in soil water content (Jackson et al., 2001). Climate change in the coming decades may well require a shift from a cool-season forage base (that requires high moisture and soil fertility) to forages that use resources more efficiently and that can be grown in a wide array of soils. Although Teff has great potential for grazing and hay production (Fig. 3), more information is needed about its cultural practice, establishment and overall management.

Figure 1. The Teff plant has a bunch type of growth habit

Figure 2. Teff 28 days after planting. (Blacksburg, Virginia – June, 2008).

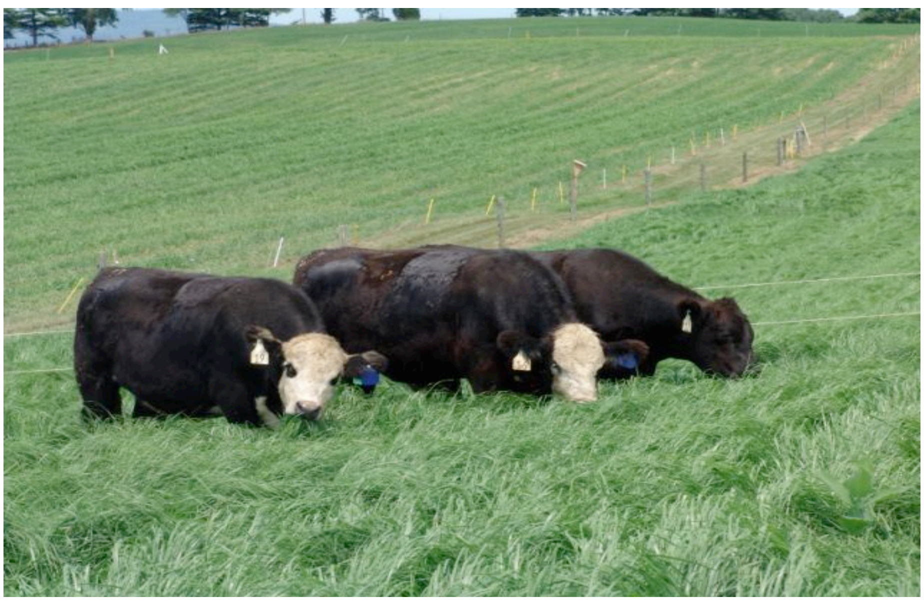


Figure 3. Animals grazing Teff (Willow Bend , West Virginia, 2007). Teff hayed in the background

**Research update**

In 2008, various Teff experiments were conducted at Kentland farm near Blacksburg, VA, to determine effects of cutting height, planting date and fertilization on biomass yield and nutritive value of Teff. Tiffany Teff was established on May 23rd and harvested on June 30th, August 10th and September 26th at the cutting heights of 2, 4 and 6 inches from the ground. A second experiment was also established on May 23rd to determine the effect of nitrogen fertilization and planting date on biomass yield and nutritive value.

*Effect of cutting height on biomass yield*

The effect of cutting height on biomass yield was obvious. At the initial harvest, yields from plots harvested at the 2 inch height exceeded the yields from plots harvested at the 4 and 6 inch heights (Figure 4). However, in subsequent harvests, Teff cut at 2 inch and 6 inch heights yielded sharply less forage than Teff cut at the 4 inch height. The influence of cutting height on yield was more pronounced for the second and third cutting dates (August and September) compared to the first (June

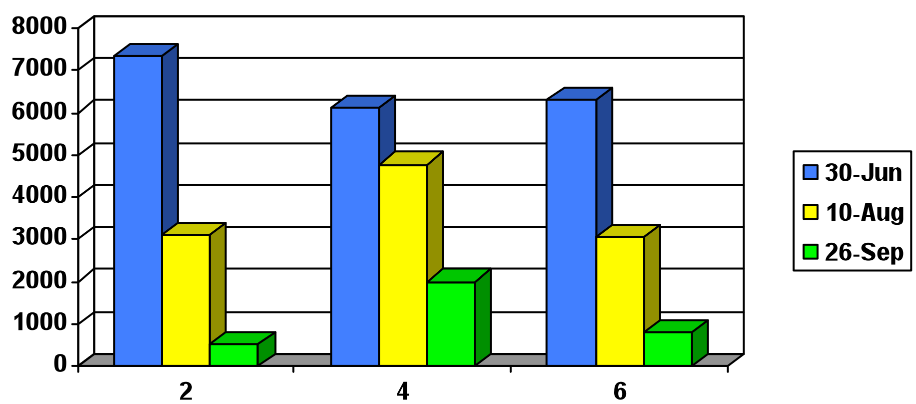


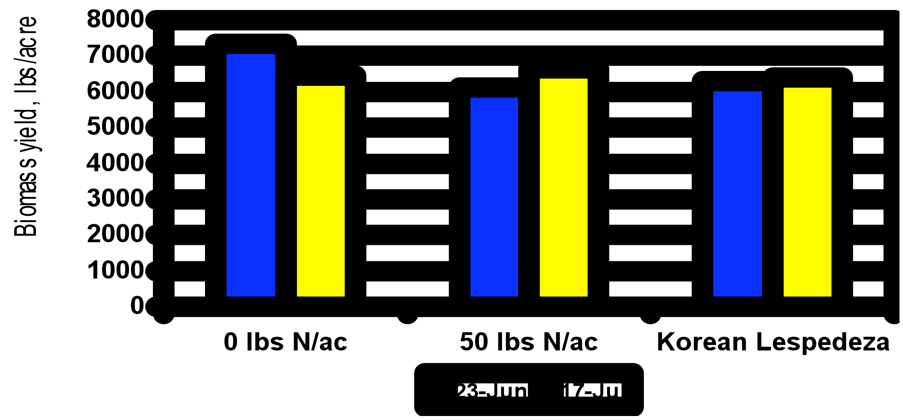

Figure 4. Effect of cutting height on biomass yield of teff planted May 23 and harvested on June 30, August 10, and September the 26.

*The effect planting dates and nitrogen fertilization on the developmental stages of Teff*

There was no difference in biomass yield at first harvest between Teff planted in June vs July (Figure 5). Similarly, there was no nitrogen effect on the biomass yield of Teff. The Korean lespedeza that was planted with Teff, established successfully, although this legume was not expected to have impacted the nitrogen status of the plots by the time of the first harvest. Teff planted in June reached maturity and headed out in 38 days vs Teff planted in July (45 days). The 1st planting date, potentially would result in an earlier first harvest and more subsequent harvests, which translates into overall more yield for the grower. There was no effect of nitrogen fertilization on nutritive value of Teff. However, crude protein (Figure 6) and fiber content (data not shown) of Teff was affected by plant maturity. As the plant progressed from 3-leaf stage to late boot/head stages, crude protein declined (25-15%) while fiber increased.

*Summary*

The results of our experiments showed that Teff re-growth is affected by cutting height. The 2 inch cutting height initially resulted in higher biomass but subsequent yield and stand density was compromised. Based on our first year results, and previous work, the 4 inch cutting height will result in a favorable yield without affecting subsequent harvests and stand density. Teff reached its final stage in 38 and 45 days for June and July planting dates, respectively. The 1st planting date should result in multiple subsequent harvests and overall more biomass yield. Including summer annual grasses such as Teff increases crop diversity in farming systems and makes them more resilient to environmental stresses and more sustainable in the long-run.




Treatment 1 = Teff + 0 lbs N/acN
Treatment 2 = Teff + 50 lbs N/ac
Treatment 3 = Teff + Korean lespedeza

Figure 5. Effect of nitrogen treatments and planting date on the biomass yield on Teff - 2008

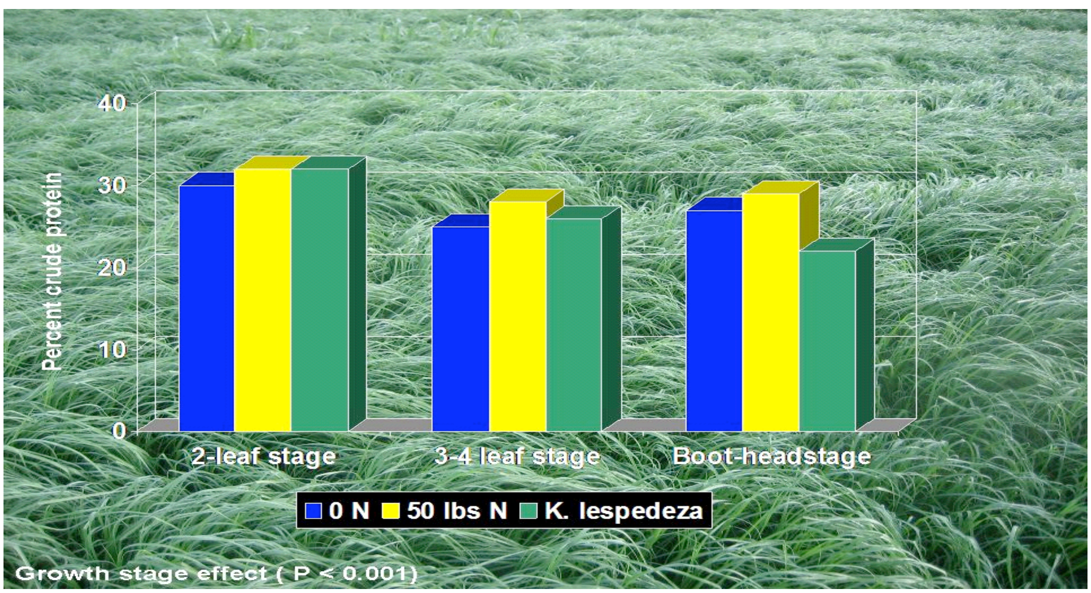



Figure 6. Effect of growth stages and nitrogen fertilization on percent crude protein

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# Forage Chains for Year Around Grass Finishing Systems

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Virginia is located in a region of the United States commonly referred to as the "transition zone." This region is located between the temperate north and the subtropical south and is marked by hot summers and mild winters. Cool-season grasses grow well in the spring and fall but have limited growth during the summer and winter months. In contrast warm-season grasses grow well during the three to four month summer period, but are unproductive for the remainder of the year. Although many producers view the seasonal distribution of forage production as a major challenge facing ruminant production, it is also an opportunity to utilize multiple species in a grazing system to build a "forage chain" that is capable of supplying high quality forage year around.

**Nutritional Requirements of Ruminant Livestock**

The nutritional requirements of ruminant livestock vary depending on the animal species, age, stage of production cycle, and environmental conditions. For example, a dry brood cow has a relatively low nutritional requirement compared to a steer that is gaining 1.7 lb/day. Table 2 shows the nutritional requirements of various animal classes. Supplying high quality forage to growing animals is a critical component of any grass finishing system. While it is fairly easy to meet this challenge in the spring and fall, the summer and winter months can pose significant challenge. However, by understanding forage plant growth and which species are adapted to your region, you can construct a forage chain that has the potential to supply high quality forage for a large portion of the year.

Table 1. Nutrient requirements of selected animal species and classes.

| Animal Species and Class | Total Digestible Nutrients | Crude Protein |
|---|---|---|
| | ----------------------------%---------------------------- | |
| Beef Steer, 450 lb, 1.5 lb ADG | 65 | 11 to 13 |
| Beef Steer, 650 lb, 1.7 lb ADG | 68 | 10-11 |
| Beef cow, lactating | 60 | 10 to 12 |
| Beef cow, dry | 50 | 7 to 8 |
| Lamb finishing | 70 | 12 |
| Ewe, lactating | 65 | 13 |
| Ewe, dry | 55 | 9 |
| Meat goat, lactating | 62 | 12 |
| Meat goat, dry | 55 | 10 |
| Meat goat, finishing | 65 to 68 | 12 to 14 |

*Adapted in part from Southern Forages, Fourth Edition.*

**Choosing the Right Forage Species**

Selecting the right forage species is one of the first steps in successful pasture management. When choosing a forage species it is important to consider the following questions:

*Is the plant adapted to this region?* In order for a pasture or hay seeding to be successful the plant must be well adapted to the region. If the plant is not well adapted to the area, even the best pasture management practices will not result in a vigorous long-lived sod. In Virginia, plants that are well adapted to areas west of the Blue Ridge Mountains may not be well adapted to Southside Virginia.

*Is the plant adapted to the soils present in the pasture?* Soils can very greatly from pasture to pasture. Some plant species require deep fertile soils while others can persist well on shallower soils that are lower in fertility. Soil drainage is another important consideration. Some plant species require well-drained soils while other can persist on less than well-drained soils.

*What is the yield and nutritive value?* Choose a species and varieties that yield well and posses a high nutritive value. In some cases, species or varieties that have lower dry matter yield may actually yield more animal per acre because their digestibility is greater.

*What is the desired end use?* Some species are better adapted to haying type management, while others are more persistent under grazing. For example bermudagrass is well adapted to close and frequent defoliation, while orchardgrass will not persist under this type of management.

*Is the plant tolerant of environmental stresses?* Plants well adapted to Southside Virginia will posses good drought tolerance. If your pastures border creeks or rivers that flood regularly, then a plant with good flooding tolerance should be chosen.

*Is the plant tolerant of grazing?* Forage species differ greatly in their tolerance of close and frequent grazing. In continuously grazed pastures, forages with excellent grazing tolerance should be used.

*What level of management does the plant require?* Plants that are less tolerant of grazing and less well adapted to the region will require more management in order to persist. Therefore, it is important to match the management level of the producer and the requirements of the plant.

*When does the plant grow?* Cool-season grasses produce most of their growth in the spring and fall, but grow very little during the summer months. In contrast, warm-season grasses grow well during the summer months, but produce very little in the spring and fall.

*Does the plant possess any antiquality factors that may restrict use?* Some forage plants possess antiquality factors that limit their use by livestock. For example forages related to sorghum can cause prussic acid poisoning.  Other plants like pearl millet or small grains are generally safe, but can in some cases cause nitrate poisoning.

*Is this species persistent under my conditions?* Profitable grazing systems are based on dependable sods that will persist for a reasonable time period.  Sods that require frequent maintance and do not hold under your conditions will increase your production costs.

**Cool-Season versus Warm-Season Grasses**

The primary forage base in Virginia and other transition zone states is cool-season grasses.  Cool-season grasses have optimum growth at approximately 70 degrees Fahrenheit. High temperatures and intermittent rainfall during the summer months limit cool-season grass growth.  This results in the production curve shown in Figure 1.  If a set stocking density is used, pastures will be under utilized in the spring and fall and overgrazed during the summer months.  Surplus forage could be harvested and fed during the summer months, but the high cost associated with hay and silage making makes this an unprofitable management decision in many cases.

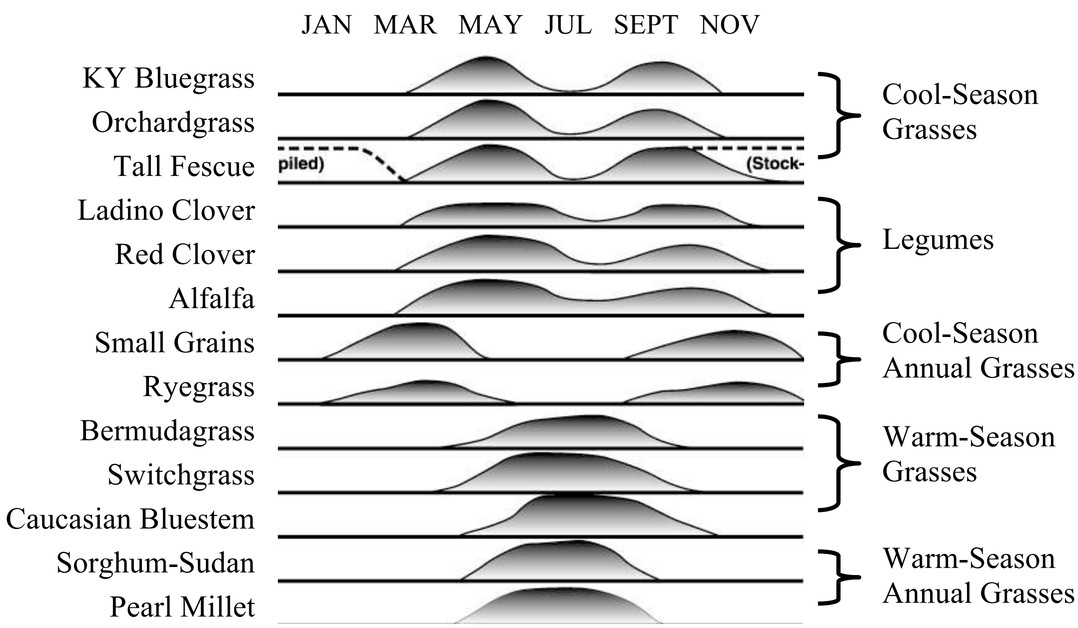



Figure 1.  Typical growth curves of cool- and warm-season grasses growing in the transition zone of the United States.  (*Adapted from Controlled Grazing of Virginia's Pastures, Publication 418-012*).

Warm-season grasses evolved from cool-season grasses and have optimum growth at approximately 90 to 100 degrees Fahrenheit.  In the transition zone, warm-season grasses grow well during the summer months when cool-season grass growth is restricted.  Warm-season species will produce approximately twice as much dry matter per unit of water used. Because warm-season grasses have optimum growth at higher temperatures and are more efficient at using water, they are a better choice to irrigate during the summer months than cool-season grasses. Cool-season grass growth can not be maintained through irrigation during the summer months.

## Cool-Season Perennial Grasses

**Tall Fescue** (*Lolium arundinacea*) is the best-adapted cool-season grass for Virginia. It is a bunchgrass that forms a tight sod that is able to withstand trampling and close grazing better than most cool-season grasses (Table 1). It also tolerates poorly drained soils and drought. It does best on medium fertility soils with a pH of 5.8-6.2, but will persist on land that is acidic and low in fertility. Most tall fescue is infected with an endophyte that imparts grazing and drought tolerance to the grass, but produces toxins that negatively impact livestock performance. Although tall fescue toxicosis is generally less severe in small ruminants, these toxins can cause decreased gains, fescue foot, reduced milk production, and reproductive problems.

The newest part to the tall fescue story is the discovery of a novel or friendly endophyte that appears to give tall fescue the persistent characteristics of the toxic endophyte, but does not produce the toxins associated with the animal disorders. Initial testing and on-farm trials in transition zone states show that animals grazing tall fescue infected with the novel endophyte performed similar to animals grazing endophyte free tall fescue. The persistence of tall fescue infected with the novel endophyte has been similar to tall fescue infected with the toxic endophyte. A major factor limiting adoption this new technology is seed cost. This cost may come down as additional novel endophyte cultivars are released.

**Orchardgrass** (*Dactylus glomerta*) is a productive cool-season grass that possesses high nutritive value and good palatability. It grows in clumps and forms an open sod. This species can be used for hay and pasture, but requires better management than tall fescue. Orchardgrass will not persist under continuous grazing. It is fairly drought tolerant, but requires higher fertility to maintain productivity and persistence (Table 1). This grass is not as well adapted to the Southern Piedmont and Coastal Plain regions of Virginia as tall fescue and should be considered semi-permanent species in these areas.

**Kentucky Bluegrass** (*Poa pratensis*) is a cool-season grass that forms a tough sod that is capable of tolerating close and frequent grazing (Table 1). This species posses rhizomes, modified stems that grow just below the soil surface, that allows it spread and fill in damaged areas in the sod. It is commonly found in pastures in the Valley-Ridge region of Virginia. However, bluegrass is lower yielding than tall fescue and orchardgrass and goes dormant during the summer months. Bluegrass is best adapted west of the Blue Ridge Mountains. Although this species can be found in pastures in the Southern Piedmont and Coastal Plains regions of Virginia, its growing season is relatively short making it poor choice in these regions.

**Reed Canarygrass** (*Phalaris arundinacea*) is cool-season grass that is very tolerant of flooding, making it good choice for poorly drained soils. In Virginia, it is best adapted west of the Blue Ridge Mountains. It does not stockpile as well as tall fescue and bluegrass.

Under good management, this coarse, sod-forming perennial grass spreads by short, scaly rhizomes, forming a thick sod. Reed canarygrass contains alkaloids that decrease palatability. Sheep appear to more sensitive to these alkaloids, refusing reed canarygrass at lower alkaloid concentrations than cattle. Low alkaloid cultivars should be used in small ruminant forage programs. These include 'Venture', 'Palaton', and 'Rival'.

Table 2. Characteristics of commonly used grass and legume species.[a]

| Grass Species | | ----------------Tolerance---------------- | | | | | |
|---|---|---|---|---|---|---|---|
| | Life cycle | Heat & drought | Wet soils | Grazing | Soil acidity | Seedling vigor | Sod forming ability |
| Tall Fescue E+ | CSP[b] | E[c] | G | E | G | G | G |
| Tall Fescue E- | CSP | F | G | F | G | F | G |
| Orchardgrass | CSP | G | P | F | F | G | F |
| Kentucky Bluegrass | CSP | P | F | E | F | P | E |
| Timothy | CSP | F | P | P | F | G | P |
| Prairie Bromegrass | CSP | F | F | P | F | G | F |
| Smooth Brome | CSP | F | F | P | F | G | G |
| Reed Canarygrass | CSP | G | E | G | G | F | E |
| Perennial Ryegrass | CSP | P | P | E | F | E | P |
| Annual Ryegrass | WA | F | E | E | G | E | G |
| Oats | WA | F | F | G | F | G | P |
| Rye | WA | F | F | G | G | E | P |
| Wheat | WA | F | P | G | P | G | P |
| Bermudagrass | WSP | E | P | E | E | F | E |
| Caucasian Bluestem | WSP | E | F | G | G | P | F-G |
| Switchgrass | WSP | E | F | P | F | P | G |
| Crabgrass | SA | F | P | E | E | G | G |
| Pearl Millet | SA | E | P | F | E | E | P |
| Sorghum | SA | E | P | F | P | G | P |
| Sorghum-Sudan | SA | E | P | F | P | E | P |
| Alfalfa | CSP | E | P | P-G | P | G | P |
| Birdsfoot Trefoil | CSP | G | G | F | G | P | P |
| Red Clover | CSP | G | F | G | F | E | P |
| Sericea Lespedeza | WSP | E | F | F-G | E | P | P |
| White Clover | CSP | P | G | E | F | F | G |
| Annual Lespedeza | WSA | G | F | G | E | F | P |

**[a]Adapted in part from Southern Forages Fourth Edition.**
**[b]CSP=cool-season perennial, WA=winter annual, WSP=warm-season perennial, SA=summer annual**
**[c]E=excellent, G=good, F=fair, P=poor**

**Perennial ryegrass** (*Lolium perenne*)**, smooth bromegrass** (*Bromos inermis*)**, prairie bromegrass** (*Bromos Willdenowii*) are other cool-season grasses that can be used in grazing systems in Virginia. While these grasses possess positive attributes, they are generally less well adapted and will require a higher level of management to persist on farms in Virginia.

**Perennial Warm-season Grasses**

**Bermudagrass** (*Cynodon dactylon*) is highly productive warm-season grass that is well adapted to the southern and eastern parts of Virginia. This grass responds well to nitrogen fertilization and requires significant amounts of nitrogen for optimum growth (250-350 lb nitrogen/A). Bermudagrass possesses a stoloniferous growth habit that forms a dense sod that is very tolerant to close and frequent grazing (Table 1). It grows best at temperatures between 90 and 100 F, when the growth of cool-season grasses is severely limited. Although bermudagrass has ample growth during the summer, it is unproductive from early fall until late spring. This grass is best used in a grazing system with a perennial cool-season grass such as tall fescue. The use of bermudagrass in Virginia has been limited by vegetative establishment. The recent development of cold-tolerant seed varieties could facilitate wide scale adoption in transition zone states.

**Caucasian bluestem** (*Bothriochloa caucasia)* is an old world bluestem that is adapted to Virginia. This warm-season grass starts growth later than switchgrass, competing less with cool-season grasses for late spring utilization. Research in Virginia has shown that it can produce approximately 240 grazing days per acre. Animal performance is good, but somewhat lower than native warm-season grasses. Establishment can be difficult due poor seed quality and low seedling vigor. It does possess a lower growth habit than the native grasses, making it better adapted to close and frequent grazing. Performance in the Southern Piedmont region has been somewhat sporadic with some stands persisting well, while others have been overtaken by common bermudagrass. This may be related to grazing pressure during the summer months.

**Switchgrass** (*Panicum virgatum*), **eastern gamagrass** (*Tripsacum dactyloides*), **big bluestem** (*Andropogon gerardii*), and **indiangrass** (*Sorghastrum nutans*) are native warm-season grasses that can grown in Virginia. Although these grasses tend to be very drought tolerant, they do not tolerate close and frequent grazing making them less well adapted to small ruminant livestock production. The native grasses are well adapted to wildlife and could be incorporate in riparian zones and field borders to stimulate wildlife production. Wildlife can be a significant profit center, especially on farms near major urban centers.

**Cool and Warm-Season Legumes**

Incorporating legumes into a cool-season grass stands increases both yield and animal performance and improves forage availability during the summer months. They also dilute the toxins produced by the endophyte in tall fescue leading to improved growth and higher conception rates. In addition, legumes form a symbiotic relationship with *Rhizobium* bacteria in which nitrogen from the air is fixed into a plant available form. There is no need for nitrogen fertilizer when tall growing legumes make up more than 30% of the pasture. The value of nitrogen fixation from common pasture legumes is shown in Table 2. <u>Legume seed should always be inoculated with the proper strain of nitrogen fixing bacteria before seeding</u>.

Table 3. Value of legumes in terms of fixed nitrogen.

| Legume Species | N Fixed | Value of Fixed Nitrogen ($/A/year) | | |
|---|---|---|---|---|
| | lb/A/year | N cost=$0.50/lb | N cost=$0.75/lb | N cost=$1.00/lb |
| Alfalfa | 150-250 | 75 | 125 to 113 | 188 to 150 |
| Red Clover | 75-200 | 38 | 100 to 56 | 150 to 75 |
| Ladino Clover | 75-150 | 38 | 75 to 56 | 113 to 75 |
| Annual Lespedeza | 50-150 | 25 | 75 to 38 | 113 to 50 |

*Adapted in part from Southern Forages, Fourth Edition.*

**Red clover** (*Trifolium pratense*) is perhaps the most important pasture legume in Virginia. It is a short-lived perennial legume that must be reintroduced into pastures every two to three years. A strong attribute of this species is that it can be frost seeded into established pastures (Table 1). Red clover has a tap root that helps to increase summer growth of cool-season pastures. Research in Kentucky and Virginia has shown that improved varieties will persist two to three years, while common red clovers persist one to two years.

**White Clover** (*Trifolium repens*) is one of the most important pasture legumes in Virginia. It has a stoloniferous growth habit that is well adapted to grazing (Table 1). White clover can be grouped into small, medium, and large types. The large or ladino types are taller and produce three to five times as much dry matter. Therefore, ladino clover is recommended for pasture use. Although white clover is not drought tolerant, it persists in pastures through reseeding. White clover and other legumes should in most cases be grown in combination with grasses.

**Alfalfa** (*Medicago sativa*) is commonly referred to as the 'queen of forages'. Alfalfa is a highly productive legume that that possesses a deep tap root. This species is best adapted to well-drained, fertile soils and will not persist in poorly drained areas. Alfalfa has excellent drought tolerance and may be a good option for summer grazing in regions of Virginia where warm-season grasses are less well adapted. Although alfalfa is commonly used for hay and silage, it can be grazed rotationally. In recent years, grazing type alfalfas have been developed and would be an excellent choice for small ruminant grazing systems. Like other legumes, pure stands of alfalfa can cause bloat in ruminant livestock. Maintaining approximately 50-50 mixture of grass and legumes will greatly reduce the chances of bloat.

**Birdsfoot trefoil** (*Lotus corniculatus*) in a nonbloating legume that is better adapted to poorly-drained, low fertility soils than other commonly used legumes. Grown on well-drained fertile soils, birdsfoot trefoil is not as productive as alfalfa. Therefore, it is important that trefoil be grown where other legumes are not well adapted. Forage quality tends to be high due to smaller stems and tannin induced bypass protein. Trefoil is a short-lived perennial, with original plants persisting two to three seasons under good management. However, this species will produce volunteer stands when allowed to reseed. Stand establishment can be difficult due to poor seedling vigor. In Virginia, this species is best adapted in the Valley-Ridge region.

**Sericea lespedeza** (*Lespedeza cuneata*) is a nonbloating, warm-season perennial legume that is well adapted to Virginia. It possesses an extremely deep tap root that imparts excellent drought tolerance. It is resistant to many diseases and has few insect problems. Sericea thrives on acid soils that are low in fertility making it well adapted to pastureland in the southeastern U.S. High tannin levels in older varieties greatly decrease palatability. Newer cultivars have lower tannin levels, finer stems, and increased grazing tolerance. Poor seedling vigor makes establishment difficult. In most cases, sericea must be planted in pure stands, with an adapted cool-season grass being drilled in once the lespedeza is well established. Like alfalfa, this species must be rotationally grazed to be persistent.

**Annual lespedezas** (*Kummerowia stipulacea* and *Kummerowia striata*) are summer-annual legumes that are well adapted to Virginia. In the past, annual lespedeza was widely used, but with the increased availability of lime and fertilizer it has been replaced with more productive cool-season legumes. This species can be frost seeded or drilled into closely grazed perennial cool-season grass pastures to increase summer forage availability and may be an excellent choice for rented pastureland where lime and fertilize inputs can not be justified.

**Annuals versus Perennials**

In Virginia, cool-season grasses produce ample forage in the spring and fall, but high and low temperatures limit summer and winter growth. Summer and winter annuals can fill this gap with relatively high quality forage when properly managed. Advantages to using annual grasses include fast germination and emergence, rapid growth, high productivity, and flexibility of utilization. Annuals can be grazed as needed and excess growth can be harvested as hay or silage. Major disadvantages include the high cost of annual establishment and the increased risk of stand failure due to variable rainfall during spring and fall establishment periods. In most cases, profitable small ruminant production will be based on perennial sods that require minimum maintance and supplemented with annuals as needed.

**Winter Annuals**

**Wheat** (*Triticum aestivum*) is one of the most versatile small grains for a farming operation. Due to its excellent winter hardiness, wheat can be sown later in the fall than barley has good potential for pasture, silage or hay production. Wheat will withstand wetter soils than barley or oats, but tends to be less tolerant of poorly drained soils than rye and triticale. Newer winter wheat varieties with Hessian fly resistance can be seeded as early as late August and produce an abundance of excellent fall grazing. Managed properly, wheat can be grazed in the fall, again in early spring, and finally harvested for hay or silage.

**Barley** (*Hordeum vulgare*) is generally more susceptible to winterkill than wheat, especially when it has been overgrazed. It should not be grazed as short or as late into the fall as wheat. Barley does best on fertile, well-drained soils. It is sensitive to acidic soil conditions and pH should be maintained above 5. Barley produces high quality silage or hay with a higher digestibility than other small grains, but lower yields. Good quality grazing can be obtained from early seeded barley.

**Triticale** (X *Triticosecale) i*s a high yielding forage crop that is gaining popularity throughout the country and particularly in the Midwest. Triticale generally has a higher forage yield, but lower quality than wheat. It is a cross between rye and wheat. As such, it is adapted to a range of soils. Tolerance to low pH is better than wheat, but not as good as rye.

**Rye** (*Secale cereale*) is the most cold tolerant and least exacting in its soil and moisture requirements of all small grains. Like wheat, rye can be sown in late August to provide fall grazing, excellent winter ground cover, and spring grazing. The rapid growth of rye, both in the fall and spring, makes it the most productive of the small grains for pasture. Rye is the earliest maturing of the small grains. The release of several grazing type ryes has provided better varieties for grazing and silage. Rye tends to be a more consistent producer of spring pasture than wheat, although it quickly becomes stemmy and unpalatable in late spring.

**Winter Oats** (*Avena sativa*) produce very palatable forage and are best adapted to well-drained clay or sandy loam soils. They do not perform as well under extremely dry or wet conditions as wheat or rye. Although oats produce high quality forage, yields tend to be lower than the other small grains. As a rule, the hardiest winter oat variety (Kenoat) is considerably less winter hardy than common wheat and barley varieties. However, in the southern US, oats will usually survive most winters. Similar to barley, winter oats must be seeded in mid-September to be well established before cold weather arrives.

**Annual ryegrass** (*Lolium multiflorum*) is a cool-season annual that can provide late fall, winter, and early spring grazing. Attributes of annual ryegrass include ease of establishment, high yields, high nutritive value, and later maturing than the small grains. In contrast to small grains, annual ryegrass continues to regrow in the spring until high temperatures limit growth in early summer. Annual ryegrass is commonly used to overseed summer pastures, thereby extending the useful season of this land area. It is adapted to all soil types and grows best at a pH of 5.7 or higher. The highest yields are obtained on fertile and well-drained soils with nitrogen fertilization.

**Summer Annuals**

**Sorghum species** (*Sorghum bicolor*) include sudangrass, sorghum, and sorghum-sudangrass hybrids. These species are tall growing coarse annuals that are best adapted to well-drained, fertile soils, but will grow on imperfectly drained soils when surface water is removed. These grasses do not tolerate low pH and require liming when grown on acid soils. The sorghum species contain prussic acid and can cause poisoning in ruminant livestock when young, drought stressed, or frosted forage is grazed. 'Piper' and 'Wheeler' are two sudangrass varieties that contain lower amounts of prussic acid. 'Piper' is probably the safest variety to graze. Extensive variety testing has shown little difference between varieties. Therefore, variety selection should be based on local availability and price and closer attention should be paid to management.

**Pearl millet** (*Pennisetum americanum*) has smaller stems and tends to be leafier than forage sorghum, sudangrass, and sorghum-sudangrass hybrids. It is better adapted to more acid soils and soils with a lower water holding capacity than the sorghum species. Pearl millet grows rapidly and will provide grazing in as little as 45 to 60 days. Unlike *Sorghum* species, there is no concern with prussic acid poisoning, so grazing can begin earlier. Dwarf varieties are available and tend to be better suited for grazing.

**Crabgrass** (*Digitaria species*) is commonly considered a weed, but possesses significant potential for supplying high quality summer forage. A primary advantage of crabgrass is that it is well adapted to Virginia and occurs naturally in most summer pastures, especially those that have been overgrazed. Crabgrass is best adapted to well-drained soils such as sands, sandy loams, loamy fine sand, loams, and silt loams that do not crack extensively. It can produce grazable forage in as little as 35 days, but normally 40 to 60 days is required. Like pearl millet, it does not contain prussic acid. Although crabgrass is an annual it acts like a perennial through reseeding. Therefore, it must go to seed at least once during the growing season. Shallow tillage in late winter or early spring incorporates the volunteer seed and guarantees a uniform stand.

### Brassicas

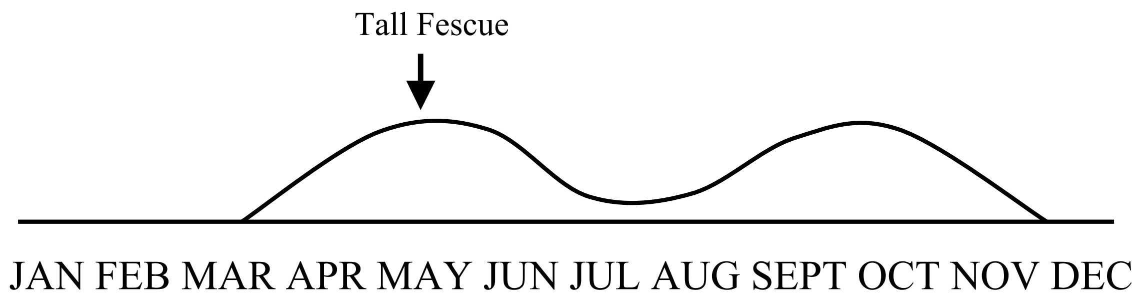
Brassicas include **kale** (*Brassica olleracea*), **rape** (*Brassica napus*), **swede** (*Brassica napus*), and **turnip** (*Brassica rapa*). Rape, turnip, or stemless kale can be planted in late spring to provide forage during the late summer period. Kale and swede can also be seeded in late spring, but will provide grazing in the late fall to early winter period. Rape and turnips can be planted in late summer to provide late fall and early winter grazing. All brassicas require well-drained, fertile soils and a near neutral pH for optimum production. Strip grazing is needed to maximize utilization of brassicas. If regrowth will be grazed, a back fence is required. Brassicas can be 90% digestible and can cause health disorders if not properly managed. Problems can be avoided by following several common sense recommendations: 1) introduce animals to brassica pastures slowly, 2) never turn hungry animals that are not adapted into brassica pastures, 3) brassicas should not make up more 75% of diet, and 4) allow access to grass pasture or dry hay at all times.

### Putting the Pieces Together

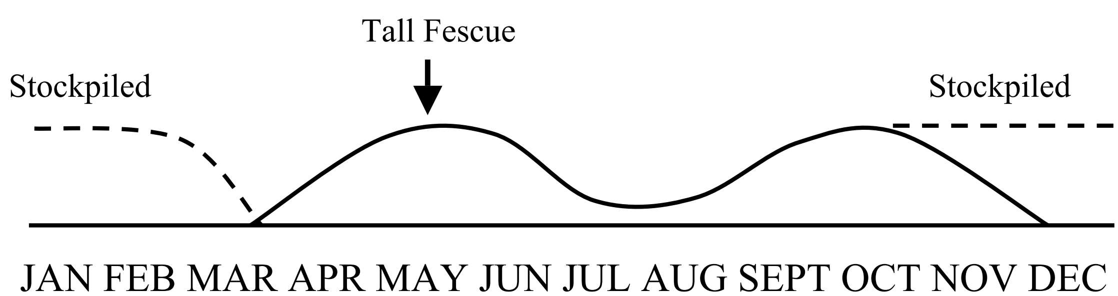
If you ever go onto two different farms and find two identical grazing systems, then one is wrong. Grazing systems are unique and dynamic entities that change and evolve as needs and experience level of graziers change. There is no one right or wrong grazing system. It is your job to build a system that meets your particular needs. Below you will find an example of a grazing system for Southside Virginia. I would like to add a word of caution. It is always easier to make a grazing system work on paper than it is in real life. It is important to build flexibility into your grazing system that will allow you to adapt to the constantly changing weather conditions that we encounter in the Virginia and other transition zone states.

**Example: A Grazing System for Southside Virginia**

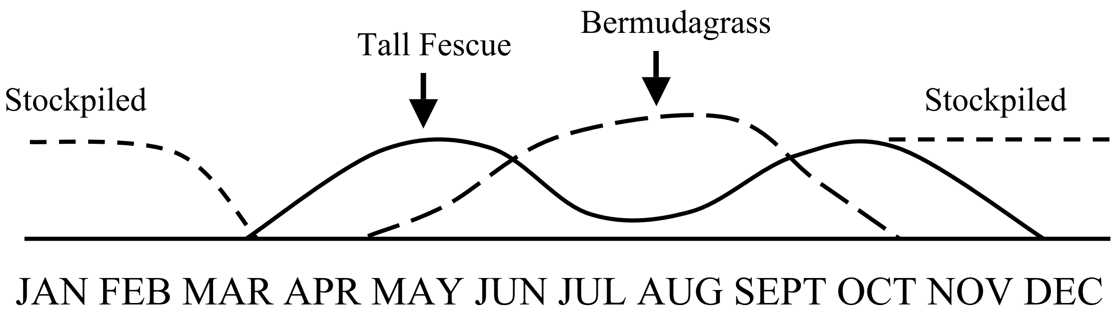
Start with a tall fescue-clover mixture. Note the summer slump in forage production and the need to feed hay during the winter months.



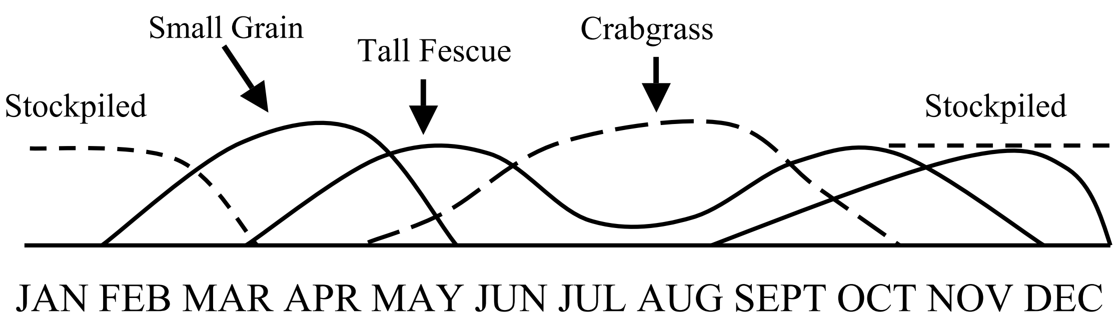

The first thing we can do to extend grazing is to actively stockpile tall fescue for winter grazing. This greatly increases the length of our grazing season. We still have a forage deficit in the summer months.




Next, we add crabgrass, a warm-season annual grass that is very palatable and highly digestible, into our forage chain. The addition of crabgrass levels off our seasonal distribution of forage by filling in the forage deficit during the summer months. We still have several short periods in the spring and fall that need to be filled in.




We then interseed a cool-season annual (small grain or annual ryegrass) into the crabgrass stands in late summer or early fall. The result is a grazing system that comes very close to meeting our desired goal of year-round grazing.




**Conclusion**

In Virginia, high temperatures and intermittent rainfall in the summer and cool temperatures during the winter limit the growth of cool-season pastures. However, a wide variety of both cool- and warm-season species can be grown in this region. Assembled into a forage chain, these species can provide year around grazing in many years. However, forage chains do require higher levels of management. It is important to remember that the simpler that you can keep your forage chain, the easier it will be to manage.

# ECONOMIC PASTURE-BASED BEEF SYSTEMS FOR APPALACHIA

**W.M. Clapham, USDA-ARS and J.P. Fontenot, Virginia Tech.**

In the hill lands of Appalachia, many farmers raise beef cattle primarily in small cow/ calf operations. Generally, these producers cannot compete with larger, highly mechanized operations, that are more efficient because of the scale. Thus, the major problem is the sub-optimal efficiency of small farms. Use of more legumes, combinations of forages, and improved management of forages and cattle would contribute to improving the competitive position of small-producers. Product quality and market acceptance is critical to success of forage-based beef systems. In addition to increased economic benefits, keeping hill land open and productive, would benefit rural and urban society, and sustain aesthetic attributes and wildlife habitat.

This project was initiated in with the idea that pasture-raised beef production could benefit farmers in Appalachia. The proposal that secured the funding for the project envisioned a collaboration among institutions in Appalachia. A collaborative project has many advantages over carrying out research at a single institution. The advantages include pooling resources, access to more researchers and graduate students, and a regional focus to amplify impact. The institutions involved are USDA-ARS; Virginia Polytechnic Institution and State University; West Virginia University and Clemson University (Fig. 1). Since cattle production represents cattle performance over time represented by important production stages, each institution was assigned responsibility to focus on specific production stages. We chose to address pasture-based research this way to minimize duplication among the institutions and to develop dependencies among the institutions to foster cooperation.

During the first five-years of the project the objectives of the research were:

1. Develop forage sequences and combinations for cow-calf, heifer development, stocker and finishing systems to deliver optimal nutritive value for efficient production of cattle for pasture finishing.

2. Optimize forage systems to produce consumer acceptable pasture finished beef, and define carcass merit and meat quality as a function of pasture-based systems.
3. Develop risk analyses of forage-based beef production systems and market demand to assess production feasibility.

--During the first phase six cow-calf forage systems were evaluated. Satisfactory performance of cows and calves was obtained for all systems. Calf performance after weaning (backgrounding) was increased by a low level of supplementation.

--The optimum rate of gain during the stockering phase was 1 lb. per day.

--Steers finished on pasture had lighter live and carcass weights, and lower USDA quality carcass grades than those fed a high concentrate ration in drylot.

--Meat from pasture-finished cattle was lower in fat and higher in lean than meat from cattle finished in drylot. No differences were obtained in tenderness and juiciness in meat from cattle finished on pasture or fed in drylot. The meat from pasture-finished cattle was higher in conjugated linoleic acid (CLA) and omega-3 fatty acid than meat finished in drylot. In the pasture –finished cattle, CLA in fat peaked after 28 days and remained high.

The research outlined by the first project met the objectives, and we developed systems to produce pasture-based beef in Appalachia. When we evaluated the performance data over the entire production cycle of the steers, we observed that the weaning and subsequent backgrounding period had a profound effect on performance during finishing. The impact of stress just prior to slaughter is known to have an acute impact on meat quality and frequency of 'dark cutters'. We concluded that in the next project plan that we include focus on measures of stress and the impact of stress on performance and subsequent meat quality. Some answers to our questions generated more questions and led to the realization, that although we could produce pasture-raised beef, production was seasonal. Seasonality is inherent with the way we produce calves, manage stockers and move livestock to conventional feedlot finishing. Seasonality is an obstacle to penetrating food service and institutional markets and is an obstacle for almost every other region of the country gearing up to produce pasture-raised beef. Seasonality has a wide-ranging impact from contracting, processing, managing inventories, whether the product is fresh or frozen, volume of product available, logistics and marketshare. The growth of market share for pasture-raised beef in the institutional, food service and large retail outlets is currently dominated by foreign imports. Seasonal production limits market access to direct marketing. For some producers, particularly those with marketing skills and tolerance to risk, this has provided profitable opportunity. Unfortunately, there are many producers that do not want to or are not set up to market their own products, and we have heard this from every corner of the country. In development of the second project plan (2007-2012), it was obvious that the issue of seasonality needed to be addressed as well as developing a system that defined quality pasture with precision and accuracy.

During 2007, we drafted the second project plan to focus on the issues of seasonality, stress and meat quality. The objectives of the second project plan are:

1. Produce a 12-month supply of pasture-based beef by expanding the harvest window with retention of acceptable meat quality.
2. Develop criteria for pasture raised beef that define the "window of acceptability'.
3. Identify management and nutritional strategies for minimizing weaning stress in calves.
4. Develop tools for pasture-based beef producers to assess and manage risk.

This new project deviates significantly from the previous project by focusing on new objectives important to the success of building a pasture-based supply of beef for domestic consumption and export that will require a consistent volume of a 12-month supply of a consistent product. Although the production stream remains essentially the same as the previous project, emphasis is placed upon the following areas: 1) utilizing those degrees of freedom at hand that will allow us to expand the harvest window; identify the "window of acceptability" for harvest end point for the producer based upon carcass quality and acceptable economic return. 2) Develop specification of the ranges for a set of parameters that define quality and consistency for pasture-raised beef; identify and define in our population genetic and phenotypic markers of efficiency, specifically frame scores and residual feed intake 3) develop and/or utilize measures of livestock stress to develop management strategies and tactics to minimize stress to reduce excitability and hence improve performance and carcass quality; and 4) address forage/livestock system development from the point of view of risk assessment or probabilities of success or failure taking into account environmental, and market-related uncertainty. This research will produce the first data to define ranges for important parameters that determine quality and consistency for heifers and steers differing in frame scores, and presumably efficiencies finished on warm and cool season forages. Estimates of residual feed intake will provide benchmarks of efficiency for pasture based cattle lines. These estimates of efficiency will be useful in determining which production stream to send stockers, to finish on: pasture or feedlot. Understanding impacts of stress, particularly during weaning will help develop management strategies to minimize performance losses during and after the weaning period that can impact subsequent performance. Data produced by this project are intended to provide information towards a mechanistic understanding of ruminal microbial forage transformation, fermentation byproducts and ultimate flavor characteristics in meat. This knowledge will facilitate characterization of factors that influence lipid oxidation and volatile flavor compounds and greatly increase our understanding of how shelf-life and flavor of forage-finished beef differs from grain-finished beef. Much of the research analysis is focused on quantifying risks associated with production particularly when facing seasonal extremes. These analyses are important because they represent a transferable product that measures probabilities of the successes or failures of sets of practices. The overall goals led to an examination of the factors that are related to product acceptability allowing us to define the range of live animal and carcass traits to produce a high quality end product.

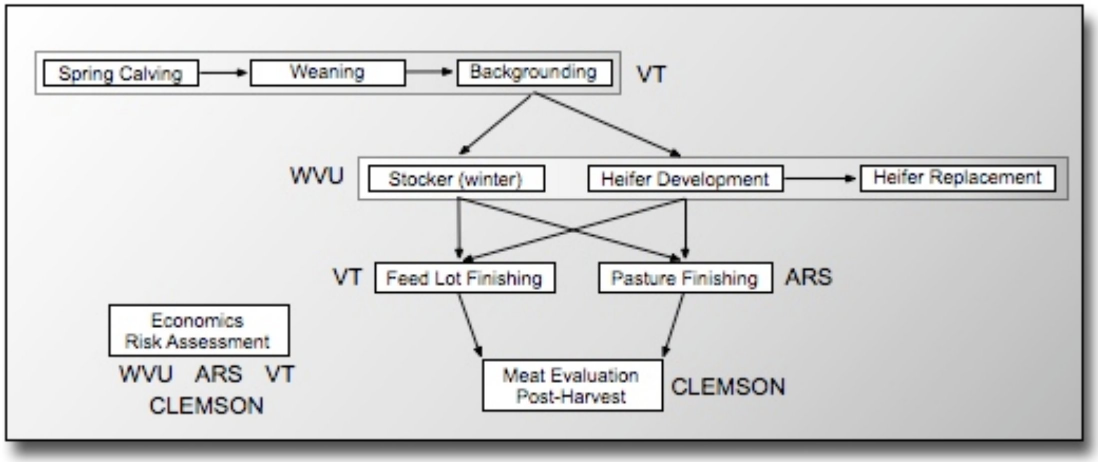



Fig. 1. Pasture-based beef production and the responsibilities of the collaborating institutions

## SVAREC Cow/Calf Forage Systems Project

W. S. Swecker, Jr, RM Lewis, ML Wahlberg, BF Tracy, DA Fiske, JP Fontenot

**Description of the present grazing system experiment**
Cows and pastures are managed to make 2 comparisons

1) Cow Size and 2) Creep Grazing methods

**Cow Size comparison**
In the fall of 2006, the cows in the herd were allotted to 2 groups based on their frame score:

1) Large – frame score ≥ 5.1 or > 52 inch hip height at maturity

2) Moderate – Frame socre ≤ 5.0 or ≤ 52 inch hip height at maturity.

As the cows differed in size, we desired to maintain a stocking density of 1.75 acres / animal unit which resulted in either 7 Large cows / 16 acres or 8 moderate cows / 16 acres. Cows were synchronized for AI and moderate cows were bred to a moderate frame Angus Bull and large cows were bred to a large frame Angus Bull (EPD characteristics below)

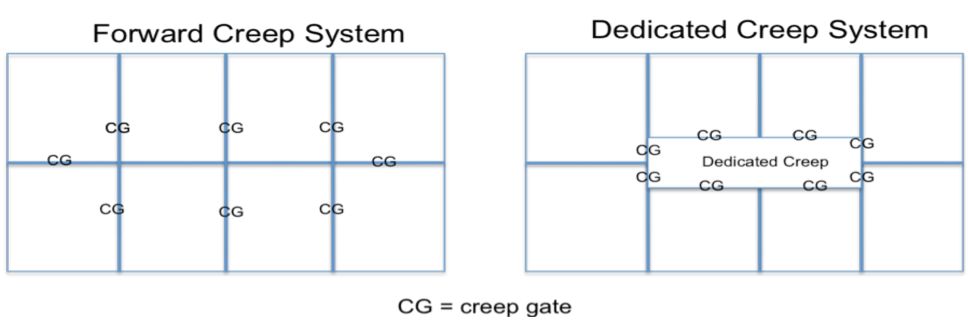
| | EPDs from American Angus Association | | | | | |
|---|---|---|---|---|---|---|
| AI Bull | BW | WW | YW | YH | US REA | $B |
| Moderate | -.8 | +43 | +66 | -.8 | +.36 | +21.1 |
| Large | +1 | +57 | +98 | +.4 | +.17 | +49.7 |

**Comparison of Creep Grazing Systems**

1) Forward Creep Grazing – Eight paddocks (2 acres / paddock) with Fescue / Clover. Calves can forward creep from cows into next available paddock through creep gate.

2) Dedicated Creep – Eight paddocks (1.8 acres / paddock) with Fescue / Clover for cows. Calves have access to a dedicated creep pasture (1.6 acres with friendly endophyte fescue and Alfalfa) through creep gates.

A diagram of the creep grazing systems is below.



**Description of Experiment**
The results in this paper summarize cow and calf performance in the production year measured from weaning in Fall 2007 to weaning in Fall 2008. The study is designed as a 2*2 factorial where we compare 2 grazing systems and 2 types of cows. Each experimental unit (7 or 8 cows, dedicated creep grazing or forward creep grazing) was 16 acres and is replicated 3 times at the SVAREC site.

**Description of the cows**
The average cow in the Forage Systems at weaning 2008 was 7 years old, weighed 1232 lbs, and had a frame score of 5.2. She was 85% Angus with Charolais and / or Hereford as the other breeds. The average calf was born on March 21, 2008 and was 173 days of age at weaning.

**Description of the forages**
The forage base of farm is native cool season grasses. The dominant forage is endophyte-infected fescue (average of 80% infected tillers in June 2007) with orchardgrass, bluegrass and assorted weeds. Paddocks are frost seeded with red and white clover in February. Each grazing system has 8 paddocks for cow grazing. Four paddocks are fertilized with nitrogen in August for stockpiling / winter grazing. Hay is fed when grazing forage is not available (late summer stockpiling and late winter)

**Results from 2007-8**

**Cows at Weaning (September, 2008)**

| Cow Group | Average wt (lbs) | Average frame score | Total cow weight per grazing system |
|---|---|---|---|
| Large | 1325 | 5.6 | 9275 |
| Moderate | 1122 | 4.6 | 8976 |
| Difference L-M | 203 lbs | 1.0 | 299 |
| (Ratio L/M) | (1.18) | (1.22) | (1.03) |

Note Cow weight and frame score differ (*P*< 0.001)

**Calf Weights by Cow Groups**

| Cow Group | Average wean wt (lbs) | Total Weight (lbs) | Lbs weaned / acre |
|---|---|---|---|
| Large | 460 | 3220 | 201 |
| Moderate | 439 | 3512 | 220 |
| Difference L-M | 21 | -292 | 19 |
| (Ratio L/M) | (1.05) | (0.92) | (0.91) |

Note: Average weaning weight differs (*P* < 0.05)

**Calf Weights by Grazing System**

| Grazing System | Average wean wt (lbs) | Lbs weaned / acre |
|---|---|---|
| Dedicated Creep | 461 | 216 |
| Forward Creep | 435 | 204 |
| Difference D-F | 26 | 12 |
| (Ratio D-F) | (1.06) | (1.06) |

Note: Average weaning weight differs ($P < 0.01$)

**Days grazing or Fed Hay by Cow size**

| Cow Group | Days Grazing | Days Fall Hay | Days Winter Hay |
|---|---|---|---|
| Large | 219 | 66 | 86 |
| Moderate | 203 | 65 | 103 |
| Difference L-M | 16 | 1 | -17 |
| (Ratio L/M) | (1.08) | (1.02) | (.86) |

Large cows ($P< 0.025$) spent more days grazing and were fed hay for fewer days

**Days grazing or Fed Hay by Grazing System**

| Grazing System | Days Grazing | Days Fall Hay | Days Winter Hay |
|---|---|---|---|
| Dedicated Creep | 204 | 65 | 101 |
| Forward Creep | 218 | 66 | 87 |
| Difference D-F | -16 | -1 | 14 |
| (Ratio D-F) | (0.94) | (.98) | (1.16) |

Cows from dedicated creep pastures ($P< 0.05$) spent fewer days grazing and were fed hay for more days

**Summary**

We report here the results from 2007-8. As many of you may remember, 2007 was a very dry years (driest in the last 50 years at this station) as was 2008. Hay feeding in the fall was needed to allow stockpiling of fescue.

As expected, calves from the larger dams are heavier at weaing, but calves from the moderate frame cows produced more pounds of weaned calf per acre. Conversely, larger cows spend more days grazing than moderate frame cows, even though total weight between groups was similar.

As to the grazing systems, calves from the dedicated creep system (calf only access to friendly endophyte fescue and alfalfa) weighed more than calves that could forward creep. Conversely, cows on the dedicated creep systems spent fewer days grazing and more days being fed hay than cows on the forward creep systems.

The terms moderate and large are relative to the conditions of the experiment and may not fit your definition of moderate or large frame cattle. Still the types and sizes of cows used here are similar to other production systems in Virginia.

## Economic Pasture-Based Beef Systems for Appalachia: Forage Dynamics in Cow-Calf Grazing Systems

**Investigators:** Benjamin Tracy[1], Ron Lewis[2] and Joao Paulo Flores[1] (Postdoctoral Associate), [1]Dept. Crop, Soil and Environmental Sciences, [2]Dept. Animal and Poultry Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

### Summary

The main objective of this project is to evaluate forage productivity, forage nutritive value, and plant species composition within different creep grazing systems used for cow-calf production. The present study was initiated in 2008 and is being conducted at the Virginia Tech Shenandoah Valley AREC at Steeles Tavern, VA. We are evaluating two different creep grazing systems in this project: 1) forward creep grazing where dams and offspring rotate through a series of paddocks (8 paddocks using 16 acres) with offspring as first grazers and dams as last grazers, and 2) a continuous creep grazing system where calves have access to a nil-ergot, endophyte-infected fescue + alfalfa pasture (1.6 acres) at all times while rotating through a series of paddocks with dams (8 paddocks using 14.4 acres). Each creep system is split into two additional treatments that include grazing by medium or large frame cows. The experimental treatments are replicated three times and stocking rate is 1.75 acres / Animal Unit.

Forage productivity, nutritive value and plant species composition was measured over the 2008 growing season. Forage mass peaked in June at an average of 1984 lbs/acre and declined to 1655 lbs/acre by October. No statistical differences in forage production were found between the creep systems or frame score types. The fact that forage mass declined minimally from June to October shows that ample forage was available to support the cow-calf groups. This situation occurred even during a relatively dry growing season. Within the forage systems, some paddocks also were used for fall/winter stockpiling. We found that forage mass on these stockpiled paddocks was about 10-20% higher than non-stockpiled paddocks - especially later in summer. This preliminary data points to some additional advantages to stockpiling pasture beyond providing winter forage.

Preliminary analysis of forage nutritive value showed expected seasonal trends. Forage nutritive value, however, was lower than expected after May with very low crude protein concentrations averaging around 8% and high fiber concentrations (e.g., neutral detergent fiber between 65-75%). An exception was the continuous creep pastures with nil ergot fescue and alfalfa. Forage nutritive values on continuous pastures were much higher (e.g., 11-12% crude protein in mid-summer) compared with the rotational paddocks. Data on plant species composition indicated a good abundance of alfalfa in continuous creep pastures, and this likely contributed to the higher forage nutritive value. Plant species composition data was collected in April, July and September. Overall, pastures had about a 50:40:10 ratio of tall fescue, bluegrass and orchardgrass, respectively. The pastures also have relatively few weeds, which is suggestive of good management and soil fertility. Despite frost seeding clover in February, clover establishment was highly variable across paddocks and appeared to show little pattern associated with previous management. Data collection on forage systems will continue for the next several years.

**Economic Pasture-based Beef Systems for Appalachia: Soil Fertility Dynamics in Cow-Calf Grazing Systems**

**Investigators:** Joao Paulo Flores (Postdoctoral Associate) and Benjamin Tracy. Dept. Crop, Soil and Environmental Sciences, Smyth Hall (0404), Virginia Polytechnic Institute and State University, Blacksburg, VA 24061 Phone: 540.231.8259, Email:bftracy@vt.edu

**Summary**

The main objective of this project is to evaluate the dynamics of soil fertility within pastures used for cow-calf production. This study is being conducted at the Virginia Tech Shenandoah Valley AREC at Steeles Tavern, VA and involves pastures devoted to the forward and continuous creep grazing systems described previously. We are testing two ideas in this study. The first deals with the general recommendation that soil fertility testing should be done every 3-5 years on pastureland. We plan to monitor soil pH and selected macronutrients (potassium, phosphorus, calcium and magnesium) over five years to learn how these variables change over time. Initial results indicate that soil nutrient concentrations generally declined 15-20% from 2007 to 2008. This decline was unexpected since most nutrients are usually recycled in grazing systems. More data is needed to confirm this trend, but it may indicate that soil fertility indices may change rapidly and require more frequent monitoring. The other objective within this subproject will be to monitor nutrients in the forage (rather than soil) to determine whether this might be a better way to gauge pasture fertility. We tested forage samples taken over the 2008 growing season for 12 different elements. Preliminary analysis on major nutrients (P and K) indicated that forages had adequate concentrations to support livestock nutritional needs over the entire growing season (April-October). The 2008 soil test results indicated that most pastures were in the M+ to M- range for P and K. Our initial results suggest fertilizing pastures to exceed M+ levels is probably unnecessary to satisfy livestock nutritional needs and that standard soil testing may be sufficient to predict forage nutrient concentrations.

**Impacts of Concentrated Hay Feeding Areas on Pasture Functioning**

**Investigators:** Joao Paulo Flores (Postdoctoral Associate) and Benjamin Tracy. Dept. Crop, Soil and Environmental Sciences, Smyth Hall (0404), Virginia Polytechnic Institute and State University, Blacksburg, VA 24061 Phone: 540.231.8259, Email:bftracy@vt.edu

**Summary**

Most forage-livestock production systems possess hay-feeding areas where animals may congregate for several months – usually in winter. These areas can become heavily disturbed and compacted from trampling by livestock. The hay feeding areas also may become focal points for weed invasion, erosion or potential pathogens. In 2008, a study was initiated at the Virginia Tech Shenandoah Valley AREC at Steeles Tavern, VA to evaluate the impact of concentrated hay feeding areas on pasture ecosystem functioning. In this study, we are evaluating 12 pastures were used for winter hay feeding. The pastures are part of the cow-calf forage production system within the project Economic Pasture-based Beef Systems for Appalachia.

The 12 hay feeding pastures were each about two acres and stocked with 7 or 8 beef cows and from January to April. For comparison, we also sampled 12 adjacent pastures that were rotationally grazed but had no hay feeding area. All pastures are rotationally grazed during the growing season. Within the paired pastures, we measured forage yield, forage nutritive value, plant species composition, soil fertility indices, soil $CO_2$ flux and soil compaction.

In 2008, pastures with hay feeding areas had less forage in early spring (465 lbs DM $ac^{-1}$ ) compared with rotational pastures (675 lbs DM $ac^{-1}$). Later in the growing season, forage yield became similar between treatments. In spring, crude protein in forage was also significantly higher in hay feeding sites (20% vs. 18%) but this difference did not persist longer into the season. Plant species composition exhibited no clear differences between the pastures. Neither soil P nor pH differed significantly ($P > 0.05$) between hay feeding areas and rotational pastures. Soil $CO_2$ flux was measured in May 2009. The flux of $CO_2$ is indicative of decomposition and soil biological activity. The first measurements showed no clear difference between pastures. Penetration resistance measurements confirmed that pastures with hay feeding areas were more compacted than rotational pastures. The mean penetration resistance measurements were less than 2500 KPa though, which is considered the threshold where compaction can adversely affect plant growth. Overall, our initial data suggests that concentrated hay-feeding areas had no long-lasting effects on the functioning of pasture ecosystems. We will continue to monitor these trends to confirm these initial findings.

**Influence of Forage Characteristics on Grazing Behavior of Weaned Calves.**

**Investigators:** Sebastian Arriola[1] (Graduate Student), , Benjamin Tracy[1], Ozzie Abaye[1], Guillermo Scaglia[2] and William. Swecker[3]. [1] Dept. Crop and Soil Environmental Science , Virginia Tech, Blacksburg, VA 24061; [2]Iberia Research Station, LSU Agricultural Center, 603 LSU Bridge Rd, Jeanerette, LA 70544; [3]Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, VA 24061.

## Summary

For Virginia, the primary forage base is endophyte-infected tall fescue (*Schedonorus phoenix* (Scop.) Holub). However, the decreased animal performance and disorders caused by the presence of the fungal endophyte *Neotyphodium coenophialum* reduces its suitability for many forage-livestock producers. The endophyte, which is found in the inter-cellular space of tall fescue tissues, forms a mutalistic relationship with the plant and helps the fescue tolerate drought, insect predation, and grazing pressure. The production of toxic ergot alkaloids by the endophyte is associated with decreased performance of animals that graze endophyte infected tall fescue. The objective of the current experiment was to determine how tall fescue type (endophyte free vs novel endophyte) and orchardgrass-legume (alfalfa vs clover) mixture affect grazing behavior of weaned steers.

Forty-eight weaned steers (218 ± 18 kg) were blocked by frame score (medium and large), and randomly assigned within block to four treatments with three replications in a 2x2 factorial design. Each treatment consisted of 2 paddocks with the combination of tall fescue and legume-orchardgrass mixture as follow: alfalfa-orchardgrass mixture (A)/E-, clover-orchardgrass mixture (C)/E- , A/E++ and C/E++. Each group of 4 steers had 24 h access to both tall fescue stand and legume-orchardgrass mixture. Botanical composition of paddocks was determined on d 0, and forage mass, sward height and nutritive value were determined on d 0, 17 and 33. Behavior of steers was scanned every 5 min on d 24 and 25 from 0700 to 1900.

The proportion of legumes was higher ($P = 0.001$) in A paddocks(37 %) compared to C paddocks (6%), while the percent orchardgrass was lower ($P = 0.040$) in A (33 %) than C (53 %). The proportion of broadleaf and grassy weeds was higher ($P = 0.013$) in E- paddocks (11 %) as compared with E++ paddocks (3 %). Sward height and herbage mass were similar between treatments during the experiment ($P > 0.05$). Nutritive value (CP, NDF and ADF) did not differ between fescue paddocks ($P > 0.05$). However, within mixed swards, CP was higher and NDF was lower in A compared with C ($P < 0.05$). Acid detergent fiber was ($P < 0.05$) lower in A than C only on d 0 and 17. Average daily gain did not differ between treatments ($P > 0.05$). Steers spent higher ($P = 0.002$) proportion of the daylight time grazing in treatments with C (56 %) as compared with A (50 %), and in treatments ($P = 0.023$) with E++ (55 %) compared with E- (52 %). Time spent ruminating, idling and lying, as well as steps taken per day, did not differ between treatments ($P > 0.05$). Regardless of differences in weeds between E- and E++, these results indicate that fescue type affected grazing behavior of calves. Difference between mixed swards in proportion of ground cover with legumes and

orchardgrass, as differences in nutritive value between A and C may have affected grazing behavior of calves between mixed swards, instead of a legume species effect within mixtures.

**Effects of Residual Feed Intake Selection: From Conception to Slaughter**

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Angus bulls with known residual feed intakes (**RFI**) have been used to breed two West Virginia University and one private producer's beef cow herds since the spring of 2005. Bulls were selected as pairs {most (-RFI) and least (+RFI) efficient} possessing similar expected progeny differences, growth performance but approximately equal but opposing RFI values within the test groups in which they were determined. Steer calves from these three herds were selected based on similarity in bodyweight and winter growth performance and utilized for a pasture-season experiments beginning in March each spring since 2007 and subsequent feedlot finishing.

In the pasture experiment, steers were allotted to 1 of 4 treatments, with treatment group being randomly assigned to 1 of 4, one-hectare plots (subdivided into 4 subplots for rotational grazing) and replicated 3 times. Thus, steers were stocked at a rate of 4 hd per hectare with 4 treatments equally represented within each terrain classification. Treatments tested were 4 positive RFI steers per pasture (**POS**), 4 negative RFI steers per pasture (**NEG**), 2 positive RFI steers per pasture lead grazing with 2 negative RFI steers follow grazing (**+/-**), and 2 negative RFI steers per pasture lead grazing with 2 positive RFI steers follow grazing (**-/+**). Animal weight-gain and pasture forage disappearance/utilization measurements were collected. Data were analyzed as two separate experiments: Experiment 1, POS vs. NEG, Experiment 2, +/- vs. -/+. Statistically analyzed results from measurements taken from the beginning of the experiment to late June (Period of excess forage) indicate that POS stocked pastures have more forage disappearance than NEG stocked pastures with no difference in animal performance. There was also no difference in pasture disappearance between +/- and -/+ stocked pastures. Although not significant, numerical differences in gain indicate that negative RFI sired steers are better able to utilize material left by forward grazed positive sired steers while no difference was seen in weight gain when positive RFI sired steers followed negative RFI sired steers. Results from late June to early August (Period of limiting forage) have not been fully analyzed but raw means show a 1.3 fold improvement in daily growth of NEG vs. POS steers. Raw means of the -/+ vs. +/- treatment showed similar better use of forage as seen in the earlier period with 1.6 fold greater ADG.

Steers were transported to a feed lot in mid October and worked up on full feed. All steers were treated equally and slaughtered in early February averaging an 832 lb carcass with a SM60 amount of marbling, 0.41 in of backfat, 13.0 sq. in. ribeye and a yield grade of 2.9. POS sired calves outperformed NEG sired calves by 0.57 lb/d over the 72 day finishing period with no difference in slaughter or hot carcass weight or standard carcass measurements. Small numerical, but non-significant differences (0.13 vs. 0.04) existed for POS vs. NEG sired calves feedlot determined RFI. When comparing -/+ vs. +/- steers, only RFI differed with +/- steers averaging -0.65 vs. 0.34 for the -/+ steers. Within leader follower treatments, negative RFI sired steers had substantially lower RFI's compared to the positive sired steers. Negative sired leader steers had an average -0.78 vs. 1.47 for positive followers for feedlot determined RFI. In contrast, positive sired leader steers had an average -0.23 vs. a -1.08 for negative followers for feedlot determined RFI. No other significant pasture treatment effects were detected during the finishing phase. RFI rankings determined from the finishing phase ranked sires from most (-RFI) to least (+RFI) efficient similarly to earlier testing. Lastly, although not statistically different, feed costs from the time steers entered the feedlot till slaughter averaged 21.63 dollars more per head for positive RFI sired steers than for negative RFI sired steers.

These results may indicate that when forage is plentiful, offspring sired by positive RFI sires are able to have a greater intake of energy than negative RFI sired offspring and therefore compensate for poorer metabolic efficiency yielding similar performance. However, under a limited forage environment, less efficient, positive RFI sired offspring are more likely to have poorer performance and create greater risk for the grass lands producer. The reduction in gain experienced by the positive sired offspring while on limited pasture allowed for them to have compensatory gain while finishing. However, the efficiency of the positive RFI sired steers was still compromised and resulted in them having an overall higher feed costs. These results indicate that selection for RFI can be made with positive results.

## Poisonous Plants

Ozzie Abaye and Kelley Smith

The term poisonous or toxic plants refer to plants that cause a wide range of effects on animal health (Tables 1 and 2). Many pasture/range plants are in fact poisonous, but are rarely consumed by animals or humans, thus they do not pose a health threat (Burrows 2001). Certain conditions like a lack of desired species in pastures/rangeland can lead to animals consuming less desired poisonous plants (Filmer 2009). However, not all toxic plants cause death. The severity of the symptoms varies tremendously among species (Tables 1 and 2) (Hardin 1961). Plants that are said to have major toxicity cause serious illness or death, whereas plants with minor toxicity cause minor problems such as vomiting or diarrhea (Filmer 2009). There are many plants that cause mechanical injury to grazing animals. These plants have thorns or spines that cause injury to the mouth and the digestive tract when ingested by the grazing animal. In the worst cases, the thorns, spines, or awns on the plant can cause internal bleeding and ultimately death (Hardin 1961). There are also plants which cause dermatitis, or irritation to the skin, when the animal comes in contact with the plant (Tables 1 and 2), as well as those that cause off flavor in milk or meat such as wild garlic and onion (Hardin 1961). In humans, the most common plants that cause skin irritation and/or dermatitis are poison oak and poison ivy. In animals, these plants can cause hair loss and severe blisters around the affected area, which can then leave the animal susceptible to infection and other diseases (Burrows 2001).

The health risk that poisonous plants impose to the grazing animal depends on the amount ingested, time of ingestion, and growth stage of the plant at the time of ingestion. In order to avoid internal or external injury due to poisonous plants, it is important to control toxic plant species in pastures (Filmer 2009). Often animals avoid injurious or poisonous plants if desired forage species are not in short supply. Thus, it is important to provide the animal sufficient amount of forage with high nutritive values so animals do not resort to consuming poisonous plants (Hardin 1961).

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