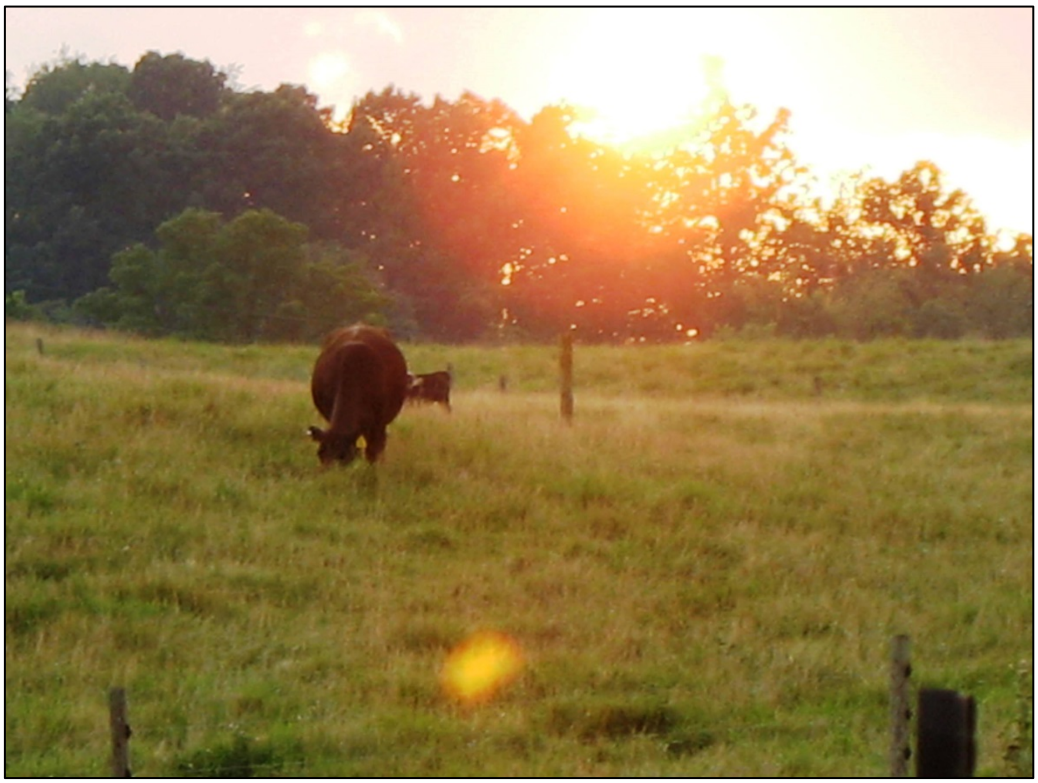
Virginia Tech
Shenandoah Valley Agricultural Research and Extension Center

2013 Field Day Proceedings



August 7, 2013

Virginia Tech Virginia Agricultural Experiment Station

Virginia Cooperative Extension
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Field Day Program

12:00 – 1:00	**Registration and visit with sponsors**
1:00 – 1:10	**Welcome**, *David Fiske, Superintendent, Shenandoah Valley Agricultural Research and Extension Center*
1:10 – 1:20	Load wagons and travel to first stop
1:20 – 1:45	**Forest & Forage = Silvopasture** – *Adam Downing, Virginia Cooperative Extension, Dr. John Munsell, College of Natural Resources and Environment, Virginia Tech, Dr. John Fike, Crop and Soil Environmental Sciences, Virginia Tech and Patti Nylander, Virginia Department of Forestry*
1:45– 1:55	Load wagons and travel to Forage Plot area
1:55 – 2:40	**Forage Species Demonstration Plots and Warm Season Annual Forages** – *Matt Booher, Virginia Cooperative Extension, J.B. Daniel, Forage & Grassland Agronomist, USDA-NRCS, and Dr. Ozzie Abaye, Crop and Soil Environmental Sciences, Virginia Tech*
	View Demonstration and Research Forage Plots
2:40 – 2:50	Load wagons and travel to Big Meadow area
2:50 – 3:10	**The Pasture-Based Beef Systems for Appalachia Project: What we've Learned –** *Dr. Terry Swecker, VA-MD Regional College of Veterinary Medicine, Virginia Tech and Dr. Ron Lewis, Department of Animal and Poultry Sciences, Virginia Tech*
3:10 – 3:25	**Nutrient Dynamics in Tall Fescue-based Pastures** – *Dr. Ben Tracy, Crop and Soil Environmental Sciences, Virginia Tech and Gordon Jones, Graduate Student, Crop and Soil Environmental Sciences, Virginia Tech*
3:25 – 3:40	**Early Weaning Affects Feedlot Performance and Carcass Traits –** *Jason Smith, Graduate Student, Department of Animal and Poultry Sciences, Virginia Tech*
3:40 – 3:55	**Strategic Phosphorus Supplementation of Beef Cattle** – *Deidre Harmon, Graduate Student, Department of Animal and Poultry Sciences, Virginia Tech*
3:55 – 4:15	**Phosphorus Status of Beef Cattle Farms in Virginia's Chesapeake Bay Watershed –** *Dr. Mark McCann, Department of Animal and Poultry Sciences, Virginia Tech and Scott Neil, Graduate Student, Department of Animal and Poultry Sciences, Virginia Tech*
4:15 – 5:00	**Yield and Botanical Assessments of Forages using Non-Destructive Methods: Yard Stick and Visual Evaluation** – *Dr. Ozzie Abaye, Crop and Soil Environmental Sciences, Virginia Tech*
5:00 – 5:10	Load wagons and travel back to Bank Barn
5:10 – 6:00	**Visit with Sponsors and Poster session –** Bank Barn
	Ultrasound Demonstration (Finishing Barn working facility) – *Joe Emenheiser, Graduate Student, Department of Animal and Poultry Sciences, Virginia Tech*
6:00 – 6:30	**Introductions and Comments from Special Guests – *Memorial grounds picnic area***
	Pre-dinner Speaker – *Mr. Matt Lohr, Commissioner, Virginia Department of Agriculture and Consumer Services*
6:30	**Dinner – *Memorial grounds picnic area***

Silvopasture: Where Forest and Forage Meet

Adam Downing,[1] John Fike[2], Greg Frey [3], and Patti Nylander[4]

Background

Silvopasture is the purposeful and managed integration of trees, forages, and livestock. With appropriate management, these intensive, integrated management systems create beneficial interactions among the system components that result in more efficient resource use and greater economic output over the life of the system. Benefits of silvopastures can include increased forage quality, reduced animal stress, improved tree growth and quality, greater farm product and ecosystem diversity and a number of conservation gains (Fike et al. 2004).

Silvopasture is purposeful
Photo Credit: Brett Chedzoy, Extension Forester with Cornell University Cooperative Extension

Silvopasture is **NOT** the casual use of one or a few random trees in a pasture; **nor** is it providing livestock access to the back woodlot for shade. Farm woodlots have suffered at the hooves of livestock for centuries when too many animals have unmanaged access to the forest. This often results in degraded soils, increased erosion and a forest stand void of desirable regeneration and at its worst degraded timber quality. The purposeful integration of trees and forages has been practiced in different parts of the world for decades or even centuries (Cubbage et al. 2012). In the U.S., this practice is best established in the Southeast, where livestock are managed under pines. Silvopasture adoption by producers has been more limited in Virginia but is beginning to pick up. The potential benefits shown in early Virginia research, greater extension efforts, and the addition of silvopastures to the list of accepted NRCS conservation practices all are contributing to greater awareness of these systems. Because of Virginia's varied climate, soil and specific site conditions, the application of this practice on any given farm will differ. All sites, however, will share certain elements in terms of balancing sun with shade and managing livestock access. Many variables within a given site such as forage species selection and establishment methods, tree species and stocking/density need to be explored and explored again for the different regions of Virginia.

Silvopasture is NOT casual, random use of trees
Photo Credit: Randy Cyr, Greentree, Bugwood.org

The barriers of implementing effective silvopasture are not only technological but social (Workman et al. 2003). For example, foresters have preached "no cows in the woods" for nearly a century. Many farmers, on the other hand, have long viewed their forest as a savings account with no management required. And, the immediate benefit of letting their cows have free access to tree/forest shade (i.e., reduced stress) is much more tangible than any long-term effects of poor management on tree or forest health.

While cows and forests have not traditionally been viewed as compatible, silvopasture management challenges this paradigm. Some foresters now are seeing the potential to have some trees in open fields or to use silvopasture management to improve degraded woodlots – many of which have a history of “high grading”, in which the best timber was cut repeatedly and the “junk” trees were left behind. Farmers are looking for cost effective shade and high-quality forage that may be available on the site of an existing forest or by strategically planting trees in a field. In addition, the potential for future income from those trees is a living bank account, particularly as better quality trees under better management can provide greater economic returns.

Silvopasture Pros & Cons

One may note that much is still debated or unknown about silvopasture management and impacts. In the table below, one may note that some studies have shown soil compaction in silvopastures, yet studies that measure tree growth have not shown a negative impact on timber trees in silvopasture. Also, few silvopasture studies have tracked the trees through the timber sale process, so the possible impact on wood quality is debatable.

	Potential Advantages	**Potential Disadvantages**
Livestock/ Forage	• Cooler environments for livestock • Less use of streams and surface waters for cooling • Reduced effects of fescue endophyte • Better animal social behaviors • Animals are distributed among trees, reducing congregation around single trees	• May require less frequent or less intensive defoliation of forages • Some legumes sensitive to shade • May require more management
Forest/Low density plantings	• Increased wood quality by pruning lower limbs (fewer/smaller knots) • Opportunity for species selection • Better management of existing forest stand • Increased growth of crop trees • Managed trees can have greater market value • Reduced invasive species	• Reduced wood quality if animals congregate around a single tree • Limited regeneration potential without exclusions or replanting • Hardwood establishment can be risky, costly, or both • Systems can require management of individual trees • Risk of tree quality reduction (epicormic sprouts) with high rates of initial forest thinning • Soil compaction (Bezkorowajnyj et

		al. 1993; Sharrow 2007)
Conservation/ social/ economic services	• Carbon sequestration • Reduced soil erosion, water runof • Greater water infiltration • Greater nutrient (N and P) capture • Greater species and market diversity • Improved wildlife and pollinator habitat • Aesthetically pleasing • Diversification of income sources • Wildlife habitat (Husak and Grado 2002; Shrestha and Alavalapati 2004) • Total return on investment comparable to, or higher than alternatives (Husak and Grado 2002; Clason 1995)	• High management intensity • Cooler, moister environment can increase bacterial loads on pasture

Establishment options

In most of Virginia the natural land cover is forest. Some parts of Virginia, such as the Shenandoah Valley, have been managed for grasslands even before European settlement with prescribed and natural fire use by Native Americans. Integrating trees and forage/livestock systems requires a greater level of management than is common on many of today's livestock or tree farms (Fike et al. 2004). However, managing both for forage-livestock and for tree production can increase the overall output of the land base in a process called "overyielding". In this way, silvopastures can potentially have greater land equivalency ratio (LER) than is possible with either trees or livestock in monoculture.*

From field to silvopasture

The most straightforward and studied silvopasture systems have tested the planting of pine trees into existing pastures. Planting trees affords maximum control of tree species, spacing and orientation. Pine trees, especially southern yellow pines, are particularly well suited to silvopastures because the trees generally are inexpensive to establish, grow rapidly, cast light shade (thus allowing more solar energy through their crowns to the forage stand below) and have high market value.

Hardwood trees have also been used where the site quality supports high quality species such as walnut trees. Pecan, black locust and honeylocust trees are other commonly considered species. These species leaf out later in the season and their compound leaves and spreading crowns tend to allow more light to reach the forage canopy than most other hardwoods. Additionally, black locust can improve soil fertility by fixing nitrogen and honeylocust pods can be a good source of energy and protein for livestock.

From forest to silvopasture

Taking an existing forest and reducing the density of the overstory trees to a level that will support forages is the least studied approach to silvopastures. Where the existing forest stand is homogenous, such as with planted pine, the ability to control spacing of overstory trees is retained. Perhaps the biggest challenges in this scenario are to limit damage to the remaining stand during the logging operation and to prepare the site for forage establishment and management. Considerations of various stump removal methods and costs versus vehicle access need to be explored.

No doubt the most complex and least understood option for establishing silvopastures involves thinning an existing hardwood stand. Virginia's hardwood-dominated forests are very diverse with up to half a dozen species comprising the dominant position in the forest canopy. These species vary with regard to their ability to withstand a heavy thinning, their morphology and its effects on light transmission through their crowns, their life span, growth rates, market value and compatibility with livestock. For a particle list of trees and livestock toxicity, see: http://sheep.osu.edu/2012/07/09/poisonous-trees

The site preparation for forage establishment will most likely be most complex here as well. Most hardwood thinning operations leave significant woody debris behind and most hardwood stumps are prolific sprouters. These sprouts will require some kind of input (chemical, mechanical, or animal) to control or forage establishment will suffer.

Economics

Research to date has shown that, although silvopasture in the United States is not a widely used system, it can have economic advantages. The total return on investment to silvopasture, as measured by internal rate of return or land expectation value, can perhaps be higher than either cattle-raising or forestry alone (Husak and Grado 2002; Clason 1995). Furthermore, the cash flow properties of silvopasture can be an advantage for landowners who want to have a long-term "savings account" forestry investment for retirement or a child's education, without giving up potential yearly income from the land (Frey et al 2012). However, there are also potential disadvantages for landowners. Silvopasture can involve high up-front costs of installing fences, watering systems, and stump removal. Also, the level of management intensity is high, which is a drawback for landowners with little time to spare.

SVAREC Demonstration

Stand Description

This wooded area is a mixture of various hardwoods. Most prevalent are: green ash, black cherry, black walnut and hickory. Other species include: white oak, black oak, black locust, and American elm. The understory is thick with non-native bush honeysuckles, multiflora rose bushes, and spicebush. There is very little hardwood

tree regeneration occurring in this stand. This small woodlot is 4.8 acres and is currently fenced to exclude all livestock. Past use of this area did include grazing. The area was pasture, with some very large, mature white oak trees present, some of which are still standing. Most of the trees currently in the stand are smaller pulpwood sized trees, with an average diameter of 10.2”. Given the size of the trees, this area is considered a fully stocked stand.

The area was fenced to exclude livestock 20-30 years ago. Since that time, there has not been significant forest management activity in this stand. Six years ago, some work was conducted using herbicides to try to reduce the amount of bush honeysuckles in the understory.

The area is mainly flat, and there is a small sinkhole at the southern tip of the woodlot close to the road. Soils within this area are in the Frederick-Christian silt loam series. The area closer to the road is in the Frederick Rock-outcrop series. This soil type is derived from the weathered products of dolomitic and cherty limestone. This soil is typically fine in texture, rocky and very prone to erosion. Overall organic matter and fertility are low; available water capacity is low. This soil type is suited for growing fair quality trees, mainly black walnut, yellow poplar, and eastern white pine.

Demonstration Methods

Finding a balance of the right quality and quantity of light to support forages under an overstory of partial tree shade is the aimed-for (and delicate) balance. To achieve this, the current stand will be thinned to approximately 50 percent of its current basal area, a number which is a generally agreed upon reasonable goal for hardwood forests (personal communication Tom Ward (NRCS), 2012?). Basal area is a measure used to describe tree stocking in a given area, a sort of density measurement that accounts for tree size. Specifically, the basal area of a tree is the cross section of a stem (trunk) measured at breast height (4’ 7” above ground) and expressed in square units per area.

The basal area of this site averages around 100 ft^2 /acre. In choosing how many trees to leave behind, we aimed for well-spaced trees of suitable quality and characteristics and a residual basal area of about 50 ft^2/ac (50% of 100 ft^2/ac). Black walnut and white ash comprise the majority of the selected species.

Walnut has good silvopasture characteristics with late leaf-out, early leaf-drop and a diffuse canopy. Ash is neither a preferred nor discouraged silvopasture species. The limitations of the site and the existing stand gave us these trees to work with. Both species are at risk for new non-native pests. The emerald ash borer and the thousand cankers disease of walnut are both fatal pathogens and are currently present in various parts of Virginia. Neither are known to exist in Augusta or Rockingham Counties.

Tentative Process Planned

Year	Season	Activity
1	Summer	Marking “keep” trees
1, 2	Winter	Commercial harvest (contract to stipulate removal of all non-marked material down to 2”)
	Spring/Summer	Goat work
	Spring	Prescribed understory burn
	Summer	Herbicide kill
	Fall	Understory burn again (to burn the herbicide kill and prepare site for planting)
	Fall	Seed forages
3	Spring/Summer	Herbicide control of woody sprouts (with selective herbicide to woody plants)

* Land equivalency ratio (LER) expresses the productivity of a site for a given production system. An LER of 1 indicates the system is producing 100% of its potential within a given set of environmental conditions. While adding trees to pasture – or forages to forested sites – could potentially lower the productivity of either component, managing the two together results in greater total output of the land area; in many such cases the resulting LER of may approach 1.15-1.2.

Citations

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Appendix

The following brochures, articles and factsheets are available from the USDA National Agroforestry Center: http://nac.unl.edu/silvopasture.htm

- What is silvopasture?
- Mitigating Heat Stress in Cattle
- Working Trees: Silvopasture
- Silvopasture: Establishment & Management Principles For Pine Forests In The Southeastern United States.
- Agroforestry Notes
    - The Biology Of Silvopastoralism
    - From A Pine Forest To Silvopasture
    - From A Pasture To A Silvopasture System
- Management Of Southern Pine Forests For Cattle Production

Authors

[1] Adam Downing, Forestry & Natural Resources Extension Agent, Virginia Cooperative Extension, Northern District

[2] John Fike, Ph.D., Forage-Livestock & Biofuels Extension Specialist, Virginia Tech, College of Agriculture and Life Sciences

[3] Greg Frey, Ph.D., Forest Management Extension Specialist, Virginia State University, School of Agriculture

[4] Patti Nylander, Senior Area Forester, Virginia Department of Forestry, Augusta County

FORAGE SPECIES DEMONSTRATION PROJECT

Matt Booher and David Fiske[1]

Introduction

The concept and purpose of this Forage Species Demonstration Project is to provide agricultural producers a side by side visual demonstration of various forage species that are conducive for or under testing for production in western Virginia. Through this project, producers will be able to appraise for themselves both traditionally grown forage species and new forage species, which 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.

Demonstration Plots

Forage Species and Variety Identification in plots:

1 / 2 / 3 / 4 / 5 / 6 / 7/ 8 / 9 /10 / 11 / 12 / 13 / 14 / 15 / 16 / 17

1. Meadow Brome 'Cache'
2. Meadow Brome 'Montana'
3. Snake Creek Pasture Mix *
4. Tall Fescue – Kentucky 31
5. Tall Fescue – Max Q
6. Tall Fescue – E34
7. Reed Canarygrass
8. RR Alfalfa (Dekalb)
9. Pasture Mix
10. Birdsfoot trefoil VNS
11. Smooth Bromegrass
12. Orchardgrass 'Crown Royale'
13. Sainfoin 'Shoshone'
14. Bermudagrass
15. Eastern Gamagrass
16. Bermudagrass
17. Switchgrass managed for wildlife

*40% smooth brome, 40% orchardgrass, 20% perennial ryegrass

[1] Crop Extension Agent, VCEPD6; Superintendent, Virginia Tech Shenandoah Valley AREC respectively.

Forage Specie Information

1 **Meadow brome, 'Cache'**
Long lived perennial bunchgrass. Currently used on limited acreage in VA.
pH range – slightly acid to mildly alkaline
Start grazing at 8", stop at 4" for rapid regrowth.
Primarily used as pasture, but is suitable for hay.
Good early spring growth & highly palatable. Good drought tolerance.
Seed in spring or late-summer ¼-1/2" at 10 lbs/ac of pure live seed
Fluffy seed can make seeding challenging

2 **Meadow brome 'Montana'**

3 **Snake Creek Pasture Mix**
40% Orchardgrass, 40% smooth brome, 20% perennial ryegrass
Use – Pasture. Good palatability, digestibility. Sod forming capability.
Time of Seeding – Early Spring or Late Summer
Seeding Rate – 25 lb/acre

4, 5, &6 **Tall Fescue (4 – Kentucky 31; 5 – MaxQ; 6 – E34)**
Use – Pasture and/or Mechanically Harvested
Strong late fall & 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 endophyte fungus
E34 – Contains endophyte beneficial to growth, lacks toxic alkaloids

7 **Reed canarygrass**
Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – Early Spring or Late Summer
pH Range – 6.0 – 7.0
Seeding Rate – 15 lb/acre drilled, 23 lb. broadcast or 6-8 lb. in mixtures
Seeding Depth ¼ - ½ inch deep; planting depth is critical
Aggressive sod former. Excellent drought or wet tolerance. Select low-alkaloid varieties.

8 **Alfalfa (Roundup ready)**
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 available
Should not use in continuous grazing situations
Very drought tolerant
Roundup Ready allows for glyphosate to be used for grass and broadleaf weed control without injury to alfalfa.

9 **Pasture Mix**
Orchardgrass, timothy, alfalfa, bluegrass, and white and red clovers

10 **Birdsfoot Trefoil**
Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – Early Spring or Late Summer
pH Range – 5.5 -7.0
Seeding Rate – 10 lb/acre alone or 6-8 lb. in mixtures
See no deeper than ¼”
Adapted to poorly drained & low fertility sites
Maintains better quality & palatability with maturity than alfalfa
Non-bloating & bypass protein due to tannin content
Longevity depends on annual self-reseeding- rest accordingly
Suitable for fall stockpiling- retains leaves after frost

11 **Smooth Bromegrass**
Use – Pasture and/or Mechanically Harvested Forage
Matures 3 weeks later than most orchardgrass
Time of Seeding – Early Spring or fall with small grains
Issues with seed bridging in drill-run through fertilizer attachment of grain drill or mix with oats and run through small grain attachment, or broadcast
pH Range – 5.8 - 6.7
Seeding Rate – 12-16 lb.PLS, may seed with timothy in fall or oats in spring
Very drought tolerant
Prefers well drained drought tolerant soils
Excellent nitrogen responder
Aggressive sod former; many stands last 25-50 years
Digestibility declines very rapidly after boot-stage

12 **Orchardgrass ‘Crown Royal’**
Midwestern variety bred for increased tillering, disease resistance
Late-maturing

13 **Sainfoin ‘Shoshone’**
Perennial, cool-season, non-bloating legume.
Grown extensively throughout western US
Requires fertile, well-drained soil
Use – Pasture and/or Mechanically Harvested Forage
Time of Seeding – early-spring or late-summer, ½”-1” deep
pH Range – 6.0-8.0
Seeding Rate – 30 lb/acre PLS
Deep taproot, good drought tolerance
Highly palatable & digestible; maintains high sugar content

.

14 **Bermudagrass**
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 summer production

15 **Eastern Gamagrass**
Tripsacum dactyloides
Use – Primarily Pasture but 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
Native Warm Season Grass
Does well in moist, 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

16 **Burmudagrass**

17 **Switchgrass (managed for forage)**
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 for adequate germination
Do not seed in mixtures
Graze or cut at 6-8 inch height
Excellent forage for summer months
Drought tolerant
Does well in less fertile soils

Acknowledgements

Sponsors:

- Augusta Farmers Coop
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- Evergreen Seed Co.
- Rockbridge Farmers Coop
- Rockingham Cooperative
- Utah Seed
- Poudre Valley Farmers Cooperative

Warm Season Forages

Matt Booher: Virginia Cooperative Extension, Crop Agent
David Fiske: Superintendent, Shenandoah Valley AREC

These demonstration plots were established to provide farmers with a look at the many species, hybrids, and varieties available for summer annual forage. Many of these forages can be a valuable tool when rotating a crop field into fall-seeded pasture, or as a targeted way to provide grazing during the summer slump. Additionally, livestock operations that typically ensile corn may find some of these species perform better on poor ground and are cheaper to raise than corn.

General Notes:

Sudangrass can be harvested as pasture, green chop or silage, but is best used for pasture. Yields of 3 to 4 tons/acre of dry matter or 10 to 12 tons/acre of green feed or silage are possible. It can be pastured 5 to 6 weeks after planting and may be cut or grazed multiple times (when regrowth reaches 18 to 20 inches) For best results, it should be grazed rotationally with a sufficiently heavy stocking rate to remove forage down to a 6 to 8 inch height in a few days. The pasture will grow rapidly when the cattle are removed for more total tonnage. Additionally, if the grazing period is short, cattle will be less likely to be grazing regrowth that is high in prussic acid. It can be very difficult to dry for hay- a good strategy is to harvest early when plants reach around 30 inches tall. For silage, harvest in the medium dough stage at 65-70% moisture. Nutritional quality is good when plants are immature (about 70% TDN, 17% CP) and drops with maturity to around 55% TDN, 11% CP.

Sorghum-sudangrass hybrids are taller, have larger stems and can be higher yielding than sudangrass. Sorghum-sudangrass hybrids are normally harvested for green chop or silage (medium dough stage) but may be used for pasture or hay if planted at a high seeding rate and harvested at 18 to 24 inches tall (regrowth is good but not as good as Sudangrass). The sorghum-sudangrass hybrids usually yield less than forage sorghums. Forage quality will be around 65 TDN, 16% CP in the vegetative state; as the plant matures quality will drop to around 55 TDN, 11% CP.

Forage sorghums are best harvested as silage, and should be harvested at the mid dough stage. 9%CP, 60% TDN. Most forage sorghums and forage sorghum hybrids are medium to late maturing; some long season and/or non-flowering types will need to be killed by frost to dry down enough for ensiling. Forage sorghums and sorghum hybrids can cause prussic acid poisoning under certain environmental conditions- mainly when grazed or fed as green chop. The energy value of sorghum silage is about 90% that of corn silage (60% TDN, 9% CP).

BMR
Many sudangrass and sorghum hybrids are BMR (brown-midrib) traited. Brown midrib is a genetic mutation that results in low lignin levels in the plant. Resulting forage quality is significantly higher in palatability and digestibility (e.g., a 5 point increase in IVTD (in vitro true digestibility)). The potential for increased lodging exists with BMR hybrids.

Millets are lower yielding and slower growing than sorghum-type plants. However, they have smaller stems and are leafier. They do not present a risk of prussic acid poisoning.
Pearl millet is the preferred species for grazing since it has the ability to regrow well from multiple tillers. Forage quality will run about 60% TDN, 12% CP prior to heading. Grazing should begin at about 20" and stop at about 9-12". Dwarf varieties of pearl millet are shorter, with a higher leaf/stem ratio.

<u>Prussic Acid</u>
Sorghum and sudangrass plants contain a compound called dhurrin, which can break down to release prussic acid (hydrogen cyanide, HCN). Sudangrass has low levels of this compound and rarely kills animals. Sorghum has the highest levels and sorghum-sudangrasses are intermediate. There is also considerable varietal difference in prussic acid content for all types of sorghums.

Dhurrin content is highest in young plants. Therefore, the recommendation is not to graze or cut for green chop until the plant is 18 to 20 inches tall. This also applies to young regrowth in pastures. After a drought, new shoots may appear and the grazing cattle will switch from the taller forage to the new tender shoots. In addition, do not graze or green chop for 10 days after a killing frost.

High levels of nitrogen fertilizer or manure will increase the likelihood of prussic acid poisoning as well as nitrate poisoning. Very dark green plant growth often contains higher levels of prussic acid.

Most prussic acid is lost during the curing process. Therefore, hay and silage are seldom toxic even if the original forage was. Do not leave green chop in a wagon overnight and then feed. The heat that occurs will release prussic acid and increase likelihood of toxicity in the feed.

Individual animals vary in susceptibility to prussic acid poisoning. Cattle are more susceptible than sheep. Animals receiving grain with the sorghum forage are less likely to be affected.

- '*Prussic Acid Concerns' Dan Undersander, University of Wisconsin*

Plots were seeded on the indicated date. 65 lbs. of actual nitrogen was applied to all plots at planting- except for the plot containing annual lespedeza.

1. **Crabgrass 'Quick-N-Big'**

   Excellent yield and high quality- holds quality with age
   This variety is earlier-maturing
   Drilled on June 4 at 7 lb./ac; ¼" deep
   Graze or hay. May allow to self-reseed in fall.

2. **Matt Poor's Grazing Mix**

   26% Sorghum sudan, 'Xtragraze BMR'
   25% Cowpea, 'Iron and Clay '
   20% Forage Soybean, 'Loredo'
   12% Pearl Millet, 'Leafy 2000'
   4 % Foxtail Millet
   4 % sunflower
   3 % Radish, Daikon type ('Groundhog')
   3 % Forage Turnip, 'Appin'
   3 % forage brassica, 'Pasja'
   Broadcast on May 29 at 50 lb/ac

3. **Crabgrass 'Red River'**

   Later-maturing variety
   Drilled on June 26 at 7 lb/ac; ½ " deep
   Graze or hay

4. **Pearl Millet 'Wonderleaf'**

   Drilled on June 26 at 20 lb/ac; ½" deep
   Graze
   Excellent regrowth, no prussic acid concerns. Start grazing at 12", stop grazing at 6"

5. **Sorghum sudan (AS6501)**

   Drilled on June 26 at 60 lb/ac; ½ " deep
   Wide-leafed, photo-period sensitive with delayed maturity
   Gene 6 BMR and improved disease resistance (fusarium)
   Ensile or graze with caution (prussic acid risk)

6. **Sorghum sudan (AS6402)**

    Drilled on June 26 at 60 lb/ac; ½ ” deep
    Short hybrid
    Ensile or graze with caution (prussic acid risk)

7. **Turnip ‘Pasja’ + pearl millet ‘Wonderleaf’**

    Grazing mixture
    No prussic acid concerns

8. **Crabgrass ½ ‘Red River’ + ½ ‘Quick-N-Big’**

    Mixture of 2 maturities

9. **Forage sorghum (7401) *DUPLICATE OF 11.***

    Seeded June 26 at 7 lb. /ac; ½ ” deep
    Gene 6 BMR brachytic dwarf. Full-season hybrid.
    Chop. Use in place of corn silage on marginal ground.
    Energy close to that of corn silage, protein is around 10-11%

10. **Annual lespedeza (common striate type) VNS**

    Not the weedy perennial! Annual legume- must be inoculated.
    Non-bloating, bypass protein due to tannin content
    Excellent quality. Grows best in heat, provides forage in July & August.
    This plot was broadcast into tilled ground May 29 at 20 lb. /ac, but works well to drill into hard-grazed fescue sod first part of April. Limit competition from sod: don’t apply nitrogen, flash graze or brushog fescue in spring to limit competition.
    Graze or hay.

11. **Forage sorghum (7401)**

    Seeded June 26 at 7 lb. /ac; ½ ” deep
    Gene 6 BMR brachytic dwarf. Full-season hybrid.
    Chop. Use in place of corn silage on marginal ground.
    Energy close to that of corn silage, protein is around 10-11%

12. **Forage sorghum (7201)**

    Seeded June 26 at 7 lb. /ac; ½ ” deep
    Shorter season hybrid, good standability

13. **Sudangrass (AS9301)**

    Seeded June 26 at 7 lb. /ac; ½ ” deep
    Gene 6 BMR
    Pasture, hay, haylage, or baleage

14. Sudangrass ‘Hayking’

Older BMR hybrid, lacks digestibility of newer hybrids, still better than non-BMR
Seeded June 26 at 7 lb. /ac; ½ ” deep

15. Alyce clover VNS & pearl millet (‘Wonderleaf’) at ½ rate (10 lb/ac)

Alyce clover is a warm season annual legume
Excellent forage quality. Non-bloating
Potential establishment issues for alyce clover
Seeded June 26 (clover at 20 lb./ac & pearl millet at 10 lb/ac)

16. Turnip ‘Pasja’

An early maturing, bulbless turnip hybrid.
Graze
Seeded June 26 at 5 lb./ac, 1/4” deep

Thanks are due to King’s Agriseeds for supplying much of the seed for this demonstration.

King’s Agriseeds Inc.
60 N. Ronks Rd., Suite K
Ronks, PA 17572

Tracy D. Neff: King’s Agriseeds Southern Region Agronomist
717-891-2343

Crabgrass 'Red River' later maturing drilled 6/26; 7 lb/ac Graze **3**	Matt Poor's mix broadcast 5/29 Graze **2**	Crabgrass 'Quick-N-Big' earlier maturing drilled 6/4; 7 lb/ac Graze **1**
Pasja turnip + pearl millet broadcast 5/29 Graze **7**	sorghum sudan (AS6402) dwarf, BMR gene 6 drilled 6/26; 60 lb/ac Graze **6**	sorghum sudan (AS6501) BMR, photoperiod sensitive, gene 6 drilled 6/26; 60 lb/ac ensile **5**
forage sorghum (7401) dwarf, BMR gene 6 drilled 6/26; 7 lb/ac ensile **11**	annual lespedeza common striate type broadcast 5/29; 20 lb/ac Graze **10**	forage sorghum (7401) dwarf, BMR gene 6 drilled 6/26; 7 lb/ac ensile **9**
alyce clover & Pear millet Millet drilled 6/26 @ 10 lb/ac broadcast 5/29; 20 lb/ac Graze **15**	sudangrass 'HAYKING' BMR gene 12 drilled 6/26; 30 lb/ac Graze **14**	sudangrass (AS9301) non-BMR: gene 6 drilled 6/26; 30 lb/ac Graze **13**

10'

30'

S W N E

Plots covered with water during a flash flood on the evening of July 11, 2013

Flash flood on the evening of July 11, 2013

The Pasture-Based Beef Systems for Appalachia Project

Ron Lewis[*], Joe Emenheiser[*], Terry Swecker[†], Ben Tracy[‡], Amy Tanner[*], David Fiske[§], Joe Fontenot[*]

[*]*Department of Animal and Poultry Sciences, Virginia Tech, Blacksburg, VA, 24061*
[†]*Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg, VA, 24061*
[‡]*Department of Crop and Soil Environmental Sciences, Virginia Tech, Blacksburg, VA, 24061*
[§]*Shenandoah Valley Agricultural Research and Extension Center, Raphine, VA, 24472*

What we've learned

- Our rotational stocking system offered a quantity of forage that exceeded the nutrient requirements of a March-calving herd by at least 2.7-fold from April through November. With fall stockpiling of forages, the nutrient requirements of cows were met into the winter. Hay feeding typically was restricted to 103 days starting in late winter.
- With genetic selection for divergent hip heights, large- as compared to medium-frame score cows weighed 100 lb (9%) more at breeding and when their calves were weaned. Large-frame score cows produced calves weighing 26 lb (6%) more at weaning at 181 days-of-age. However, that difference in weaning weight did not offset the lower output with fewer cow-calf pairs when animal unit equivalents (AUE) per acre of land were held fairly constant.
- Offering calves access to a designated creep area with higher quality forages – in our case nil-ergot, endophyte-infected fescue (MaxQ) and alfalfa – resulted in a modest increase in calf weaning weight (16 lb or 4%). This benefit was found in both large- and medium-frame size calves.
- Calving rates to artificial insemination (AI) were higher when climatic conditions were milder. Those conditions occurred in 2009, when early June temperatures and humidity were unseasonably low, and in 2012, when AI breeding was shifted to early May. Across those 2 years, on average 67.4% of cows calved to their single AI breeding. When AI breeding instead coincided with the higher temperatures and humidity typical to late May and early June, calving rates were substantially lower (42.3%). By breeding earlier in spring, where lower temperatures and humidity are the norm, calving rates in a herd may be improved.

Background

Consumer demand is growing for foods that are produced regionally using more natural production systems. Among the animal production systems fitting that definition are pasture-based beef finishing programs. In previous research it was demonstrated that beef can be produced from extensive production systems that make use of the forage resources available in the Appalachian region of southeastern United States. Furthermore, such systems are a particularly attractive way for producers in this region to add value to their land and capital resources in a growing market sector.

Although the early results were promising, additional efforts were needed to address issues influencing greater uptake of pasture-based beef finishing systems. For instance, what are acceptable quality specifications for pasture-based beef products for food retailers? What animal genetic resources suit a year-round supply chain? What management systems can effectively match forage resources to animal genetic potential? Tackling these questions has required close collaboration with USDA-ARS, West Virginia University, and Clemson University.

Virginia Tech's focus has been on the cow-calf component of the system. Our interests have been in developing management strategies that effectively match animal and forage resources to produce weaned steers suited for pasture or conventional finishing. We have considered two sizes of Angus cow – large-and medium-frame – calved in spring and managed in a rotational stocking system. Our system utilized two creep feeding regimes (forward or designated creep) and the fall stockpiling of fescue. In this field-day report we summarize what we have learned about the efficiencies of this cow-calf system as part of a pasture-based beef program.

Project description

Rotational stocking system. The study was conducted at Virginia Tech's Shenandoah Valley Agricultural Research and Extension Center (SVAREC) in Steeles Tavern. During development of the site in 2000, the pastures were either killed or suppressed, and reseeded with Kentucky 31 tall fescue and mixed red and white clover. The pastures were frost seeded with mixed clover species in February 2007 and 2009.

The rotational stocking system was established in 2007 and consisted of 3 pasture areas, each approximately 64 acres. Within each area were four 16-acre paddocks, with each paddock consisting of either eight 2-acre (forward creep) or 1.8-acre (designated creep) plots. Starting in 2008, from April through July, the 8 plots within a paddock were rotationally stocked with cow-calf pairs. Rotation decisions were taken by the farm superintendent, with the rest periods for plots increased as forage growth slowed over summer.

In each paddock, 4 of the 8 plots were stockpiled for winter grazing. In July, the 4 paddocks to be stockpiled were grazed while the other 4 paddocks were rested. The stockpiled paddocks were then fertilized in mid-August with 60 lb actual nitrogen per acre, and then rested through the fall. Grazing of stockpiled forage began in mid to late-November and usually continued until January. If needed, hay was fed after stockpiled forage was depleted and until grazing began the subsequent spring.

Forages were sampled in each plot mid-monthly from April through November. Sample measurements included forage dry matter (DM) mass (lb DM per acre), and crude protein and fiber percentages. The number of days a plot was rested prior to sampling was also calculated. The forage mass and quality data summarized had been collected in the 2008 to 2011 grazing seasons.

The amount and duration of hay feeding was also recorded, with information available from October 2007 through September 2012. Those data were accumulated by production year, which we defined as the period between sequential weaning events.

Climatic information (daily temperature, precipitation and humidity) was available from the Natural Resource Conservation Service from a weather station located on the SVAREC site.

Cattle. Ninety Angus-cross cow-calf pairs were stocked in the rotational system with a target of 0.6 Animal Unit Equivalents (AUE) per acre, or 9,500 to 10,000 lb of cow per 16 acre. The cows were between 3 and 17 years of age, although most cows were 6-year-olds. The calves were stocked alongside their dams until weaning in September. Body weights (lb), condition scores (9-point scale) and hip heights (inch) were recorded on cows at breeding and weaning of their calves. Calf weaning weights were also collected. Cow and calf data were available from weaning in 2007 to breeding in 2013.

In 2007 to 2011, cows were synchronized and bred by artificial insemination (AI) in late May or early June, followed by clean-up bulls. The breeding season was about 60 days. In 2012, cows were instead synchronized and bred by AI in early May. The cows were then re-synchronized, with those expressing heat in early June bred a second time by AI. No clean-up bulls were used in 2012, shortening the breeding season to about 30 days. Calving began in March and typically ended in May.

Treatments. The experiment considered two main factors or treatments: cow frame size and calf creep system. Cows were classified as either large or medium-frame based primarily on their sires, which were selected for divergent Expected Progeny Differences (EPD) for yearling hip height. In Table 1, the average EPD for several production traits are provided by frame-score category for the Angus bulls used for AI in the study. In selecting bulls on their yearling hip height EPD, other traits correlated with size also differed between the categories.

Table 1. Expected Progeny Differences (EPD[1]) for large- and medium-frame score bulls used for artificial insemination

Frame size	Calving ease (%[2])	Birth wt. (lb)	Weaning wt. (lb)	Yearling wt. (lb)	Yearling hip height (inch)
Large	6.6	1.68	53.8	100.5	0.64
Medium	11.6	-0.74	40.0	72.1	-0.35
Difference (L-M)	-5.0	2.42	13.8	28.4	0.99

[1] The EPD summarized were obtained from the American Angus Association sire evaluation (http://www.angus.org/Angus.aspx) in May, 2012.
[2] Expressed as a difference in percentage of unassisted births, with a higher value indicating greater calving ease in first-calf heifers.

Paddocks were stocked with either 7 large- or 8 medium-frame cow-calf pairs to achieve equal AUE per acre. Calves were either given access to forward creep in the next fescue-clover plot to be grazed by cows, or to a designated creep area that remained fixed throughout the season. The designated creep plots had been seeded with a nil-ergot, endophyte-infected fescue (MaxQ) and alfalfa.

Results

Rotational stocking system. From April to November, forage mass was on average 2,281 lb DM per acre. The crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) percentages of those forages were 14.1%, 33.1%, and 61.5%, respectively. As the ADF value of a forage increases, its digestibility decreases. As the NDF value of forage increases, feed intakes of animals decrease.

Early in the growing season (April to June), pasture rest periods were shorter and forage accumulated. In mid-season (July and August), rest periods were shorter in the plots to be stockpiled and longer in the plots not to be stockpiled; unsurprisingly, forage primarily only accumulated in the rested plots. The opposite occurred later in the season (September to November) when the stockpiled plots were instead rested.

Crude protein contents of the forages followed expected seasonal patterns. The months of lowest quality forage (June through August) correspond with the “summer slump,” during which new growth of cool season forages slows. Stockpiling allowed the accumulation of quality forage for winter grazing. From September onward, a greater forage CP level in rested (stockpiled) as compared to stocked (non-stockpiled) plots suggested diet selectivity by cows.

The ADF and NDF contents of the forages also followed seasonal patterns. Fiber contents tended to be lowest during May, which was characterized by lush new season growth, and highest during July, during the heat of summer. Grazing pressure (stocking rate relative to forage accumulation) was greatest during

July. Higher fiber contents in forage samples reflected the limited amount of quality new growth being more completely consumed. Additionally, the ADF contents were lower for stockpiled paddocks when being rested. This further substantiates selectivity for less fibrous material in the plots not rested, as well as new growth of cool season forages late into the fall.

One way to evaluate the effectiveness of a grazing system is its capacity to meet the nutritional requirements of grazing cattle. In Table 2 we compare available nutrients to corresponding beef cattle requirements. The nutritional needs of the cattle were adequately met by this system in all months of the grazing season. The availability of daily DM was at least 2.7-fold that required. Our predictions were conservative, since they assumed no forage regrowth within a month. However, we also did not consider factors such as selectivity and grazing height, which would limit harvest efficiency.

Table 2. Mean forage nutrients available [dry matter (DM), total digestible nutrients (TDN), and crude protein (CP)] relative to diet nutrient requirements for beef cows in different months given March calving

	Nutrient requirements[1]			Nutrient availability[2]		
Month	DM (lb/cow/day)	TDN (%)	CP (%)	DM (lb/cow/day)	TDN[3] (%)	CP (%)
April	26.9	58.7	10.1	73.2	73.1	19.8
May	27.8	59.9	10.7	144.2	67.6	15.4
June	28.4	57.6	9.9	187.4	60.6	10.9
July	27.3	56.2	9.3	80.7	60.2	10.3
August	26.5	54.7	8.5	106.0	59.6	11.2
September	25.8	53.4	7.9	87.5	61.1	12.2
October	24.3	44.9	6.0	69.2	63.2	13.5
November	24.0	45.8	6.2	65.3	65.2	12.6

[1] Nutrient requirements are derived from National Research Council and assume a 1,200 lb cow calving in March with moderate (20 lb) milk production.
[2] Nutrient availabilities consider only plots stocked during the month.
[3] Total digestible nutrients (TDN) percentages were calculated from mean acid detergent fiber (ADF) values, using the equation: TDN = 4.898 + (89.796 x (1.0876 - (0.0127 x ADF))).

Hay feeding. In an average year, 27.1 lb of hay was fed daily to each cow for 103 days (3.4 months). That implies that for much of the year (8.6 months), including well into winter, our rotational stocking system with fall stockpiling produced enough forage to maintain the herd. However, the number of days hay was fed varied appreciably across the 5 production years (Figure 1). Typically, when hay was fed for more days, some hay feeding was required during the fall when the number of plots stocked was halved to allow stockpiling of fescue in the other plots.

Hay was fed to cows for the same number of days on both the designated and forward creep paddocks. However, cows stocked on the designated creep paddocks ate slightly more hay daily than those on the forward creep paddocks (on average 27.7 *versus* 26.4 lb per day, respectively).

Large-frame cows on average were fed hay for 13 fewer days than medium-frame cows. On a per head basis, the large- and medium-frame cows consumed nearly the same amount of hay daily (27.5 *versus*

26.6 lb per day, respectively). Therefore, with the 7 large-frame as compared to 8 medium-frame cows we stocked on a paddock, about 20% less hay was fed to the large-frame category.

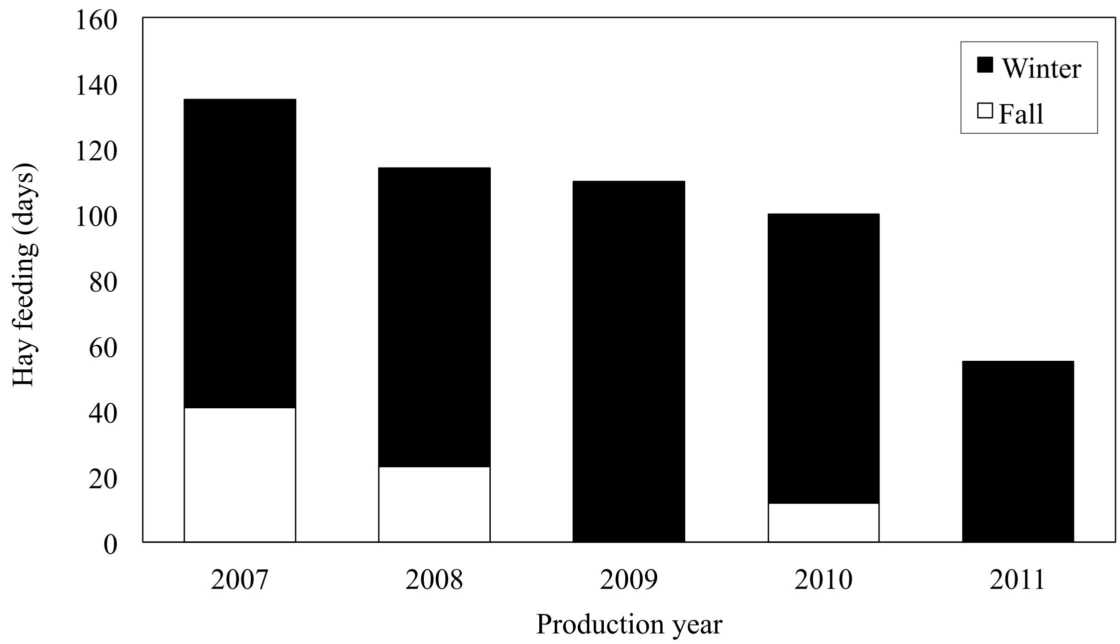

Figure 1. Number of days hay was fed in fall, prior to the availability of stockpiled forages, and in winter, after the stockpiled forages had been fully utilized. A production year was defined as the period from weaning in one year, which occurred in September, until weaning in the subsequent year.

Cow weights, condition scores and hip heights. Creep feeding system had no effect on cow weights, condition scores or hip heights. However, cow weights and hip heights reflected frame score (Table 3). Large-frame cows were on average about 100 lb heavier than medium-frame cows at both breeding and weaning of their calves. That 9% difference in weight was fairly consistent across cow ages. Weights increased until cows reached 7-year-of-age with little change thereafter. As 7-year-olds, large- and medium-frame cows at breeding weighed on average 1,469 and 1,336 lbs., respectively. There was no difference in condition score between frame-score category at breeding or weaning, although it did increase as cows aged. Condition score also varied across years reflecting annual changes in weather and forage resources.

The total weight of the cows rotational stocking a paddock – either 7 large- or 8 medium-frame cows – is also provided in Table 3. Our intent was for the AUE per acre to be the same for the two frame score categories. However, the total weight of the large-frame cattle was slightly lighter (5%) than that of the medium-frame category at both breeding and weaning of their calves. Therefore stocking rate was less for the large- as compared to medium-frame categories.

Calf weights. Calves were weaned at an average of 181 days of age. In Table 4, the influences of frame size and creep feeding regime on calf weaning weights are shown. Large-frame calves weighed about 26 lb (6%) more at weaning than medium-frame calves. Calves with access to the designated creep weighed about 16 lb (4%) more at weaning than calves with access to the forward creep. Therefore, in terms of individual calves, there was a slightly greater advantage in weaning weight resulting from genetic selection than creep feeding. Also, the comparatively young age at weaning likely lessened the difference in calf weaning weights due to frame-size and creep feeding treatments.

Table 3. Cow weights, condition scores, and hip-heights by frame size category

Event	Frame size	Avg.wt. (lb)	Avg. condition score (points)	Avg. hip height (inch)	Total wt. (lb per paddock[1])
Breeding	Large	1,350	5.6	53.4	9,595
	Medium	1,242	5.7	51.4	9,949
	Difference (L-M)	108	0.1	2.0	-354
	Ratio (L:M)	1.09	0.98	1.04	0.96
Weaning	Large	1,313	6.0	53.4	9,247
	Medium	1,214	6.0	51.4	9,727
	Difference (L-M)	99	0.0	2.0	-480
	Ratio (L:M)	1.08	1.00	1.04	0.95

[1] Either 7 large-frame or 8 medium-frame cows and calves were rotationally stocked among 8 plots on a 16-acre paddock.

Table 4. Calf weaning weights (lb) with respect to frame size category and creep feeding regime

	Creep feeding			
Frame size	Designated	Forward	Difference (D-F)	Ratio (D:F)
Large	505.8	490.1	15.7	1.03
Medium	479.9	463.1	16.8	1.04
Difference (L-M)	25.9	27.0	-	-
Ratio (L:M)	1.05	1.06	-	-

Still, an important caveat needs to be added. Seven large- versus 8 medium-frame cow-calf pairs were stocked on a paddock. As shown in Table 5, the additional medium-frame calf more than compensated for lower individual calf weights. The total weight weaned from the medium frame cows was about 286 lb (8%) more than from the large-frame cows. With the differences in frame size and weight we achieved between frame score categories, the gains from genetic selection were not sufficient to offset fewer calves to be marketed.

Our motivation for a large- and medium-frame herd was to extend the harvest window for pasture-finished steers. Medium-frame, smaller mature size steers would be anticipated to reach harvest condition (fatness) at younger ages than large-frame steers. Therefore, herds of mixed cow sizes may extend the marketing period for pasture-based beef. However, given the size of the herd and the relatively short selection horizon, the differences in frame size achieved thus far were likely too small to fully test that possibility.

Table 5. Total calf weaning weight (lb per paddock[1]) with respect to frame size category and creep feeding regime

	Creep feeding			
Frame size	Designated	Forward	Difference (D-F)	Ratio (D:F)
Large	3,540.6	3,430.7	109.9	1.03
Medium	3,839.3	3,704.8	134.5	1.04
Difference (L-M)	-298.7	-274.1	-	-
Ratio (L:M)	0.92	0.93	-	-

[1] Either 7 large-frame or 8 medium-frame cows and calves were rotationally stocked among 8 plots on a 16-acre paddock.

Cow reproductive efficiencies. Across the 6 years, the average calving rate from AI breeding was 51.7%. On average 76.3% of cows exposed calved. Neither frame size nor creep feeding system affected AI or overall calving rates. Reproductive efficiency was also similar across cow ages, although AI and overall calving rates increased up through 6-year-old cows, and then decreased as cows aged further.

Only breeding year substantially affected reproductive rates. Calving rates from AI alone, and AI and clean-up breeding in combination, are shown in Figure 2. As a reminder, in most years (2007 to 2011), cows were AI bred once in late May or early June. Clean-up bulls were then used. In 2012, cows were instead first bred by AI in early May. Following re-synchronization, those cows that expressed heat in early June were AI bred a second time.

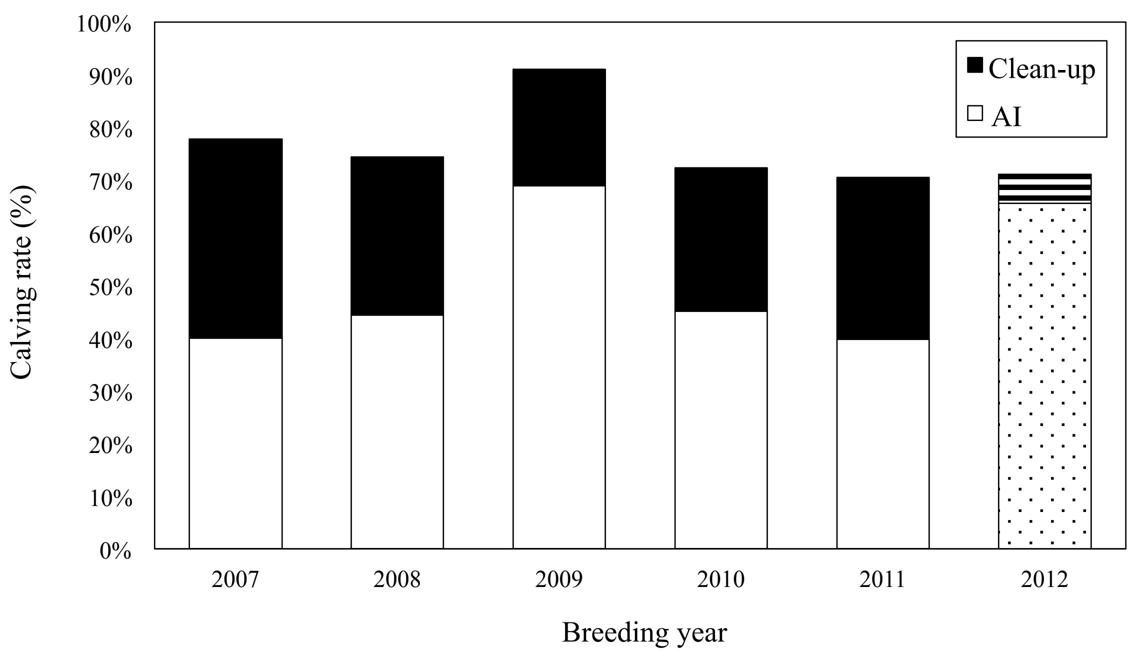

Figure 2. Calving rates associated with artificial insemination (AI) or with clean-up breeding by natural service or a second AI. In 2007 to 2011 (solid bars), cows were bred once by AI in late May or early June

followed by clean-up bulls. In 2012 (textured bars), cows were first bred by AI in early May, with those expressing heat in early June bred by AI a second time. No clean-up bulls were used in 2012.
The variation in calving rate across years can in part be explained by climatic conditions. The temperature-humidity index (THI), which combines humidity and temperature, is an indicator of heat stress. It has been shown that if THI remains high over the breeding season, particularly when coupled with high minimum daily temperatures, pregnancy rates decline.

Climatic information was examined for the first 30 days of the breeding seasons across the 6 years. From late May in 2007 and 2008, and early June in 2010 and 2011, the THI and daily temperatures were high and reproductive rates lower. On average in those 4 years, 42.3% of the cows calved from the AI, and 73.7% of the cows calved overall once the clean-up breeding was included. In 2009, conditions in early June were milder, with 69.2% of cows calving to the AI and 91.1% calving overall.

In 2012, cows were first bred by AI early in May when both THI values and daily temperatures were predictably lower. Most cows conceived and calved to that first AI (65.6%). Our calving rate was 1.7-fold higher from this AI in early spring as compared to the average of that in late spring in the previous 5 years. In 2012, following re-synchronization, 18 cows expressed heat in early June. However only 5 (28%) of those cows calved to that second AI. By June, climatic conditions had become more severe. Even if clean-up bulls had been used, calving rates likely would have been only moderately higher.

With breeding in late spring in the Appalachian region, particularly if shade is limited and cattle graze endophyte-infected fescue, climatic conditions may lead to reduced calving rates. Starting the breeding season earlier in spring, or switching to a fall breeding, may improve the reproductive efficiency of a herd.

Yet more to learn

Our evaluations of the efficacy of this pasture-based system have primarily focused on outputs, namely calf weaning weights and cow reproductive rates. We have also considered the forage nutrients provided by this rotational stocking system in terms relative to dietary requirements of spring-calving beef cows. However, these inputs and outputs still need to be combined to more holistically define overall efficiency of this system.

We stocked the rotational system with cows that were at least 3-year-olds. The development of those cows deserves attention, in particular with regards to the potential impact of differences in frame size on weight and age at sexual maturity.

The project has involved a broad team. The focus at Virginia Tech has been on the cow-calf sector. Collaborators at USDA and West Virginia University have considered the stocker and finishing phases of a pasture-based system. A collaborator at Clemson University has assessed meat quality at and following harvest. These various aspects of a pasture-based beef system need to be considered together to develop clear recommendations. Lastly, an economic analysis of these data considering the overall benefits and costs of a pasture-based program is needed.

Although we have learned a lot, we yet have more to learn. We look forward to your continued interest in this exploration of pasture-based beef systems, and their value to the rural community in Appalachia.

Acknowledgements

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For further information, please contact:

- Dr. Ron Lewis, Department of Animal and Poultry Sciences, Virginia Tech; E-mail: rmlewis@vt.edu; phone: 540-231-1906.
- Dr. Terry Swecker, College of Veterinary Medicine, Virginia Tech; E-mail: cvmwss@vt.edu; phone: 540-231-7375.

Nutrient Dynamics in Tall Fescue-based Pasture

Gordon Jones and Ben Tracy
Department of Crop & Soil Environmental Sciences, Virginia Tech

One of the purported benefits of raising livestock on pasture is efficient nutrient cycling. Compared to grain production and confined feeding, pasture-based livestock operations often have low requirements for imported feed or fertilizer, and well-managed perennial pastures should experience only small nutrient losses. While these concepts are well known, there has been little study of the actual change in soil nutrient concentrations in tall fescue-based pasture under rotational stocking management.

A cow-calf grazing experiment began at the Shenandoah Valley Agricultural Research and Extension Center in Steele's Tavern, VA in 2008. Groups of small (SM; 8 cows of frame score of 3.0 - 5.0) and large (LG; 7 cows of frame score 5.1 - 7.0)-framed cows were rotationally-stocked in two types of creep grazing system: dedicated and forward (Figure 1). There were three replications of each of the four animal size and creep grazing combinations—a total of 96 paddocks, about 0.8 hectares each. Cow-calf pairs were stocked in each grazing system at a rate of approximately 0.8 hectares acres per pair.

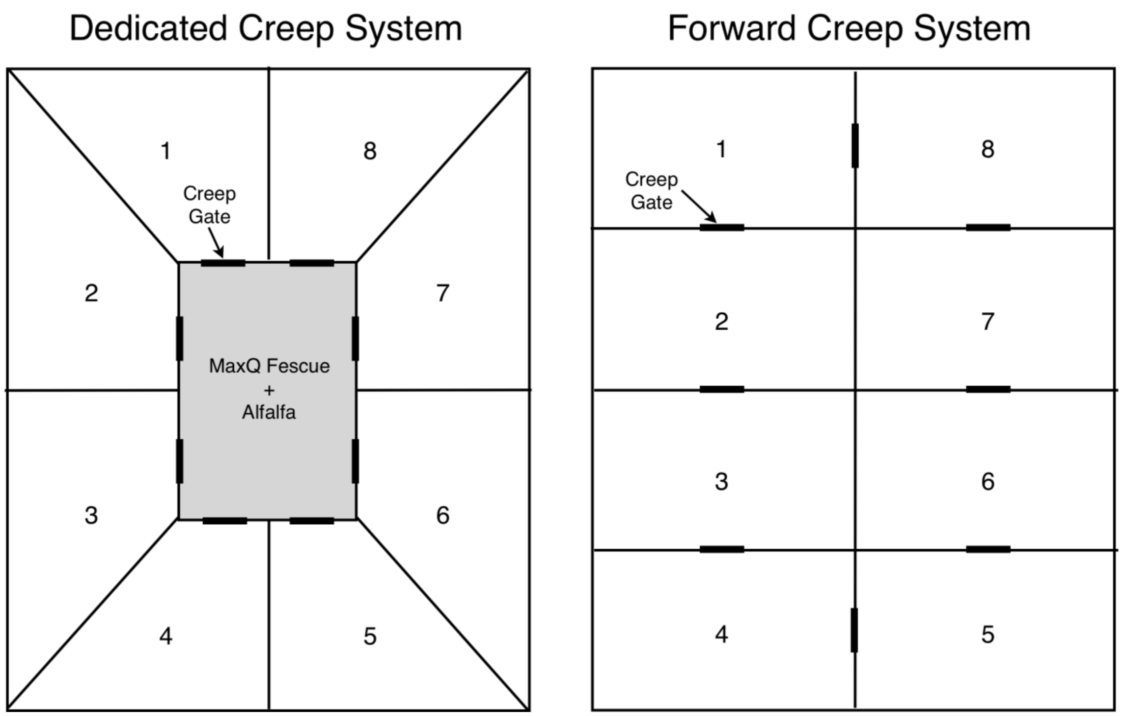


Figure 1: Schematic diagram of dedicated creep system and forward creep system Creep gates allow calves to pass through, while excluding the cows. In the dedicated creep system, calves always had access to the dedicated creep paddock, which had been planted with alfalfa and novel endophyte tall fescue (MaxQ). In the forward creep system, calves have access to the next paddock forward in the rotation (e.g. when cows are stocked in paddock #1, calves could access paddocks #1 and #2).

The pasture was primarily endophyte-infected tall fescue, with smaller amounts of bluegrass, orchardgrass, and white clover previously established on Frederick and Christian silt loams. Soil pH, phosphorus (P), and potassium (K) were corrected to soil test recommendations prior to grazing, but no fertilizer was added between 2008 and 2012. Soil from each paddock was sampled each November and analyzed for pH, Mehlich 1 extractable P, and exchangeable K at the Virginia Tech Soil Testing Lab. Forage was harvested from each paddock once per month from April through October and analyzed for its mineral composition.

Through five years of rotational stocking, soil pH declined by 0.04 – 0.06 pH units yr^{-1}, which is a very small decrease. Soil P declined by 1 – 1.6 mg kg^{-1} yr^{-1} and K concentrations did not change with time through this study. Given these trends, it could take 8 – 13 years before pH or P concentration of these soils would decline to a level negatively affecting pasture productivity. Though initial soil conditions differed slightly in some grazing systems, neither cow frame score nor type of creep grazing had an effect on changes in soil nutrient concentration through time. The soil from paddocks in which hay Was fed showed increased concentrations of P and K.

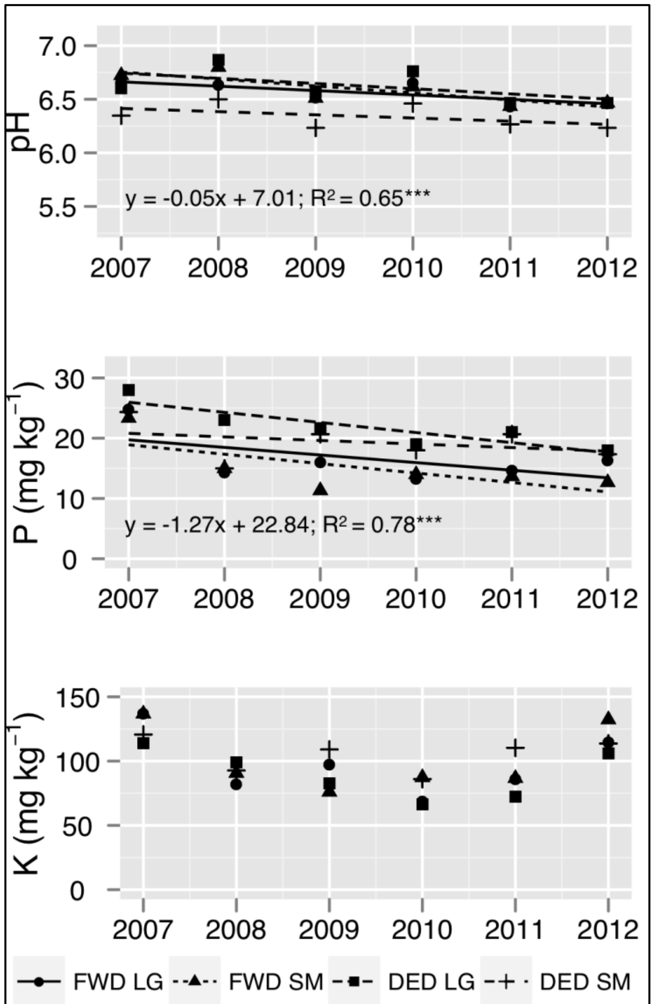


Figure 2: Soil pH, P, and K by grazing system and year. The equation of combined model of the 4 grazing systems with respect to time is listed, as is the model R^2 and significance level (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).

Forage analysis showed that pasture provided sufficient concentrations of macronutrients—nitrogen, phosphorus, potassium, calcium, magnesium and sulfur—to meet the requirements of dry beef cows throughout the growing season, but only meet the higher nutritional requirements of lactating beef cows in early spring. A comparison of nutrient concentrations of forage and soil from the same paddock indicated that soil nutrient concentrations are not necessarily a good predictor of forage nutrient concentrations. Forage nutrient concentrations vary for a variety of reasons apart from soil nutrient concentrations. Among all of the paddocks, we found soil P and K to have more variation, than did the forage tests for P and K. This may indicate that forage testing is a better indicator of pasture macronutrient status than is soil testing.

These results confirm the idea that nutrients are efficiently recycled and retained in pastures. Soil pH likely declined as a result of leaching as rainwater moved through the soil profile. The decline in P may have been related to the transportation of nutrients from general grazing areas to less productive areas, such as near waterers. These results would likely differ depending on the soil type and larger losses are expected in heavily stocked continuously grazed pasture soils. Soil testing at least every five years is recommended to ensure adequate conditions for pasture growth, and the strategic placement of hay feeding can help to replenish essential soil nutrients. The use of supplements containing phosphorus appears to be unnecessary for dry beef cows on this type of pasture, but supplementation with salt and micronutrients is still recommended.

Early Weaning for Improvements in Feed Efficiency and Carcass Traits

J.K. Smith, S.P. Greiner and M.A. McCann
Department of Animal and Poultry Sciences, Virginia Tech, Blacksburg, VA

Traditionally, early-weaning has been utilized by cattleman as a reproductive management tool. By reducing the duration of the anestrous period and maternal nutrient requirement, early calf removal, when combined with an estrous synchronization program, can be an effective means of battling a number of the environmental challenges that spring-calving producers are often faced with as the breeding season progresses into early summer. By removing a calf from its dam, the nutritional dependency of the calf then becomes the responsibility of the producer. As conventional creep-feeding and preconditioning programs rarely meet the protein and energy demands of early growth, intensive nutritional management programs are necessary to meet the requirements of the calf.

Observations within Virginia Tech's commercial beef herd have shown calves weaned at less than 120 d are capable of consuming up to three percent of their body weight daily in dry matter from a high-energy, grain-based ration following a short adaptation period. Although the majority of early work conducted in this field has focused on the additive effects of early nutritional management on calf growth and reducing the duration of time from weaning to harvest, researchers have more recently focused efforts on evaluating the effects that early-weaning may have on carcass traits. These results, however, have been inconsistent, with some researchers reporting improvements in marbling score and quality grade, and others reporting no such differences when compared to calves raised in a conventionally-weaned production setting. Research efforts at Virginia Tech have focused on identifying the ability of early-weaning and early nutritional management to metabolically imprint, or change the animal in such a way that can be utilized by producers to maximize profitability and production efficiency. In this experiment, a subgroup of calves were removed from their dams at 104 d of age and placed in a feedlot where they were quickly transitioned to a grain-based ration for an additional 100 d. Following the 100 d grain supplementation period, calves were commingled with their conventionally-weaned contemporaries and backgrounded for 153 d prior to entering a 120 d finishing phase at the Shenandoah Valley Agricultural Research and Extension Center. Results from this experiment suggested that after entering the finishing phase at a similar ultrasound predicted intramuscular fat percent (Figure 1) and body weight, carcasses from early-weaned calves were heavier, and had a greater marbling score and larger ribeye area when compared to conventionally-weaned calves (Table 1). This effect, however, appears to have been unique to calves born in the fall, as no differences were observed between weaning groups for calves born in the spring. Further research is necessary in order to determine if the differences in these effects are the result of changes associated with calving season, or the genetics of the fall- and spring-calving cowherds.

Although no improvements were observed for carcass traits of calves born in the spring, spring-born early-weaned calves were more efficient during the final finishing phase when efficiency was evaluated using residual feed intake (RFI), a measure of feed efficiency that standardizes the animals in an attempt to remove any variation provided by average daily gain and body size. Although the improvement in finishing RFI was not statistically significant for early-weaned calves that were born in the fall, the improvement was statistically significant when data from fall-born and spring-born calves were combined and analyzed as if they were the product of a single calving season. Interestingly, the improvements in marbling score do not appear to be related to finishing RFI (Table 1), indicating that these effects occur independently of one another, suggesting that they are caused by separate biological modifications. Additionally, finishing RFI appears to be positively correlated with pre-finishing growth of early-weaned calves, as differences in backgrounding average daily gain are capable of explaining almost sixty percent of the variation in finishing RFI. These effects were unique to early-weaned calves in this experiment, suggesting that finishing RFI may be more predictable for early-weaned calves when compared to that of calves that were weaned at 204 d of age.

Although results of this project suggest that early-weaning is capable of improving finishing feed efficiency while enhancing a number of the carcass traits for fall-born calves, producers are often hesitant to adopt early-weaning as a management practice due to concerns related to profitability. Early-weaning requires a greater initial out-of-pocket financial investment when compared to conventional weaning. Results of a five year economic analysis (Table 2) indicate that although early-weaning may not have enhanced profitability, net return for producers retaining ownership in fall-born early-weaned calves would not have been statistically different from conventionally-weaned calves for 2 of the past 5 years (including projected profitability for 2013). The calculated breakevens in this analysis suggest that early-weaning followed by intensive grain supplementation should not be considered to be a profitable option for producers that market calves at weaning and do not receive premiums for the potential improvements in carcass value. However, producers retaining ownership throughout finishing could consider early-weaning to be a viable management option to decrease the forage requirement of their cowherds in times of drought, or when the choice-select spread is predicted to be high and packers are expected to provide financial incentive for quality-grade based value-added retail markets, such as Certified Angus Beef.

Current efforts in this project are focused on reducing the initial investment required immediately following early-weaning through identifying the optimal duration and amount of grain supplementation during the early feeding period. Additionally, resources are being devoted toward better understanding the biological mechanisms associated with the epigenetic changes linked to early-weaning. More thoroughly understanding these mechanisms will provide researchers with the ability to evaluate their implications to current management strategies. This ability will then allow researchers to provide more insightful recommendations related to the utilization of early-weaning as an alternative management option when the opportunity arises. Up until this point, efforts have focused on the implications of early-weaning on the finishing performance and carcass traits of steers. In the event that the effects on residual feed intake are the same for and remain present throughout the productive lifetime of females, these epigenetic changes may be capable of enhancing maternal efficiency and more easily returning the initial investment to producers. However, research in this field is necessary to determine the propensity of these effects in the female.

Researchers and producers alike are continuously searching for methods of enhancing beef product quality while improving efficiency and profitability. Although early-weaning may not currently be an option that all producers should utilize, results of this project suggest that early-weaning may be an advantageous method of improving carcass quality and finishing efficiency while maintaining profitability for producers that intend to retain ownership in cattle throughout finishing during times of limited forage availability.

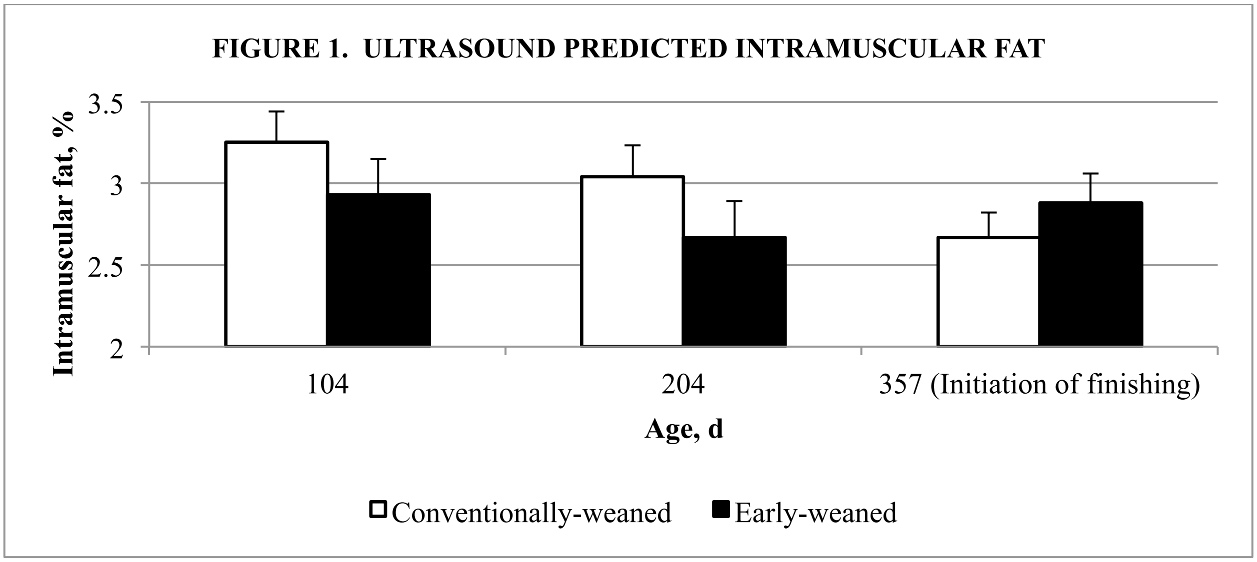


FIGURE 1. ULTRASOUND PREDICTED INTRAMUSCULAR FAT
Intramuscular fat, %
3.5
3
2.5
2
104
204
357 (Initiation of finishing)
Age, d
Conventionally-weaned
Early-weaned

Table 1. Carcass traits and finishing performance of early- vs. conventionally-weaned steers.

		Weaning regimen	
Carcass trait	Calving season	EW	CW
Harvest live weight, pounds	Fall 2009	1281^{w}	1186^{x}
	Spring 2010	1121	1165
	Combined	1201	1176
Hot carcass weight, pounds	Fall 2009	739^{w}	671^{x}
	Spring 2010	649^{z}	690^{y}
	Combined	694	680
Ribeye area, square inches	Fall 2009	13.7^{w}	12.1^{x}
	Spring 2010	11.5	11.9
	Combined	12.6	12.0
Marbling score[1]	Fall 2009	647^{w}	518^{x}
	Spring 2010	543	566
	Combined	595^{w}	542^{x}
Percentage of carcasses qualifying for CAB[2]	Fall 2009	100^{w}	50^{x}
	Spring 2010	33	40
	Combined	81.0^{y}	55.0^{z}
Dry matter intake	Fall 2009	22.8	23.8
	Spring 2010	22.7	24.1
	Combined	22.7	24.0
Feed:gain[3]	Fall 2009	4.72	4.96
	Spring 2010	4.82^{x}	5.31^{w}
	Combined	4.77^{x}	5.13^{w}
RFI[4], pounds of TDN[5] per d	Fall 2009	-1.01	0.18
	Spring 2010	-0.31	0.90
	Combined	-0.66^{x}	0.55^{w}
Improvement[6] in RFI, percentage	Fall 2009	6.25	--
	Spring 2010	6.81^{y}	--
	Combined	6.53^{w}	--

[1]Marbling score: 400-499 = small = choice -, 500-599 = modest = choice, 600-699 = moderate = choice +
[2]CAB = Certified Angus Beef, LLC retail brand
[3]Expressed as pounds of TDN to pounds of gain
[4]RFI = Residual feed intake, measured as the difference between predicted and observed feed intake
[5]TDN = Total digestible nutrients
[6]Expressed as a relative improvement when compared to RFI of CW steers
^{wx}Means within row differ significantly between weaning regimen ($P < 0.05$)
^{yz}Means within row have a tendency to differ between weaning regimen ($P < 0.10$)

Table 2. Economic incentives[1] for retaining ownership of early- vs. conventionally-weaned steers

Year	Calving season	EW feed cost[2,3]		Finishing feed cost[2]		Carcass Premium[4,5]		Carcass Value[6]		Calculated breakeven[7]		Net Return[5,8]	
		EW	CW	EW	CW	EW	CW	EW	CW	EW	CW	EW	CW
2013	Fall	320.78	--	331.75	333.05	51.14^{w}	(12.66)^{x}	1535.19^{w}	1335.70^{x}	1126.88^{w}	891.11^{x}	408.31	444.59
	Spring	176.43	--	335.93^{x}	444.47^{w}	(9.59)	(1.16)	1251.65^{z}	1338.57^{y}	948.89	958.04	302.76^{x}	380.53^{w}
	Combined	248.61	--	333.84^{x}	388.76^{w}	20.78^{w}	(6.91)^{x}	1389.97^{y}	1337.13^{z}	1037.89^{w}	924.57^{x}	355.53^{x}	412.56^{w}
2012	Fall	371.86	--	323.08	334.34	47.74^{w}	(14.91)^{x}	1519.97^{w}	1322.71^{x}	1148.04^{w}	867.40^{x}	371.93^{z}	455.31^{y}
	Spring	176.58	--	266.25^{x}	366.73^{w}	(12.93)	(0.20)	1224.22^{z}	1313.94^{y}	858.11	855.30	366.11^{x}	458.64^{w}
	Combined	274.22	--	294.66^{x}	350.54^{w}	17.40	(7.55)	1372.09^{y}	1318.32^{z}	1003.07^{w}	861.35^{x}	369.02^{x}	456.7^{w}
2011	Fall	319.05	--	278.51	288.23	39.35^{w}	(0.09)^{x}	1296.70^{w}	1142.28^{x}	1029.41^{w}	796.29^{x}	267.28^{x}	346.00^{w}
	Spring	182.25	--	297.44^{x}	409.69^{w}	6.70	18.94	1134.89^{x}	1217.34^{w}	873.72	873.26	261.17^{x}	344.08^{w}
	Combined	250.65	--	287.98^{x}	348.96^{w}	23.03	9.42	1215.79	1179.81	951.57^{w}	834.77^{x}	264.23^{x}	345.04^{w}
2010	Fall	283.50	--	243.91	252.41	40.62^{w}	2.82^{x}	1051.91^{w}	921.64^{x}	938.01^{w}	735.47^{x}	113.90^{x}	186.16^{w}
	Spring	122.56	--	178.04^{x}	245.24^{w}	1.57	10.84	952.30^{x}	1020.74^{w}	673.38	683.81	278.92^{z}	336.93^{y}
	Combined	203.03	--	210.98^{x}	248.83^{w}	21.10	6.83	1002.11	971.19	805.70^{w}	709.64^{x}	196.41^{x}	261.55^{w}
2009	Fall	229.71	--	188.13	194.69	41.21^{w}	(5.58)^{x}	1043.92^{w}	905.44^{x}	807.19^{w}	652.75^{x}	236.73	252.69
	Spring	132.04	--	191.80^{x}	264.18^{w}	3.85	10.69	842.77^{x}	901.82^{w}	675.37	677.75	167.40^{x}	224.07^{w}
	Combined	180.88	--	189.97^{x}	229.44^{w}	22.53^{w}	2.55^{x}	943.35^{y}	903.63^{z}	741.28^{w}	665.25^{x}	202.07^{x}	238.38^{w}

[1]Expressed in dollars per head or dollars per carcass
[2]Estimated based on historical data provided by Allison Miller at Augusta Cooperative Farm Bureau, Inc., Staunton, VA
[3]Reported as an overall average for early-weaned calves, as individual feed intake data was not collected during the early-weaned feeding period
[4]Calculated/predicted based on historical 5-area weekly weighted average direct slaughter cattle premiums and discounts data reported by the USDA Agricultural Marketing Service. Carcass premium = Carcass cwt x ((quality grade premium/cwt) + (CAB premium/cwt) + (yield grade premium/cwt) + (hot carcass weight premium/cwt))
[5]Values reported without parentheses indicate a premium, while values reported inside parentheses indicate a discount
[6]Carcass value = (carcass cwt x (base carcass value/cwt)) + carcass premium
[7]Calculated breakeven = (estimated cow cost/head) + (early feed cost/head) + (finishing feed cost/head)
[8]Net return = carcass value – calculated breakeven
^{wx}Means differ significantly within row and across weaning regimen ($P < 0.05$)
^{yz}Means have a tendency toward differing within row and across weaning regimen ($P < 0.10$)

Fecal Phosphorus Characteristics of Forage-Fed Beef Steers Supplemented with Feed or Mineral Phosphorus

D.D. Harmon, E.A. Riley, M.A. McCann, Animal and Poultry Sciences

Introduction

Phosphorus (P) is an important mineral for both plants and animals. In beef cattle, P is used in the body for bone and teeth formation, energy metabolism, and is an important component of genetic material. Many types of forage are below the P requirement of a lactating cow and cattlemen address this by including P in a free choice mineral. Phosphorus is not only the most expensive mineral to supplement, but it is also a major environmental concern in the Chesapeake Bay and its watershed. Historically, high phosphorus diets fed to confined livestock and poultry has received the most attention and scrutiny. Excess dietary P is excreted mainly in the feces.

In Virginia, the number of beef cattle far exceed that of dairy cattle and the contribution of grazing beef cattle has received little if any attention. Total fecal P (TP) has been found to increase with increasing levels of dietary P. Fecal P can be divided into inorganic P (P_i) and organic P (P_o), with P_i being more of an environmental concern due to its water solubility and runoff potential. The quantity of P provided in feed and mineral supplements to beef cattle consuming fresh forage or hay should impact the amount and form of P excreted. Supplementing P only when needed has the potential to reduce P imported into the Chesapeake Bay watershed.

Project Objectives

1. Determine the effect of an inorganic source of phosphorus supplementation or corn gluten feed on fecal phosphorus parameters in forage fed beef cattle steers, quantifying the relationship between phosphorus intake and phosphorus excretion.
2. Development of a field tool to assist extension professionals and producers in assessing the phosphorus status of both pastureland and grazing beef animals.

Experiment 1 Eight Hereford steers with an initial average body weight of 670 lbs, were randomly assigned one of four dietary P treatments. Dietary P levels were achieved by adding increasing levels of dicalcium phosphate (0 g, 33 g, 65 g, and 95 g) to a basal diet of 11lbs/d, chopped grass hay. The dicalcium phosphate was fed separately from the hay and mixed with 1.75 lb/d beet pulp, 0.50 lb/d rumen-protected fat supplement, and 20 g/d of a P-free trace mineral salt. Dietary P intake was calculated to equal 50, 100, 150, and 200% of the daily dietary requirement of growing beef steers. The steers were housed individually and fitted with total fecal collection bags that were emptied and changed twice daily. During this study, there were a total of 4 periods with each steer receiving a different dietary P treatment every period. Steers were adjusted to each diet for 9-d followed by a 5-d collection period. Feed and fecal samples were dried, ground, subsampled and analyzed for inorganic and total P.

Daily Dietary Offering						
Diet	**Dicalcium Phosphate (g)**	**Fat (lb)**	**Beet Pulp (lb)**	**Salt (g)**	**Low P Grass Hay (lb)**	**P (g)**
Diet 0	0	0.5	1.75	20.00	11	6
Diet 1	33	0.5	1.75	20.00	11	12
Diet 2	65	0.5	1.75	20.00	11	18
Diet 3	95	0.5	1.75	20.00	11	24

Experiment 2 Eight Hereford steers, with an average body weight of 941 lbs, were randomly assigned to one of four dietary treatments. Steers were fed a basal diet of chopped grass hay (0.13% P) and 0, 1.1, 2.2 or 3.3 lb/d of dried corn gluten feed pellets. All steers were supplemented with 2.0 lb/d beet pulp, 1.0 lb/d rumen-inert fat supplement and 18 g/d trace mineral salt. Urea was added to the respective diets at levels of 95, 72, 49, and 31 g/d to ensure equal dietary protein across treatments. Steers were housed individually and fitted with total fecal collection bags. Steers were adjusted to each diet for 9-d followed by a 5-d collection period. Feed and fecal samples were dried, ground, subsampled and analyzed for inorganic and total P.

Daily Dietary Offering							
Diet	**Corn Gluten Feed (lb)**	**Urea (g)**	**Fat (lb)**	**Beet Pulp (lb)**	**Salt (g)**	**Low P Grass Hay (lb)**	**P (g)**
Diet 0	0.0	95	1.0	2.0	18	15.7	10
Diet 1	1.1	72	1.0	2.0	18	15.7	14
Diet 2	2.2	49	1.0	2.0	18	15.7	18
Diet 3	3.3	31	1.0	2.0	18	15.7	22

Results

Experiment 1

As dietary P concentration increased both fecal total P and inorganic P increased linearly (Figure 1), indicating that P excretion is a function of P intake in forage fed beef steers supplemented with an inorganic source of P. Manure P solubility was not significantly affected by increasing levels of dietary P (Figure 2). Fecal TP levels explained 67% of the variation in P intake of steers fed varying levels of inorganic P supplementation and therefore is a good indicator of P status (Figure 3). Performance measures of weight gain, average daily gain, and gain to feed ration were not impacted by increasing levels of dietary P.

Figure 1: Total P and Inorganic P Excretion by Diet

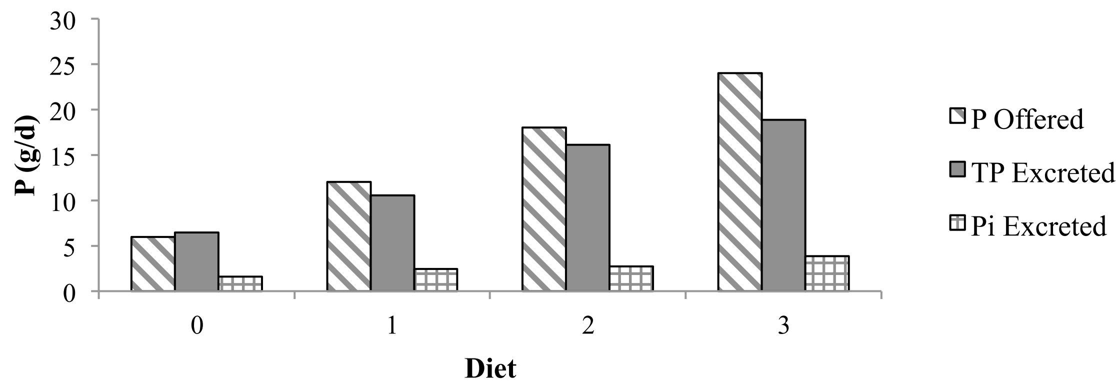


Figure 2: Inorganic and Organic Fractions of Fecal P

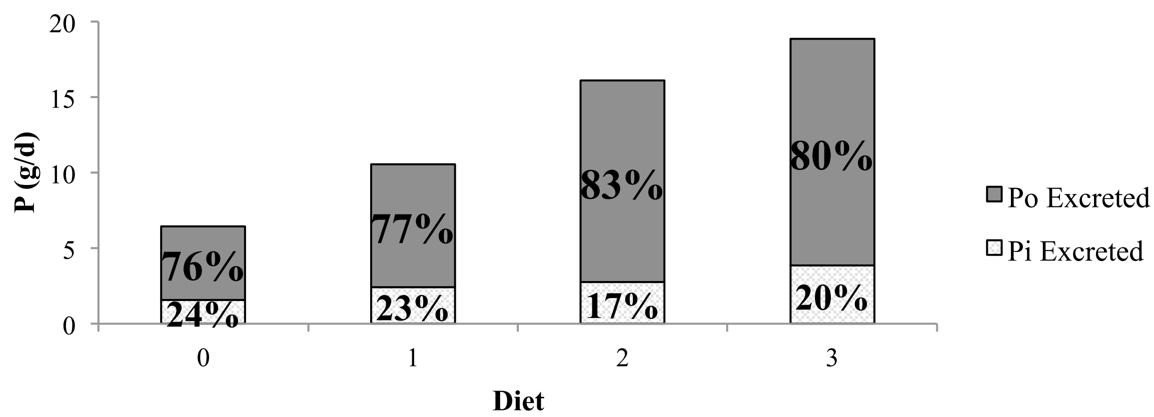
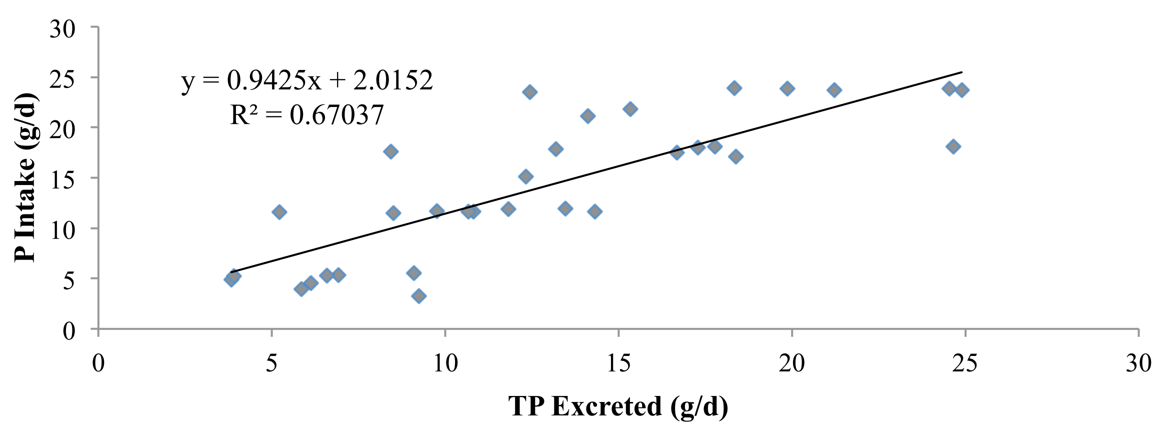


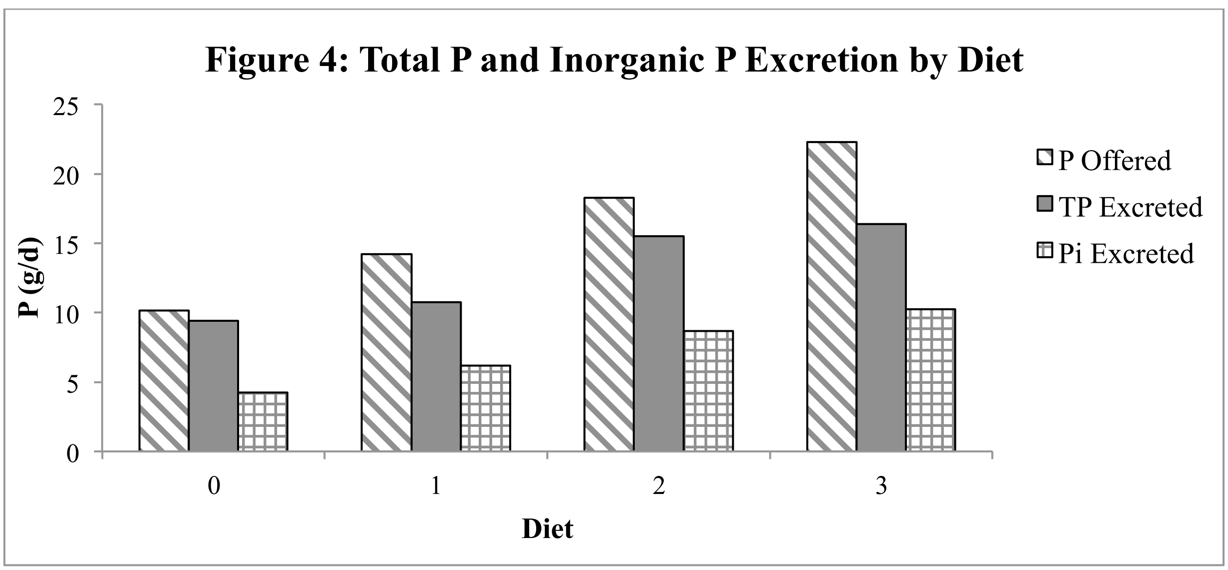
Figure 3: P Intake by TP Excreted



Experiment 2 Fecal total P and fecal inorganic P increased linearly with increasing levels of corn gluten feed supplementation suggesting P excretion is a function of P intake (Figure 4). Fecal total P excretion was highly correlated with fecal inorganic P excretion. Fecal P_i levels expressed as a percent of TP increased linearly as corn gluten feed supplementation increased (Figure 5), with organic P levels exhibiting a corresponding decrease. Fecal inorganic P levels were more closely related to dietary P levels than fecal total P levels (Figure 6), indicating that fecal inorganic P has the potential as a field diagnostic tool to predict dietary P. Plasma inorganic P levels increased linearly with increasing levels of corn gluten feed supplementation, confirming increasing levels of P in the diet.

Implications

The incidence of overfeeding P can be reduced if supplemental P is offered only when needed. Forage sampling allows a comparison between an estimate of cattle diet P content and the P requirement for a given stage of production. Cattle in well-managed and fertilized pastureland or those receiving high concentrate diets, likely need no extra P supplementation. Prevention of overfeeding of P on beef cattle operations is a strategic managerial practice that can reduce fecal P levels and potentially lower P levels in the Chesapeake Bay watershed.



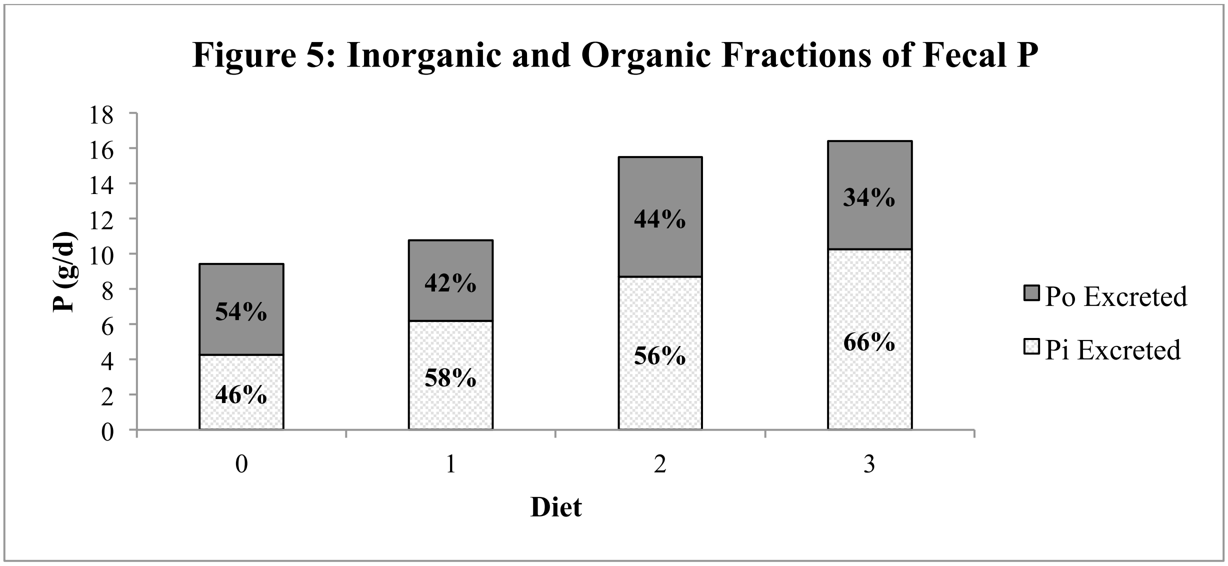


Figure 5: Inorganic and Organic Fractions of Fecal P
P (g/d)
18
16
14
12
10
8
6
4
2
0
54%
46%
42%
58%
44%
56%
34%
66%
0
1
2
3
Diet
Po Excreted
Pi Excreted

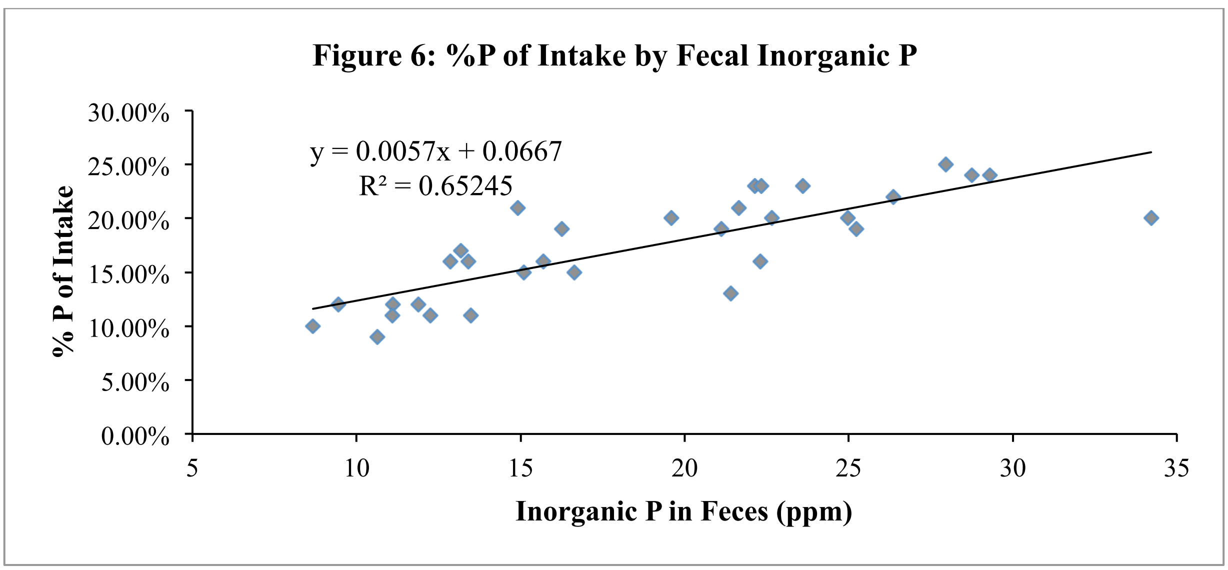


Figure 6: %P of Intake by Fecal Inorganic P
% P of Intake
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
y = 0.0057x + 0.0667
R² = 0.65245
5
10
15
20
25
30
35
Inorganic P in Feces (ppm)

Phosphorus Supplementation of Beef Cattle

Mark A. McCann, Scott J. Neil and Deidre D. Harmon, Animal and Poultry Sciences

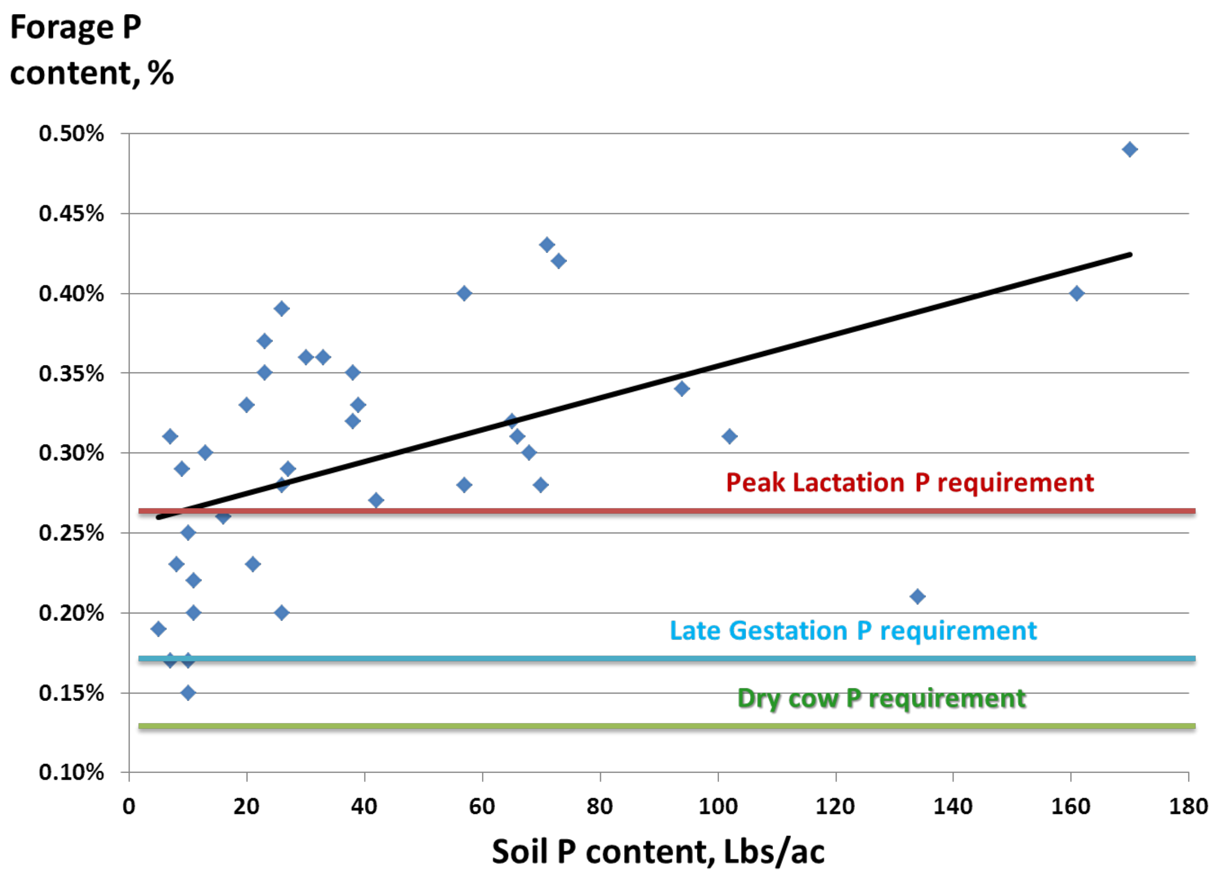
Phosphorus in Virginia continues to be an important topic among crop, poultry and livestock production systems. The draft TMDL proposal for the Chesapeake Bay provides aggressive reduction targets for nitrogen, phosphorus and sediment. Virginia beef cow/calf production systems have an opportunity to limit phosphorus inputs and thus increase economic benefits while minimizing environmental impacts. In the past, phosphorus has often been over-supplemented due to its once cheap cost and at the advice of many nutritionists and veterinarians. However, more emphasis should be placed on meeting, not exceeding mineral requirements to be both economically and environmentally responsible.

In an effort to more accurately and efficiently supplement phosphorus (P), the Virginia Agricultural Council, Virginia NRCS (Conservation Innovation Grant) and Virginia Cooperative Extension cooperated on a project which collected information and samples from beef cattle farms in the Chesapeake Bay watershed counties. Samples collected from participating farms included soil, forage and fecal samples, a questionnaire regarding fertilization and supplementation practices and a tag from their free-choice mineral. Forage samples were submitted to Cumberland Valley Labs for nutrient and mineral analysis. Soil samples were analyzed by Virginia Cooperative Extension Soil Testing Laboratory and Fecal P was analyzed in the Dairy Science Ruminant Nutrition Lab. Two counties with the most samples (80) from the Shenandoah Valley are summarized in these proceedings.

Results

The figure below displays farm data from the two counties plotting forage P content by the soil P level. Although related, there is considerable variation in forage P content. Soil P and forage P were moderately correlated ($r=.42$, $P<.01$). In general, as soil P increased, there was tendency for forage P to increase. The variation in the relationship is probably due to differences in moisture, stage of forage growth and plant species.

Figure 1



Perhaps more telling are the lines drawn across the graph relating the P requirement for various classes of beef cattle. All the fresh forage samples in the study were adequate in P content to meet a dry cow's requirements, while 98 % met late gestation P requirement and 87 % met P requirement during peak lactation. While feedlot cattle and fast growing bulls have the highest P requirement, these classes are fed high concentrate rations which are high in P. Stocker cattle generally have a more moderate growth rate and their nutrition program utilizes either grazed or stored forages.

Cattlemen who participated in the study also submitted tags of the free-choice mineral they were feeding. Farm mineral supplements were categorized into four levels of P content (0, 1.0-2.5, 3.0-5.0, and > 6.0 %). Mineral supplement P content was unrelated to forage or hay P content. In fact, the average forage P content from the farms for the 0, 1-2.5, 3-5 and 6-8 % mineral categories was 0.27, 0.37, 0.37 and 0.46 %, respectively. As P content of the mineral supplement increased the total phosphorus concentration of the feces also increased (Figure 2). Also, as the Total P of the feces increased, a greater percentage of the P was in the inorganic form. This is characteristic of P excretion on diets which exceed the animal's requirement. The inorganic form of P is water soluble and provides a greater runoff risk.

Figure 2

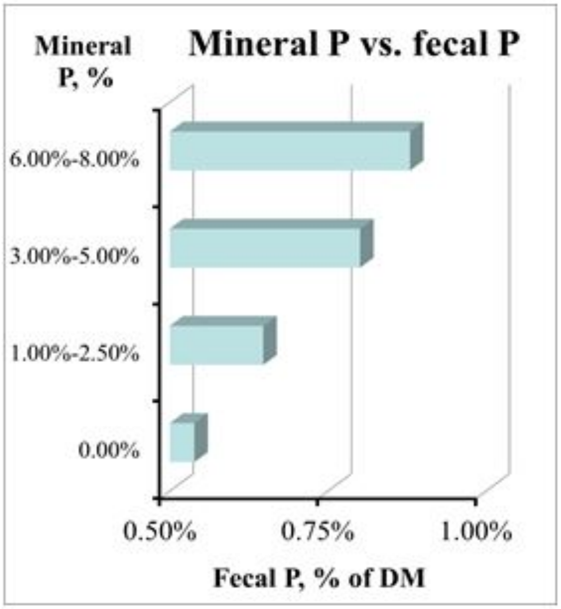
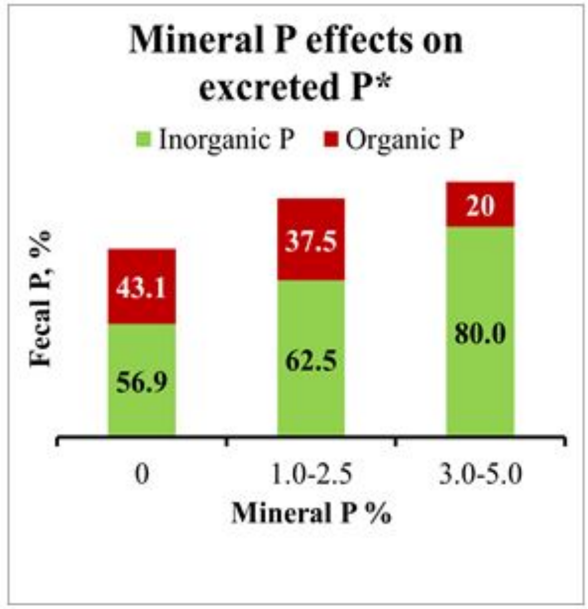


Figure 3



Conclusion

Results from the field trial indicate on the majority of farms forage P was adequate for stockers and lactating cows. Removing P from the mineral supplement would reduce P excretion and also save money. Results also indicate that sampling grazed forage and /or hay is the best way to accurately gauge the phosphorus status of their herds. Sixty five% of the cattlemen participating in the study were receptive to modifying their P supplementation based on forage test results while only 6% were opposed to any modification.

Bottom line phosphorus supplementation is important; however there is no advantage to providing more than requirements. Actually it costs more and is an environmental concern.

Estimating Yield Using Pasture Height

Ozzie Abaye, Virginia Tech and Ed Rayburn, West Virginia University

Pasture assessment involves the processes of estimating the botanical composition, quality, productive ground cover, and available forage (lb/acre). Timely and frequent pasture measurement/assessment is crucial due to the seasonal and yearly changes in pasture productivity as a result of animal and environmental factors. On farm, the most practical way of assessing pastures is based on visual estimation. Effective, efficient sampling methods that allow managers to rapidly determine pasture biomass without significant labor costs are greatly needed. Sampling methods have been researched in depth yet labor costs still are significant in adapting most of the techniques. Further, precise and efficient methods for sampling pastures are still needed.

Accurate sampling methods are very important to managers who must maintain high quality pastures to maintain high animal performance. Correct descriptions of botanical composition as well as productive ground cover of grasslands or pastures are essential to interpretation of species survival, competitiveness, adaptability, and diversity. Not only is a description of initial conditions needed, but often it is desirable to make frequent assessments of botanical components to describe seasonal effects as well as effects of climate, competition among planted sward components, and encroachment of weed species.

Estimating pasture production will help make grazing management decisions. By knowing the amount of forage and expected growth, one can manage proactively, rather than reacting to crises. The goal is to effectively estimate forage availability and balance forage supply with animal requirements. Estimates of forage production are useful for allocating paddock area or projecting carrying capacity. Effective and timely pasture evaluation help answer the following questions:

- Paddock size and number
- When to move or not to move livestock to the next paddock.
- The amount of forage available in the next paddock to support the group of animals and meet production goals.

- Am I leaving enough residue to support regrowth and/or for winter survival.
- Is the re-growth rate adequate so that livestock can return to previously grazed paddocks as planned?

With the numerous techniques available today, one must carefully consider all options when selecting the most efficient and accurate assessment methods. The most common non-distractive pasture evaluation techniques for estimating yield, botanical composition, and ground cover are: visual assessments, and canopy and plant height measurements. Dr. Ed Rayburn, *WVU* Extension Forage Agronomist, measured the average heights of the pasture using a ruler (Fig 1) and stated that is the simplest and rapid way of assessing forage yield.

Fig. 1. To use a ruler to measure pasture height, place the end of the ruler on the ground while holding the ruler vertical to the ground. Estimate the average height of the top of the pasture's canopy, the upper leaves of the pasture. (Ed Rayburn, WVU Extension For age Agronomist John Lozier, WVU Research Assistant III, 2003)

Unless for calibration or research purposes, clipping samples to assess biomass yield requires considerable time and labor and additionally not practical for everyday farm use. On the other hand, ruler height measurement can be easily used to assess forage biomass yield (Table 1).

Table 1. General calibrations for pasture forage density and forage mass at different mean pasture heights as measured with a ruler (Adapted from Ed Rayburn, WVU Extension Forage Agronomist)

Ruler height	Thin (aftermath meadow)	Average (mix grass clover)	Thick (tall fescue)
	------ ------------------ (DM lb/acre)	------------------	
3.0	822	1037	1530
4.0	1064	1338	1987
5.0	1291	1617	2417
6.0	1502	1874	2821
7.0	1697	2109	3198
8.0	1876	2321	3549
9.0	2039	2511	3873
10.0	2187	2679	4170
11.0	2319	2824	4441
12.0	2435	2948	4686
13.0	2536	3049	4904
14.0	2620	3128	5096
15.0	2689	3185	5260
16.0	2742	3219	5399
17.0	2780	3231	5511
18.0	2801	3221	5596

Thanks for attending

and have a safe trip home

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