

# Materials and Methods

## ➤ Experimental site

- ❑ NCDCA Mountain Research Station, Waynesville
- ❑ 35.50° N latitude & 83.00° W longitude
- ❑ Altitude: 884 meters - Rainfall: 1,239 millimeters



## ➤ Experimental design for both experiments

- ❑ Randomized complete block replicated three times in a 13.3 a (Study 1) and 20.8 a (Study 2) abandoned orchards with 15 to 60% slopes

North Carolina, located on the eastern coast of the USA, with its 100 counties: North Carolina State University is located in Wake county (red). The NCDCA Mountain Research Station is located in Haywood county in Western North Carolina (brown) North Carolina is divided into 4 main regions from west to east: the Mountains, the Piedmont, the Coastal Plains, Tidewater, and a small region of deep sand called the Sandhills



View of a mountain pasture invaded by woody perennial shrubs and trees

## Materials and Methods

### Study 1

Four grazing seasons (1991-1994)

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- Control
  - Area fenced to keep animals out
- Goats alone
  - 12.2 mature does/acre
- Goats + cattle
  - 7 mature does + 0.8 to 1.2 growing steers/acre (496 lb initial BW)

Vegetation management experiment conducted at the Mountain Research Station in Waynesville. Expt 1: 1991-1994



## Materials and Methods

### Study 1

Four grazing seasons (1991-1994)

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➤ **Grazing management**

☐ **Mob grazing**

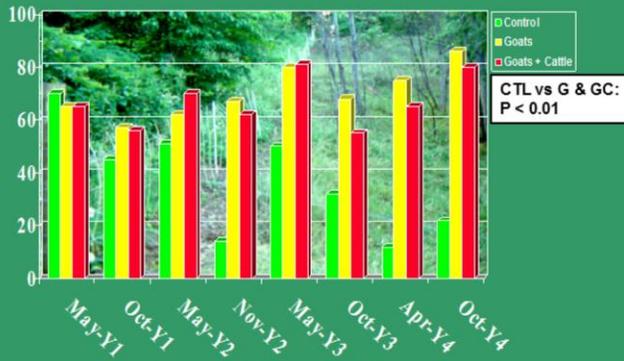
✓ 45 to 60 days in May-July

✓ 24 to 35 days in Sep-Oct

➤ **depending on forage  
availability**

Vegetation management experiment conducted at the Mountain Research Station in Waynesville. Expt 1: 1991-1994

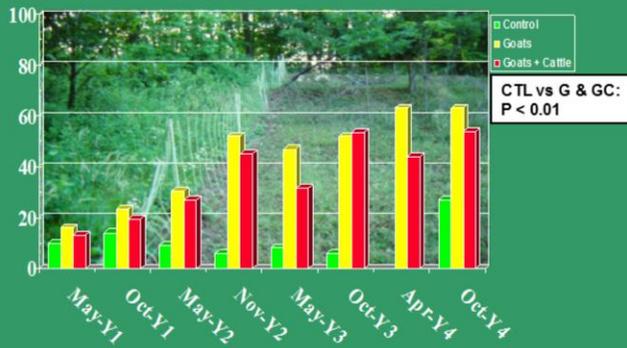
## Vegetative ground cover (%) through 4 grazing seasons Study 1



Percent vegetative ground cover declined in the control pasture from 70% in May-Y1 to 22% in October-Y4 because overstory of brush, trees and *R. multiflora* shaded out herbaceous vegetation on the ground. During that same period, vegetative ground cover increased linearly from 65% in May-Y1 to 86% in October-Y4 in the goat pastures, and from 65 to 80% in the goats + cattle pastures, with no difference between the grazed treatments. In addition, vegetative ground cover decreased from spring to fall in the goats and goats + cattle pastures due to defoliation and shading by overstory vegetation leafing out in the control plots

Background picture: control pasture (left) and pasture grazed by goats + cattle (right). All graphs have the same format: measurement of the variable of interest on the Y-axis and dates when measurements were taken on the X-axis.

## Cover from herbaceous forage species (%) through 4 grazing seasons Study 1



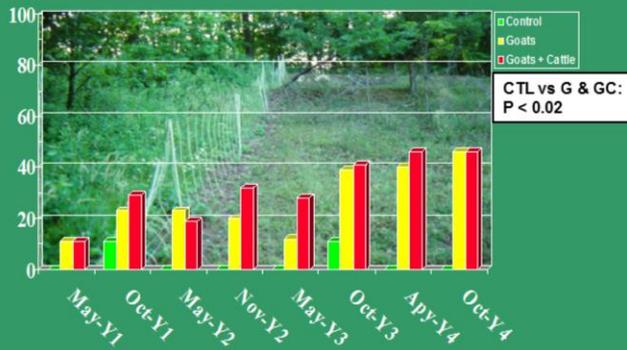
The cover from herbaceous grass species increased linearly from 16 to 63% in the goat pastures and from 13 to 54% in the goats + cattle pastures with no difference between the grazed treatments. Conversely, the cover from herbaceous forage species remained low and ranged from 10 to 27% in the control plot. *F. arundinacea*, *P. pratensis* and *T. repens* accounted for the preponderant portion of herbaceous forage species in the grazed pastures.

Background picture: control pasture (left) and pasture grazed by goats + cattle (right).

## Tall fescue frequency (%) through 4 grazing seasons

### Study 1

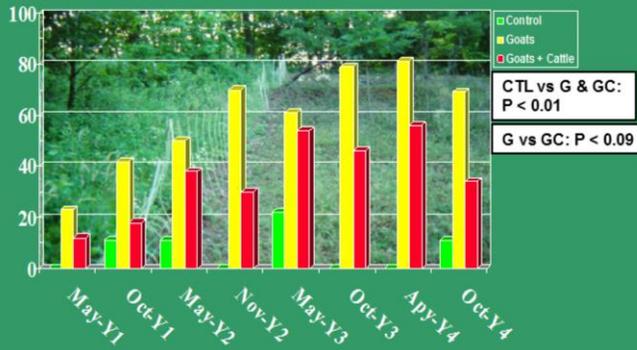
Important grass species



Tall fescue frequency increased linearly from 11% in May-Y1 to 48% in October-Y4 in both the goat and the goats + cattle pastures and remained a minor herbaceous component in the control plots.

## Bluegrass frequency (%) through 4 grazing seasons Study 1

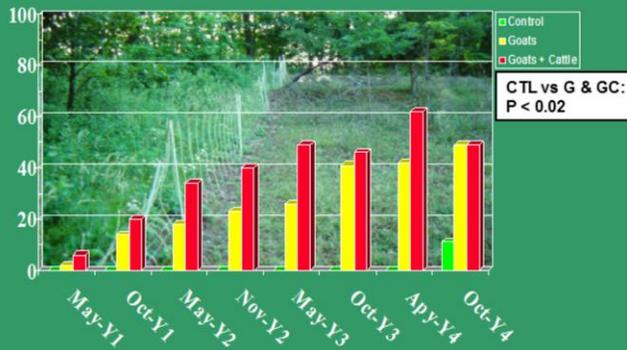
Important grass species



Bluegrass exhibited linear increases in frequency from 23% in May-Y1 to 71% in October-Y4 in the goat pastures, and from 12 to 34% in the goats + cattle pastures. Frequency patterns were similar between the grazed pastures with a tendency for a higher frequency in the goat pastures. Bluegrass remained a minor herbaceous component in the control pastures

## White clover frequency (%) through 4 grazing seasons Study 1

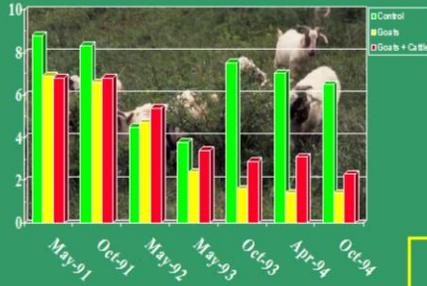
Important legume species



White clover increased linearly over the years in the goat and the goats + cattle pastures, with no difference between the grazed pastures (Avg: 4% for May-Y1 and 53% for Oct-Y4). White clover remained a minor herbaceous component in the control pastures.

Background picture: control plot (left) and plot grazed by cattle + goats (right).

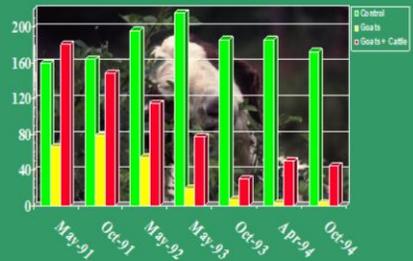
### Multiflora rose height (feet) through 4 grazing seasons Study 1

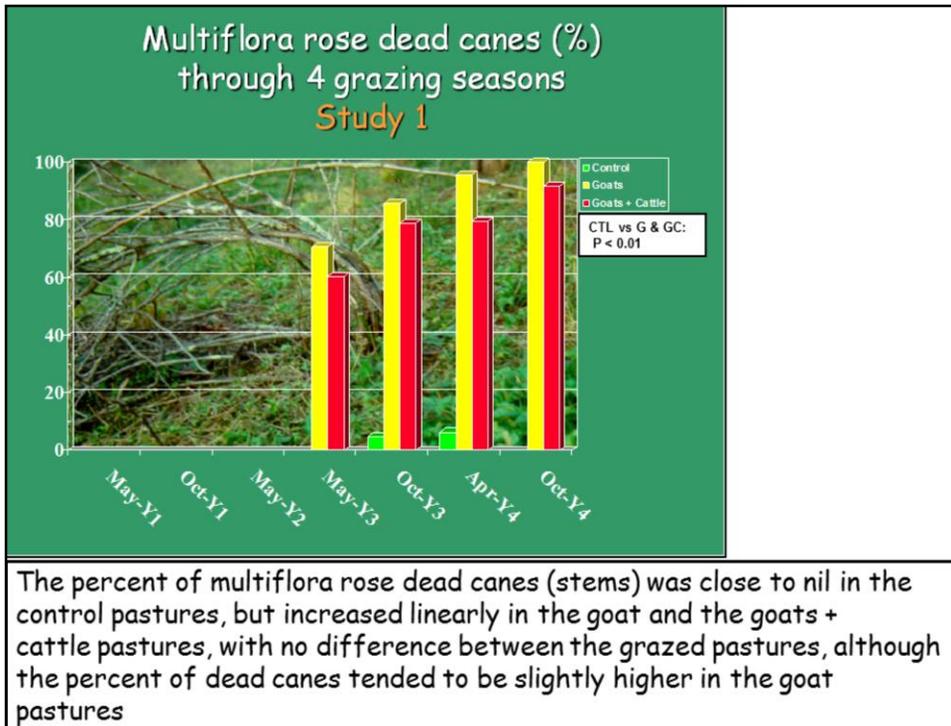


Multiflora rose height and canopy area stayed high in the control pastures, but decreased linearly in the animal pastures with no difference between the goats and the goat + cattle pastures, although there was a tendency of a greater decrease in the goat pastures due to the greater stocking density.

Height of Multiflora rose was reduced from 2.1 m to .4 m in the goat pastures and from 2.1 m to .7 m in the goats + cattle pastures. By the end of the study, canopy area measured .3 and 4 m<sup>2</sup> in the goat and goat + cattle pastures, resp.

### Multiflora rose canopy area (ft<sup>2</sup>/bush) through 4 grazing seasons Study 1

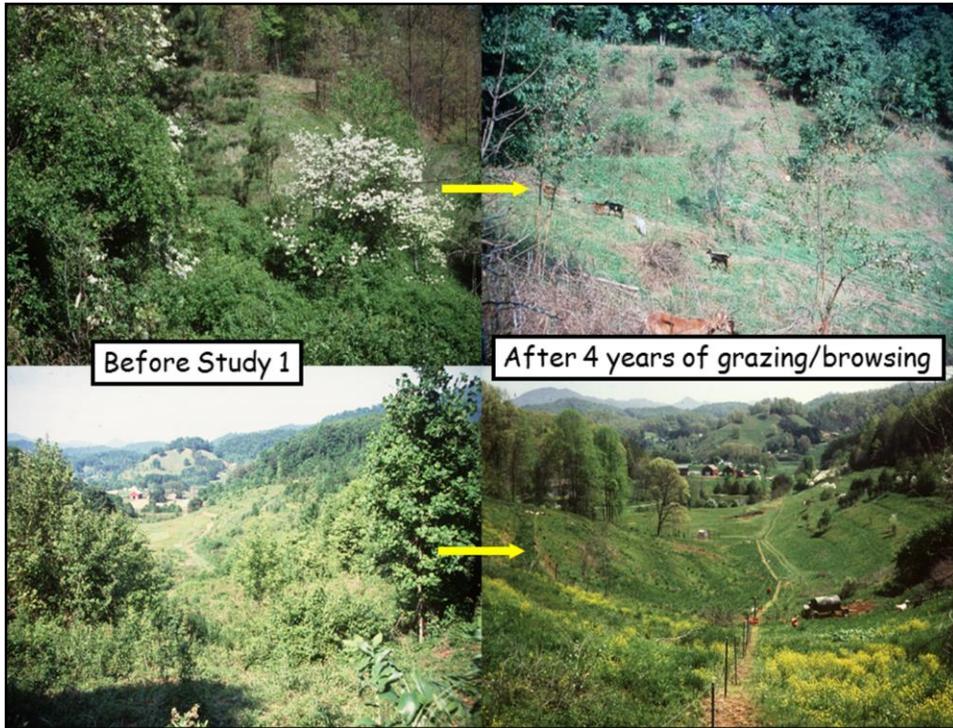




Background picture: multiflora rose bush with 100% dead canes (stems)



Goats browse height using bipedal stance



Pictures of the experimental site before Study 1 on the left, after 4 years of grazing/browsing on the right. Dead trees were cut and removed from the site.

# Materials and Methods

## Study 2

Four grazing seasons (1996-1999)

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### ➤ Control

- ▣ Area fenced to keep animals out

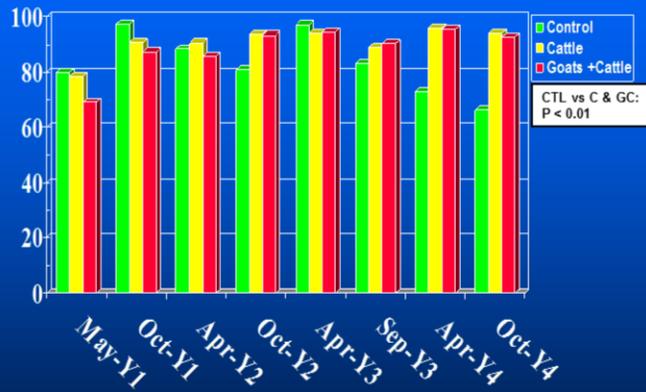
### ➤ Goats + cattle

- ▣ 1.4 goats (79 lb) and 0.7 steer/a (510 lb initial BW)

### ➤ Cattle alone

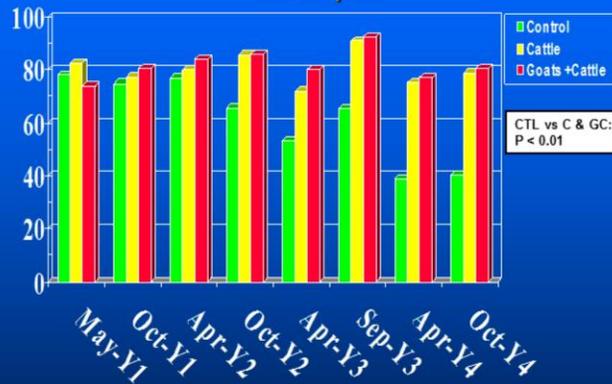
- ▣ 0.7 steer/a (510 lb initial BW)

## Vegetative ground cover (%) through 4 grazing seasons Study 2



Over the 4 grazing seasons, vegetative ground cover was similar (avg: 89.6%) in both the cattle and the goats + cattle pastures. Vegetative ground cover followed the same trend, during the first 2 grazing seasons, but decreased thereafter from 97.1% in April-Y3 to 66.3% in October-Y4.

## Cover from herbaceous forage species (%) through 4 grazing seasons Study 2

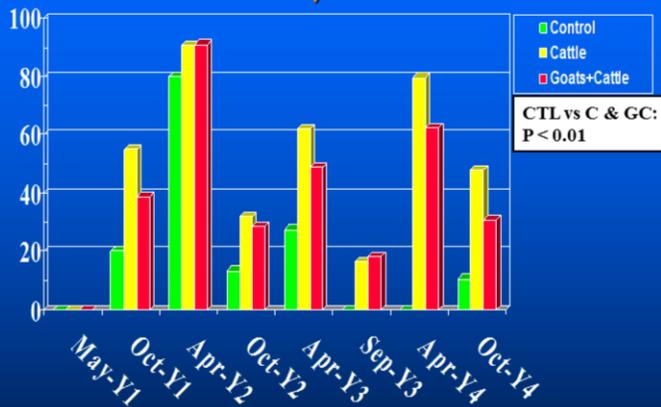


The cover from herbaceous forage species remained the same in both the cattle and the goats + cattle pastures (avg: 81%). Conversely, cover from herbaceous forage species decreased linearly in the control pastures, from 78% in May-Y1 to 39% in October-Y4, the shift being attributed to the overstory of brush and rose bushes that shaded out herbaceous vegetation on the ground. As in Study 1, *F. arundinacea*, *P. pratensis* and *T. repens* accounted for the preponderant portion of herbaceous forage species in the grazed pastures.

# Bluegrass frequency (%) through 4 grazing seasons

## Study 2

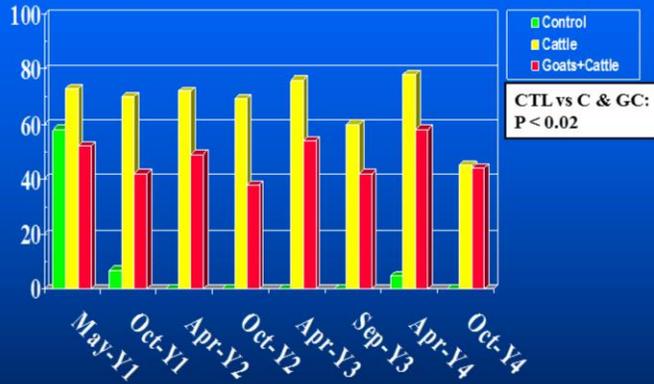
Important grass species



Bluegrass frequency declined in the control compared to the cattle and the goats + cattle pastures, and was absent from the control in Sep-Y3 and Apr-Y4. Grazed pastures had a similar frequency of Bluegrass (avg:50.1%) with the goats + cattle pastures tending to have a lower frequency. Bluegrass was strongly seasonal, being observed at a higher frequency in spring than fall.

# White clover frequency (%) through 4 grazing seasons Study 2

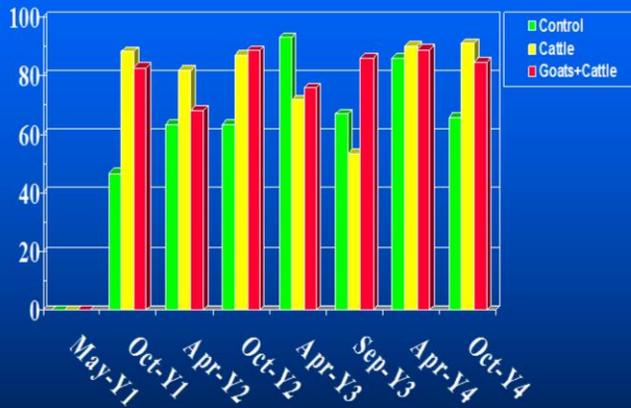
Important legume  
species



In the cattle and the goats + cattle pastures, white clover frequency was similar (avg: 55%) and exhibited no seasonality. White clover played a minor role in the control pastures where it was observed only in spring and fall in Y1 and fall in Y4)

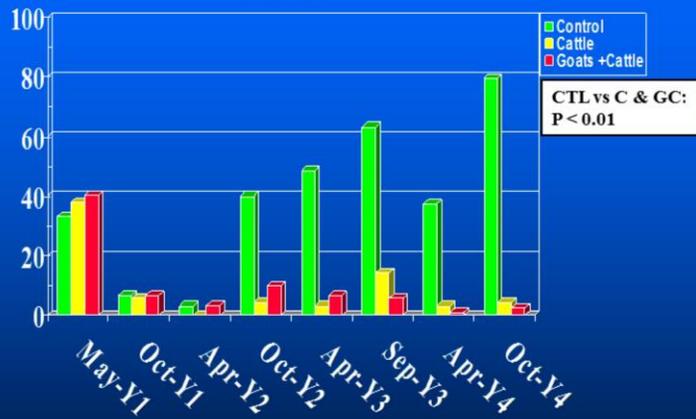
# Tall fescue frequency (%) through 4 grazing seasons Study 2

Important grass  
species



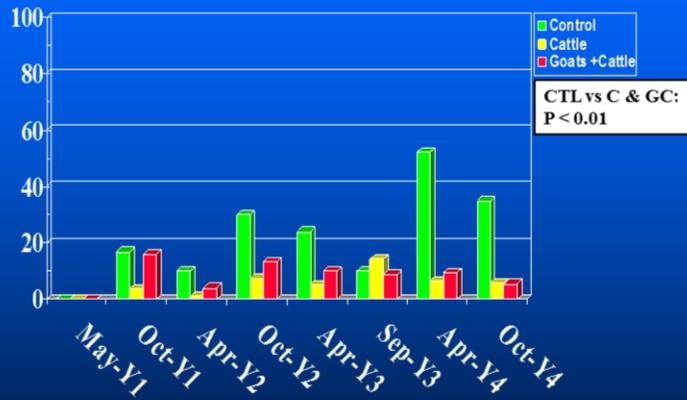
Tall fescue was high in all pastures and did not change during the course of the study. In the control pastures, lack of sunlight at the ground level due to the natural successional reforestation process did not seem to affect tall fescue as much as was the case for bluegrass and white clover.

## Brambles frequency (%) through 4 grazing seasons Study 2



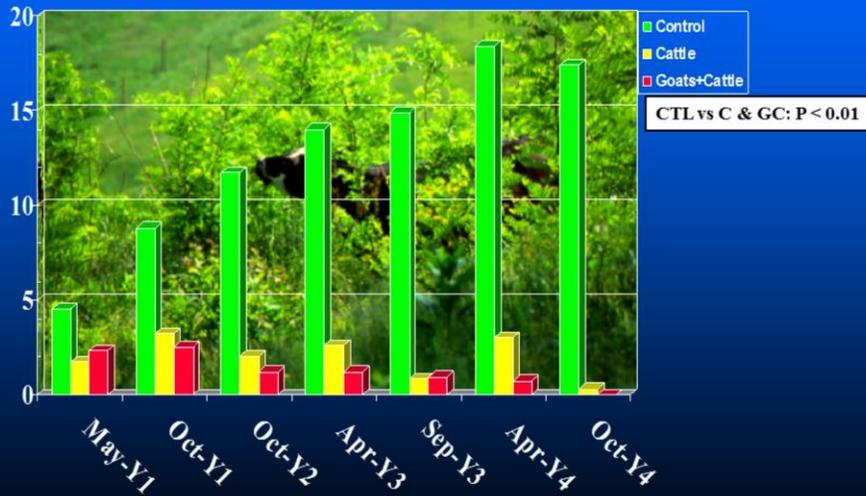
Goats grazing with cattle and cattle grazing alone were very effective in controlling brambles and grazed it to a similar extent. Conversely, brambles frequency increased from 6.7% in October-Y1 to 79.6% in October-Y4 in the control pastures

## Honeysuckle frequency (%) through 4 grazing seasons Study 2



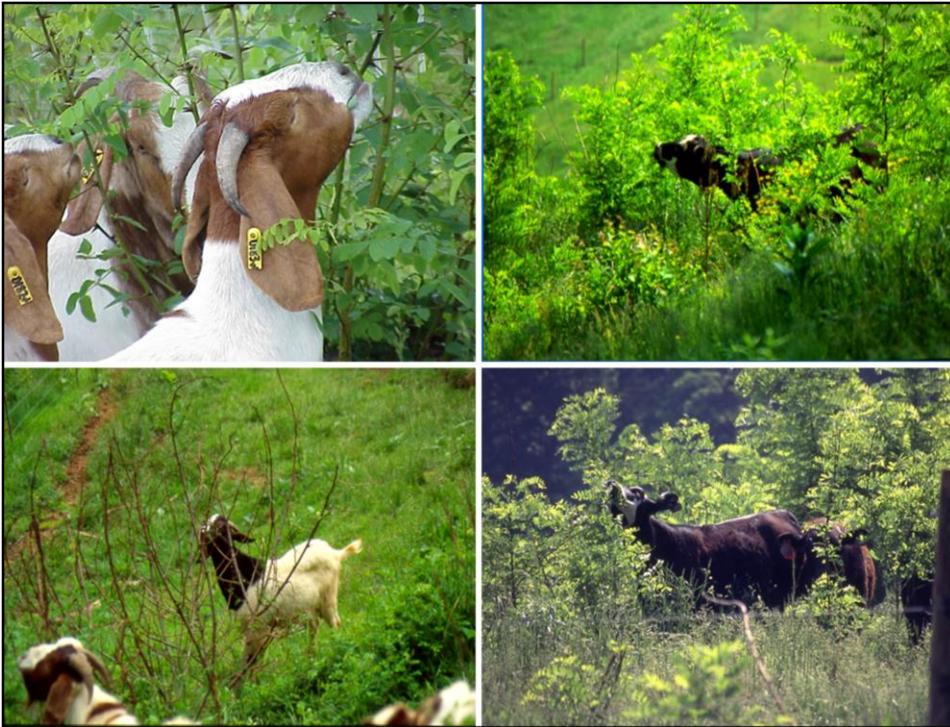
Honeysuckle, a climbing vine, increased in frequency in the control pastures because it tolerates shade well and was well controlled in both the cattle and the goats + cattle pastures.

## Black locust height (feet) through 4 grazing seasons Study 2

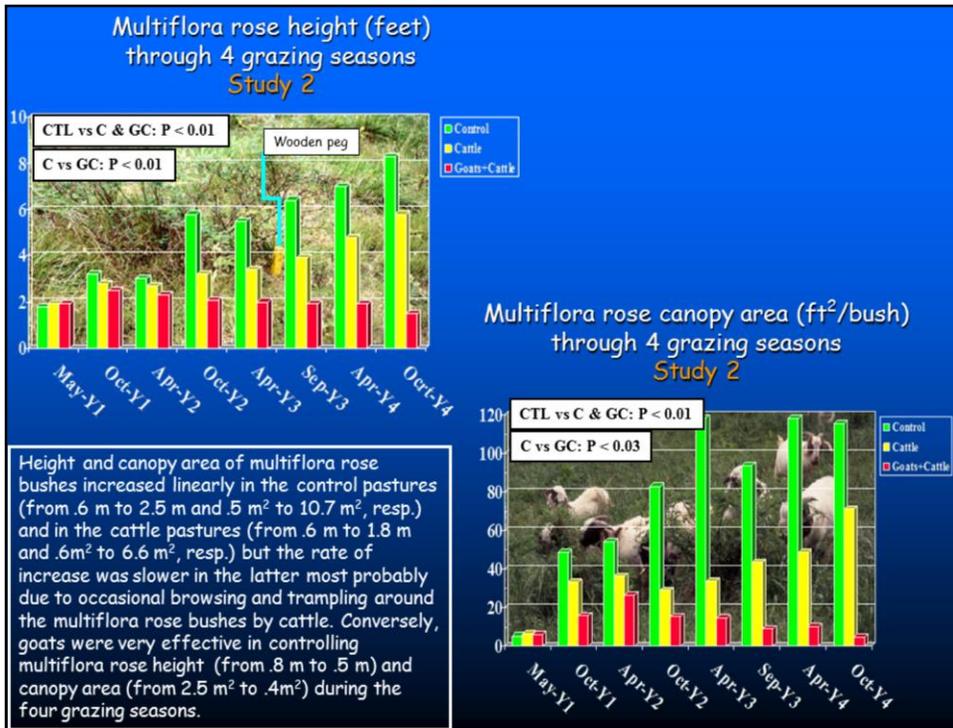


Vegetation management experiment conducted at the Mountain Research Station in Waynesville

Black locusts (*Robinia pseudoacacia*) trees were practically eliminated over the 4-year period in both C and G+C plots

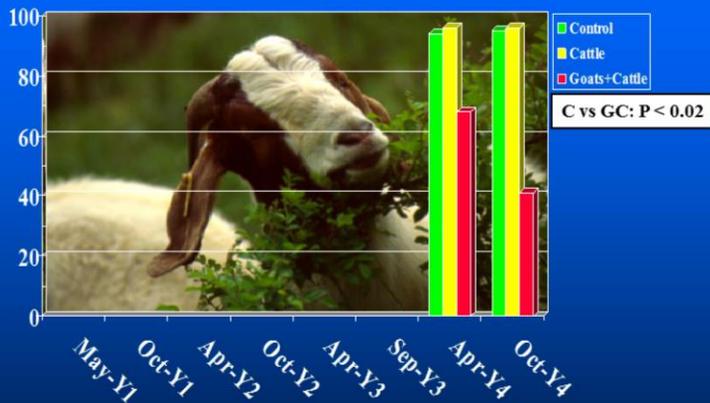


Beef cattle and goats defoliating *R. pseudoacacia*



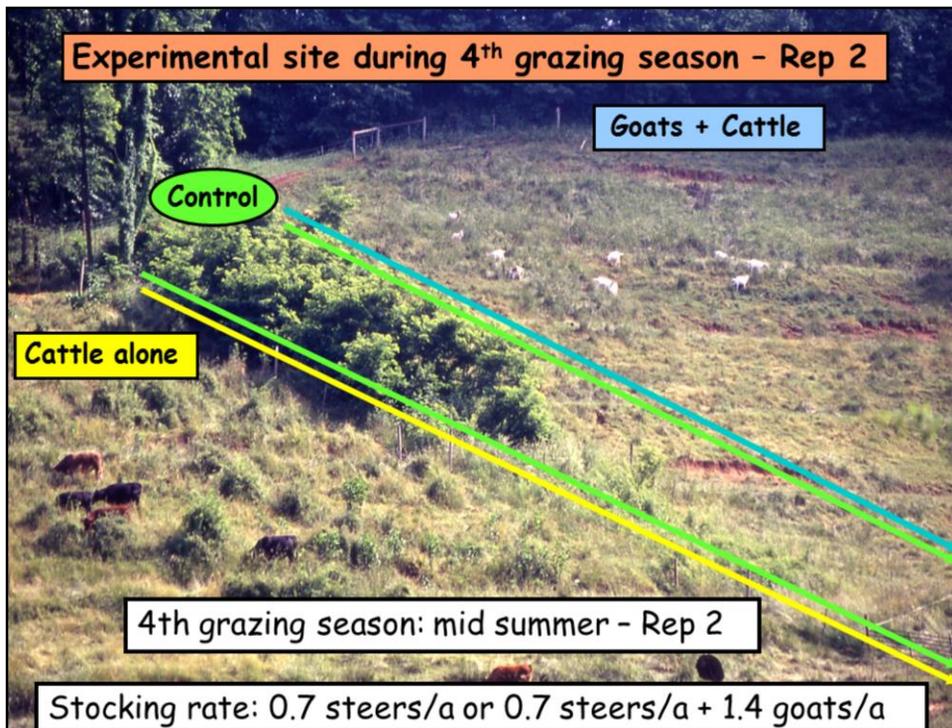
Background picture: Multiflora rose in a goats + cattle plot and goats browsing multiflora rose

*R. multiflora* live canes (%)  
through 4 grazing seasons  
Study 2



After 4 grazing seasons, only 41% of multiflora rose canes (stems) were still alive in the goats + cattle pastures, compared to 95.5% in the control and cattle pastures. Therefore, the reduction in height, canopy area and number of live canes in the goats + cattle pastures indicated that their condition was severely affected.

Background picture: goat browsing multiflora rose



Vegetation management experiment conducted at the Mountain Research Station in Waynesville.

Pictures were taken during the fourth grazing season. Plots depicted are:

left: grazed by cattle only (7 head of beef cattle)

center: control (not grazed for 6 years)

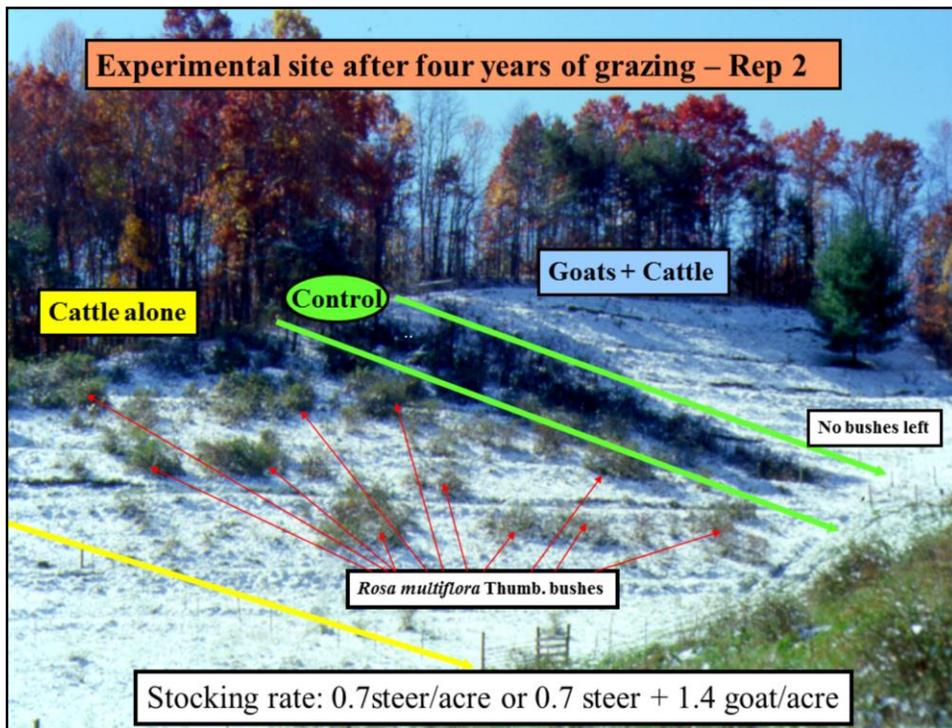
right: grazed by cattle (7 head) and meat goats (14 head).

Parts of the control were impenetrable by the fourth grazing season.

Note the difference between the cattle only (left hand side) and the cattle + goat (right hand side)

plots: shrubs, mainly multiflora rose (*Rosa multiflora*) bushes, can easily be seen on the cattle

only plot. Shrubs have disappeared on the cattle + goat plots due to repeated defoliation by goats.



2nd vegetation management experiment conducted at the Mountain Research Station in Waynesville in late October 1999 (1st snowstorm of the season).

- Cattle alone (7 head) and cattle + goats (7 cattle + 14 goats) were rotated throughout the grazing season on 3 replications consisting of 3 plots each (control - no grazing-, cattle alone and cattle + goats). Experiment lasted 4 years (4 grazing seasons)..

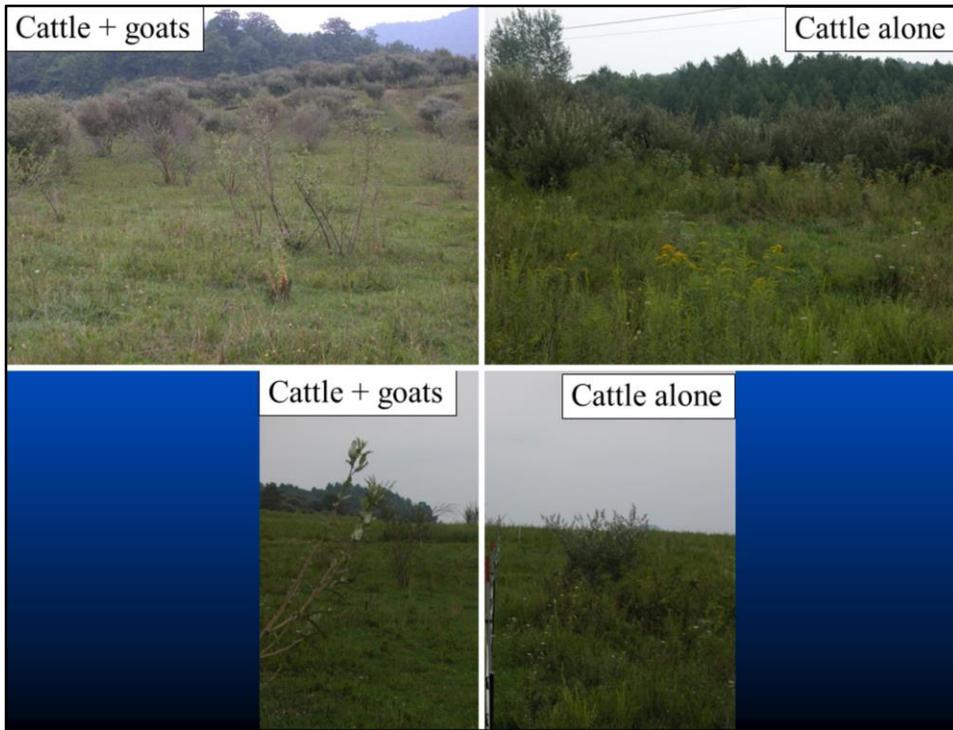
- Picture represents one replication at the end of the 4th grazing season. Note multiflora rose bushes in cattle alone plot, and their absence in cattle + goat plot. We could not take measurements in parts of the control plots because browse was

too thick.

# Southwest Virginia reclaimed mine land

- Cattle Only Pastures
  - 3 Steers
- Mixed Grazing Pastures
  - 3 Steers + 15 goats
- Control



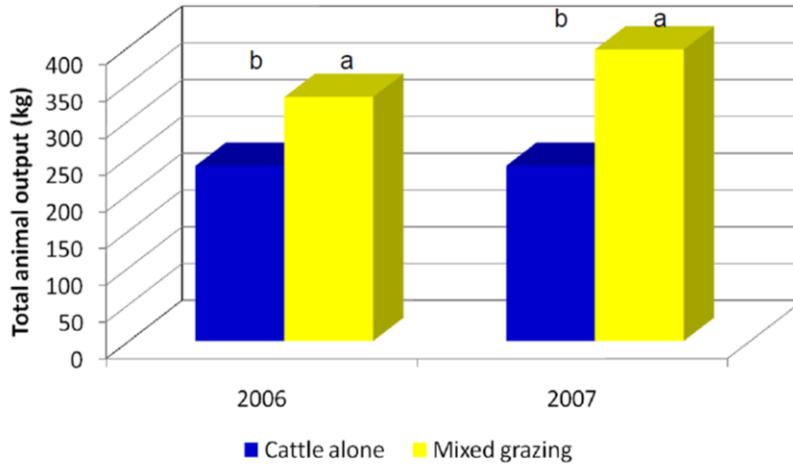


Study conducted over 2 years on reclaimed mine land in southwest Virginia



Goats consumed autumn olive and completely debarked the tree branches, thus killing the trees

## Total animal output





## Multispecies grazing

Recommendation: possible to add 1 to 2 head of mature goat per head of beef cattle without reducing beef cattle production, but changing botanical composition of pasture (control of browse and broadleaf weeds by goats) and increasing productivity per acre (goats for sale)

# Graze multiple species



- Sheep and goats share the same internal parasites, but they are different from the parasites that affect cattle and horses.
  - Except maybe the barber pole worm in young calves.
- Producers who graze multiple species of livestock report fewer parasite problems.
- Cattle and horses “vacuum” sheep/goat pastures of infective worm larvae.
- There are other benefits to mixed species grazing, such as complimentary grazing habits.

# Poisonous Plants

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Degree of poisoning or resiliency depends on:

- **How much eaten**
- **Which plant part**
  - Fresh or wilted
- **When? spring, summer fall, winter**
- **Stage of maturity of plant**
- **Animal class**
  - Young growing or adult animal

Complex problem



**Black Cherry, wild cherry**

*Wilted leaves, twigs, seeds*

Prussic acid poisoning

**HIGHLY TOXIC, MAY BE FATAL  
IF EATEN**

**CAUTION**  
Leaves and small branches  
can be blown into the field  
where your animals are  
grazing during a storm



## Black Cherry (*Prunus serotina*)



- Symptoms: staggering or convulsions within 15 to 30 minutes; death within 1 hour
- Control: cut down and remove tree, treat stump to prevent resprouts



Same family as black cherry



Johnsongrass, sorghums

Prussic acid poisoning

Do not allow animals to graze until at least 15" tall  
Avoid grazing during or shortly after a drought, when plants are wilted, or for at least 2 to 4 days after a killing frost



**Azalea, Rhododendron**

**Andromedotoxin**

***All parts***

***HIGHLY TOXIC, MAY BE FATAL IF EATEN***





**Mountain Laurel**

*All parts*

Andromedotoxin, arbutin

**HIGHLY TOXIC, MAY BE FATAL  
IF EATEN**





**Jimsonweed, thorn apple,  
stinkweed, datura**

*All parts, mainly seeds  
and leaves*

Tropane alkaloids

**TOXIC ONLY IF LARGE  
QUANTITIES EATEN**



## Poison hemlock



Dangerous but rarely eaten  
Parts of plant: leaves and unripe fruits

Poisonous Principle: alkaloids, also contains coniine and coniceine which are teratogenic

Animals Poisoned: horses, cattle, swine, poultry, goats, sheep





We have nightshade in some of our pastures. Goats simply avoided these plants. Problem may arise if animals are starved: in that case they may eat everything in sight.

Grazing pigweed during  
normal or wet weather

No problem



Grazing pigweed following drought

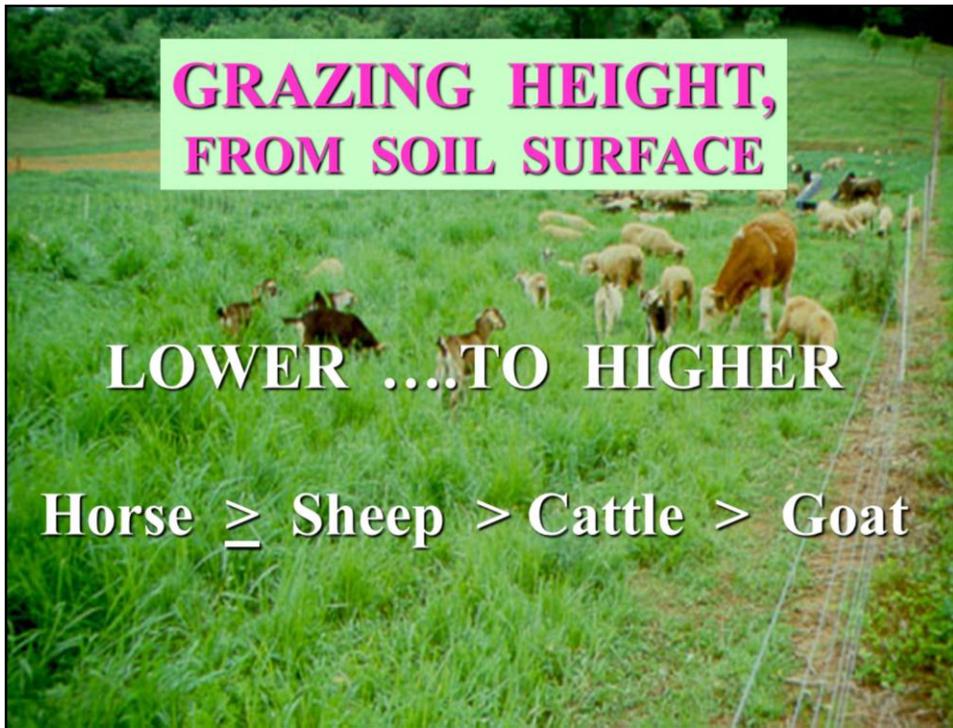
Toxic levels of nitrate may sometimes  
occur

## Goat Grazing Preferences

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- Graze along fence lines before grazing center of pasture
- Prefer foraging on rough and steep land over flat, smooth land
- Graze the top of the pasture canopy fairly uniformly before grazing close to soil level (**top-down grazers**)
- Goats do not like to graze close to the ground
- Do best when moved frequently to a fresh cut, fresh paddock or sub-paddock using control grazing and strip grazing principles

Although natural browsers, goats are opportunistic feeders, they like to consume a large variety of feeds, and also do well in a grazing situation if the manager adapts grazing management to meet goat grazing/browsing behavior



Usually, horse pastures are very short because of mismanagement. Horses do well in taller pastures when control-grazed to avoid overgrazing.

# FEED COSTS

cents per kg dry matter

## ■ PASTURES

– Permanent.....	7.7 – 11.0
– Annual.....	10.0 – 13.0

## ■ STORED FORAGES

– Hay.....	13.0 - 22.0
– Silage.....	12.0 - 19.0

## ■ BYPRODUCTS and/or

<u>CONCENTRATES</u> .....	20.0 – 55.0
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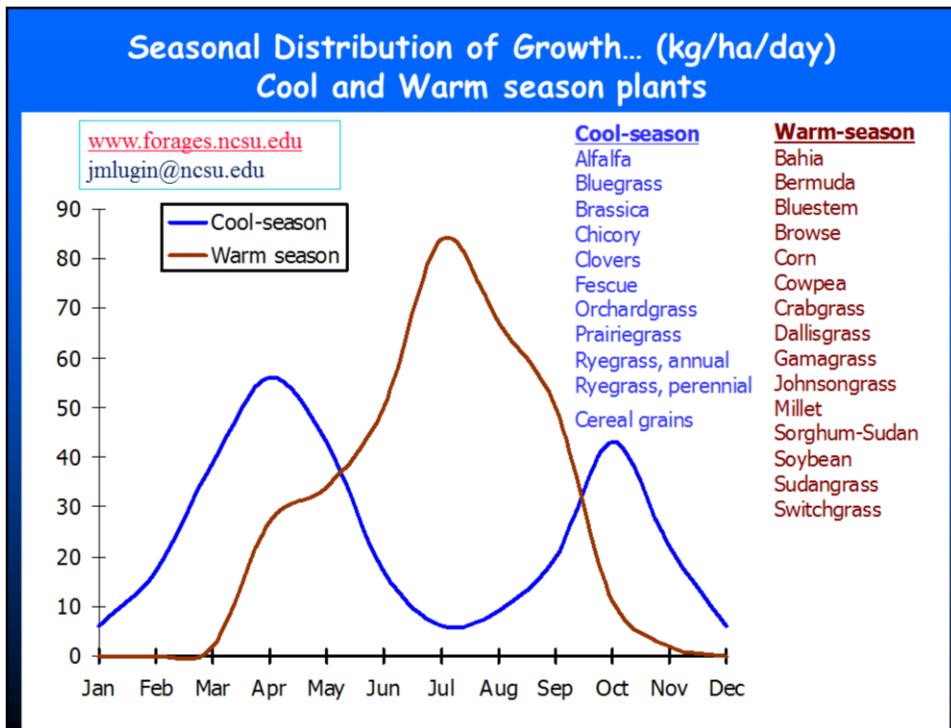
Benson & Washburn **NCSU BUDGETS** (2013)

Profitable meat goat production is pasture/browse based. Cost per kg dry matter is lowest for grazed pastures.

Additional losses (loss of leaves in the field and due to fermentation) and labor, machinery, fuel, etc. increase the cost of stored forages

Concentrate and by-products vary widely: using byproducts when price is low is a good strategy.

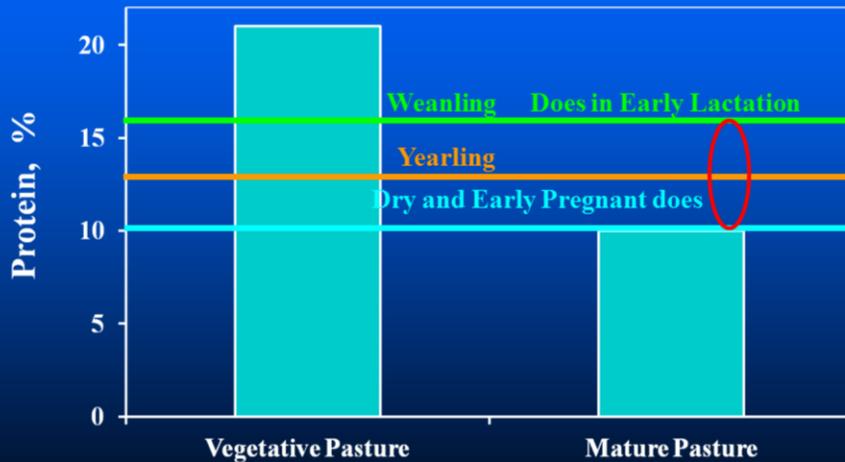
May need to have it tested for energy, protein, calcium and phosphorous before buying.



In North Carolina, the climate is temperate in spring, fall and winter, and sub-tropical during the summer.

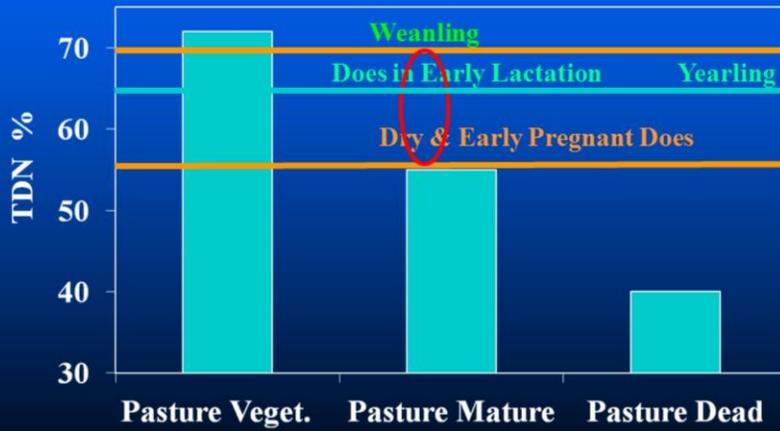
Cool-season forages have a bi-modal pattern of growth (blue growth curve), and forage systems need to include warm-season forages (brown growth curve) for the summer months

## Forage Quality & Goat Requirements Protein



Graph depicting the quality of vegetative and mature pasture in relation to the nutritional requirements of goats of different classes. As goats of different classes have different nutritional requirements, they should not be grazed together, but grouped according to nutritional requirements, so as to match the forage resources of the farm to nutritional requirements of the animals, and thus reducing feeding costs.

## Forage Quality & Goat Requirements Total Digestible Nutrients



The same applies for total digestible nutrients, a measure of energy

## Chemical composition of various plants browsed by goats (%)

Browse type	Crude protein	Neutral detergent fiber	Calcium	Phosphorous
<i>Multiflora rose</i>	18.8	34.5	0.99	0.32
<i>Black locust</i>	23.0	44	1.26	0.21
<i>Honeysuckle</i>	12.8	34.5	1.21	0.30
<i>Brambles</i>	15.9	24.5	0.23	0.84
<i>Privet</i>	18.0	26.8	0.89	0.34
<i>Green briar</i>	17.0	39.5	0.60	0.18
<i>Kudzu leaves</i>	23.7			
<i>Trumpet creeper</i>	16.7	43.1	0.42	0.22

## A Strategy for Pasture Use

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- Group animals into categories according to nutritional needs
  - Goats with highest nutritional needs: does in early lactation, yearlings and weanlings, should have access to the best pastures
  - Dry does, bucks, pregnant does not nursing can meet nutrient requirements on mature pasture

Self explanatory

## Feeding Goats, End of Pasture Season

- Consider supplementing with a small grain pasture
  - cereal rye, annual ryegrass
- Stockpiled fescue
- Use of brassicas
  - Turnips, kale, mustard
  - Only ½ of daily ration
- Use controlled grazing principles
  - Restrict animals in small area (1-2 days grazing max.)



Stockpiling means deferred grazing, that is letting the forage grow in the fall and graze at a later date during late fall-early winter. The quality of the forage will be lower (depending on their nutritional requirements some animal classes will have to be supplemented with purchased feed) but nonetheless this strategy allows the producer to lengthen the grazing season and reduces the amount of hay to buy.

## Use of Hay

- Offer grass hay ad lib. If hay is 10-11% Protein, feed 1 pound of 16% protein feed. May need higher protein or higher energy feed if hay is lower quality
- A higher quality hay (12-14% protein) will allow use of corn at  $\frac{1}{2}$  to 1 lb/hd/day



When feeding hay, several things are important. First, to know what kind of supplementation if any, is needed, hay needs to be tested. There is a NC Department of Agriculture & Consumer Services (NCDA & CS) forage testing lab in Raleigh: work with your extension agent if you need your hay to be tested. It would be preferable to know the quality of the hay before purchasing it. Some producers who make hay for sale routinely have it tested before selling it. Guessing can result in over or under feeding of a supplement. Either way reduces profitability. Second, goats should be grouped by nutritional needs. The best hay should go to kids, lactating does, or does in late pregnancy.

These hay and feed recommendations are from Drs. Frank and Bruce Pinkerton in an article entitled " Supplemental Winter Feeding of Goats"



Mineral blocks, such as in the upper left picture, are too hard for goats. In addition, minerals are costly, and should not be exposed to the elements. At NCSU, we feed loose minerals at the rate of 1 oz/mature doe/day.

The mineral feeder on the right-hand side was bought commercially from Vigortone. The livestock agent from Graham county in NC told me that he bought one twenty years ago, that the plastic is UV resistant and that it is still in excellent shape. On the bottom left picture, I would put a flap on the opening of the PVC pipe to protect the minerals from rain.

Minerals from goats should contain copper, around 1000 ppm (mg/kg). Some companies sell minerals with approximately 1700 ppm copper, which is ok. If you raise sheep, the sheep minerals should not contain copper or only trace amounts, as copper can be toxic to sheep.

In addition, we are (NC, VA) in a zone deficient in selenium (Se), all minerals should contain selenium. Selenium is tightly regulated so most minerals contain the same amount.

If you have any doubt, call the livestock agent in your county.

It is also a good idea to keep the tags that come with the bags as they contain the minerals and their amounts.

- And finally, don't forget about...
- **WATER!** All production, growth and animal performance will be affected if insufficient or poor quality water is available.
- **Body condition:** The best way to monitor your nutritional program is to watch your goats and what is happening with their body condition



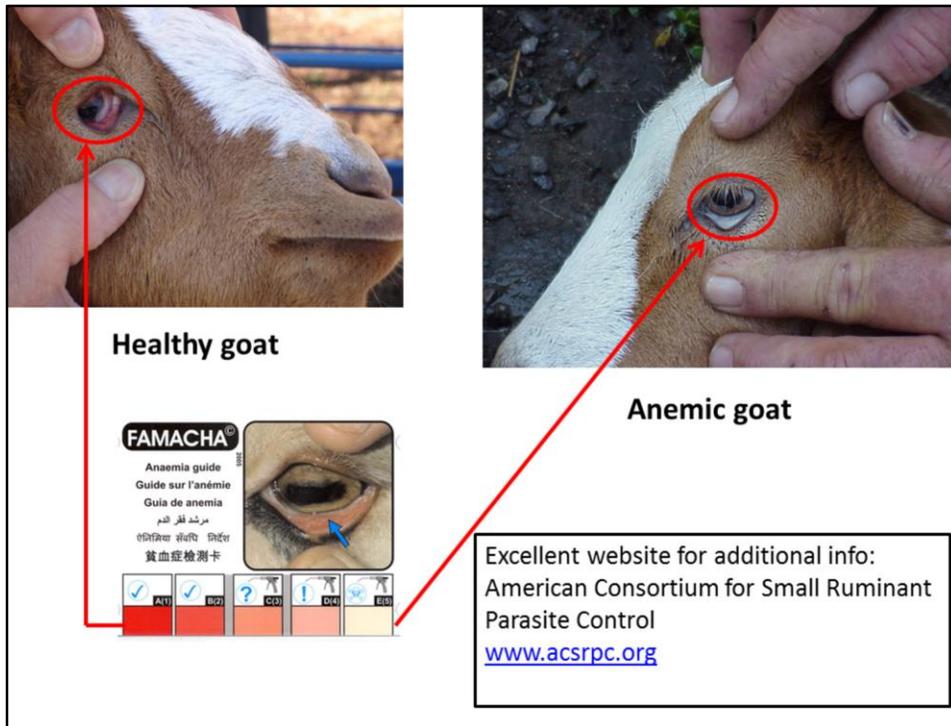
#### **Body Condition - Web Resources**

***Body Condition Scoring – Langston University video***

<http://www.luresext.edu/goats/research/bcshowto.html>

***interactive***

<http://www.luresext.edu/goats/research/bcs.html>



The FAMACHA card was developed for sheep in South Africa and validated for goats and camelids in the USA. It goes from 1 (very healthy) to 5 (very anemic). It only works for the barber pole worm, a nematode sucking blood, that leads to anemia. Using this card, one can quickly assess the degree of anemia of any goat or sheep without having to analyze a fecal sample.

The barber pole nematode is the predominant worm found in small ruminants during the growing season.

The American Consortium for Small Ruminant Parasite Control has an excellent website with a lot of pertinent information

[www.acsrpc.org](http://www.acsrpc.org)

Do not forget to click on 'Timely Topic' under 'Parasite Control'.

# Parasite Dewormers

■ CLASS OF DRUG	■ TRADE NAME
– Ivermectin	– Ivomec
– Moxidectin	– Cydectin
– Morantel	– Rumatel, Positive Pellet, Strongid
– Levamisole	– Levasol, Tramisol
– Fenbendazole	– Safeguard, Panacur
– Albendazole	– Valbazen
– Oxfendazole	– Synanthic

There are 3 families of dewormers, denoted by the different colors. Always read the label for restriction of its use before using any kind of dewormer. For instance, Valbazen should not be used in the 3 months of pregnancy (pregnancy last 150 days on the average for both sheep and goats).

# Management Tips

## Do NOT buy resistant worms



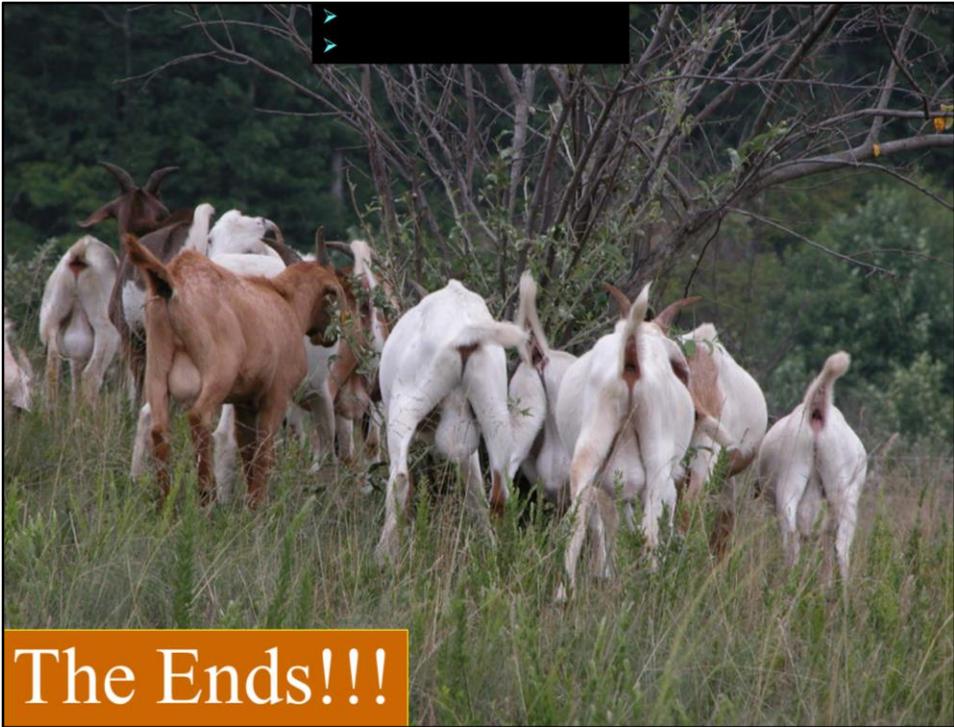
- ▶ All new additions should be quarantined and aggressively dewormed upon arrival
- ▶ Deworm with 3 dewormers from different drug classes
  - Moxidectin (**cydectin**), levamisole (**prohibit**), and albendazole (**valbazen**) upon arrival
  - Follow recommendations about use of dewormers
- ▶ Should remain in quarantine for 10 - 14 days
  - Perform FEC to confirm that no eggs are shed
- ▶ Place animals onto pasture

Recommend holding animal in confinement on arrival. After the animal acclimates to the new conditions and has recovered from the transport, feed should be withheld for 24 hr (but give free-choice water) and a fecal sample collected for a fecal egg count. Animal should then be treated with a full dose of each of the 3 drugs. The drugs should not be mixed together, but can be given one right after the other. After 2 weeks another fecal egg count (FEC) should be done to confirm that no eggs are being shed. If eggs are shed after this triple treatment, then the animal is infected with super-resistant worms. In such a case the animal must remain in confinement until the fecal egg count comes down to 0 – this could take 6 months. If treatment appears to be effective and FEC is 0, then the animal can be placed onto pasture – but always put them out onto a worm-contaminated pasture –NEVER onto a new/clean pasture. This is because a 0 FEC does not mean there are no worms – only that there are too few to detect. If put out onto a clean pasture, the very few eggs shed (from super-resistant worms) will not be diluted and so over time will become the dominant parasite population.

Dosages of dewormers for both sheep and goats are found on two separate excel files saved in pdf format.

You may want to keep you newly-purchased animals in quarantine for a longer period of time so that you could make sure they are healthy. Problems to look for are hoof rot, sore mouth, pink eye, and CL (Caseous lymphadenitis). CL bacteria lodge in the lymph nodes and create infections that look like a lump. If those lumps burst open, the released pus could contaminate your entire farm. In the case of CL, it is necessary

to cull those animals immediately. In addition, humans should protect their hands from the pus as the organisms could cause skin infection. Wash hands well after handling infected animals and dispose of gloves and anything that contains pus.



The Ends!!!