SOIL SMaRTS

Specific Management and Resources Trainings for Soil Health in Tennessee

TRAINING CURRICULUM

J. de Koff, M. Hubbs, D. McMillen, D. Morris, and G. Brann

Tennessee State University
Cooperative Extension

Southern SARE
Sustainable Agriculture Research & Education

UT Extension
Institute of Agriculture
The University of Tennessee

USDA United States Department of Agriculture

This curriculum was developed through a Southern SARE grant and collaboration between Tennessee State University, the USDA-NRCS, and the University of Tennessee. The objective of this curriculum is to provide training on soil health and sustainable management practices for soil health to extension agents and local officials so that they may disseminate this information to their stakeholders.

Soil Smarts Training Curriculum

Collaborators: Jason de Koff, Michael Hubbs, David McMillen, Danny Morris, Greg Brann
Cover design and design layout: Brett Seybert

Funding was provided through the Southern Sustainable Agriculture Research and Education (SARE) Program

Tennessee State University
3500 John A. Merritt Blvd.
Nashville, TN 37209

MODULE 6. GRAZING MANAGEMENT TO IMPROVE SOIL HEALTH

Learning objectives:

Participants will be able to:

- Incorporate soil health principles into grazing systems
- Identify management strategies to integrate soil health into grazing systems
- Discuss the impact that grazing has on soil health and function
- Gain an understanding of stocking density and its importance to soil health
- Understand grazing principles that improve soil health

Materials:

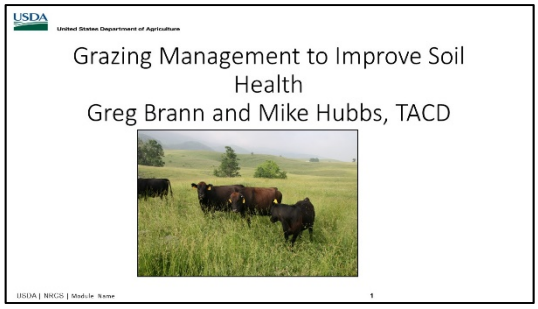
- PowerPoint® slides "Module 6: Grazing management to improve soil health"
- Lesson guide: Use the notes in this lesson guide to present information for each presentation slide.
- Questions found at the end of this lesson guide can be used to test participants' knowledge at the end of the presentation. This can be combined with clickers to improve audience engagement and create discussion.
- An evaluation of the presentation can be found in this lesson guide following the lesson questions.

Topics:

Grazing/cutting height
Stocking rate
Manure
Nutrient cycling
Soil health principles
Plant diversity
Disturbance

Slide 1

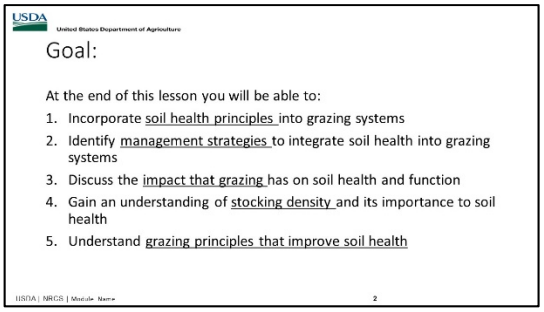
This module will focus on identifying grazing management strategies to improve soil health.



Slide 1

Slide 2

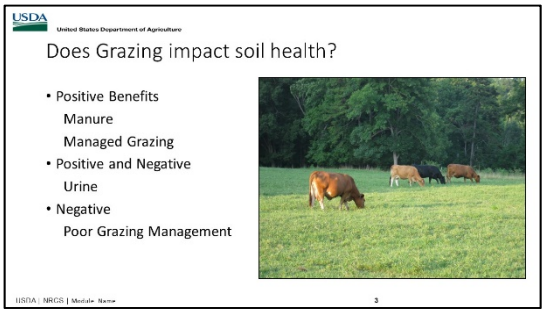
Follow material on presentation slide.



Slide 2

Slide 3

Grazing management has a tremendous impact on the soil health and function necessary for high production. These impacts include:



Slide 3

1. Manure can accelerate the building of organic matter and improve soil health if considered as part of a good grazing system. This begins as residue is broken down in the stomach of livestock.
2. Urine does recycle nutrients but the greater amounts on each "spot" can be a shock to the soil system.
3. Poor grazing management as we might guess leads to overgrazing, poor nutrient distribution, less microbial activity, more runoff, etc…

Grazing management focuses on the hoof and mouth action of the cows…

Slide 4

Here is a slide of what we would like to do, turn the livestock in at a certain height. Take half, leave half.

Slide 4

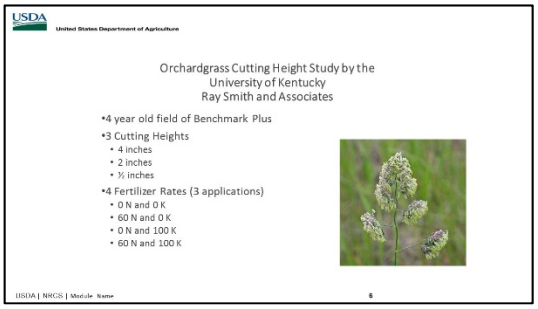
Slide 5

We want to allow for the roots to recover (roots shown above). The photosynthesis collected by the remaining leaf area will produce carbon and some of that carbon is exuded by the roots and helps enhance the soil biology.

Slide 5

Slide 6

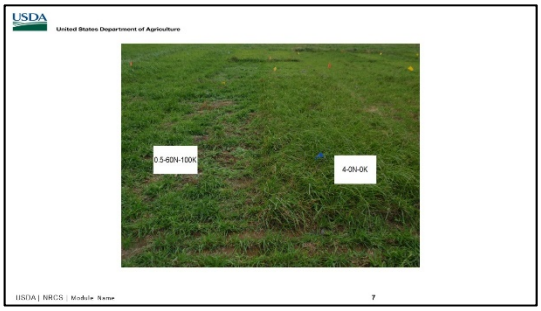
These are some results out of the University of Kentucky looking at different cutting heights and fertilizer rates.



Slide 6

Slide 7

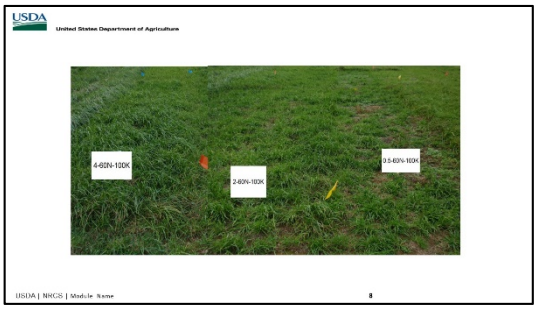
As you can see after 30 days, the half inch cutting height with 60N and 100K is much shorter than the 4 inch cut with no nitrogen or potassium. Therefore, the cutting/grazing height of grass is more important than the nutrients. It takes grass to grow grass.



Slide 7

Slide 8

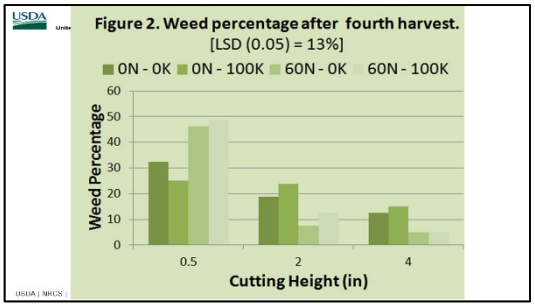
This shows a similar trend where all plots had the same amount of fertilizer but the 4 inch cutting/grazing height had good recovery, the 2 inch cutting height has less recovery and little recovery from the half inch cutting height.



Slide 8

Slide 9

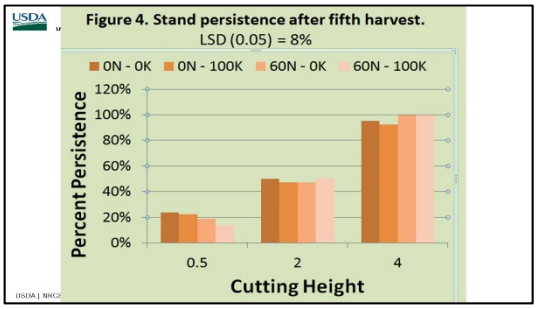
On weed percentage after the fourth harvest, you have a greater number of weeds with the half inch cutting height than the others, particularly with those that have the higher rates of nitrogen. When you overgraze, the ground is more bare, temperatures are higher, leading to greater weed pressure.



Slide 9

Slide 10

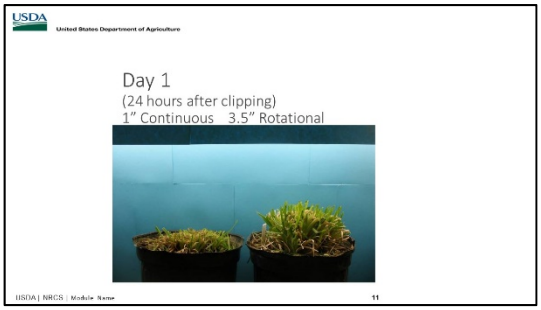
With stand persistence after the fifth harvest, you see greater persistence with higher cutting height and no effect from nitrogen or potassium. If we can stop grazing at 4 inches, particularly with cool season grasses, there's a lot of benefits.



Slide 10

Slide 11

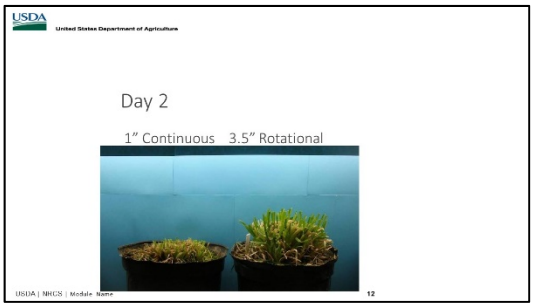
This is another study where in the pot on the left, orchardgrass was clipped down to a 1 inch height on a daily basis for 30 days and with the pot on the right was clipped down to 3.5 inches after a 30 day recovery period. The next few slides show what the daily recovery looked like over time.



Slide 11

Slide 12

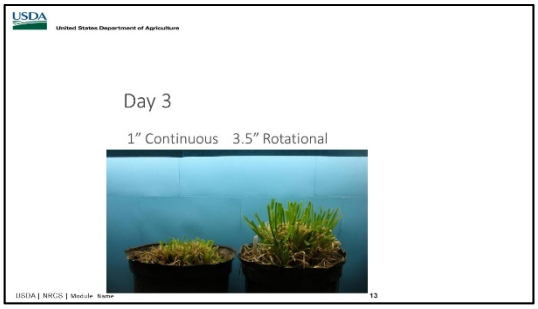
This is Day 2.



Slide 12

Slide 13

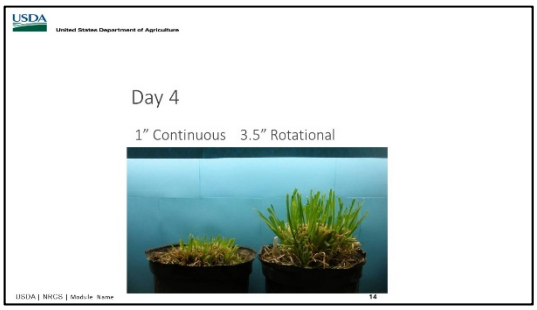
This is Day 3.



Slide 13

Slide 14

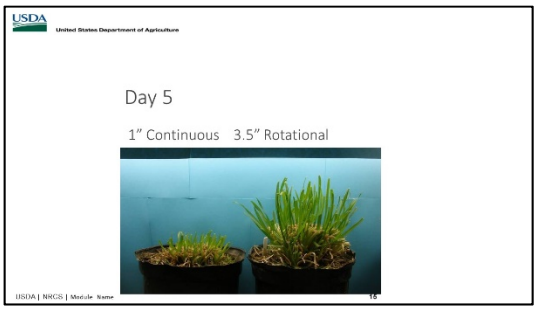
This is Day 4.



Slide 14

Slide 15

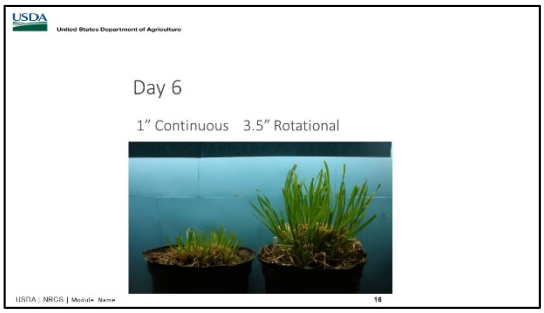
This is Day 5.



Slide 15

Slide 16

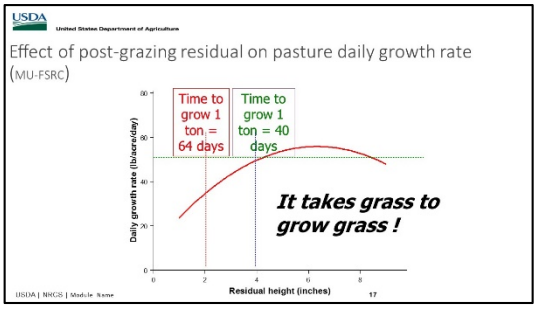
This is Day 6. You can see the 3.5 inch that had a 30 day recovery period prior to the experiment is recovering much quicker than the one inch continuous clipping. It all comes back to photosynthesis and the leaf area that is available for photosynthesis. If we don't have good leaf area, we can't capture sunlight. This is true whether we are talking about cover crops or grazing management. Photosynthesis produces the energy for the plant. Some of the carbon that is produced is released through the roots and feeds the biological organisms in the soil. This is the cycle for grazing management. If we overgraze, this cycle shuts down, the microorganisms in the soil shut down or become dormant until carbon is available again.



Slide 16

Slide 17

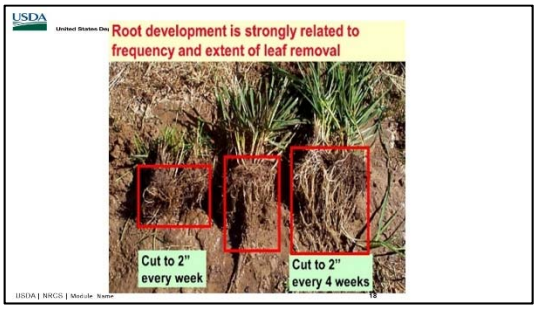
This slide shows it takes about 50% longer to grow a ton of feed if the pasture is grazed down to 2" compared to 4".



Slide 17

Slide 18

In this study they cut it down to 2 inch height, which is shorter than is normally recommended, and varied the frequency of the cutting. The one on the left is cut every week and you can see the root development is much less than the one on the right that was only cut every four weeks. Therefore, if an area is overgrazed, continuously grazed, the roots will be stunted because there is less carbon ending up in the roots because there is less photosynthesis in the shoots. This is why you can take a rainfall simulator over an overgrazed pasture and see almost as much water erosion as from cropland.



Slide 18

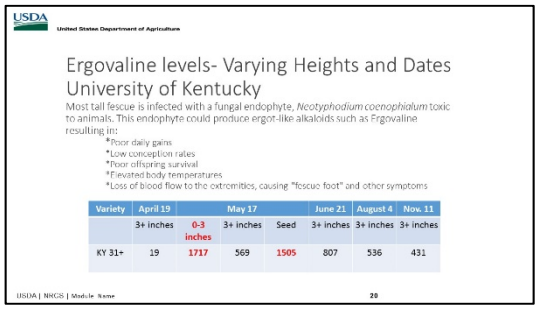
Slide 19

In this slide you can see the points identified where grazing close at this stage can reduce spring production by 25 to 50%. Available forage at this stage is less than 100 lbs per acre, less than one tenth of a bale. Animals cannot consume enough so you might as well feed hay at this stage and rest the pasture. You're not getting any benefits out of it.

Slide 19

Slide 20

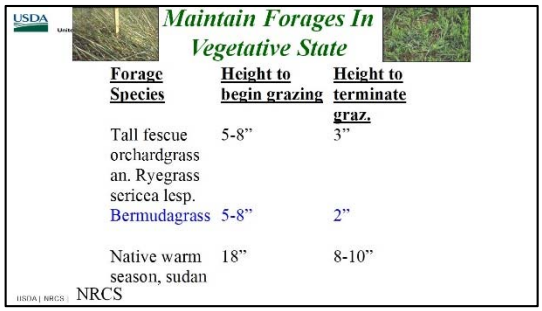
This study shows different ergovaline levels from the fungal endophyte in tall fescue. Basically, managing at 3 inches or higher produces less of this toxin. With endophyte fescue you can also dilute it with legumes or other species.



Slide 20

Slide 21

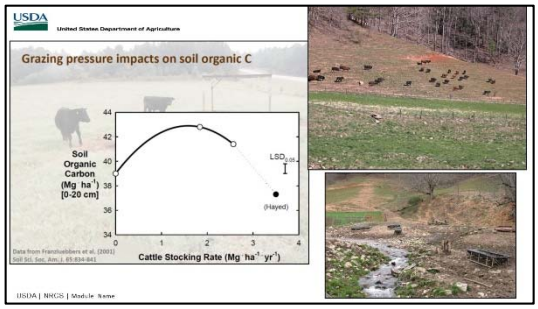
This slide shows the beginning and termination heights for different forage species. Most of the forages have a beginning height of 5 to 8 inches and bermudagrass can be grazed a little lower than the others. With the native warm-seasons you have much higher beginning and termination heights. The growing point on many of the warm-season grasses is at 6 inch height so you don't want to go below that if you are cutting for hay or grazing or you will start to lose your stand.



Slide 21

Slide 22

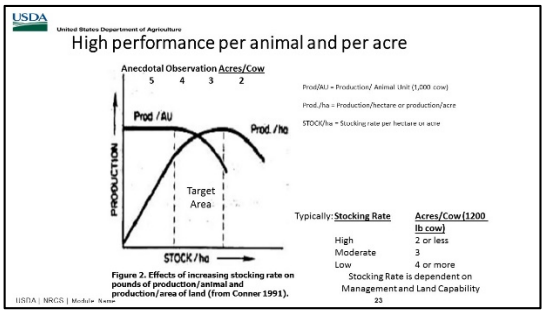
In overgrazing, there are effects below ground as well as the obvious stresses on forages. Negative changes in aggregation, bulk density, and soil carbon. Here we see the increase in SOC as stocking rate increases (positive changes) to a point, then the SOC retreats as it is overstocked. This all relates back to the leaf area and carbon production mentioned in some of the previous slides. Also, note as pastures are hayed and all the carbon is removed, SOC would typically decrease significantly. Research by Alan Franzluebbers. 1 Mg per hectare equals about 892 lbs per acre.



Slide 22

Slide 23

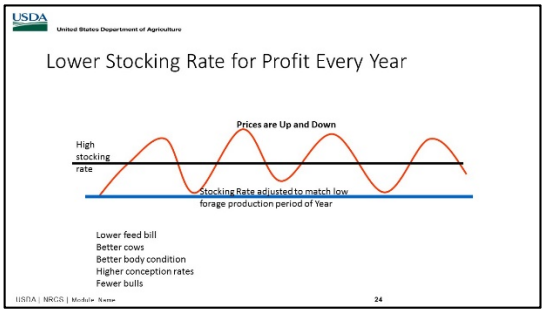
This slide shows the relative production based on stocking rate. The stocking rate is dependent upon productivity, rainfall, the animals and management. As your management increases, you can get more to the right side of the graph. Some producers in Tennessee get up to 2 acres per cow or less but they are moving them on a daily basis or twice daily



Slide 23

Slide 24

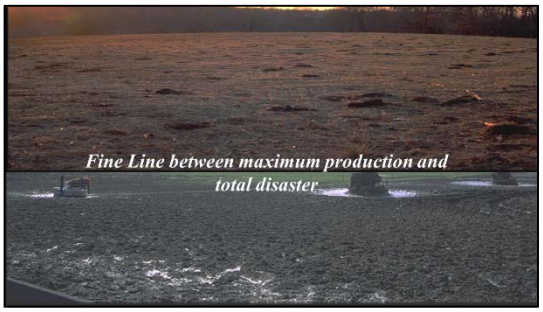
It's a good idea to start out your stocking rate adjusted to match the low forage production period of the year to make sure you have the management skills and a lower feed bill. A lot of the profit margin is based on the feed bill. Anytime we can cut back on hay, we are putting more profit in our pocket.



Slide 24

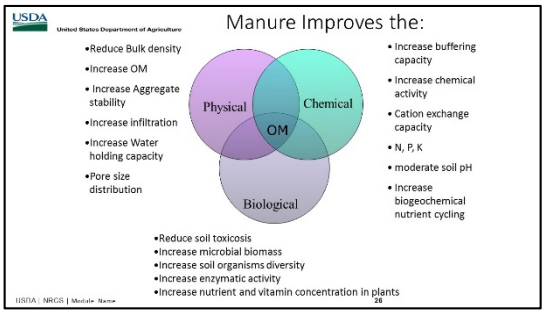
Slide 25

As long as we have time, roots and cover, we avoid disaster. If not, it is a disaster.



Slide 25

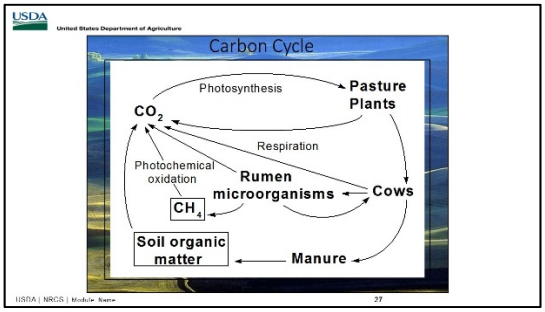
Slide 26



Slide 26

Manure can have many positive impacts on the physical, chemical, and biological properties of soils. These are all related to organic matter because manure is organic matter. The soil is less compacted when we have active carbon on the soil. The soil's ability to resist water pressure (aggregate stability) is better when we have organic matter. The nitrogen and carbon in manure becomes available for organisms to build soil organic matter which improves the physical properties described. Biological: Manure can increase biological activity, total number and diversity of microorganisms due to nutrient and carbon concentrations. Chemical: Manure contains valuable amounts of nutrients. Manure leads to stable organic matter. This has high cation exchange capacity (CEC) potential which allows for greater nutrient retention and provides increased buffering capacity making soils more resistant to changes in things like pH. Some manures can raise pH due to higher calcium concentrations while manures can reduce acidification compared to inorganic fertilizers due to the stable conversion of nutrients like nitrogen to plant usable forms (organic N to ammonium).

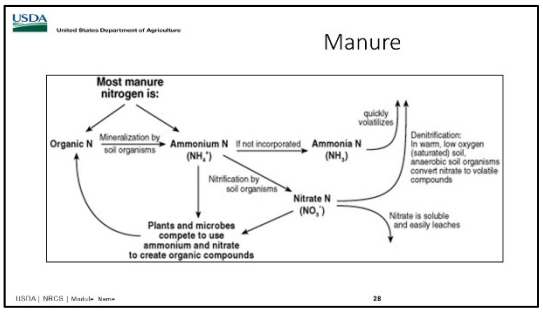
Slide 27



Slide 27

Now look at this carbon cycle. Without animal inputs, the cycle is less complex with Photosynthesis to plants to respiration back to CO_2. With herbivores introduced, soil microorganisms take the carbon in manure which has been altered by processes (including gut microorganisms) in livestock and further decompose to soil organic matter and plant available nutrients. So, livestock convert the forages to forms that soil organisms can use more efficiently (in the right conditions) and into stable organic matter. The process is enhanced.

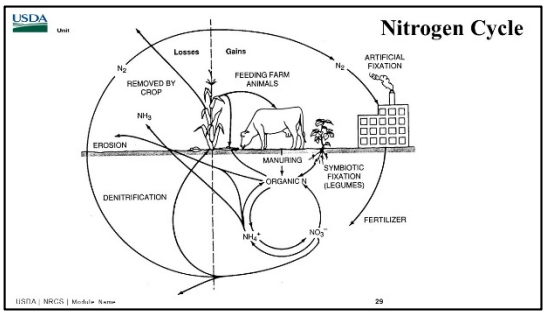
Slide 28



Slide 28

So, nitrogen in the organic state (ON) or as it's mineralized to ammonium (NH_4) state is very stable and does not readily leach. Healthy soil systems are better at recycling N to stable ON due to a healthy, diverse population of microorganisms. Plus: NH_4 is plant available and not as subject to leaching. Converting to nitrate (NO_3) (also plant available) is a natural process but NO_3 is highly leachable. But, again, in healthy forages systems, both microorganisms and plants will use greater amounts of available nitrogen. This is good news! The N stays in the system. Losses to the atmosphere and water can be low compared to urine…

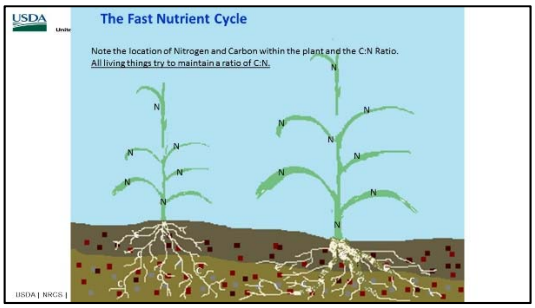
Slide 29



Slide 29

Let's look once more at the nitrogen cycle and the potential for manure to aid in the cycling of N. Nitrogen is broken down in manure from stable organic nitrogen (ON) to ammonium (mineralized), then to nitrates (nitrification). Increases in biological activity from manure organic matter increases uptake of nitrogen into the bodies of microorganisms. This stabilizes N and improves the cycling. So, let's take a look at the way herbivores, plants, and soil biology can work together and mimic nature so all can benefit.
Then we will look at what happens when this breaks down as a result of poor management or when herbivores are not present.

Slide 30



Slide 30

So here is actual footage of the process that is considered the Fast Nutrient Cycle. The grasses here are between the 3rd leaf stage and flower. Notice that the new growth grows on top of the plant. This new growth is high in nitrogen and low in carbon, i.e. high in protein.
Notice the carbon to nitrogen ratio is in balance to what the grass desires. All living things try to maintain a ratio of carbon to nitrogen. If this ratio is changed in any direction the organism will react in some manner to get the ratio back. For example, if you consume more protein than carbon for long periods you will get a craving for carbon. And visa versa. But we are able to walk to the store and get what we need (a bag of chips or French fries from McDonalds, which are high in carbohydrates) to keep our ratio in balance. But a plant can't walk to the store. So what will a plant do if it's C:N ratio is disrupted? Let's see.

Slide 31

Slide 31

Oh no, here comes Gertrude, notice how she is only taking the tops of the plants and then moving to the next plant. Why doesn't she graze the lower portion of the grass plant? Because it is the highest quality forage available, right? The bottom half of the plant is higher in carbon and low in protein and is less digestible than the tops. Gertrude is in high demand of protein, she is milking her calf and is trying to get in condition to reproduce again. She is seeking highly digestible crude protein so see selects the tops and moves to the next plant. This is nothing new to the plants. They evolved under this type of strategy. With large herds of bison grazing through the area, they took the tops and moved on. If the plants put the highest quality feed on the bottom and the top was poor quality what would happen to that plant? It would be overgrazed and doomed to die. Let's watch this actual footage to see if this is really the case.

Slide 32

Slide 32

Notice how Gertrude is taking the top of this plant. Let's see if she will graze it to the bottom or if she will go to the next plant. What do you think? Why? She will go after the highest nutrition first which is the tops, right. Let take a look and see…

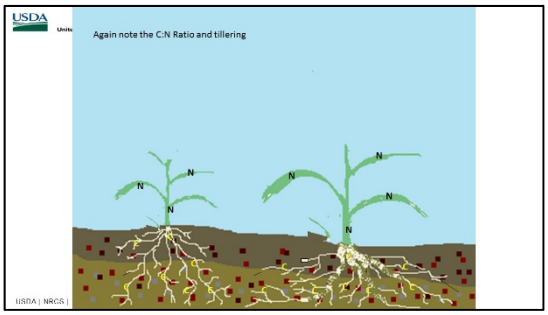
Slide 33

Slide 33

Wow, notice how she took the top and move to the next grass plant.

Slide 34

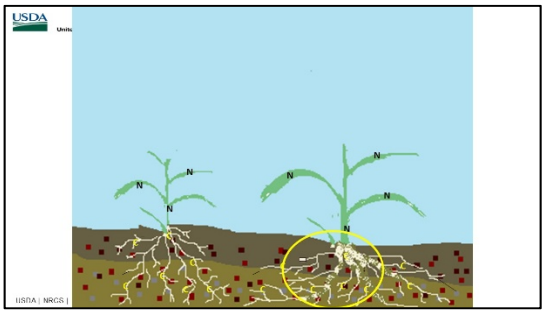
Notice the auxiliary tiller has been activated. Which is slower growing which is ok because it slows down the plants from going to seed and shutting down for the rest of the year. All living things want to reproduce. Plants have two methods: Their first choice is sexual reproduction, or seed production, but if that is interrupted by grazing or other types or defoliation, then it will go to asexual reproduction….tillering, as we see here. It takes more sun energy to make seed production than leaf production. If we can stop the plant from going to seed we will force it to go to tiller. We will force the plant to grow longer, absorbing more energy from the sun, capturing more carbon from the air. Also note the C:N Ratio. The plant has lost a lot of Nitrogen to the cow. So there is an imbalance of Carbon to nitrogen. More carbon than nitrogen. What's a plant to do????



Slide 34

Slide 35

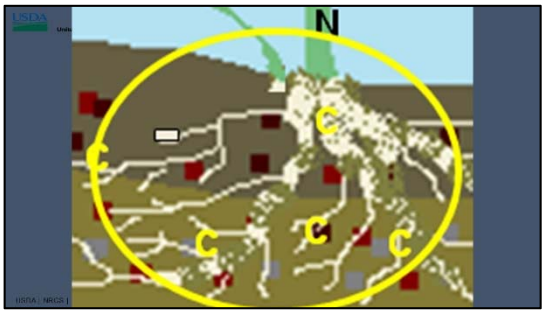
There is also something happening in the root zone. Let's take a look.



Slide 35

Slide 36

Notice all the carbon. Not much nitrogen.. Any thoughts on what the plant can do to get more nitrogen??? Let's get a closer look.



Slide 36

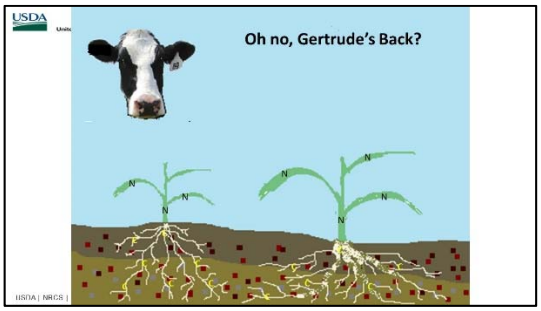
Slide 37

Roots slough off and are broken down by microbes which release N to the plant roots.

Slide 37

Slide 38

Oh no, here comes Gertrude again!! What is the next part of the plant she will eat? Yes, the factory. Let's watch and see.



Slide 38

Slide 39

Yep, she sure did take the factory off. Now what?

Slide 39

Slide 40

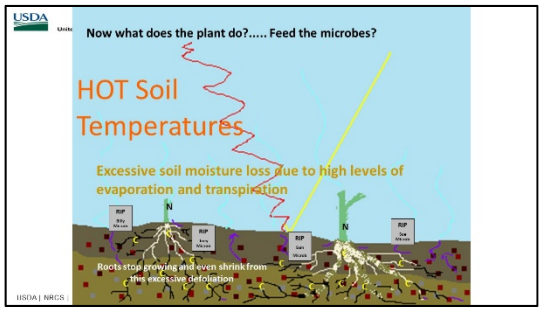
Oh no, she is now going after all of our factories. There goes take half leave half. What could we have done to avoid this? Yes, we should have moved her to the next pasture before this occurred.

But what is going to happen to the symbiotic relationship between the animal, the plant and the microorganisms? Let see.

Slide 40

Slide 41

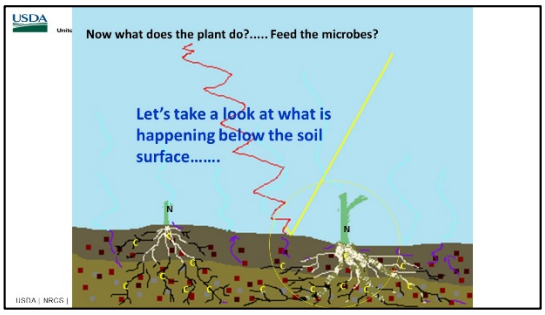
We now have removed the solar panels from the plants, created hot soil temperatures, increased moisture loss, shut down our roots and possibly shortened them. Due to the hot soil temperatures and dry conditions we have caused all of our workers to go dormant and even die. Let's go to live footage and see what actually happens..



Slide 41

Slide 42

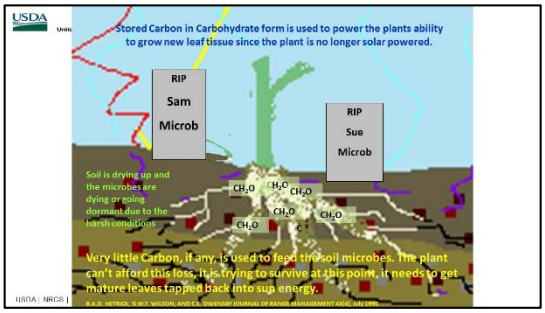
Ask the audience what they think the plant response will be. Will it excrete sugars to the microbe? Once they have explained what they think will happen, go to the next slide to watch and see.



Slide 42

Slide 43

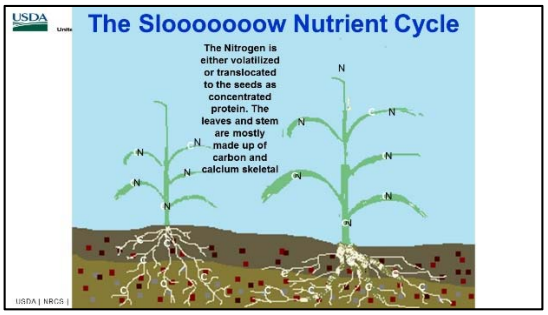
The polysaccharides are used to make new tillers since the plant is no longer solar powered. It is running on stored carbohydrates. It can't afford to give carbon to the microbes that it needs to grow new leaves. It will do this first and hopefully get them to maturity before you know who comes back. If Gertrude does come back what do you think she will be after then? The old growth or this lush new growth? Yes the new growth probably before it becomes mature. That is if there is any moisture left to make new growth.



Slide 43

Slide 44

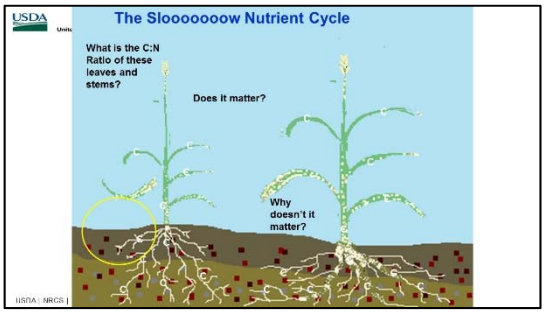
So here is actual footage of the process that is considered the Slow Nutrient Cycle. The grasses here are in the boot to flower stage. Notice that the new growth still grows on top of the plant and is still high in nitrogen and low in carbon (ie. high in protein). But as time goes on the plant goes to seed production robbing the plant of it's protein and concentrating it in the seed. The carbon to nitrogen ratio is still in balance to what the grass desires. There is no need for the plant to trade sugar for nutrients when it is in a couch potato mode.



Slide 44

Slide 45

The slow nutrient cycle occurs if grazing occurs after the flower stage if at all. CRP would fall into this cycle, any non-grazed areas of your pastures or pastures that are grazed after the flower stage. Most of the nitrogen leaves the plant either by concentrating protein in the seeds or volatilizes from the leaves and stems.

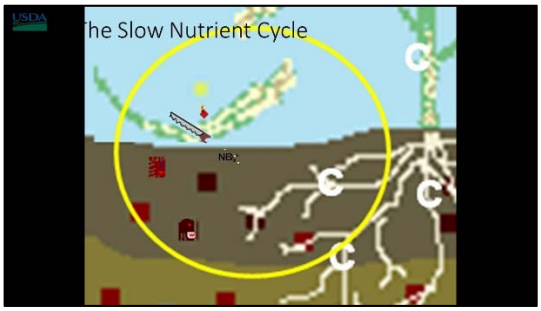


Slide 45

If grazed at this time, there will be no sugar handouts to the microbes because the plant has produced seed and has shut down. There is no reason for the plant to give up carbohydrates to grow. It has accomplished its mission and is resting for the rest of the growing season. So what will the microbes have to eat? Where can they get their carbon? Let's watch and see.

Slide 46

As leaves fall to the ground, the microbes break them down and it releases nutrients.



Slide 46

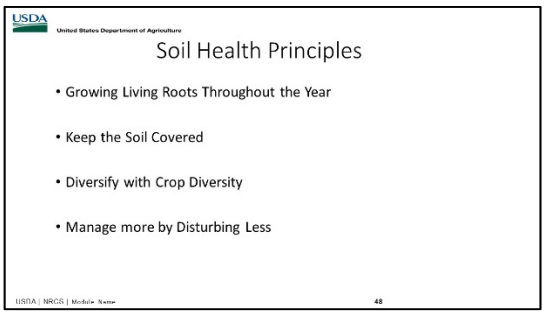
Slide 47

Conclusions: Let's look at how this might look above ground. Under well managed systems, where nutrients are consistently cycled and carbon is effectively added, grazing is a beneficial practice. Here, there is a positive relationship between soil biology, livestock, and plants. After grazing, plants release exudates including sugars. Bacteria feed on these exudates and release nitrogen back to the plant for its use. Forages are meant to be grazed. Look at the ungrazed system on the right. Here processes have slowed down. Higher C/N ratio plant residues are decomposed much slower. No manures are added to assist in the decomposition. Therefore nutrients are cycled much slower.

Slide 47

Slide 48

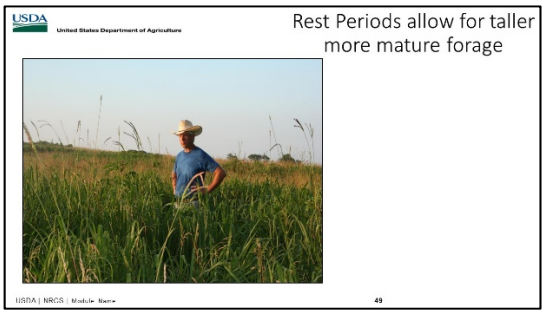
Let's look at our 4 soil health principles as they relate to our perennial grazing systems.
Living roots will keep making carbon for microbes.
Keeping the soil covered will help insulate the microbes from extreme temperatures.
The more diversity we have aboveground, the more diversity we have belowground.
An example of a disturbance in pasture is overgrazing.



Slide 48

Slide 49

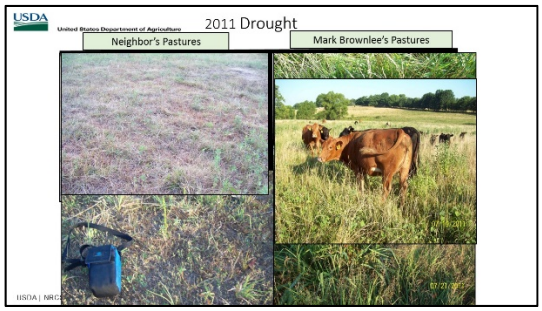
Let's look at Mark Brownlee's operation. He lives in Missouri. Mark had been rotating twice daily at about 100,000 stock density. This is a good example of what having residue can help do. Mark allows forages to grow taller and more mature before using the livestock to trample residue onto the soil surface.
Livestock have eaten weeds that were showing up in Mark's pasture, confining them in a small area makes them less selective, aids in weed control.



Slide 49

Slide 50

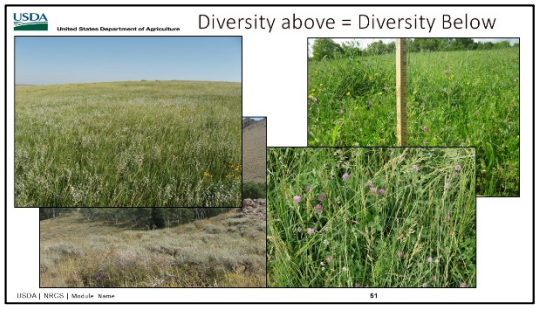
This is from the 2011 drought. Compare the neighbor's farm next door. Cooler and moister conditions at the surface and below the soil surface allowed the forages to thrive in stressful conditions.



Slide 50

Slide 51

We all know that diversity in our pasture systems is good for livestock, but it also increases biological diversity below ground. More diversity in plants and microorganisms leads to healthier systems that are more resilient and resistant to drought and pest issues while improving nutrient cycling and overall system health. Diversity is not always just about adding annuals into the system. It can mean diversity of perennial species as well. In this photo, there are several examples.

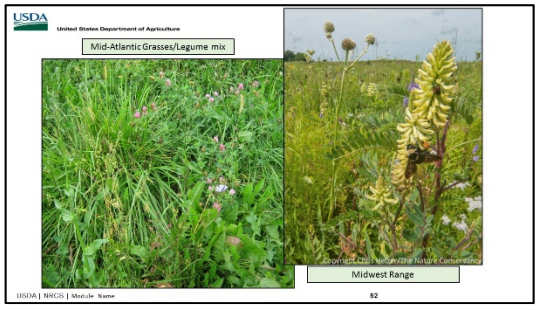


Slide 51

Common introduced cool season mixtures could include several grasses and legumes. In many locations warm season mixtures are more prominent. According to Greg Brann, weeds are opportunities. Opportunities to train cattle to eat weeds through management systems like mob grazing.

Slide 52

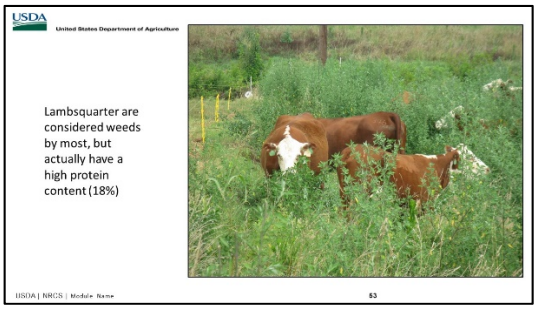
Here are a couple of good examples of healthy diverse systems. On the left are mostly introduced grasses and legumes from the mid-Atlantic region of the US, similar to Tennessee. Also in there are some species we might consider weeds but are very nutritious readily grazed. On the right is a range system from the Midwest. These are primarily native species. Both systems can be enhanced and thrive with grazing management. Sometimes new seeding is required but many times there is a healthy seedbank within the soil to provide adequate diversity.



Slide 52

Slide 53

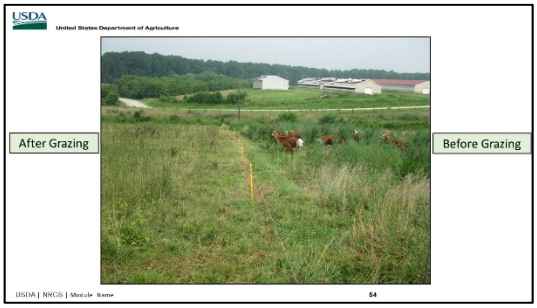
Some things we think of as weeds are actually nutritious and readily eaten by livestock. This is an infestation of lambsquarter. This herd loved it. They were not forced to eat things they didn't want and were readily moved from one temporary paddock to another. The protein content was about 18%



Slide 53

Slide 54

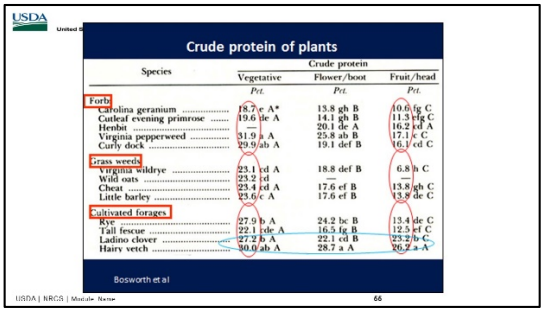
Here is the before grazing and after grazing photo. On the left, the cattle ate the leaves and left the stems. The weed was controlled through proper management. Again, this is diversity not always considered.



Slide 54

Slide 55

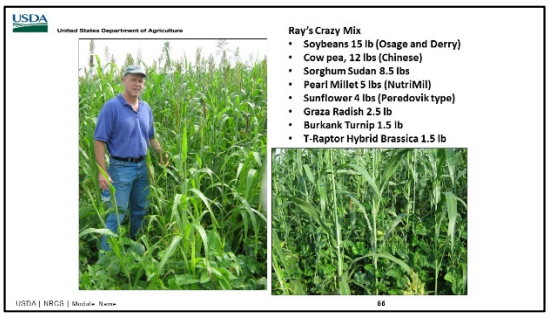
This slide shows other examples of plants and their crude protein contents. You can see some of the weeds can have crude protein contents that are similar to cultivated forages. The point is don't always dismiss a plant as just a weed that must be chemically eradicated when in many cases it is highly nutritious and desired by livestock.



Slide 55

Slide 56

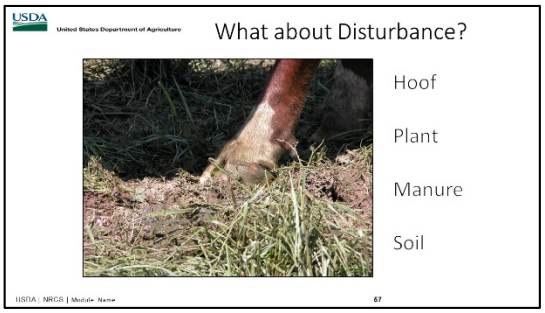
Annuals seeded onto perennial pasture land is popular now as a practice for a variety of reasons. This was an old fescue field. The producer's goal was to renovate it and later put in a perennial warm season grass to offer some good grazing for the summer. In the late spring, the existing stand was terminated, you can even use a disturbance like overgrazing to get rid of the existing stand. The above mix was drilled and growing animals were put on at the stage shown above. Cattle gained over a pound per day which was a lot better than the old fescue during the summer. Much of the residue was trampled. The diversity from these annuals gives the system an instant boost and adds to the biological diversity below ground. After a couple of years of cool and warm season annual mixes, the field will be seeded in perennial forages.



Slide 56

Slide 57

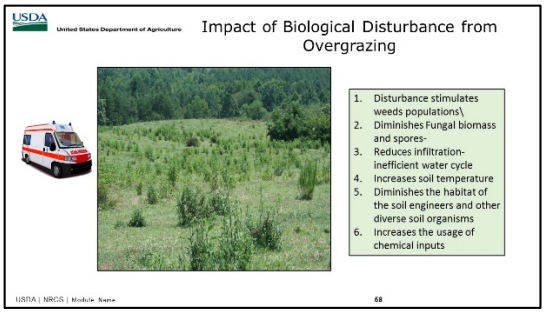
Disturbance in pasture systems is not always bad. It can be beneficial when the hoof, plant, manure, and soil interact. But it must be in a well-managed system to avoid detrimental effects to all the resources. Negative impacts can include compaction, reduced forage quality, increased weed pressure, and decreased water quality due to high concentrations of nutrients coupled with erosion. As mentioned previously, overgrazing can be used as a transition for seeding. Month prior to end of seeding date.



Slide 57

Slide 58

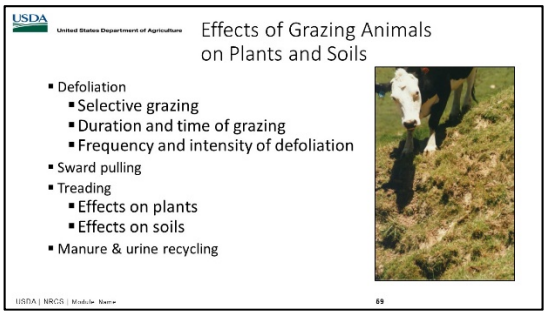
If you overgraze too much though you can get this result. Weeds become the "first responders" (see ambulance) after overgrazing but these weed are not the diversity we want. Discuss any of the outcomes listed.



Slide 58

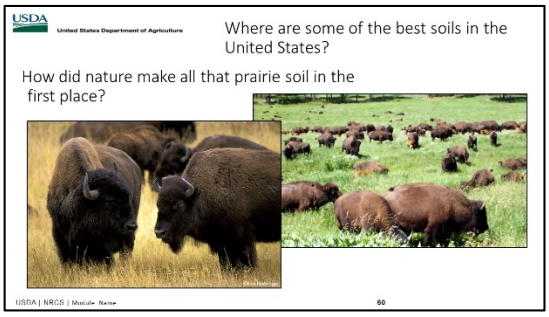
Slide 59

Grazing animals can impact plants and soils. Management can determine if it is good or bad. Here are some of the effects and what to consider. Higher density grazing with shorter duration can reduce selectivity. Again, allowing plants to be repeatedly grazed without restoring energy and leaf area diminishes plant health and thus its collaboration with soil biology. Allowing animals to "tread" on areas of pasture for long periods can cause extensive damage to plants and soil. Pore space can be severely reduced. However, what if the time on an area is short with larger amounts of residue placed on the soil surface by the animal hoof. It could actually be a positive outcome. Let's look at some ways to mimic nature and use livestock in a positive manner.



Slide 59

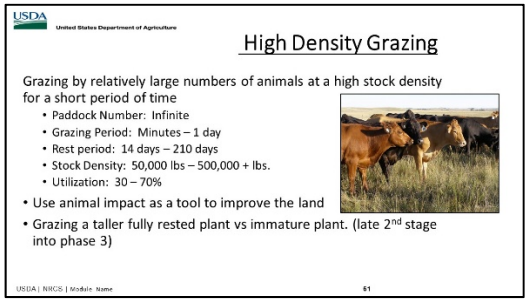
Slide 60



Slide 60

The bison roamed around eating the grass. Primarily it was warm season grass and forbs but there was a tremendous amount of diversity. There is still discussion about exactly how the bison grazed. There were a lot of factors that came into play. Time of year, growing or dormant grasses, available water, what areas burned, what didn't burn, lots of things. Some writings and accounts say they were in small groups grazing only in the burned areas for the entire year. These burned areas would have been grazed pretty hard while unburned areas were almost ungrazed and then the next year they moved to another burned area. There are also accounts of large herds numbering in the hundreds of thousands. As you can imagine when a large herd like this moved through an area everything probably got grazed and/or trampled pretty hard. In either of these scenarios the grasslands were severely grazed and then rested for a long period of time, severely grazed and then rested. It was this type of management that developed some of the most fertile soils in the world. I think we can use different forms of this type of management to repair our eroded and worn out soils.

Slide 61



Slide 61

Here's the definition of High Density Grazing that we can use.

Paddock number: can be an infinite number with the size adjusted for the time of the year to account for the amount of forage that is available

Grazing period: short periods require more management to move, but have the potential for higher soil health returns

Rest Period: the longer the better, has benefits beyond the forage, can be used to break pest cycles

Stock density: can be adjusted by how large you make the paddocks

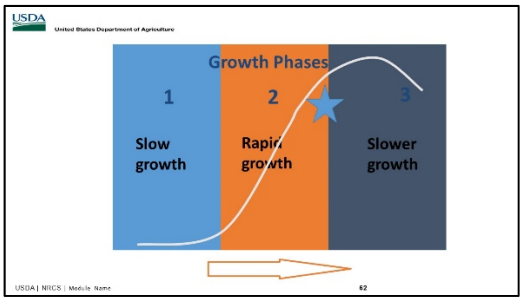
Utilization: need to keep in mind that the "micro herd" needs some forage too

Hoof action (trampling) is what helps to feed the soil microbial community

Grazing taller forage takes a change in paradigm as to how we typically look at forage management

Slide 62

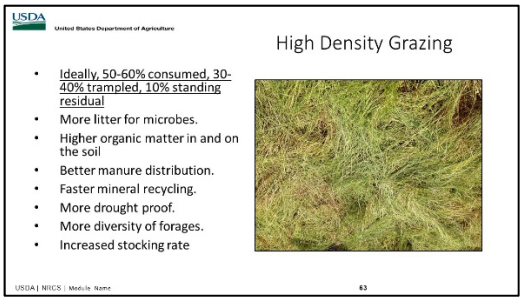
The latter part of stage 2 is the target for high stock density grazing. Earlier stage 2 is what is used in a more traditional system, where C/N ratios are lower. So, with higher C/N ratio material, livestock move thru faster while trampling some of the material flat onto the surface, much like a roller crimper would do on cropland.



Slide 62

Slide 63

While a larger percentage of the total live biomass is trampled compared to traditional systems, much of this is higher lignin with a high C/N ratio. More of this material is trampled and some farmers might feel that a lot of forage is being wasted. When we have things like recovery time, good soil biology, organic matter, that is building up a bank that pays the dividends shown on the slide. With all these soil health improvements, theoretically stocking rates could be increased due to improved yields.

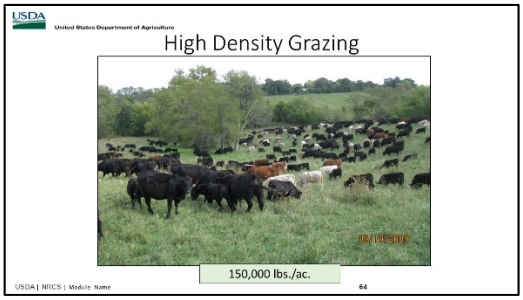


Slide 63

Slide 64

Here is an example from Doug Peterson in Missouri. This is a density of about 150,000 pounds. (density=pounds of animal on a specific area for a specific amount of time) Lots of forage. Utilization was around 50%. Most of what was left was stems.

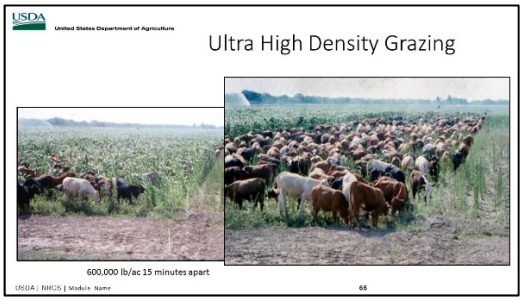
"We DID NOT want to be hard on the cows. We did not want to restrict intake or make them eat something they did not want to. "



Slide 64

Slide 65

Here are a couple of pictures that show Ultra High Density Grazing. This is around 5-7 hundred thousand pounds stock density. The pictures were taken 15 minutes apart. These stockers are moved every 30 minutes.



Slide 65

Slide 66

Here is a field that was allowed to rest from March through Aug in 2008. Then it was grazed/trampled at a stock density of about 150,000 lbs per acre. Not the half a millions pounds like the slide before but significant.

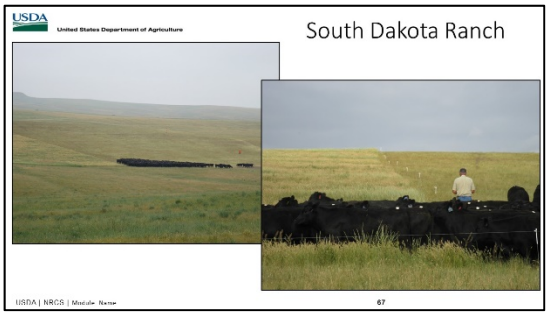
Slide 66

Did the cattle "waste" some grass? Well, they didn't eat it all but it was all used for a specific purpose. It was trampled onto the surface of the soil creating a layer of mulch, just like the hay pile, that allowed the clover to germinate and grow. In case you are wondering there has not been any clover broadcast on this field, no lime and no fertilizer of any kind for many, many years if ever.. A USDA soil microbiologist said that it typically takes a couple of years for the soil microorganisms to really begin to respond to the increase in decaying plant material. It has been managed for two years in this manner. It is likely that because of the trampling the natural nutrient cycle is starting to really kick in and that is why we are seeing the clover increase. This is closer to the 10 to 20% standing that is recommended.

This is a close up of another field on a different farm. This one has not had any lime or clover added in at least 20 years maybe not ever. It was hayed for 20+ years and now this is the 3rd year for this field to be "mulched" in this manner. What will all this clover do? Besides improving the nutritional value of what the livestock are eating it will let us tap into a free nitrogen source, the air.
There are a couple of things you have to notice. First there is not any bare soil. There is still a lot of green grass. This means the soil stays cooler and they are still able to carry on photosynthesis

Slide 67

This is a rancher in western South Dakota. He is also using some higher density grazing. He uses temporary fencing to more frequently move livestock. The photo on the left gives an idea of the extent of his ranch. Cattle are not really restricted to the small area you see. They are just ready to move to the next paddock as you see being done in the right photo. In just a few years of using this management style, this rancher has noticed improved forages with better diversity of species while the cattle are easier to handle.



Slide 67

Slide 68

Extending the grazing season by stockpiling forages and strip grazing is a form of high density grazing as livestock "advance" as the fence is moved. Plus the living root is enhanced by the fall/late summer growth (stockpiling).

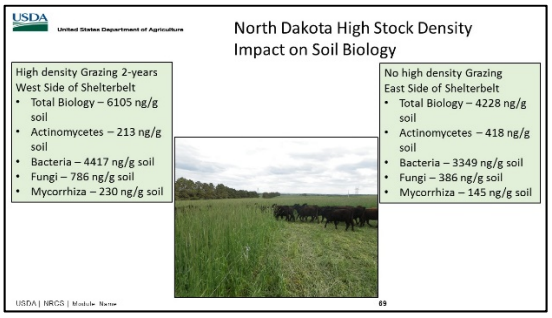
This is a look at that same stockpiled/stripgrazed pasture the next spring. Diversity has improved. The producer had never seen vetch in this pasture before. The hoof, soil, plant, residue, interaction has stimulated dormant seed to germinate.

Slide 68

Slide 69

Here is some high density grazing in North Dakota

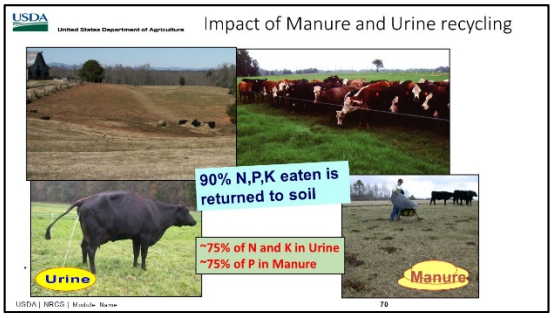
Look at the biological results from a comparison of those systems in ND. There is a greater balance of biology in this higher density grazing. Look at total biology and greater numbers of Fungi….a soil health indicator! In Tennessee, a cropland with no till and cover crops had a total biology value similar to that on the right and when animals were added it got as high as 6000 ng/g for total biology.



Slide 69

Slide 70

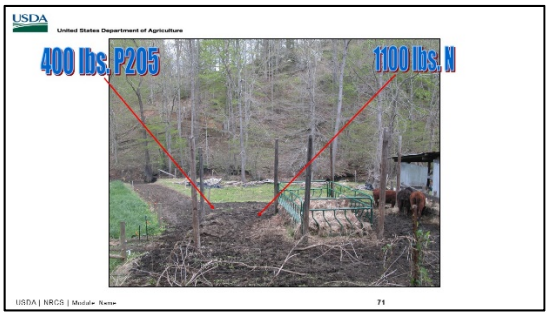
So let's go back and look at manure and urine. Remember that most of what goes in comes out the back end. So we need to make the best use out of it as possible.



Slide 70

Slide 71

In this example 30 head are fed for 120 days. This could easily be about 400 pounds of P2O5 and 1100 pounds of N deposited on one area. So this could be applied to provide nutrients for forages and be properly recycled instead of becoming a water quality problem as shown here (note the stream in the background).

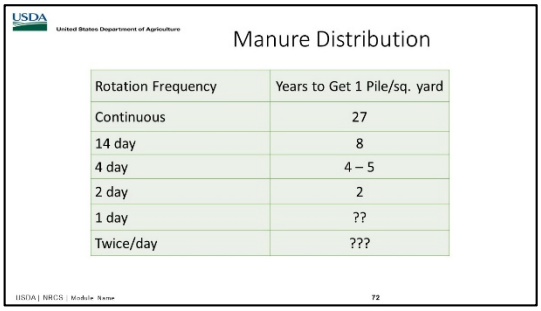


Slide 71

Slide 72

As part of the MU study, they estimated how long portions of the field might go without receiving manure. In continuous grazing, parts of the pasture will only receive manure from the cattle every 27 years. In other words portions of the pasture only receive fertilizer every 27 years. Intensive grazing can reduce this to every 2 years.

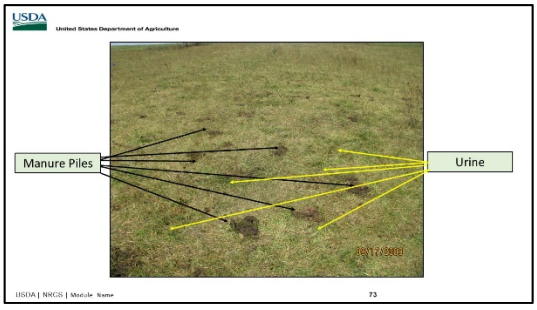
There is no data for once per day or more than once per day.



Slide 72

Slide 73

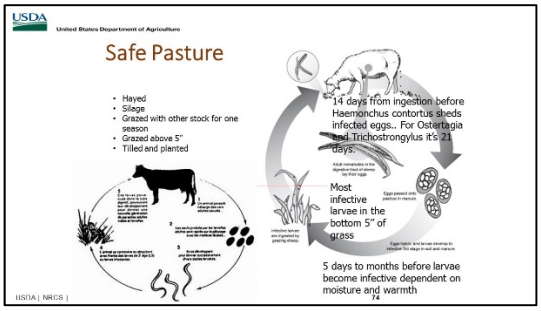
Here is an example of manure that is well distributed. Are there any areas of refusal? It has been over 4 months since anything has been on this field. Previous manure piles are gone, urine smell went away. It can take as long as 90 days for just the urine smell to go away. If we were on a 30-45 day rotation do you think we would have had areas they avoided because of manure and urine? You bet we would have. 45-60 days should be okay, sheep no problem.



Slide 73

Slide 74

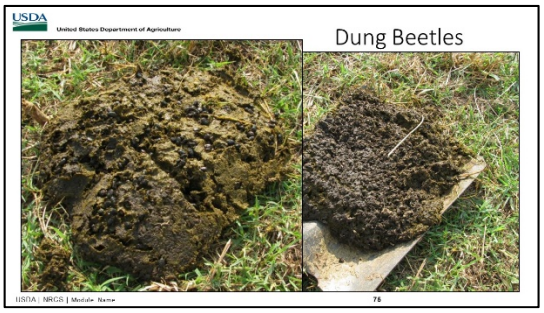
You also want to keep the grazing height higher to reduce disease from things like infective larvae that can be ingested with grass up to 5 inches tall.



Slide 74

Slide 75

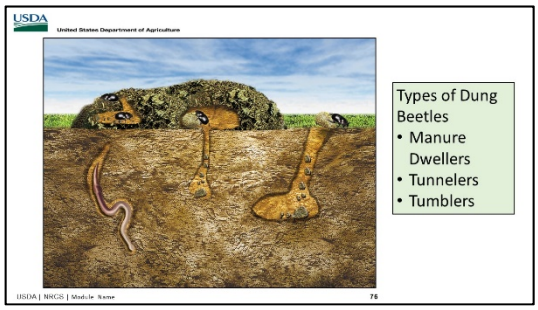
What about dung beetles? They can move and bury organic matter. These are natural tillers in perennial systems. They can persist in grazing systems but certainly thrive better where internal pesticides are absent.



Slide 75

Slide 76

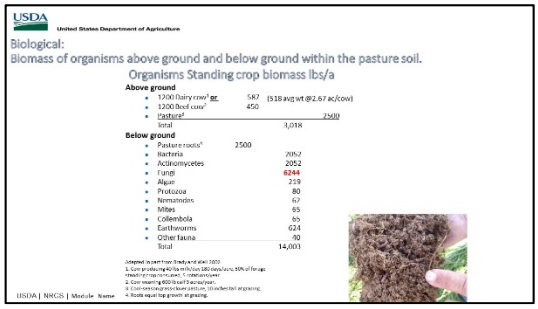
There are three basic kinds of dung beetle. Those that live in the manure, those that move manure directly down and the well-known tumblers.



Slide 76

Slide 77

This slide shows the difference in the biomass of animals above ground (3,018 lbs) and below ground (14,003 lbs) for a pasture soil.



Slide 77

Slide 78

Chickens can be great for natural pest control (fly larvae etc) and they can spread manure with their feet. Wait a few days to put chickens out to give dung beetles time to move manure and lay eggs. Otherwise the chickens will eat some of your beetles. 3 days later after beef.

Slide 78

Test their Knowledge - Questions for the audience

Q: Based on the University of Kentucky study, which is more important, cutting height or nutrient rate of application?
A: Cutting height

When you overgraze, the ground is more bare, temperatures are higher, which leads to _greater weed pressure_.

According to the study by the University of Missouri, it takes _50%_ longer to grow a ton of feed if pasture is grazed to 2" compared to 4".

Q: How can you reduce levels of toxic ergovaline in endophyte fescue?
A: Manage it at 3" or higher or dilute it with legumes or other species.

The form of nitrogen that his highly leachable is _nitrate_.

Q: What is stocking rate dependent upon?
A: It is dependent upon productivity, rainfall, the animals and management.

Q: For grazing, what determines whether fast nutrient cycling or slow nutrient cycling occurs?
A: The age of the plant when it is grazed. As long as a plant is not overgrazed, when it is grazed in the vegetative stage it will slough off roots that are quickly broken down and nutrients are released. If grazed after the flowering stage, any leaves remaining that fall to the ground are higher in carbon and less quickly digested by microbes. Roots no longer need to provide carbohydrates to microbes because the plant is no longer growing and does not need the nutrients.

Q: Under high density grazing, what is the ideal proportions for the amount consumed, trampled, and left standing?
A: 50-60% consumed, 30-40% trampled, 10% standing residual

Soil Health Evaluation

Name of Activity: Grazing management to improve soil health	Date of Activity:

A. Instruction	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. The agent/specialist was well prepared.	①	②	③	④	⑤	⑥
2. The agent/specialist presented the subject matter clearly.	①	②	③	④	⑤	⑥

B. General Learning and Change	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. I have a deeper understanding of the subject matter as a result of this session.	①	②	③	④	⑤	⑥
2. I have situations in which I can use what I have learned in this session.	①	②	③	④	⑤	⑥
3. I will change my practices based on what I learned from this session.	①	②	③	④	⑤	⑥

C. Specific Learning How much *did you / do you* know about these subjects?	*Before this program I knew…*					*Now I know….*				
	Very little	Little	Some	Much	Very Much	Very little	Little	Some	Much	Very Much
1. *The impact that grazing has on soil health*	①	②	③	④	⑤	①	②	③	④	⑤
2. *Stocking density and its importance for soil health*	①	②	③	④	⑤	①	②	③	④	⑤
3. *The impact that manure has on soil health*	①	②	③	④	⑤	①	②	③	④	⑤

D. Specific Practices To what degree *did you / will you* do the following?	*Before this program I did…*					*In the future I will realistically do….*				
	Very little	Little	Some	Much	Very Much	Very little	Little	Some	Much	Very Much
1. *Measure different field indicators of soil health*	①	②	③	④	⑤	①	②	③	④	⑤
2. *Incorporate sustainable agricultural methods for soil health*	①	②	③	④	⑤	①	②	③	④	⑤
3. *Seek additional NRCS information on financial and/or technical assistance for improving soil health*	①	②	③	④	⑤	①	②	③	④	⑤

E. Satisfaction with Activity	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. *I would recommend this program to others.*	①	②	③	④	⑤	⑥
2. *As a result of this program, I am more likely to seek additional information from UT/TSU Extension.*	①	②	③	④	⑤	⑥

F. Any suggested changes, additions, etc. to the curriculum?

Thank you for participating in this survey!