SOIL SMaRTS

Specific Management and Resources Trainings for Soil Health in Tennessee

TRAINING CURRICULUM

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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

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

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MODULE 7. ECONOMIC BENEFITS OF IMPROVING SOIL HEALTH

Learning objectives:

Participants will be able to:

- Determine and evaluate the benefits of improving soil health based on economic impacts, reduced risk, increased production efficiencies, and more resilient soils.

Materials:

- PowerPoint® slides "Module 7: Economic benefits of improving 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:

Erosion/runoff
Value of organic matter
Nitrogen loss and efficiency
Drainage and water storage
Weed suppression
Insect pests and disease
Grazing economics

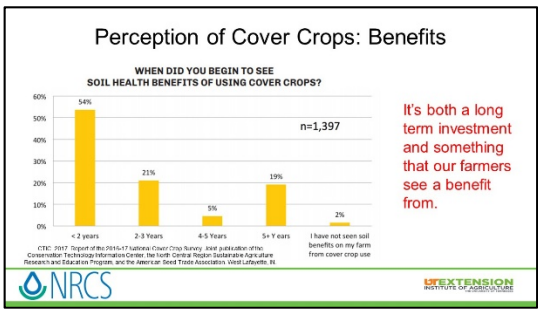
Slide 1

This module will focus on identifying the economic benefits involved in improving soil health.

Slide 1

Slide 2

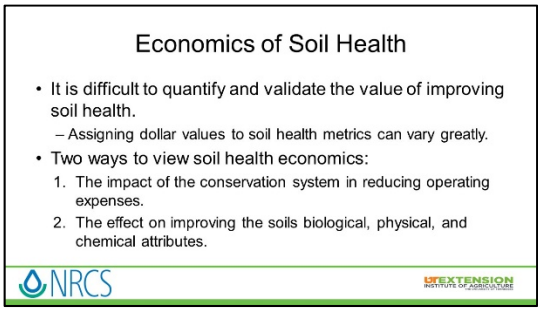
The survey shown on the screen comes from the latest National Cover Crop Survey. The results of this survey were likely the largest effort to obtain feedback from producers on their experiences with cover crops. The question above is an important one to have answered by farmers. It helps us to understand the farming community's perception of the use of cover crops. It also points to the fact that cover crop use is a long-term investment.



Slide 2

Slide 3

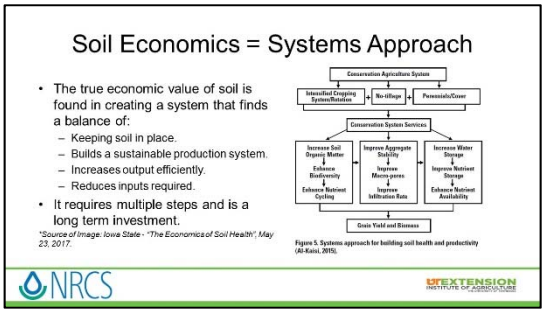
The above two points need to be made when discussing the economics of soil health. The economic return from a healthy soil is very difficult to measure. The reason is how do you place a value on an asset that is not easily sold or bought. The best method in valuing soil health is to measure the impact it has on the farming operation's bottom line. In agriculture, we tend to measure the economic impact of a production practice by asking how it increases yield and/or how much it costs.



Slide 3

Slide 4

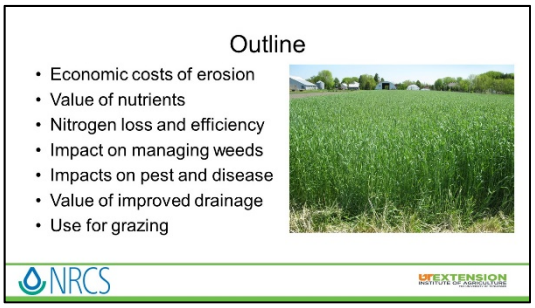
Like the figure above shows, the systems approach has many moving parts that are reliant on one another. Soil health is impacted by tillage practices, crop rotation, and the presences of vegetation in all seasons. The benefit of these production practices is multifaceted. However, the benefits are not seen overnight and will vary greatly from year to year.



Slide 4

Slide 5

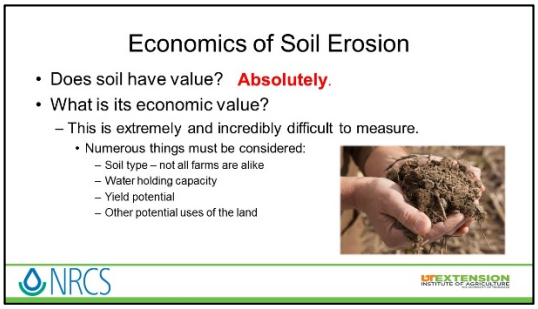
We will cover each of these in greater detail in a few minutes. Some of these have a greater impact on a producer's decision to implement cover crops.



Slide 5

Slide 6

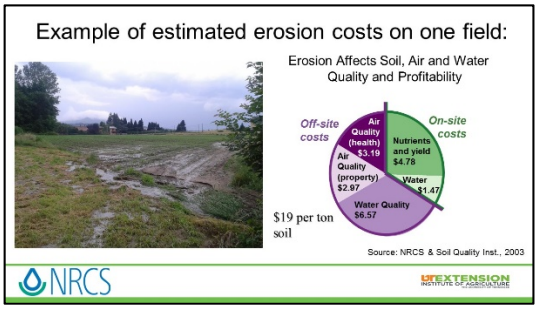
The value of soil erosion is difficult to quantify. What is not difficult to do is understand the value of a highly productive soil. When trying to determine the value of a soil, you have to consider the location of the land, the productivity of the soil, drainage of the soil, and the other possible uses for the land.



Slide 6

Slide 7

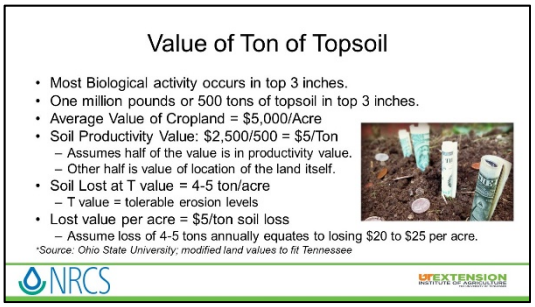
Erosion costs can come in various forms. Erosion increases costs by requiring landowners, or farmers, to excavate or create conservation structures. Also, productivity of the soil is reduced due to lost topsoil. NRCS research in 2003 estimated that the cost of erosion was approximately $19 per ton.



Slide 7

Slide 8

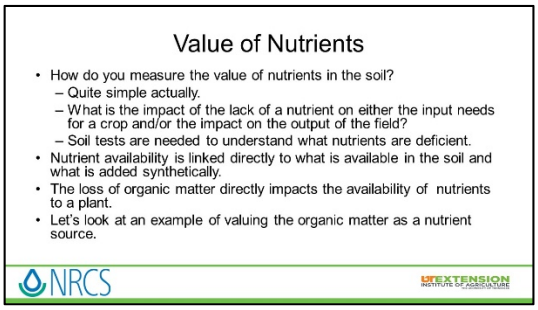
This example shows how you can calculate the value of topsoil. This study was conducted by the Ohio State University to show the value of topsoil based on the value of the land. I have adjusted the values to fit the values of land here in Tennessee. The T Value means tolerable erosion levels and was developed by NRCS. The example assumes that half of the land's value is in its productivity. Based on all of the assumptions made for this example, the loss of topsoil on this farm equates to $20-$25 per acre on an annual basis.



Slide 8

Slide 9

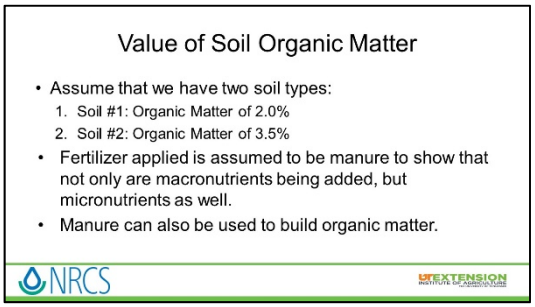
Nutrients play such a vital role in both row crop and forage production. In fact, the nutrients found in the soil are part of the discussion on soil health. Cover crops can improve the nutrients found in the soil over time. As organic matter increases, we tend to see the nutrients found in the soil increases. A glaring question that needs to be addressed is: How do you measure the value of the nutrients in the soil? The easiest way to measure the impact of nutrients in a soil is to quantify the reduction of output.



Slide 9

Slide 10

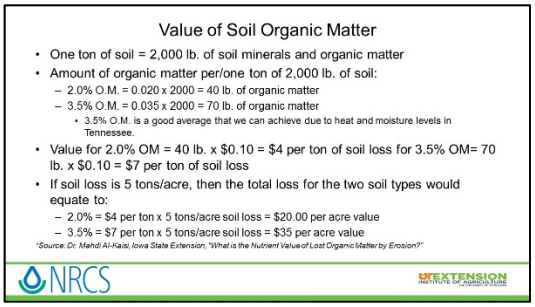
We are going to look at an example of the value of having more nutrients in the soil. We are going to focus on the soil organic matter levels of two different soil types.



Slide 10

Slide 11

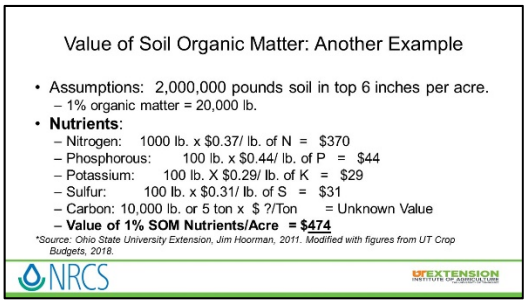
This example assumes that there is an actual value assigned to organic matter. As mentioned earlier in the presentation, it is hard to place a tangible value on soil and the contents therein. I would like to stress again the likely best way to quantify the value of organic matter is through its direct impact on reducing operating expenses and crop output. This valuation is a long-term process and one must keep that in mind.



Slide 11

Slide 12

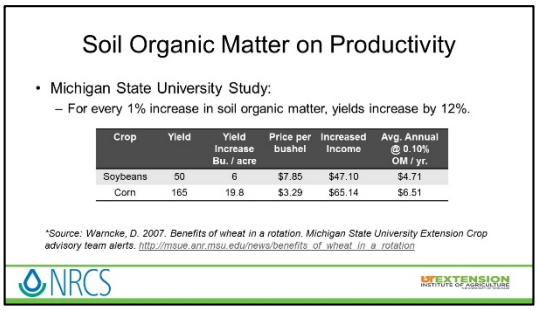
In this example, we assume that there are 2,000,000 pounds of soil in the top six inches. For every 1% of organic matter, the total weight would equate to 20,000 lbs. of organic matter per acre. Ohio State University developed a method of quantifying the value of nutrients per acre. If we assume that 1,000 lbs. of N, 100 lbs. of potassium, phosphorus, and sulfur, and use the respective values from the UT Crop Budgets, we derive a value of $474/acre for every 1% of soil organic matter.



Slide 12

Slide 13

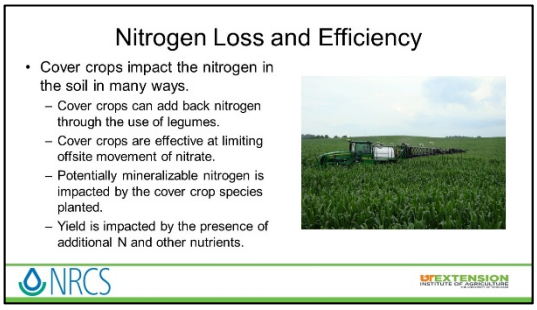
This study from Michigan State shows that for every 1% increase in soil organic matter, yield will increase by 12%. If that assumption is indeed correct, the 12% increase in yield for a soybean field with an average yield of 50 bu./acre would result in a $47.10 increase in income.



Slide 13

Slide 14

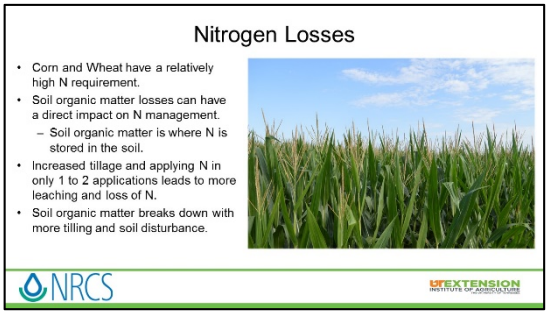
Cover crops can increase the nitrogen in the soil. Legumes can be used to fix nitrogen in the soil. Also, soil organic matter influences leaching and denitrification. Of course, yield potential is directly impacted by the availability of nitrogen to the plant.



Slide 14

Slide 15

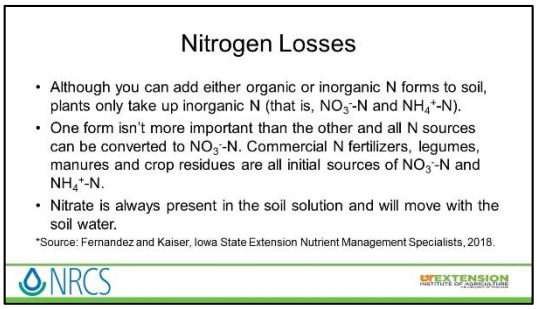
Nitrogen loss can be managed by altering production practices. Conservation tillage practices such as no-till and use of cover crops can reduce nitrogen loss. Since organic matter is one place where N in the soil is housed, any production practice that can increase soil organic matter can partially reduce N loss.



Slide 15

Slide 16

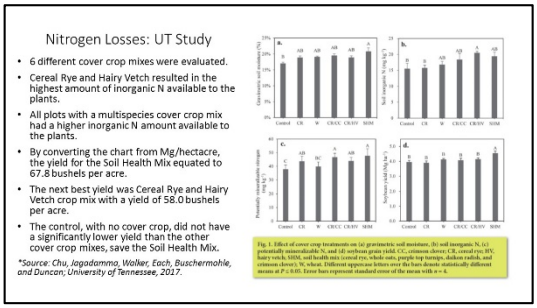
Follow material on presentation slide.



Slide 16

Slide 17

A study conducted by the University of Tennessee compared different cover crop mixes to determine which had a higher amount of N available to plants. The study showed that the multispecies cover crop mix provided more inorganic N to the soybeans. Also, the multispecies cover crop mixes increased yields in the soybean trials in comparison to the single species cover crops.

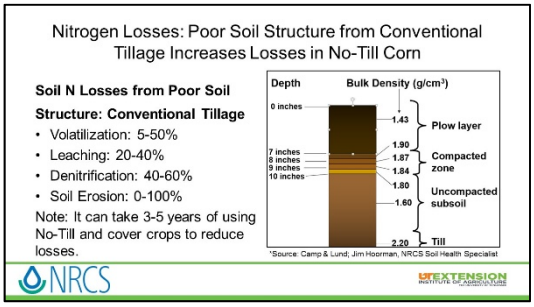


Slide 17

Slide 18

When farmers convert to no-till from conventional tillage, did they start with good soil structure? Do they still have soil compaction problems?

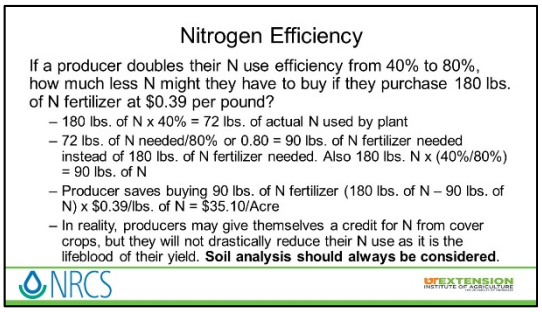
Generally the answer is yes, they have multiple problems in the soil, especially with poor soil structure. Due to poor soil structure, water runs off due to poor water infiltration and a lack of SOM. This causes soil erosion, a huge loss in SOM (floats with the water), and a large N investment (1000# for every 1% SOM). Due to poor soil structure, denitrification losses of N can be 40-60% due to standing water and the loss of N to the atmosphere. In sandy soils without much SOM, leaching losses can be 20-40%. On the soil surface, volatilization losses can be 5 to 50% because there is no residue to cool the soil and no residue on the soil surface initially to absorb and tie up N in the soil profile. It may take 3 to 5 years to improve soil structure with NT and cover crops before these losses are reduced. Our N efficiency in conventional tilled soils is only 30 to 40%. (Source: NRCS, Economic Benefits of Soil Health)



Slide 18

Slide 19

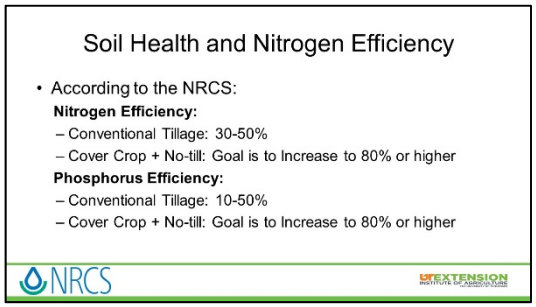
As mentioned earlier, one goal of cover crops is to increase the amount of soil organic matter in the soil. With more organic matter in the soil, nitrogen efficiency is purported to increase. In this example, if we increase nitrogen efficiency from 40% to 80%, doubling the amount of nitrogen being utilized, the producer can save 50% on their nitrogen costs and reduce the amount of applied N by 90 pounds per acre. By valuing nitrogen at $0.39 per elemental pound, we show a total savings of $35.10 per acre.



Slide 19

Slide 20

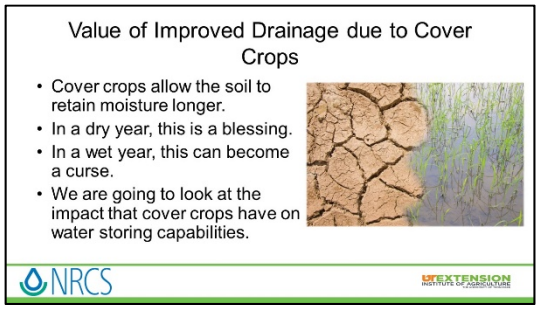
Nitrogen efficiency is drastically reduced when conventional tillage practices are used. Producers are encouraged to use a no-till system and utilize a cover crop that increases the amount of organic matter found in the soil. Also, phosphorus efficiency is impacted by tillage practices and organic matter levels. Therefore, it is important to consider tillage practices, crop residue, and perform soil tests to know the nutrients present in the soil before making an application. You may be leaving money on the table by either over applying fertilizer or not adopting cover crops.



Slide 20

Slide 21

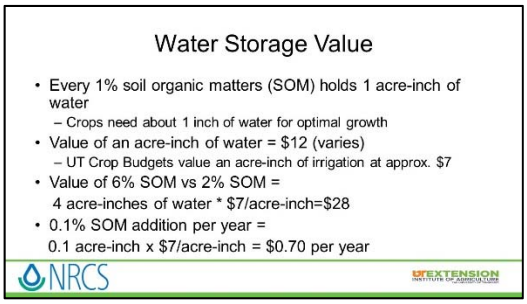
Soil drainage impacts the movement of nutrients through the soil. Soils that do not drain properly tend to have a negative impact on production. A producer can do a few things to address drainage such as installing tile or delaying planting during wet months. However, our focus is on how cover crops can be used to improve drainage. The benefit of cover crops will vary from a dry year to a wet year. In a wet year, cover crops can provide an added challenge. Like most things in agriculture, the benefit of a production practice or product choice depends on growing conditions, which makes results very, very subjective. But, we do want to look at the benefits of cover crops in regard to water storing capabilities.



Slide 21

Slide 22

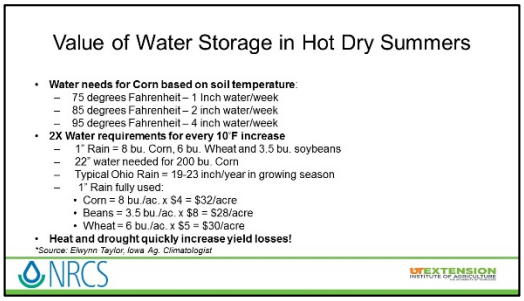
With higher amounts of soil organic matter, we tend to see an increase in water retention. The increase in soil organic matter will aid in keeping more moisture in the soil longer. This example shows the savings from not having to irrigate as much. Of course, these costs savings only hold water if we are talking about irrigated land. Yes, the pun was intentional.



Slide 22

Slide 23

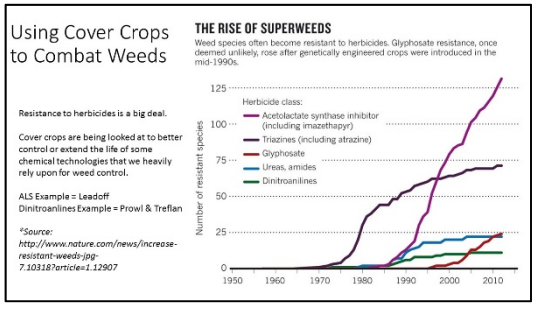
The water needs for crops are affected by temperature. As the temperature rises, the amount of water needed increases as well. The water needed essentially doubles for every 10 degree increase in temperature once the temperature hits 75°F. In this example, we can see that 22" of water is needed to produce a 200 bu. corn crop. By using the assumption that 1" rain increases corn yields by 8 bushels, the value of a fully utilized inch of rain is $8 per acre, assuming a price of $4 per bushel. If we use the same methodology on the soybean and wheat example, we show that the decrease in stress on the plant equate to a savings of $28 per acre for soybean and $30 per acre for wheat.



Slide 23

Slide 24

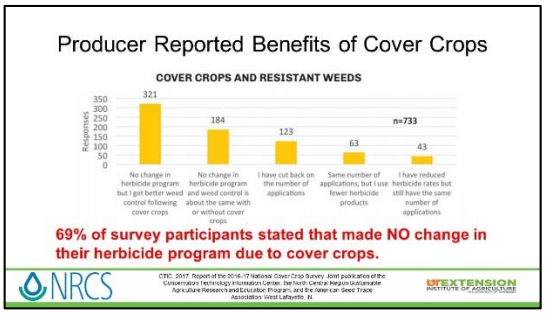
Cover crops can also be used to combat weeds. The increase in weed resistance has led us to become reliant upon only a few families of herbicides. As we increase the reliance upon only a select few chemistries, we increase the chance of creating a level of resistance that we cannot overcome with a solution poured from a jug. This chart shows how some species of plants have become resistant to common classes of herbicides. The number continues to increase. Cover crops are being looked at to try to be part of the solution to controlling resistant weeds.



Slide 24

Slide 25

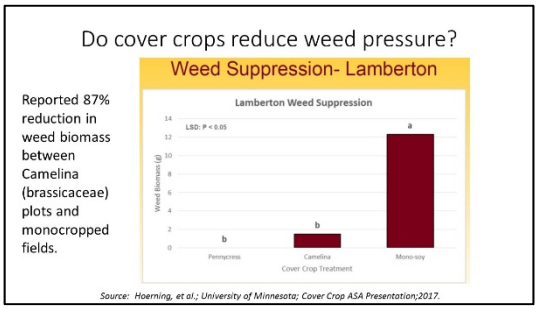
I would like to reference the 2016-2017 National Cover Crop Survey again. The question was posed to the farmers that participated in the survey whether cover crops had changed their herbicide program. 43.7% of the respondents said that there has been no change in their program but that they have better weed control following cover crops. 25.1% of respondents reported that there was no change in their herbicide program and that weed pressure was unchanged following cover crops. 31.2% of respondents did state that their total use of herbicides was reduced in some manner.



Slide 25

Slide 26

The University of Minnesota conducted research between two different locations. In each of the locations, a field of soybeans, planted in a monocrop, were compared to a field planted with either Pennycress or Camelina, which are a harvestable oilseeds. The plots with the Camelina had less weed biomass in comparison to the monocropped soybeans.

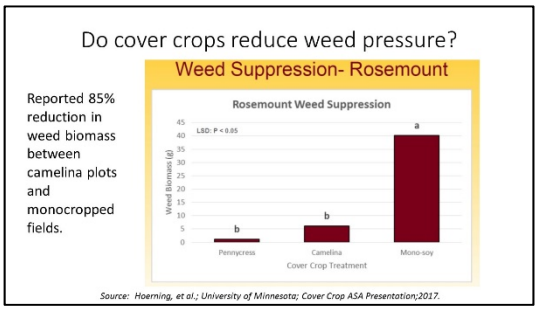


Slide 26

Location #1 Results.

Slide 27

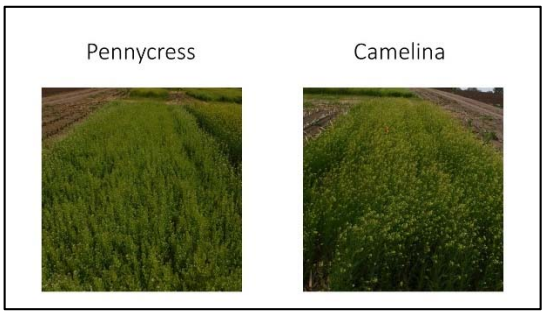
Location #2 results from the University of Minnesota field study.



Slide 27

Slide 28

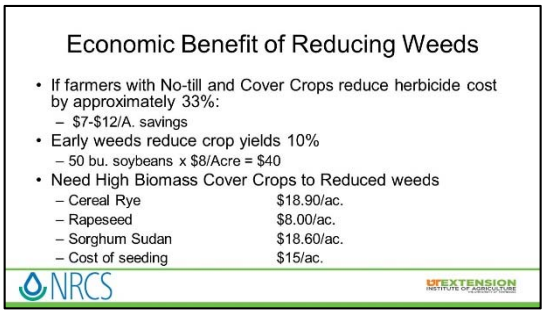
Images of cover crops used in the previous two slides. Pennycress on left and Camelina on the right are both an oilseed grown in colder climates such as MN and Canada.



Slide 28

Slide 29

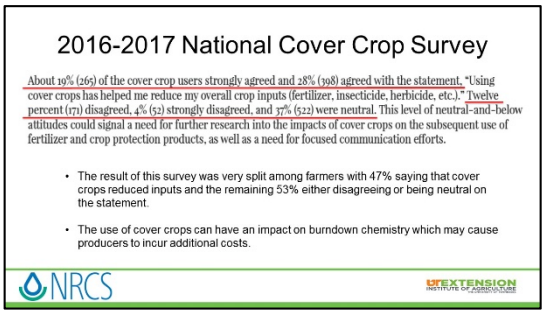
Let's look at an example of the economic benefit of reducing weeds. The NRCS suggests that with the use of no-till and cover crops that herbicide use can be reduced by 33% (Source: NRCS, Economics Benefits of Improved Soil Function), which results in an average savings of $7-$12 per acre. They also show that early weeds can reduce crop yields by 10%, which directly impacts a farmer's overall profitability. In order to reduce weeds, a high biomass cover crop needs to be planted.



Slide 29

Slide 30

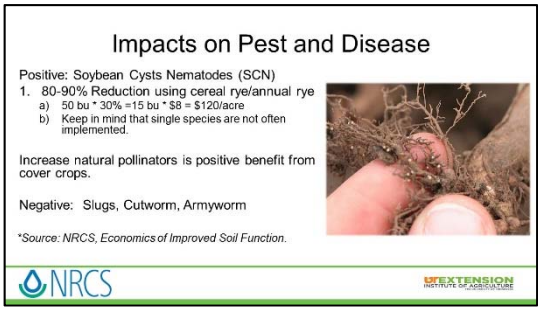
A relevant quote from the narrative of the 2017 National Cover Crop Survey.



Slide 30

Slide 31

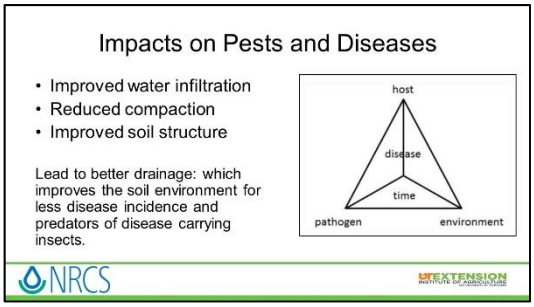
Example of the impact cover crops have on pests and diseases. The reduction in pests such as the soybean cyst nematode has a positive impact on yield. The presence of cover crops does attract additional pests such as vole, slugs, and other insects. These added pests can come with added costs and reduced yields, but the issues will likely vary from field to field.



Slide 31

Slide 32

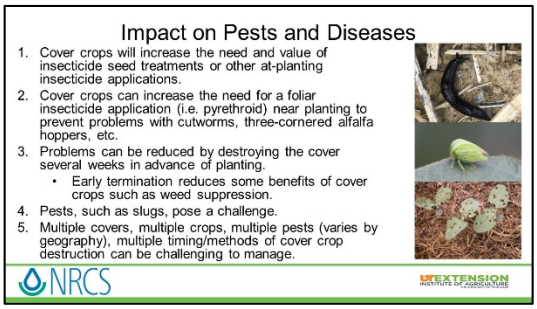
Cover crops help to improve water infiltration, reduce compaction, and improve soil structure. All of which lead to better drainage which can create an environment that is habituated by predators that remove harmful diseases.



Slide 32

Slide 33

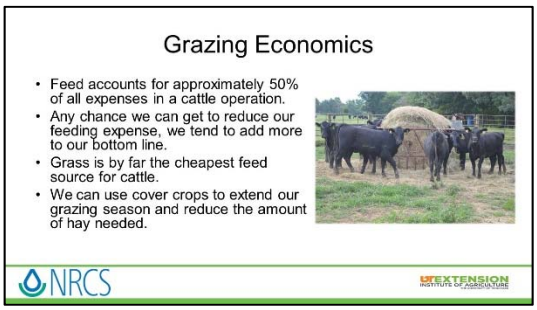
A few things to consider when using cover crops. The impact on pests and diseases can be very beneficial, but can as easily be problematic. Comments were gathered from input provided by Dr. Scott Stewart, University of Tennessee, IPM Coordinator and Professor Entomology and Plant Pathology.



Slide 33

Slide 34

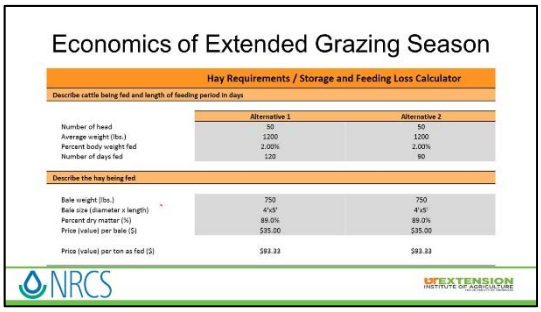
Cover crops can also be used to graze. This helps to reduce feed costs for producers. Grass is the cheapest feed source for livestock. Therefore, any extension of the grazing season will lower the overall feed bill for the herd.



Slide 34

Slide 35

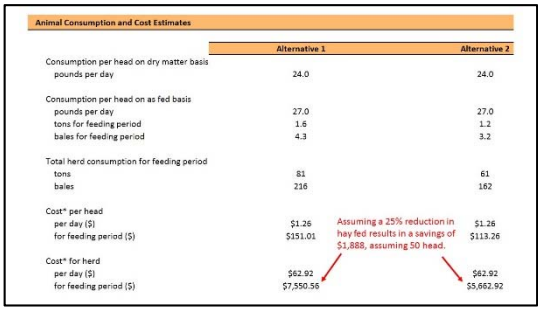
Example of the impact of a longer grazing season. The above example is taken from the UT Extension Hay Calculator. We assume that the use of cover crops reduces the producer's hay requirements by 25%, or 30 days.



Slide 35

Slide 36

The total savings from having a longer grazing season is $1,888 (25% savings).

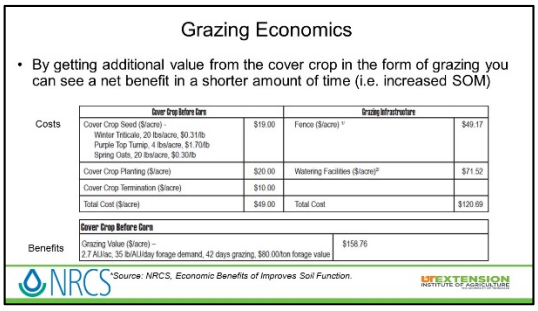


Slide 36

Slide 37

Total cost of a cover crop mix planted before corn was $49,
Cost of fence and water was $120.69/acre

Benefit of grazing
Cover crop produced approx. 4,000 lbs. of forage
Allowed 2.7 AU/acre to be grazed for 42 days
To have purchased this forage would have cost $80/ton
total $158.76

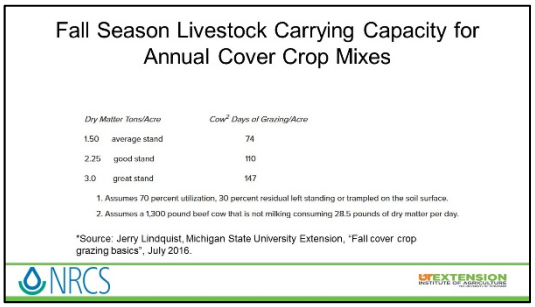


Slide 37

This doesn't include the value of the nutrients returned through the cows

Slide 38

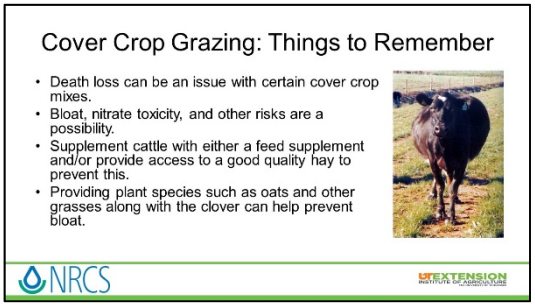
This information comes from Michigan State University Extension. Their study shows that a good stand of cover crops can be an excellent source of grazing. The better the stand of grass results in a longer period of grazing. With a good stand, the cows had an average grazing time of 110 days. In this study, cover crops could potentially replace the need for hay as the primary feed source in winter months.



Slide 38

Slide 39

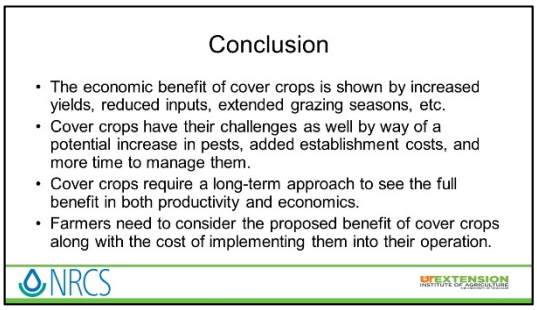
Cover crops present some challenges that cattle producers need to keep in mind. Address all of the bullet points to show they can impact the health of the herd.



Slide 39

Slide 40

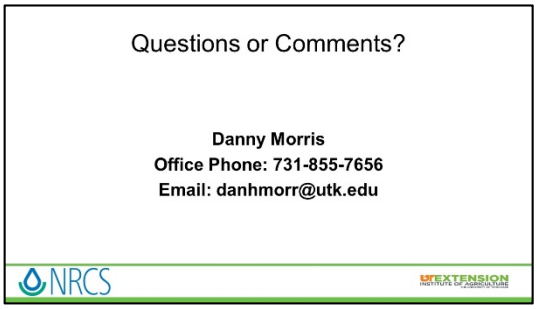
Follow material on presentation slide.



Slide 40

Slide 41

For more information, contact Danny Morris, UT Area Farm Management Specialist



Slide 41

Test their Knowledge - Questions for the audience

Q: What is the estimated cost of erosion?
A: $20-25/acre/year

The estimated value of the nutrients present in 1% organic matter is _474_ $/acre.

According to a study by Michigan State University, for every 1% increase in organic matter, there was a _12%_ increase in yield of corn and soybean.

Q: On the soil surface, how much nitrogen can be lost under conventional tillage due to volatilization?
A: 5-50%

Every 1% organic matter can hold about _1_ acre-inch of water.

Q: How do cover crops help reduce the potential for plant disease?
A: They reduce the potential for saturated soils by increasing water infiltration, reducing compaction, and improving soil structure. Some cover crops can even promote predators that consume certain disease organisms.

Q: How can you control the potential for insect problems when using cover crops once cover crops have been planted?
A: Apply foliar insecticides at planting (cash crop) or terminate cover crops several weeks before planting.

Q: If a producer is able to graze an extra 30 days using cover crops, what will their savings be?
A: 25%

Soil Health Evaluation

Name of Activity: Economic benefits of improving 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 economic impacts of erosion*	①	②	③	④	⑤	①	②	③	④	⑤
2. *The economic impacts of soil organic matter*	①	②	③	④	⑤	①	②	③	④	⑤
3. *The effect of good soil management on nitrogen efficiency*	①	②	③	④	⑤	①	②	③	④	⑤
4. *The impacts cover crops can have on grazing economics*	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!