

SOIL SMARTS

Specific Management and Resources Trainings
for Soil Health in Tennessee

TRAINING CURRICULUM

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TENNESSEE
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Cooperative Extension

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INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE



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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MODULE 5. COVER CROP MANAGEMENT

Learning objectives:

Participants will be able to:

- Identify management strategies to integrate cover crops into soil health management systems.
- Discuss the impact that cover crops have on soil functions, e.g. water infiltration & availability, nutrient cycling.
- Identify benefits of cover crops in agricultural systems.
- Understand key concepts for successful cover crop management, including planting, termination and species selection.
- Design a cover crop (mono and multi-species) strategy to address identified resource concerns
- Discuss key concepts to troubleshoot problem cover crop plantings
- Discuss differences in cover crop planning and management across various geographic regions

Materials:

- PowerPoint® slides “Module 5: Cover Crop Management”
- Lesson guide: Use the notes in this lesson guide to present information for each 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:

Agricultural benefits

Needs for success

Cover crop diversity

Identifying needs of the producer

Establishment methods

Types of cover crops and blends

Soil moisture management

Herbicide restrictions

Termination methods

Seeding rates

Local examples

Ideas

Planning tools

Slide 1

This module will cover a number of aspects of cover crops including their benefits, types and blends, planting and termination, and tools for further assistance.



Slide 1

Slide 2

Follow material on presentation slide.

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Learning objectives

By the end of the lesson you will be able to:

1. Identify management strategies to integrate cover crops into soil health management systems
2. Discuss the impact that cover crops have on soil functions, e.g. water infiltration & availability, nutrient cycling
3. Identify benefits of cover crops in agricultural systems.
4. Understand key concepts for successful cover crop management, including planting, termination and species selection.
5. Design a cover crop (mono and multi-species) strategy to address identified resource concerns
6. Discuss key concepts to trouble shoot problem cover crop plantings
7. Discuss differences in cover crop planning and management across various geographic regions

Slide 2

Slide 3

Photos...Upper left corner going to the right:

Grazing cover crops

Rhizobium on hairy vetch

Turnip and radish

Purple top turnip making soil aggregates

Some people get really excited about seeing a big radish or turnip, but we need to understand how the tool (cover crop) helps to improve soil function.

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Cover Crops:

"If you're trying to make your soil healthier, You shouldn't see it very often"

Slide 3

Slide 4

Do you understand the use of cover crops as biological primers? Food Security Act policy has driven the agency to think about cover crops to be used to prevent erosion to meet Highly Erodible Land Conservation compliance. When we understand how a soil functions we see that cover crops are more than annual crops used for erosion protection but are used as biological primers that can build the health of soil when accompanied by a management system that follows the principles of soil health.

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Is it a Cover Crop or Biological Primer?

- Cover crops have been used mainly to provide cover to protect from forms of erosion.
- Many soil health innovators realize that cover crops can be more than providing cover, they are biological primers that jump start the revitalization of the degraded soil ecosystem.



Slide 4



Slide 5

We want to mimic nature in our current farming practices. By following the soil health management principles we can relate our current systems back to times when large herds of bison moved across the landscape.

Soil works for you if you work for the soil by using management practices that improve soil health and increase productivity and profitability immediately and into the future. A fully functioning soil produces the maximum amount of products at the least cost. Maximizing soil health is essential to maximizing profitability. Soil will not work for you if you abuse it.

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Nature's Way:



Slide 5

Managing for soil health (improved soil function) is mostly a matter of maintaining suitable habitat for the myriad of creatures that comprise the soil food web. This can be accomplished by disturbing the soil as little as possible, growing as many different species of plants as practical, keeping living plants in the soil as often as possible, and keeping the soil covered all the time.

What practice does all this? The use of cover crops integrated into existing rotations can allow the soil to start being rebuilt. It is crucial to integrate and follow all soil health management principles in order for the soil to become and remain healthy.

The video shows buffalo grazing.

Slide 6

As much as 10 metric tons of material may pass through the bodies of earthworms on a hectare of land each year, resulting in nutrient rich "casts" that enhance soil stability, aeration, and drainage (Lee 1985).


Some bacteria are responsible for "fixing" nitrogen, a key element in proteins, by drawing it out of the atmosphere and converting it to forms usable by plants and, ultimately, human beings and other animals.

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Why should farmers try cover crops?

Agricultural Benefits

- Supplemental grazing
- Improve organic matter
- Nitrogen capture/cycling
- Additional lasting residue/cover
- Weed suppression/disease cycle
- Beneficial insects
- Food source for predators/pollinators



Source: <http://www2.mndnr.state.il.us/Biology/ecos/soil/soil6c.htm>

Slide 6

Slide 7


It's a long list of benefits which can improve the productivity of the soil.

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Why should farmers try cover crops?

Agricultural Benefits

- Soil structure, compaction, porosity (physical properties)
- Erosion and runoff reduction (HELC)
- Nitrogen fixation by legume cover crops
- Soil water management
- Soil health – biological life



Source: <http://www2.mndnr.state.il.us/Biology/ecos/soil/soil7.htm>

Slide 7

Slide 8

Herbicide carryover is very critical when planting subsequent cover crops, some common herbicides may have an up to 18 month plant back restriction.


Adjust and learn local conditions that could have a positive or negative effect on the next crop

What resource concerns am I trying to solve with this cover crop mix?

Some cover crops will work when flown on but the best way to establish a successful CC is to drill it.

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Considerations for successful cover crop planning




- Site preparation/Early weed control is essential
- Herbicide carryover and label restrictions
- Timing and species (adequate growing season)
- Crop rotation/diversity
- Seeding method seed-soil contact (broadcast vs. drilling, adequate equipment)
- Seed size/seeding depth
- Site and moisture conditions


Slide 8

Slide 9

More things to keep in mind...there is definitely some planning involved in keeping a continuous cover over the soil.



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Considerations for successful cover crop planning (cont.)

- Residue management (cash crop) before and after cover crop emergence
- Moisture management (cover benefits, water use)
- Nutrient cycling considerations (C:N ratio, living root)
- Weed, insect and disease management
- Termination method/timing – know before you plant how you are going to terminate
- Establishment of next cash crop
- Economics (yield impacts, cost of establishment, soil improvement)
 - ("can we afford not to use a cover crop" J. Fuhrer, 2016)


Slide 9

Slide 10


Crop diversity is a major player when improving soil health on your farm. Take a minute and look at nature, plants were created to grow in diverse ecosystems, not monocultures.

If we are trying to regenerate a resilient soil that can handle multiple stresses, this resilience comes from diversity. It is just like a 401K retirement plan...if your portfolio is not diverse then you are at great risk.

If we plant a cover crop with just legumes and/or brassicas we may not be solving resource concerns. For example, the Carbon:Nitrogen ratio is very low with legumes and brassicas and very little if any residue will be left over the winter to provide armor on the soil surface.



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Why Diverse Cover Crop Mixes?

1. If *Soil Health* is the goal, *Crop Diversity* cannot be ignored or overstated
2. Plants were created to grow in diverse ecosystems
3. *Resilience* comes from *Diversity*
4. Balanced "diet" for soil biology
5. Balance: because even good things (legumes, brassicas) when not used in moderated balance can be harmful

Slide 10

Slide 11

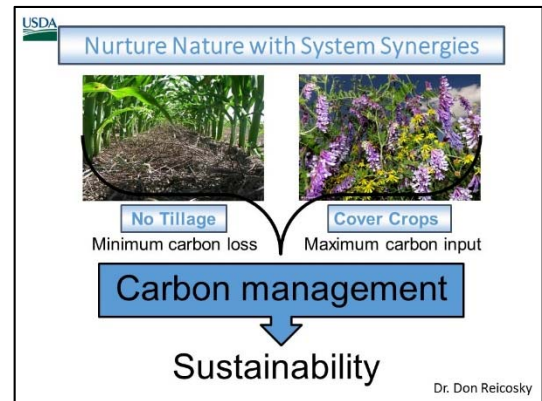
Slide shows a picture of a mixed species seed mix. Producers are used to and comfortable seeding one species of seed but when faced with the task of seeding a very diverse mix like the picture above, growers may be intimidated. The above mix can be commercially bought and delivered in prepared bags ready to be seeded. Also producers can buy individual seeds and mix themselves on the farm through the use of concrete mixers, feed mixers, farm built blenders, mixed by hand in the seed box, or using multiple seed boxes. Seeds can be commercially spread, broadcast by hand, ground or aerial equipment, or by a seed drill or planter. Producers will have different objectives and different seeding methods.



Slide 11

Slide 12

Cover crops help to manage carbon in the soil but they need to be combined with a no-till system. No-till minimizes carbon loss and adding cover crops into rotation increase the carbon input.



Slide 12

Slide 13

Photo (left to right): radish, purple top turnip, pea, crimson clover, hairy vetch

Make sure we have addressed the goals and concerns from the producer using the questions on this slide. Know when certain cover crops can be planted.

Be careful of the money spent on cover crops as it is easy to get to costly, so look for alternative species, try small seed covers.

This slide is titled "Questions to ask when planning cover crops with a producer" and features the USDA logo. It lists four questions: 1. What are the goals/concerns? 2. What are the environmental (climate, rainfall, frost, growing season) considerations? 3. What is the timeframe? 4. What is the budget? To the right of the list is a photograph of a field with various cover crops growing.

Slide 13

There are innovative cover crop companies out there that have calculators (i.e. SmartMix Calculator by Green Cover Seed) to help you practice developing alternative multi species cover crop mixes, some even provide a real time quote or cost per acre estimate.

Slide 14

A good soil health consultant should be very aware of the resource concerns that are facing the farming operation, review this short list with your producer when in the planning and inventory stage of conservation planning

This slide is titled "Cover Crops: Designing for what you don't have!" and features the USDA logo. It includes two photographs of cover crops on the left. On the right, under the heading "Identify Resource Concerns", is a bulleted list: Provide crop diversity, Provide soil surface armor (erosion), Build soil aggregates, Improve the water cycle, Integrated Pest Management, Build soil organic matter, Nutrient cycling, Air Quality, Enhance pollinator /predator habitat, Adjust carbon/nitrogen ratios, Wildlife winter food & shelter, Livestock integration, and Nitrogen fixation.

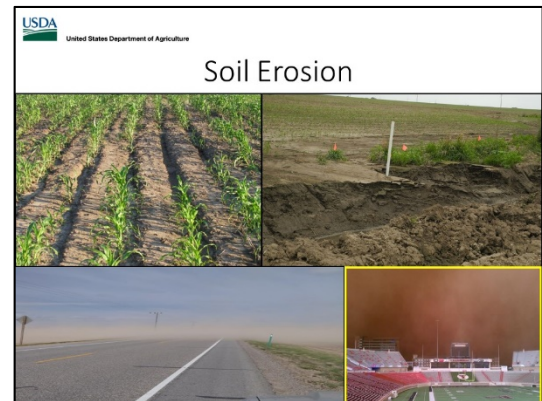
Slide 14

Slide 15

Bottom left: wind erosion 50+ tons per acre loss

Bottom right: Lubbock Texas, wind erosion

Cover crops provide a continual cover during those times of the year when erosion from wind and water is most likely to occur.



Slide 15

Slide 16

Cover crops suppress weeds by:

Outcompeting them for available resources

Smothering them with a thick organic residue layer

Some cover crops have chemical (allopathic) effects

Caption picture: \$12/ac weed control program in soybeans. Proof that cover crops with crimped biomass adds money in your pocket. This field is in the heart of Palmer pigweed country. This is its third year in rolled biomass.



Slide 16

Slide 17

Here is a great side by side comparison on Palmer amaranth and mares tail control with the addition of heavy biomass cover crops. The picture speaks for itself. The field on the left is a long-term, no-till soybean field without cover crops. The field on the right has soybeans planted into 10,000 lbs. of biomass cover crops consisting of crimson clover, hairy vetch, Austrian winter pea, daikon radish, wheat, cereal rye, triticale, and canola rolled down with a cultipacker. The field on the right has had a burndown application and one post application of herbicide. Trying to control herbicide resistant weeds with herbicides alone will always be an uphill battle. The better we manage the biomass, the better weed suppression we will have.



Slide 17

Second picture: Same field from two months prior (6/22/16). Notice the armor on the soil!

Slide 18

It is important to tie these goals back to how they will meet the soil health management principles.

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What are your goals/resource concerns?
Generally speaking....

1. The more specific your goals/concerns, the less diverse your mixes will typically be
2. The tighter your planting windows, the fewer species will work and thus the less diverse your mixes will be
3. Minimum of 6 to 8 weeks of growth necessary to achieve most benefits

Slide 18

Slide 19

No-till drill

Broadcast + Bush hog

Broadcast + Stalk chopper

Aerial seeded post harvest

Tractor, Combine, Sprayer mounted seeders



Slide 19

Slide 20

When can the producer plant cover crops in their rotation? The easiest in most rotations is behind small grain crops.

Be aware of crop insurance implications, they seem to be a constant moving target.

There may be short windows to grow cover crops ex. 60 days between cash crops to build diversity, scavenge nutrients, and suppress weeds.

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What is your timeframe?

1. Spring - fallow ground or prior to a spring crop (chemical/mechanical termination) (Check crop insurance implications!)
2. Early Summer - Right after wheat harvest (frost or chemical/mech. termination)
3. Late Summer - Delay after wheat harvest (frost termination)
4. Fall - After fall crops (frost termination or over-wintering)

Slide 20

Slide 21

It is good to use some common sense thinking when including cover crops into your operation. Consider this list from a producer who fully implements cover crops on his operation.

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Cover Crop Tips


- Use species that are adaptable to your environment
- Adjust species composition to season of use
- Diversity (speeds up biological time)
- Be aware of herbicide residuals
- Check with crop insurance eligibility
- Don't use a species in the mix if you are planning to seed it in that field next year
- If grass finishing, do not allow any grains to set seed
- "It can't grow in the bin, when in doubt seed it"! (G. Brown)

Slide 21


Slide 22

Photo from Matt Griggs' farm in Humboldt, TN
On a per acre basis, the mix includes 10 lbs cereal rye, 2 lbs annual ryegrass, 10 lbs oats, 10 lbs crimson clover, 10 lbs Austrian winter pea, 6 lbs vetch

To diversify and promote soil biota it will take a diversity of plant roots to provide these services and build this habitat. Most crop rotations and pasture forages contain few species and usually lack diversity.

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Diversify!



- Hard to improve soil health if there is no diversity of crop types.
- Need to add species diversity.

Griggs Farm, Humboldt, TN 6 way cover mix for corn

Slide 22

Slide 23

"In early stages of development plants give priority to roots so the biomass below ground may be 10 times the biomass above ground" (Nature and property of soils, p. 467)

Compaction relief with cover crops – radish (shown in slide). Use a shovel to look at root development. Some folks may look at a little 3 inch radish and say its "a failure" they never took the time to use a shovel and look at the compaction relief being accomplished belowground.



Slide 23

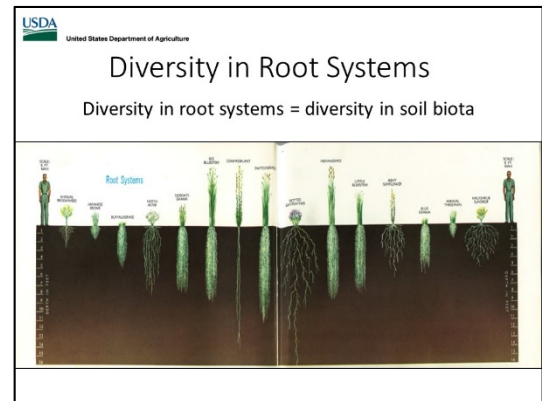
Slide 24

We are also looking at below ground root diversity, we need tap roots for deep compaction relief, and to bring up leached nutrients to the soil surface.

We need fibrous roots to build surface aggregates.

We could use bulb type roots for late winter grazing, once the tops have long been frozen and lost.

We need roots that explore different depths of the soil, to extract nutrients, water and to get carbon to deeper depths.



Slide 24

Slide 25

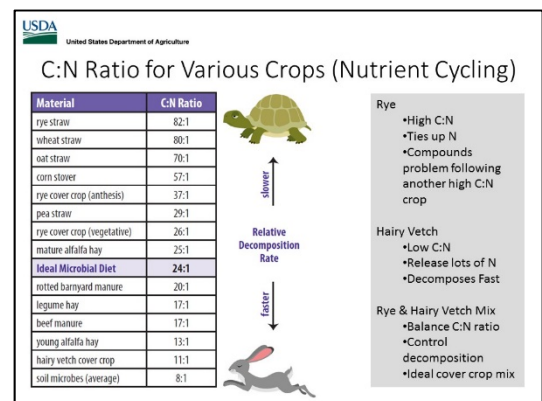
When designing a cover crop system, planners need to have a knowledge about certain characteristics of the plants they are using. Review this list quickly, as you'll go through more in detail in other slides.



Slide 25

Slide 26

- Cover crops added to a cash crop rotation can help manage nitrogen and crop residue cover in a cropping sequence.
- A low C:N ratio cover crop containing legumes (pea, lentil, cowpea, soybean, sunn hemp, or clovers) and/or brassicas (turnip, radish, canola, rape, or mustard) can follow a high C:N ratio crop such as corn or wheat, to help those residues decompose, allowing nutrients to become available to the next crop.
- Similarly, a high C:N ratio cover crop that might include corn, sorghum, sunflower, or millet can provide soil cover after a low residue, low C:N ratio crop such as pea or soybean, yet decompose during the next growing season to make nutrients available to the following crop.
- Understanding carbon to nitrogen ratios of crop residues and other material applied to the soil is important to manage soil cover and crop nutrient cycling.



Slide 26

Slide 27

Right species: use species that address specific resources concerns or client objectives

Right inoculants: Try to find a cover crop dealer that knows about rhizobium (inoculant)

Right seeding rates: 30 to 40 lbs per acre is a pretty common rate, but you can easily go lower with small seeded species.

Right seeding time: Different species have different planting date requirements. Keep these in mind when creating and planting a blend.

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Get 4 Things Right

1. The Right Species
2. The Right Inoculants
3. The Right Seeding Rates
4. The Right Seeding Time



Slide 27

Slide 28

According to the NRCS, the four functional groups include cool-season broadleaf, cool-season grass, warm-season broadleaf, warm-season grass. A cover crop blend does not have to have all four functional groups to be successful.

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Plant Functional Groups & Species

Legumes	Common Vetch	Grass	Italian Ryegrass
Spring Pea	Lentil	Oats	Proso millet

Broadleaf	Broadleaf
Safflower	Daikon radish
Purple top turnip	Winter canola

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Slide 29

Example of a state cover crop seed calculator from TN and Green Cover Seed Smartmix calculator

The various components of these calculators include:

- Cover crop categories, e.g. legumes, grasses, brassicas & broadleaf
- Type of cultivar
- Seed rate lbs. per acre
- Seeds per lb.
- Seeds per acre
- Total PLS planned (in lbs.) for the field

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Commercial and NRCS TN Cover Crop Mix Calculators

Species	Seed Rate (lbs/acre)	Seeds per lb.	Seeds per acre
Common Vetch	10	1,000,000	10,000,000
Italian Ryegrass	10	1,000,000	10,000,000
Oats	10	1,000,000	10,000,000
Proso millet	10	1,000,000	10,000,000
Safflower	10	1,000,000	10,000,000
Purple top turnip	10	1,000,000	10,000,000
Daikon radish	10	1,000,000	10,000,000
Winter canola	10	1,000,000	10,000,000

Slide 29

Slide 30

The cool season mix shown in the slide worked well for a corn/soybean rotation in Coffee county, TN.

The photo is of a warm season mix. They skipped soybeans in rotation and planted a 12 species summer blend to see what strides could be made to make the field more productive for a 2018 corn crop.

No matter what...plant diverse mixes, never monocultures, if mimicking nature and increasing soil health is your goal.

High plant diversity = High biological diversity

Slide 31

Cover crops as part of a soil health management system have the potential to nearly address all resource concerns on a producer's operation. Increased infiltration can occur from the continued use of cover crops by replacing dead roots of a cover crop or cash crop with roots of another cover crop. Vacant root channels and channels made by the soil biology provide conduits into the soil profile. Cover crops when rolled down on the soil surface provide a thick mat of residue that can intercept the sun's rays to reduce evaporation from the soil profile. Cover crops can also be managed to grow longer into the next growing season to take up excess moisture to aid in planting the next cash crop. Or, the cover crop could be terminated while still in the vegetative stage, before peak water use, to make and develop seed.

Slide 32

Note: When soil temperature reaches 95 degrees 15% of moisture is used for growth and 85% is lost through evaporation and transpiration.

It is important when evaluating the health of agricultural fields to also evaluate the closest natural ecosystem, such as a forest. Notice how the management systems that more closely mimic nature show temp. and infiltration trending closer to the forest.

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Example cool & warm season Biological Primer mixes

Cool Season mix
Corn/Soybean rotation
(20 lbs Legume/40 lbs Cereal grain/2 lbs Broadleaf)

10 lbs Austrian Winter Pea
5 lbs Crimson Clover
5 lbs Hairy Vetch
15lbs Cereal Rye
15 lbs Triticale
10 lbs Oats
1.5 lbs Daikon Radish
.5 lb Other Broadleaf


12 way Warm Season Mix

KIND	VARIETY	PURITY	GERM	ORIGIN
SORGHUM BUDAGRASS	GREEN GRAZER	25.00%	85%	TX
PEAS	IRON & CLAY	25.00%	85%	FL
MILLET	PEARL LEAFY 22	10.00%	80%	TX
SUNN-HEMP	AU GOLDEN	10.00%	85%	AL
SOYBEANS	HUTCHERSON	10.00%	85%	AL
SWEET CLOVER	YELLOW BLOSSOM	5.00%	85%	CA
SUNFLOWER	PIRECECHUK	3.25%	85%	OK
BUCKWHEAT	MANCAN	3.25%	85%	ND
MILLET	WHITE PHOEO	3.25%	85%	SD
DAIKON RADISH	SOLBUBSTER	1.50%	85%	OR
PHACELIA	ANGELIA	1.00%	85%	GER
TURNIP	PURPLE TOP	1.00%	85%	OR

CROP: 0.40%
INERT: 1.50%
WEEDS: 0.10%
NOXIOUS WEEDS / LB: NONE

LOT: T-48944
TEST DATE: 5/17
NET WEIGHT: 99.1LB

TURNER SEED INC.
LAVERGNE, TN 37086



Slide 30

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Soil Moisture Management

- First function to return to the system
- Increase Infiltration
- Reduce Evaporation
- Removes Excess Moisture
- Terminate while cover crop is vegetative (before peak water use occurs)
- Soil moisture is directly related to soil temperature

Slide 31

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92°F Sunny Day June 24			
	Soil Temp 2" depth (°F)	Infiltration Rate (in/Hr)	
Forest	73	82	
Stand Alone No-Till Soybeans	102.6	2	
18 inch cover terminated soybeans	94.1	5	
48 inch crimped biomass soybeans	85	7	
Conventional tillage soybeans	110.5	<1	
Stand Alone No-Till Corn	91	2	
24 inch cover terminated corn	84	4	
48 inch crimped biomass corn	82.6	9	
Conventional tillage corn	113	<1	

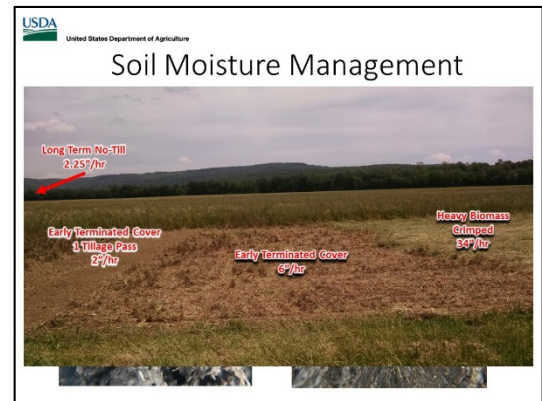
Slide 32

Slide 33

The image on the left is of a field managed with absence of tillage for over 60 years with cover crops implemented the last 7 years. It has an average infiltration rate of 20 in/hr. The image on the right is a field that is long-term no-till corn/soybean rotation with no cover crops for over 25 years. It has an average infiltration rate of 2 in/hr. It will take some time to get the field to the right rejuvenated, but it can be done.

The next images show the soils at 10x magnification. You can easily see the differences in aggregation which relate to the differences in infiltration rate.

In the final image, notice how a single tillage pass can impact how water enters the soil.



Slide 33

Slide 34

Things to monitor closely when planting a cash crop into cover crops:

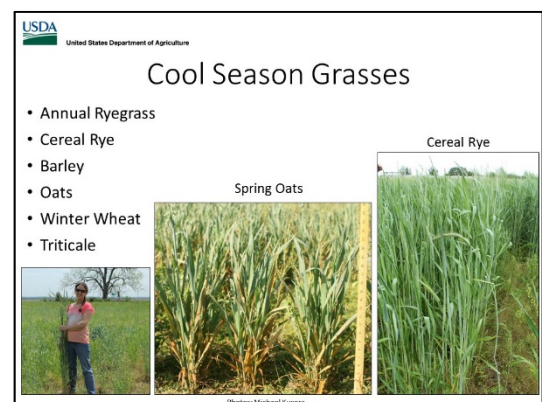
- Ensure good seed to soil contact
- Soil temp and moisture must be right
- Ensure you're getting the seed at the correct depth
- Ensure proper closing on seed trench
- Ensure down pressure is set correctly



Slide 34

Slide 35

Examples of cool-season grasses for cover crops.



Slide 35

Slide 36

Examples of warm-season grasses for cover crops.

Brown mid rib types are favorites for those that implement grazing into the farm system. They have better digestibility.



Slide 36

Slide 37

Examples of cool-season broadleaf for cover crops.



Slide 37

Slide 38

Examples of warm-season broadleaf for cover crops.

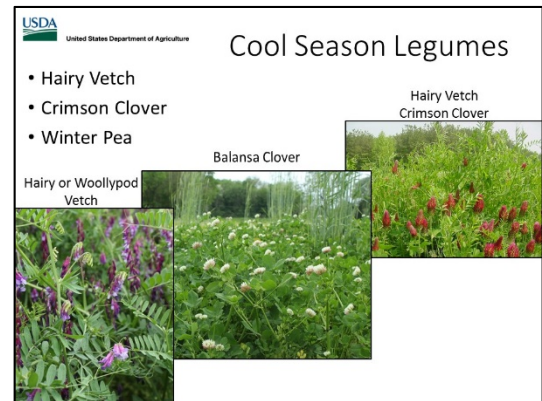
Buckwheat planning restrictions (2 yr from a wheat crop)



Slide 38

Slide 39

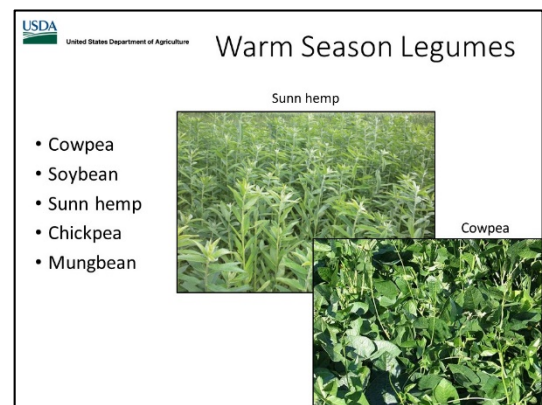
Examples of cool-season legumes for cover crops.



Slide 39

Slide 40

Examples of warm-season legumes for cover crops



Slide 40

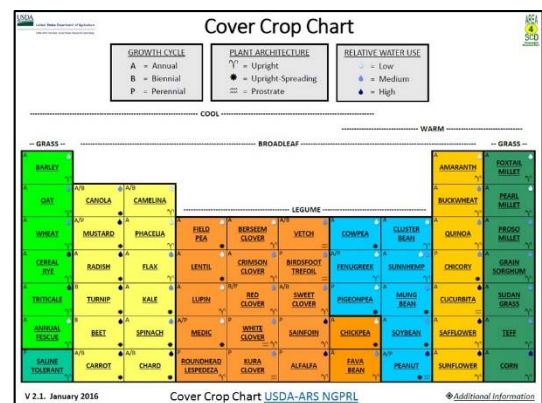
Slide 41

This is a picture of an interactive “periodic table” that provides a lot of good information about many different cover crops.

The interactive chart is part of your downloads available on the flash drive included with this curriculum. Let folks know where they can get it and show them how it works.

Periodic table is from the following website:

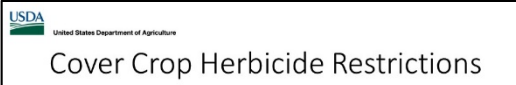
<https://www.ars.usda.gov/plains-area/mandan-nd/ngprl/docs/cover-crop-chart>



Slide 41

Slide 42


There are several considerations to look at when planning or planting cover crops. Herbicide residuals could terminate desired species in cover crop mixes.



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Cover Crop Herbicide Restrictions

- Forage and grain (food chain)
 - Herbicide must be labeled for all crops
- Rotation/plant back restrictions
- Forage restrictions (grazing, haying)
- Cover only (soil building or erosion)
 - At your own risk (some labels lack info)
 - Review labels/experience
 - Climate & soils (biological activity)



Slide 42

Slide 43

There are many ways to terminate cover crops and a lot will depend on the climate and the objective of the producer. There are many variables when considering termination methods. Be aware of crop insurance guidelines.

- Crimper/Roller: Can be used independently or as combination. To be used independently, crimper/roller must snap, crimp, or break vegetation stems to stop flow of nutrients throughout the plant. Must be completed when target species reaches early maturity before viable seed.
- Herbicide burn down: popular method on grain operations. Completed before or after planting operation by applying herbicide to kill vegetation.
- Grazing: Use of animals to graze and trample cover crop vegetation to aid in termination. Time grazing period close to early maturity of vegetation. Implement take half leave have rule to support soil biology and soil health management principles.
- Combination of methods: Producers may use two or more methods to kill cover crops. For example, herbicide burn down to kill the cover crop followed by roller crimper to place residue on the ground for maximum weed suppression and to provide easier planting.



Cover Crop Termination Methods

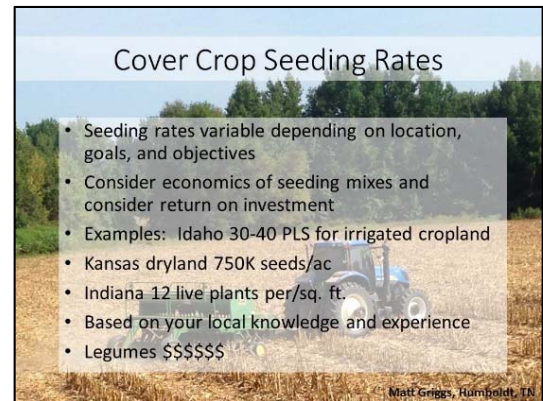
- Crimper
- Roller / Light pole/ Culti-packer
- Herbicide burn down
- Grazing (Remove cattle to allow for regrowth)
- Combination of methods

Mark Briggs, Humboldt, TN

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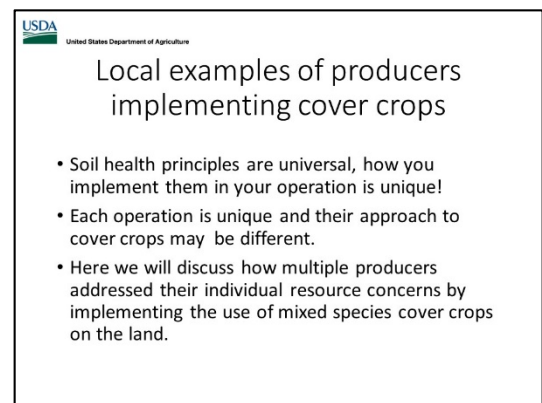
Follow material on presentation slide.



Slide 44

Slide 45

The following slides will show some examples in Tennessee of producers using cover crops.



Slide 45

Slide 46

Ray Jones is a second generation farmer, farming in the Asbury community of Coffee County, TN. His operation encompasses approx. 1000 acres. He grows corn/soybeans on about 700 acres and has about 300 acres of pastureland. Back in the 60's, farming with his dad, they started trying no-till and fully adopted it in the late 80's due to improved equipment, herbicides, and savings on labor, time, and fuel. In the 80's and 90's he began using cover crops but, due to termination issues, they quit using cover crops and transitioned to straight no-till. About 6 years ago he began adding cover crops back in his rotation. To date every cropland acre he farms gets a multi-species cover crop planted on it. He is also integrating livestock onto some of his cropland acres. Ray truly understands why he is planting cover crops and would be the first to tell you that farming nature's way has its own set of challenges. Ray is an outside-the-box thinker and is always willing to share his story with others.



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Slide 47

Robert Henley is an agronomist at Security Seed and Chemical and landowner/manager of his farm of 70 acres in Hillsboro, TN in Coffee County. Robert utilizes his farm to try new things to better help his customers reach their farms' yield potential in corn and soybeans. A portion of Robert's farm has not seen tillage in the last 60 years plus. It was in pasture and went straight into no-till production and he has added cover crops in the rotation the last 7 years. The history of this field truly explains why it is functioning the way it is. From this field in 2014, Robert entered a 315 bu/ac dry land corn entry in the NCGA yield contest and won the state. In 1980 Robert rented a different field out to green bean farmers. When it came time to harvest the green beans they rutted the field up badly and the field had to be tilled to smooth it back out. Since then this field has not rebounded from the tillage events and has not been as productive as the other. So, Robert skipped a soybean crop in 2017, planted a summer cover mix that was shown earlier, then planted a cool season cover mix in hopes of rejuvenating its productivity.



Slide 47

Slide 48

These slides are from Matt Griggs at Griggs Farm in Humboldt, TN.

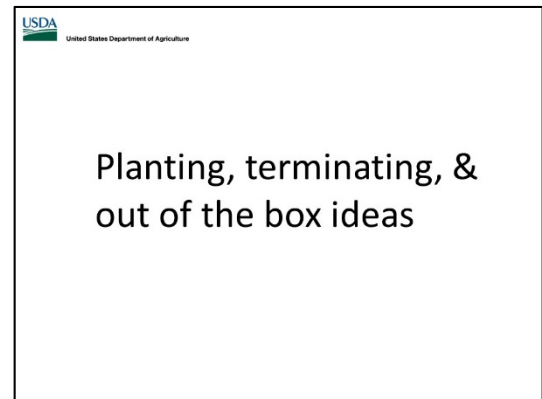
- In the top left image, he is using a roller crimper on a stand of winter cover crops (cereal rye, ryegrass, crimson clover, hairy vetch, Austrian winter pea, radish, and buckwheat). It was planted on Sept. 20th and terminated on May 10th. It produced 32,000 lbs fresh biomass/acre with 45 lbs N/acre of projected N availability during the growing season.
- In the top right image, corn was planted into 10 lbs/acre cereal rye, 2 lbs/acre annual ryegrass, 10 lbs/acre oats, 10 lbs/acre crimson clover, 10 lbs/acre Austrian winter pea, 6 lbs/acre hairy vetch. The cover crops were planted November 10th and terminated April 20th. The field averaged 202 bushels/acre.
- In the bottom right image, he is using a roller crimper on a stand of summer cover crops (Sudangrass, Millet, Sunn Hemp, Radish, Buckwheat, Mung bean, Clay iron pea, Okra, Teff grass, Sunflower) that were drilled behind winter wheat on June 25th. They were terminated on Sept. 25th and had a winter mix drilled in after.



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Slide 49

The next slides will identify some other ideas for planting and terminating cover crops.



Slide 49

Slide 50

The video is of a ZRX Crimper Roller from Dawn Biologic. It is expensive at around \$2,000/row!



Slide 50

Slide 51

The image on the left is a culti packer on a front-end loader to roll covers and drill beans in one pass. The covers are then terminated with herbicide.

The video at the top right shows a farmer using a roller/crimper.

The image at the bottom right is a farmer designed and engineered crimper.



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Slide 52

Planting into heavy biomass has multiple challenges. Certainly without guidance. This farmer couldn't see where he was going. So he removed a row marker disk and put on a tire. He planted green without GPS (worked great).



Slide 52

Slide 53

The video shows a producer planting corn into a green cover crop. It was hit with herbicide the next day.



Slide 53

Slide 54

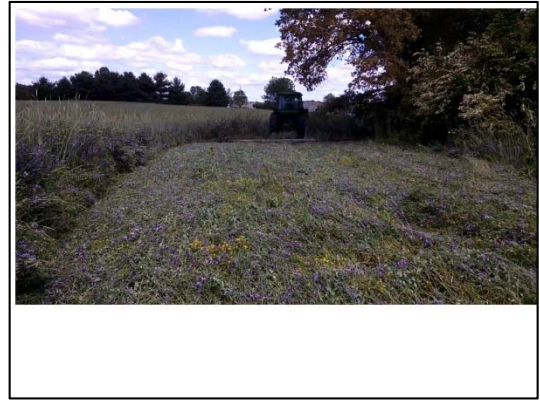
This video shows a producer using a single pass roller and crimping 12,000 lbs of biomass and planting soybeans. It was hit with herbicide about a week later.



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Slide 55

This video shows a producer laying covers down with light pole from the local utility department.



Slide 55

Slide 56

This video shows a producer using a roller/crimper on 16,000 lbs of biomass. Soybeans were planted after roller/crimper and the cover crops were chemically terminated afterwards.



Slide 56

Slide 57

This video shows a producer planting corn after approx. 9,000 lbs of biomass is rolled down. The cover crops were chemically terminated after planting.



Slide 57

Slide 58

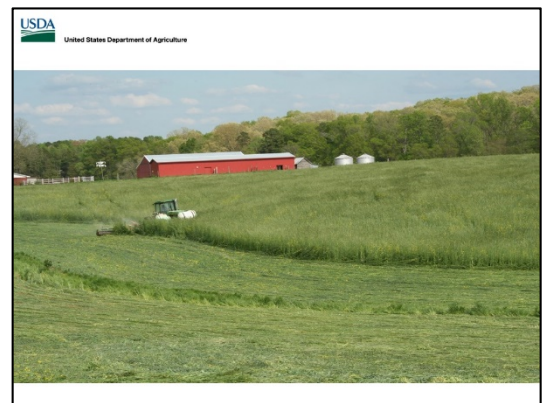
This video shows a producer planting corn into green cover crops. The cover crops were left standing and chemically terminated after planting corn.



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Slide 59

Rolling covers to terminate them, some producers also spray a non selective herbicide at the same time. This image is in the southeastern U.S., of an overwintering cover crop.



Slide 59

Slide 60

After rolling, the producer is going to no-till corn into the multi-species mix.



Slide 60

Slide 61

You can see this is rolled and planted with very little soil disturbance.



Slide 61

Slide 62

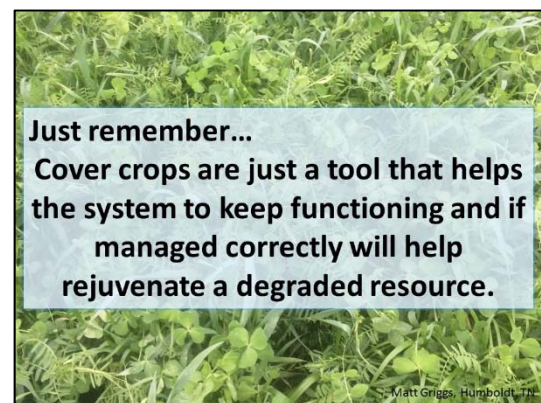
Slice and dice with a disk drill, you could not do this with a hoe drill!



Slide 62

Slide 63


Follow material on presentation slide.



Slide 63

Slide 64

These are some cover crop planning tools that can assist in identifying cover crops and how to make blends.



United States Department of Agriculture


Cover Crop Planning Tools

- Cover Crop 340 Practice Standard
- Cover Crops Quick Facts – University of Tennessee – W417
- Midwest Cover Crop Council
<http://www.mccc.msu.edu/index.htm>
- Resources and Publications
<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/resource/>
- Sustainable Agriculture Research & Education (SARE)
 - Online Book and Topic Room on Cover Crops
- [Cover Crops for Sustainable Crop Rotation and Soil Health \(SARE\)](http://www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops) at <http://www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops>
- No Till Farmer Pluses and Minuses
- Various industry cover crop calculators

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Slide 65

The first tool on the previous slide is the NRCS Cover Crop 340 Practice Standard. This document can be found in the Appendix of your curriculum and provides some examples of mixes that can be used along with their seeding rate and planting window.



United States Department of Agriculture

Example cover crop mixes from NRCS Cover Crop 340 Practice Standard

COVER CROP EXAMPLE MIXES:				
Multiple Species Cover Crop Mix (Cool Season planted prior to Soybeans)				
Crop Mixes	Seeding Rate Lb./Ac ¹		Seeding Date	C:N ratio in Late Vegetative State ²
	Drilled	Broadcast		
Mix 1				
Cereal Rye	20	26	August 15 to October 15	31
Oats ³	20	26		
Austrian Winter Peas	11	14		
Crimson Clover	4	5		
Radish	1	1		
Turnip	0.5	0.5		
Basic Cover Crop Mix (Cool Season prior to Corn or Soybeans)				
Mix 6				
Cereal Rye	20	26	August 15 to October 15	30
Wheat	20	26		
Crimson Clover	5	7		
Austrian Winter Peas	14	18		
Radish	1	1		

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Test their Knowledge - Questions for the audience

Q: What are some of the benefits of cover crops?

A: Supplemental grazing, improved organic matter content, nitrogen capture/cycling, residue/cover, weed suppression, beneficial insects, food source for predators/pollinators, improved soil physical properties, erosion and runoff reduction, soil water management, feed soil biology

Q: What are important things to think about when planning for cover crops?

A: Site preparation, herbicide carryover/restrictions, timing, species, diversity, seeding method, seeding depth, residue management, termination method/timing, management for moisture, weeds, disease, insects, establishment of next cash crop, economics, producer needs and goals

The minimum amount of growth for cover crops in order to achieve most benefits is 6 to 8 weeks.

According to the NRCS, the four functional plant groups are:

1. Warm-season grasses
2. Warm-season broadleaf
3. Cool-season grasses
4. Cool-season broadleaf

Q: How do cover crops help with soil moisture management?

A: Their roots increase infiltration by creating new channels through the soil profile. Their residue helps reduce evaporation. They can remove excess moisture to aid in planting. They can be terminated before peak water use occurs.

Cover crop termination methods can include:

1. roller/crimper
2. cultipacker
3. chemical burndown
4. grazing
5. combination of methods



Soil Health Evaluation

Name of Activity: Cover crop management 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 <i>did you / do you</i> 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. <i>The impacts that cover crops have on soil functions</i>	①	②	③	④	⑤	①	②	③	④	⑤
2. <i>Management strategies for cover crops</i>	①	②	③	④	⑤	①	②	③	④	⑤
3. <i>Cover crop blends</i>	①	②	③	④	⑤	①	②	③	④	⑤

D. Specific Practices To what degree <i>did you / will you</i> 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. <i>Measure different field indicators of soil health</i>	①	②	③	④	⑤	①	②	③	④	⑤
2. <i>Incorporate sustainable agricultural methods for soil health</i>	①	②	③	④	⑤	①	②	③	④	⑤
3. <i>Seek additional NRCS information on financial and/or technical assistance for improving soil health</i>	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>I would recommend this program to others.</i>	①	②	③	④	⑤	⑥
2. <i>As a result of this program, I am more likely to seek additional information from UT/TSU Extension.</i>	①	②	③	④	⑤	⑥

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

Thank you for participating in this survey!