TECHNICAL SPECIFICATION
COVER CROP CODE 340

Background

Soil is the major interface between agriculture and the environment. Capturing energy in the form of sunlight powers agriculture. This source of energy is free to all farmers, but unfortunately, many of our agricultural crops are only growing approximately four to six months out of the year. Cover crops can fill this gap to generate energy for plant and soil communities in agriculture. Cover cropping has a long history of documenting benefits for farms and the environment.

Benefits and Challenges of Cover Crops

Cover crops have numerous ecosystem services benefits and Figure 1. depicts some of the benefits.

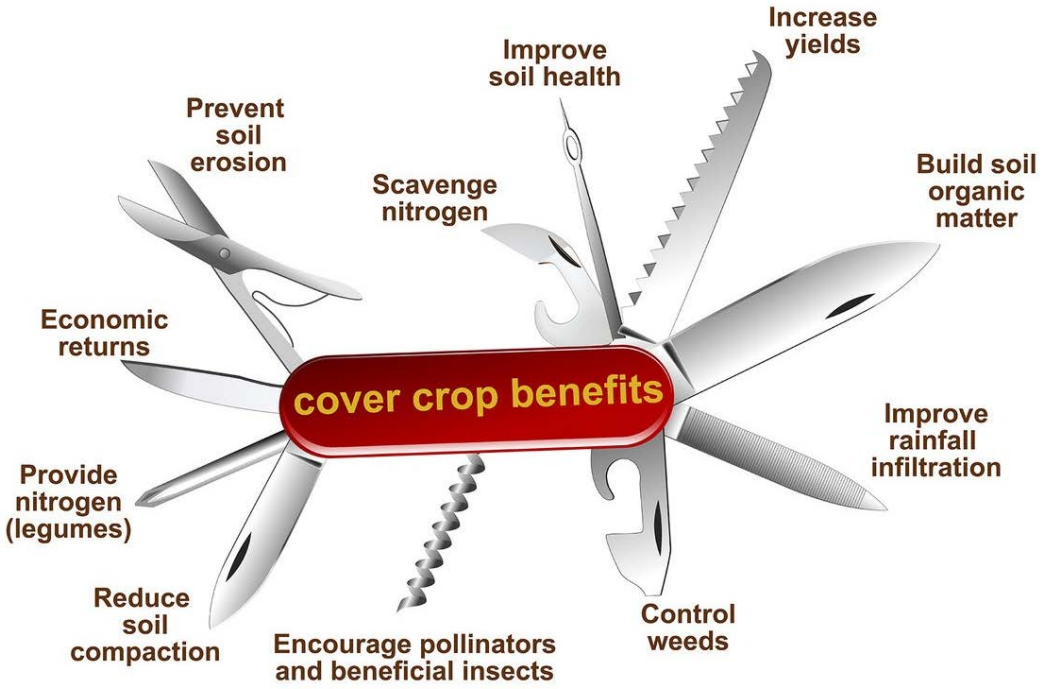

Figure 1. Cover Crop Benefits Illustration by Carlyn Iverson, courtesy of USDA-SARE

The swiss army knife is a utensil with many functions and choosing the correct one is key to completing the task. The cover crop is a conservation practice with many benefits. Likewise, choosing benefits that meet the farmers objectives and supports soil health principles is important.

Challenges of cover crops also exist and can be found in Table 1. Many farmers have found solutions on their individual farms to overcome these challenges and are willing to stay committed to cover cropping.

Table 1: Benefits and Challenges of Cover Crops Adapted from Dabney et.al. 2001

Challenges of Cover Crops
Labor to plant cover crops
Timeliness of planting, growth and termination
Additional costs of seed, equipment, and chemicals
May increase certain pest populations
Soil moisture monitoring
Allelopathy affects
Voles or small rodents

General Information

Procedures, technical detail, and other information listed below provide additional guidance for carrying out selected components of the cover crop practice. This material is mentioned in conservation practice standard for a cover crop and supplements the requirements and considerations listed therein.

In general, the desire is to have a cover crop that:

- Easily establishes
- Grows rapidly to provide ground cover quickly
- Produces a sufficient amount of biomass
- Should be disease resistant and not act as a host for diseases of the cash crop
- Can be easily terminated/killed
- Be economically viable

The degree which cover crops meet these desired traits depends on the soil, climate, succeeding cash crop, management of the cover crop, and characteristics of the cover crop itself.

The overall goal is to have cover crops fit into an overall soil health management system for our customers.

The NRCS Cover Crop (Code 340) conservation practice standard does not allow cover crops to be harvested as seed.

Cover Crops and Federal Crop Insurance

It is the responsibly of the land manager/operator to ensure their planned cover crop will not affect their crop insurance coverage. This document can be found at the following link: NRCS Cover Crop Termination Guidelines 2014 Version 3

Using the Calculator for Seeding Dates

When using the cover crop calculator, plan for a 100% seeding rate, which is also the minimum rate. The calculator functions are designed for 100% seeding rate. Increases to seeding rates can be made in the notes section.

Seedbed Preparation and Methods

Preceding crop residues should be spread evenly before seeding. Cover crops provide numerous benefits and seeding cover crops with minimal disturbance is crucial for implementing a soil health management system.

Cover crop seeding success is dependent on many factors including seeding date, temperature and moisture before and after seeding, seedbed conditions, fertility, amount of crop residues, planting depth, seed to soil contact, seeding rate, seed quality, time of freeze after seeding, insects and diseases.

Seeding guidance for species is found in the Texas Cover Crop Calculator in NRCS Field Office Technical Guide.

Existing weeds should be eliminated by applying herbicides if it is determined that sufficient weed pressure exists to hinder establishment and growth of the cover crop. Make sure to determine the best herbicide combination and timing. Work with an agricultural consultant or AgriLife Extension staff regarding this issue. Herbicides can affect cover crops and grazing animals. If you are not sure regarding herbicide carry over a soil bioassay is recommended. Simply collect soil from the area you would like to seed the cover crop into and an area with a similar soil type, but no herbicide residue, and plant seed from the cover crop you would like to use. Observe growth for 3 weeks and if the plants look the same in the untreated and treated soil, you should be safe to plant to desired crop.

Methods

The Texas Cover Crop calculator is based on the drilled rate and broadcast rates.

No-Till Drills

This seeding method is common and provides good seed to soil contact. No till drills need to be set properly for effective seed placement and plant residue challenges. Use a no till drill that is designed to handle heavy crop residues and the type of seed being planted. This is especially important for small seeded species like clovers, canola, collards or kale, turnips, annual ryegrass, etc.

Depth control for most drills is not as precise as a planter, so it is important to set it for the optimum depth and check often to assure placement doesn't exceed the maximum depth for selected species. Drilling in soils that are too wet can cause compaction and frustration with the equipment.

When planting mixes, set depth of the drill for the species of greatest desire/need to address the resource concern being addressed by the cover crop.

Photo: Small farms can also benefit from drilling cover crops with proper equipment. Small no till drill.
Photo Credit: Carlos Villarreal NRCS

Broadcast Seeding

Seed may be broadcast using a seeder that can spread seed in a uniform manner. This seeding method works best in light residue crops. Expect only fair seed to soil contact with no planting depth control. This method relies on rain, freeze/thaw cycles, or irrigation to incorporate the seed. Heavier seed such as cereal grains or oil seed radishes are more adapted to this method when seeding into newly harvested crop residues. It is recommended that the seed be cultipacked.

Pre-mixing the seed with needed fertilizer or pelletized lime and utilizing an airflow applicator can also be effective. Wind speeds should be 15 mph or less when broadcasting light seed such as annual ryegrass.

On pastureland, the disc gangs on a light tandem disc can be set at near zero-degree angle to create micro grooves benefitting seed to soil contact.

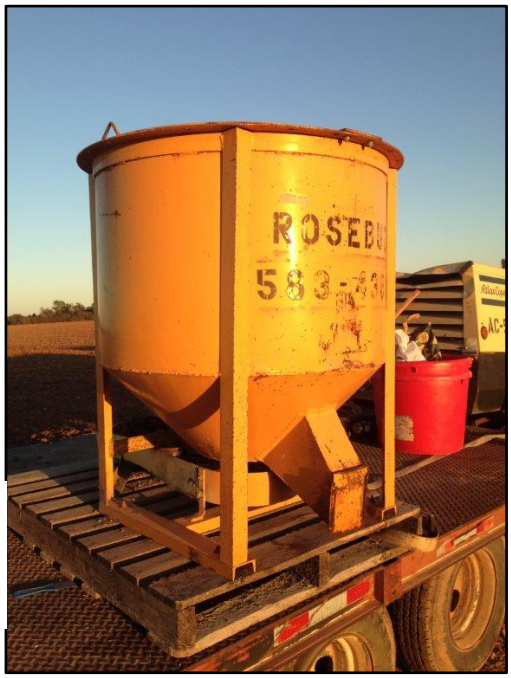

Photo: Seed mixer for cover crop planting. Inoculants or fertilizers can also be added using mixers. Photo Credit: Trey Bethke - NRCS

Narrow Row Planting

Many split-row or narrow row planters (15” row width or less) can be equipped with seed plates, such as are used for sugar beets or sorghum, which work well for many cover crop species. Additional adaptation and/or calibration may be necessary due to variation of seed size among cover crop species and varieties. This method should provide the fastest and most consistent emergence. To meet criteria for maintain or increase soil health and organic matter, at least two species of cover crops will be planted either in alternating rows or combined. One of the species must be a grass. This method will not be used if weed control is the primary purpose.

Photo: Planting cover crops using narrow row planters. Oilseed radish and cereal rye in alternate rows.

Photo Credit: Jodie Reisner - NRCS

Other Seeding Methods

Interseeding is a common term used to describe seeding cover crops while the main crop is growing. Aerial seeding using a plane, helicopter, or high clearance spreader into the existing crop can be an effective seeding method to acquire earlier growth. Seed spread on the surface is more rain dependent, generally requires a higher seeding rate, and takes longer to establish. Seeding cover crops just ahead of leaf drop or early crop maturity will aid in mulching the seed and conserving moisture. Results are dependent on adequate rainfall. Seed mixes with species of similar density is recommended and wind speeds should be 15 mph or less. Broadcast seeding rates will be used with this method.

Rotary harrows or vertical tillage equipment is used to fluff or cut residue to allow improved seed to soil contact. These implements lack seed depth control and can disturb soil leaving it exposed to water and wind erosion. If a seed box is attached to these implements, it can be a fast, single operation that can seed many acres in a short period of time.

Other cover crop seeding innovations exist and should be evaluated on a case by case basis.

Seed placement with a Double Disk Opener

Photo Credit: Fred Schrank - NRCS

Systems Approach

Selecting Cover Crops – Farmer Objectives/Purpose(s) – Know your environment, soils, realistic goals, and cash crops.

Understanding the farmers objective/purpose for planting cover crops is a key first step in selecting cover crops. Document the purposes in the conservation assistance notes and the Texas Cover Crop Calculator.

Think of the cover crop as another component in the rotation. Cover crops need to be managed just like a commodity crop. Creating conditions that are beneficial to the next crop is usually one of the primary goals of a cover crop.

The cover crop should be integrated as part of a conservation cropping system. Such practices include Conservation Crop Rotation (Code 328), Residue and Tillage Management No Till (Code 329), and Residue and Tillage Management Reduced Till (Code 345). This system if implemented over time will improve soil health and water quality in Texas.

Cover crops to reduce water and wind erosion will be managed to maintain biomass and/or residue during the critical erosion period.

Tillage management and crop rotation interact with influences on soil physical properties. This relates to soil water, and in semi-arid regions the effect of rotation and crop residue management is critical for soil water storage and extraction. In the Southern Great Plains, decreasing tillage and increasing surface residues of wheat increased soil water storage. The next sorghum crop also had increased yields (Reeves, 2017).

Cover crops may include single or multiple species plantings. Planting a mixed species cover crop can provide some added environmental benefits by increasing root diversity and structure.

Using the Texas Pasture Conditioning Score may assist in assessing the resource needs of the pasture and selection of cover crop species.

Factors Affecting Establishment of Cover Crops

Rotation/Sequence – farmers choose to grow a sequence of crops and fitting cover crops into these sequences can be challenging. Cropping sequences may not always be in years because in Texas some farmers grow several crops in one year. Therefore, crop sequences should be considered as a unit of time rather than in years.

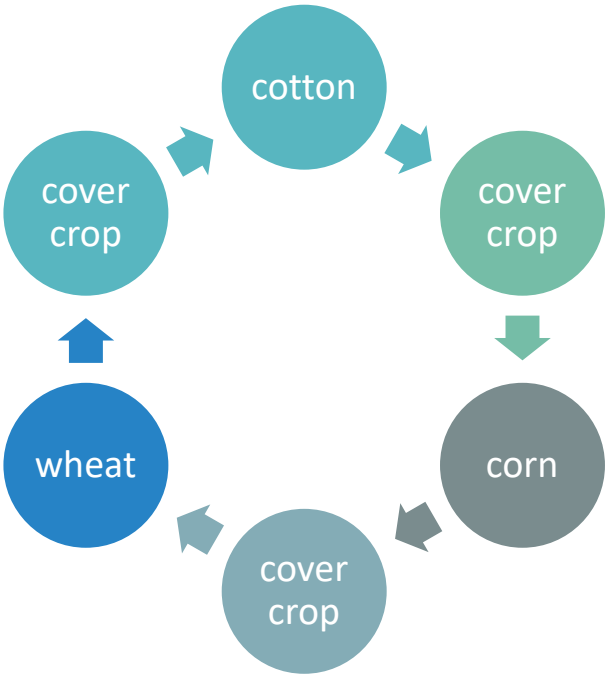

Figure 2. Commodity Crop and Cover Crop Sequencing

Understanding crop sequencing will influence cover crop choices. Sometimes a farmer will face challenges to apply cover crops after each commodity crop but understanding the challenges as a conservation planner will be valuable as solutions are tried on the farm.

Timing of planting is a key factor in overall cover crop success. Earlier planting can provide a longer timeframe for cover crop establishment if adequate moisture and temperatures are favorable. Earlier planting can also help plants survive the winter with greater success. Timing of termination is also important. For cool season cover crops accumulation of biomass in the spring is desired for building soil health, suppressing weeds, and erosion control.

Quality seed is needed for cover cropping and buying seed in a timely manner is important for early planting.

Regardless of who grows or sells the seed, a copy of the current (within nine months) analysis must be provided. This test is valid for nine months after the end of the month the test was made, so long as the seed remains in Texas. (Note: The state law pertains to the sale, offer for sale, expose for sale or transport for sale of any agricultural seed within Texas.) Seed purchased outside of Texas must comply with all federal seed laws.

All seed and planting materials shall meet state quality standards. Rules and statutes pertaining to seed quality in Texas can be found in Chapters 9, 10, 61, 62, and 64 of the Texas Agricultural Code. Refer to Texas Department of Agriculture website at www.agr.state.tx.us under the Laws/Regulations Section."

Soil pH

Ensure that soil pH conditions are appropriate for successful legume establishment by soil testing. Legume seedlings are particularly sensitive to acidic soil conditions. Acid soils also reduce rhizobia colonization at legume roots, nodulation, and nitrogen fixation. Farmers should apply lime to address pH conditions of 5.5 or lower before seeding legumes. Cool season legumes need to be planted early to survive the winter. If the farmer wants to gain as much nitrogen as possible from the legumes, they need to be terminated later. Greatest nitrogen accumulation is when at least 30% of the legumes are in bloom.

To find more information on the pH needs regarding clovers, the Aggie Clover website has good information. AggieClover | Teaching, Research, Extension and Service

All cover crop legumes must be inoculated with proper bacteria before or at planting. This list of proper inoculums is in the Texas Cover Crop Calculator.

Fertilization

Cover crops usually follow heavily fertilized crops. They may not require additional fertilization. Fertilization may be necessary if the goal is to 1) produce high biomass to build soil organic matter with a cover crop like sorghum-sudangrass, or 2) produce a large root to reduce soil compaction with a crop like oil seed radish. Apply additional lime, fertilizer and other organic by-products using rates, form, timing, and placement method consistent with a current soil test.

Cover crops are designed to scavenge or fix nutrients available in the soil. Additional nutrients can also cause weeds to grow well. Fertilizer and soil amendment recommendations (if applicable) will be applied based on results from a current soil test.

Care should be taken not to provide excess nitrogen to legumes this may inhibit natural symbiotic nitrogen fixation to occur.

Designing a Mix

Types of cover crops consists of some multiple species of annuals consisting of grasses, forbs and legumes in a specified combination that will increase soil function, nutrient recycling, and water utilization. This criterion is met when two or more functional groups are planted.

- Warm Season Grasses – WSG
- Cool Season Grasses – CSG
- Warm Season Broadleaves - WSB
- Cool Season Broadleaves - CSB
- Warm Season Legumes – WSL
- Cool Season Legumes - CSL

Look for the type(s) of functional groups that are missing in the rotation. An obvious example is continuous cotton or wheat. Cotton is a warm season broadleaf (WSB), therefore a cool season grass (CSG) or legume (CSL) would add a functional group. Another example would be a cotton/wheat rotation. This rotation contains a warm season broadleaf (WSB) and cool season grass (CSG) and adding a diverse cover crop mix after wheat can add several function groups. Thinking through designing a mix can be challenging at first but well worth the time and effort of understanding the concepts.

We typically do not recommend planting legumes alone due to the high cost of seed. Grasses and legumes do well together because grasses can use some of the nitrogen fixed by the legumes to grow into healthy plants.

Understanding the crops in the rotation and their growth patterns and such will assist in understanding what recommendation we would give to help the farmer meet their objectives with the cover crop.

Table 2 gives information for understanding high and low residue crops in Texas. This will help understand if a farmer has several low residue crops or a combination of high and low residue crops.

Texas Farmer holding a diverse mix of warm season cover crop seed. Photo Credit: Jodie Reisner - NRCS

Table 2: Texas High and Low Residue Crops

High Residue Crops Texas	Low Residue Crops Texas
Winter Cover Crops Summer Cover Crops	Peanuts
	Potatoes
	Vegetables or any root crops
Corn Grain	Corn Silage
Millets	Cotton
Perennial Forages (grass or legume)	Sunflowers
Small Grains (winter or spring)	Soybeans
Sorghum Grain	Sorghum Silage
Sudangrass Hybrids	Tomatoes
Rice	Wheat Silage

Concerns

Radishes or turnips may not winter kill in Texas, which could lead to planting problems the following spring. Having large tubers at planting time or trying to terminate with tillage can cause problems.

Areas of Texas that have large acres of wheat as the cash crop can have challenges using cereal rye as a cover crop. If cereal rye goes to seed, wheat seed can be docked at the elevator when a farmer sells their wheat.

Sorghums are warm season grasses that can have continuous regrowth until terminated with a herbicide or killing frost. Crimping will not terminate sorghum.

C:N Ratios

Carbon to Nitrogen ratio (C:N) is a ratio of the mass of carbon to the mass of nitrogen in a substance. For example, a C:N of 10:1 means there is ten units of carbon for each unit of nitrogen in the substance.

Soil organisms typically like food stuffs that have a C:N ratio of 24:1. This provides energy to survive and reproduce. When the C:N ratio is in this range or below they can readily consume it. If the material has a high C:N ratio like small grains that have matured to grain production, this can have C:N ratios up to 80:1. The organisms will have find

additional nitrogen to go with the excess carbon to consume the plant material. This additional nitrogen will have to come from any excess nitrogen in the soil.

As soil microorganisms tie up excess nitrogen (immobilization), this situation could create a deficit of nitrogen in the soil until some of them die, decompose, and release nitrogen (mineralization) contained in their bodies, or some other source of nitrogen becomes available in the soil.

Soil microorganisms consume the lower C:N crop residues in less time which can leave the soil surface bare. Crop residues on the soil surface are important for protecting soil aggregates from the destructive force of raindrops hitting the soil, conserving soil moisture, and providing habitat for arthropods that shred crop residue and eat weed seeds. While it is important to maintain soil cover, it is also essential that those same residues decompose to release plant nutrients and build soil organic matter. Therefore, it is important to pay attention to crop residue C:N ratios to maintain soil cover when desired yet allow the cover to ultimately break down and be recycled by soil organisms.

NRCS has an excellent publication: Carbon to Nitrogen Ratios in Cropping Systems

Grazing

Grazing or forage production is not a purpose in the cover crop standard. Cover crops shall not be terminated with livestock. Deadlitter cover crops shall not be grazed.

Note: It must be understood that any grazing benefits come secondary to the primary purpose of improving the condition of the soil. These guidelines apply to all cover crops. Any grazing that will take place cannot jeopardize, in any way, those soil health benefits.

Planning and Implementation information for Grazing Cover Crops

- Before cover crops are grazed, the cover crops will need to have enough biomass produced to justify grazing and to maintain the soil health benefits. In most cases, the cover crop will need to have been established for at least 3 months if adequate moisture has been available. Most cover crops planted later in the fall would not be established enough to graze in the winter, but if stands are adequate, cover crops should be able to be grazed in the spring prior to termination. Cover crops will not be grazed during drought conditions.
- Different species have different tolerances to grazing. Grasses (cereal grains) are more tolerant than brassicas. There may be circumstances where monocultures of cereal grains could be lightly grazed during the winter.
- A forage estimate and a livestock inventory should be completed and included for fields that are intending to be grazed. To insure adequate soil health benefits, utilization by livestock should be between 40% and 50% of available cover crop forage.
- Leaving adequate growing cover is critical to providing the needed soil health benefits. Sometimes cover crops will need regrowth time after grazing to make sure enough biomass is produced to meet the intended purpose of the cover crop.
- Grazing will not occur during saturated soil conditions. Severe damage could occur to the soil and to a stand of cover crops.
- Be careful about grazing cover crops that may have residual pesticides present. Some herbicides have restrictions of no grazing for 18 months following application. A chemical may have been used on the crop or in the rotation that can be taken up by the cover crop, thus restricting the use of the cover crop by livestock.

When a cover crop will be grazed ensure that crop selection(s) comply with pesticide label rotational crop restrictions and that the planned management will not compromise the selected conservation purpose(s).

- Check each cover crop to ensure that the crops pose no danger to livestock. A few examples are: (i) sorghum-sudangrass may cause prussic acid and nitrate poisoning if the young growth is grazed or if the crop is grazed after frost, (ii) turnips may cause copper toxicity in sheep, (iii) red clover contains phytoestrogens that may complicate sheep breeding, and (iv) many of the legumes may cause bloat and should not be grazed when wet.

In semi-arid climates it should be recognized that in most years a cover crop will not provide enough extra biomass to meet the intended purpose of the practice and allow for forage to be harvested by livestock.

Termination

Cover crops should not be terminated before they reach adequate maturity. In the case of small grains this would be at the boot stage of development. Grazing is not a method of termination.

Methods of Termination

- Frost – Selecting species that are not tolerant to frost and thus "winter kill" such as planting warm season annuals very late in the growing season.
- Mowing – Mowing or chopping the plants below the growing point. Mowing residue may leave dense and/or uneven residue layer on the soil surface which may inhibit planting/seeding operations or emergence of the subsequent cash crop.
- Crimping – Using a roller to lay down and crimp cover crop residue in the direction the cash crop will be planted. Crimping residue may leave dense residue layers on the soil surface which may inhibit planting/seeding operations as well as inhibit weed germination and growth.
- Herbicides – Apply non-selective herbicides according to labeled rates and methods. Select herbicides that will not have residual effects on the next cash crop.
- Tillage – Use tillage implements to cut, chop, bury, break, layover or mix the cover crop residue with the soil. It is recommended that tillage should only be used for termination in certified organic operations organic transition operations, or those operations where herbicide effectiveness on the cover crop is limited.

Crimping a cover crop. Photo Credit: Cliff Kinnibrugh - NRCS

Dead Litter Cover

In Semi-Arid climates where a dead litter cover is needed to protect the land from erosion during grass establishment. The cover crop shall be 100% high residue and shall be planted by the appropriate deadline for warm or cool season as prescribed by the Texas Seeding Calculator.

Economic Benefits and Concerns

Herbicide/Insecticide/Fungicide Input Reductions – Cover crop residue, vegetation competition, and soil organism activity may result in reduced chemical applications. For example, having an early season mulch layer may eliminate the need and costs for herbicide treatments.

Reduced Erosion – Cover crops may immediately reduce onsite soil erosion. This benefit includes the fertility value per ton typically lost to soil erosion. In some cases, reducing erosion with cover crops also reduces machinery costs to repair gullies and clean sediment out of ditches.

Overall Soil Fertility (long-term benefit) – When used as part of a crop rotation over many years, cover crops impact both physical and biological soil properties. These soil improvements may result in the soil's ability to increase available nitrogen, phosphorus and potassium in plants/crops.

Improved Water Storage and Infiltration - As soil organic matter increases, the soil's ability to store water also increases. The economic benefits of improved soil infiltration and water storage can reduce irrigation costs or increase the soil's resilience from drought in dryland systems.

Cost of cover crop seed needs to be planned for and starting out with simple mixes can help with reducing costs.

Anticipate changes in nutrient cycling, especially available nitrogen as a soil health system is being implemented. Transitioning to no-till and less ground disturbance planting techniques will alter residue amounts.

Farmers will need to be prepared for some adverse effects, and willing to begin small and adapt as they learn to become successful in cover crop adoption.

Zone Considerations

Zone 1 and/or Zone 2

In arid fragile environments such as those with low rainfall and/or high evapotranspiration rates, soils are less forgiving to severe management or environmental events which disrupt the system. Some variables such as weather are unable to be controlled however many effects are compounded by management practices such as crop rotation, cover crop, tillage, and the timing of these practices.

Historical crop management in the Southern Plains/High Plains consisted of full width tillage, low surface residues, and low crop diversity such as continuous conventional tillage of wheat and cotton. When utilizing no till or reduced till farming practices coupled with cover crops, soil erosion can be greatly reduced. However, due to the dryer conditions, have a continuous living root (cash crops and cover crops) year around may have limited success on dryland farms. Farmers should be aware that if a cover crop and a cash crop are grown back to back without significant rainfall to replenish soil moisture, the subsequent cash crop could have a yield reduction.

Zone 3 and Zone 5

If not fully terminated, cover crop species such as black oats, annual rye grass, cereal rye, triticale, sorghum sudan grass, brassica, and others can become an unwanted plant species in the future cash crop. Allowing seed to mature can make these situations worse. The farmers cash crops, such as oats, wheat, grain sorghum, can be negatively impacted by having degraded grain purity and quality. When designing a cover crop mixture, choose alternative type species. Other strategies to compensate for unwanted plants and weeds are accomplished through an intensity of crop rotations and herbicide selection.

Other Resources

ATTRA https://attra.ncat.org/

Midwest Cover Crop Council http://mccc.msu.edu/

Southern Cover Crop Council https://southerncovercrops.org/

National Center for Appropriate Technology (NCAT) http://www.ncat.org/

SARE SARE Cover Crop Room

Texas A&M AgriLife Extension https://lubbock.tamu.edu/cover-crops/

https://overton.tamu.edu/faculty-staff/gerald-wayne-evers/cool-season-legumes/management/

Soil Health USDA NRCS https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/

Soil Health Institute https://soilhealthinstitute.org/

Univ. Of Nebraska Lincoln https://cropwatch.unl.edu/cover-crops

USDA NRCS-Plant Material Centers
https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/plantmaterials/technical/publications/?cid=stelprdb1077238

USDA Plants Database https://plants.usda.gov/java/

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