Leafy Greens
Climate-Smart Grown in SC

Year 1 Training

Overview

- Welcome!
- Introduction of Climate-Smart Program Personnel
- Goals
  - Climate-Smart Grant
    - Increase the acres in SC using climate-smart practices
  - Today's training
    - Understand program requirements
    - Understand climate-smart practices and their implementation
    - Planting implementation worksheet

Implementation and Incentive Payments for Participants

EProcurement Systems Overview

Implementation Contact

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Implementation Coordinator
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Incentives Contacts

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Ramonda L. Pollard
Grants Administrator
SC State University
803.536.8974
rpollard@scsu.edu
(until Incentives Coordinator is put in place)

Incentives Disbursement

- Incentives will be reimbursed once a year when all practices have been implemented and verified.
- If practices are implemented on more acreage than in the participation agreement, payment will only be for the amount in the signed participation agreement

Incentives Payments for Participants

How to Register

- Participants assigned to Clemson University should've received an email from support@sciquest.com inviting you to register as a supplier/vendor for Clemson University. Please check spam folder in your email as we are finding that it is automatically going to that folder. This registration process is done entirely online.

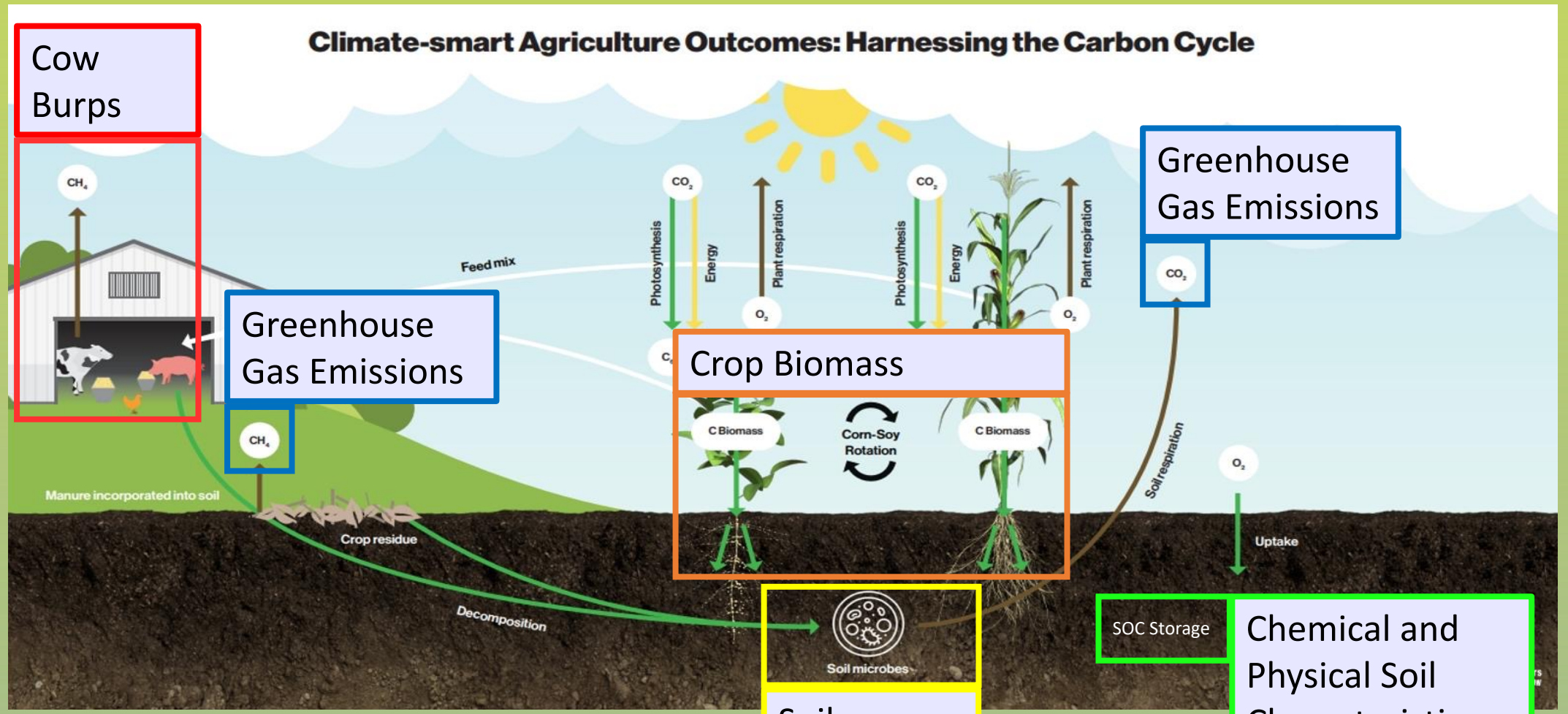
- SC State has application forms that you will need to fill out with their Incentives Coordinator. Their process is very similar in what paperwork you will need.

- Everyone MUST have an email for either vendor system in order to complete the registration process for payments.

- Link for helpful youtube video before starting Clemson's registration process:
  - https://youtu.be/WKcGjm_c6PQ?si=NiBLDZ5BuYj0BEpkpk

Climate-Smart Measurements

What are we Measuring on Select Climate-Smart Sites?



What are we Measuring on Select Climate-Smart Sites?

Year 1

Greenhouse Gas Emissions

- **4 sites** selected for this measurement.
- Will be voluntary and with permission from the participant.

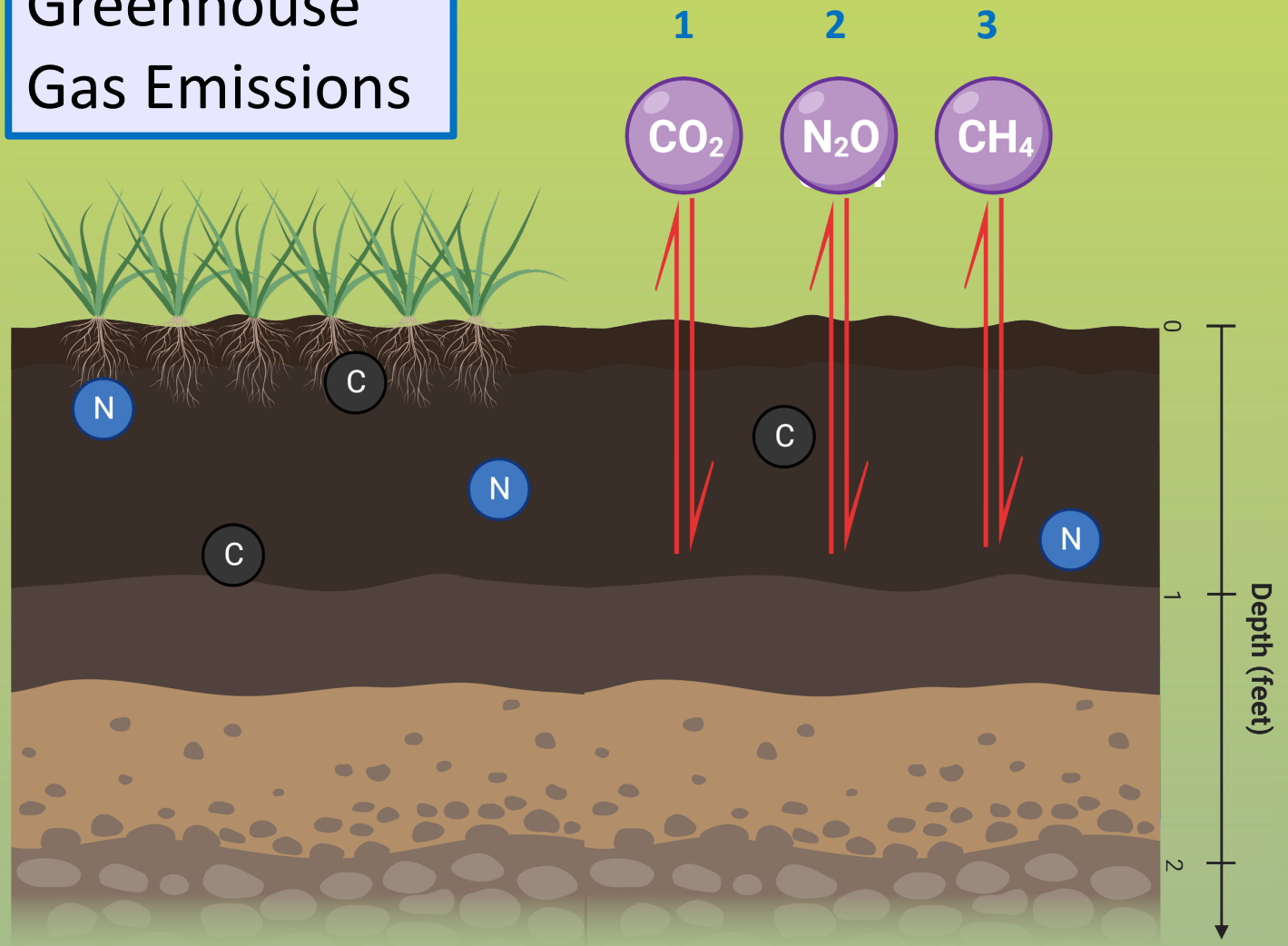
Chemical and Physical Soil Characteristics

- **80 sites** selected for this measurement.
- The Participant Agreement included this potential measurement on any farm.

Selected sites will represent the 3 agricultural commodities in this program.

What are we Measuring on Select Climate-Smart Sites?

Greenhouse Gas Emissions



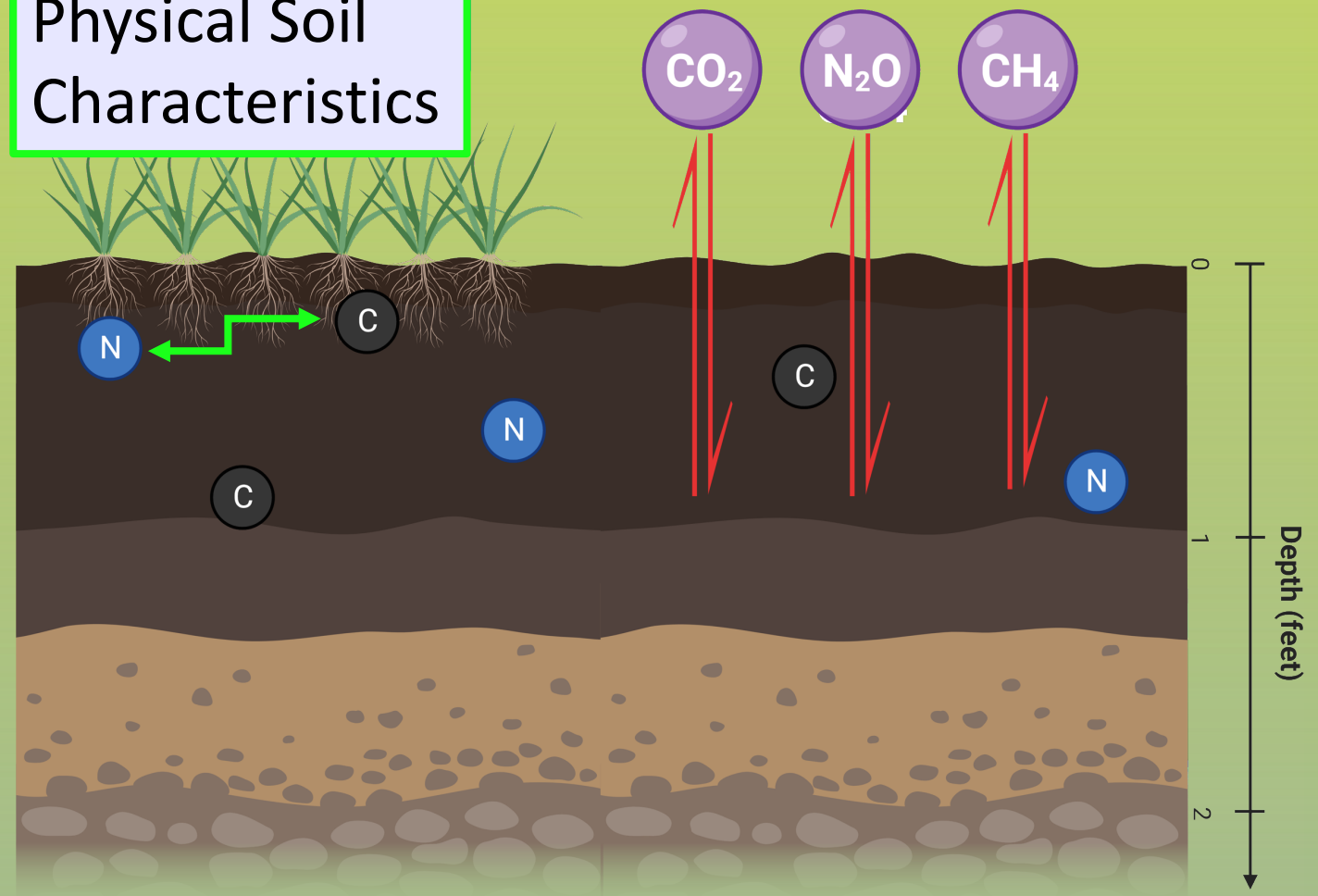
Measuring fluxes or emission of greenhouse gases (GHG):

1. Carbon dioxide (CO_2)
2. Nitrous oxide (N_2O)
3. Methane (CH_4)

GHG Flux Chambers: The "How" will be explained.

What are we Measuring on Select Climate-Smart Sites?

Chemical and Physical Soil Characteristics

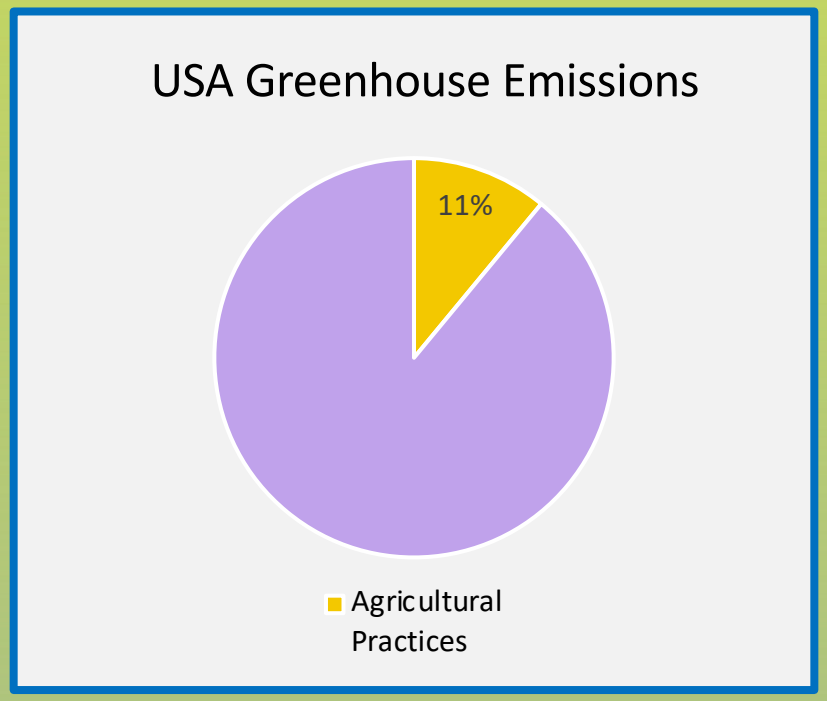


Soil samples collected on-site & analyzed off-site by technicians:

1. Carbon and Nitrogen
2. Bulk Density
3. pH
4. Nutrient Content

<u>Why</u> are we Measuring GHG Emissions and Sampling Soil?

Agricultural practices and related emissions account for **11% of USA GHG emissions**



Climate-Smart Grown in SC aims to **reduce GHG emissions** and **improve soil health** through incentivizing **climate-smart practices**.

Why are we Measuring GHG Emissions and Sampling Soil?

Direct measurements help verify and improve USDA models which calculate GHG emissions.

GHG Emissions	Analysis informs us how climate-smart practices affect **GHG emissions** and **carbon cycling**.
Soil Sampling	Analysis informs us how climate-smart practices affect **soil health, structure, fertility**, and **carbon sequestration.**

Growers will have better, data-supported information regarding the **environmental** and **production benefits** of climate-smart practices. There will be data transparency.

How are we Measuring GHG Emissions?

GHG Flux Chambers

Mobile Trailers

Long-Term Measurement

Year 1

- Continuous Measurement.
- Will be moved for production practices.

Year 2-5

- Every other week.

How are we Sampling Soils?

Soil Cores taken to represent the field.





Short-Term Measurement

- Techs on-site for less than a couple hours.
- Samples taken once a year.

<u>Who</u> is doing all these measurements?

Climate-Smart Personnel

- Field and Lab Technicians
- Postdocs
- PhD Students

Based throughout the state.

- Clemson, Blackville, Georgetown, Florence.

The **Extension Associates** for your enrolled commodity will **inform you when** the measurement personnel will come to your farm **and what** they will be doing

<u>Who</u> Do You Contact if You Have Questions?

In general

Your Extension Associate for the commodity enrolled

More info about Measurements

Measurement Coordinator Cady Kurz cadyk@Clemson.edu

Market Development Team

Building Partnerships for Climate-Smart Commodities in South Carolina

The Research Team

Dr. Nathan Smith

Associate Professor and
Extension Economist
--Peanuts

Dr. Michael Vassalos

Associate Professor
--Consumer demand

Dr. Anastasia Thayer

Assistant Professor
-- Livestock

Dr. Felipe Silva

Assistant Professor
--Leafy greens

Activities and Tasks

- Enrolled producer survey
- Yearly follow-up survey
- Exit survey
- Data collection for enterprise budget creation

Enterprise Budgets

Shortlist:

- Fertilizer application (rate, price, treatment, machinery and implement details, dates)
- Pesticide/herbicide/fungicide application (rate, price, treatment, machinery and implement details, dates)
- Labor
- Detailed production practices from establishment to harvest

Stay tuned for more information

https://www.clemson.edu/extension/agribusiness/resources/request-budget.html

SPRING GREENS - HAND HARVEST - IRRIGATED						
ESTIMATED COSTS AND RETURNS PER ACRE				Select Irr. Method	Drip	
400 BOXES 1 1/9 BU BOXES (20 LB AVG) - MAY HARVEST						
	OP	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. GROSS REVENUE						
GREENS PRICE RECEIVED		BOX	400.00	$14.00	$5,600.00	
GROSS REVENUE:					**$5,600.00**	
2. DIRECT COSTS						
SEED/PLANTS		LBS	3.00	$7.23	$21.68	
FERTILIZER						
NITROGEN (5-10-10)		CWT	12.00	$16.25	$195.00	
SIDE DRESSING - CALCIUM NITRATE		GAL	400.00	$1.75	$700.00	
LIME (PRORATED)		TON	0.50	$52.00	$26.00	
CROP PROTECTION						
HERBICIDES		ACRE	1.00	$4.83	$4.83	
FUNGICIDES		ACRE	1.00	$56.46	$56.46	
INSECTICIDES		ACRE	1.00	$73.10	$73.10	
PLASTIC MULCH		ROLL	2.18	$35.00	$76.30	
MACHINERY						
FUEL		ACRE	1.00	$351.62	$351.62	
REPAIRS & MAINT.		ACRE	1.00	$51.65	$51.65	
LABOR						
OPERATOR LABOR		HRS	14.13	$12.96	$183.12	
HARVEST COST						
HARVESTING & HAULING		BOX	400.00	$2.75	$1,100.00	
MACHINERY OPERATOR LABOR		TOT	1.00	$81.39	$81.39	
MARKETING		BOX	400.00	$0.75	$300.00	
1 1/9 BU BOX		EACH	400.00	$1.95	$780.00	
OTHER						
TAKE UP PLASTIC		ACRE	1.00	100.00	$100.00	
IRRIGATION		ACRE	1.00	$74.73	$74.73	
DRIP TAPE & ACCESSORIES		ACRE	1.00	$452.27	$452.27	
STAKES & TWINE		ACRE	1.00	$129.00	$129.00	
INTEREST ON OP. CAP.		DOL.	$2,000.58	7.0%	$140.04	
TOTAL DIRECT COSTS:					**$4,897.19**	
3. INCOME ABOVE DIRECT COSTS:					**$702.81**	

Expected Output

- Production Information:
  - Enterprise budgets to help inform adoption and decision-making
  - Fact sheets and trainings with Extension teams and producers.

- Market Information:
  - Consumer willingness-to-pay for “climate-smart” commodities
  - Barriers to industry (restaurants, specialty stores, etc.) purchase of “climate-smart” commodities

Questions?

Horticultural Research Team

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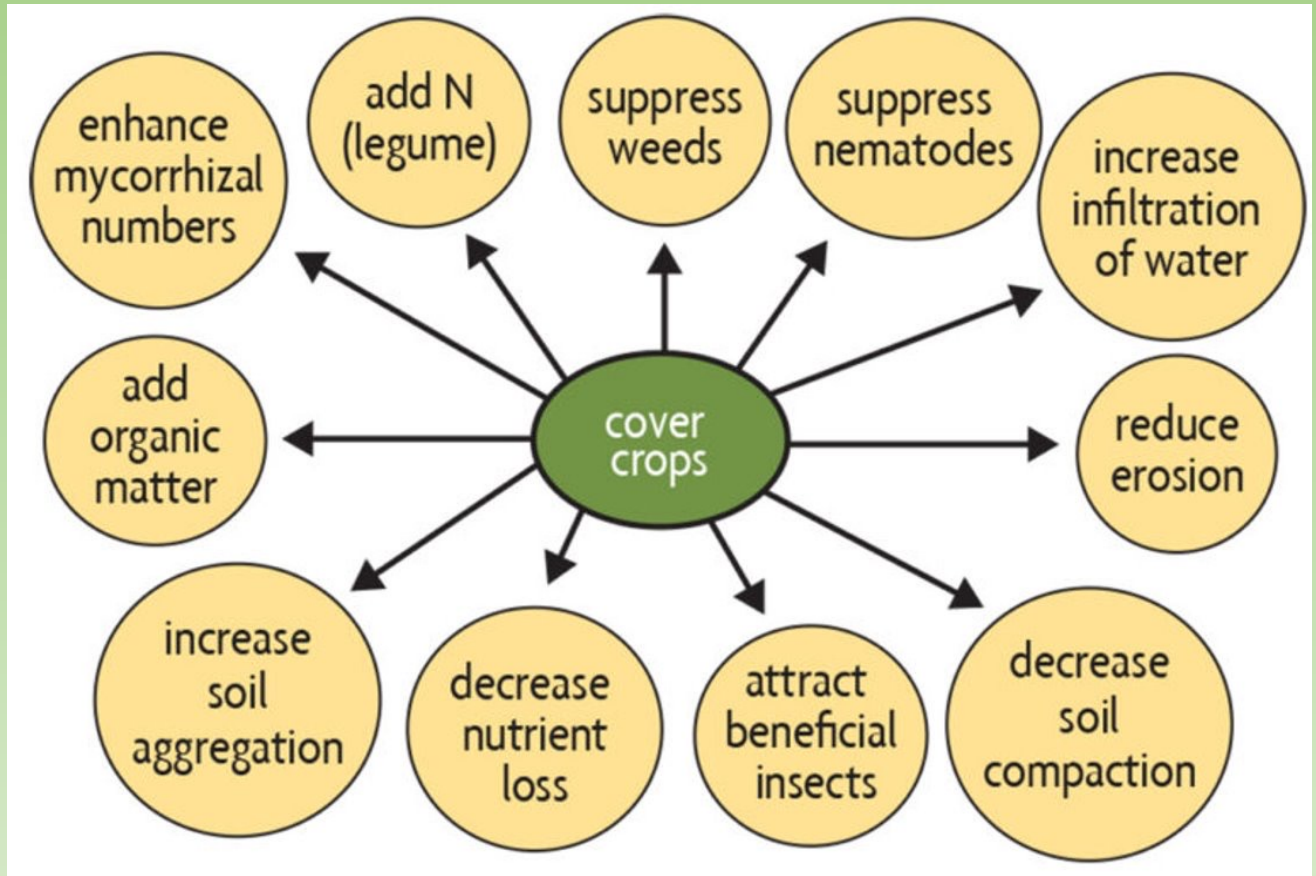
Cover Crops Benefits

- Cover crops provide multiple potential benefits to soil health and to the following crops, while also helping to maintain cleaner surface water and groundwater.
- They prevent erosion, improve soil physical and biological properties, supply nutrients to the following crop, suppress weeds, improve soil water availability, and break pest cycles.
- Some cover crops are able to break into compacted soil layers, making it easier for the following crop's roots to more fully develop.



Cover Crops for Sustainable Crop Rotations - SARE
https://www.sare.org/resources/cover-crops/

Cover Crops

Definition: Grasses, legumes, and forbs planted for seasonal vegetative cover

Purpose:

- Reduce erosion from wind and water
- Maintain or increase soil health and organic matter content
- Reduce water quality degradation by utilizing excessive soil nutrients
- Suppress excessive weed pressures and break pest cycles
- Improve soil moisture use efficiency
- Minimize soil compaction

Cover Crops Benefits

The term “cover crop” refers generally to plants that are grown but not harvested. Different **types** of plants are grown as cover crops for some primary purposes:

Catching and cycling nutrients

- **Recommended Types**: Grasses such as cereal rye and oats.
- Especially useful in high-nutrient environments.

Fixing nitrogen via symbiotic relationship with *Rhizobium* bacteria (green manures)

- **Recommended Types**: Legumes (e.g., hairy vetch and red clover).
- Especially useful on organic farms or by others who want to “grow” their own nitrogen.

Cover Crops Benefits Continued

Smothering weeds

- **Recommended Types:** Competitive, fast-growing species (e.g., buckwheat, sorghum-sudangrass, cereals).
- Especially useful when weed control is a challenge.

Biofumigating pests with glucosionlates and isothiocyanates

- **Recommended Types:** Brassicas (e.g., mustards and radishes).
- Especially useful when growing disease-susceptible crops with limited chemical control.

Loosening compacted soil

- **Recommended Types:** Strong-rooted crops (e.g., cereal rye, radishes, hairy vetch, alfalfa).
- Especially useful to improve a degraded soil.

Cover Crops Benefits Continued

Growing biomass and organic matter

- **Recommended Types:** Fast-growing crops (e.g., sorghum-sudangrass, cereal rye, sunn hemp).
- Especially useful when soils are low in organic matter or when you aim to capture carbon.

Providing cover for the soil surface

- **Recommended Types:** Crops that establish quickly during the off season to protect the soil (e.g., rye or oats in cool climates).
- *Canopy functions* (where benefits are primarily derived from the aboveground biomass) and
- Root functions (where benefits are from the belowground biomass)
- *Multiple* benefits

Cover Crops Benefits Continued

Organic matter:

- Grass cover crops are more likely than legumes to increase soil organic matter.
- The more surface residue and roots provided to the soil, the better the effect on soil organic matter.
- Some cover crops grow as much or more biomass underground than above.
- For example:
  - Good production of hairy vetch or crimson clover cover crops may yield from 1 1/2 to more than 4 tons of dry weight per acre if allowed to grow long enough.
  - If a vigorous grass cover crop like cereal rye is grown to maturity, it can produce 3–5 tons of residue.
- The amount of residue produced by an early terminated cover crop may be as little as ½ ton per acre
- Small cover crop plants add some active organic matter, but they may add little to long-term build-up of soil organic matter if not enough root growth and residue are allowed to develop.

Cover Crops Benefits Continued

Organic matter continued:

- A five-year experiment with clover in California showed that cover crops increased organic matter in the top 2 inches from 1.3%–2.6% and in the 2- to 6-inch layer from 1%–1.2%.
- Researchers found cover crops led to an organic matter increase of 8.5% over original levels and an increase of soil nitrogen by 12.8%.
- The longer the cover crop grows and the less tillage that is used, the greater the increase in soil organic matter.
- In other words, the beneficial effects of reduced tillage and cover cropping can be additive, and the combination of practices has greater benefits than using them individually.

Cover Crops Benefits Continued

Beneficial organisms:

- Cover crops help maintain high populations of mycorrhizal fungi during the period between main crops and thereby provide a biological bridge between cropping seasons.
- The fungus also associates with almost all cover crops (except brassicas), which helps maintain or improve inoculation of the next crop.
- Mycorrhizal fungi help promote the health of many crop plants in a variety of ways and improves soil aggregation.
- Cover crop pollen and nectar can be important food sources for predatory mites and parasitic wasps, both of which are important for biological control of insect pests.
- A cover crop also provides good habitat for spiders, and these insect feeders help decrease pest populations.

Cover Crops Benefits Continued

Beneficial organisms continued

- Use of cover crops in the Southeast has reduced the incidence of thrips, bollworm, budworm, aphids, fall armyworm, beet armyworm and white flies.
- Earthworm populations may increase markedly with cover crops, especially if combined with no-till.
- Aggressive tillage harms earthworm populations and destroys their burrowing channels—as well as those from old roots—that reach the surface, reducing infiltration during intense rainfall.
- Tillage reduces weed seed predation by beetles, an important ecological service for reducing viable weed seed.

Cover Crops Benefits Continued

FARMERS SAY COVER CROPS HELP THE BOTTOM LINE

- A 2019–2020 national cover crop survey, with 1,172 farmers found new insights into farmer experiences with cover crops.
  - Most producers, working with their seed dealers, are finding ways to economize on cover crop seed costs
  - 16% paying only $6–$10 per acre for cover crop seed
  - 27% paying $11–$15 per acre
  - 20% paying $16–$20 per acre
  - 14% paying $21–$25 per acre
  - Only about one-fourth were paying $26 or more per acre.
- This survey was conducted annually beginning in 2012 (except for 2018–2019).
- On average, reported yields were higher as a result of planting cover crops in all years, and most notably in the drought year of 2012 when soybean yields were improved by 12% and corn yields were 10% better. Yield gains were more modest in the wet year of 2019, when the average increase was 5% for soybeans and 2% for both corn and wheat.

Cover Crops Benefits Continued

Farmers also reported significant savings on fertilizer and/or herbicide production costs in the 2019–2020 survey for the following crops:

- soybeans: 41% saved on herbicide costs and 41% on fertilizer costs
- corn: 39% saved on herbicide costs and 49% on fertilizer costs
- spring wheat: 32% saved on herbicide costs and 43% on fertilizer costs
- cotton: 71% saved on herbicide costs and 53% on fertilizer costs

  52% of farmers “planted green” into cover crops on at least some of their fields.
  - (“Planting green” is the term for seeding a cash crop into a standing cover crop and terminating the cover crop soon after.)
- Of those, 71% reported better weed control and 68% reported better soil moisture management, with 54% indicating that cover crops allowed them to plant earlier.

Cover Crops Benefits Continued

- Of those, 71% reported better weed control and 68% reported better soil moisture management, with 54% indicating that cover crops allowed them to plant earlier.
- Of the horticulture producers surveyed, 58% reported an increase in net profit. Only 4% observed a minor reduction in net profit, and none reported a moderate loss in net profit.
- Survey participants indicated an increase of 38% in land devoted to cover crops over the previous four years and the use of a range of cover crop seed and mixes to address their individual needs.
- This survey showed many positive aspects of cover crop integration and that farmers continue to find benefits to their use.

Cover Crop Requirements

Cover Crops (CPS 340) - For operations not currently implementing cover crops. Select and plant cover crops compatible with production system; terminate mechanically (roller crimper or flame) or chemically prior to planting cash crop; cash crop planted into residues left on the soil. All tillage practices accepted
Conservation Practice Standard Cover Crop (Code 340) (usda.gov)
https://efotg.sc.egov.usda.gov/api/CPSFile/23444/340_NC_CPS_Cover_Crop_2020

Requirements:

- Select and plant cover crops compatible with production system
- Terminate mechanically or chemically prior to planting cash crop
- Plant cash crop into residue on soil, or incorporate residue as in normal operations
- All tillage practices accepted

Cover Crop Requirements Continued

General Criteria Applicable to All Purposes:

- Plant species, seedbed preparation, seeding rates, seeding dates, seeding depths, fertility requirements, and planting methods will be consistent with applicable local criteria and soil/site conditions.
- Select species that are compatible with other components of the cropping system.
- Ensure herbicides used with crops are compatible with cover crop selections and purpose(s).
- Cover crops may be established between successive production crops, or companion-planted or relay planted into production crops.

*Select species and planting dates that will not compete with the production crop yield or harvest.

Cover Crop Requirements Continued

*Do not burn cover crop residue.

- Determine the method and timing of termination to meet the grower's objective and the current NRCS Cover Crop Termination Guidelines.
  - Current NRCS Cover Crop Termination Guidelines are posted in FOTG Sec IV in the 340 Cover Crop CPS folder.
  - https://www.nrcs.usda.gov/sites/default/files/2022-09/Termination_Guidelines_Designed_6.28_10.24am_%28002%29.pdf
- When a cover crop will be grazed or hayed 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).

Considerations for Choosing a Cover Crop

Planning - Built Around Markets

- Cover Crops are typically Planted one Season in Advance
- Two Main Windows
  - Spring/Summer Cover Crop Plantings for Fall Greens Crop
  - Fall/Winter Cover Crop Plantings for Spring Greens Crop

Cover Crop Use in Leafy Green Cultivation

What is a Cover Crop?

✓Any crop planted specifically for the purpose of improving or holding soil.

Why Cover Crop?

✓ Cover crops are an excellent way to hold and stabilize topsoil when land is not in use.

✓ Cover crops are excellent for carbon sequestration and mitigation of climate change

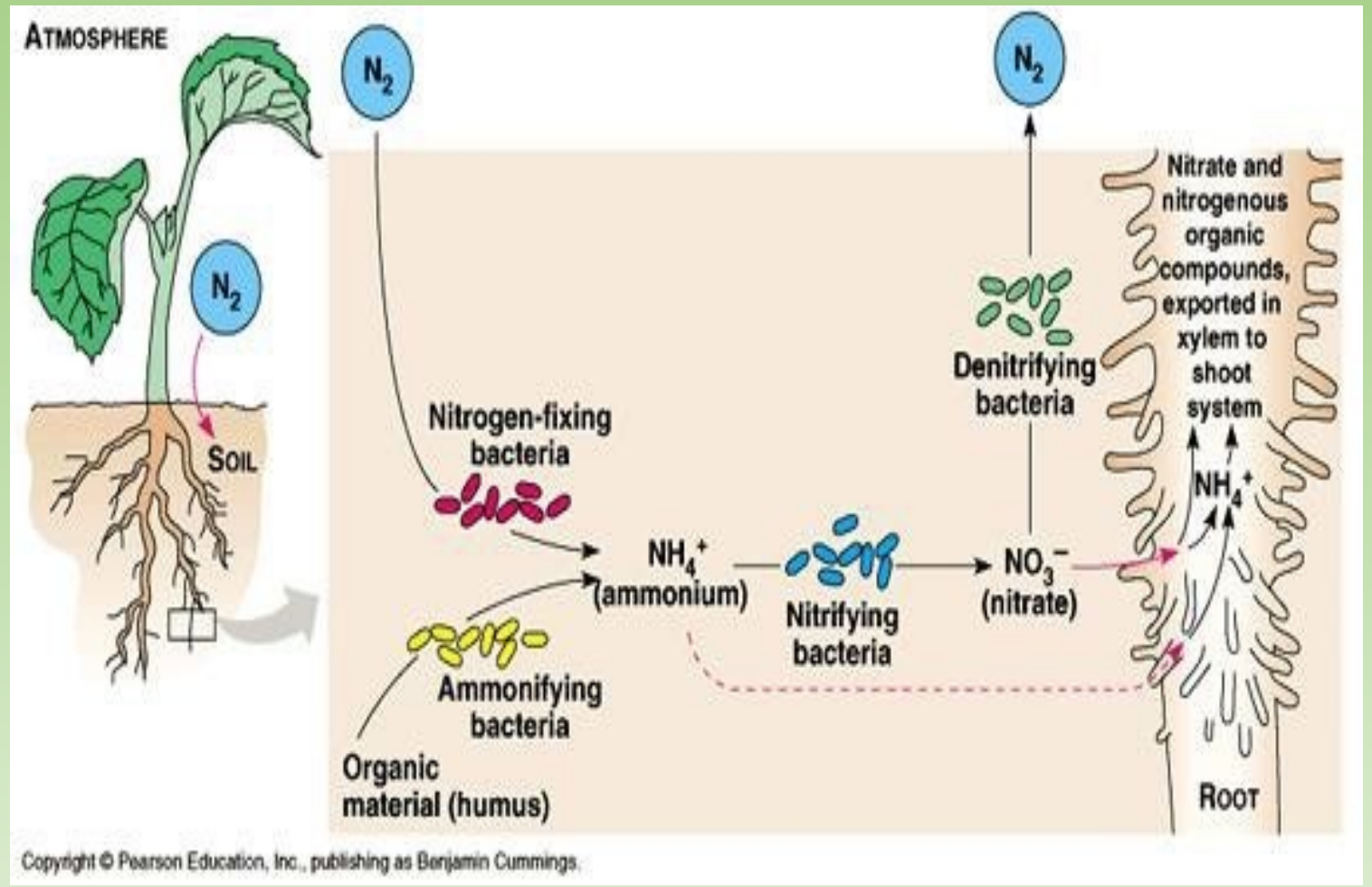
✓ Deep rooted cover crops to help loosen hard soils and increase aeration and improve soil health.

✓ Cover crops in the legume-family help “fix” nitrogen, making it readily available to plants.

✓ Cover crops can also be used as a weed barrier between rows of crops.

✓ Some cover crops can attract beneficial insects.

Nitrogen Fixing Legumes at Work



Important Take Aways

- Selecting the best cover crops for different uses.
- Application methods
- Methods of incorporation
- Termination Methods

Cover Crop Costs

Seed costs and rates for various southeastern USA cover crops.

Cover Crop	Price	Per Acre		Per 1000 ft²	
	$/lb	lb/acre	$/acre	lb/1,000ft²	$/1,000 ft²
Crimson Clover	1.63	16	26.13	0.4	0.65
Hairy Vetch	2.60	20	52.00	0.5	1.30
Iron Clay Cowpea	0.85	50	42.42	1.1	0.93
Sunn Hemp	2.58	30	77.40	0.7	1.81
Velvet Bean	4.00	30	120.00	0.7	2.80
White Clover	4.73	7	33.11	0.2	0.95
Persian Clover	3.00	5	15.00	0.1	0.30
Winter Pea	0.71	75	53.38	1.7	1.21
Black Oat	0.50	60	30.00	1.4	0.70
Buckwheat	1.00	55	55.00	1.3	1.30
Cereal Rye	0.57	90	51.60	2.1	1.20
Mustard	4.00	10	40.00	0.2	0.80
Oat	0.37	75	27.50	1.7	0.62
Radish	3.09	10	30.88	0.2	0.62
Sorghum-sudangrass	1.03	35	36.05	0.8	0.82
Wheat	0.32	75	23.75	1.7	0.54

Raw seed costs based on 2014 data unless otherwise noted. Does not include shipping costs.

$/lb x lb/acre = $/acre; lb/acre ÷ 43.56 = lb/1,000ft²

This table shows typical costs and rates for various southeastern USA cover crops. The costs are an average of several southeastern retailers. Your costs and rates may differ.

Buckwheat Radish Lupin Rye Wheat Clover

Cover Crop Costs

Estimated costs to establish and terminate a cereal rye cover crop

Input / Activity	Unit	Cost	Units/Acre	Cost	
		$/unit		$/acre	$/1000ft²
Establishment					
Seed (Cereal Rye)	pounds	0.57	90	51.30	1.18
No-till Drill	acre	9.71	1	9.71	0.22
Fertilization					
Fertilizer	pounds	0.59	30	17.70	0.41
Application	acre	6.32	1	6.32	0.15
Cover Crop Termination					
Chemical Termination					
Glyphosate	ounces	0.13	16	2.08	0.048
Application	acre	1.68	1	1.68	0.039
MechanicalTermination Rolling, mowing, etc.	acre	4.14	1	4.14	0.10
			Total Cost	92.93	2.13

All input / activity costs are based on 2014 data. Application costs do not include fixed costs.

This table is an example of the costs for establishing, growing, and terminating a cover crop. For this example we used rye. Your own system or costs may differ, of course.

National Soil Dynamics Laboratory
Conservation Systems Research
Conservation Systems Fact Sheet No. 040
October 2014
USDA-ARS-NSDL
411 S. Donahue Dr.
Auburn, AL 36832
334-887-8596

www.ars.usda.gov/msa/auburn/nsdl

USDA United States Department of Agriculture
Agricultural Research Service

Cover Crop Chart

AREA 4 SCD Cooperative Research Farm

GROWTH CYCLE	PLANT ARCHITECTURE	RELATIVE WATER USE
A = Annual	♈ = Upright	💧 = Low
B = Biennial	✱ = Upright-Spreading	💧💧 = Medium
P = Perennial	〰 = Prostrate	💧💧💧 = High

COOL						WARM			
--GRASS--	BROADLEAF								--GRASS--
A 💧 ANNUAL FESCUE ♈									A 💧 BROWNTOP MILLET ♈
A 💧 BARLEY ♈								A 💧 AMARANTH ♈	A 💧 FOXTAIL MILLET ♈
LEGUME									
A 💧💧 OAT ♈	A/B 💧 CAMELINA ♈	A/P 💧 MUSTARD ✱	A 💧 BALANSA CLOVER 〰✱	A 💧 CHICKPEA ✱	A/P 💧 MEDIC ♈	A 💧 COWPEA ✱	A 💧 CLUSTER BEAN ✱	A 💧💧 BUCKWHEAT ♈	A 💧 PEARL MILLET ♈
A 💧 SPELT ♈	A 💧 PHACELIA ♈	A/B 💧💧 CANOLA ✱	A 💧💧 BERSEEM CLOVER ♈	A 💧 PEA ♈	A 💧 LUPIN ♈	A/P 💧 LABLAB 〰✱	A/P 💧 JACK BEAN ✱	A 💧💧 QUINOA ♈	A 💧💧 PROSO MILLET ♈
A 💧💧 WHEAT ♈	A 💧💧 FLAX ♈	A 💧💧💧 RADISH ✱	A 💧💧 CRIMSON CLOVER ✱	A 💧 LENTIL ✱	A 💧💧 FABA BEAN ♈	A/P 💧 FENUGREEK ♈	A 💧 VELVET BEAN ✱	P 💧💧 CHICORY ✱	A 💧💧 GRAIN SORGHUM ♈
A 💧💧💧 CEREAL RYE ♈	A 💧💧 KALE ✱	B 💧💧💧 TURNIP ✱	B/P 💧💧 RED CLOVER ♈	A/P 💧💧 LESPEDEZA 〰✱♈	A/B 💧💧 SWEET CLOVER ♈	A/P 💧 PIGEONPEA ✱	A 💧💧 MUNG BEAN ✱	A 💧💧💧 CUCURBITA 〰	A 💧💧 SUDAN GRASS ♈
A 💧💧💧 TRITICALE ♈	A 💧💧 SPINACH ✱	B 💧💧💧 BEET ✱	P 💧💧 WHITE CLOVER 〰✱	P 💧💧 BIRDSFOOT TREFOIL 〰	P 💧💧💧 ALFALFA ♈	A 💧💧 PARTRIDGE PEA ♈	A 💧💧 SOYBEAN ✱	A 💧💧💧 SAFFLOWER ♈	A 💧💧 TEFF ♈
P SALINE TOLERANT ♈	A/B 💧💧💧 CHARD ✱	A/B 💧💧💧 CARROT ✱	P 💧💧 KURA CLOVER 〰	A/B 💧💧 VETCH 〰	P 💧💧💧 SAINFOIN ♈	A 💧💧 SUNNHEMP ♈	A/P 💧💧💧 PEANUT 〰✱	A 💧💧💧 SUNFLOWER ♈	A 💧💧💧 CORN ♈

https://www.nrcs.usda.gov/sites/default/files/2022-09/CCC%202018-final%203.05.18.pdf

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Cover Crop Seed Sources

See Company / Website	Phone Number #
Mixon Seed	(803) 531-1777
Seedway	(800) 836-3710
Johnny's Selected Seeds	(877) 564-6697
hancockseed.com	(800) 552-1027
King's AgriSeeds, Inc.	(717) 687-6224
AMPAC Seed Company	(541) 928-1651
Ernst Conservation Seed	(800) 873-3321
https://www.trueleafmarket.com/	(801)-491-8700
https://www.deercreekseed.com/	(877)-247-3736

Herbicide Application Scenarios in Cover Crops

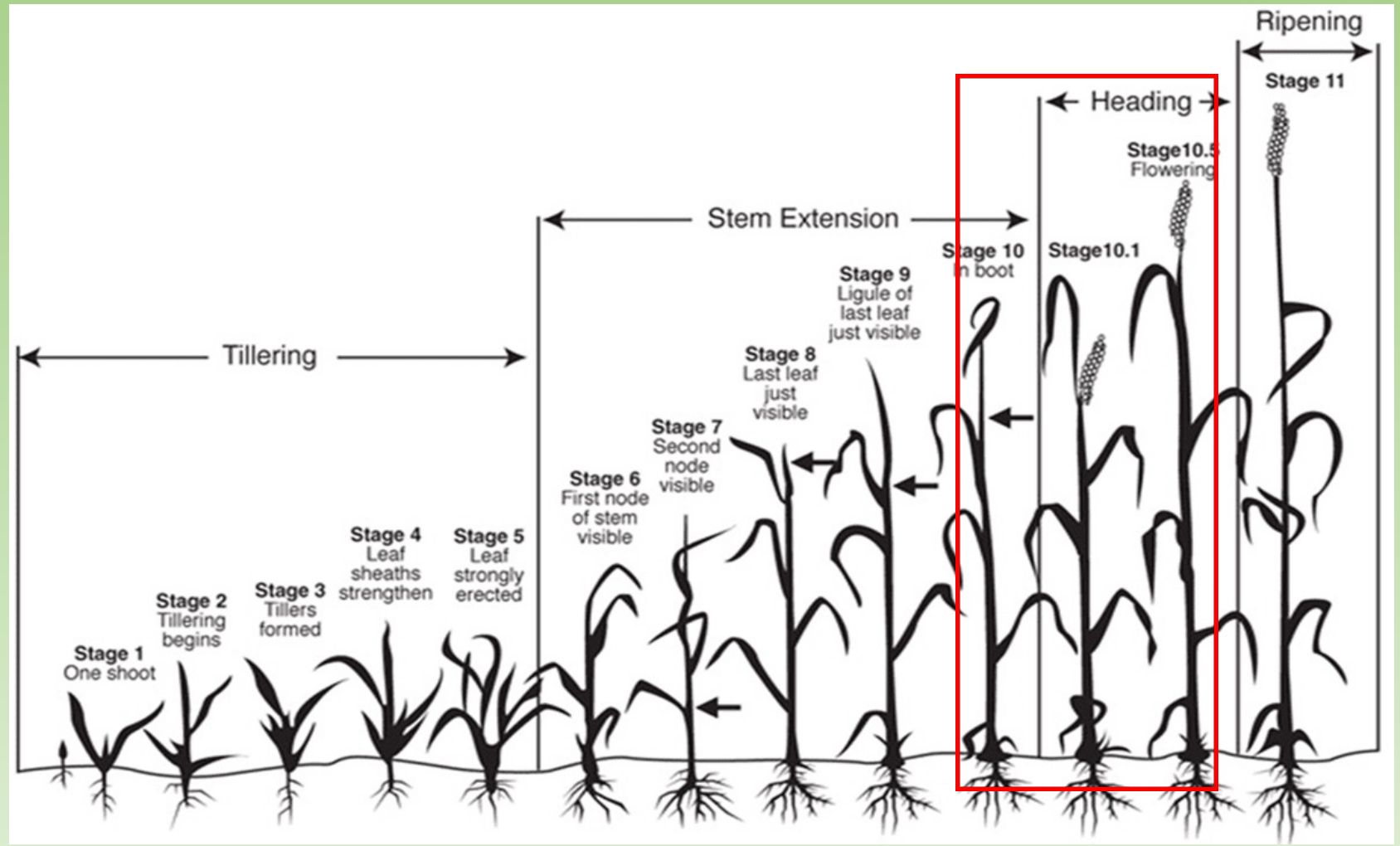
Fall Cereal Rye

•Delaying cereal rye termination until the time of cash crop planting or later by planting green has been shown to be an effective management strategy to achieve early-season weed suppression in some cash crop systems.

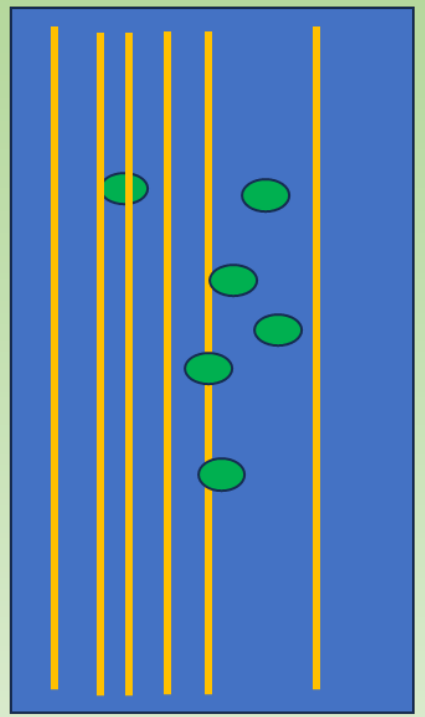
- To achieve dependable weed suppression of later emerging weeds from cereal rye (i.e. waterhemp), delaying termination until around the root growth or anthesis growth stage of cereal rye is needed to allow for the maximum amount of rye biomass accumulation and cereal rye residue persistence.

- Later termination of cereal rye can be done chemically with glyphosate and/or using a roller-crimper.

Stages of Small Grain Growth *mature



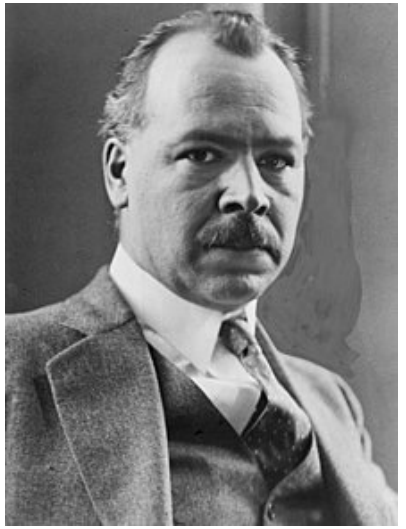
Important to make sure winter annual weeds or perennial weeds do not compete with establishing cereal rye.



Nikolai Vavilov and Vavilovian Mimicry

- Vavilov was a Russian geneticist who was imprisoned by Joseph Stalin. Vavilov had conflicting views with Trofim Lysenko.

Model: Crop being imitated
Mimic: Weed imitating the model
Operator: Purpose is to distinguish model from mimic: ex human hand weeding, herbicide etc.



- The ability of a weed species to evolve to appear phenotypically similar to the desirable crop, evolve to tolerate management practices applied to the desirable crop, or both—a process that should be known as Vavilovian mimicry.

Sanitation

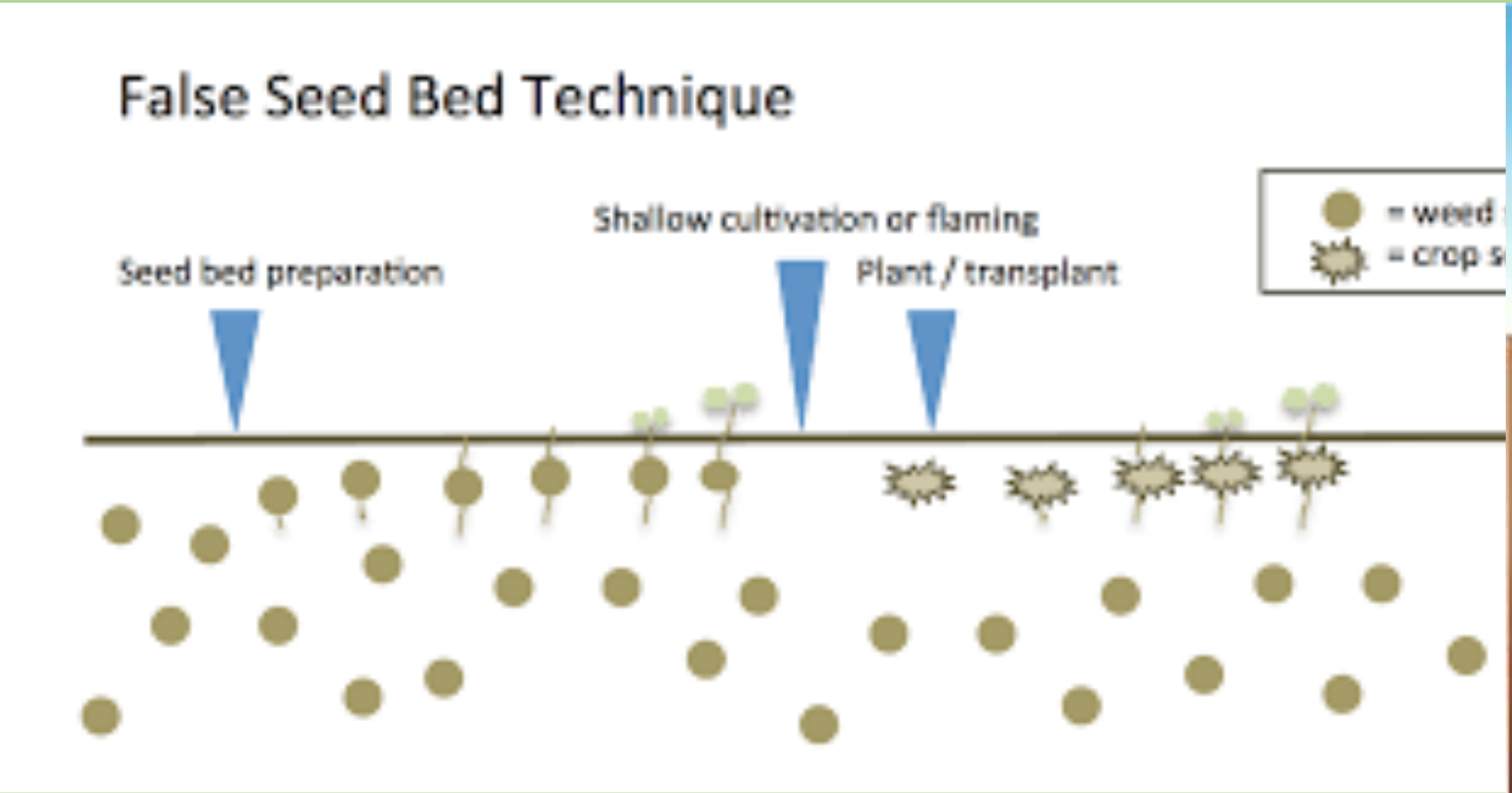
- Clean Equipment

- Make sure crop seed is weed free

Weed Mapping/Scouting

- Base line weed scouting should begin at or near harvest.
- Multi-Task: Scout for weeds, insects, disease symptoms
- Scout early-Important to discover weed patches before spread through
- Tools for scouting include a hand lens, field maps, weed ID books, sampling bags
- Keep good records with respect to emergence patterns of weeds as influenced by environmental factors.
- Clemson Vegetable Weed Lab- https://www.clemson.edu/cafls/research/weeds/index.html

Stale Seed Bed Technique



Summer Grass Cover Crops

- Hybrids are fast growing summer annuals that produce a lot of growth in a short time.
- Since summer cover do not recommend use of auxin herbicides to control early season weeds.
- Produce a lot of phytochemicals that have anti-nematode and allelopathic properties.
- Several week interval between termination and seeding cash crop.

Figure 10.4. Root systems of four grass cover crops at early stages of growth (two months in a greenhouse). From left: annual ryegrass, barley, triticale (winter biennials) and sorghum-sudangrass (summer annuals). Photos by Joseph

Terminate With Glyphosate or Glufosinate

- If using a glufosinate product include 2.5% v/v of liquid AMS in the tank and 0.25% NIS.

- Many glyphosate products available be sure to read label regarding adjuvant loading. Depening on water source might need to add AMS.

Fall Legume Cover Crops

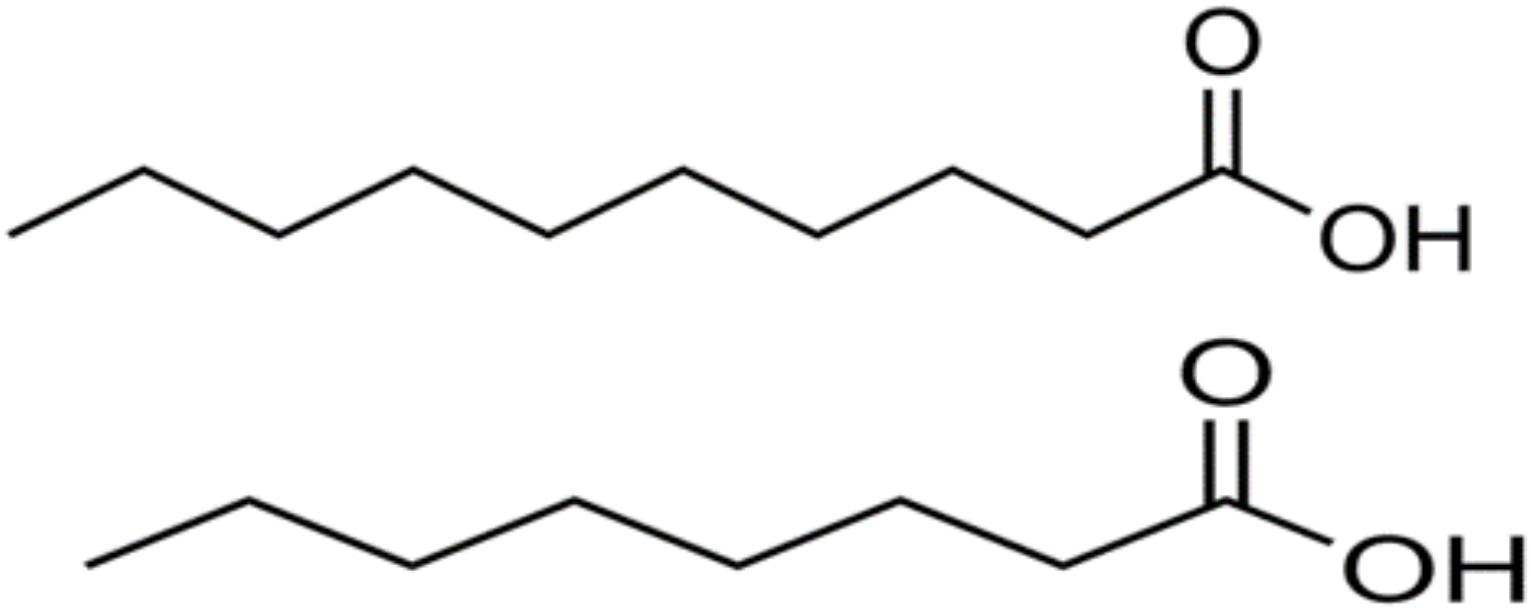
- Crimson Clover-aggressive growth, smothers weeds.
- For control of grasses weeds early in establishment can use clethodim or sethoxydim.
- Due to difficulty managing , don't recommend as living mulch in non-plasticulture scenarios.

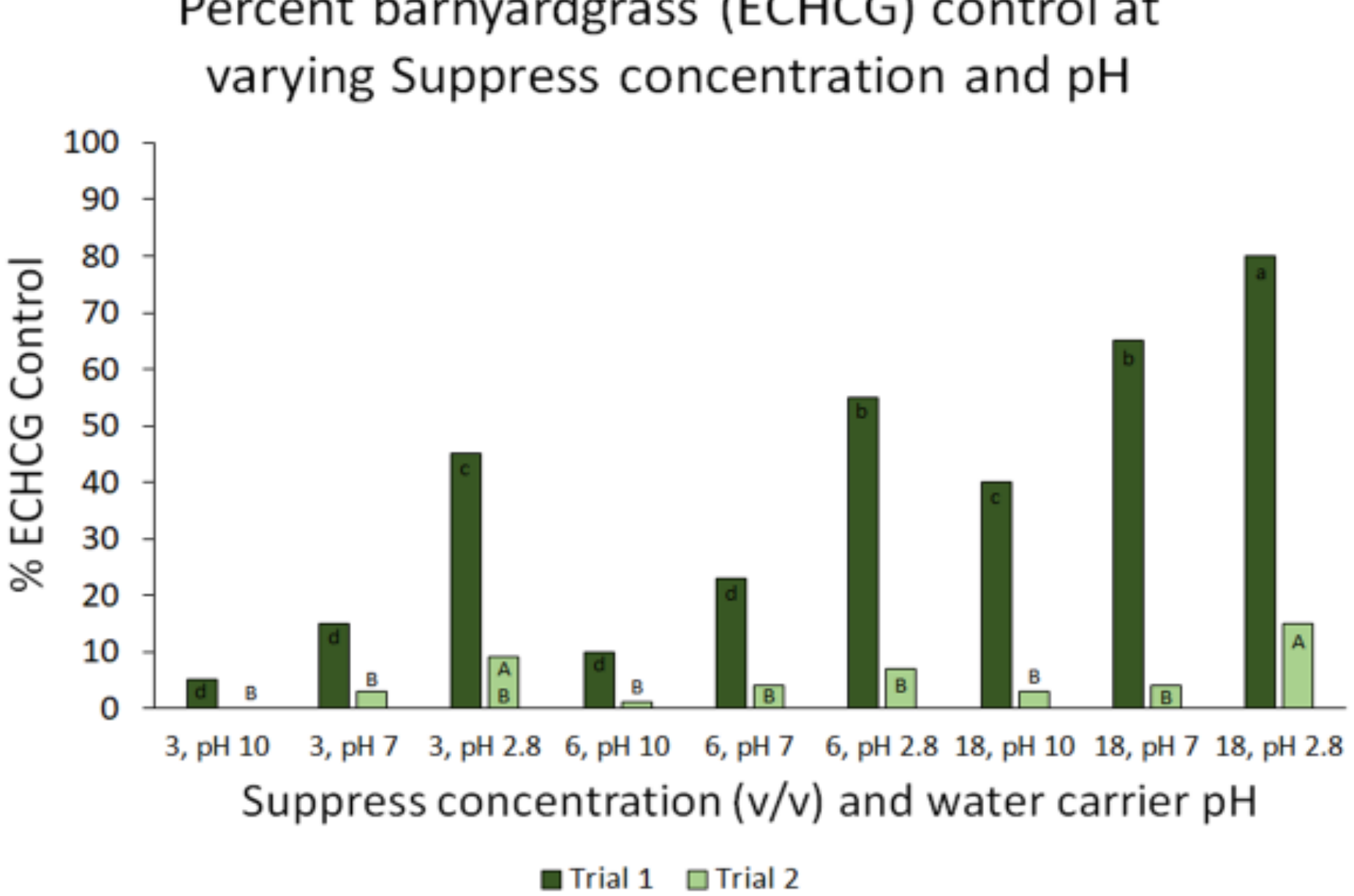
Herbicide Tools

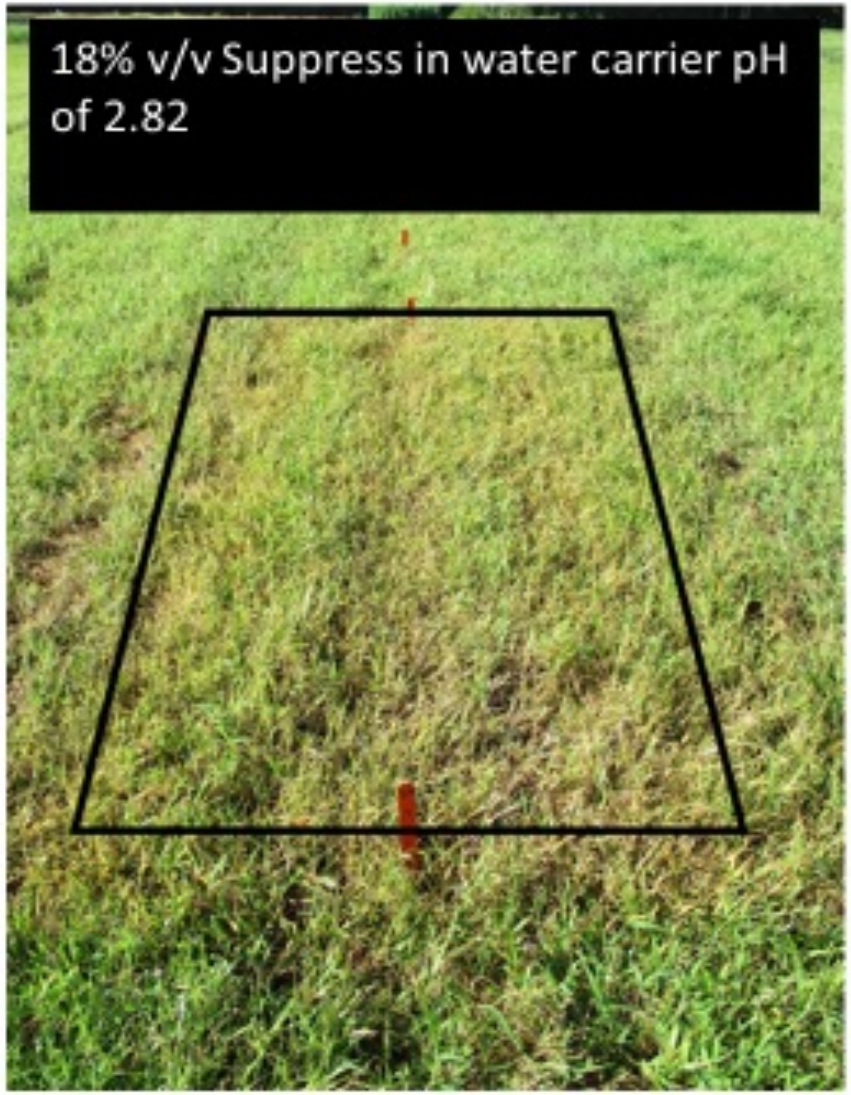
Burndown Herbicide Preplant	Trade Name	Characteristic
Glyphosate	Roundup, many others	Moves through roots and shoots, effective. Non selective. Check formulation label
Glufosinate	Liberty/Rely	Systemic activity not as good as glyphosate if 2.5% AMS and 0.25% NIS is added to tank. Non selective
Carfentrazone	Aim	Carfentrazone- contact, better on broadleaf weeds
PRE Herbicide for Leafy Greens	**Trade Name**	**Characteristic**
S-Metolachlor	Dual Magnum	Collards and kale Only, apply when crop is at least 3 inches tall or 10 days after transplanting.
Trifluralin	Treflan	Needs to be incorporated pre-plant, very volatile
DCPA	Dacthal	Going through EPA re-registration, good on BL and grasses, high use rate. Try not to use wettable powder formulation.
POST Herbicide for Leafy Greens	**Trade Name**	**Characteristic**
Sethoxydim/Clethodim	Poast/Classic	Systemic controls grasses only
Clorpyralid	Stinger	Controls Legumes such as hemp sesbania, vetch

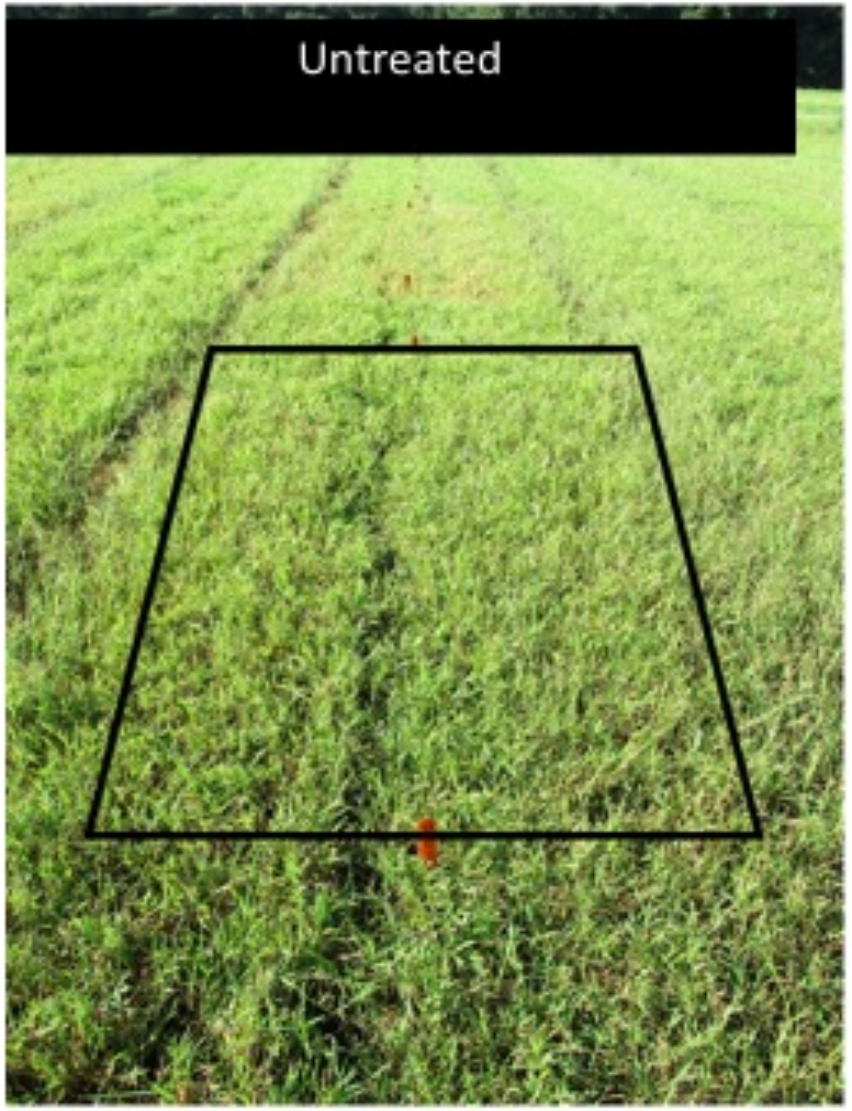
Suppress Organic Herbicide

- Capric + Caprylic Acid




Percent barnyardgrass (ECHCG) control at varying Suppress concentration and pH
% ECHCG Control
100
90
80
70
60
50
40
30
20
10
0
d
B
d
B
c
A B
d
B
d
B
b
B
c
B
b
B
a
A
3, pH 10
3, pH 7
3, pH 2.8
6, pH 10
6, pH 7
6, pH 2.8
18, pH 10
18, pH 7
18, pH 2.8
Suppress concentration (v/v) and water carrier pH
Trial 1
Trial 2


18% v/v Suppress in water carrier pH of 2.82


Untreated

Important Points to Consider in Crop Rotation Decision Making

- How long to wait before using plot again for cash crop?
    - Typically, for short-term – less than 90 days.
- Cover crops to use- (buckwheat, oats, tillage radish, sudangrass, turnips, wheat).
- 90-180 days -
    - red clover, winter rye, and vetch.
- Long-term (180 days +)- clovers, forage Grasses.

Simple Rules Regarding When to Plant

Soil Compaction Problem
Select cover crops with deep tap roots: tillage radish, turnips, clovers

Nitrogen Fixation
Cover crops in the legume family: alfalfa, clovers, field peas

Spring
peas, oats,
hairy vetch, clover, radish, turnips

Summer
alfalfa, clovers, field peas

Fall
winter rye, field peas, ryegrass, crimson clover,
hairy vetch

Winter
mix red clover with winter rye to hold a field over Winter.

*Choose a cover crop with high biomass, such as sorghum sudangrass, winter rye, crimson clover as well.

*The larger a crop, the more difficult it is to incorporate.

Example of Cool Season Cover Crops

- Triticale, Hairy Vetch, Fava Bean, and Austrian Winter Pea mix), and clover-grass pasture/cereal-Italian rye mix.

- <u>Intercover Crop</u>
- Crimson Clover/Rye
- Vetch/Rye
- Pea/Rye

Example of Warm Season Cover Crops

- Sorghum/Sudan Sudex, Southern Pea, Sunn Hemp, Indeterminate soybean, etc

- <u>Intercover Crops</u>
- Sudex/Sunn Hemp
- Sudex/Cowpea
- Sudex/soybean Intercover Crop

Terminating Your Cover Crop

✓Winter-kill

✓Mowing

✓Tillage

✓Combination of mowing and tilling winter-kill, mowing, tillage, a combination of mowing roller-crimping

✓Grazing

✓Herbicides (not recommendation for organic farming)

✓Time to terminate ----- Spring

Termination

Determine the method and timing of termination to meet the grower's objective and the current NRCS Cover Crop Termination Guidelines. Current NRCS Cover Crop Termination Guidelines are posted in FOTG Sec IV in the 340 Cover Crop CPS folder.

Cover Crops (CPS 340) Incorporating mature cover crop residues/normal agricultural operations. All practices *

Reduced Tillage (CPS 345) Mature cover crop flail mowing, bush hogging, no-till drill, ridge tillage, strip tillage etc.

Mulching (CPS 484) Mature cover crop strip tilled with mulch applied, and the alleys left in living or desiccated/mowed/crimped etc. cover crop

Terminating Your Cover Crop with Roller Crimpers

https://www.youtube.com/watch?v=kmrxhdaRohQ

Benefits of Using Cover Crop Post-Harvest…

Why Plant Cover Crops After Leafy Green Harvest?

- ✓ Cover crops allow your farm to rest and rejuvenate after harvest.
- ✓ In early spring, terminate them, till them in, and have your leafy green field ready for planting.
- ✓ Can allow to continue growing for the entire season for crop.
- ✓ They can be used for crop rotation.
- ✓ Cover crops in the legume-family cover help “fix” nitrogen, making it readily available to plants.

Reduced Tillage

Definition: Managing the amount, orientation, and distribution of crop and other plant residue on the soil surface year-round while limiting soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting

Purpose:

- Reduce sheet, rill, and wind erosion and excessive sediment in surface waters (soil erosion)
- Reduce tillage-induced particulate emissions (air quality impact)
- Improve soil health and maintain or increase organic matter content (soil quality degradation)
- Reduce energy use (inefficient energy use)

Conservation Practice Standard Residue Management Reduced Till (Code 345) (usda.gov)
https://www.nrcs.usda.gov/sites/default/files/2022-09/Residue_And_Tillage_Management_Reduced_Till_345_CPS.pdf

Post-Cover Crop CPS 340: All Practices *

After a mature cover crop has been grown under CPS 340, all cultural practices are allowed*

- **No burning of cover crop residue.**
- **Does not specifically prohibit desiccation or directed weeding**
  (https://nam12.safelinks.protection.outlook.com/?url=https%3A%2F%2Fflameengineering.com%2Fpages%2Fproduct-videos&data=05%7C01%7Clmbarne%40clemson.edu%7C3b63dd2751a24679088508dbab15aebc%7C0c9bf8f6ccad4b87818d49026938aa97%7C0%7C0%7C638291881845980768%7CUnkno)

Tillage Variations

Reduced Tillage Requirements

Requirements:

- Select and plant cover crops
- Reduced tillage practice (strip-till, ridge-till, mulch-till, no-till)

Reduced Till

CPS 340, 345

https://www.youtube.com/watch?v=SQQRHURvJUI

Reduced Till

CPS 340, 345

Strip Till
CPS 340, 345


Strip Till
CPS 340, 345

Mulch Application

- Whole field seeded in Regal Graze Ladino Oct, 12lbs/Ac
- Early spring rough bed acts as a disk (the width of bed)
- After approximately 10 days (depending on weather)
- Roto-till, press, lay plastic, drip, pre-emergent fertilizer, soil amendments or chemical as in conventional or organic plasticulture systems

CPS 340, 345, 484
Cover Cropping, Reduced Tillage and Mulching

Leafy Green Production Considerations

https://www.nxtbook.com/greatamericanmediaservices/GAMS/southeastern-u-s-vegetable-crop-handbook-2023/index.php

Topic	Page Number
Crop Rotation, Soils, Fertility	1
Nutrient Management	3
Minimum Tillage	11
Helpful Resources and Transplant Production	14
Brassica Variety Recommendations	49
Greens, Mustard and Turnip Variety Recommendations	66
Brassica Chemical Weed Control Recommendations	337
Brassica, Collard, Kale and Mustard Green Chemical Insect Control Recommendations	143,148
Greens, Mustard and Turnip Weed Control Recommendations	347
Brassica, Greens, Mustard and Turnip Chemical Disease Control Recommendations	226

Reduced Tillage Requirements

- General Considerations: Removal of crop residue, such as by baling or grazing, can have a negative impact on resources.
- These activities should not be performed without full evaluation of impacts on soil, water, animal, plant, and air resources.
- Reduced till may be practiced continuously throughout the crop sequence or may be managed as part of a residue management system that includes other tillage methods such as no till.
- Production of adequate amounts of crop residue necessary for the proper functioning of this practice can be enhanced by selection of high residue-producing crops and crop varieties in the rotation, use of cover crops, and adjustment of plant populations and row spacing.

Reduced Tillage Requirements

PLANS AND SPECIFICATIONS

Specifications shall be prepared for each site and purpose and recorded in the approved implementation requirements document.

- Purpose for applying the practice.
- Planned crop(s).
- Amount of residue produced by each crop.
- All field operations or activities that affect:
    - o Residue orientation.
    - o Surface disturbance.
    - o The field operations and amount of residue (pounds/acre or percent surface cover) required to accomplish the purpose, and the time of year it must be present.
- Planned STIR value, SCI value, and erosion rate.
- Benchmark and planned energy consumptions.

Mulching

Definition: Applying plant residues or other suitable materials to the land surface

Purpose:

- Improve the efficiency of moisture management
- Reduce irrigation energy used in farming/ranching practices and field operations
- Improve the efficient use of irrigation water
- Prevent excessive bank erosion from water conveyance channels
- Reduce concentrated flow erosion
- Reduce sheet, rill, & wind erosion
- Improve plant productivity and health
- Maintain or increase organic matter content
- Reduce emissions of particulate matter

Mulching Requirements

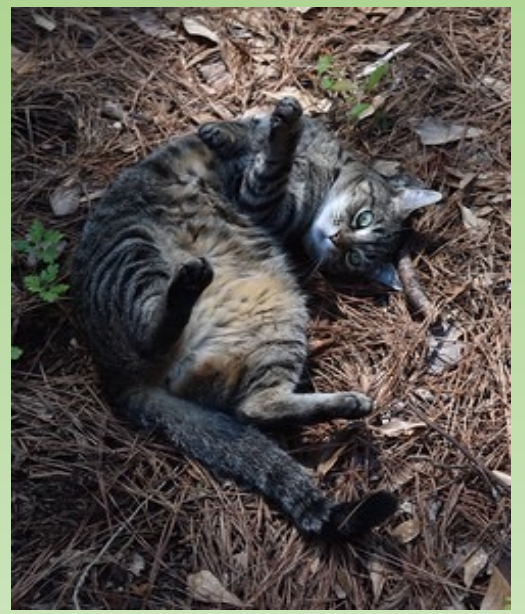
Requirements:

- Conventional (plastic), UV-reactive (solar), biodegradable, or natural* mulch with living or terminated cover crops in the alleys
  - Cover all beds in enrolled acreage

*Natural mulch is not recommended with living cover crops in alleys

Mulch types

- Plastic Mulch
- Silage Tarp (Double Cropping Systems)
- Pine Straw etc.



Plastic Mulch

- Inorganic plastic mulches have been used by commercial growers since the early 1960s, with black and clear plastics being the most popular.

- Plastic mulches normally are used in conjunction with drip irrigation to maintain optimum soil moisture and for improved stand establishment.

Benefits of Plastic Mulch

- Early Planting
- Soil Moisture Conservation
- Weed Control
- Improved Quality
- Reduced Root Compaction
- Reduction in fertilizer loss
- Insect Control

Early Planting Benefits

- Earlier plant growth and earlier crop production are two primary benefits of using black and clear plastic mulches.
- Earlier crop production generally results in higher market prices and higher yields.
- Black plastic mulch can accelerate crop production as much as one to two weeks.
- Clear plastic mulch has been shown to increase earliness as much as three weeks in northern climates*
- Weed growth can be a major problem under clear plastic unless appropriate herbicides or fumigants are used.

Soil Moisture Benefits

Weed Control

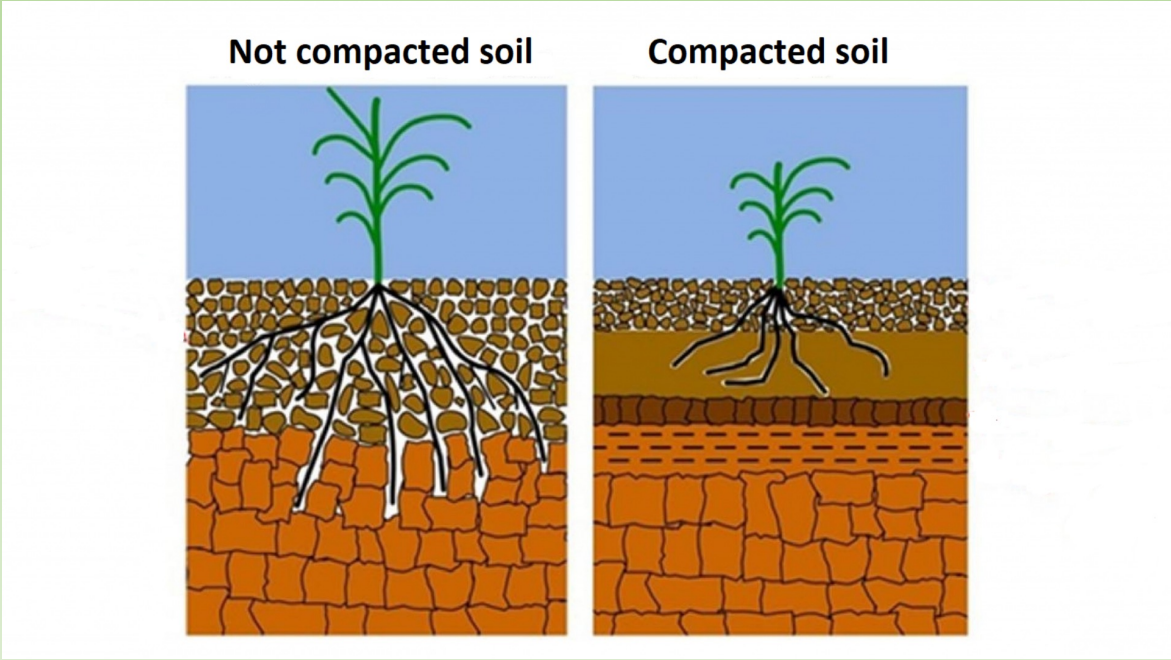
Since black plastic mulch prevents light from reaching the soil, growth of annual and most perennial weeds can be prevented. Thin black plastic mulch will not, however, control nutsedge.

Improved Quality

Plastic mulches help prevent crops from touching the soil. This reduces the incidence of rots and keeps produce cleaner.

Reduced Soil Compaction

Better weed control results in less cultivation and less root pruning. Undisturbed beds also show less compaction. Weeds between beds can be controlled with directed herbicides or by mechanical means.



Reduction in Fertilizer Losses

- Flood and furrow irrigation techniques tend to leach nitrogen and other water-soluble nutrients below the root zone.
- Since plastic mulch techniques generally include drip irrigation, nutrient loss is kept to a minimum. Nutrients can be injected into the drip system to the root zone as needed.

Insect Control

In some cases, reflective silver and white plastic mulches help repel aphids and other insects that damage plants and are vectors of viral diseases.

Disadvantages of Mulch Removal and Dispersal*

- Removing the plastic mulch after the cropping season is the biggest disadvantage
- Although removal equipment is available, plastic tends to become brittle making it difficult to remove in one piece
- The “tucks,” or sides of the mulch buried in the dirt, remain intact, since they are not exposed to the sunlight and separate from the brittle mulch on the bed top. Little pieces of plastic can scatter across a field
- Many landfills also will not accept plastic, and it is difficult to recycle Photodegradable and biodegradable mulches have been evaluated, but results have been mixed
- Another alternative is woven, black polypropylene mulch (Landscape fabric) with an ultraviolet light inhibitor that can be reused for many seasons

Cost

- The cost of applying plastic mulch can be quite high both in terms of materials and equipment
- The minimum equipment required includes bed-shaping equipment and a mulch applicator
- Other equipment may include a drip-line applicator (usually associated with the mulch application) and a transplanter or seed planter
- The advantages of using a mulch for earliness, increased yields, reduced water application, better weed control and higher prices must offset the increased cost

Management

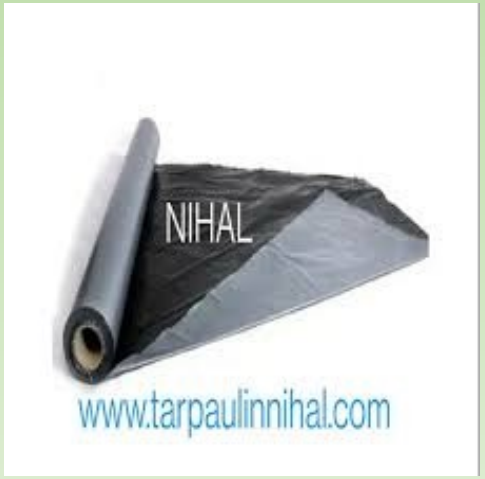
With drip irrigation, managing plastic mulch is more intense. Wilting plants could mean a plugged drip line, while overly wet areas could mean rodent damage to the lines. Drip line problems are hard to evaluate when covered with mulch.

Polyethylene Mulch

Types of Plastic Mulch

Most commercial plastic mulches are made of either linear, low-density polyethylene or high-density polyethylene. High-density polyethylene is lighter and stronger than the same thickness of low-density polyethylene. Most plastic mulches vary in thickness from 0.75 to 1.5 mil and may be smooth or embossed (McCraw and Motes, 1991). The diamond-shaped pattern on embossed plastics helps reduce contraction and expansion of the mulch. Also, it generally is more resistant to wind fatigue and cracking. Plastics come in rolls 2,000 to 4,800 feet long (depending on the thickness) and are 3 to 5 feet wide.

Woven, black polypropylene mulches have been used in the greenhouse and nursery industries for some time as weed barriers. These ultraviolet, light-stabilized mulches are guaranteed to last up to five years. They allow water and air penetration while controlling weeds. These tear-resistant mulches (16 mil thick) can be reused year after year. In experiments with small vegetable producers in northern New Mexico, these mulches have been used to warm the soil, control weeds, harvest rainfall and reduce evaporation of moisture from the soil.



Mulch Colors

Black

Clear

White

Silver

Red

Black Mulch

- Black plastic mulch is the most popular color used in commercial vegetable production, especially for weed control.
- This plastic absorbs most incident solar radiation, including visible, infrared and ultraviolet light. Much of the thermal energy, however, is lost to the atmosphere through convection and reradiation.
- Transferring of thermal energy to the soil can be optimized by maximizing mulch contact with the soil.
- Soil temperatures under black plastic during the daytime can be as much as 5 °F higher at a 2-inch depth and 3 °F higher at a 4-inch depth than bare soil at the same depths (Lamont, 1999).

Clear Mulch

- Soil temperatures during the daytime under clear plastic can reach 8–14 °F higher at the 2-inch depth and 6–14 °F higher at the 4-inch depth than bare soil at the same depths due to a greater (85 to 95%) solar radiation transmittance.

- Incoming solar radiation, however, makes weeds a major problem under clear plastic unless controlled with a herbicide or fumigant (Lamont, 1999). Solarizing or disinfecting of the soil has been used in some areas of the country to reduce soilborne diseases and some weeds.

- To achieve sufficiently high temperatures for solarization, the soil must remain covered for several weeks during the hot part of the summer. Good soil moisture will improve thermal conduction of heat into the soil profile (Katan, 1980).

White Mulch

- Light is reflected back into the atmosphere or the plant canopy from a white plastic mulch, resulting in slightly cooler (−2 °F at 1-inch depth) soil temperatures.
- White plastic mulches can be used to establish crops in the summer, when a reduced soil temperature might be beneficial.
- Coextruded white on black plastic mulch helps cool the soil (white) while controlling weeds (black) (Lamont, 1999)
- The light reflected back into the plant canopy with white mulches also can be helpful for some greenhouse crops that have limited light.

Silver/Aluminum Mulch

- Reflective silver or aluminum mulches also give cooler soil temperatures.
- They tend to repel aphids, which can serve as vectors for various viral diseases (Lamont, Sorensen and Averre, 1990).

Red Mulch

- Red plastic mulch has been shown to increase tomato yields and quality in some trials and reduce the severity of early blight in others.
- It also has been shown to increase yields of honeydews, muskmelons and zucchini.
- In addition, it has been shown to significantly increase soil temperatures (Lamont, 1999).
- Not all red colors are the same, however, and results have not been consistent.

Other Colors

- Yellow, orange, blue and gray plastic mulches also have been evaluated. The different radiation patterns that are reflected back into the canopies of various crops from these mulches affect plant growth and development in different ways.
- Some colors like yellow attract certain insects like green pea aphids and cucumber beetles (Lamont, 1999). Such mulches might be used in a field to grow “catch crops” to pull insects away from other crops.
- Blue-colored mulches have been shown to increase zucchini and honeydew yields.
- More research needs to be conducted to determine the effects of these colors on plant growth, yields, earliness and pest resistance.

Wavelength Selective Mulches

- These mulches selectively absorb photosynthetically active radiation (PAR), while transmitting solar infrared radiation.
- Also called infrared-transmitting (IRT) mulches, they help control weeds and exhibit improved soil-warming characteristics, although generally not as well as clear plastic.
- Colors range from blue-green to brown (Lamont, 1999).

UV Reactive Mulch

AN ENTIRELY NEW GENERATION OF MULCH FILM

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SC STATE UNIVERSITY 1896

PATENTED TECHNOLOGY - SUPERIOR PERFORMANCE

- **TIGHTER**
- **SMARTER**
- **LIGHTER**
- **STRONGER**
- **GREENER**

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SOIL TEMPERATURE CONTROL

PREVENTS WEEDS

DETERS SOIL EROSION

REDUCES EVAPORATION

REDUCES SOIL COMPACTION

SIMPLY, THE MOST ADVANCED MULCH FILM EVER

IMPROVES CROP QUALITY

REDUCES ROOT DAMAGE

REDUCES FERTILIZER LEACHING

EXTENDS GROWING SEASON

CLIMATE-SMART GROWN IN SC

IMPROVES CROP MANAGEMENT & EFFICIENCY

SHRINKS TIGHTLY TO THE BED IN SUNLIGHT

300% STRONGER THAN CONVENTIONAL FILM

DOES NOT FLAP OR RIPPLE IN WIND

20% TO 50% LESS PLASTIC USED PER FOOT

ROLL LENGTHS UP TO 3 TIMES LONGER

LONG LIFESPAN, REMAINING STRONG AND FLEXIBLE

PLANTING LINES PRINTED ALONG CENTER

CLIMATE-SMART GROWN IN SC

SC STATE UNIVERSITY 1896

A BETTER GROWING CLIMATE AND A BETTER CROP YIELD

MOISTURE IS RETAINED IN SOIL → LESS ROOT DEHYDRATION

MAXIMUM HEAT TO SOIL TRANSFER → EARLIER GROWTH

IMPROVED HEAT RETENTION IN SOIL → LONGER GROWING SEASON

IMPROVED CONTROL OF FERTIGATION → MORE CONSISTENT GROWTH

REDUCED SEEDLING DAMAGE → EVEN PLANT SIZE

CLIMATE-SMART GROWN IN SC

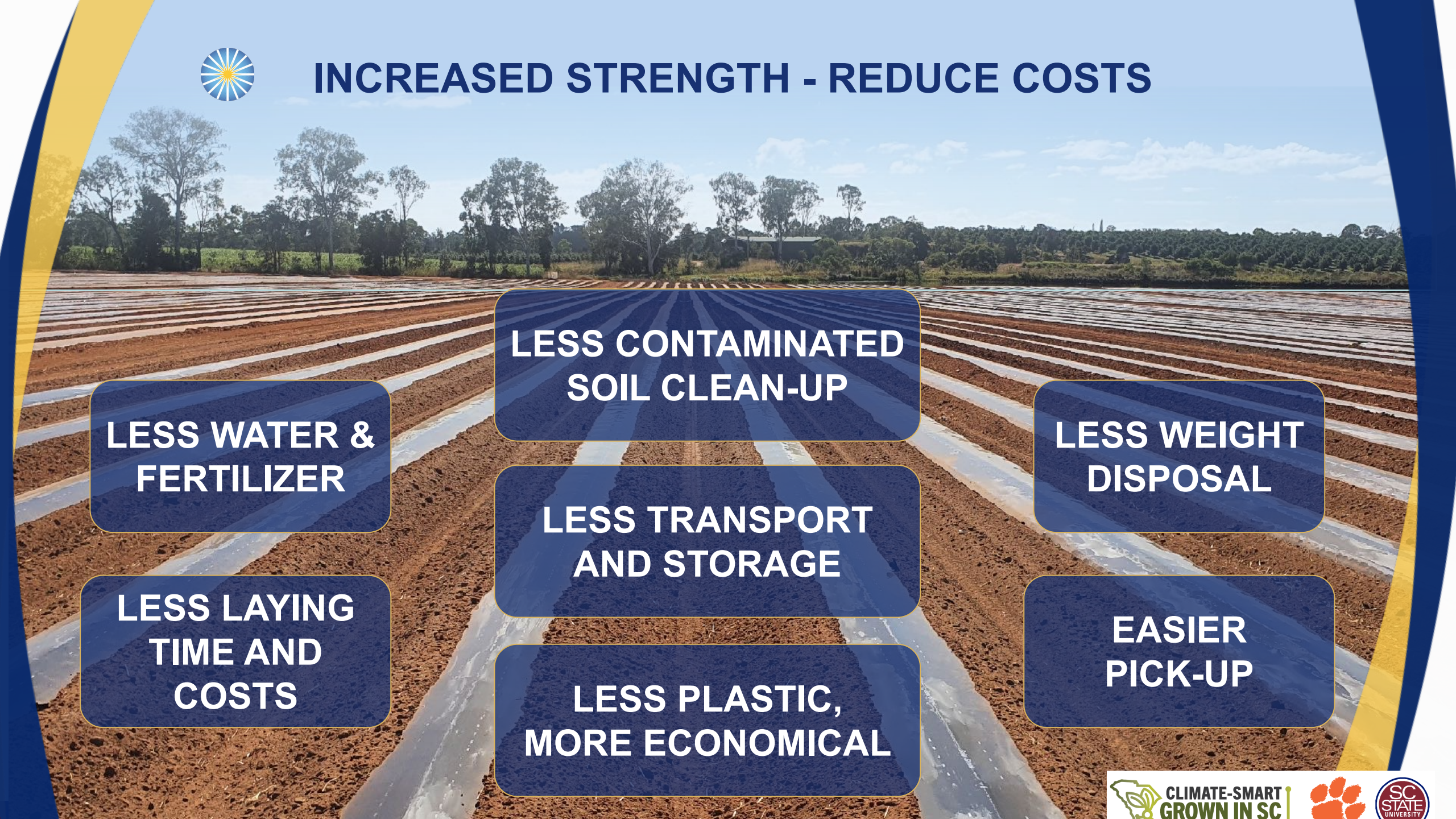
DELIVERS MORE ENVIRONMENTAL BENEFITS

- REDUCES WATER AND FERTILIZER USAGE
- SAVES ELECTRICITY USED FOR IRRIGATION OPERATING COSTS
- REDUCES VEHICLE EMISSIONS FOR TRANSPORT, LAY, AND LIFT
- LESS WEIGHT AND VOLUME OF PLASTIC TO LANDFILL
- LESS TOPSOIL LOST TO WASTE
- LESS PLASTIC CONTAMINATION OF SOIL
- MACHINE COLLECTION SAVES 80% LABOR TIME

CLIMATE-SMART GROWN IN SC

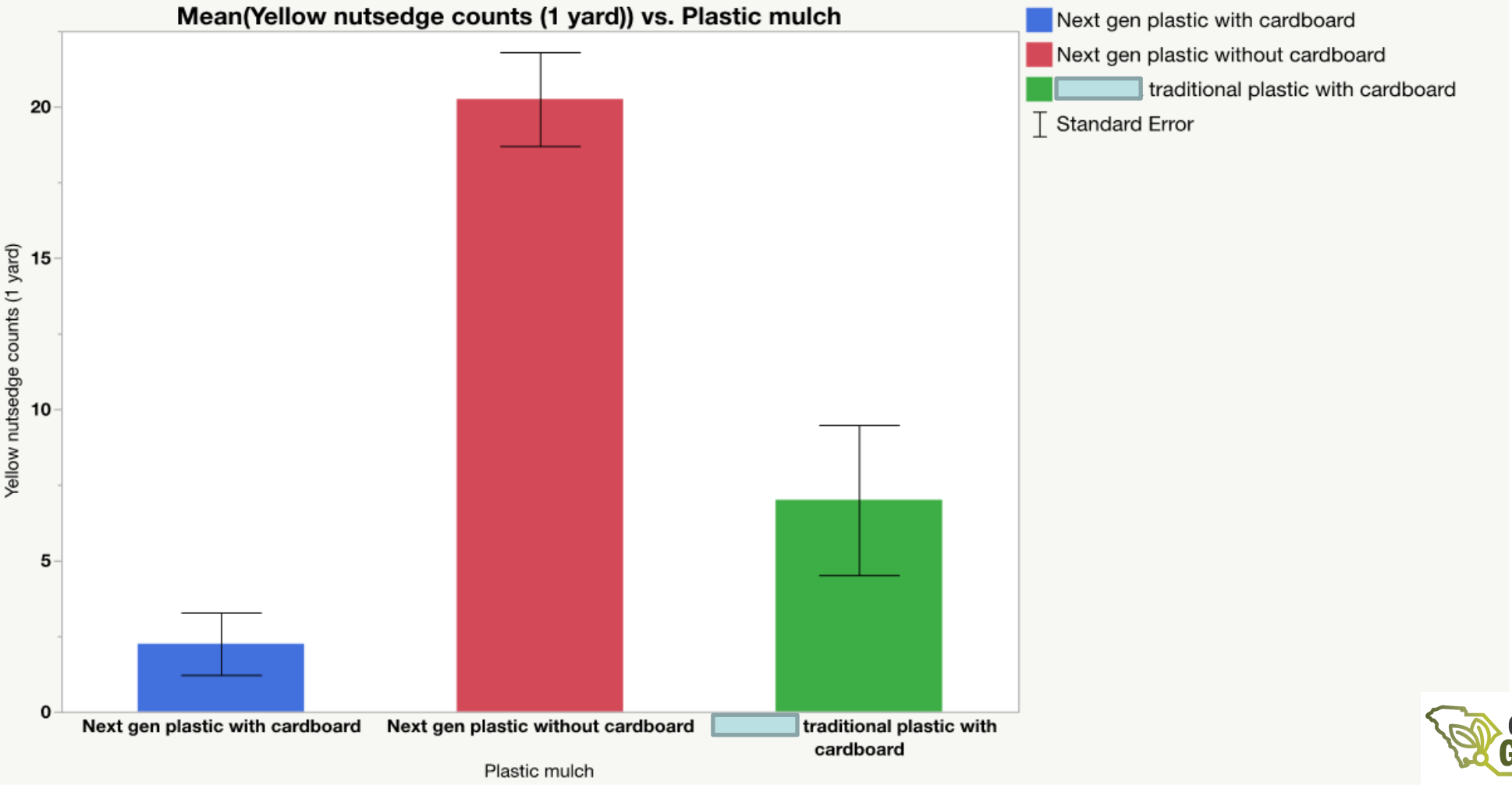
SC STATE UNIVERSITY 1896

INCREASED STRENGTH - REDUCE COSTS



CLIMATE-SMART GROWN IN SC

Clemson Studies with Solar Shrink



Biodegradable Mulch

For agricultural use, BASF offers the certified soil-biodegradable ecovio® M 2351 for mulch films. The compound consists of the biodegradable co-polyester polybutylene adipate terephthalate (PBAT) ecoflex®, other biodegradable polymers made from renewable raw materials and inorganic fillers. Mulch films made of ecovio® M 2351 can remain in the soil and ploughed in after mechanical harvest: Farmers do not have to laboriously remove and recycle them. Naturally occurring soil microbes like bacteria or fungi recognize the structure of the film as food they can metabolize. The remaining end products after biodegradation are CO2 , water and biomass (mass from natural living organisms, e.g. cells).

Sustainability of Biodegradeable Mulch

- The fundamental benefits of mulch films made of ecovio® for sustainable agriculture are increased yield, less herbicides, water savings and earlier harvesting.
- Farmers have also observed a higher level of resistance of their plants to fungal diseases, a more homogeneous quality of harvest, and better-tasting crops.
- The responsibility for maintaining yield stability of agricultural land is of major social importance. This is why extensive internal and external studies not only verified the biodegradability of mulch films made of ecovio® M 2351, but also identified and analyzed the microbes in the soil (bacteria and fungi) that are involved in biological degradation.

BASF Recommendations for Mulch

01 / Storage

- All rolls should be stored inside
- Rolls can be kept for the following season
- Ensure that any left-over rolls remain in their original packaging

02 / Soil preparation

- Prepare soil well with slightly rounded seed bed
- Ensure that any organic residues are sufficiently buried

03 / Irrigation tubes

- Slightly bury drip irrigation tubes (1-2 cm) to avoid risks of premature biodegradation, e.g. splitting of film at contact point

04 / Irrigation

- Irrigate according to official recommendations as a maximum
- Any excess of water may prematurely biodegrade films

05 / Fertilization

- If you use organic fertilizers, they must be incorporated into the soil about one month before laying out

06 / Laying out

- For the thinner films (between 8-12 µm), start laying out slowly, then increase to normal speed (adapted to soil conditions at 3-5 km/h)
- Release the roll brake, if there is one

07 / Planting

- Always lay out and then plant as soon as possible (max. about 2-3 days in between)
- Preferably transplant instead of sowing
- Be aware that sowing instead of transplanting increases light exposure of film by 2-3 weeks

08 / Biodegradation

- Bury film residues as soon as possible after harvest to complete the biodegradation process
- Be aware that in salty soils (Ec>3 mS/cm) biodegradation may be slowed down

09 / Fumigation

- Keep in mind that fumigation will slow down biodegradation

10 / New crops

- If you use mulch films with new crops, always test at small scale first (below 1 ha)

Soil Preparation and Pre-plant Fertilization Prior to Forming Beds and Laying Plastic

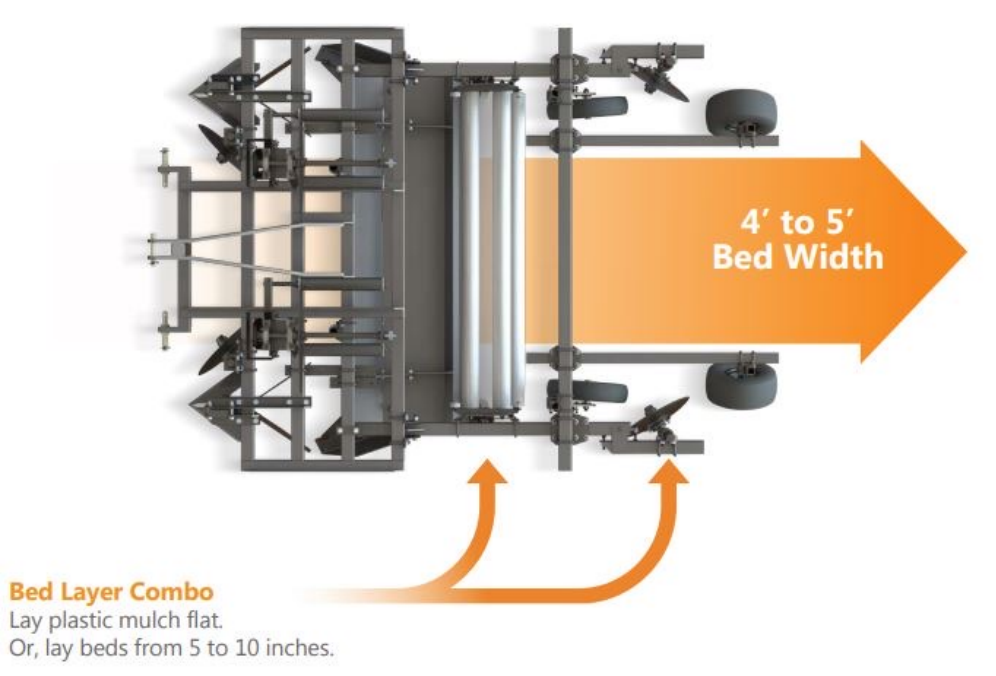
- The soil should be deep plowed or disked at least one month before bed preparation.
- Incorporate crop residues well.
- Remove all trash, rocks or clods from the field that may hinder the application of the plastic.
- Pre-plant fertilizers can be broadcast and incorporated into the beds as they are formed.
- Good soil moisture (60 to 80% of field capacity) is necessary to make firm, smooth beds (Granberry, Kelley, Chance, McLaurin, Harrison, Sanders, 1994).
- It is important that the bed be firm, so the soil doesn't settle.

Importance of Bed Uniformity

- Uniformity is key: Do not want wet areas or clods. Uneven beds will make it difficulty to accurately apply water and fertilizer through drip. Easier for nutsedge to puncture

- "When you think about laying plastic, you think about moisture, you think about fertilizer, you think about the fumigant, and you think about long-term stability of the bed and the plastic depending on how many crops you're going to grow"-Stanley Culpepper
- 150 lb person standing on plastic should have a half inch foot print.

Equipment Needed



https://www.kenncomfg.com/

Plastic Mulch and Dripline Applications

1. Beds are raised with hilling discs
2. Beds are compressed to a uniform height and density with a bed shaper
   - Beds normally have **5- to 6-foot centers** and generally are **4 to 6 inches high** and **30 to 34 inches wide, sloping slightly (1.25 inches) from the center to the edges** to shed excess rainfall (Lamont, 1991).

Mulch applicators generally include:

- A mulch dispenser that holds at least one roll of plastic
- Small discs at the bed edges to clean out or open the furrows
- Rubber inflatable tires that press the edges of the mulch into the furrows, and
- Discs that cover the edges (tucks) of the mulch with soil to keep it in place.

*The plastic must be kept taut to ensure good contact with the soil. Drip line and fumigant applicators usually are located in front of the mulch applicator. Newer machines may combine bed formation and mulch application.

Removal of Plastic

The plastic must be removed after the growing season. Do not disc plastic under. Machines are available commercially for plastic removal, but they can be expensive. In most cases, the plastic must be removed by hand and disposed of in a landfill.

WHY CONSIDER DRIP IRRIGATION?

- Soil water is the most limiting factor for crop production in the world.

- Only 45% of the earth's arable land receives adequate moisture for crop growth.

Soil Water Terms

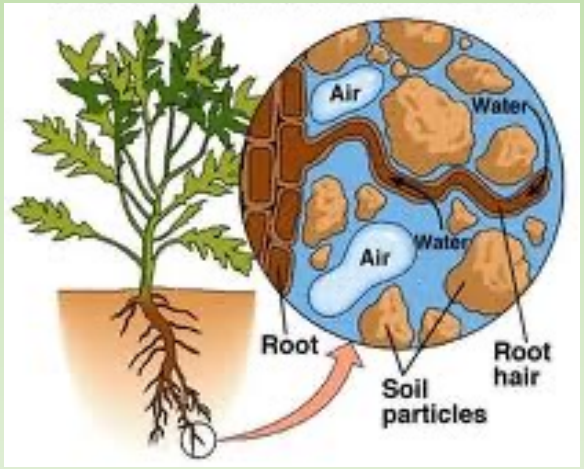
SATURATION – all pores are full of water, little to no oxygen

FIELD CAPACITY (FC) - forces pulling water down (gravity) and soil forces holding water are equal, oxygen available

PERMANENT WILTING POINT (PWP) – held so tightly by soil that plant can not pull away from soil

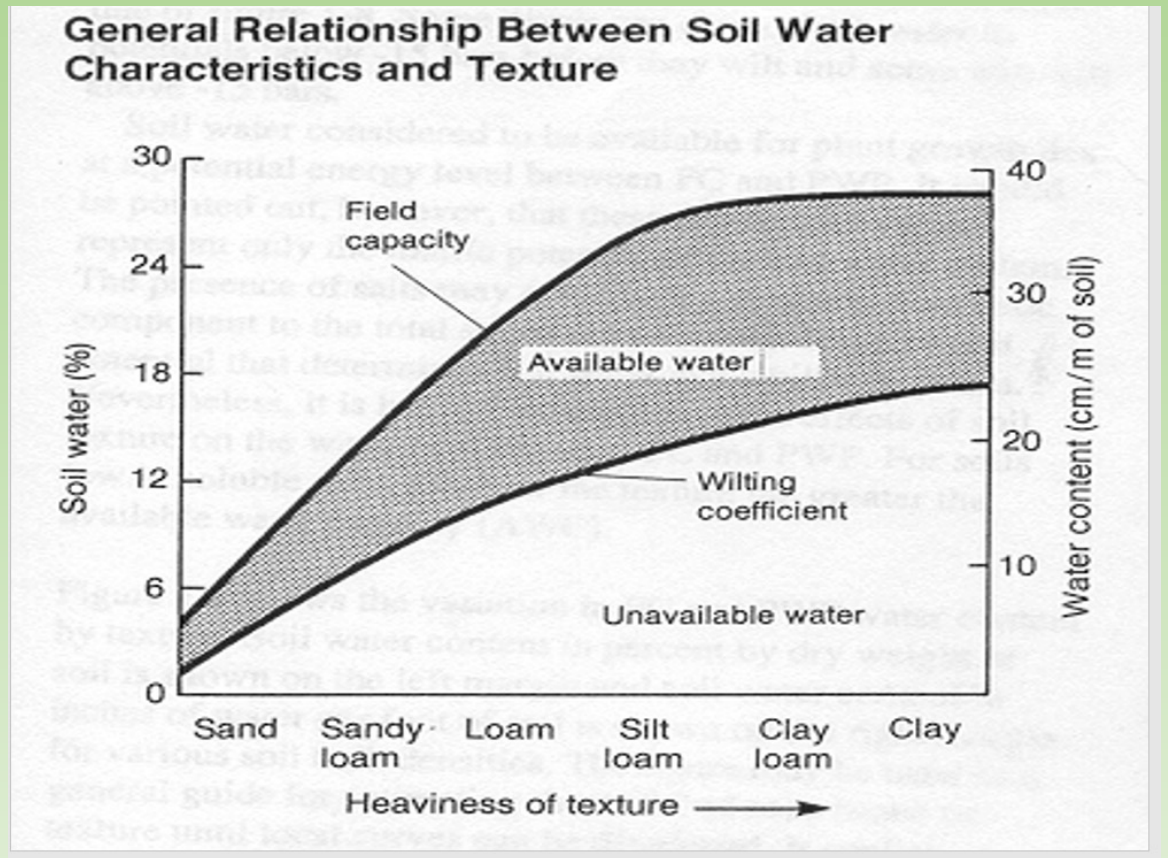
AVAILABLE WATER (AW) – amount of water held between FC and PWP

Field Capacity – Permanent Wilting Point = Available Water

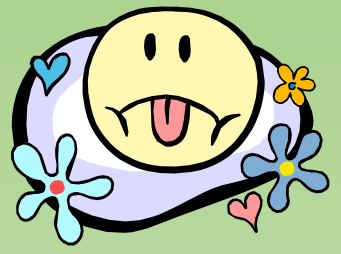


SOIL AVAILABLE WATER CAPACITY (AWC)

- A NUMERICAL VALUE IS GIVEN TO SOILS FOR THEIR AWC
- AWC IS DETERMINED BY % SAND, SILT, CLAY, ORGANIC MATTER



DISADVANTAGES OF DRIP IRRIGATION



NOT MANY !!!

1. INITIAL COST OF SYSTEM COMPONENTS.
2. LIMITATIONS DO EXIST AND DESIGN AND INSTALLATION CAN BE CRITICAL.
3. POOR MANAGEMENT CAN RUIN YOUR CROP.
4. END OF THE YEAR REMOVAL.

DRIP IRRIGATION BASIC COMPONENTS

WATER SOURCE

Surface, Well, Municipal

PUMP

Electrical, Gas or Diesel

FILTRATION

Screen filters, Sand/media filters

INJECTION COMPONENT FOR NUTRIENTS / CHEMICALS

Electrical Powered Pump, Venturi

SYSTEM CONTROLS

Computer controller, Manual, Electronic, Hydraulic valves, Pressure Regulators

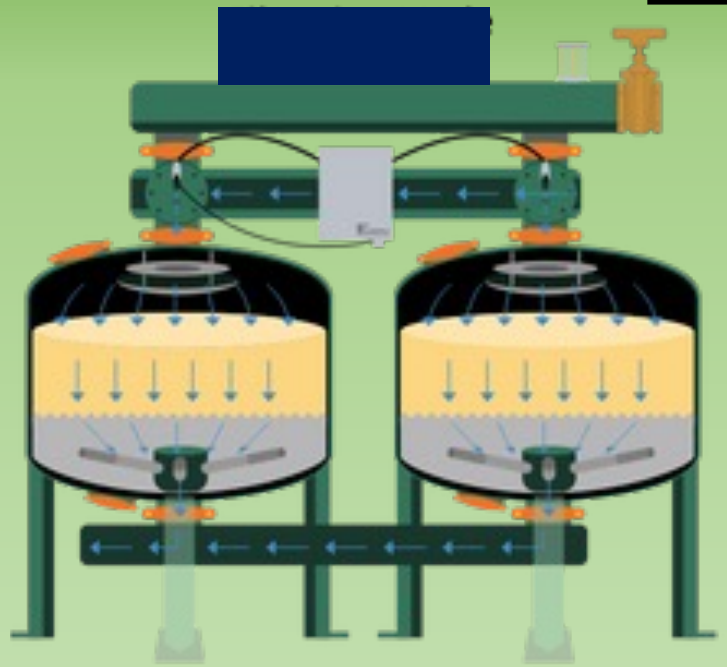
DISTRIBUTION SYSTEM / DESIGN

Supply lines, Sub-mains, Drip Tape

PUMP SIZING

1. <u>Gallons per minute (GPM) per acre</u>
    - Drip tape flow rate/100’
    - Linear feet per acre
2. Suction Lift – 0 for submersible pump
3. Field Elevation – highest point in field
4. Friction Loss – mains, submains, drip tape….
5. PSI needed for drip tape emitters
6. Total Dynamic Head (TDH) – all of the above
7. GPM + TDH = Pump Size

FILTERS



Fertigation Injectors

Positive Displacement Pumps

- Wide range of flow rates
- Precise calibration
- Can be automated

Chem-Tech

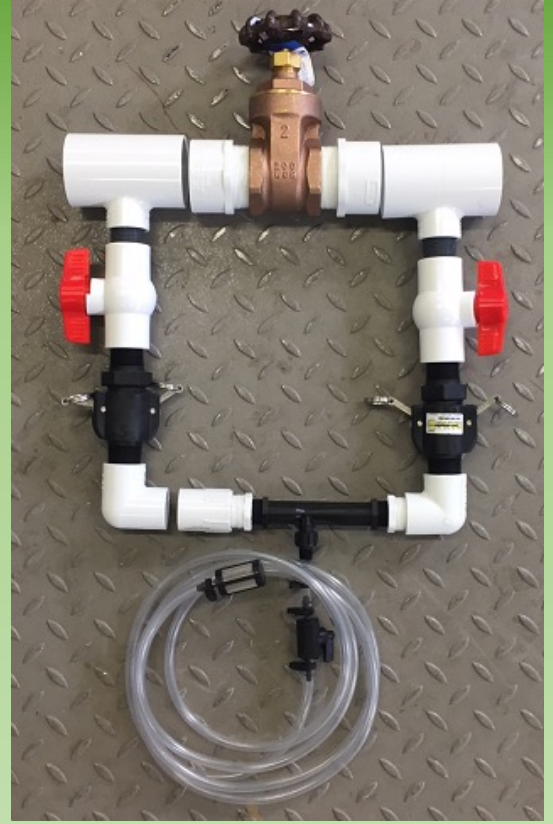
- ≈$300
- Max Injection – 3.5 oz/min

Pulsatron

- ≈$700
- Max Injection – 14 oz/min

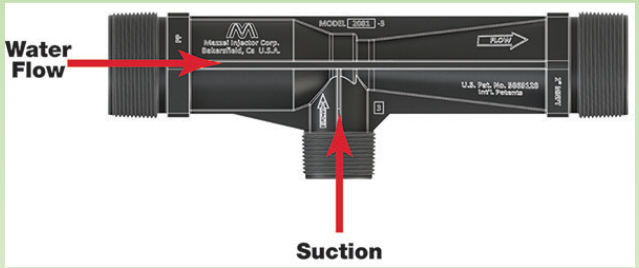
Simplex Type Pumps

- ≈$1000's
- Max Injection – 10 – 100+oz/min



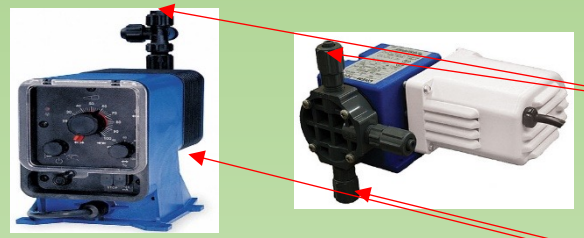
Venturi Type Injectors

- Inexpensive
- Injection amount varies with flow rate
- Difficult to automate



CALIBRATION OF FERTILIZER INJECTORS

Follow operator's manual



Pulsatron and Chem-Tech

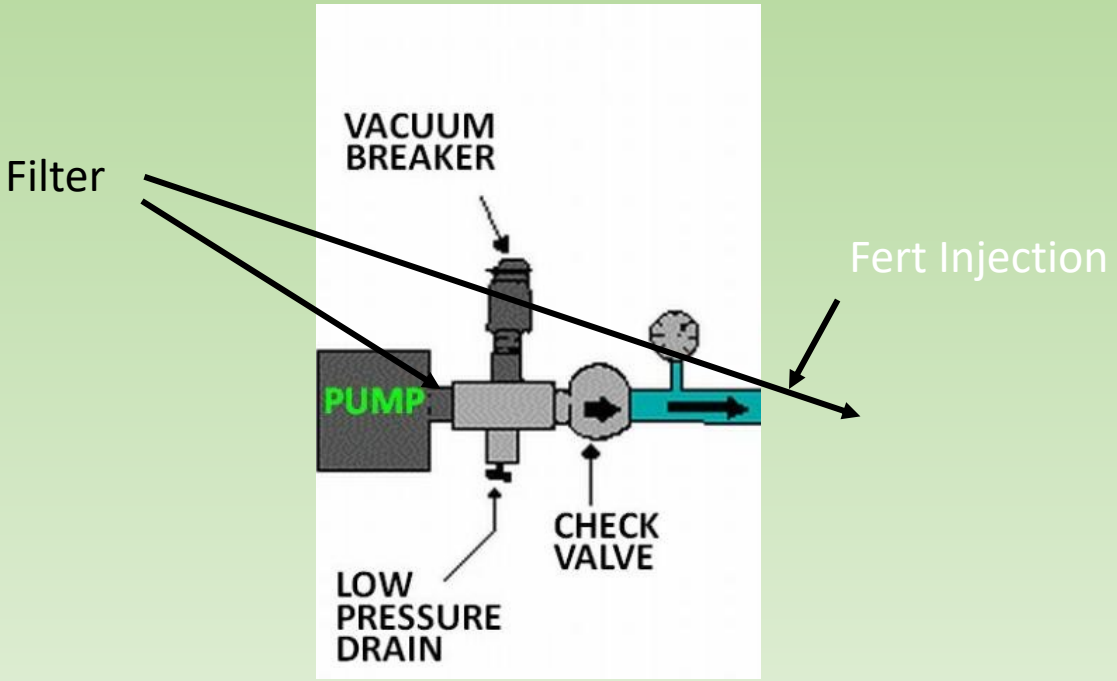
- Both have adjustable rates (Max to Min)
- Connect injection line to irrigation pipe
- Turn on irrigation and injector pump
- Time draw down of known quantity of fertilizer
- Determine ounces pumped per minute

Venturi

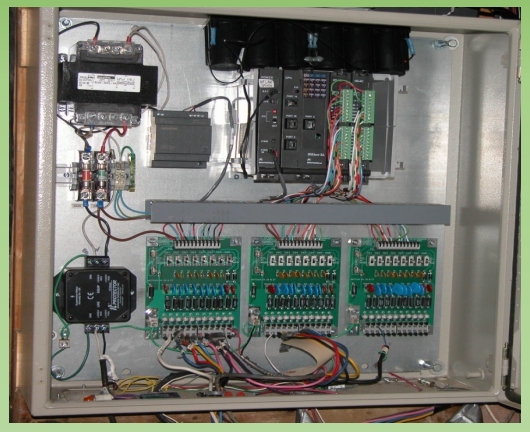
- Close valve to divert water through Venturi
- Time draw down of known quantity of fertilizer
- Determine ounces pumped per minute

Fertigation Line Requirements

- Check valve
- Low Pressure Drain
- Vacuum Relief Valve



IRRIGATION CONTROLLERS



Motorola

RainBird

Sterling

Bermad

Tempus

DRIP TAPE


NETAFIM


AQUA-TRAXX


T-Tape


Unroll this direction


JAIN
Irrigation Inc


JOHN DEERE
T-Tape


RO-DRIP


Chapin


QUEEN GIL
HIGH FLOW
Romatech Agro

DYE TEST


C2 R2 OE

WATER MANAGEMENT

- CROP WATER REQUIREMENTS
- EFFECTIVE ROOT ZONE
- SOIL WATER HOLDING CAPACITY
- IRRIGATION SYSTEMS CAPABILITIES

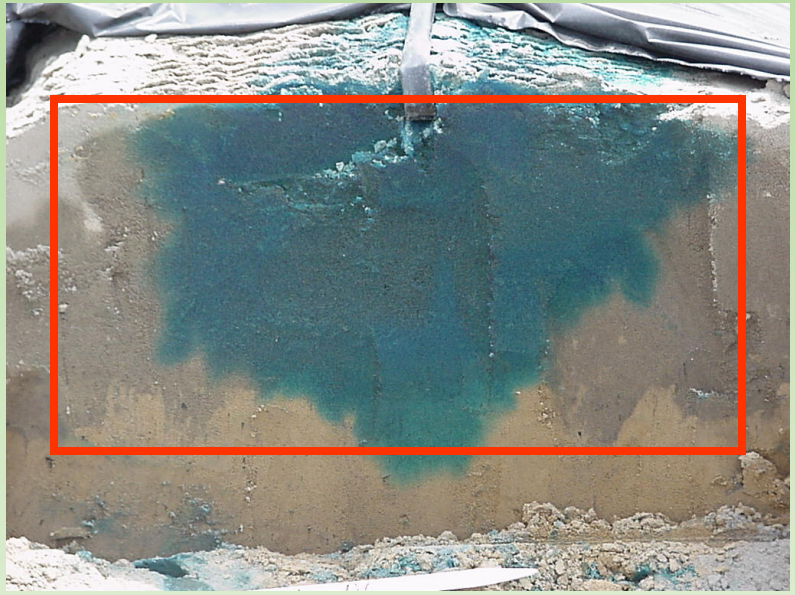
CROP WATER REQUIREMENTS

- GENERAL RULE OF THUMB:
- VEGETABLES NEED AN AVERAGE OF 1 INCH WATER PER WEEK IN ORDER TO GROW VIGOROUSLY.
    - EARLY GROWTH - 0.5 INCH WATER / WEEK
    - PEAK GROWTH - 1.0 + INCH WATER / WEEK
- *1 INCH WATER / ACRE = 27,154 GALLONS*
- *3,879 GALLONS / DAY = 27,154 GAL. / WEEK*

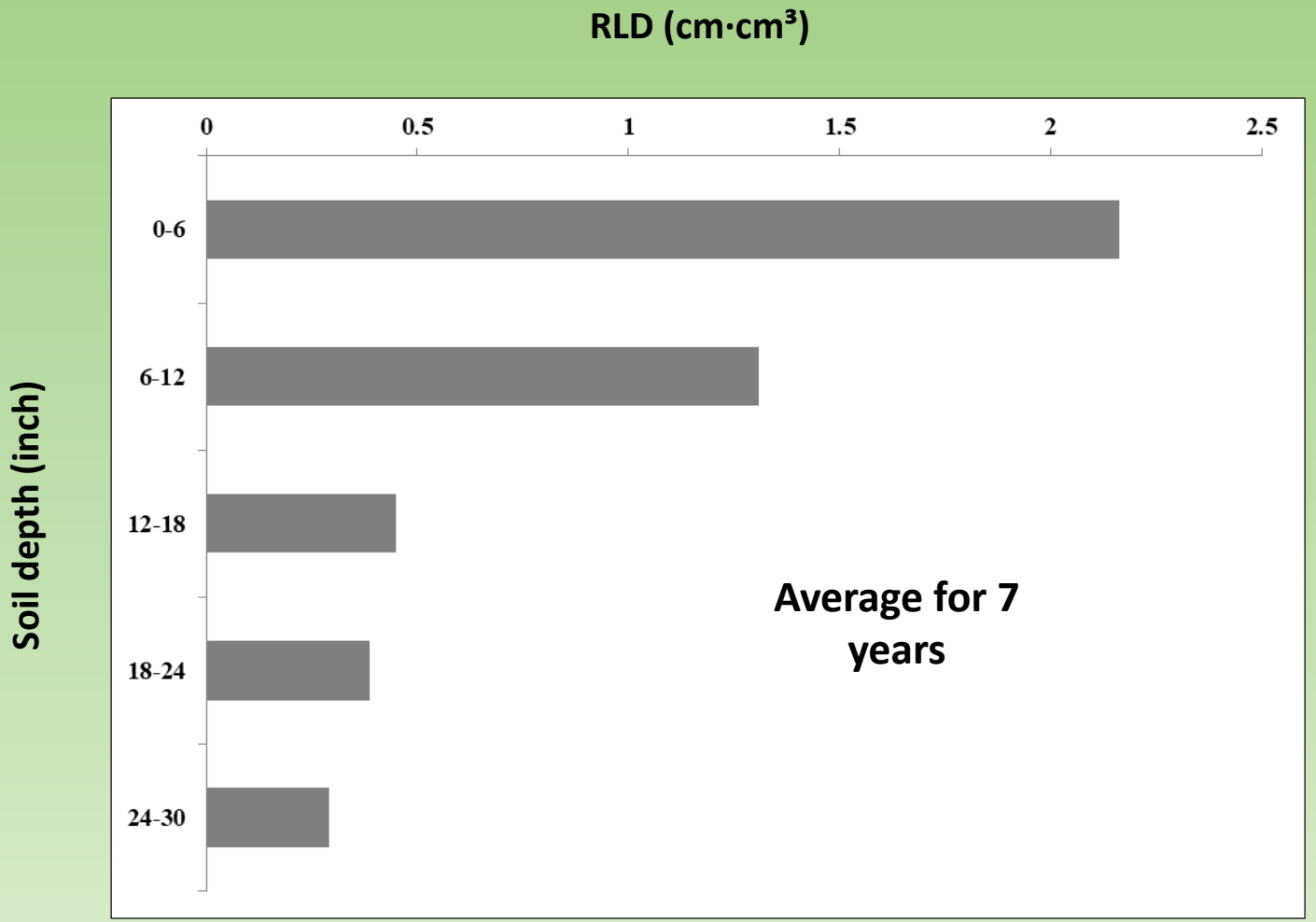
EFFECTIVE ROOT ZONE

- Plants may send roots as deep as 48” and some roots will extend out from under the plastic.

- BUT!! MOST OF THE FINE ROOTS ARE IN THE TOP 12 INCHES SOIL DEPTH.



Root Length Density (RLD) by Depth (2008 – 2014)



Loamy Sand &Wagram Sand – 76% Roots in 0-12”

Closing

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- Lacy Barnette: (803) 563-7223, lmbarne@clemson.edu
- Jhessye Moore-Thomas: (512) 537-6597, jmooret@clemson.edu
- Dr. Florence Anoruo: (803)-347-6909, fanoruo@scsu.edu
- Dr. Brandon Huber: (215)-630-6268, bhuber@scsu.edu
- (864) 656-3386, climatesmart@clemson.edu
- Reminders
  - Subsidiary reports from FSA
  - Turn in Planting Plans **(*PLEASE ADD YOUR NAME*)** and Evaluations
  - Year 1 implementation and incentives
  - Measurements
- Q&A

Resources:

- Some Soil and Water Conservation Districts have equipment for rent
- Co-ops for seed and transplants
- Possible facilitation for farmer sharing
- Plastic purchasing options