COVER CROPS IN ORGANIC VEGETABLE SYSTEMS

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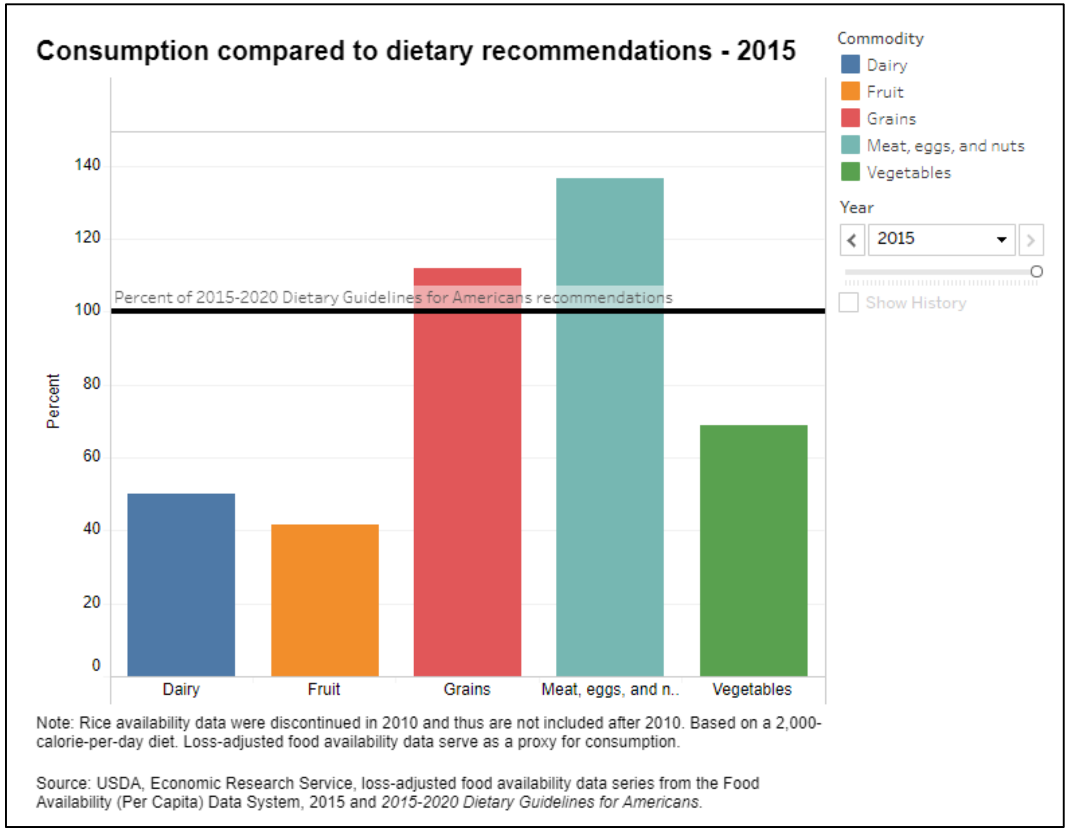
OVERVIEW

- What's the Problem?
- Ways Covers Can Be Used In Vegetable Systems
- Key Issues Cover Crops Can Address
- Termination Strategies
- Documented Benefits
- Resources for Beginning and Advanced Cover Crop Adopters

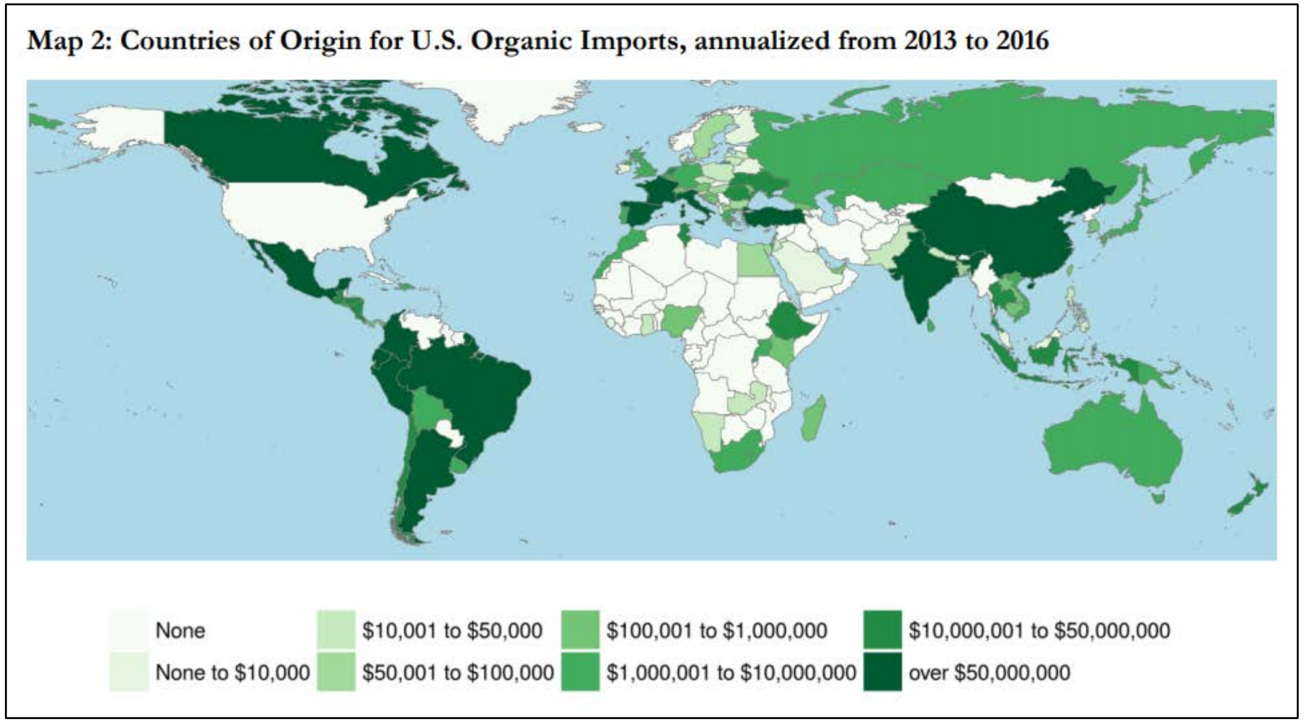
What's the Problem?

Per capita consumption of fruits and veg. = 632 lbs/yr



USDA ERS, 2015. Loss Adjusted Food Availability. https://www.ers.usda.gov/data-products

Organic imports exceed exports by a margin of 3:1.



Organic Trade Association. 2017. U.S. Organic Trade from 2011 to 2016. https://ota.com

Celery harvest in Florida. Date Unknown. Univ. FL Library Archives

Water Quality and Quantity Risks in Florida

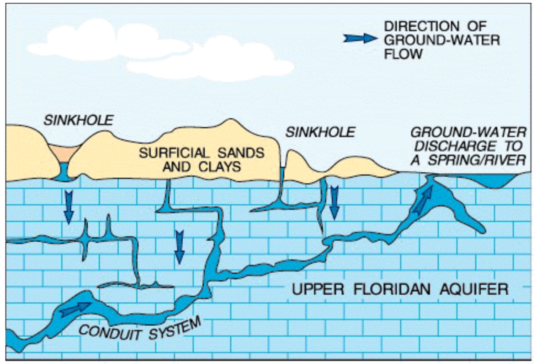
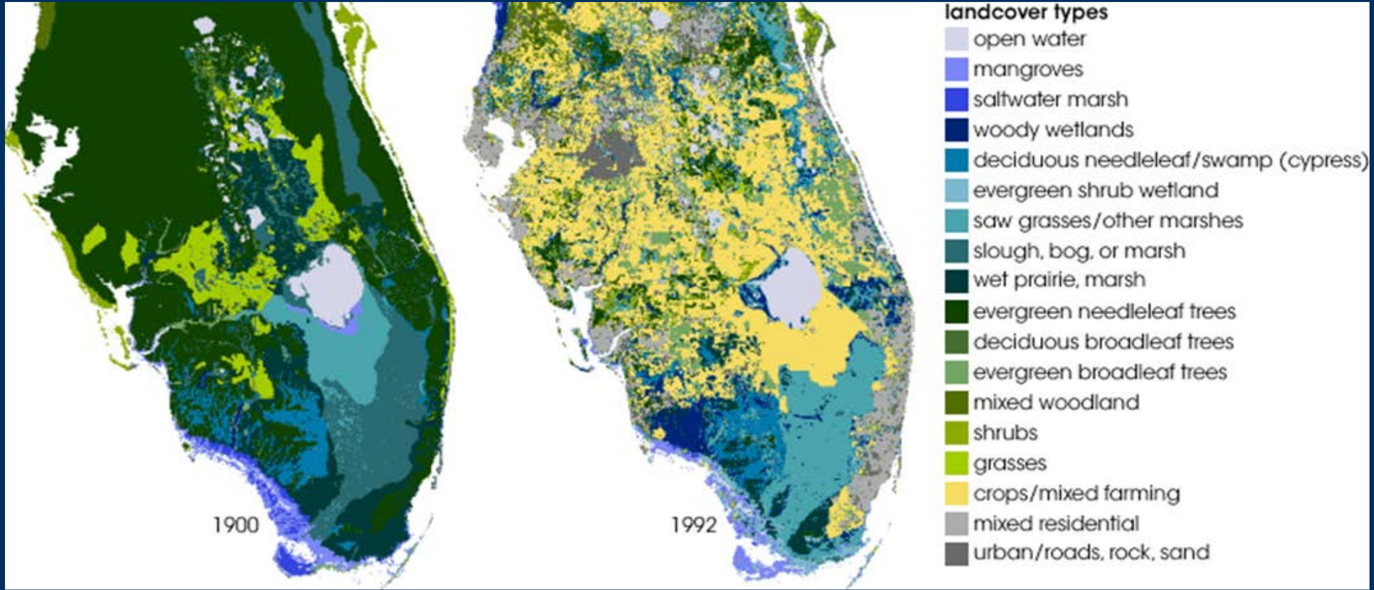
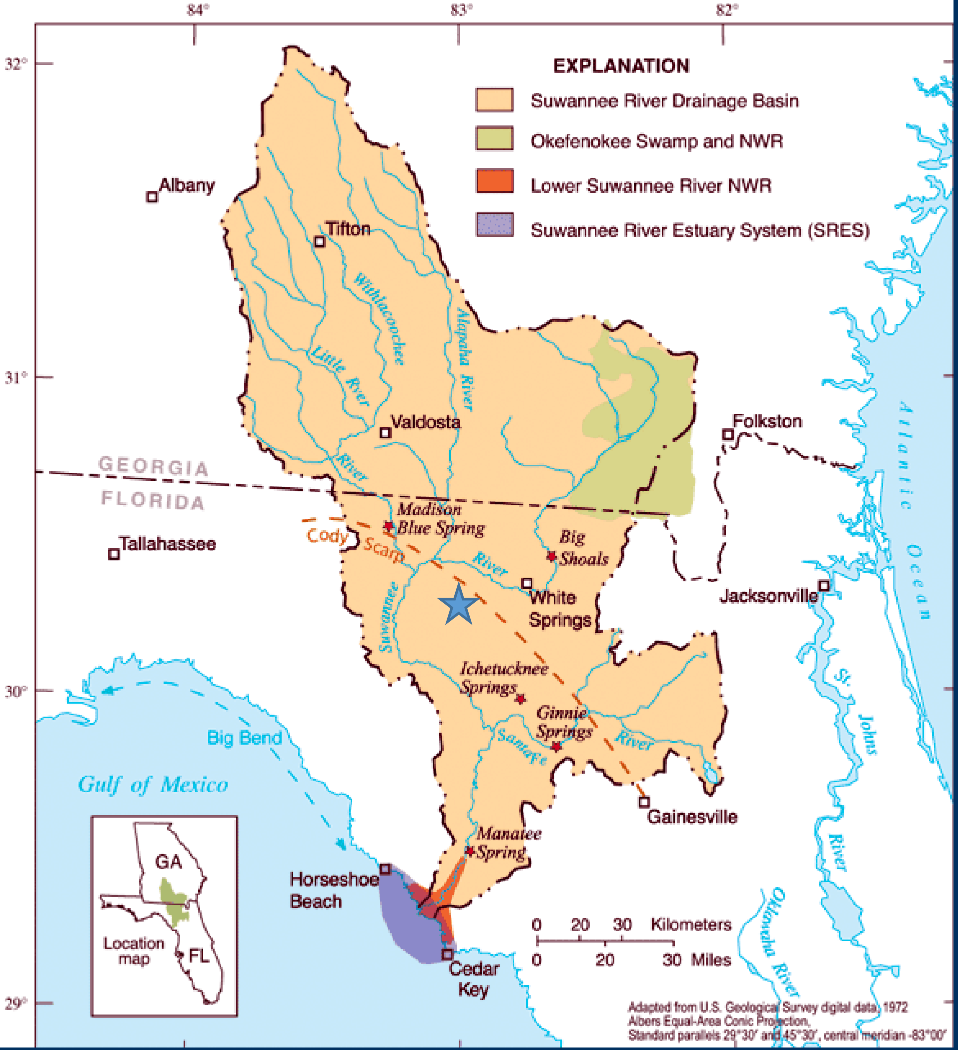
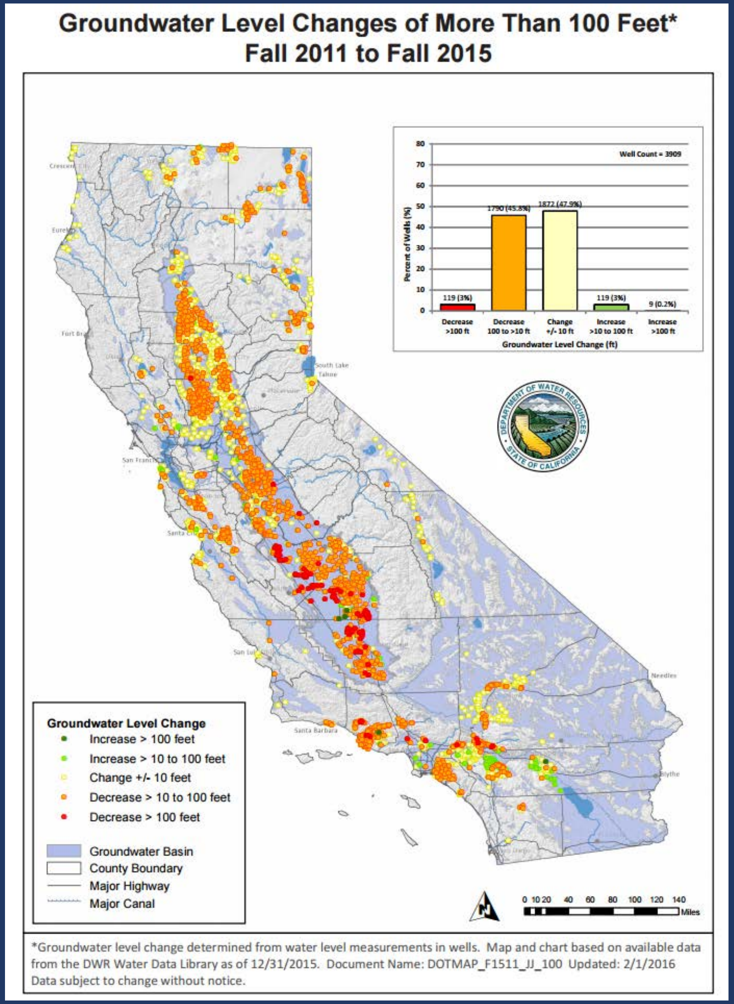


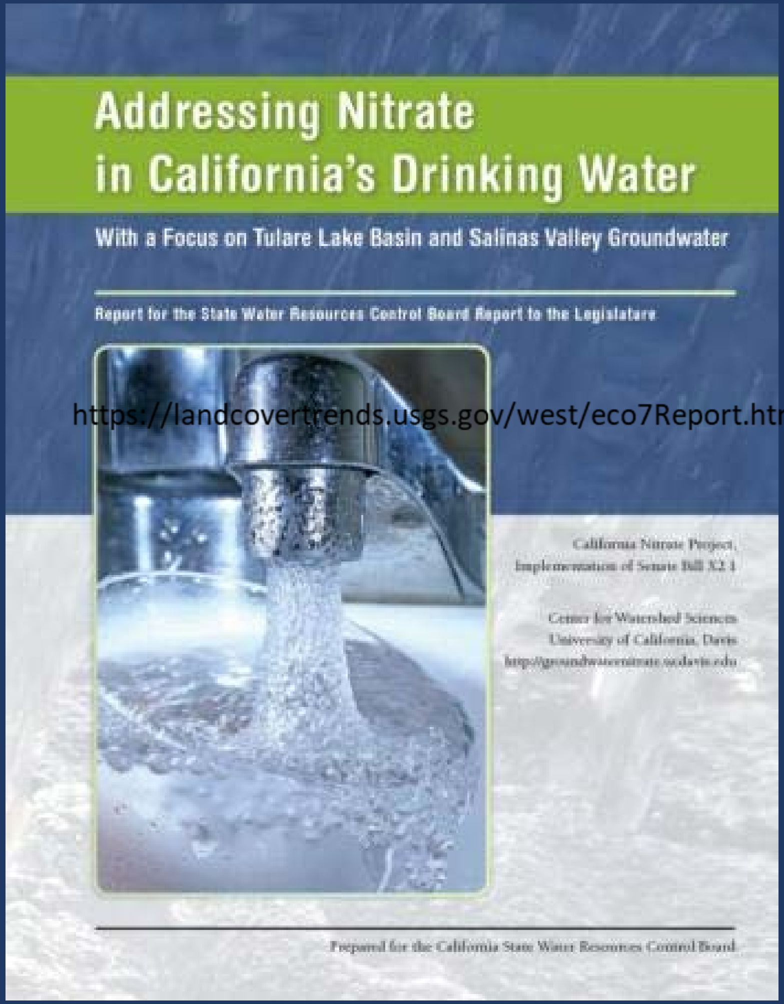
Figure 1. Generalized cross section in the Suwannee River basin showing karst features that facilitate the exchange of water between the surface and subsurface.



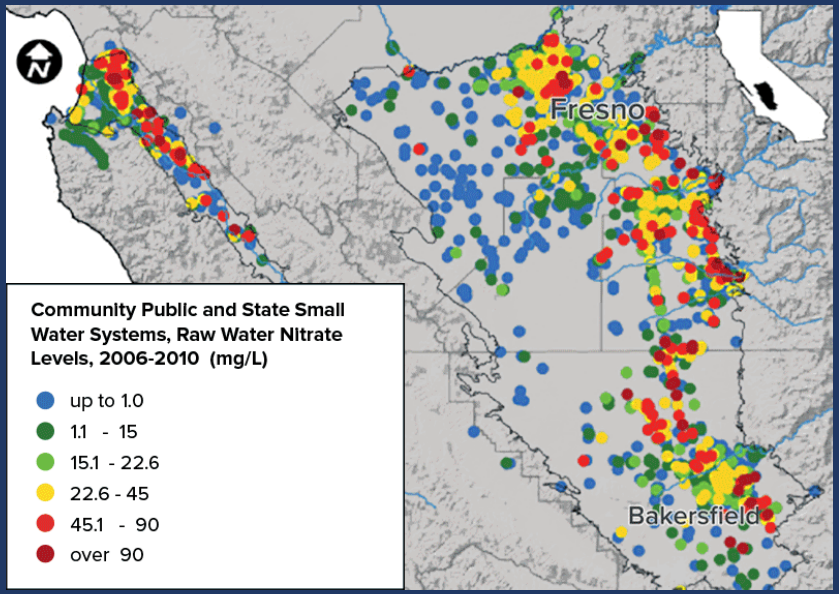


Water Quality and Quality Risks in California





https://landcovertrends.usgs.gov/west/eco7Report.html



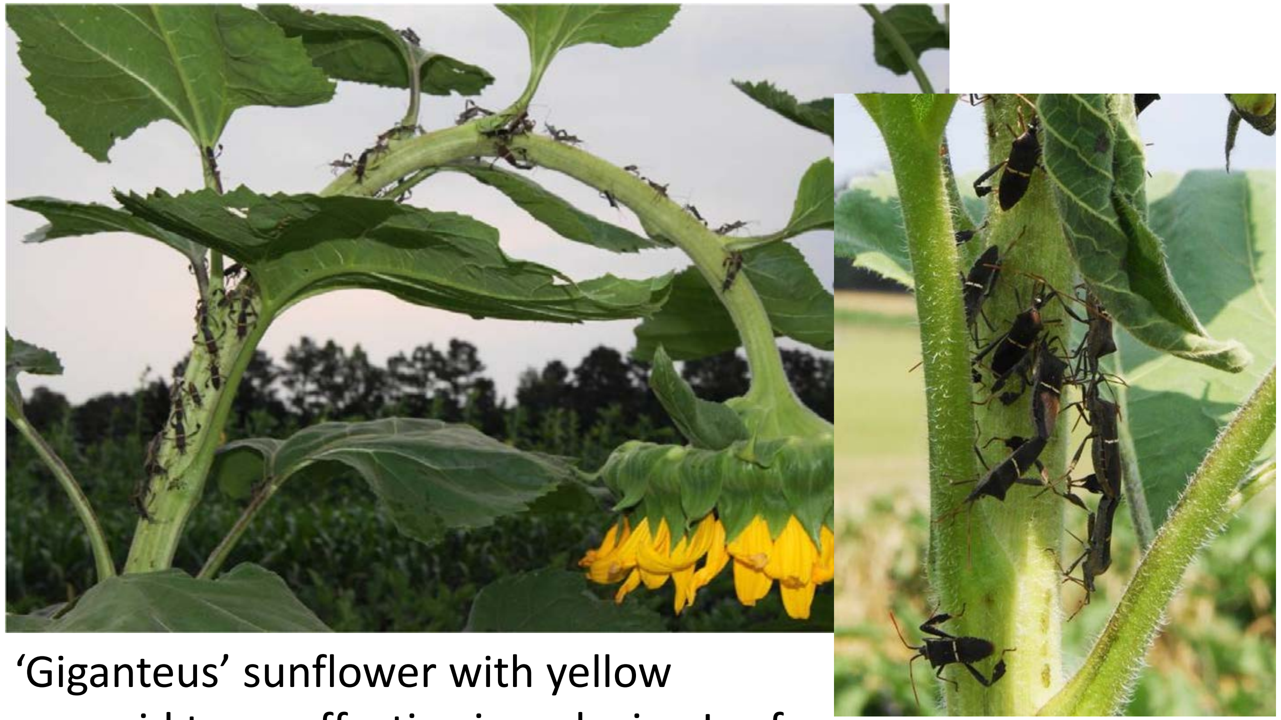
http://www.water.ca.gov/waterconditions/docs/DOTMAP_F1511_100.pdf
https://landcovertrends.usgs.gov/west/eco7Report.html

USES OF COVER CROPS IN VEGETABLE SYSTEMS

- In field perimeters:
  - a trap crop or
  - habitat for beneficial insects
- In furrows:
  - a wind break,
  - acquire soil nutrients,
  - remove/retain moisture
- In rotation:
  - reduce weed seed deposition
  - reduce nematodes
  - add organic matter
  - cycle nutrients
  - manage soil moisture

COVER CROPS IN FIELD PERIMETERS

Stink bugs (Pentatomidae) and leaf footed bugs (Coreidae) are important pests of many fruit and vegetable crops.



‘Giganteus’ sunflower with yellow pyramid traps effective in reducing Leaf footed stink bug. Russ Mizzell, UF-IFAS

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Stink Bug Management Using Trap Crops in Organic Farming

Organic Agriculture November 18, 2015 Print

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eOrganic author: Russell F. Mizell III, University of Florida

Introduction

Stink bugs (Pentatomidae) and leaffooted bugs (Coreidae) are currently an overarching issue in agriculture. Stink bugs—mainly the brown, the dusky, the green and the southern green—and the leaffooted bugs have become important primary pests of most fruit, nut, vegetable, and seed crops (Fig. 1). Additional major and minor species also occur throughout the U.S. Another non-native, damaging species, the brown marmarated stink bug (BMSB), is now spreading across the U.S. Stink bugs are extremely polyphagous—they feed on a wide range of plants. They can move over large distances and use a sequence of plants/crops as their populations increase throughout the year. Stink bug seasonal abundance and distribution are driven by food quality and availability. These insects are tolerant of many insecticides and are difficult to suppress. Interestingly, stink bugs also include beneficial preators—these beneficial insects can be distinguished by examining the mouthparts (Fig. 2).

For the reasons discussed above, stink bugs are difficult to manage—especially in organic systems. Initial research suggests that trap cropping may be a useful strategy available to organic producers for managing these troublesome pests, but continued efforts are needed to identify appropriate trap crops and management to use for different

Brown Marmorated Stink Bug

Note that the best plants to use as trap crops for the Brown Marmarated Stink Bug (BMSB) have not been determined to date, but sunflowers, squash, zucchini, and pumpkin appear to have strong merit. Hollyhocks are also used by all stages of the first generation of BMSB, are easy to grow, and may have some merit for use by homeowners to attract and kill BMSB as they leave dwellings where

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Triticale with crimson clover and vetch, sorghum, millet, buckwheat, and sunflower are the main species recommended to attract the native stink bug species found in the Southeastern U.S.

http://articles.extension.org/pages/61596/stink-bug-management-using-trap-crops-in-organic-farming

COVER CROPS IN FIELD PERIMETERS

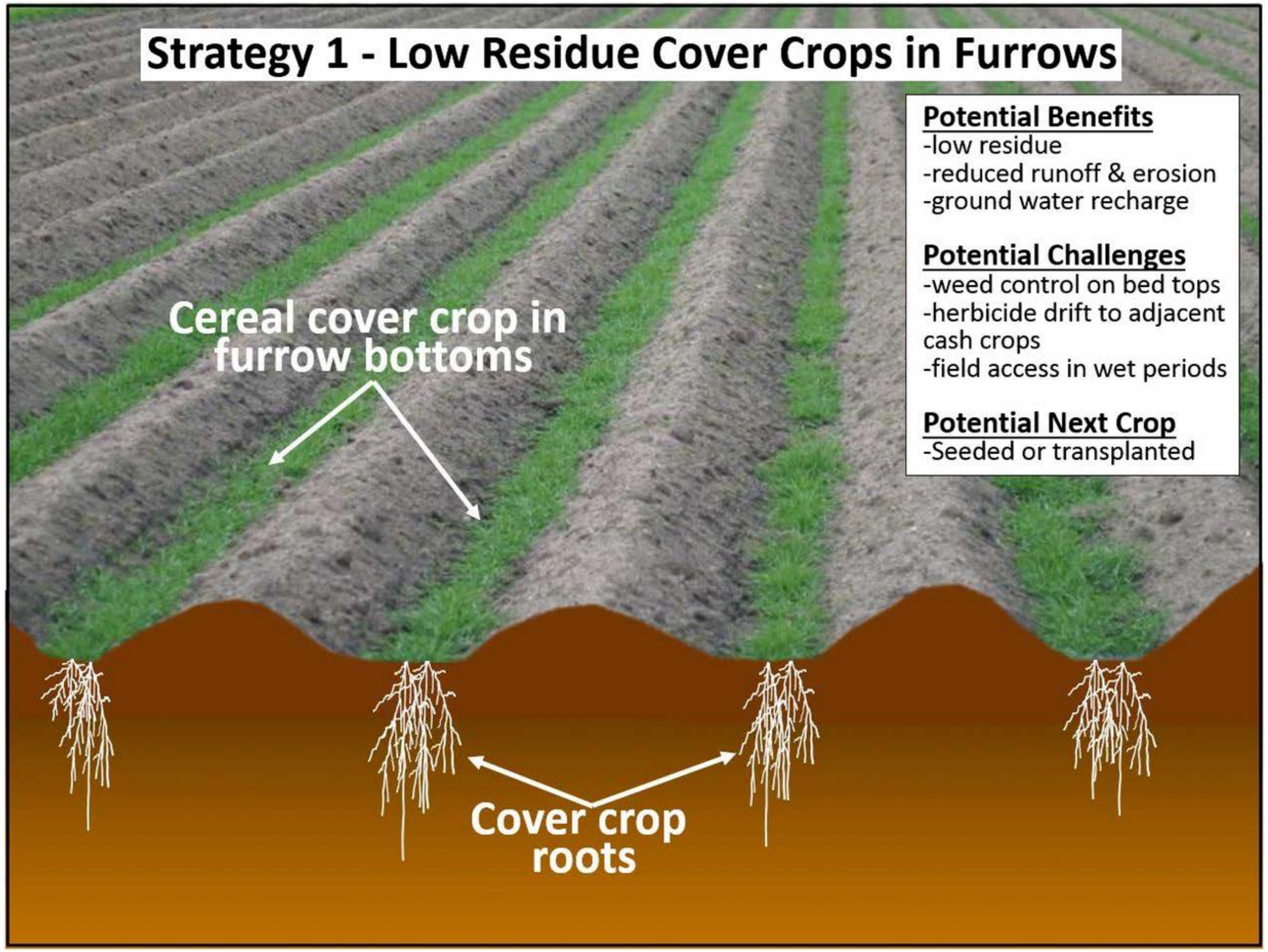
- Primary insect pest of blueberries for the Rooneys was stink bug.
- A trap crop of triticale and buckwheat was planted in field perimeters.
- The stink bug, *Piezodorus guildinii* was relatively abundant in the buckwheat, and was attacked by an orange tachinid fly.
- Insecticides were still needed, but were only applied to the trap crop, thus eliminating the need to apply insecticides to the blueberry crop.

Blueberry growers Scott and Billie Rooney, Wellborn, FL.

COVER CROPS IN FURROWS

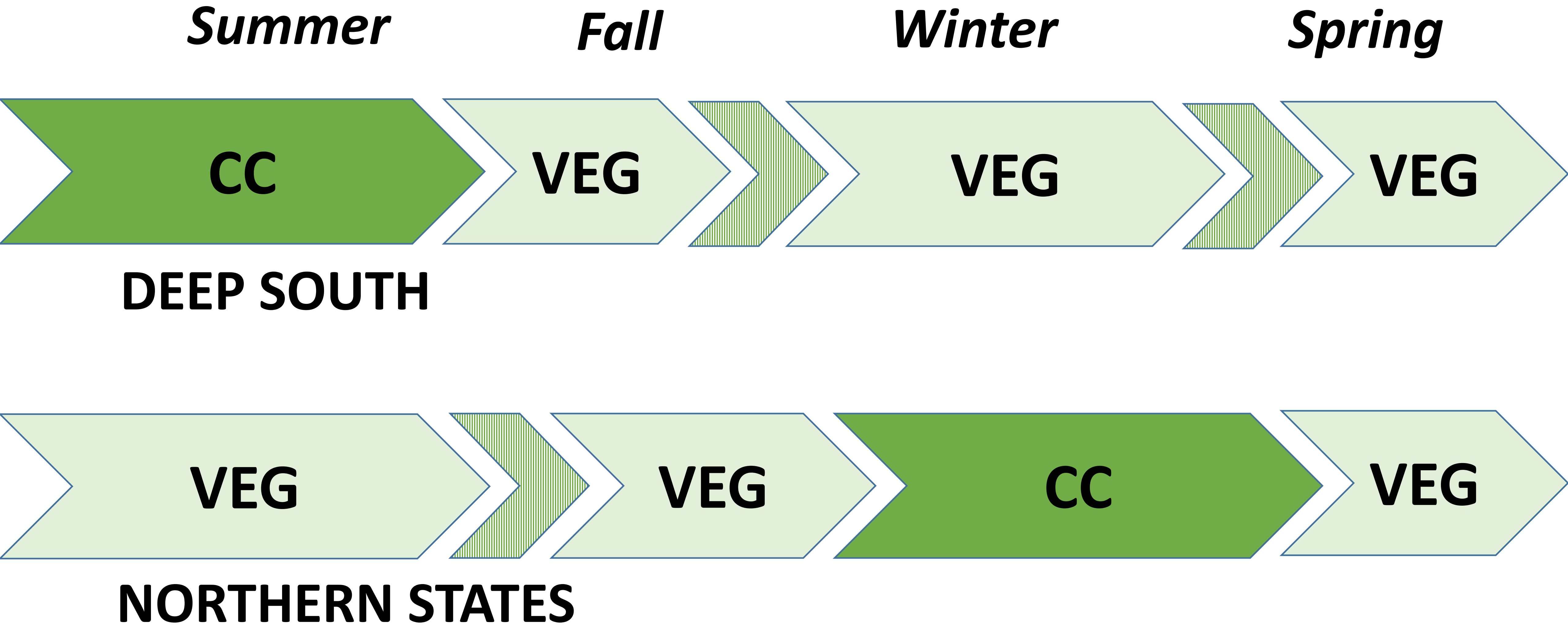
Cover Crops in CA Furrows

- In conventional systems, herbicide is used to terminate covers in furrows prior to vegetable planting.
- In organic systems, plant a succulent cover such as mustard or buckwheat and terminate by cultivation or plant a species that will winter/summer kill naturally.



E. Brennan, 2017. Can we grow organic or conventional vegetables sustainably without cover crops? HortTechnology (27) 151-161

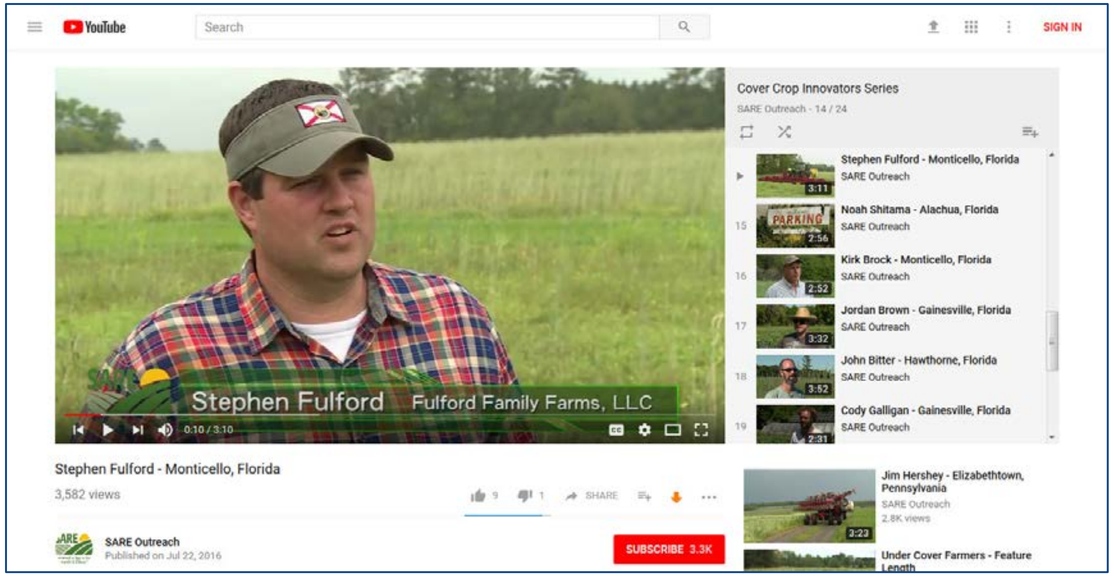
COVER CROPS IN ROTATION



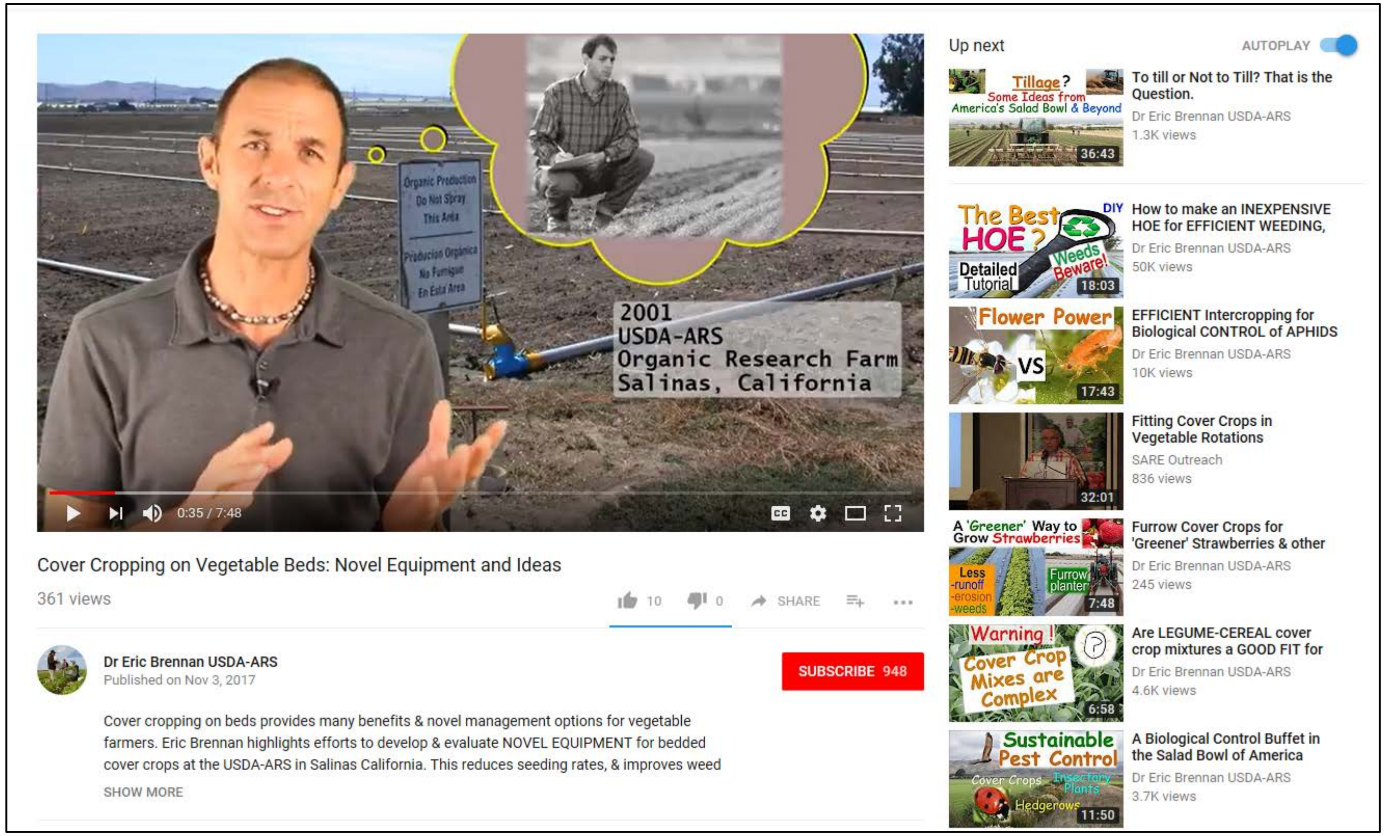
CRITERIA FOR DESIGNING ROTATIONS

- Identify time period in your system when you have the ability to seed, manage, and terminate a cover crop.
- Verify you have the equipment to manage the crop.
- Identify one primary objective.
- Review the list of recommended cover crop species in your area from NRCS, University, or other evidenced-based recommendation source.
- Evaluate the possible interactions of cover crop and subsequent vegetable crops and eliminate potential bad actors.
- Develop a back up plan.

COVER CROPS IN ROTATION



SARE Cover Crop Innovator Series – You Tube

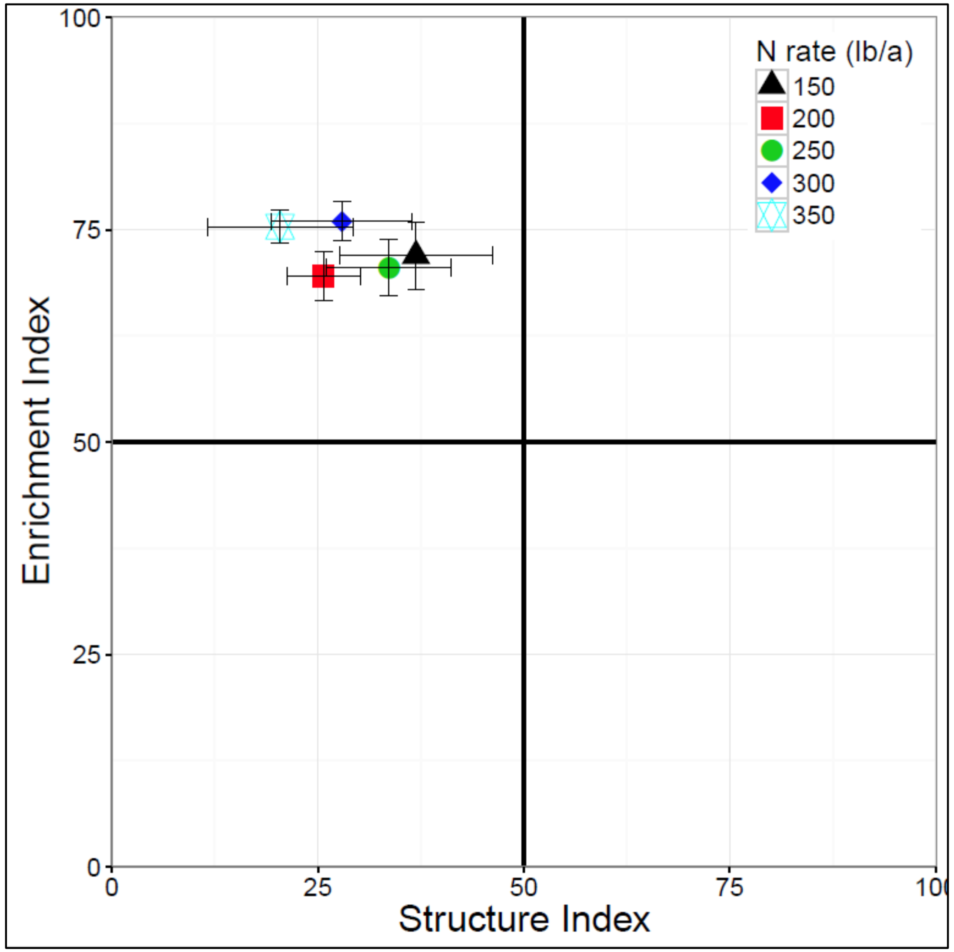


Buckwheat -> Broccoli
(Eastern Pennsylvania, T. Bjorkman, Cornell Univ.)
Pearl Millet + Sunn hemp -> Cabbage
(Florida, D. Treadwell, L. Zotarelli, P. Ditmar, UF)
Southern Pea -> Lettuce
(Kruse and Nair, Iowa Univ.)

Dr Eric Brennan USDA-ARS - YouTube Channel

COVER CROPS IN ROTATION – NEMATODE MANAGEMENT

- Cover crops are documented to reduce nematode density but are highly dependent on cover crop **cultivar** and nematode species.
  - Legion nematodes < French marigold, pearl millet (‘HGM 100’)
  - Root-knot nematodes < grasses
  - American dagger nematode < Rapeseed ‘Dwarf Essex’
- Mechanism for nematode suppression is unknown, but likely root exudates create an unfavorable environment for pathogenic nematodes, or a beneficial environment for beneficial nematodes.



Faunal profile (Ferris) at UF-IFAS Organic Unit in Live Oak, FL. Soil ecosystem is enriched but disturbed. **Z. Grabau et al., 2017.**

Family	Weed	Pathogen	Crops affected	Reference
Amaranthaceae	Palmer amaranth, (Amaranthus palmeri), Lambs quarters (Chenopodium album)	Tobacco rattle virus (Tobravirus)	Beet, tobacco, potato	Dikova 2006, Goyal et al. 2012
Brassicaceae	Wild radish (Raphanus raphanistrum)	Beet western yellows virus (Polerovirus)	Broccoli, cauliflower, radish, and turnip (also beet, lettuce, spinach, and pea)	Zitter and Provvidenti 1984
Cucurbitaceae	Wild cucurbits (Cucumis spp.)	Cucumber mosaic virus (Cucumovirus)	Cantaloupe, cucumber, pumpkin, and squash (also bell pepper, celery, spinach, tomato, and watercress)	Goyal et al. 2012
	Creeping cucumber (Melothria pendula)	Papaya ringspot virus type W, Zucchini yellow mosaic virus (both aphid-transmitted Potyviruses)	Cantaloupe, squash, watermelon	Kucharek and Purcifull, 2001
	Balsam-apple or Balsam pear (Momordica charantia)	Squash vein yellowing virus (whitefly-transmitted Ipomovirus)	Squash and watermelon	Adkins et al. 2008, Shrestha et al. 2016
Fabaceae	Kudzu (Pueraria mont ana var. lobata), Florida beggarweed (Desmodium tortuosum), Clover (Trifolium spp.)	Soybean rust, Phakopsora pachyrhizi and P. meibomiae (Basidiomycota: Pucciniomycotina)	Soybean, common bean, garden and field peas	Rupe and Sconyers 2008
Poaceae	Johnsongrass (Sorghum halepense)	Maize dwarf mosaic virus A (aphid-transmitted Potyvirus)	Corn	Gatton 2015
Solanaceae	Jimsonweed (Datura stramonium)	Tomato mosaic virus (Tobamovirus) Potato virus X (Potexvirus)	Pepper, tomato	Alemu et al. 2002

COVER CROP TERMINATION

- **Cover Crop Incorporated**
  - The most flexible
  - Can be followed by plastic mulch
  - Requires the most tillage for total incorporation
  - Forced into a fallow period of 2-3 weeks as you incorporate
  - Incomplete incorporation can result in volunteer cover crop and residual crowns and stems that can interfere with planters.
  - Can delay vegetable establishment

- **Cover Crop on the Surface**
  - Difficult to cultivate if weeds emerge
  - Benefits more fully realized with 5,000 lbs or more dry matter, and low lignin content crops will decompose quickly
  - Impart stability to the system under temperature and moisture variability
  - Must fully terminate, sometimes regrowth ocurrs
  - Can delay vegetable establishment

Ron Morse, 1990. HortTechnology

No-till Vegetable Production—Its Time is Now

Ronald D. Morse

Additional index words. conservation tillage, residue management, high residues

Summary. Advantages of no-till (NT) production systems are acknowledged throughout the world. During the 1990s, production of NT vegetable crops has increased for both direct seeded and transplanted crops. Increased interest in reduced-tillage systems among research workers and vegetable growers is attributed to: 1) development and commercialization of NT transplanters and seeders, 2) advancements in the technology and practice of producing and managing high-residue cover crop mulches, and 3) improvements and acceptance of integrated weed management techniques. Results from research experiments and grower's fields over the years has shown that success with NT transplanted crops is highly dependent on achieving key production objectives, including: 1) production of dense, uniformly distributed cover crops; 2) skillful management of cover crops before transplanting, leaving a heavy, uniformly distributed killed mulch cover over the soil surface; 3) establishment of transplants into cover crops with minimum disturbance of surface residues and surface soil; and 4) adoption of year-round weed control strategies.

Benefits of conservation tillage in general and no-tillage (NT) systems in particular are well documented for many agronomic crops such as field corn (*Zea mays* L), soybean [*Glycine max* (L.) Merr.], and cotton (*Gossypium hirsutum* L.) (Carter, 1994; Crosson, 1981; Griffith et al., 1986; Lal et al., 1990). Adoption of conversation tillage systems is increasing in North and South America to the extent that it now constitutes the normal or conventional method of crop production for field corn and soybean in some areas (Hebblethwaite, 1997).

Evolution of conservation in the United States

A major change in tillage practices has required a long transition period because the change involved development and adaptation of new types of equipment and methodology as well as different ways of perceiving the soil ecosystem (Brussard and Ferrera-Cerrato, 1997).
In the early 1900s, moldboard plowing, excessive secondary tillage operations, and multiple cultivations led to serious erosion problems which led to serious flooding and dust storms (Phillips and Phillips, 1984). In 1943, Edward Faulkner boldly challenged the validity and wisdom of using the moldboard plow (Faulkner, 1947). Faulkner asserted: "The truth is that no one has ever advanced a scientific reason for plowing. The entire body of reasoning about the management of the soil has been based upon the axiomatic assumption of the correctness of plowing.

Department of Horticulture, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.

Table 1. Feasibility[z] of achieving successful production of vegetable crops, using no-till[y] production systems.

Vegetable crop		Planting method	
Botanical name	Common name	Direct seeded	Transplanted
Zea mays L.	Sweet corn	High	NA
Phaseolus sp.	Snap bean, lima bean	High	NA
Brassica sp.	Cabbage, broccoli, cauliflower, collard	Low	High
Cucurbita sp.	Pumpkin, summer squash, winter squash, gourds	High	High
Cucumis sp.	Muskmelon, honeydew melon, cucumber	High	High
Citrullus lanatus Thumb.	Watermelon	High	High
Capsicum annuum L.	Bell pepper, cayenne pepper	Low	High
Lycopersicon esculentum Mill.	Tomato	Low	High
Solanum tuberosum L.	Potato[x]	Moderate	NA
Ipomoea batatas L.	Sweetpotato	NA	Moderate

[z]Feasibility based on past and current observations in research plots and grower fields. In many cases, grower experience has been limited to small-scale [<25 acres (11 ha)] fields. Feasibility ratings: high = broad-scale success achieved by both researchers and growers; moderate = experience limited mainly to small-scale research plots; low = not currently recommended because of insufficient research and/or grower experiences; NA = not applicable because planting method is not commonly practiced.
[y]No-till includes strip-till systems.
[x]For potato, whole seed tubers or cut seed tuber pieces are planted.

Seeding Strategies - Modify Existing Equipment

Great Plains 3P605 NT Drill with raised drive wheels

Termination Methods

Mowing with rotary mowers, flail mowers, stalk choppers have very different outcomes.

Termination Methods

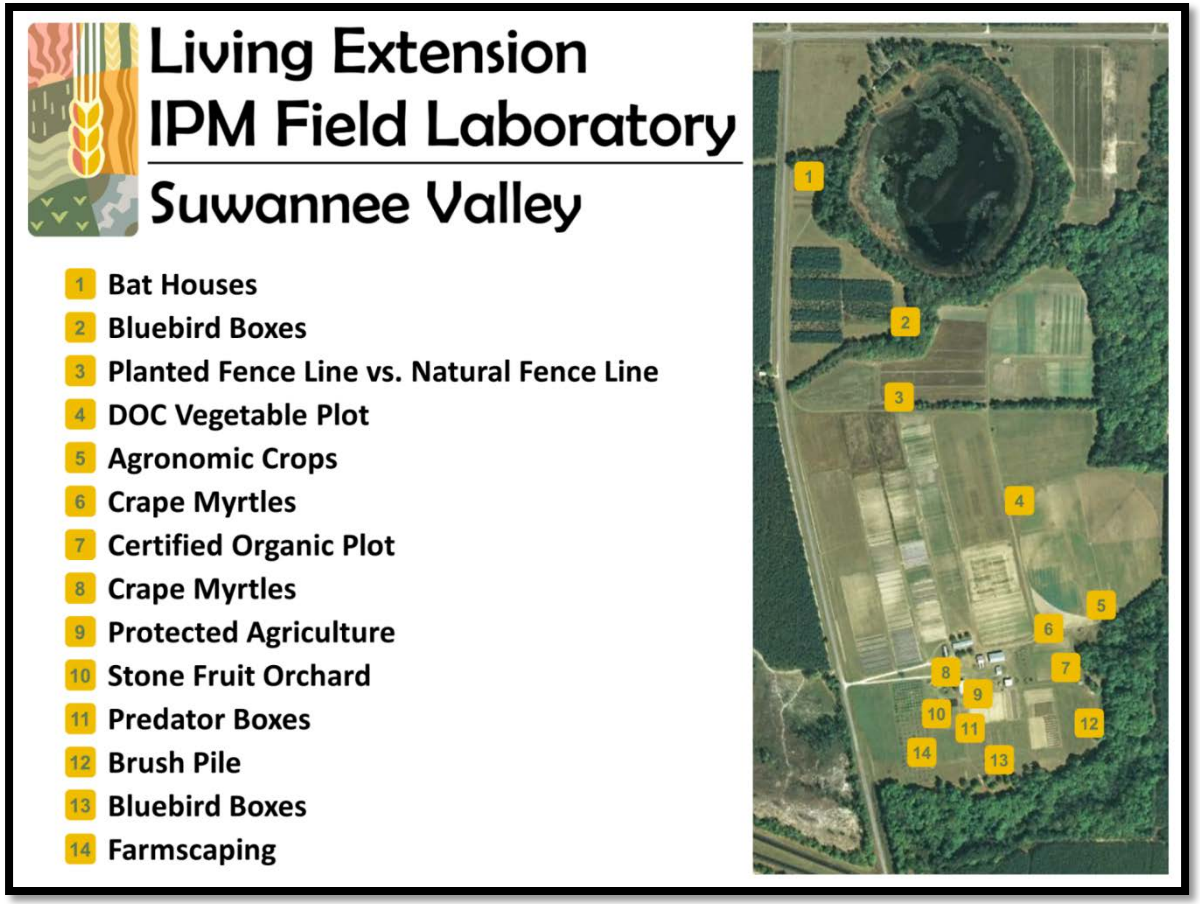
Example of Successful Roller-Crimping

- Kornecki (USDA-ARS) assisted grower Frank Randle (AL) develop a cover crop management plan.
- Primary objective was weed control.
- Winter cover of crimson clover and rye to okra, tomatoes, or squash.
- First four years, tillage was needed to control weeds, but after that reduced tillage was adopted. Yields increased.

Riggs, 2013. Roller/Crimper Technology Offers Benefits to Growers. Growing for Profit Magazine.

Mulching Strategies for Jalapeño Pepper in FL and USVI

- The 2-year study was conducted at the UF-IFAS Organic Unit in Live Oak, FL.
- Objective: Identify mulching system that reduced weed density and maintained yield
- Four treatments arranged in a RCBD, then split to two levels of weeding intensity (high and low) six weeks after planting to evaluate the effectiveness of weed management among treatments.



UF/IFAS Suwannee Valley Agricultural Extension Center

Treatments

Four Mulch Treatments:

1. **<u>ROLLER-CRIMPER</u>:** Sunn hemp terminated by crimper, residue remains on soil surface
2. **<u>NO MULCH</u>:** Sunn hemp mowed and soil incorporated
3. **<u>PLASTIC</u>:** Sunn hemp mowed and soil incorporated, Plastic mulch 122 cm wide, 1.5 ml thickness, white on black applied
4. **<u>CUT-N-CARRY:</u>** Sunn hemp residue mowed and soil incorporated, rye straw applied to surface.

Two Weed Removal Frequencies:

- Each plot was divided in half perpendicular to tractor direction, and weeding treatments were randomly assigned to each plot six weeks after planting (WAP).

1. **<u>LOW INTENSITY</u>** weeding (every 3rd weeks)
2. **<u>HIGH INTENSITY</u>** weeding (every week)

Organic Jalapeno Pepper Yield (*Capsicum annum* L. 'Tormenta')

MANAGEMENT	**Marketable Yield**		**Total Yield**	
	2013	**2014**	**2013**	**2014**
MULCH SYSTEM	—— kg ha^{-1} ——		—— kg ha^{-1} ——	
Roller-Crimped Sunn Hemp	16,061 b[z]	9,071 b	20,512	9,121 b
Cut and Carry Rye Straw	22,706 a	9,856 ab	23,845	9,945 ab
Plastic Mulch	15,008 b	10,834 a	19,056	10,937 a
No Mulch	16,794 b	7,074 c	18,611	7,121 c
	P = 0.0063	*P* = 0.0005	*P* = 0.2296	*P* = 0.0004
WEEDING FREQUENCY	—— kg ha^{-1} ——		—— kg ha^{-1} ——	
Weekly	18,241	9,748	21,478	9,817
Every Third Week	17,044	8,669	19,535	8,745
	P = 0.4350	*P* = 0.6024	*P* = 0.3189	*P* = 0.0612

[1]Values followed by different letters differ ($p<0.05$) according to a least significant range separation.

Summary

- Crop productivity can be stabilized in variable weather due in part to buffering capacity of surface mulch (rye straw)
- The frequency of weeding did not influence pepper yield, fewer weeding events will be economically beneficial
- RT Sunhemp had fewer weeds early in the season, but Cut and Carry mulch had fewer weeds later in the season.
- Future research investigate additional crops and include more environmental data.

SUMMARY

- Change is constant
- Change costs money
- Process is something
- People are everything
- Decision to change occurs years before actual change can be measured
- If you build it, and build it well, measurable, beneficial changes will come

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THE SOURCE FARM

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United States Department of Agriculture
National Institute of Food and Agriculture

UNIVERSIDAD DE PUERTO RICO
1903

UNIVERSITY OF THE VIRGIN ISLANDS
1962

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