

# Till Minimally, Cover Strategically

## Sustainable Vegetable Production

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# Zheng Wang

- UCCE Vegetable and Irrigation Farm Advisor since March 2018
- University of Kentucky: PhD (2011-2015)
- The Ohio State University: Postdoc (2015-2017)
- Optimizing regional and statewide vegetable production

# Today's Class

- **Major differences of tillage systems**
- **Use of cover crops**
- **Incorporation of cover crops into conservation tillage**

# Why Till?

- Prepare fine seedbeds for germination
- Create good seed-soil contacts
- Destroy existing weeds
- Loosen soil for root development
- Improve soil profile aeration
- Warm soil for early maturity

# Many Terms

**Aggressive tillage, conventional tillage, intensive tillage, full-field tillage, standard tillage, plastic mulch, plasticulture.....**

- **Deep tillage: > 10 inches**
- **< 15% crop residues left on soil surface**
- **100% top soil disturbed**
- **Tractor-powered tools to accomplish field work**
- **Raised beds commonly used w/o plastics**

# Full-field Tillage in Vegetable Production

## Moldboard Plow



**Inverts soil up and down.**

**Leaves no surface cover.**

**Includes curved plate with sharp edges.**

[https://www.youtube.com/watch?v=zo\\_5EihK4-l](https://www.youtube.com/watch?v=zo_5EihK4-l)

# Full-field Tillage in Vegetable Production

## Disk and Chisel



**Turns over soil slightly.**

**Leaves some residual cover.**

**Breaks soil into small particles.**

<https://www.youtube.com/watch?v=uWM5Z3nCXdl>

# Full-field Tillage in Vegetable Production

## Rototill



Tines spin fast to break soil into even smaller particles for vegetable planting.

# Full-field Tillage in Vegetable Production



**Shape raised beds covered with or without plastics.**

# Friend or Foe?

**After heavy rains**



**Aggressive tillage leads to:**

- 1) Soil erosion and compaction
- 2) Cost increase
- 3) Soil property degradation
- 4) Environmental issues
- 5) Shortened soil life
- 6) Less arable lands
- 7) Soil “addicted” to tillage

# Arable land is losing

According to American Farmland Trust...

- **> 1 acre lost/minute in the U.S.**
- **1982-2007, > 23 million acres lost = size of Indiana**
- **Deforestation to make up the land scarcity**

**Tillage is a source of land degradation.**

# Planting without plowing

News & Highlights

FOOD AND AGRICULTURE ORGANIZATION  
of THE UNITED NATIONS



## Conservation tillage: the end of the plough?

Early 1970s in South and North America

Crop residues

Cover crop

Fuel cost

**New techs  
lessen the need  
for tillage.**

**Conservation  
tillage**



Taken by Dr. Zheng Wang at Lexington, KY and Wooster, OH.  
Credits: Univ. of KY and The OSU-OARDC.

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# Conservation Tillage

**$\geq 1/3$  soil undisturbed and covered with crop residues**

**Types: no-till and reduced tillage**

**Modified or specialized equipment required**

**Unique field preps and management**

# What are the Benefits?

**In contrast to the standard tillage, conservation tillage tends to:**

**Protect soil integrity (stabilization): less disturbance**

**Reduce cost: tractors, chemicals, fuels**

**Alleviate environmental burdens: less nutrient loss, leaching**

**Sustain more water: crop residues, good water storage**

**Elongate soil arability: soil depletion slows down**

# No-till/Zero-tillage



- 0% soil disturbance
- Rely on crop residues (last cash crop or cover crop)
- Vegetables are planted with no-till transplanter (disk, in-row chisel, and coulters)
- More common for agronomic crops

# Form Mulches: Roller-crimper



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# No-till Planter

[https://www.youtube.com/watch?v=lwLj\\_GvLQn0](https://www.youtube.com/watch?v=lwLj_GvLQn0)

# Reduced Tillage: A Combination

**Till plant rows only and leave other areas undisturbed and covered.**

**Strip tillage and Ridge tillage**

**Combine benefits of no-till and regular tillage**

# Strip Tillage (Clockwise)



**Grow**



**Terminate**



**Transplant**



**Till minimally**

Plant into a narrow opened space created by a strip tiller (less than 12" wide).

Tilled area provides more favorable soil conditions for plants to grow.

The rest field is protected.

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# Strip Tiller

Video from Dr. Anu Rangarajan  
Cornell Univ.

<https://www.youtube.com/watch?v=hdnr7ymlpKs>

**Excellent Residue Handling:** Dual gauge wheels hold down residue as spring cushioned coulter cuts ahead of shank.

Dual 16" gauge wheels offer precise depth control.

**Autoreset:** Offers up to 10" of obstacle clearance.

A 3/8" O.D. stainless steel tube for NH<sub>3</sub> or liquid fertilizer application is included.

Spring cushioned and adjustable 18" coulters help compensate for wear and conditions.

**14" Row Cleaners:** Individually adjustable, spring loaded row cleaners are standard equipment and feature heavy duty hubs and sealed bearings.

**Shank & Point:** High tensile steel shank is accurately set to work depths of 5" to 9" while chrome carbide point fractures and raises soil. NH<sub>3</sub> or liquid fertilizer tube is standard. Diffuser plate distributes granular material and assists in sealing of NH<sub>3</sub> materials.

**Berming Discs:** 18" discs capture ripped soil and place it into the berm. Wrenchless "no-tools" operating width adjustment for customizing berm height. Disc mountings with multiple adjustments fit more soil conditions. Adjustable for both width and angle plus fore and aft positioning.

**Optional Rolling Baskets:** Fracture and crumble soil clods in berm when operating in less than ideal conditions. "No-tools" down pressure adjustments for quick, accurate repositioning.

Choice of standard 2 1/8" wide or optional 1 5/16" wide chrome alloy point.

The T1 alloy steel, 5/8" x 4" Shank features a replaceable leading edge chrome alloy wear strip.

Rolling baskets feature convenient "flip-up" storage when not in use.

Hiniker Series 6000 Single-row  
Strip tiller

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**Like other conservation tillage,  
strip tillage can...**

**protect soil structure and quality**

**reduce nutrient leaching**

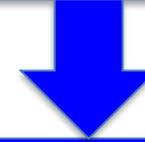
**retain soil moisture**

**enhance microbial activity**

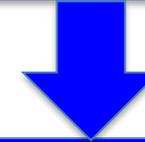
**save fuel and other costs**

**increase fruit quality (cleaner fruit)**

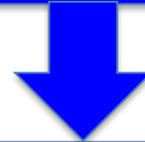
**Do we overlook anything?**



**Crop Yield!**



**Consistency among crops**



**Crops suited in strip tillage**

# Can You Tell What Crops Are Well-Suited to Strip Tillage and Why?

**Corn (including sweet corn)**



Source: Morning Ag Clips

# Can You Tell What Crops Are Well-Suited to Strip Tillage and Why?

**Soybean**



Source: MN Department of Agriculture

# Can You Tell What Crops Are Well-Suited to Strip Tillage and Why?

**Cucurbits (summer/winter squash, pumpkin, melon)**



Source: Weed management strategies, eXtension

# Can You Tell What Crops Are Well-Suited to Strip Tillage and Why?

Starting with drawbacks, strip tillage sometimes...

increases weed problems

causes lower soil temperature

delays crop maturity

restricts root penetration

produces lower yields

Corn has a wide range of herbicides for weed control, a deep/extensive root system, and a vigorous upright growth habit.

Soybean has a wide range of herbicides for weed control and a high seeding density that canopy closes the between-row space quickly to prevent weed growth.

Cucurbit crops are deep-rooted, generally planted in late spring or early summer after soils have warmed, and also have an aggressive growth habit, which can help shade weeds.

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**Other vegetables, such as tomato, pepper, and brassicas, have been studied for their suitability in reduced-tillage systems. However, their yield performance and other variables were dynamic in a case-by-case situation.**

# Summary

**Dramatic differences between conventional and conservation tillage from many aspects.**

**Conservation tillage: not simply reduce plows.**

**Currently not a wide-spectrum, universally accepted tool due to crop and environment specificities.**

# Today's Class

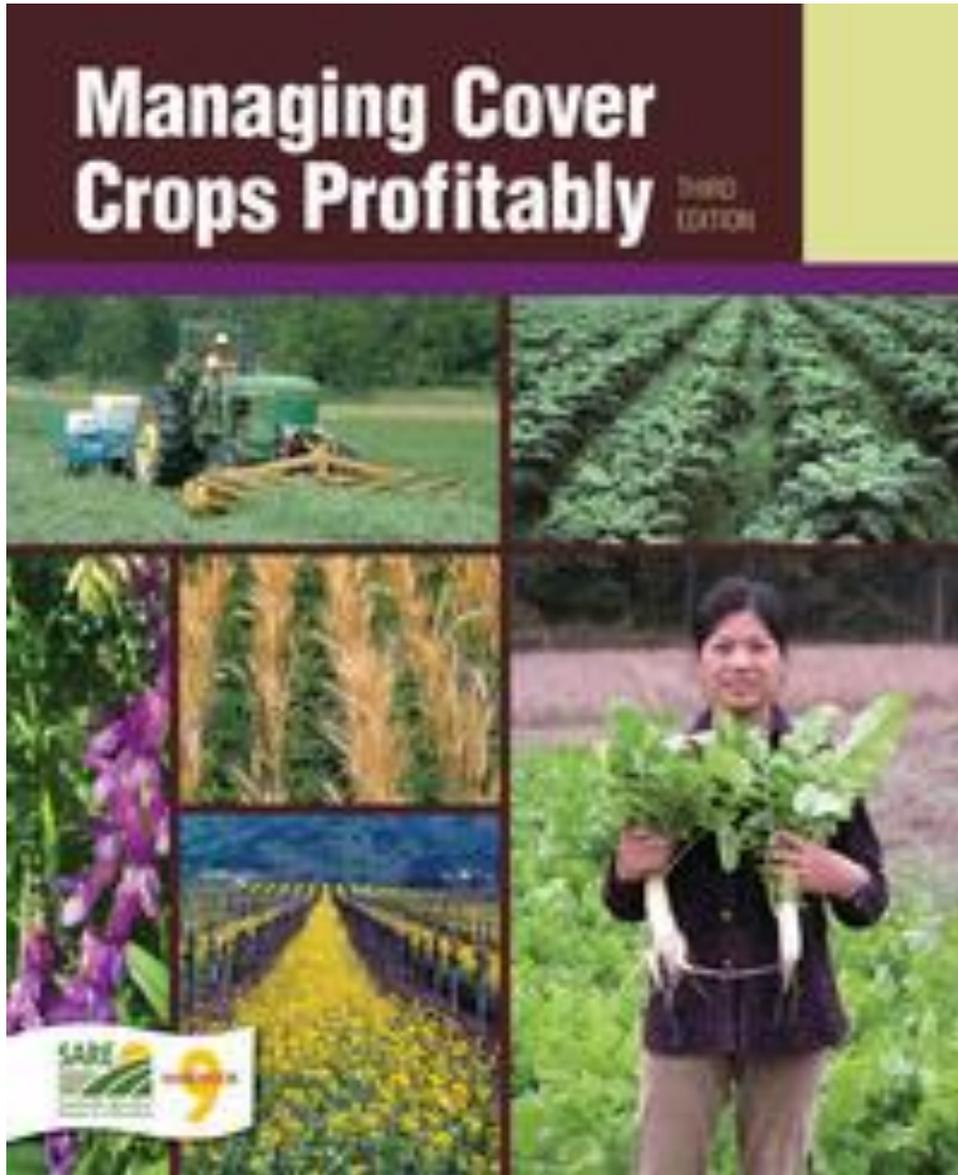
- **Major differences of tillage systems**
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- **Incorporation of cover crops into conservation tillage**

# What is a Cover Crop?

**A cover crop is a plant that is used primarily to slow erosion, improve soil health, enhance water availability, smother weeds, help control pests and diseases, increase biodiversity and bring a host of other benefits to your farm.**



# Types of Cover Crops



<https://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition>

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# Types of Cover Crops

## *Grasses:*

- annual cereal grains,
- annual/perennial forage grass, and
- warm-season grass



**Winter Rye**

# Types of Cover Crops

## *Grasses:*

- annual cereal grains,
- annual/perennial forage grass, and
- warm-season grass



**Annual Ryegrass**

# Types of Cover Crops

## *Grasses:*

- annual cereal grains,
- annual/perennial forage grass, and
- warm-season grass



**Sorghum Sudangrass**

# Types of Cover Crops

## *Legumes:*

- summer annual legumes,
- winter annual legumes,  
and
- biennial and perennial  
legumes



**Cowpea**

# Types of Cover Crops

## *Legumes:*

- summer annual legumes,
- winter annual legumes,
- and
- biennial and perennial legumes



**Hairy Vetch**

# Types of Cover Crops

## *Legumes:*

- summer annual legumes,
- winter annual legumes,  
and
- biennial and perennial legumes



**White Clover**

# Types of Cover Crops

## *Brassicas:*

- leafy species,
- oil-producing species,  
and
- root species



**Mustard**

# Types of Cover Crops

## *Brassicas:*

- leafy species,
- oil-producing species,  
and
- root species



**Rapeseed**

# Types of Cover Crops

## *Brassicas:*

- leafy species,
- oil-producing species, and
- root species



**Tillage Radish**

**Multiple R's: right time? right rate? right management? right purpose? .....**

**Abundance is not a problem; not knowing how to match their functions with your goals before conservation tillage is a problem.**

# By purpose, cover crops can...

- 1) suppress weeds
- 2) replenish soil nutrients
- 3) increase soil organic matter
- 4) scavenge excess nutrients
- 5) enhance soil properties



# Examples

**A tomato grower from Wisconsin plans to protect his field by shifting from intensive tillage to strip tillage and growing cover crops. Historically, his soil is lack of nitrogen, but his weed control was good by using herbicide. How can you help him with cover cropping using your knowledge?**

**Keywords extracted: Tomato, Wisconsin, lack of N, low weed pressure.**

**Further analysis: Tomato, Wisconsin, lack of N, low weed pressure.**

**Tomato = high nutrient demanding.**

**Wisconsin = cold and long winter and short summer.**

**Lack of N = replenishment is necessary.**

**Low weed pressure = good habit, keep it.**

## **Solutions:**

**Hairy vetch is the possible choice because it is**

- 1) winter-hardy enough down to Zone 3 (snow cover).**
- 2) efficient in nitrogen fixation (> 100 lb N/Acre).**
- 3) killed easily and decomposed quickly (less likely to become a new weed).**

# Examples

**A tomato grower from Wisconsin plans to protect his field by shifting from intensive tillage to strip tillage and growing cover crops. Historically, his soil is lack of nitrogen, and he wants to reduce the cost of using herbicide. How can you help him with cover cropping using your knowledge?**

**Keywords extracted: Tomato, Wisconsin, lack of N, weed pressure, high cost of weed control.**

**Further analysis: Tomato, Wisconsin, lack of N, weed pressure, high cost of weed control.**

**Tomato = high nutrient demanding**

**Wisconsin = cold and long winter and short summer**

**Lack of N = replenishment is necessary**

**Weed pressure = good mulch coverage**

**High cost of weed control = effects last longer**

# Solutions:

**“Hairy vetch + winter rye” is the possible choice because it is**

- 1) winter-hardy enough down to Zone 3 (snow cover).**
- 2) efficient in nitrogen fixation (> 100 lb N/Acre).**
- 3) killed easily and decomposed quickly (less likely to become a new weed).**
- 4) producing large biomass to suppress weed emergence.**
- 5) decompose slowly that control effects last longer.**
- 6) growing rapidly even in the winter.**

# They are Different...

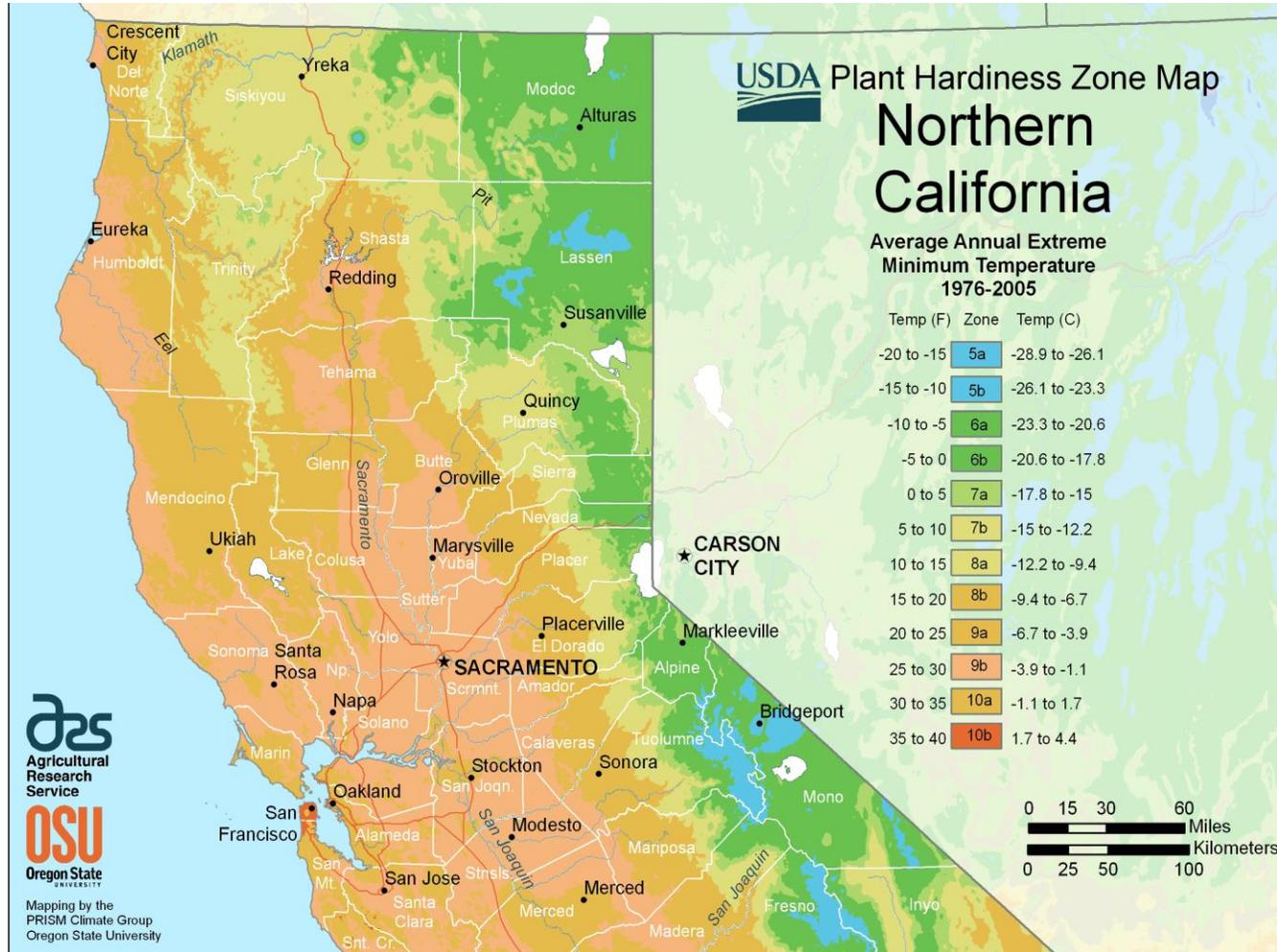
A (tomato vs. broccoli) grower from (Wisconsin vs. California) plans to protect his field by shifting from intensive tillage to strip tillage and growing cover crops. Historically, his soil is (lack vs. excess) in nitrogen, and he wants to (reduce the cost of using herbicide vs. turn to organic). How can you help him with cover cropping using your knowledge?

# Recap: Five Questions to Ask

**Before implementing conservation tillage, ask yourself**

- 1) where am I?**
- 2) what is my production practice and scale?**
- 3) am I ready for seeding cover crops (e.g., equipment, rate, irrigation)?**
- 4) what is my goal (very important)?**
- 5) can they overwinter and when to terminate?**

# Where am I?



**Northern California Plant Hardiness Zone Map 1976-2005 (Note: Stanislaus County locates Zone 9b). In this hardiness zone, most cover crops can overwinter.**

**Source: USDA-ARS and Oregon State University**

# What is my production?



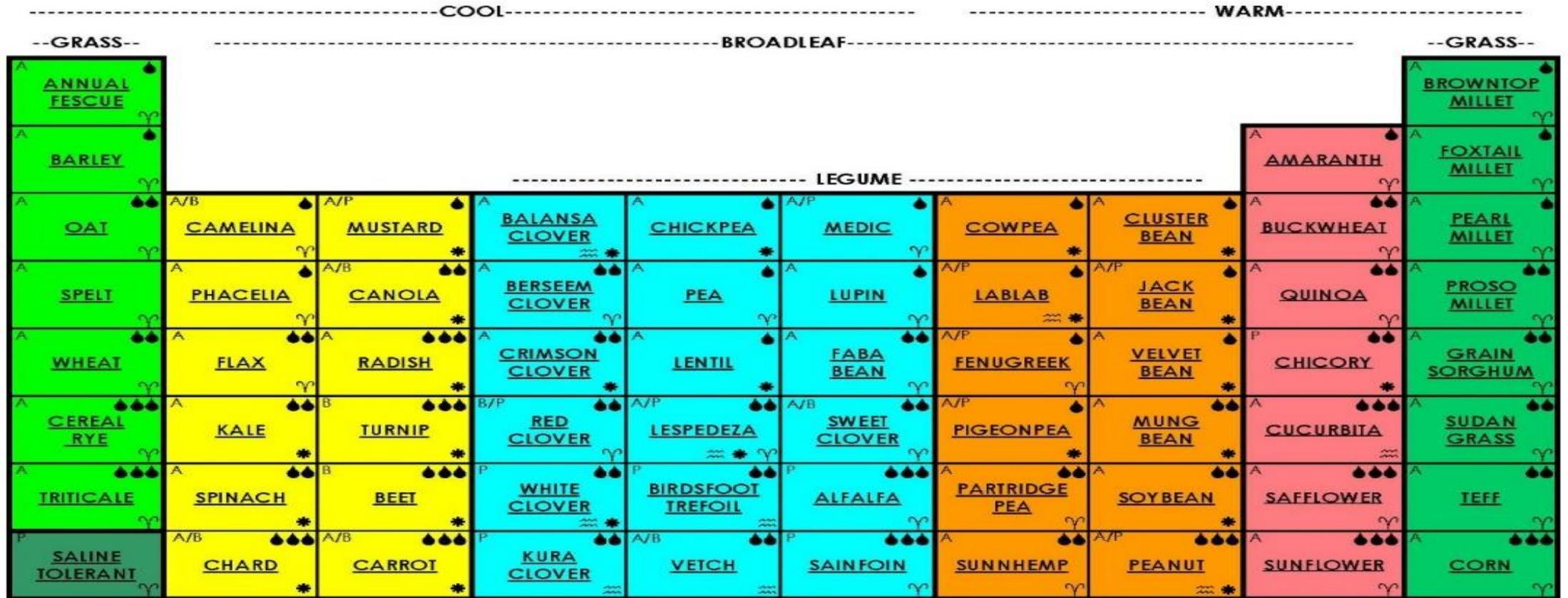
**Small: pole type**



**Big: bush type**

# Cover Crop Chart

| GROWTH CYCLE  | PLANT ARCHITECTURE    | RELATIVE WATER USE |
|---------------|-----------------------|--------------------|
| A = Annual    | Υ = Upright           | ● = Low            |
| B = Biennial  | * = Upright-Spreading | ●● = Medium        |
| P = Perennial | ≡ = Prostrate         | ●●● = High         |



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◆ Additional Information

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

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**GOOD LUCK!**

**THANK YOU**

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# Post-class Survey

**Please complete the post-class surveys.  
Feel free to contact Dr. Zavalloni or me (209.525.6822;  
[zzwwang@ucdavis.edu](mailto:zzwwang@ucdavis.edu)) with questions.**