Making the Most of Cover Crop Mixtures

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Penn State **Extension**

Many thanks to…

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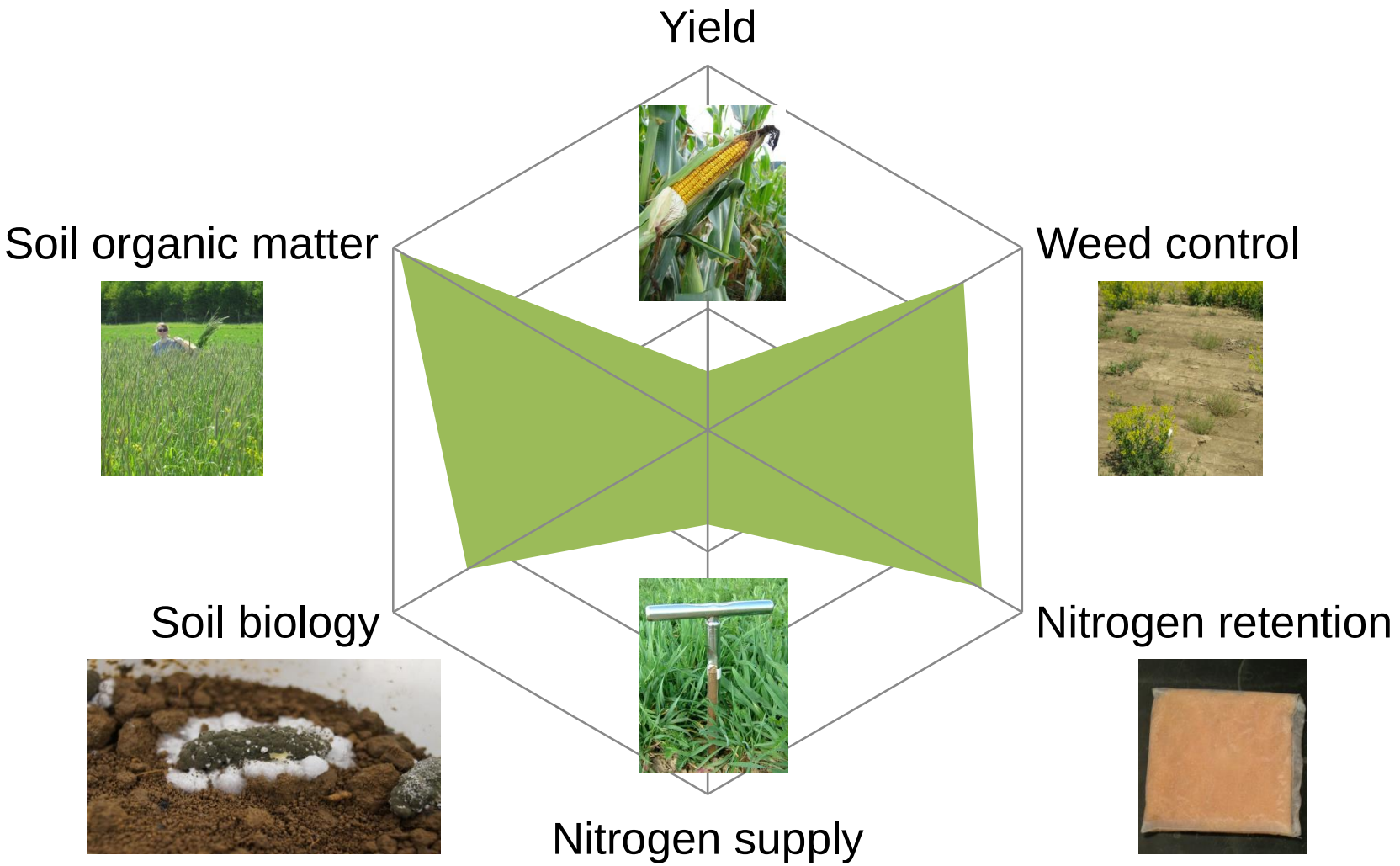
Why Mixtures?

Mixing species can **diversify** the benefits provided by a cover crop

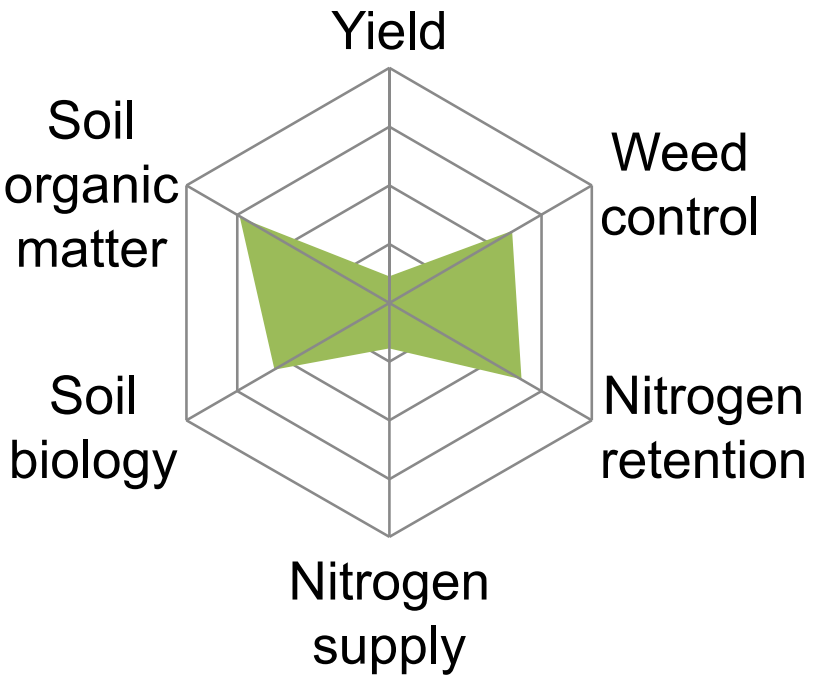
Quantifying cover crop benefits



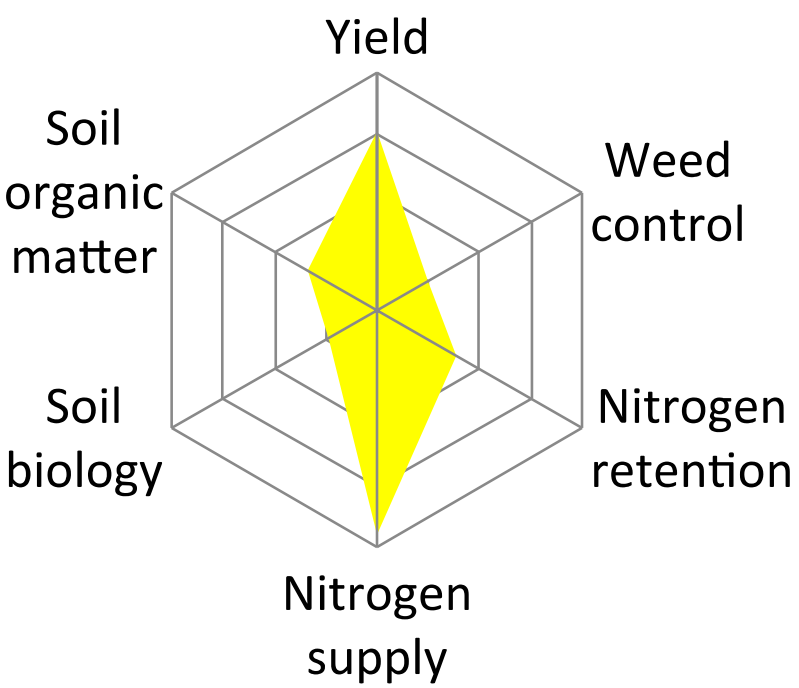
Slide credit: Denise Finney

Monoculture multifunctionality

Rye



Pea



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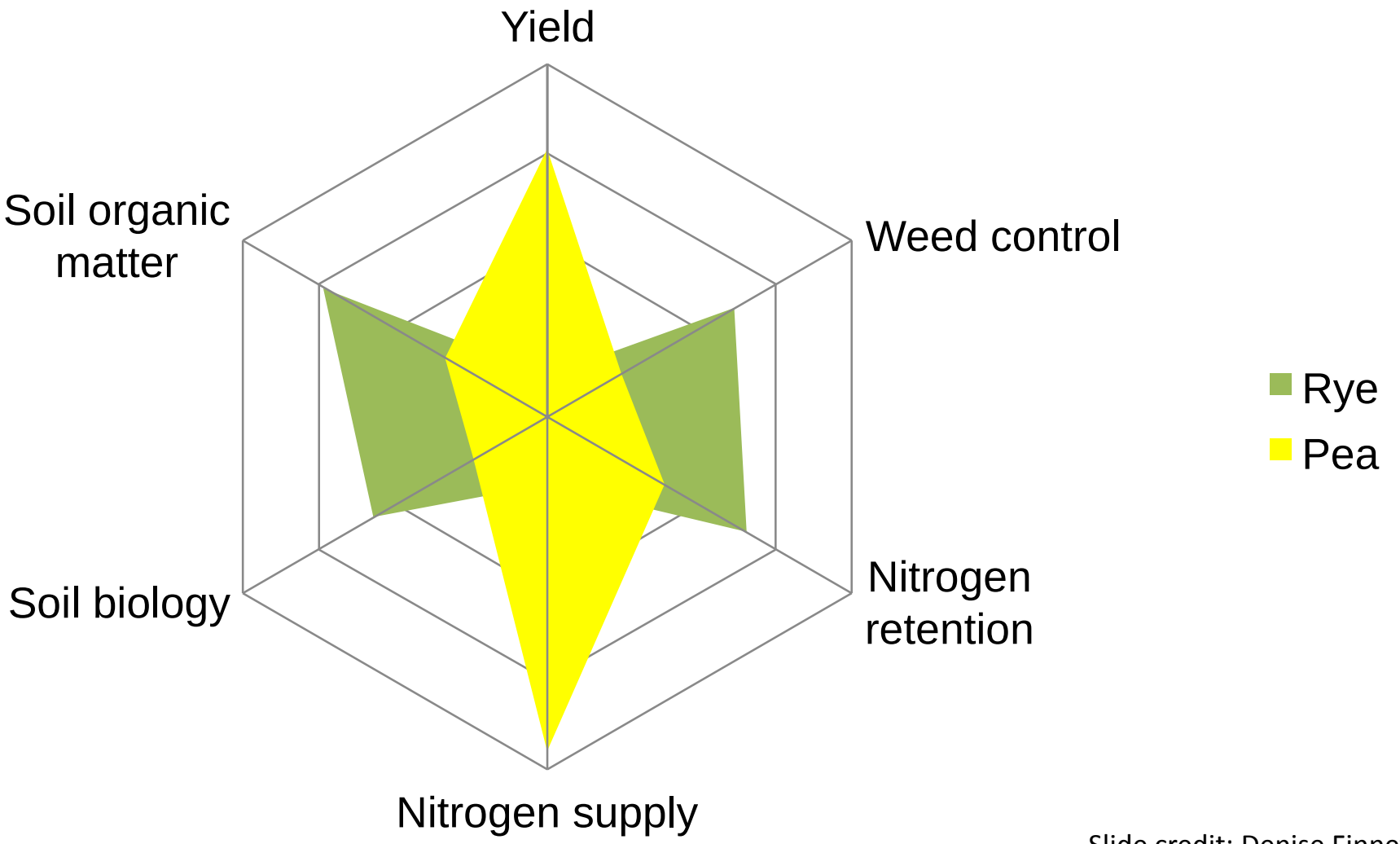
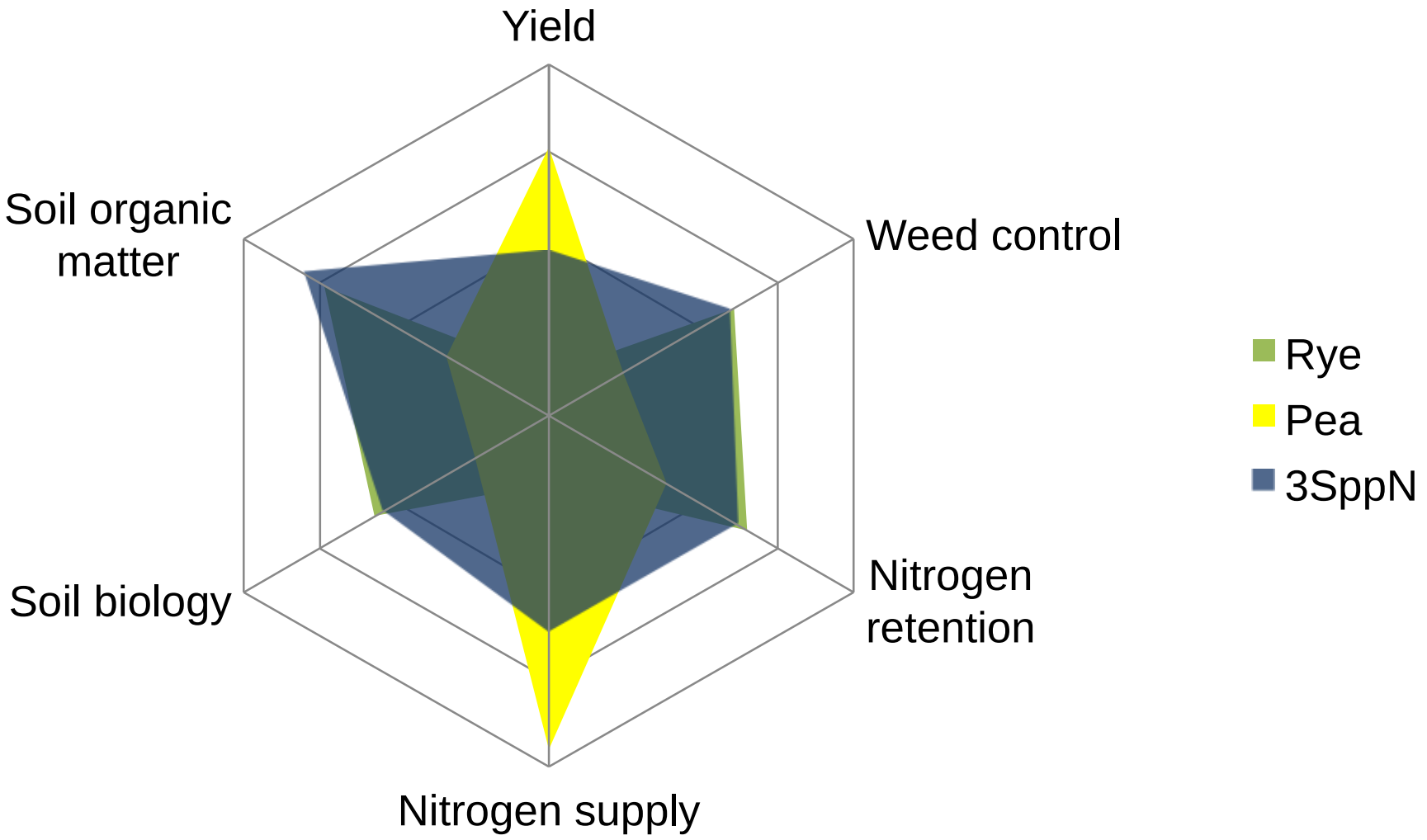
Mixture multifunctionality???



Slide credit: Denise Finney

Mixture multifunctionality – diverse benefits



Slide credit: Denise Finney

CC Mixtures: Research and Practice

Are Researchers Crazy?

- Not Crazy Enough!
  - Have to simplify
  - Focus on measurable benefits – soil health?
  - Interested in determining, costs, benefits, and tradeoffs
  - Limited number of species (2-8)
- To translate research results to more diverse mixes:
  - Species = functional groups

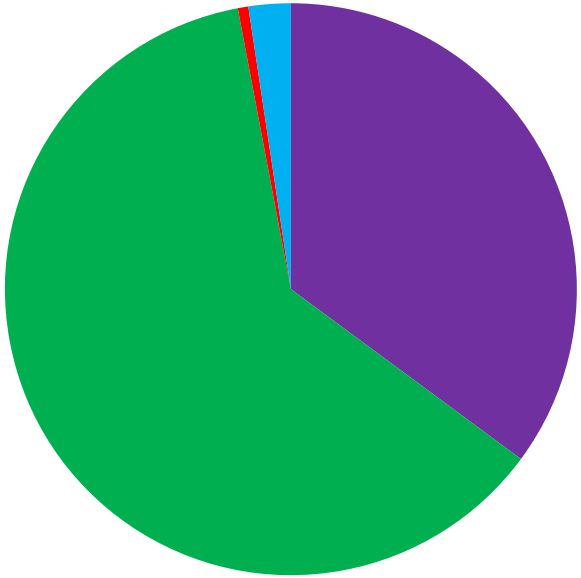
Five Steps to Success!

1. Understand your context
2. Identify your goals
3. Select complementary species
4. Follow the fundamentals of establishing mixtures
5. Farm-tune your mix

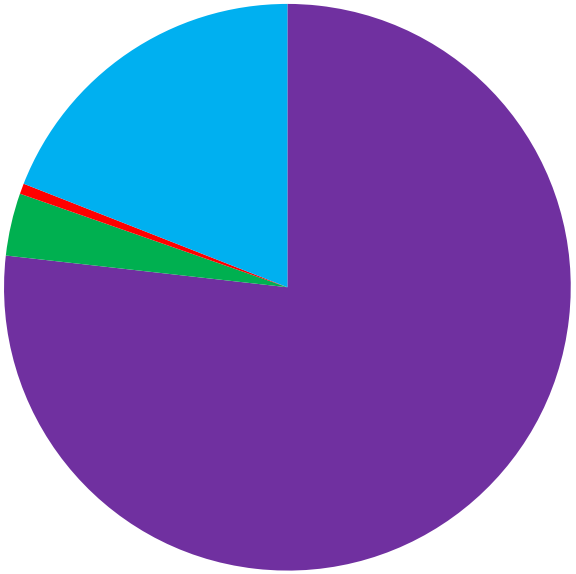
Context is critical!

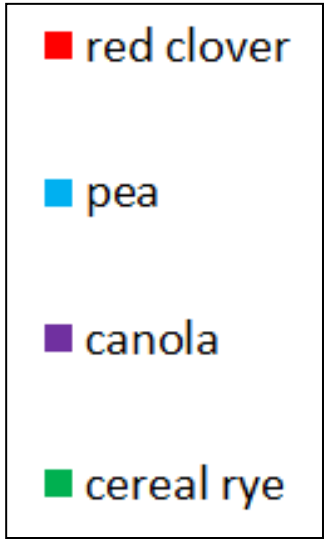
Same 4-species mix, same year, different farms:

Berks County

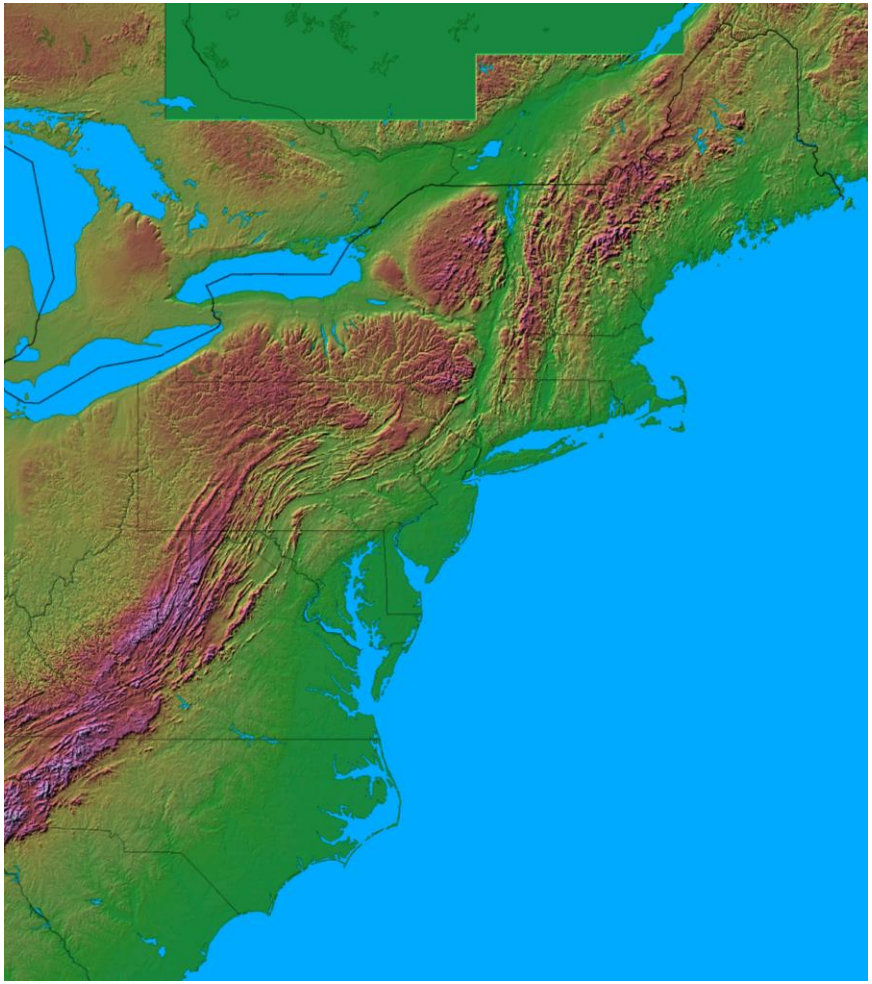


Montour County





Context questions



Climate?

Soil?

Planting window?

Previous cash crop?

Following cash crop?

Budget?

Planting equipment?

What are the key points of context on <u>your</u> farm(s)?

Identify your (diverse) goals

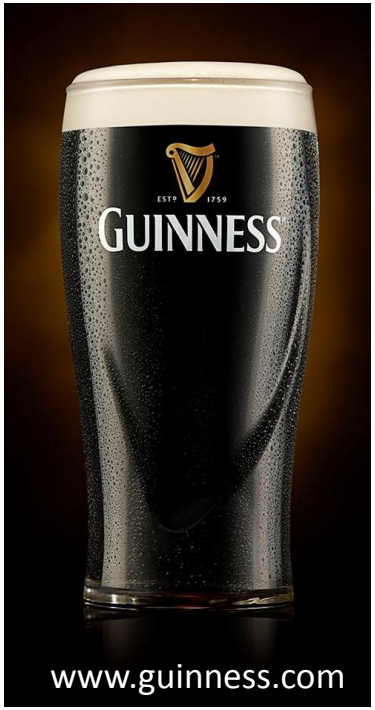
What are the needs on the farm?

- Alleviate compaction
- Improve soil structure
- Nitrogen fixation
- Nitrogen retention
- Weed suppression
- Lasting surface mulch
- Beneficial insects
- Fall and/or spring forage production

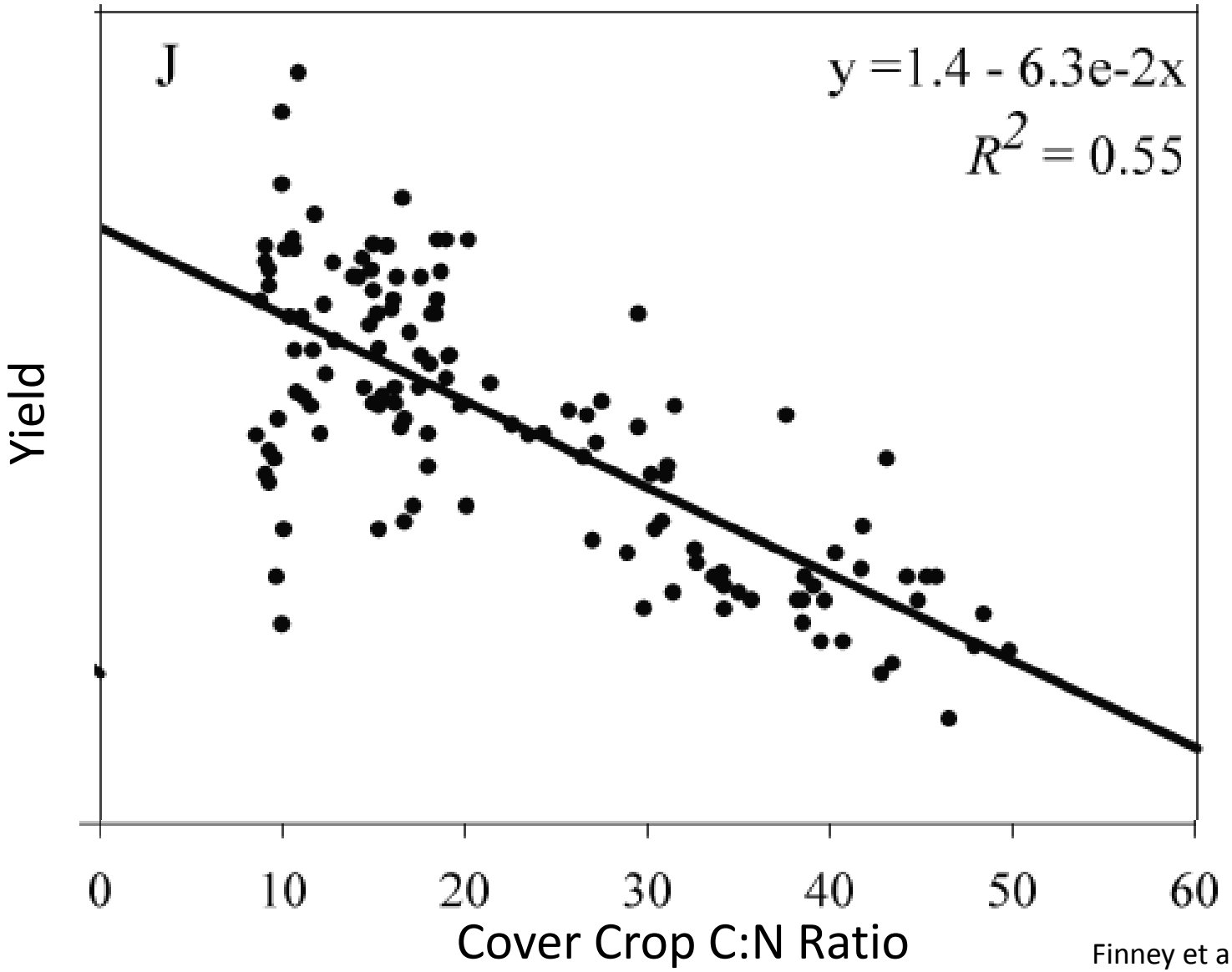
Pick a target C:N ratio

C:N sets the parameters of what to plant and when to terminate

OR

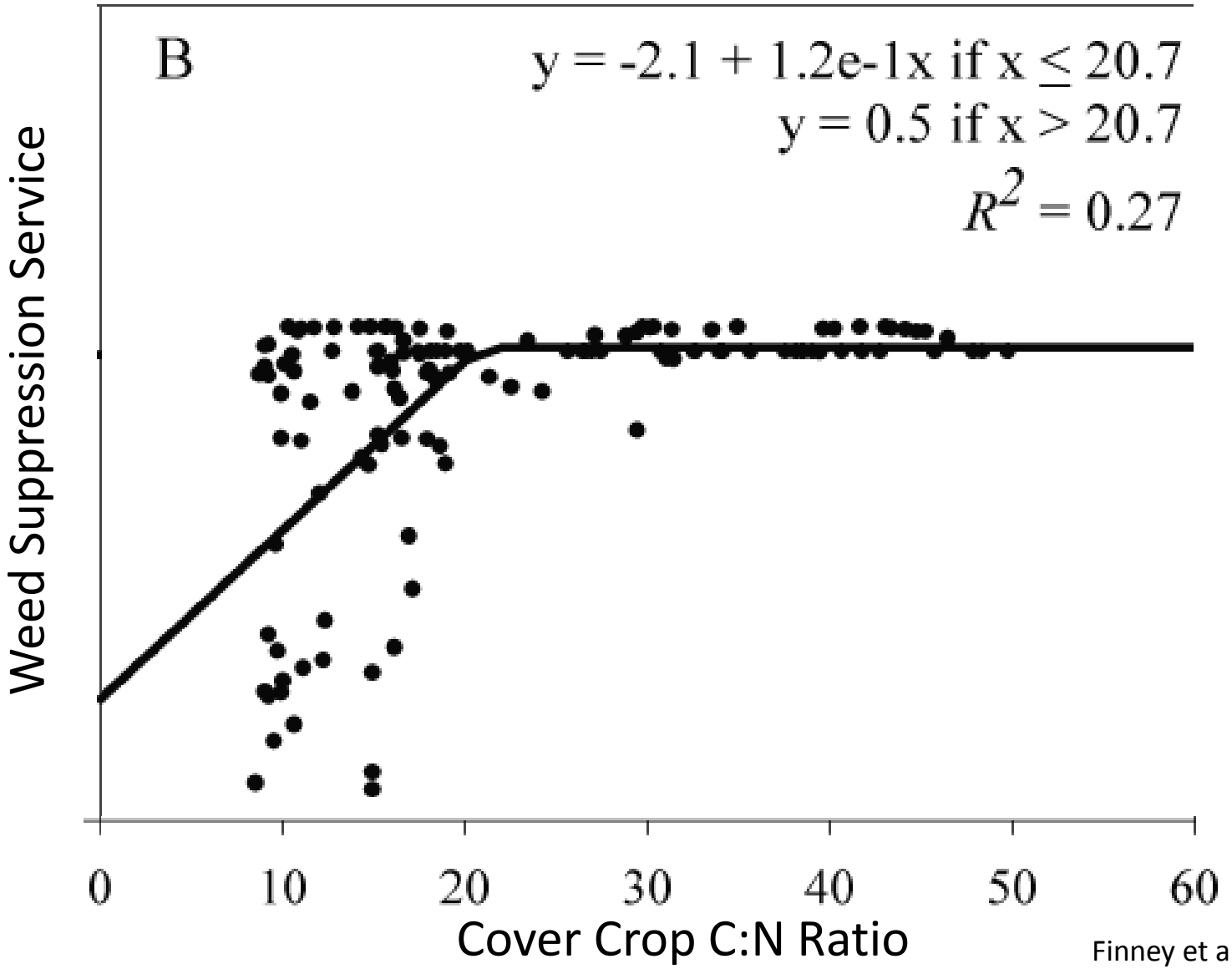


Low C:N ratio associated with high cash crop yield



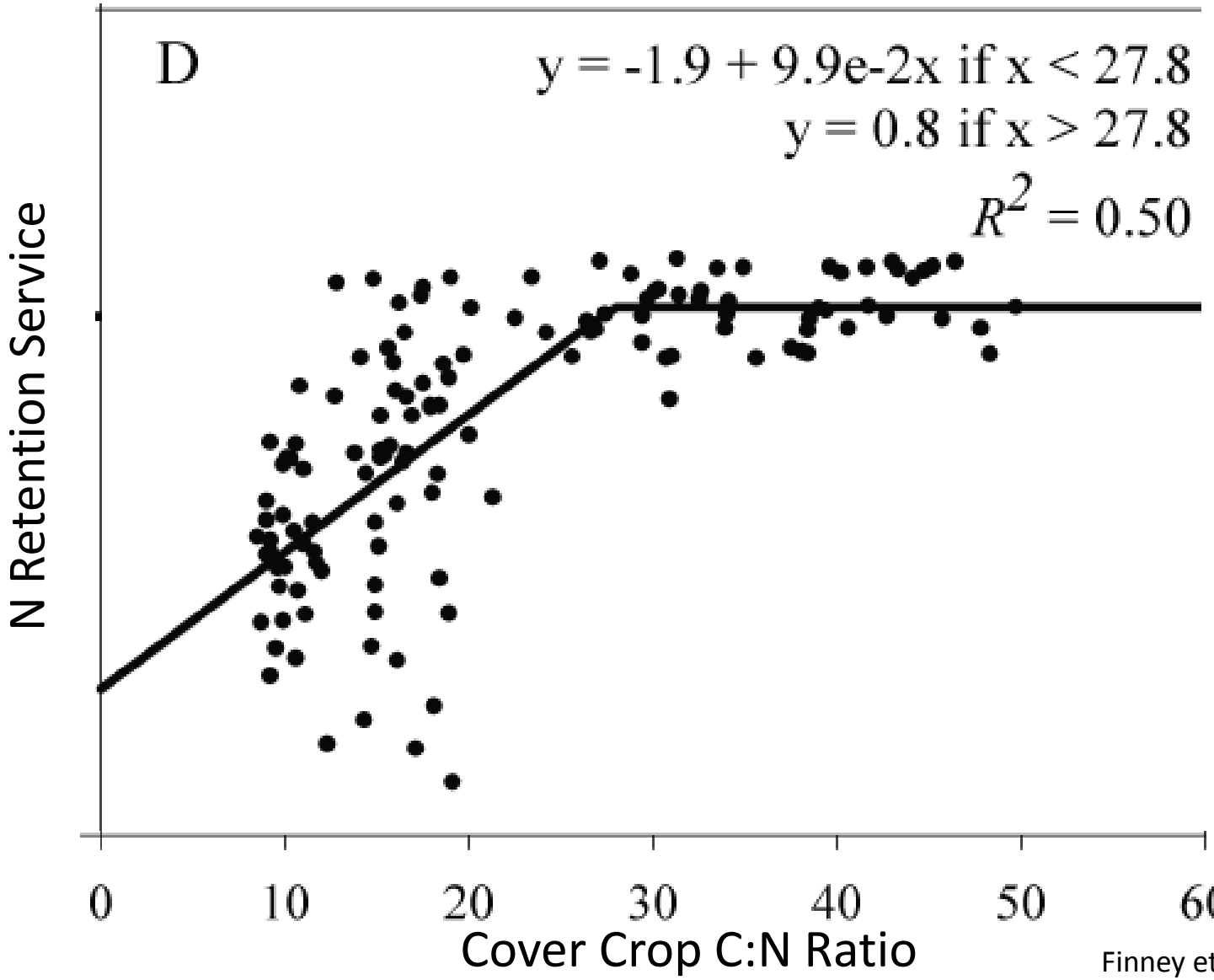
Finney et al. 16, Agron. J. 108

Low C:N ratio associated with low weed suppression



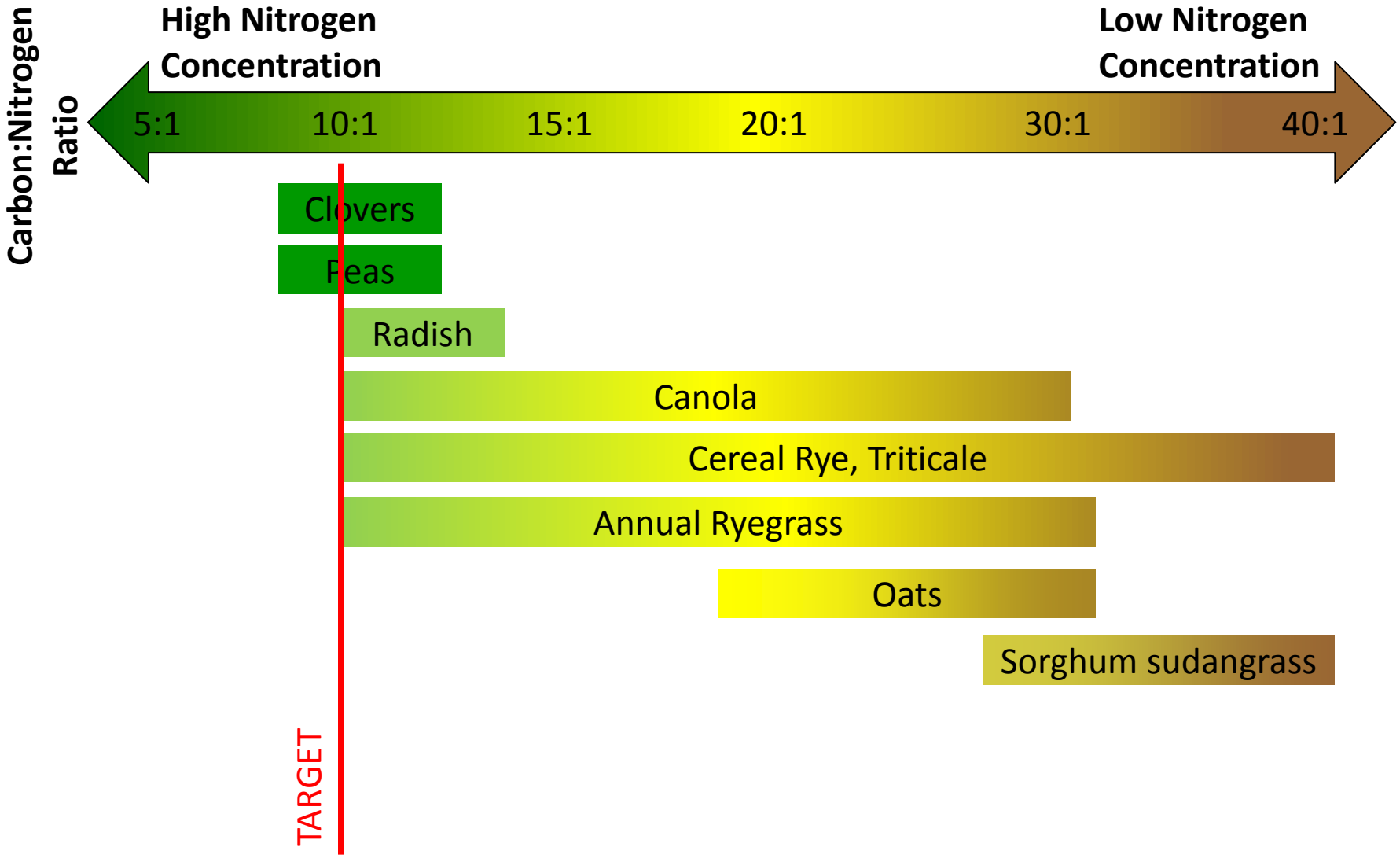
Finney et al. 16, Agron. J. 108

Low C:N ratio associated with low N retention



Finney et al. 16, Agron. J. 108

Use dominant species and maturity to estimate C:N

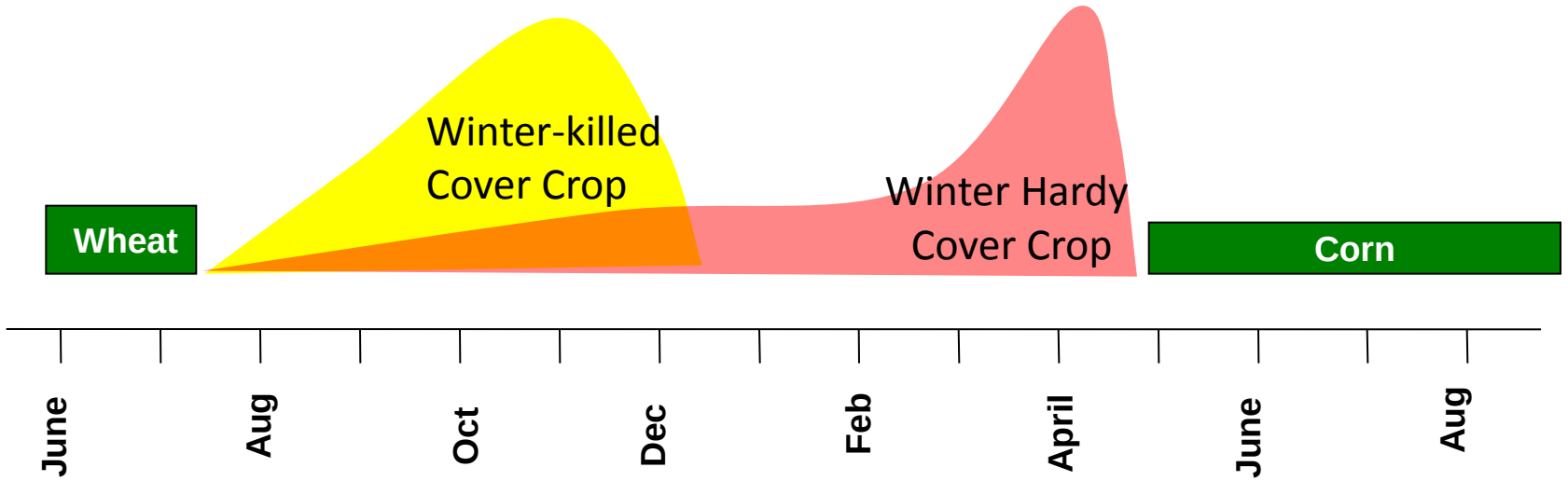


Many benefits increase with greater cover crop biomass

- Nitrogen retention
- Nitrogen supply
- Weed suppression
- Erosion control
- Soil organic matter

To increase biomass, select complementary species

Complementary growth periods

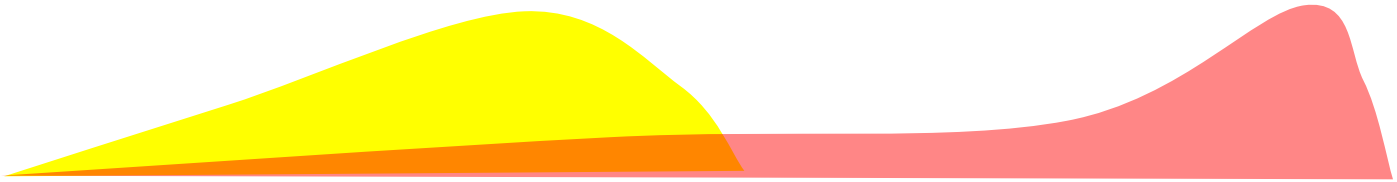


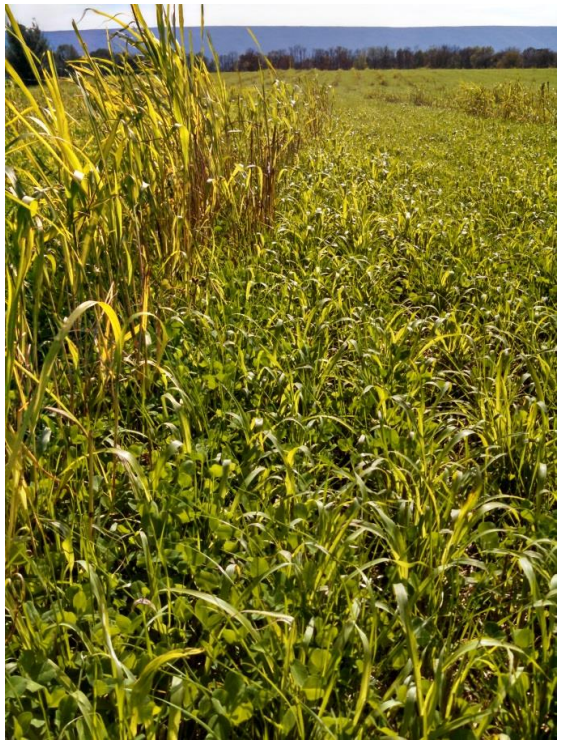
Winter-killed
- Oats
- Sorghum-Sudangrass
- Sunnhemp
- Fava Beans
- Soybeans

Winter Hardy
- Cereal Rye
- Annual Ryegrass
- Red Clover
- Triticale
- Canola

Complementary Growth Periods

Sorghum sudangrass + annual ryegrass + crimson clover





Complementary Maturation in Spring

- Cereal rye matures too early compared to legumes
- Consider triticale or annual ryegrass instead

Hairy vetch + triticale

Annual ryegrass + crimson clover

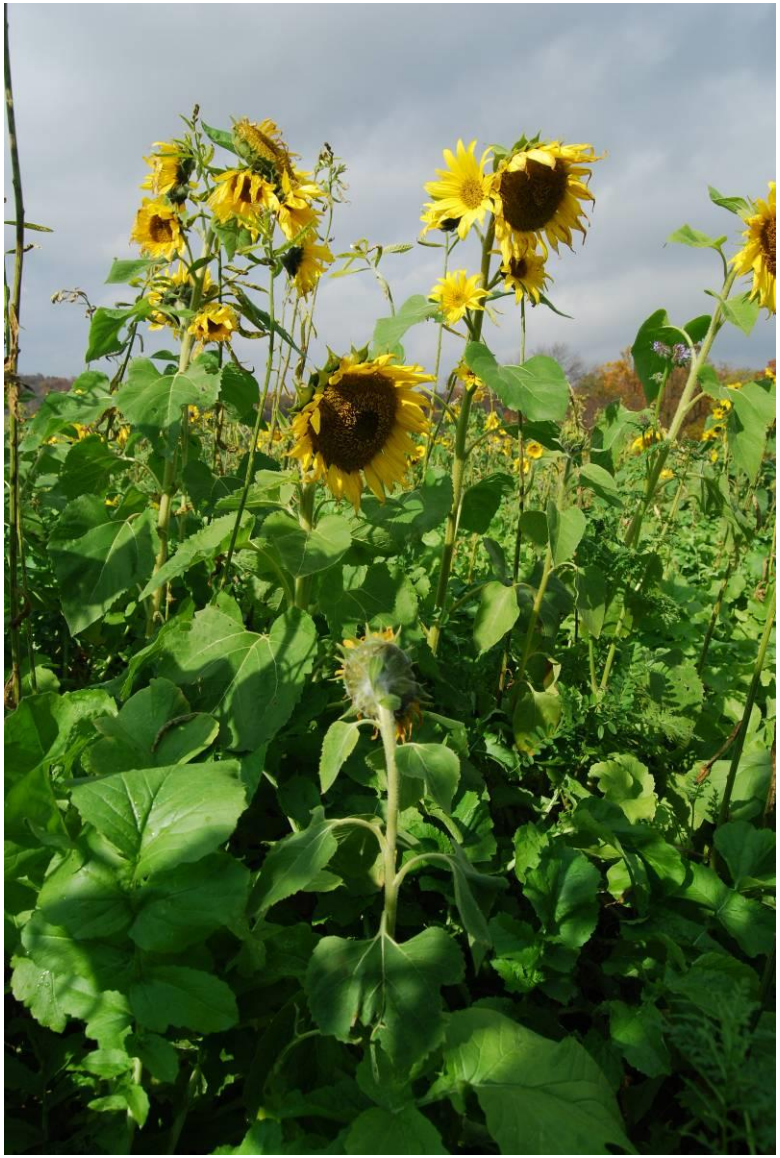
Complementary growth forms

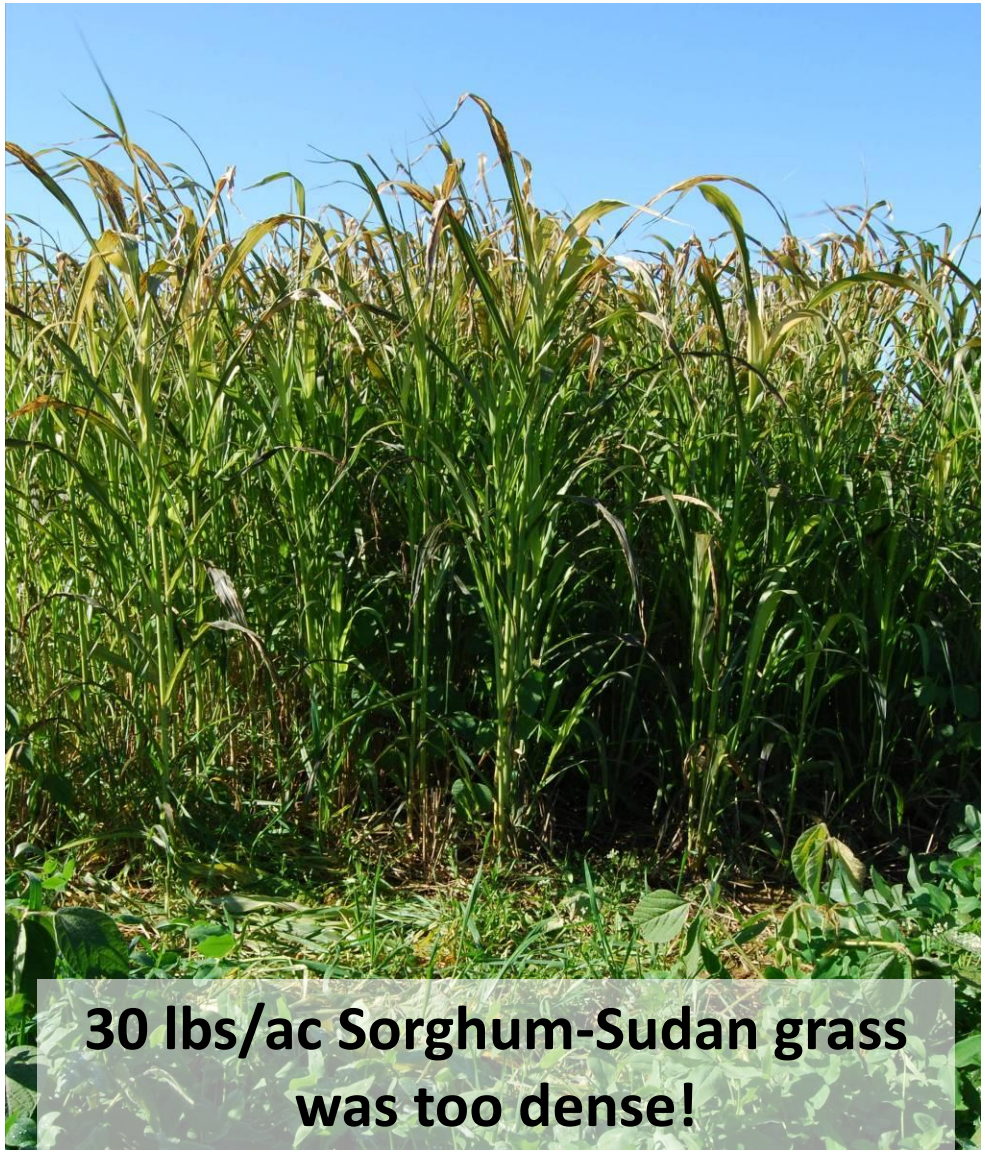
- Mix tall-open species with low-dense species and vining species
- Don’t plant any of the species too densely

Sunnhemp alone

Sunnhemp with understory

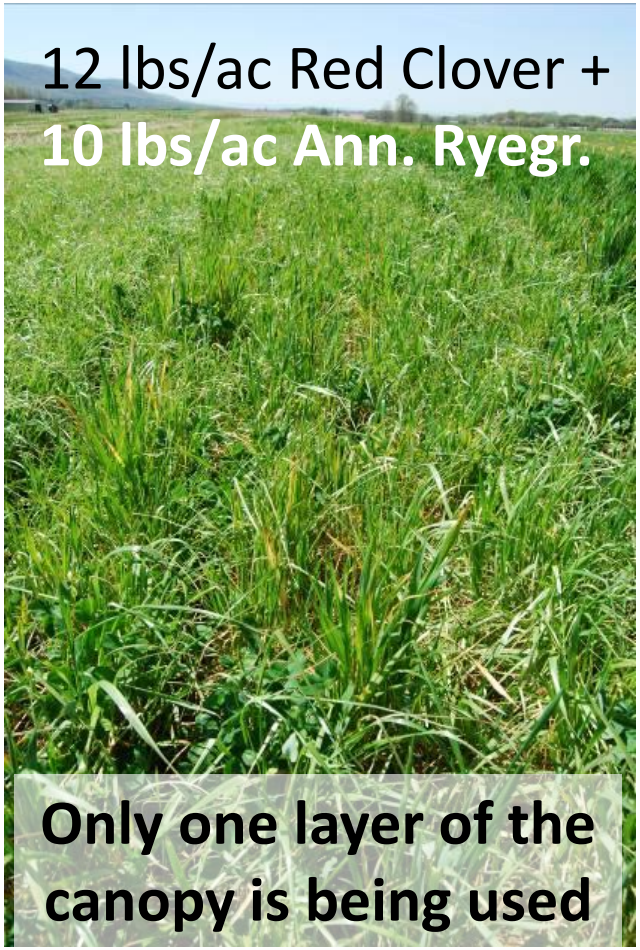
Complementary growth forms





30 lbs/ac Sorghum-Sudan grass was too dense!

Lack of complementarity increases competition

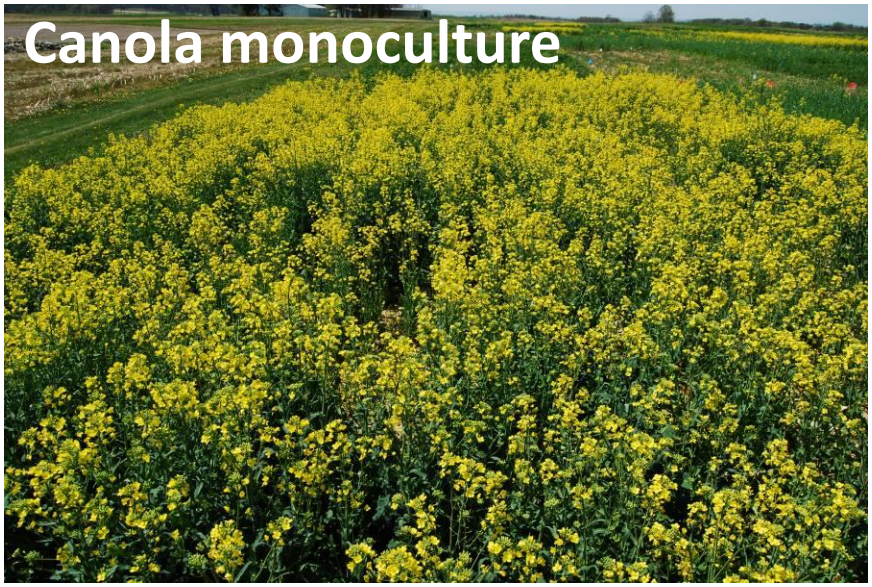


Complementary nutrient acquisition strategies

Beyond Biomass: Benefits from specific species

- Flowering species for pollinator resources
- Alleviating compaction with forage radish roots
- High forage quality from annual ryegrass or triticale

How much of the species do we need to achieve the benefit?



Extension Fact Sheet: Making the Most of Mixtures

Table 1. Characteristics, ability to provide various services, and recommended planting date windows for nonlegume winter cover crops commonly used in temperate cropping systems.

Species	Optimum Termination Timing	Growth Form	Nitrogen Retention	Nitrogen Supply	Erosion Control	Alleviate Subsoil Compaction	Weed Suppression	Resources for Beneficial Insects	Habitat for Beneficial Insects	Forage Production	Planting Date Window, Weeks before First Killing Frost[7]	Potential Drawbacks
Cereal Rye (*Secale cereale*)	ES to MS	SD to TO	♦	■	♦	●	♦	●	♦	♦	4 weeks prior to 6 weeks after	Narrow window for spring management due to rapid maturity progression in spring; mature residues can immobilize nitrogen
Triticale (x *Triticosecale*)	MS	SD to TO	♦	■	♦	●	♦	●	♦	♦	4 weeks prior to 6 weeks after	Mature residues can immobilize nitrogen
Wheat (*Triticum aestivum*)	MS to LS	SD to TO	♦	■	♦	●	♦	●	♦	♦	4 weeks prior to 3 weeks after	Mature residues can immobilize nitrogen
Spelt (*Triticum spelta*)	MS to LS	SD to TO	♦	■	♦	●	♦	●	♦	♦	4 weeks prior to 6 weeks after	Mature residues can immobilize nitrogen
Annual Ryegrass (*Lolium multiflorum*)	MS	SD	♦	■	♦	●	●	■	♦	♦	3 to 10	Mature residues can immobilize nitrogen
Oats (*Avena sativa*)	WK-25°	SD	●[1]	■	●	■	♦	■	♦	♦	3 to 10	Highly competitive against other species in the mix
Sorghum-sudangrass (*Sorghum bicolor* x *S. bicolor* var. *sudanese*)	WK-32°	TO	●[1]	■	●	♦	●	■	♦	●[5]	8 to 12	Highly competitive against other species in the mix; high carbon residues can immobilize nitrogen
Forage Radish (*Raphanus sativus* var. *longipinnatus*)	WK-25°	SD	●[1]	♦[2]	●[3]	♦	♦[4]	■	●	●	3 to 10	Highly competitive against other species in the mix
Canola (*Brassica rapa*)	ES to MS	SD to TO	♦	●	♦	●	♦[4]	♦	♦	●/♦[6]	3 to 10	Highly competitive against other species in the mix; can host pests of brassicaceaous cash crops
Sunflower (*Helianthus annuus*)	WK-32°	TO	●[1]	■	●	●	■	♦	●	■	10 to 14	

Cover Crop Mixtures: Establishment Details

Achieving the right seeding depth

- Mix the seeds and shoot for the middle - ~0.75 to 1”
  - Sometimes leads to poor stands
- Separate seeds by size into different drill boxes
  - Most reliable, need the right equipment
- Can also make separate trip
  (eg. drill, then broadcast/cu

Cover Crop Mixtures: Establishment Details

Preventing seed separating and settling

- Rarely a problem
- Worst case is large round and small round seeds
  - (eg. Austrian winter pea + Canola)
- Seeds of different shapes and sizes mixed together create a stable packing arrangement

Cover Crop Mixtures: Establishment Details

Selecting row configurations

Forage radish and hairy vetch in alternating 15” rows

August

November

Cover Crop Mixtures: Establishment Details

Selecting row configurations

Forage radish and cereal rye in alternating pairs of 7.5” rows

November

March

Cover Crop Mixtures: Establishment Details

Selecting row configurations

In a drill with two seed boxes:

- Tape over alternating openers in the desired configuration

Other options:

- Cardboard baffles
- Split row planters

Cover Crop Mixtures: Establishment Details

Finding the right seeding rates

- Start with an educated guess, plant a small acreage, observe results, adjust as needed

For a grass-legume mix

- Reduce grass seeding rate to between ½ and ¼ the monoculture rate
- Keep legumes near monoculture rates

Limit seeding rates for highly competitive species

- Forage radish – 2 to 3 lbs/acre
- Canola – 3 to 4 lbs/acre
- Sorghum-sudangrass – 15 to 20 lbs/acre
- Oats – 20 to 40 lbs/acre

Cover Crop Mixtures: Establishment Details

Accounting for redundancy

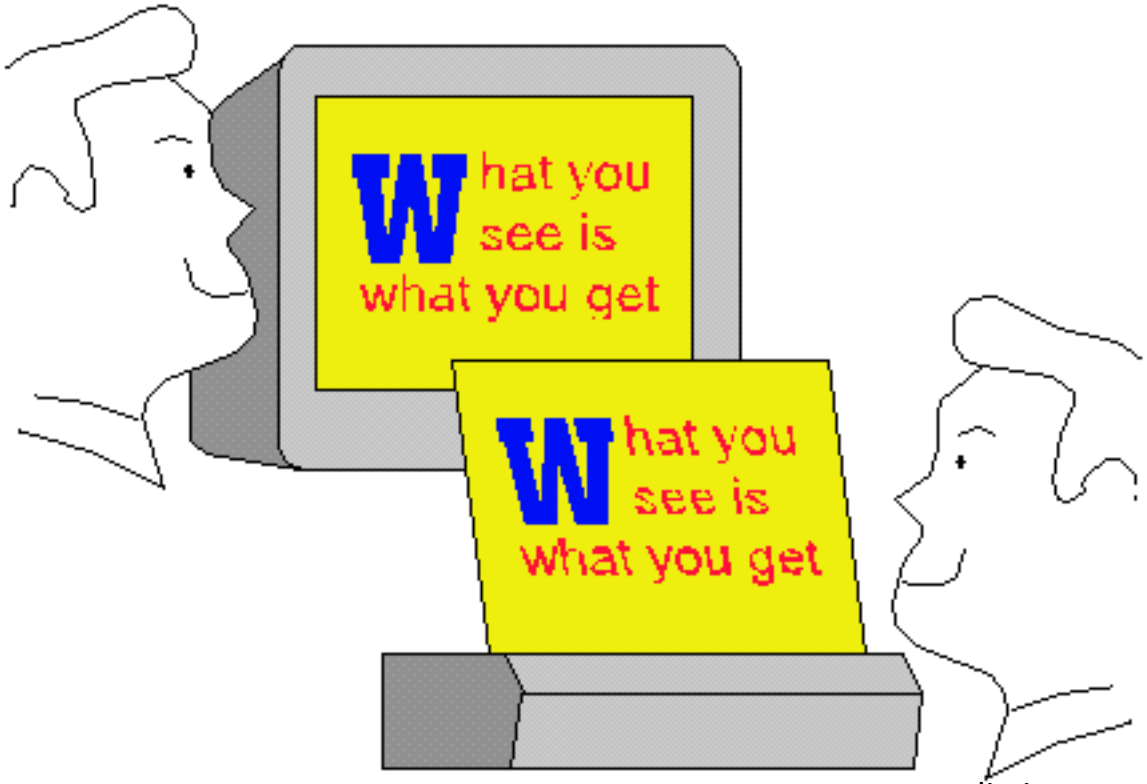
- When species share the same growth period, growth form, and nutrient acquisition strategy, divide seeding rate by the number of species in the group

3X / acre

=

1X / ac **1X / ac** **1X / ac**

So you've planted a diverse cover crop mixture…



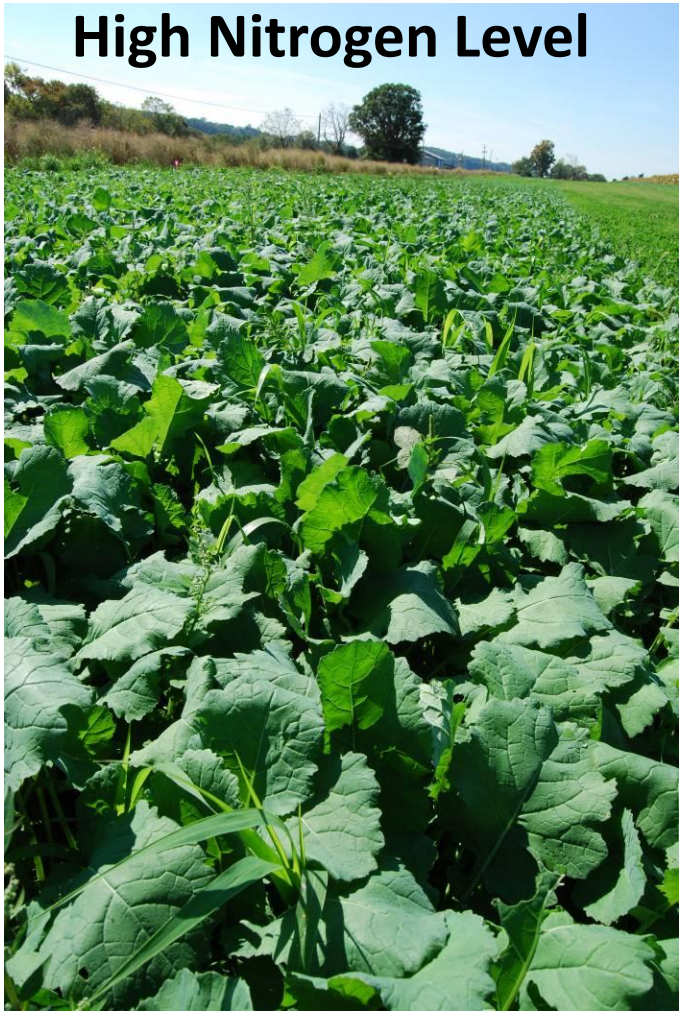
www.yourdictionary.com

…what will you get?

A diverse mixture can adapt to different soil fertility levels

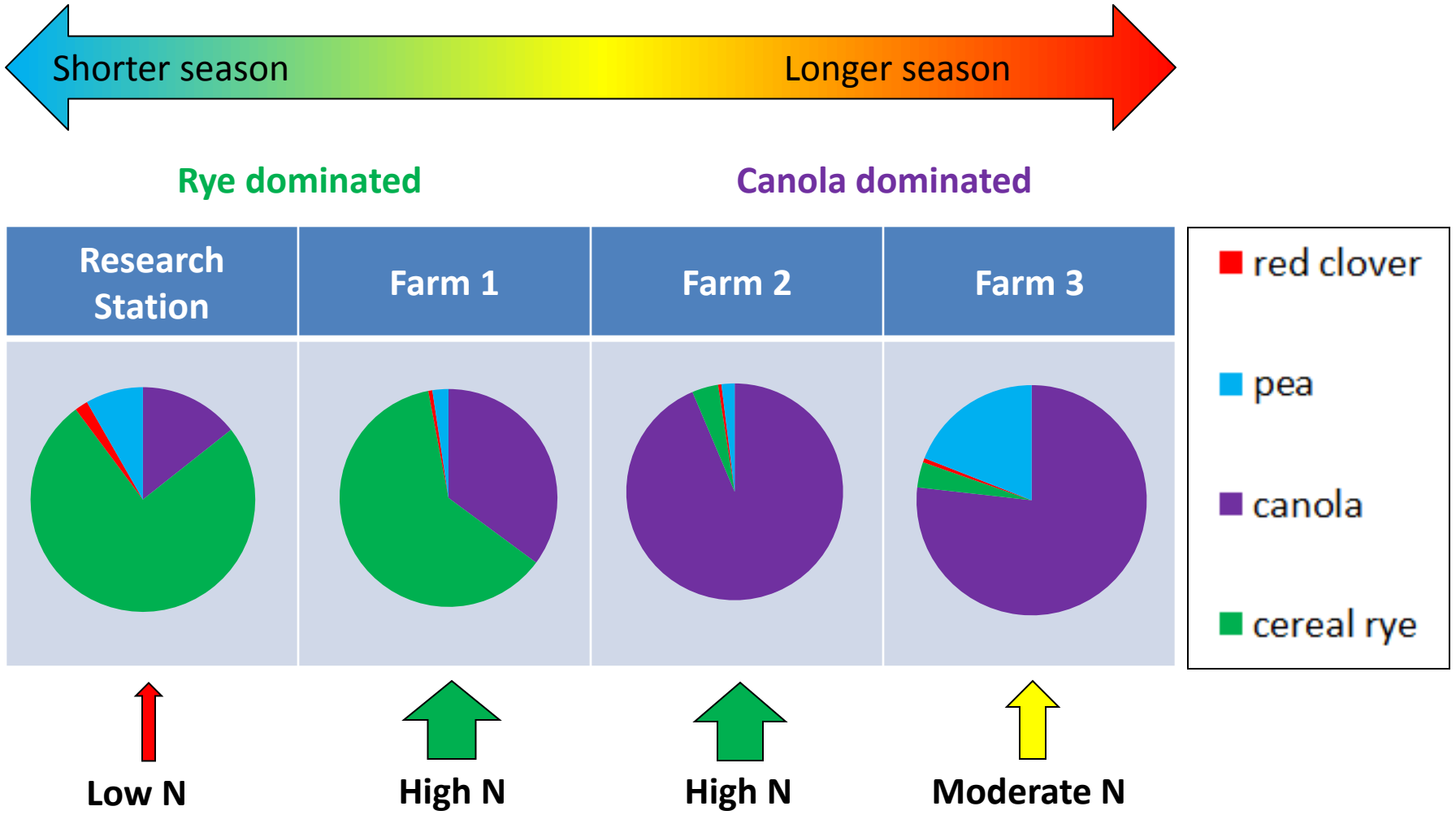
Low Nitrogen Level

High Nitrogen Level

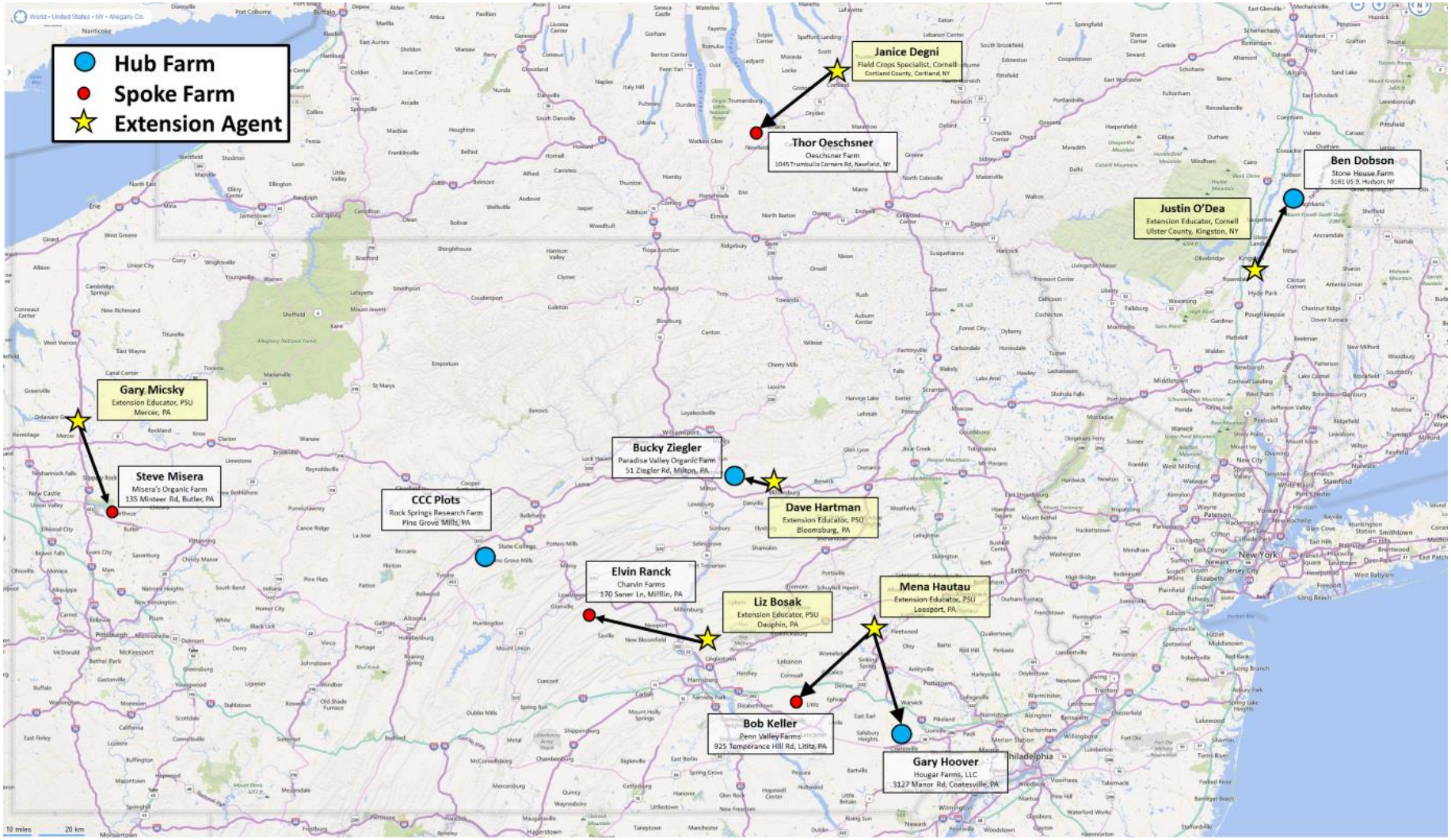


25 lbs/ac cereal rye + 39 lbs/ac Austrian winter pea + 6 lbs/ac canola + 6 lbs/acre red clover

The same “4 Species Mix” varied widely by farm



Next Challenge: Farm-Tuning Cover Crop Mixtures



Conclusions

- Research is showing that mixtures can diversify benefits over monocultures
- Five steps to success:
  1. Understand your context
  2. Identify your goals
     - C:N ratio is key
  3. Select complementary species
     - Growth form / Growth period / Nutrient acquisition
  4. Follow basic management recommendations for establishment and seeding rates
  5. Farm-tune the mix: Observe results and make adjustments as necessary

Thank You!

Feel free to contact us for more information:

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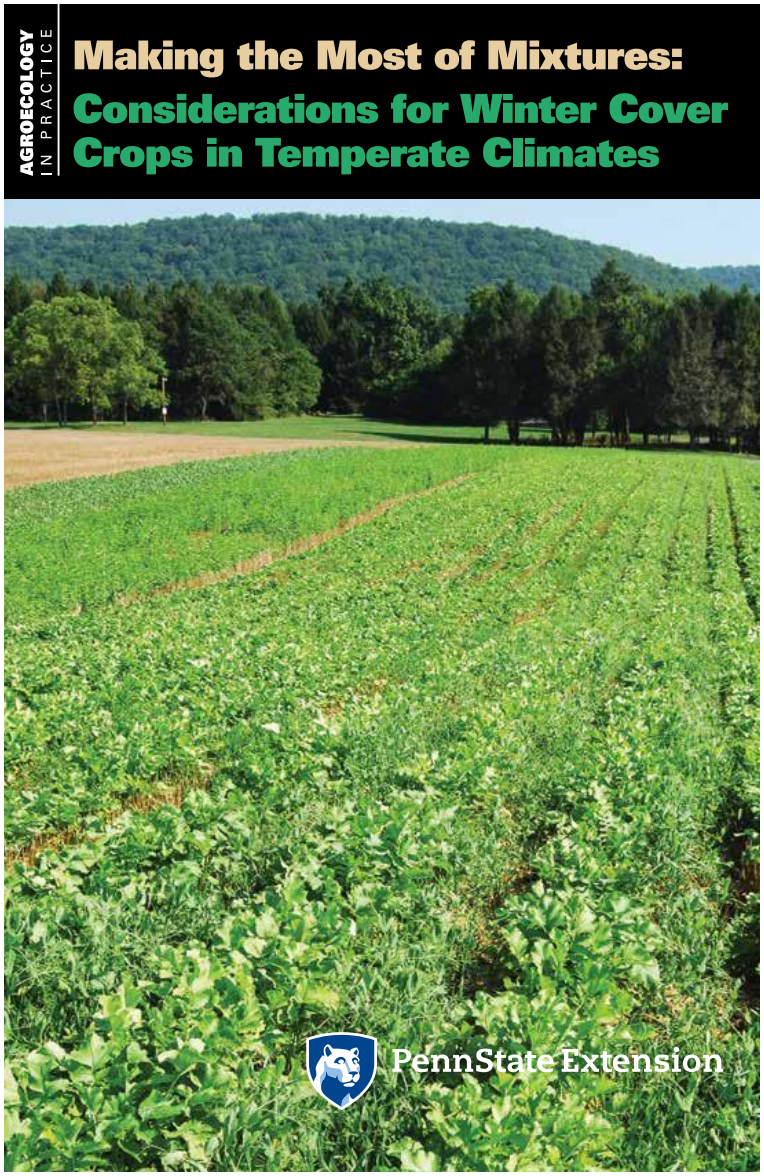

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extension.org
http://www.extension.org/pages/72973/making-the-most-of-mixtures:-considerations-for-winter-cover-crops-in-temperate-climates

Making the Most of Mixtures: Considerations for Winter Cover Crops in Temperate Climates

Organic Agriculture May 18, 2015

Authors:

Charles White, Penn State University; Mary Barbercheck, Penn State University; Tianna DuPont, Penn State University; Denise Finney, Penn State University; Abbe Hamilton, Penn State University; Dave Hartman, Penn State University; Mena Hautau, Penn State University; Jermaine Hinds, Penn State University; Mitch Hunter, Penn State University; Jason Kaye, Penn State University; Jim La Chance, Penn State University

extension.org
Mixtures webinar – 71186
Making mixtures guide – 72973

Seeding Rates in Cover Crop Cocktails (CCC) Experiment, Penn State 2015-2016

Cover Crop	Seeding Rates (lbs/acre)	Seed Cost / acre
Crimson Clover	34	$67
Canola	18	$55
Radish	8	$41
Triticale	124	$71
Oat	87	$23
Winter Pea	65	$60
Biculture	Triticale (29), Winter Pea (50)	$62
3 spp mix, Nitrogen	Crimson Clover (13), Triticale (29), Winter Pea (25)	$66
3 spp mix, Management	Radish (1), Oat (17), Winter Pea (41)	$50
5 spp mix	Crimson Clover (8), Canola (3), Triticale (24), Winter Pea (14), Red Clover (3)	$58
6 spp mix	Crimson Clover (11), Canola (1), Radish (1), Triticale (11), Oat (8), Winter Pea (50)	$62

Slide credit: Ebony Murrell

Can mixtures achieve multiple goals?

Yes – but make a plan

Guidelines:

1. **Weeds**: Have 1-2 species that provide fast ground-cover in the fall, then add species to achieve other goals
2. **Insects**: To support beneficial insects for pollination or biological control, manage mixtures to include flowers
3. **Nitrogen**: Combine a well-adapted legume with a low seeding rate of a winterhardy grass or brassica
4. **Overall**: Aim for balanced biomass from all species in the mix to benefit from a range of functions

Nitrogen Management with Cover Crop Mixtures Rule of Thumb

To balance N retention and supply, combine a well-adapted legume with a low seeding rate of a winterhardy grass or brassica