

Ecologically Intensive Pest Management



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Major Crises Facing the Planet



Climate change

Pollution

Human health

Civil unrest

Declines in biodiversity

Biodiversity is in Decline

Birds

Meehan et al. 2010. PNAS 107: 18533
Mineau and Whiteside. 2013. PLoS ONE 8(2): e57457
Hallmann et al. 2014. Nature 511: 341

Butterflies

Swengel et al. 2011. J Insect Conserv 15: 327
Pleasants and Oberhauser 2013. Insect Conserv Divers 6: 134

Grassland habitats

Wright and Wimberley. 2013. PNAS 110: 4134
Johnston. 2014. Landscape Ecol 29: 81

Insect communities

Landis et al. 2008. PNAS 105: 20552
Hallmann et al 2017. PLoS ONE 12: e0185809

Wetland habitats

Wright and Wimberley. 2013. PNAS 110: 4134

Butchart et al. 2011. Science 328: 1164
Potts et al. 2010. TREE 25: 345
Frick et al 2010. Science 329: 682
Newton 2004. Ibis 146: 579

Monoculture Production Schemes

A photograph of a large-scale agricultural field, likely corn, showing rows of green plants stretching towards the horizon. The field is a monoculture, with all plants being the same species. The sky is visible in the background, and a small building can be seen on the far right.

The only way to
maintain these systems
is with agrichemicals.

Agrichemicals are an
addiction



Solution to the Problem

Change agriculture

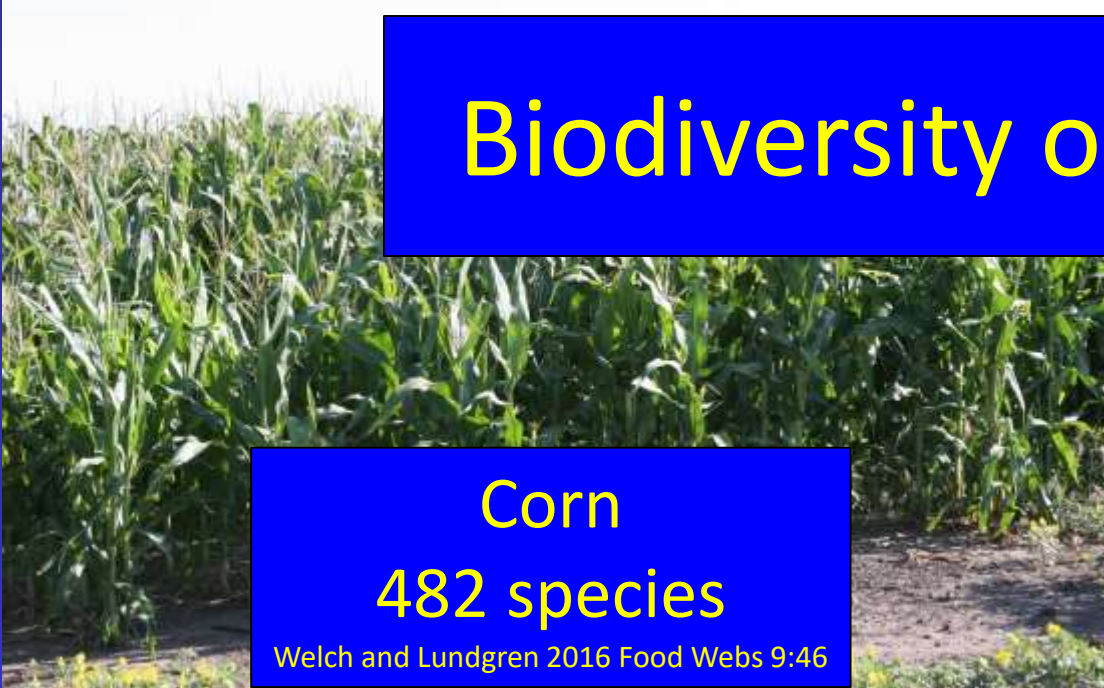
Anything less, and bees will continue to die.

How to Promote Soil Health and Biodiversity

Reduce disturbance
(tillage, agrichemicals)

Increase diversity
(Plants, microbes, animals, revenue streams, etc)

Biodiversity on Farms



Corn
482 species

Welch and Lundgren 2016 Food Webs 9:46



Wheat
103 species (predators)

Choate and Lundgren 2015 Crop Prot 77:110



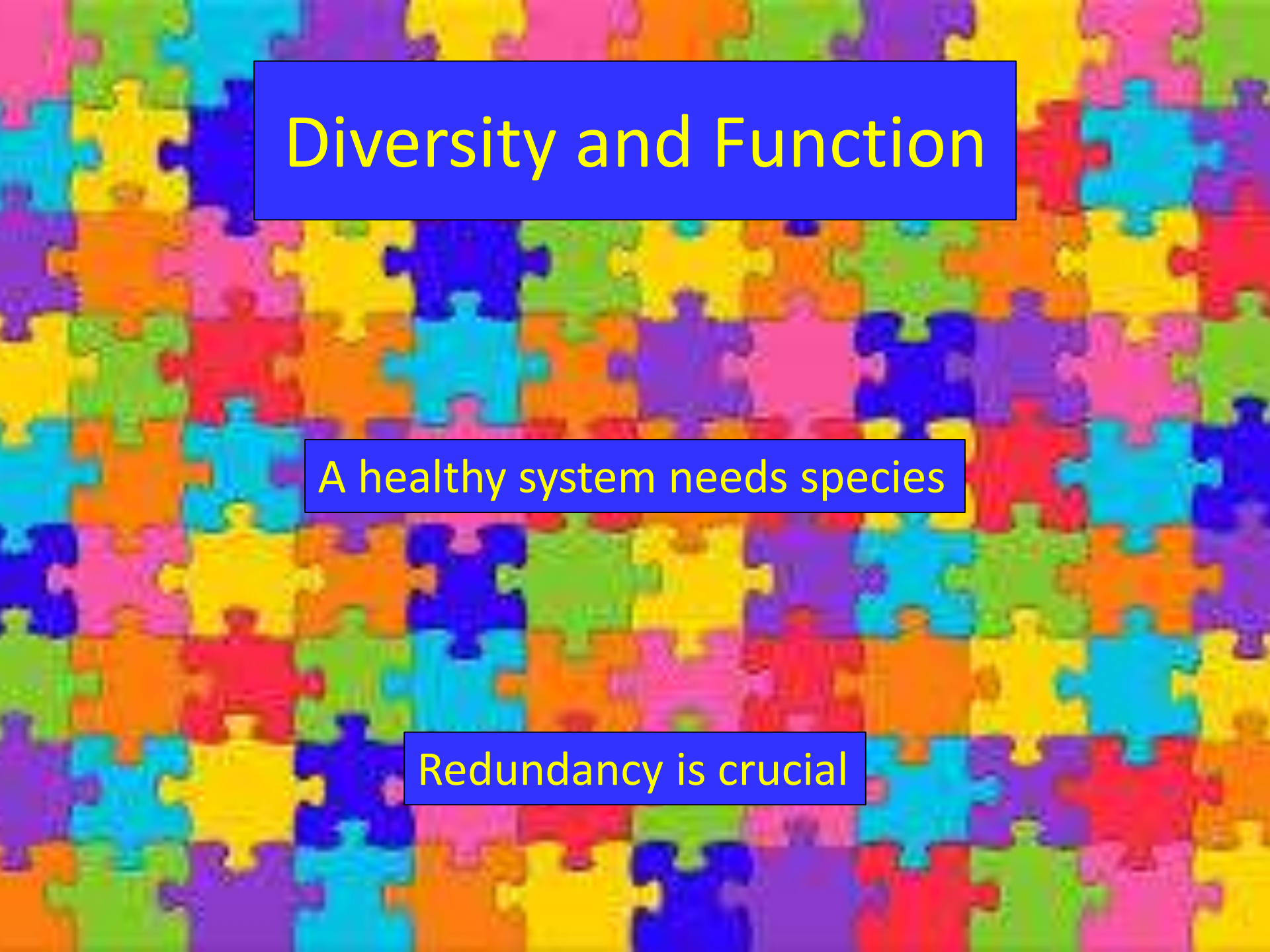
Soybean
126 species (predators)

Lundgren et al 2013. Crop Prot 43: 110

Cattle Dung
172 species

Pecenka and Lundgren Rangld Ecol Mgmt in press

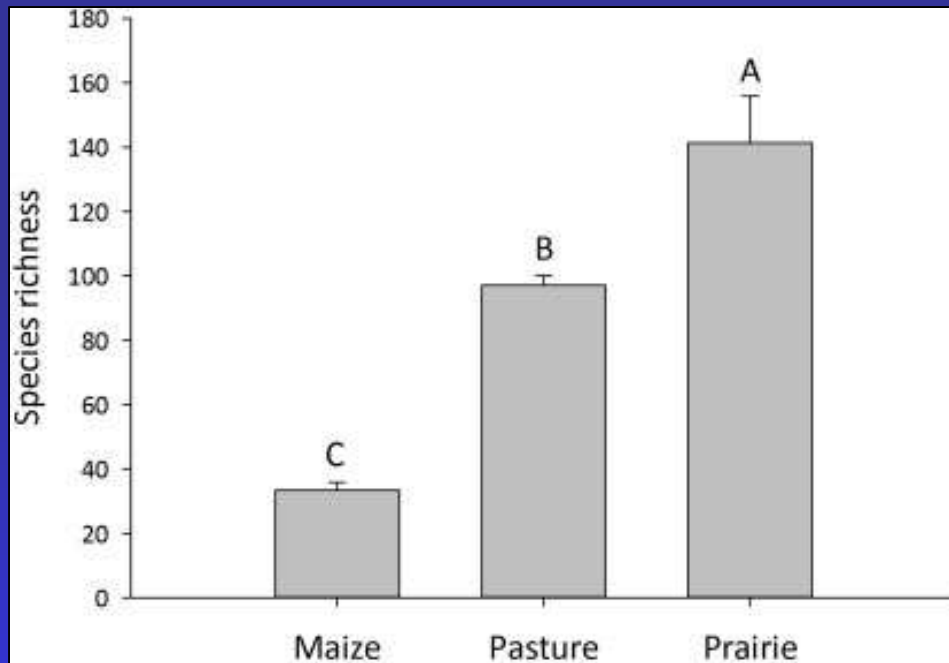




Diversity and Function

A healthy system needs species

Redundancy is crucial



Tilled cornfields had
24% of species
found in prairies



Biological Networks



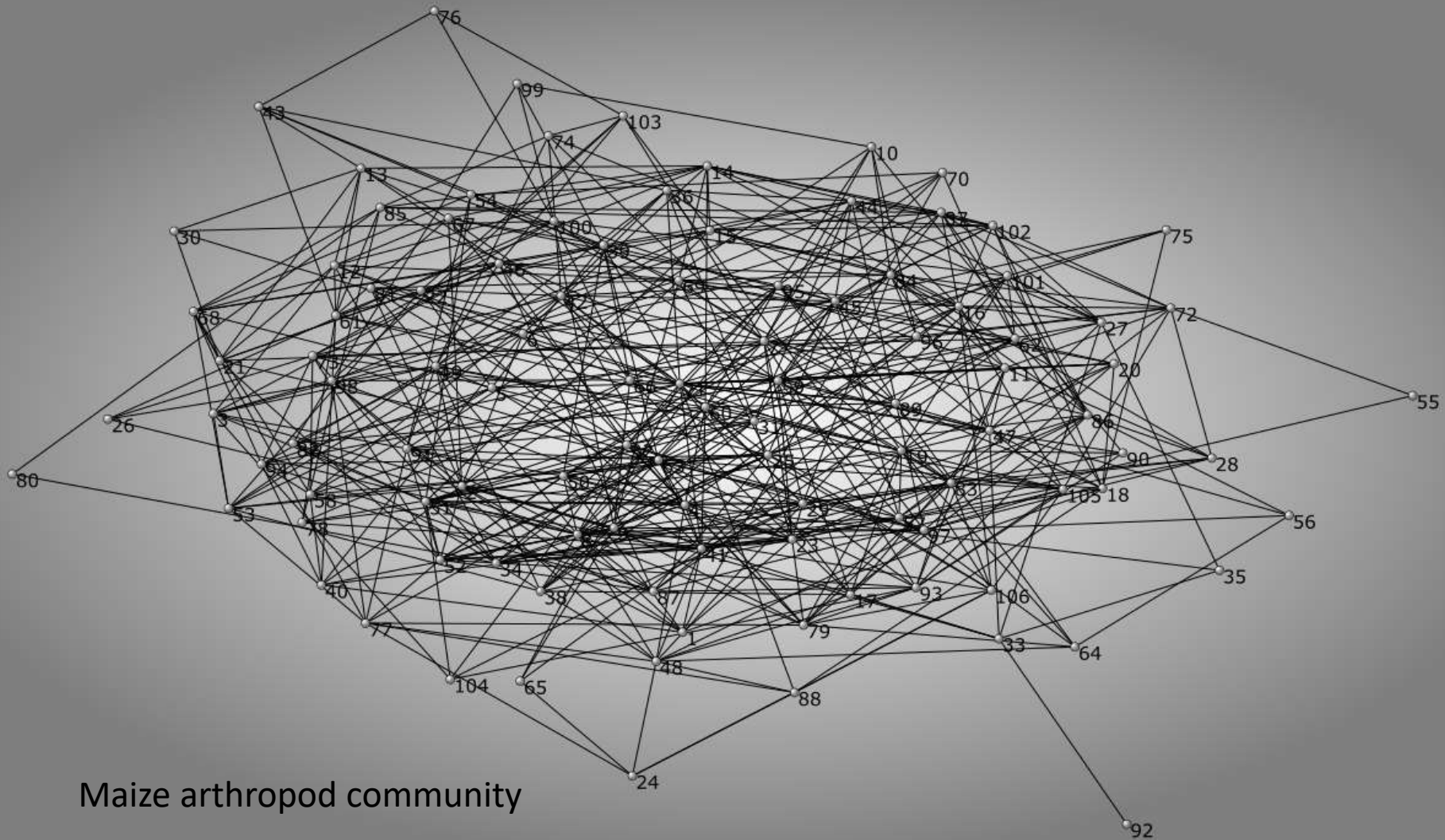
Perceptions of Biological Networks

Our understanding of species networks
primarily comes from simplified systems

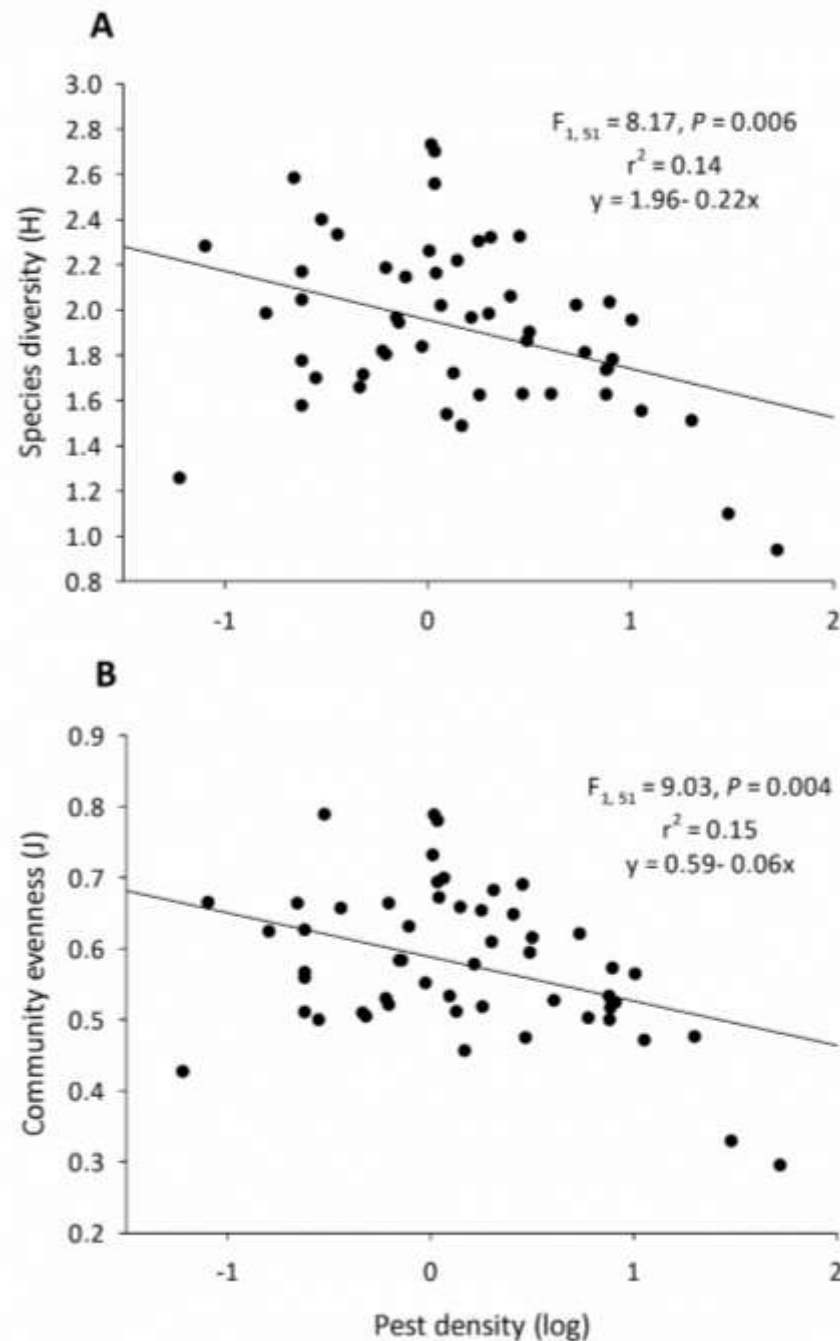
Crowder et al 2010. Nature 466: 109
Finke and Snyder 2008. Science 321: 1488
Tylianakis et al. 2010. Biol Conserv. 143: 2270

But simplified systems ignore the complexity of
biological communities and their unforeseen
interactions

Community Network in Agroecosystems



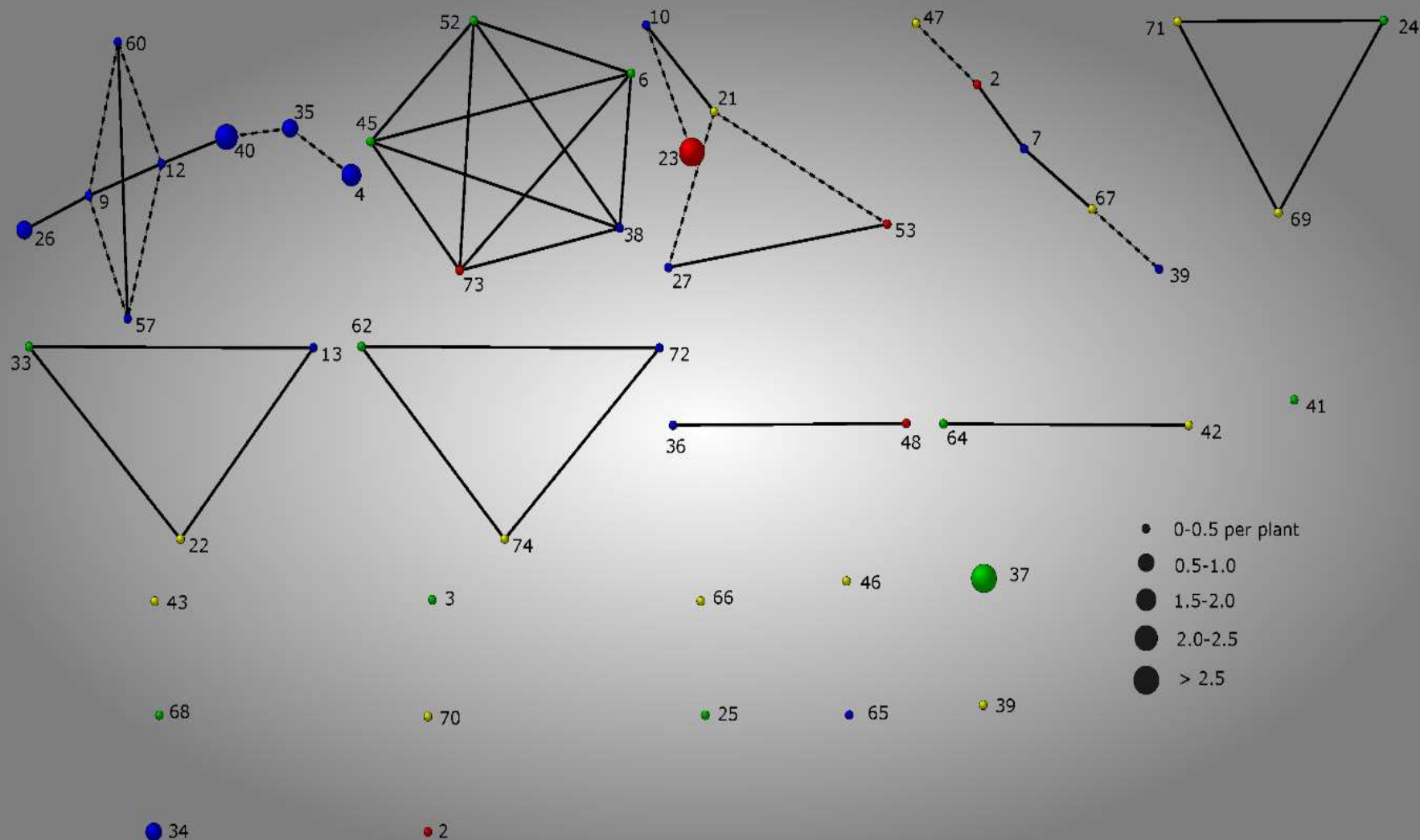
Biodiversity on Farms Reduce Pest Pressure in Corn



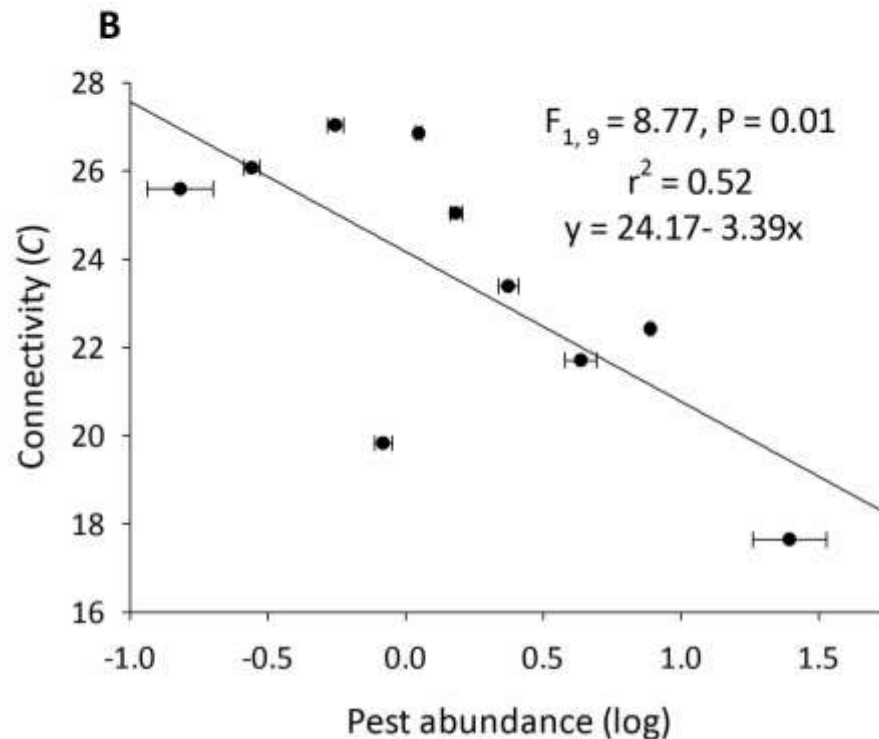
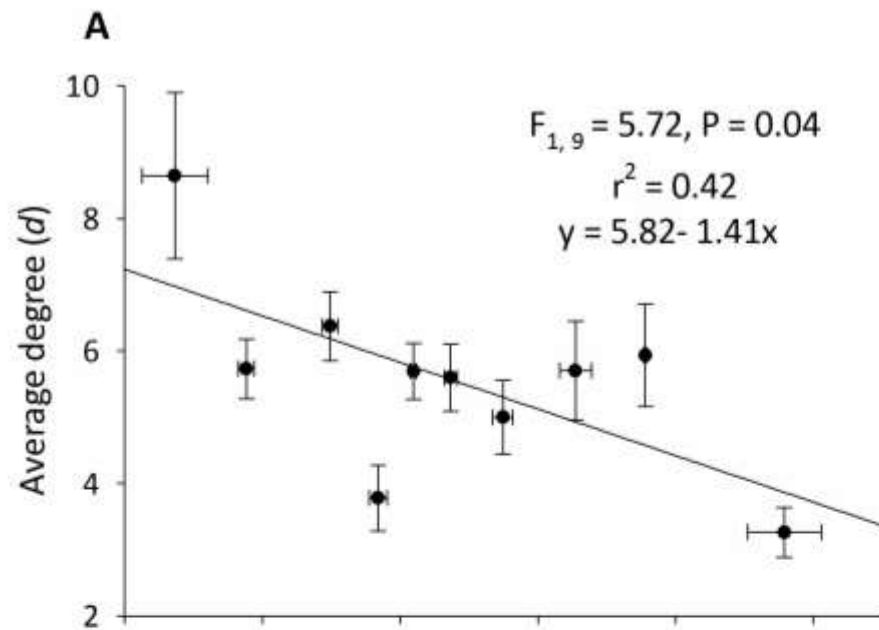
Lundgren and Fausti 2015. Science Advances 1: e1500558

Network Topology and Pest Abundance

High Pest Abundance



Network Topology Affects Pest Abundance



Fewer linkages
between species
increases pests

Four Principles

- 1) Stop tilling (or reduce it)
- 2) Never leave bare soil
- 3) Some plant diversity is better than none, and more is better than less
- 4) Integrate crops and livestock

A Better Way to Farm



Best management
practices
Regional focus
Systems level

Claire LaCanne, MSc

Regenerative
No insecticides

Conventional
Insecticides

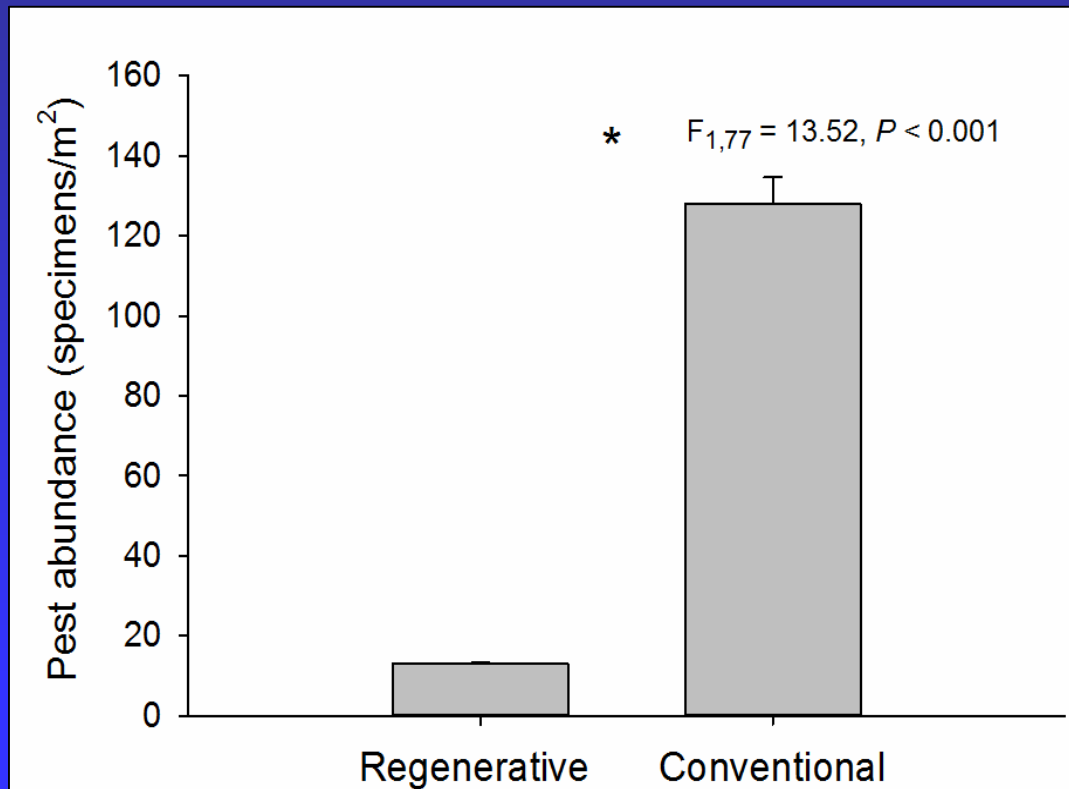
Approach

Full bioinventory
of corn community



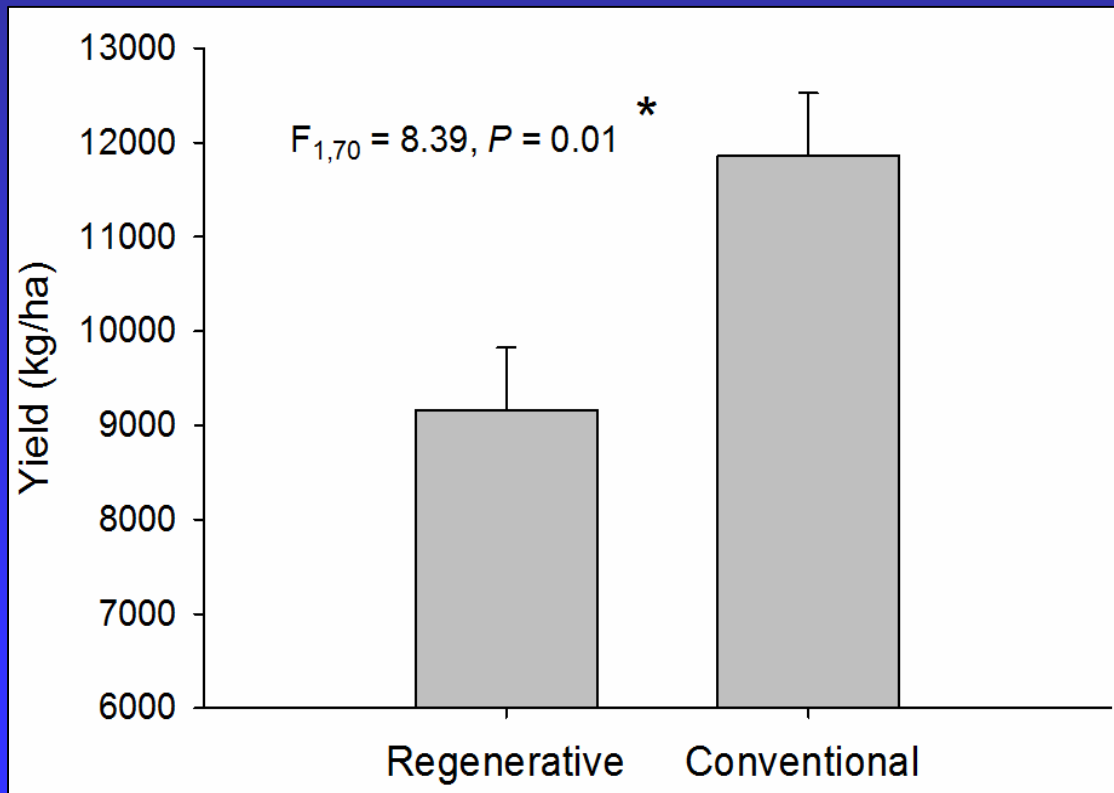
Yields and profit

Pest Populations



Regenerative systems
had 10-fold fewer pests
than insecticide-treated
systems

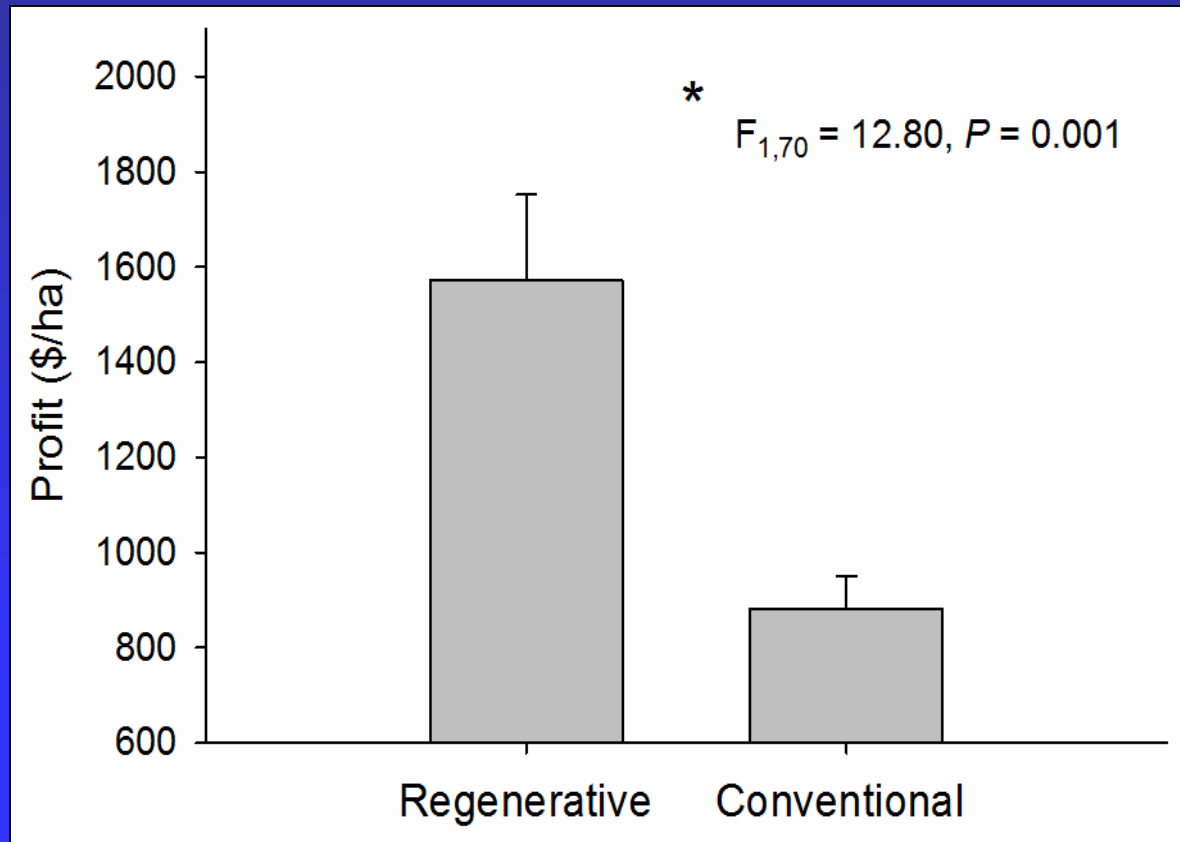
Yield



Yields were
reduced by 22%

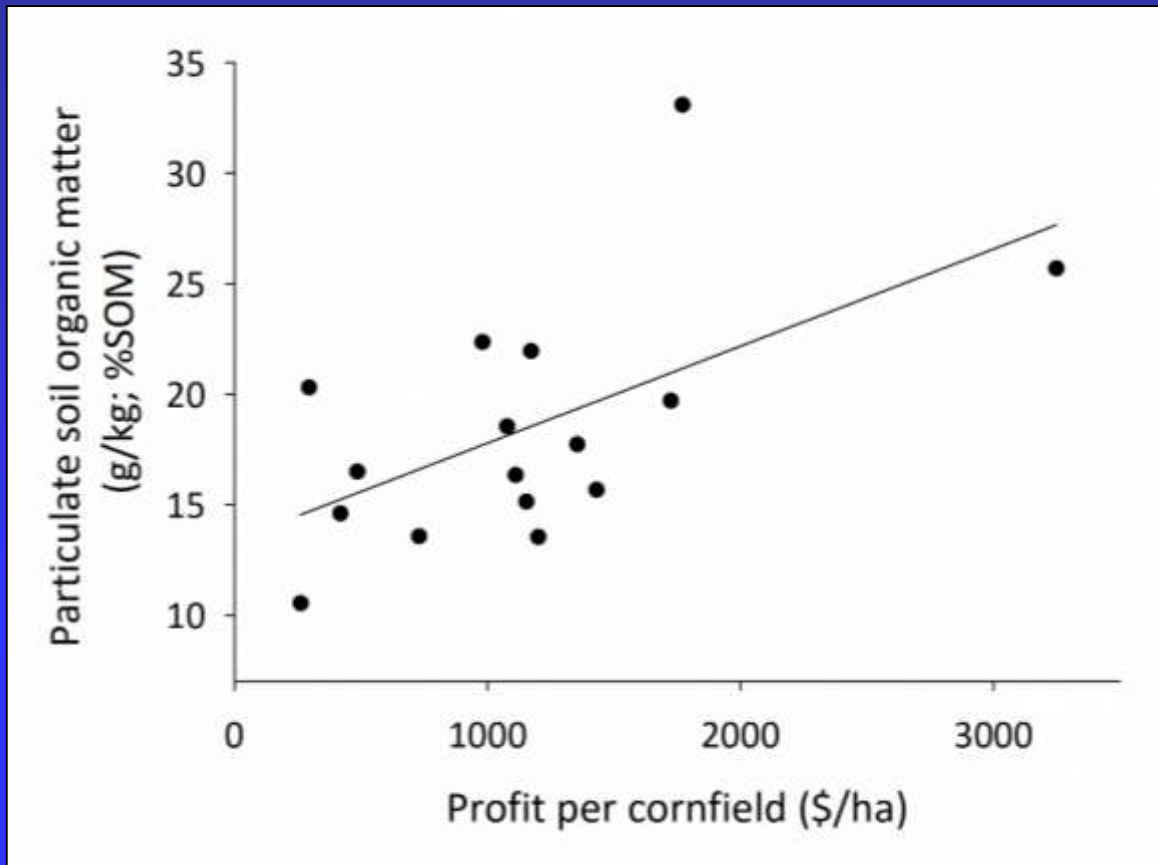


Profits



Regenerative
systems were twice
as profitable

Soil Health and Profit



Field profitability was
**NOT RELATED TO
YIELD**

Corn profitability is
directly related to
particulate organic
matter of the soil

California Agriculture



Characterized by

Heavy tillage

Heavy pesticide use

Very little plant
diversity in cropland

Is there a better way?

Regenerative Almond Production

A man with a beard, wearing a dark jacket with red and grey panels, stands in the center of a wide, straight path in an almond orchard. The path is covered with a layer of dry, light-colored almond blossoms or petals. Rows of almond trees, some with green leaves and others with white blossoms, line both sides of the path, receding into the distance under a bright sky.

Are regenerative almond
systems superior to
conventional systems?

Tommy Fenster, MSc candidate

Regenerative

No till

No pesticides

Perennial ground cover

Compost

Compost teas

Livestock integration

Conventional

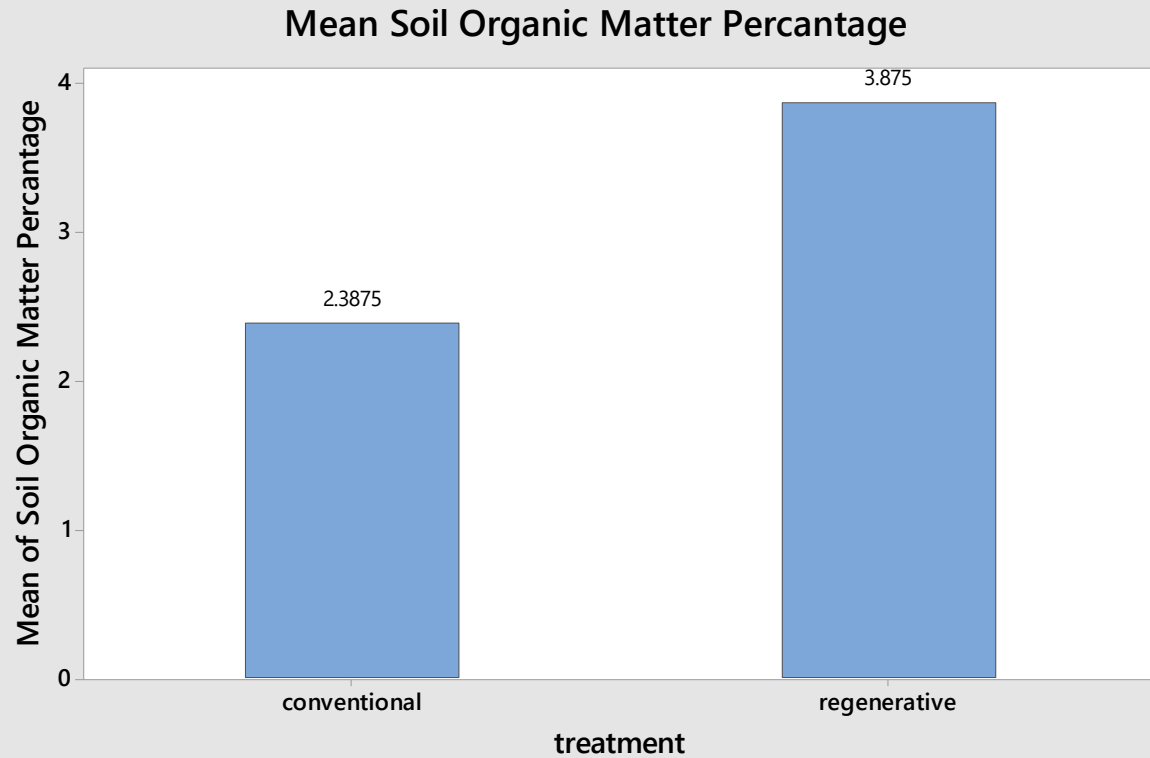
Tillage

Bare soil

Multiple pesticide applications annually



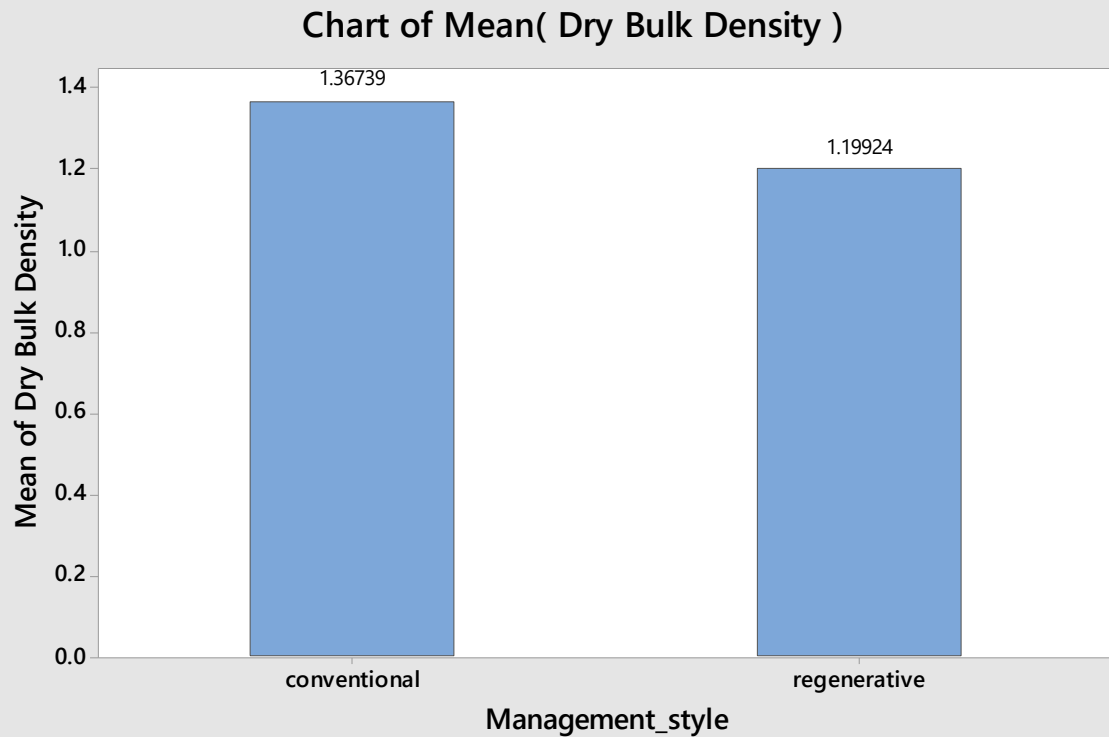
Soil Organic Matter (0-15cm)



P-Value= 0.029

N per treatment = 8

Soil Bulk Density



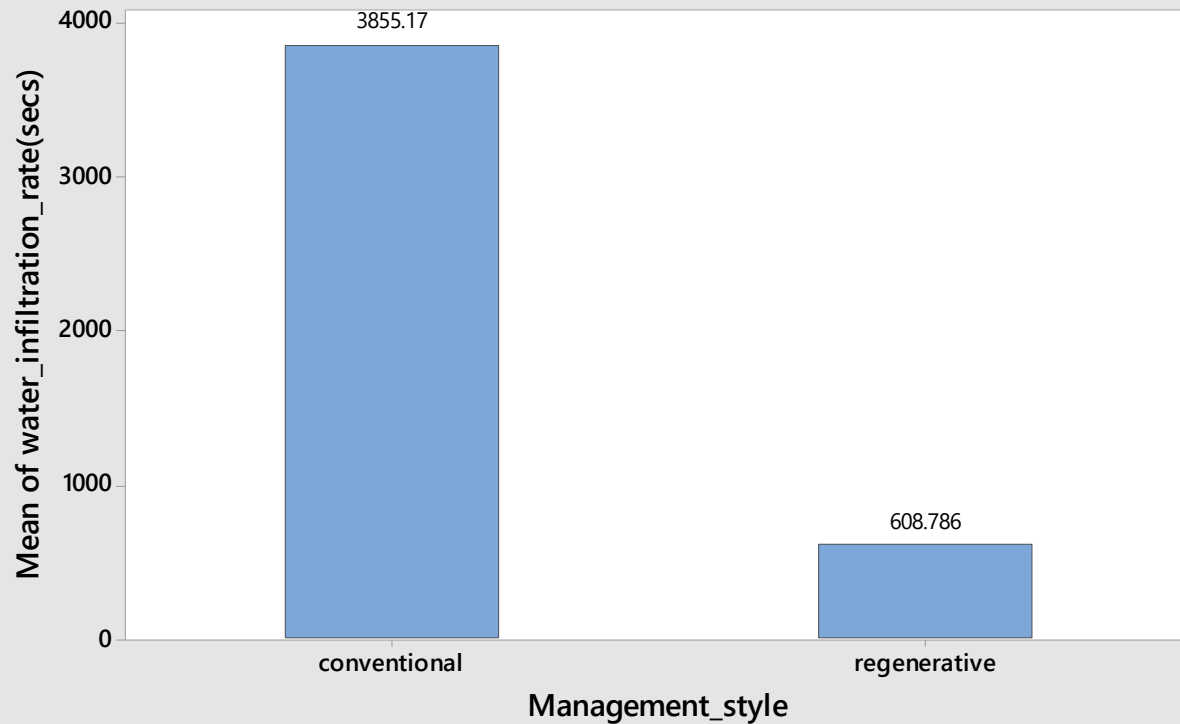
P-Value= 0.000

N for conv = 24

N for regen= 25

Water Infiltration Rate

Chart of Mean(water_infiltration_rate(secs))

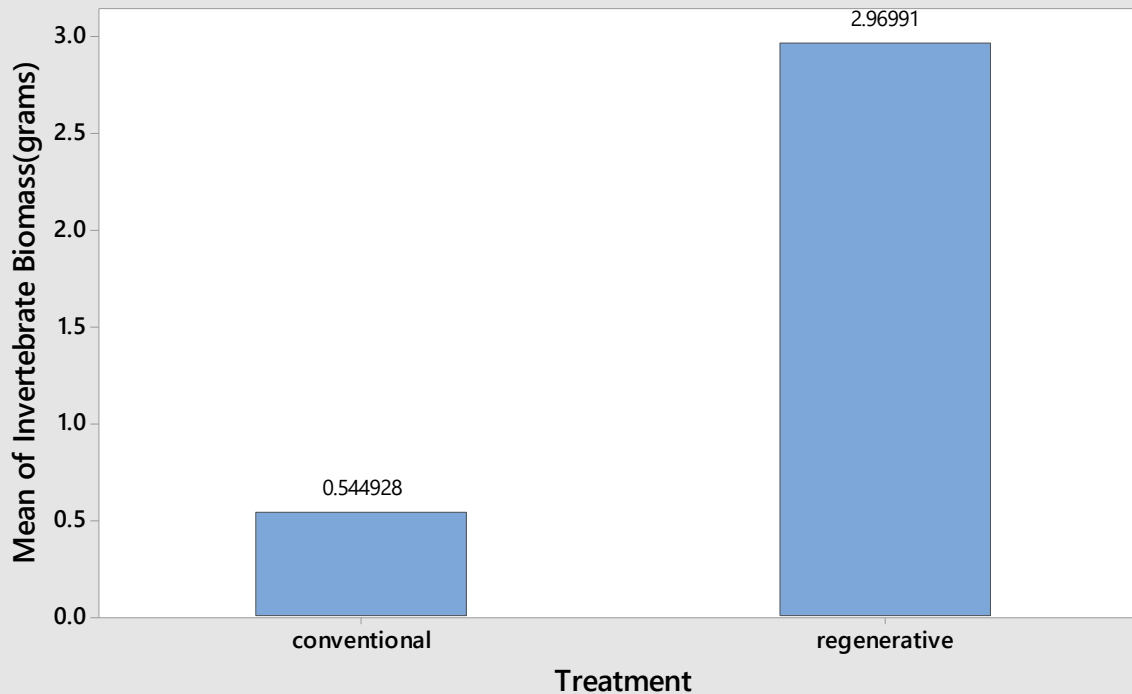


P-Value= 0.007

N per treatment = 8

Invertebrate Biomass

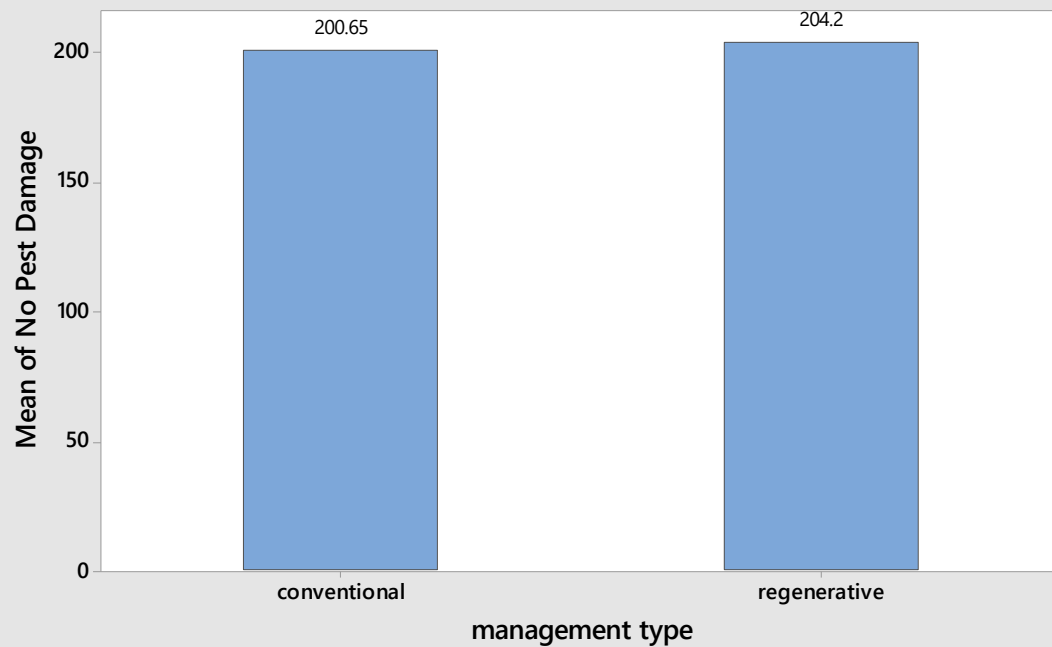
Chart of Mean(Invertebrate Biomass(grams))



P-Value = 0.000 N per treatment = 96

Pest Populations

Chart of Mean(No Pest Damage)



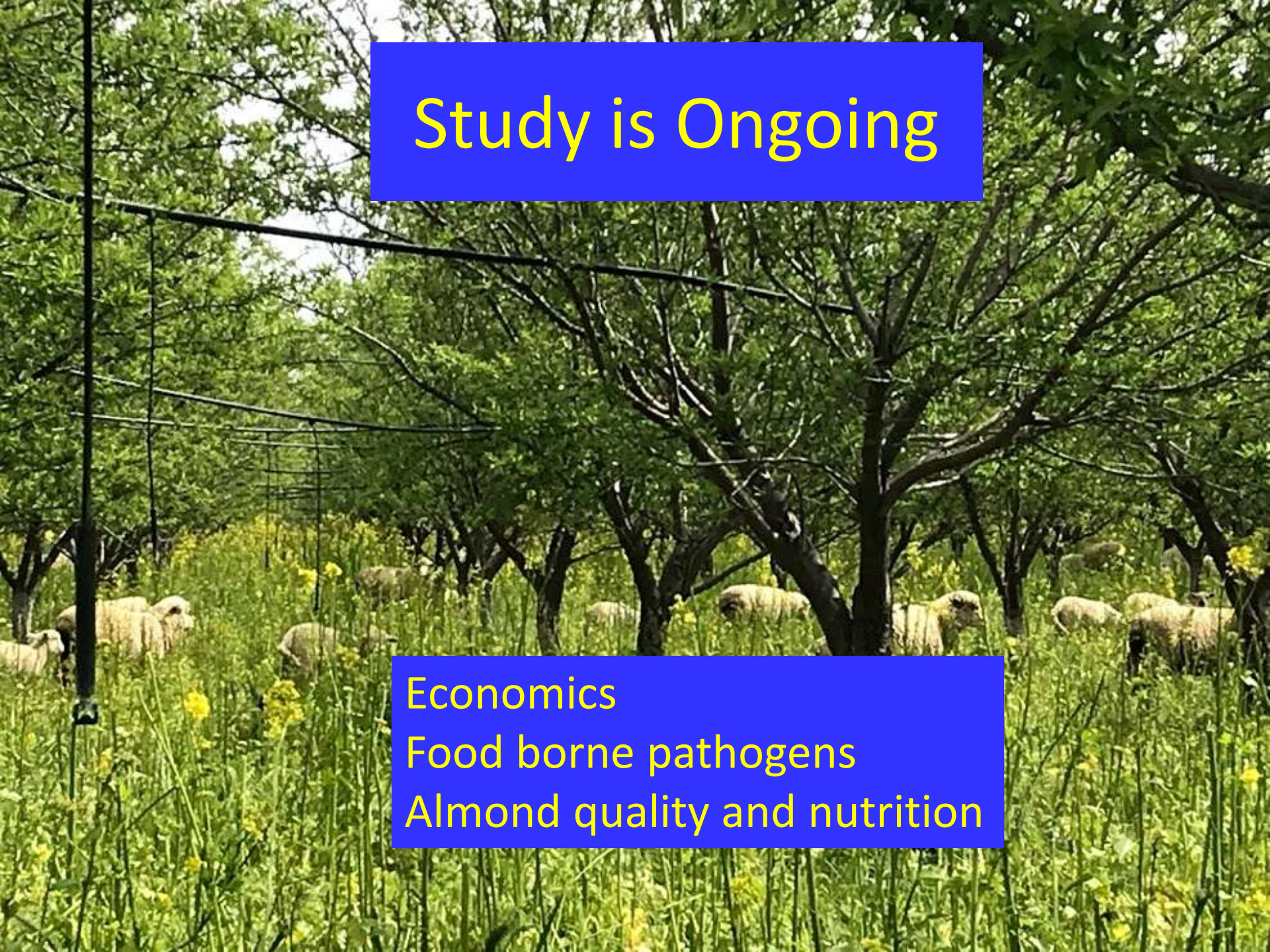
P-Value = 0.932

N per treatment = 20



Regenerative Systems had Higher:

- 30% higher soil organic matter
- Equivalent pest populations
- Higher soil microbial communities
- 6 times higher water infiltration rates

A photograph of a sheep farm. In the foreground, there is a black metal fence. Behind the fence, several sheep are grazing in a field of tall green grass and yellow wildflowers. In the background, there are many trees with green leaves. A blue rectangular box with yellow text is overlaid on the top right of the image.

Study is Ongoing

Economics
Food borne pathogens
Almond quality and nutrition

Problems with Avermectins

Most of the treatment
comes out in the dung

Campbell 1985. Science 221: 823

A half-life of 240 days

Herd 1995. Internat J Parasitol 25: 875



Avermectins kill the 98% of insects
(non-pests) found in dung



What Causes Pests?

Not enough diversity

Too much disturbance

Effects of Regenerative Ranching on Maggots

How does high intensity grazing,
and long rest periods affect pests
of cattle?



The Ranches

16 ranches eastern SD

A range of conditions
and management
practices



Regenerative ranches

>10 AU per ha

Moved within 10 d

No avermectins

Conventional ranches

<5 AU per ha

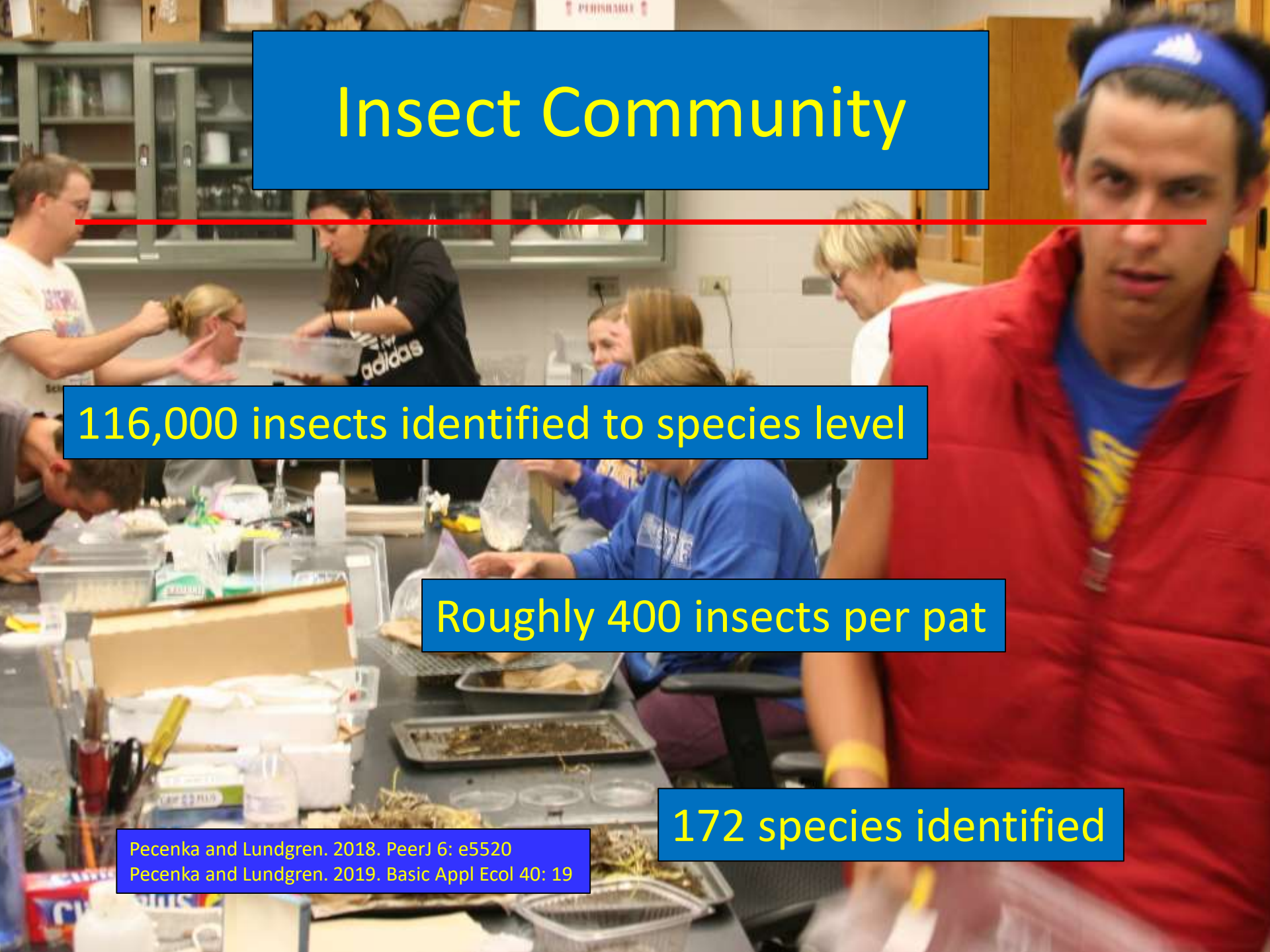
Moved after 30 d

Avermectins twice per year

Intensively surveyed the
insect communities in
the dung



Insect Community

A photograph of a laboratory setting where several people are working at tables. The tables are cluttered with various scientific equipment, including plastic containers, trays, and bottles. In the foreground, a man in a red jacket and blue headband is looking towards the camera. Other people are seen in the background, some wearing lab coats or casual clothing, engaged in their work. The overall atmosphere is one of a busy, collaborative research environment.

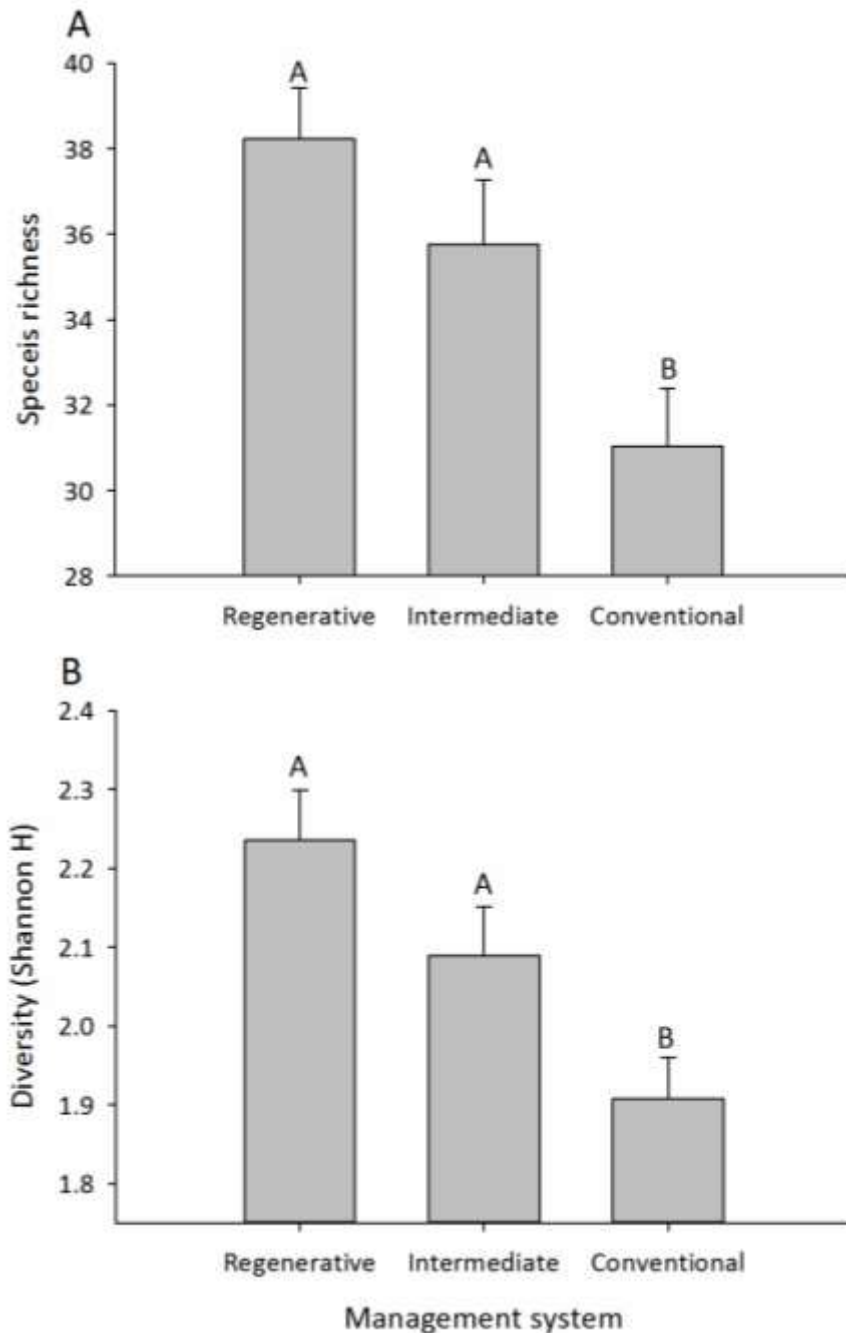
116,000 insects identified to species level

Roughly 400 insects per pat

172 species identified

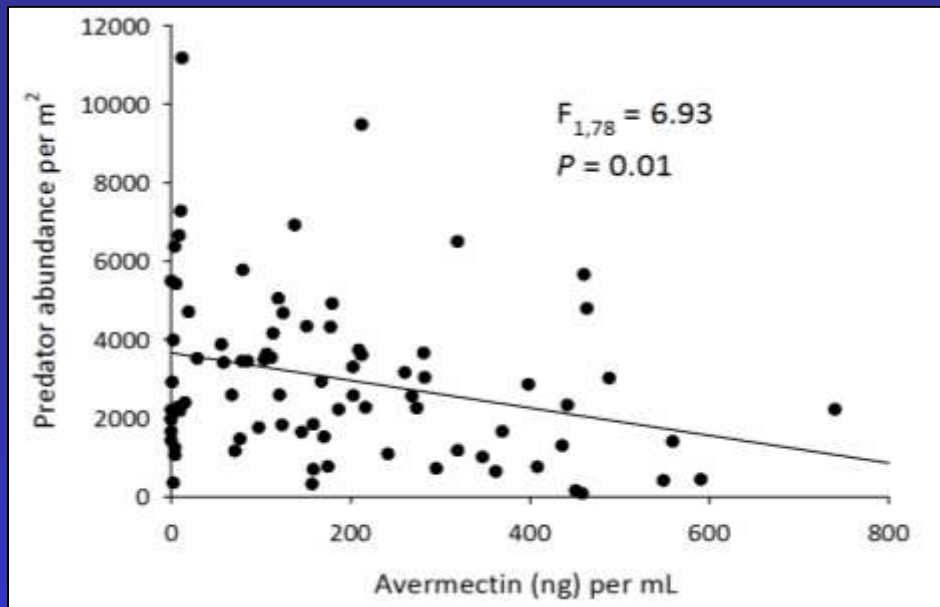
Pecenka and Lundgren. 2018. PeerJ 6: e5520
Pecenka and Lundgren. 2019. Basic Appl Ecol 40: 19

Insect community



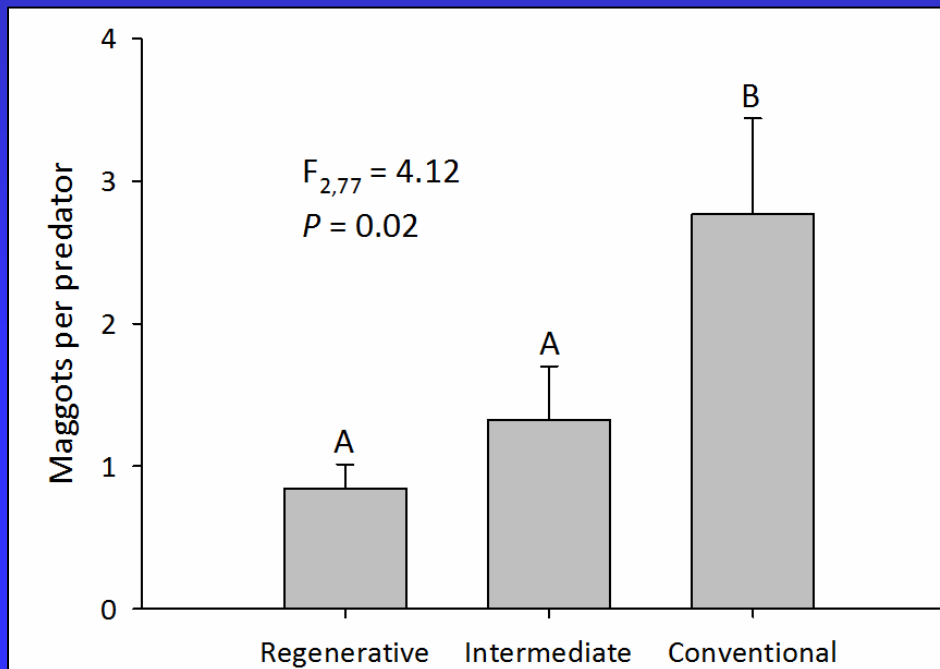
Species diversity was encouraged by regenerative herd management

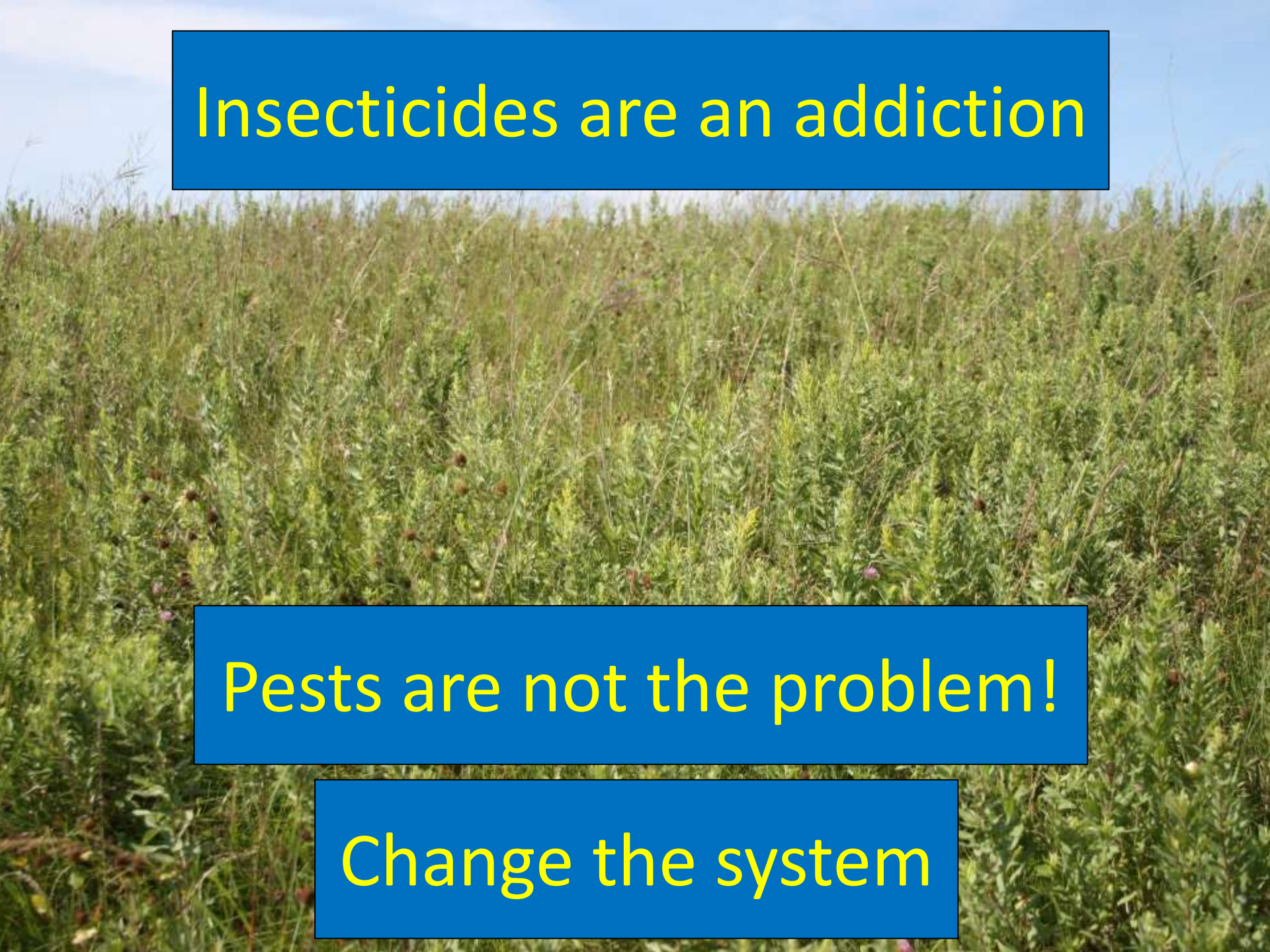
Pecenka and Lundgren. 2018. PeerJ 6: e5520
Pecenka and Lundgren. 2019. Basic Appl Ecol 40: 19



Predators

Predators in dung were favored by regenerative herd management



A photograph of a field filled with tall, green weeds and grasses, some with small purple flowers. The field is dense and stretches towards a clear blue sky with a few wispy clouds.

Insecticides are an addiction

Pests are not the problem!

Change the system

Combatting Pests Without Pesticides

Abandon pesticides

High intensity grazing

Frequent movement of animals

Integrate herds

Four Principles

- 1) Stop tilling (or reduce it)
- 2) Never leave bare soil
- 3) Some plant diversity is better than none, and more is better than less
- 4) Integrate crops and livestock

Why isn't Regenerative Farming Mainstream?

Paradigm shifts take time

Science has been misdirected

Thanks!

Hundreds of donors



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