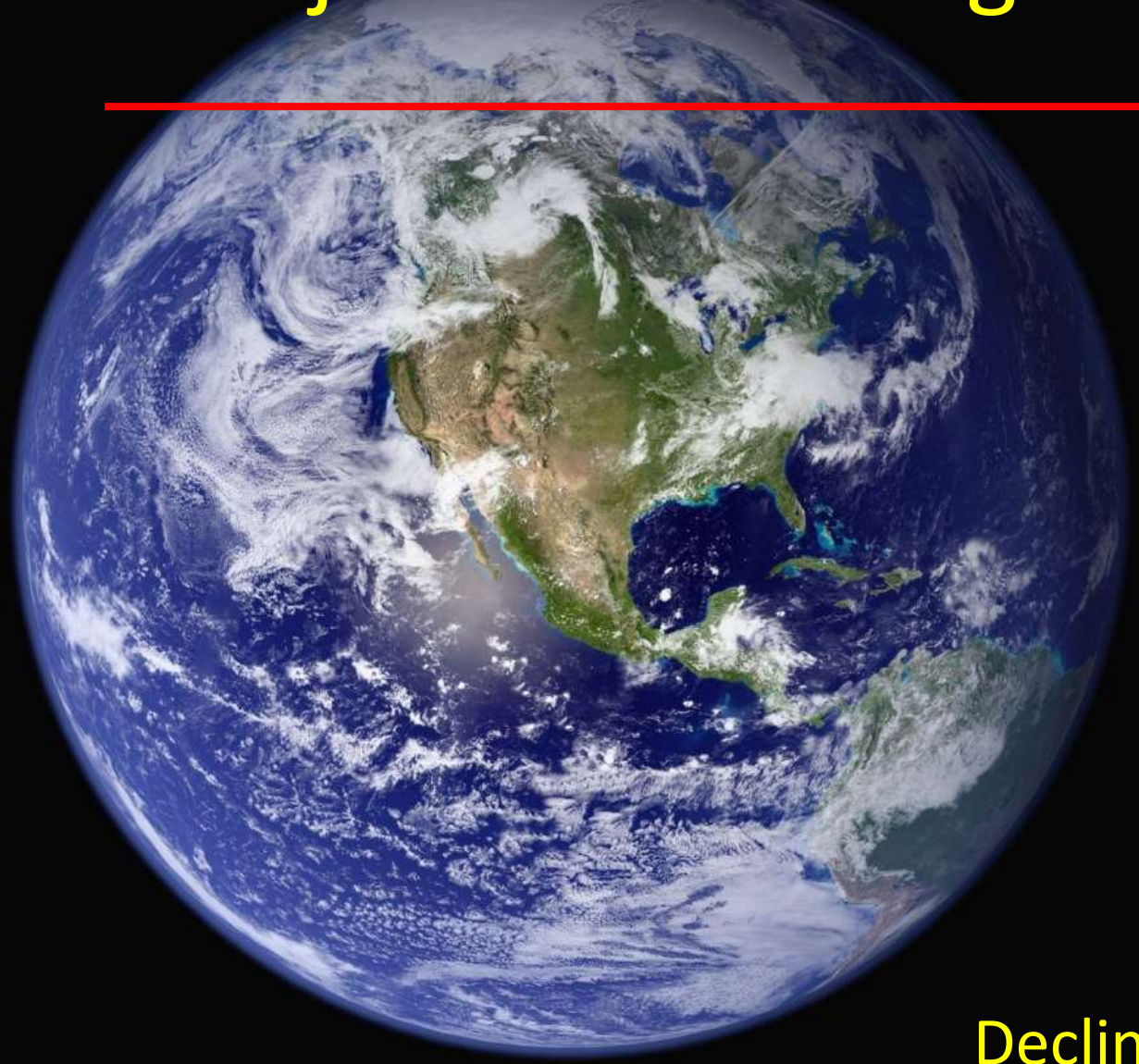
Ecologically Intensive Pest Management

Jonathan Lundgren
Ecdysis Foundation
Blue Dasher Farm

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

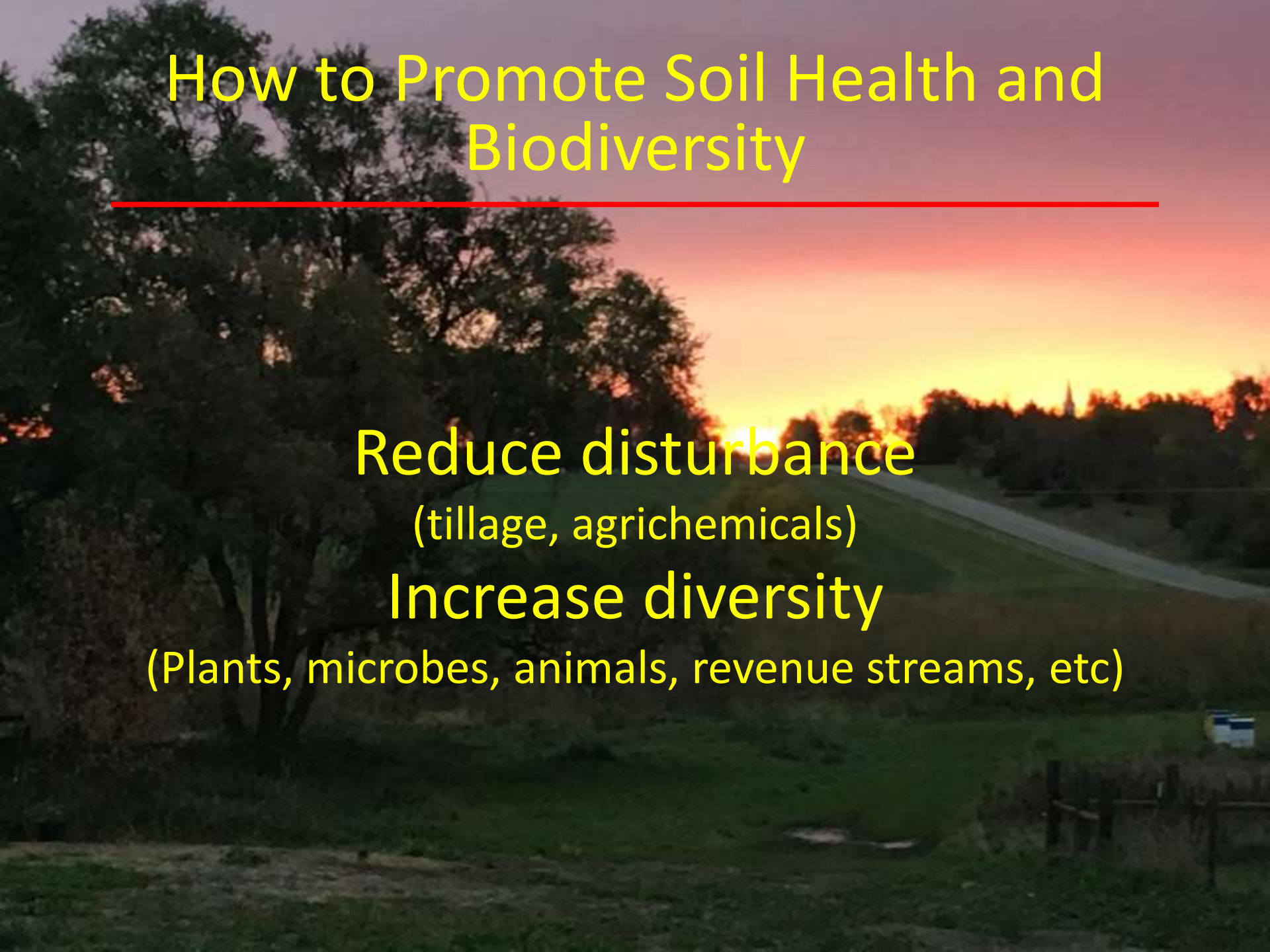
Monoculture Production Schemes

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



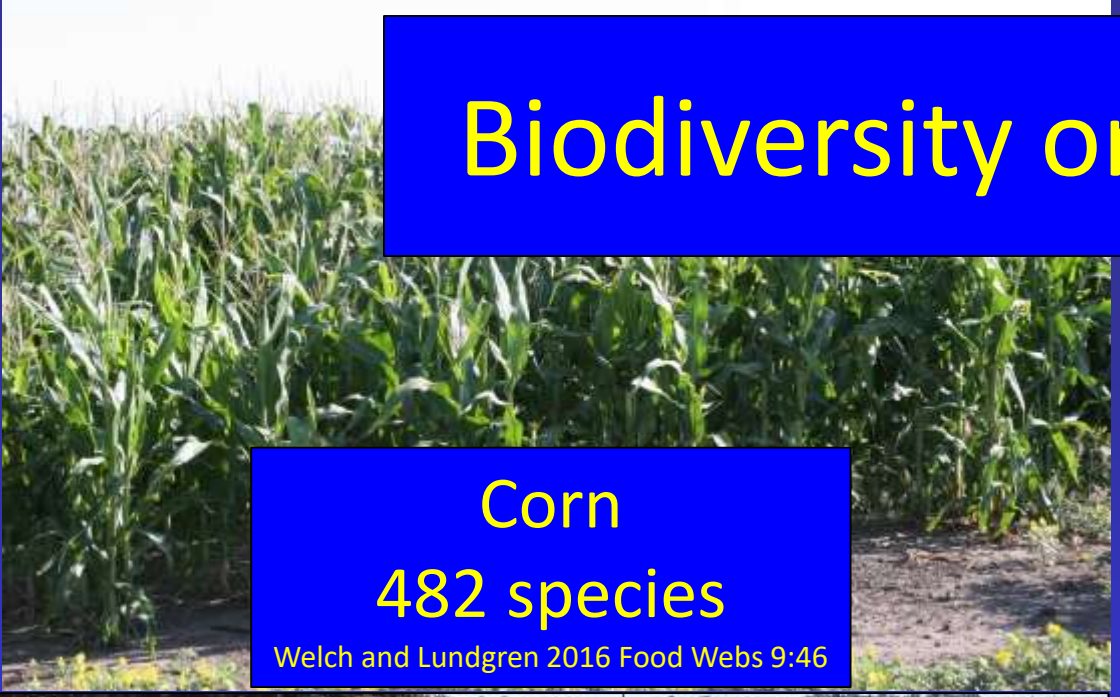
Reduce disturbance

(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

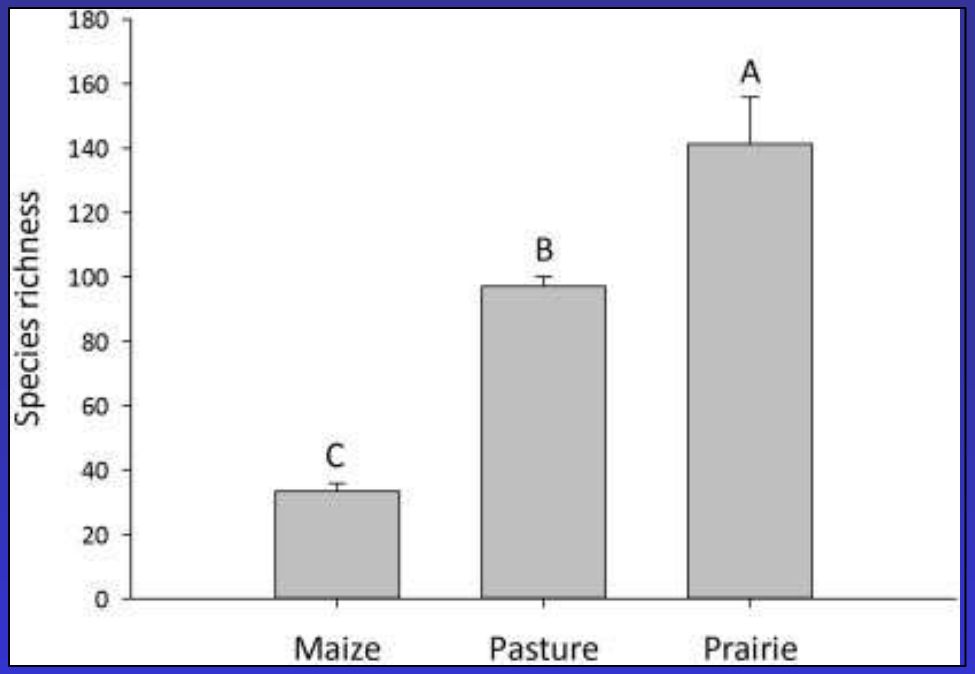
Soybean
126 species (predators)
Lundgren et al 2013. Crop Prot 43: 110

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

Schmid et al. 2015. Ann Entomol Soc Am 108: 993

Biological Networks

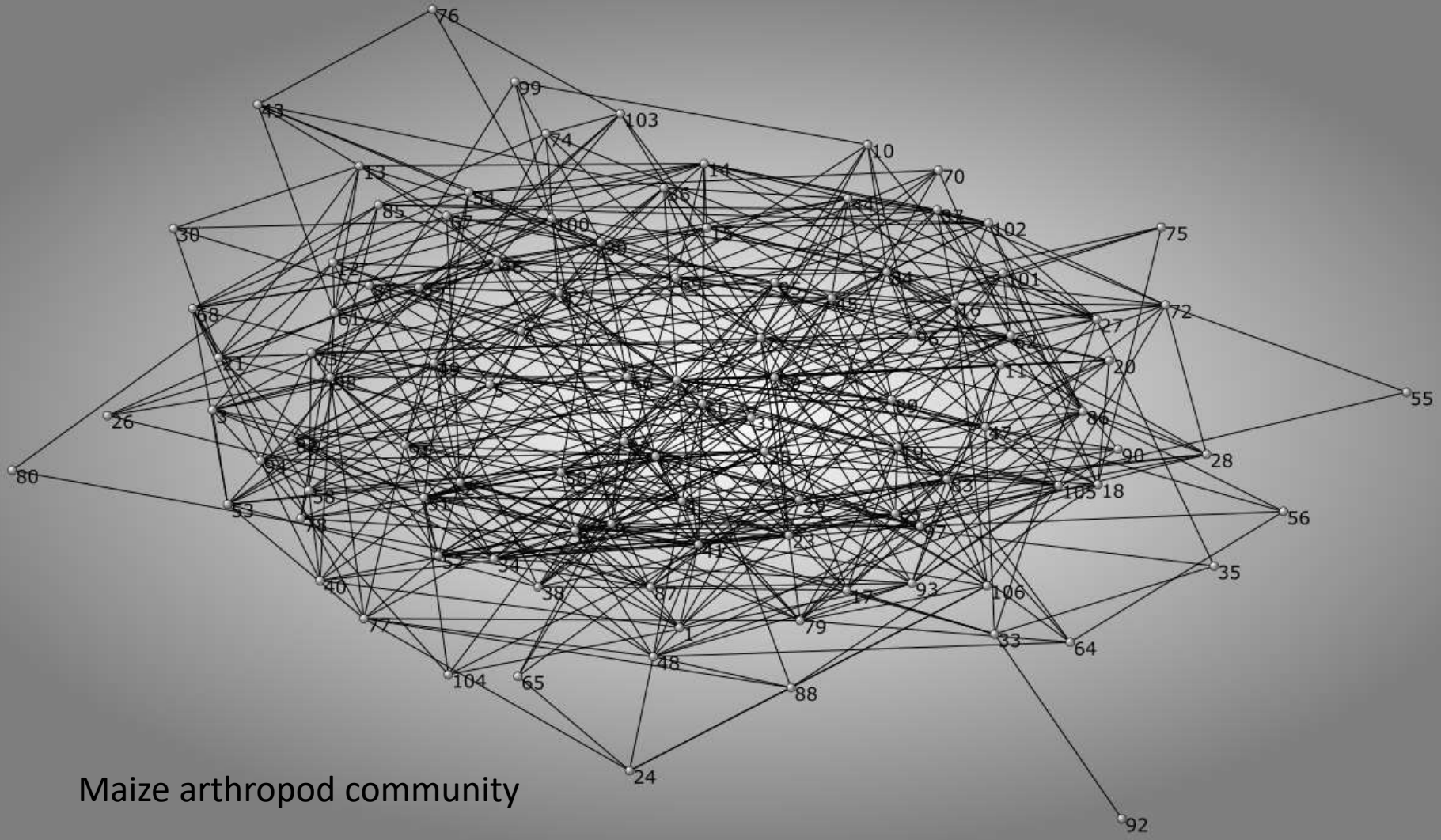
Perceptions of Biological Networks

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

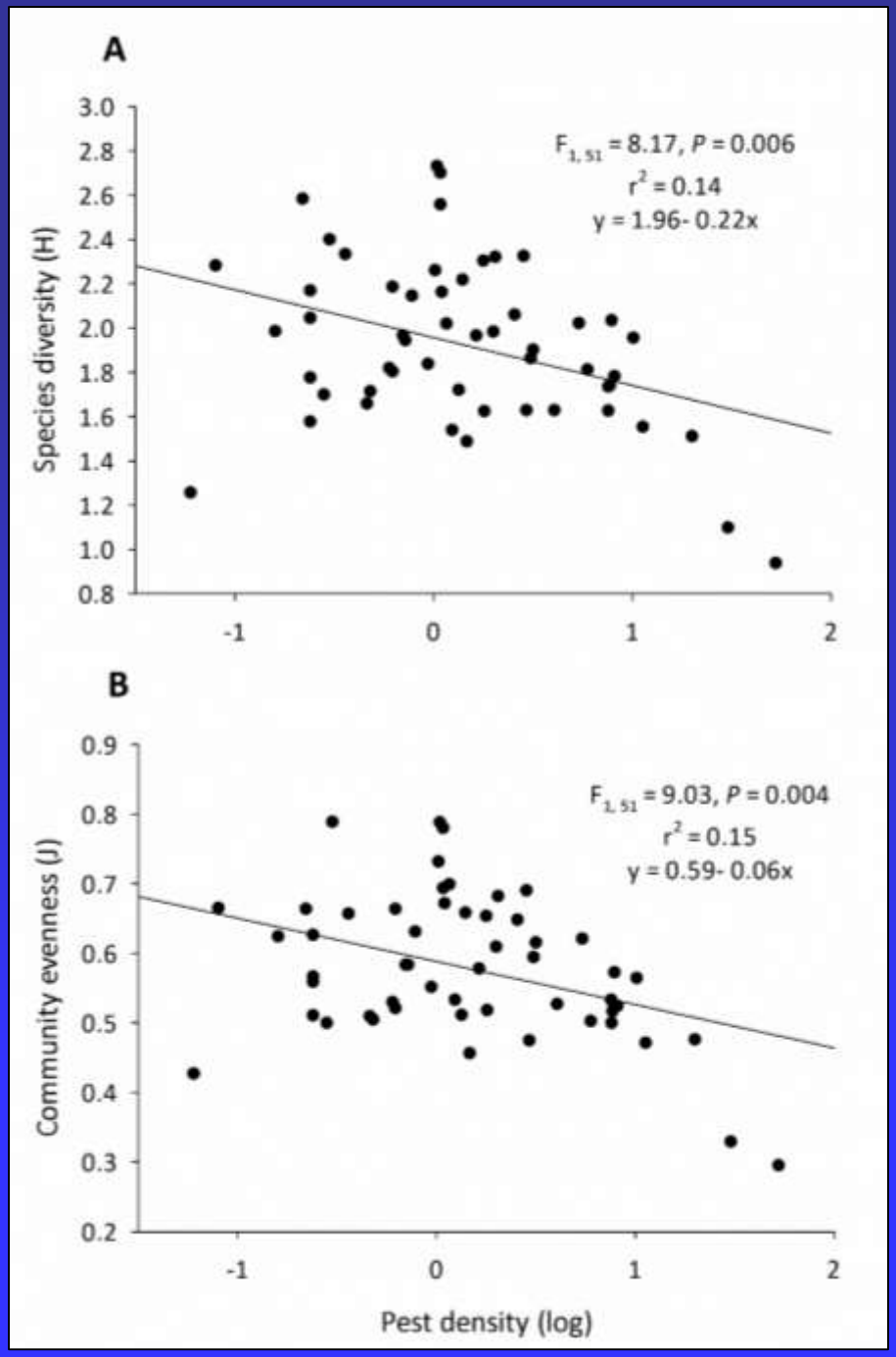
But simplified systems ignore the complexity of biological communities and their unforeseen interactions

Community Network in Agroecosystems



Maize arthropod community

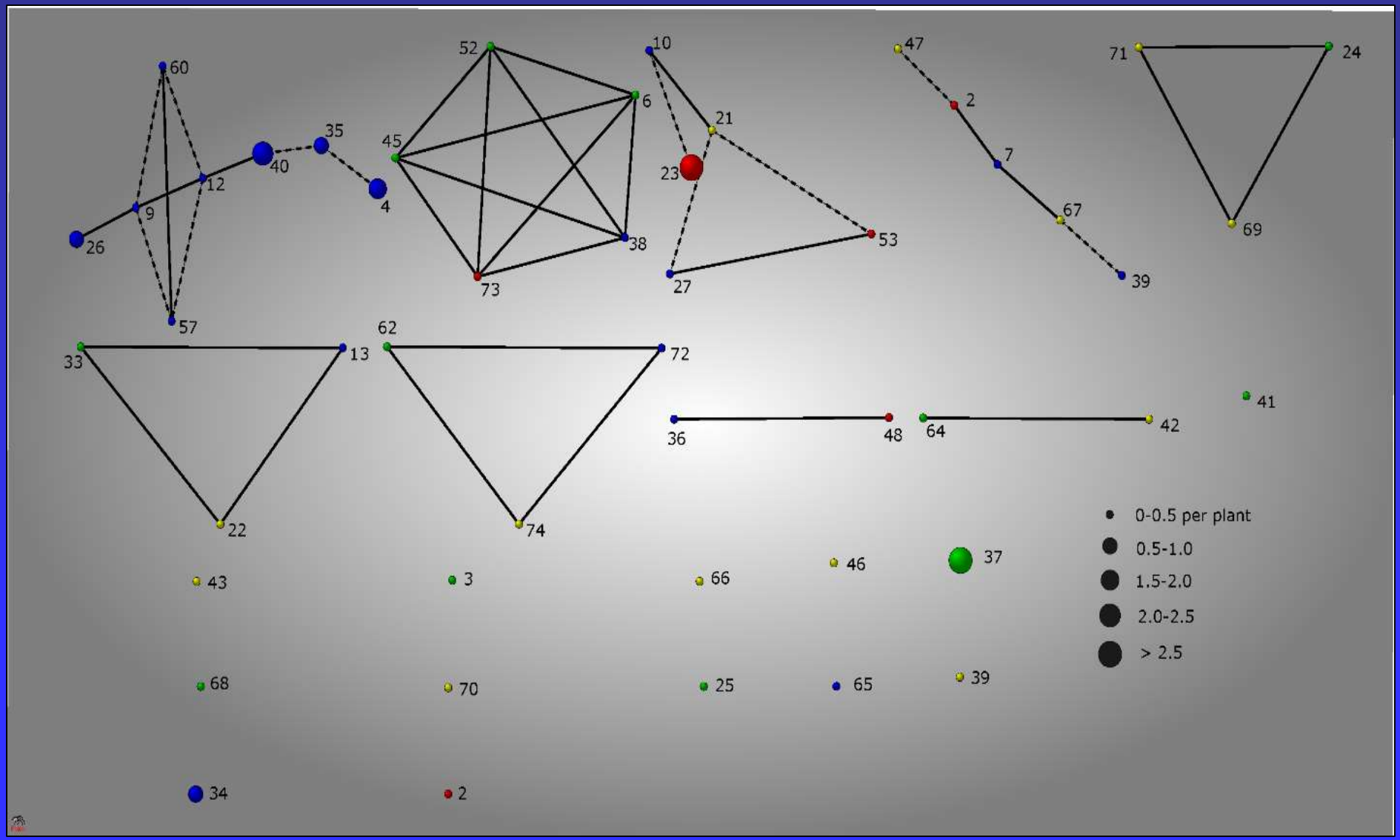
Biodiversity on Farms Reduce Pest Pressure in Corn

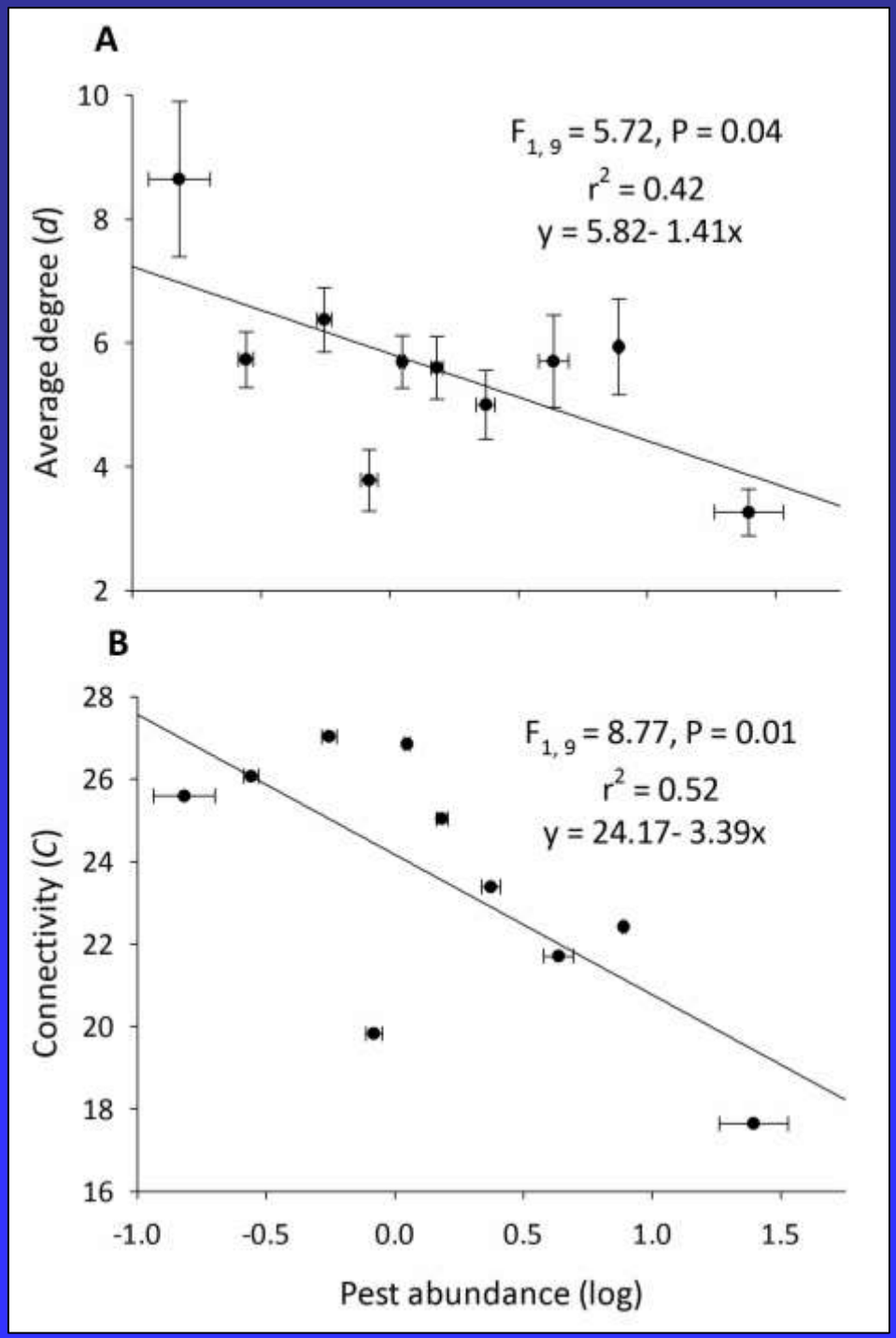


Lundgren and Fausti 2015. Science Advances 1: e1500558

Network Topology and Pest Abundance

High Pest Abundance





Network Topology Affects Pest Abundance

Fewer linkages between species increases pests

Lundgren and Fausti 2015. Science Advances 1: e1500558

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

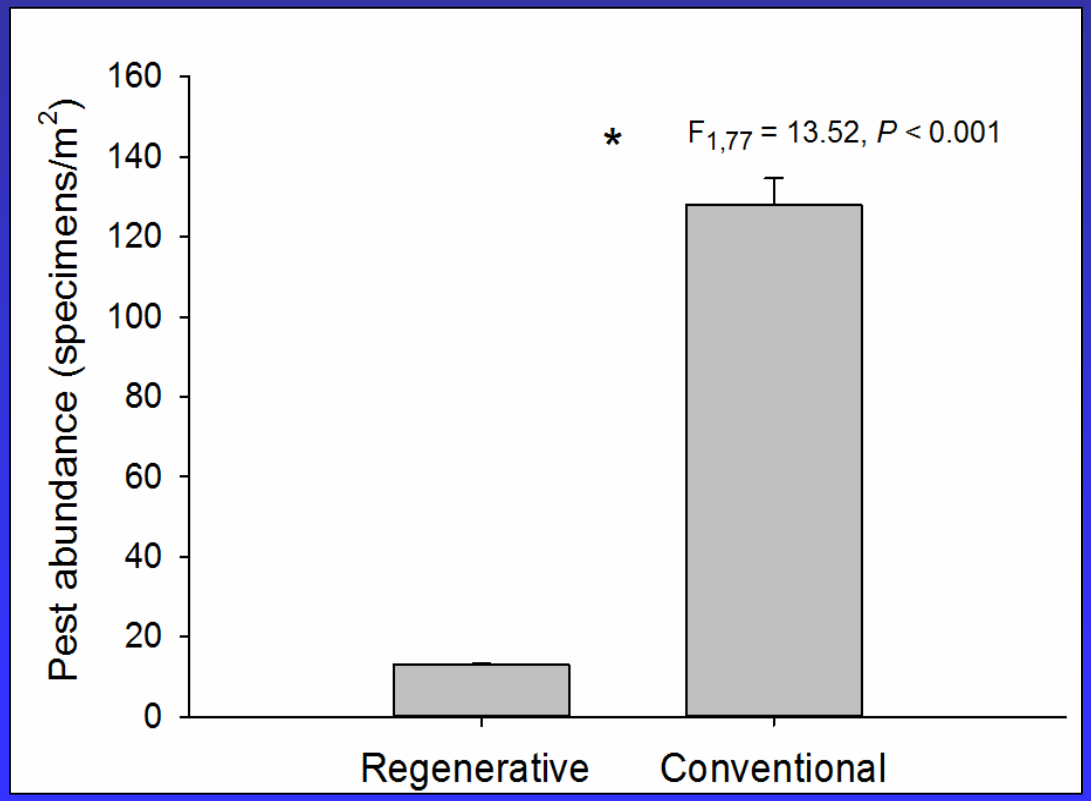
LaCanne and Lundgren. 2018. PeerJ 6: e4428

Approach

Full bioinventory
of corn community

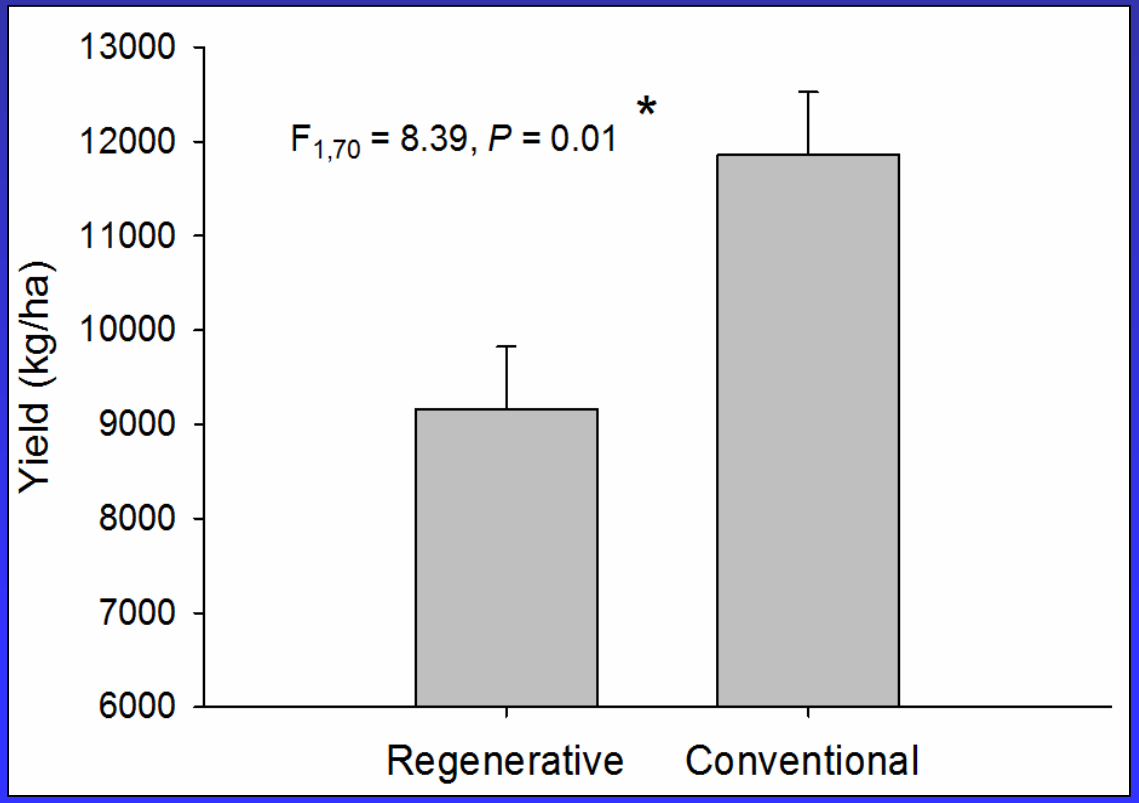
Yields and profit

Pest Populations



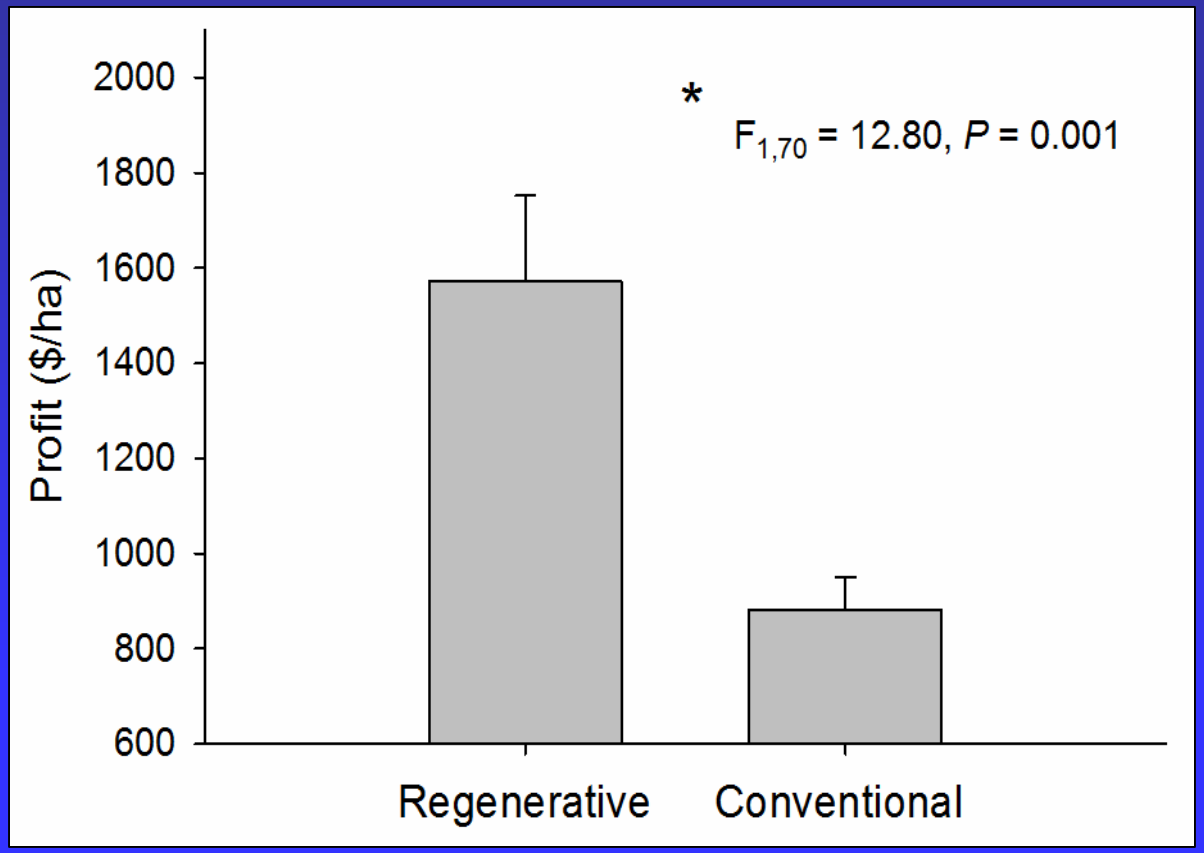
Regenerative systems had 10-fold fewer pests than insecticide-treated systems

Yield



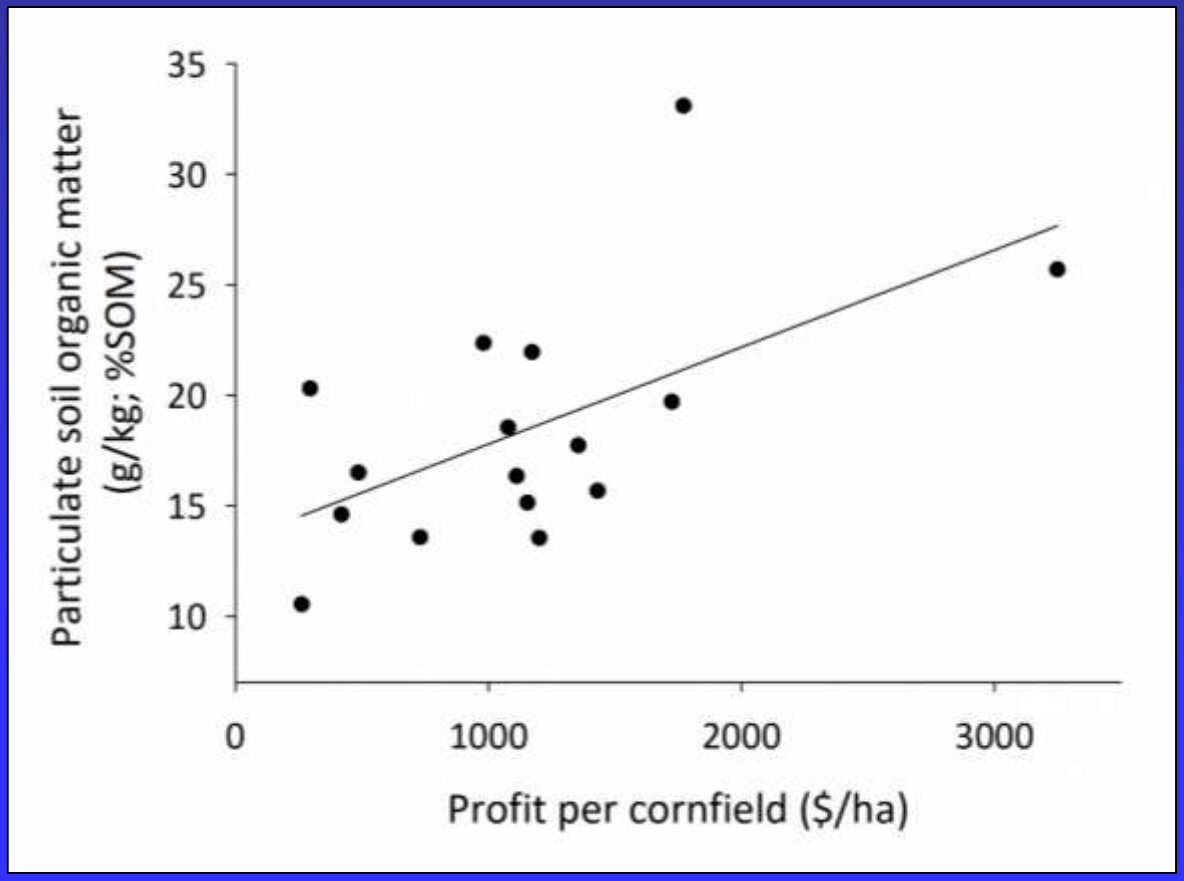
Yields were reduced by 22%

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

Are regenerative almond systems superior to conventional systems?

Tommy Fenster, MSc candidate

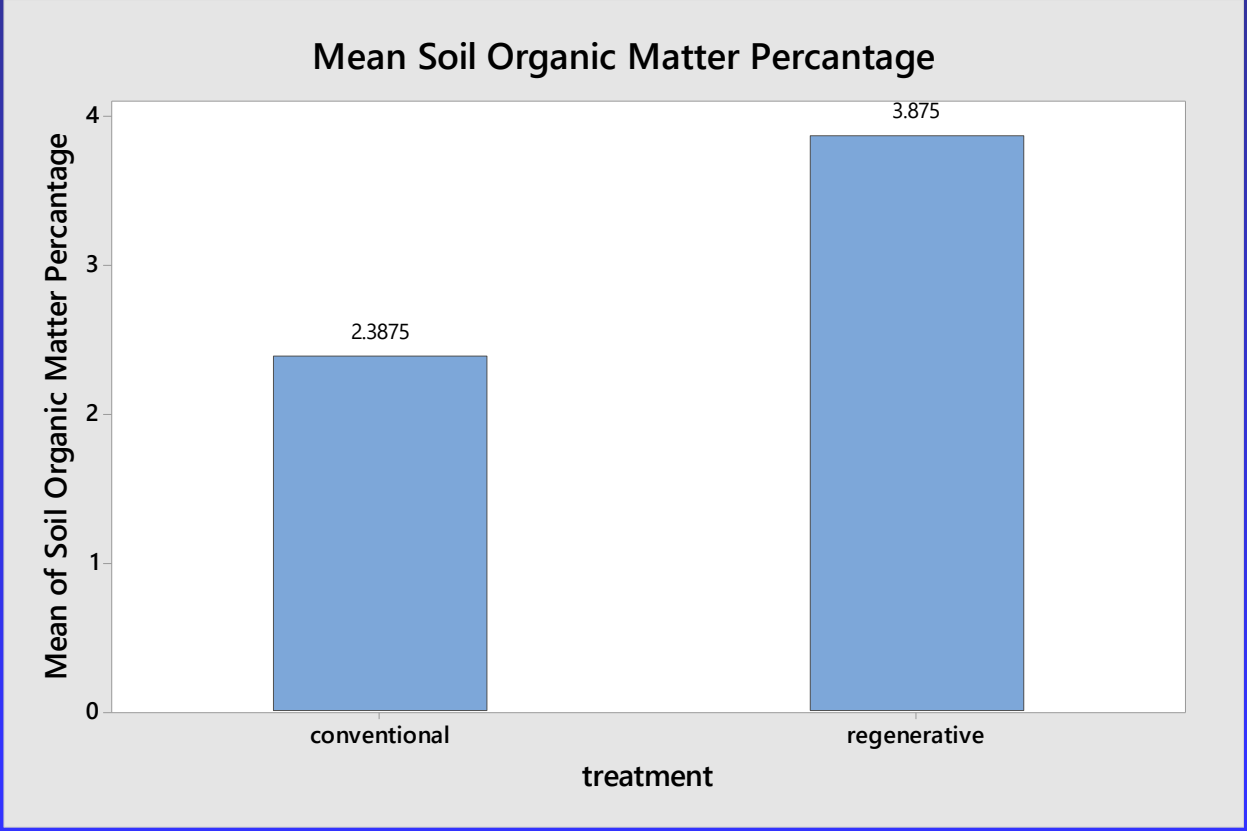
Regenerative

No till
No pesticides
Perennial ground cover
Compost
Compost teas
Livestock integration

Conventional

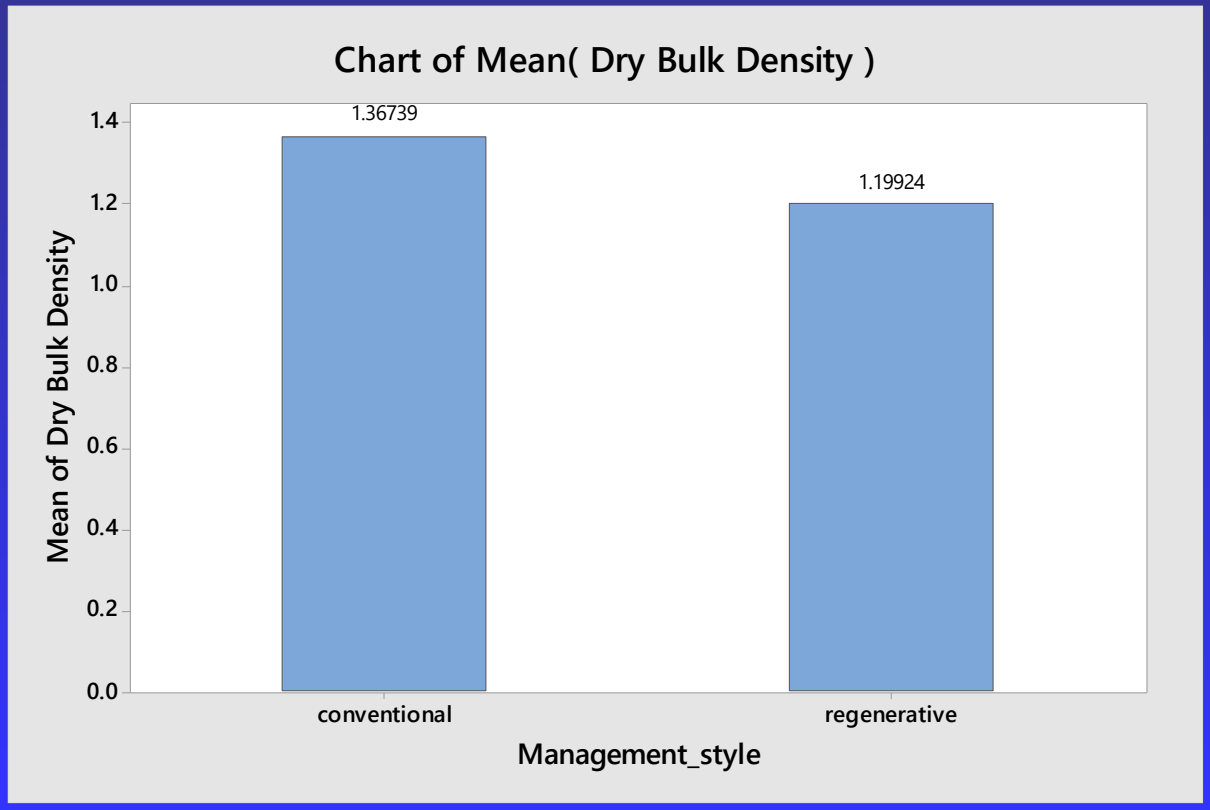
Tillage
Bare soil
Multiple pesticide applications annually

Soil Organic Matter (0-15cm)



P-Value= 0.029 N per treatment = 8

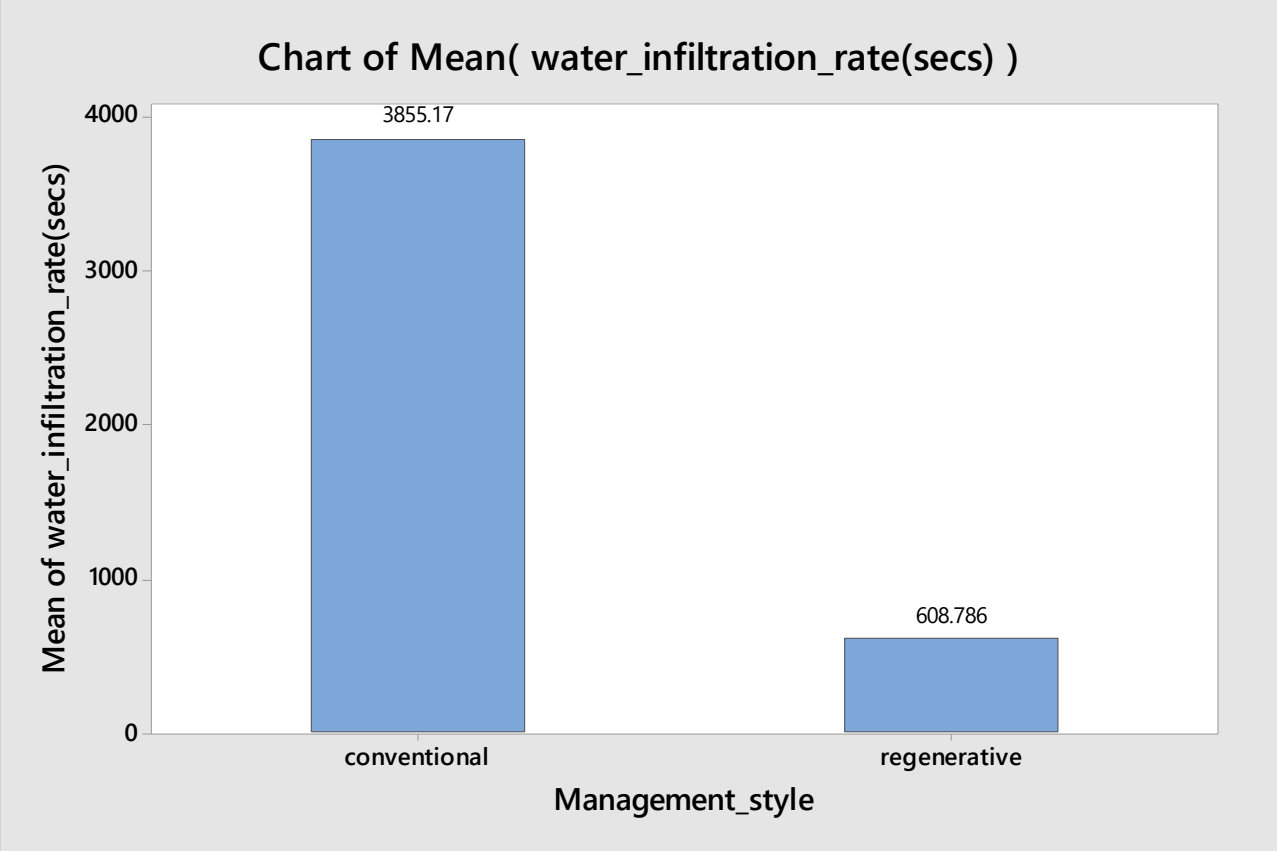
Soil Bulk Density



P-Value= 0.000

N for conv = 24
N for regen= 25

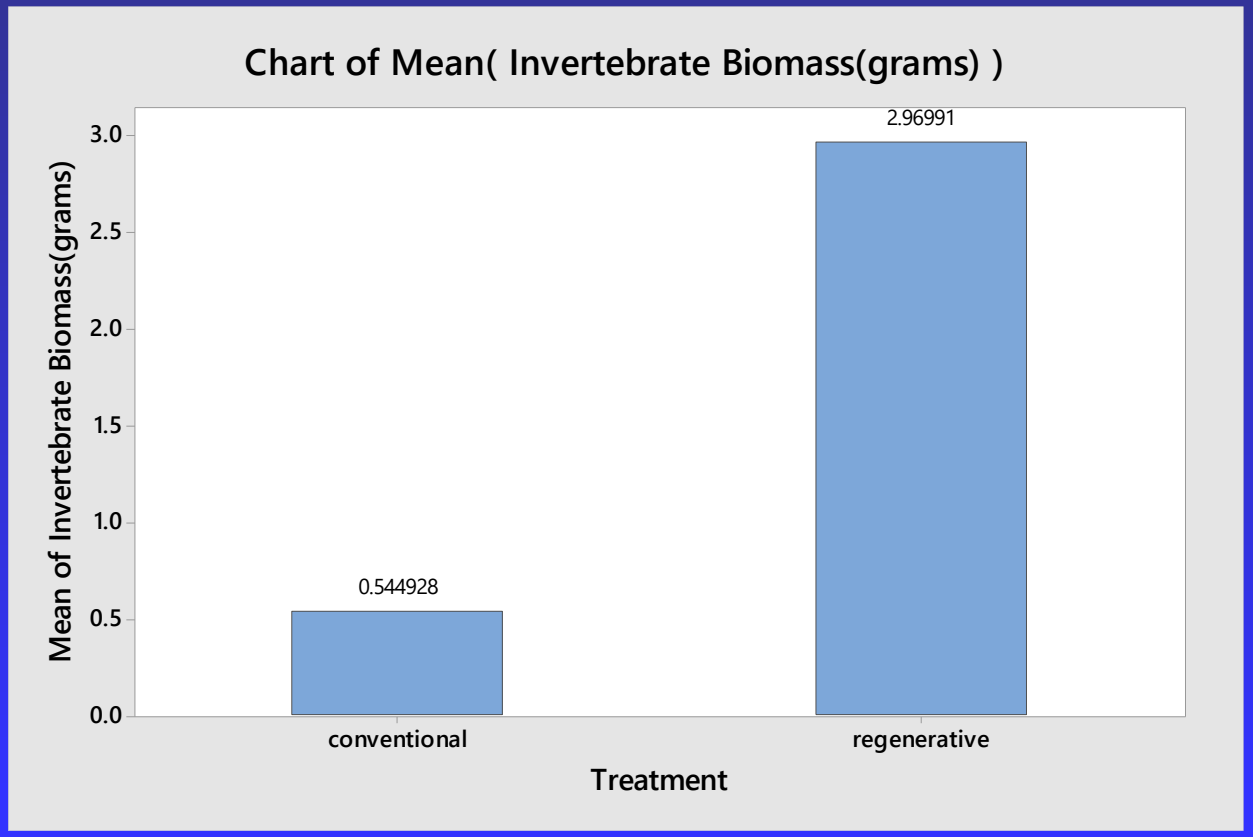
Water Infiltration Rate



P-Value= 0.007

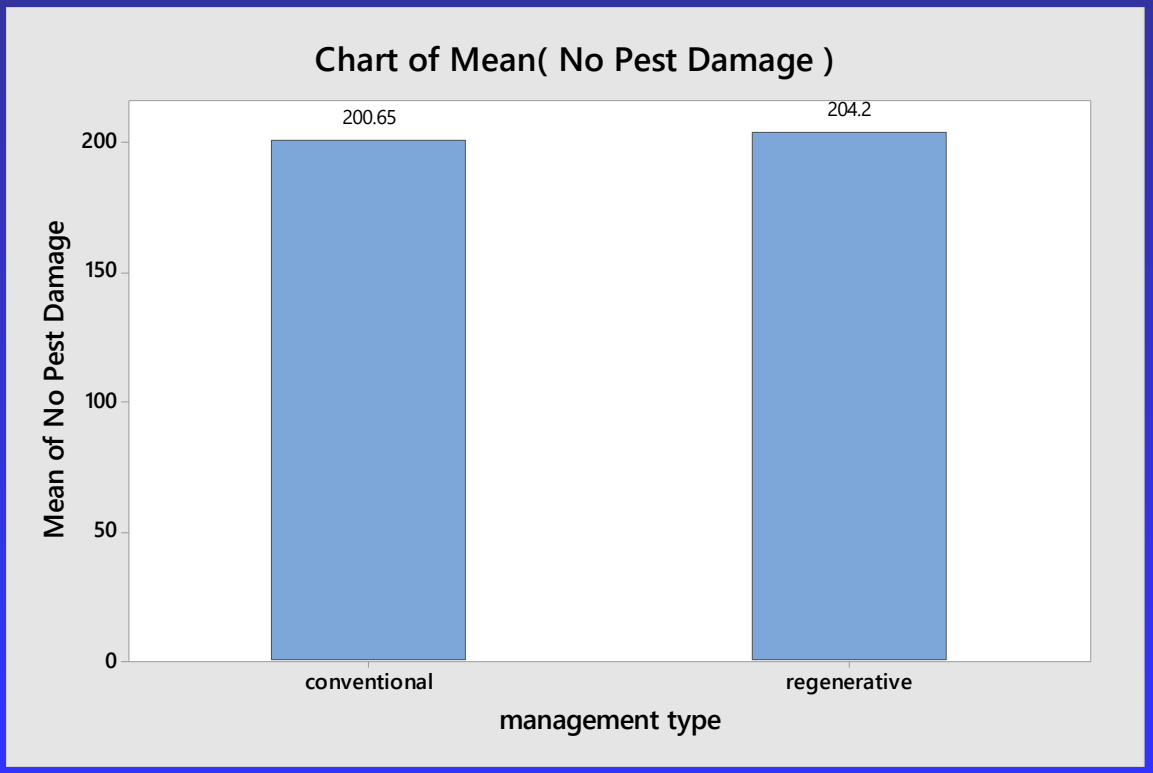
N per treatment = 8

Invertebrate Biomass



P-Value = 0.000 N per treatment = 96

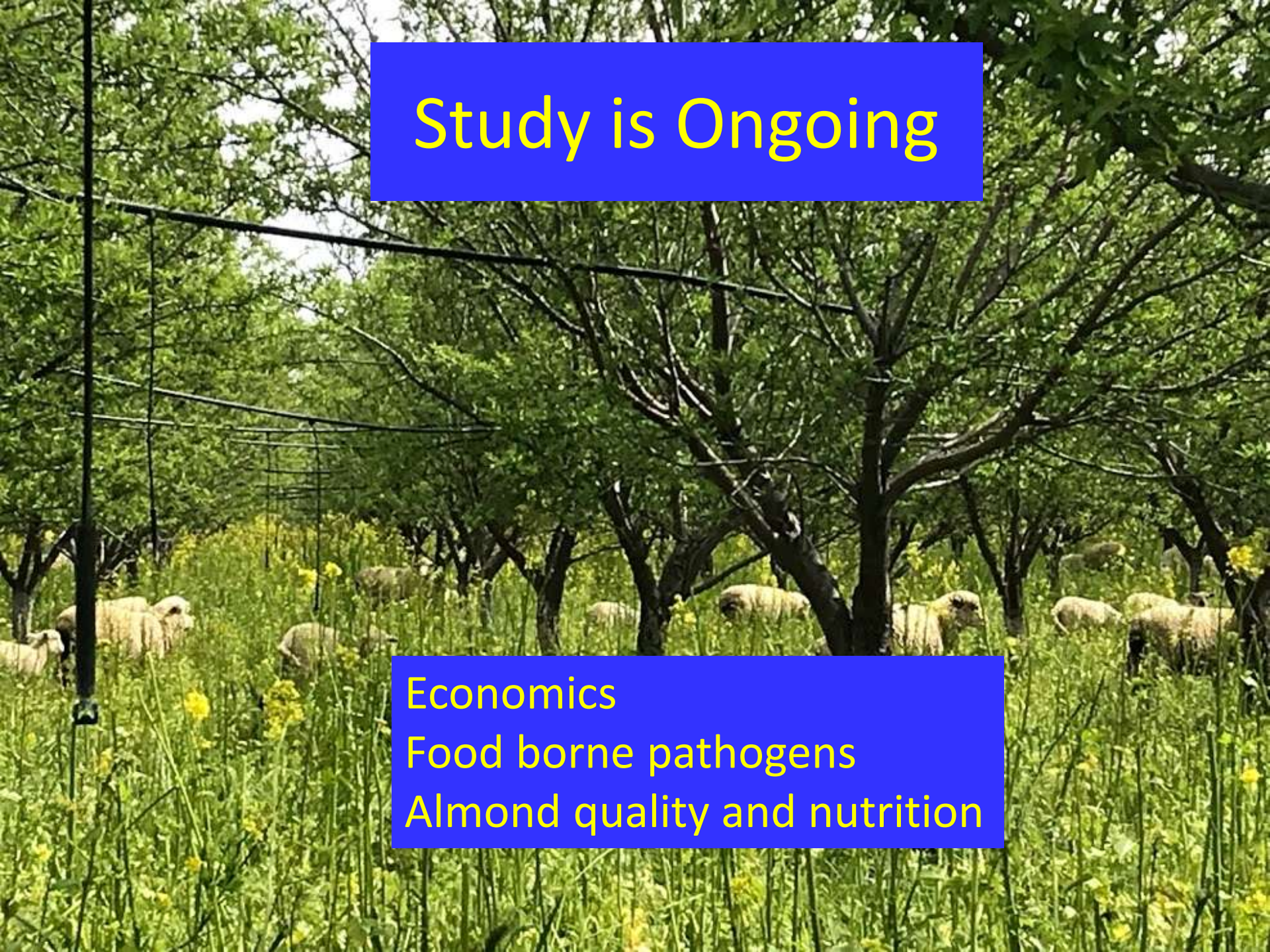
Pest Populations



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


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

<u>Regenerative ranches</u>

>10 AU per ha

Moved within 10 d

No avermectins

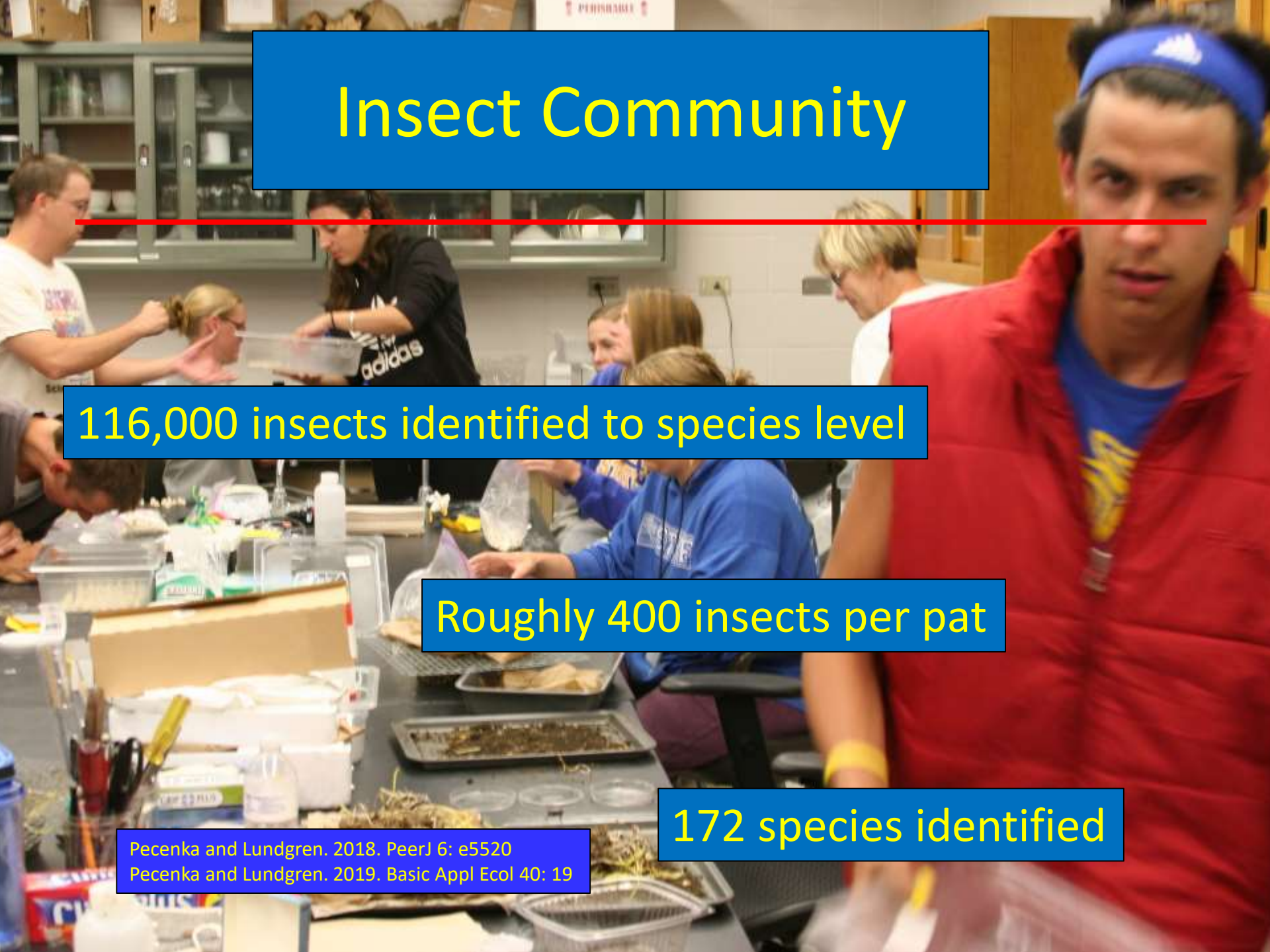
<u>Conventional ranches</u>

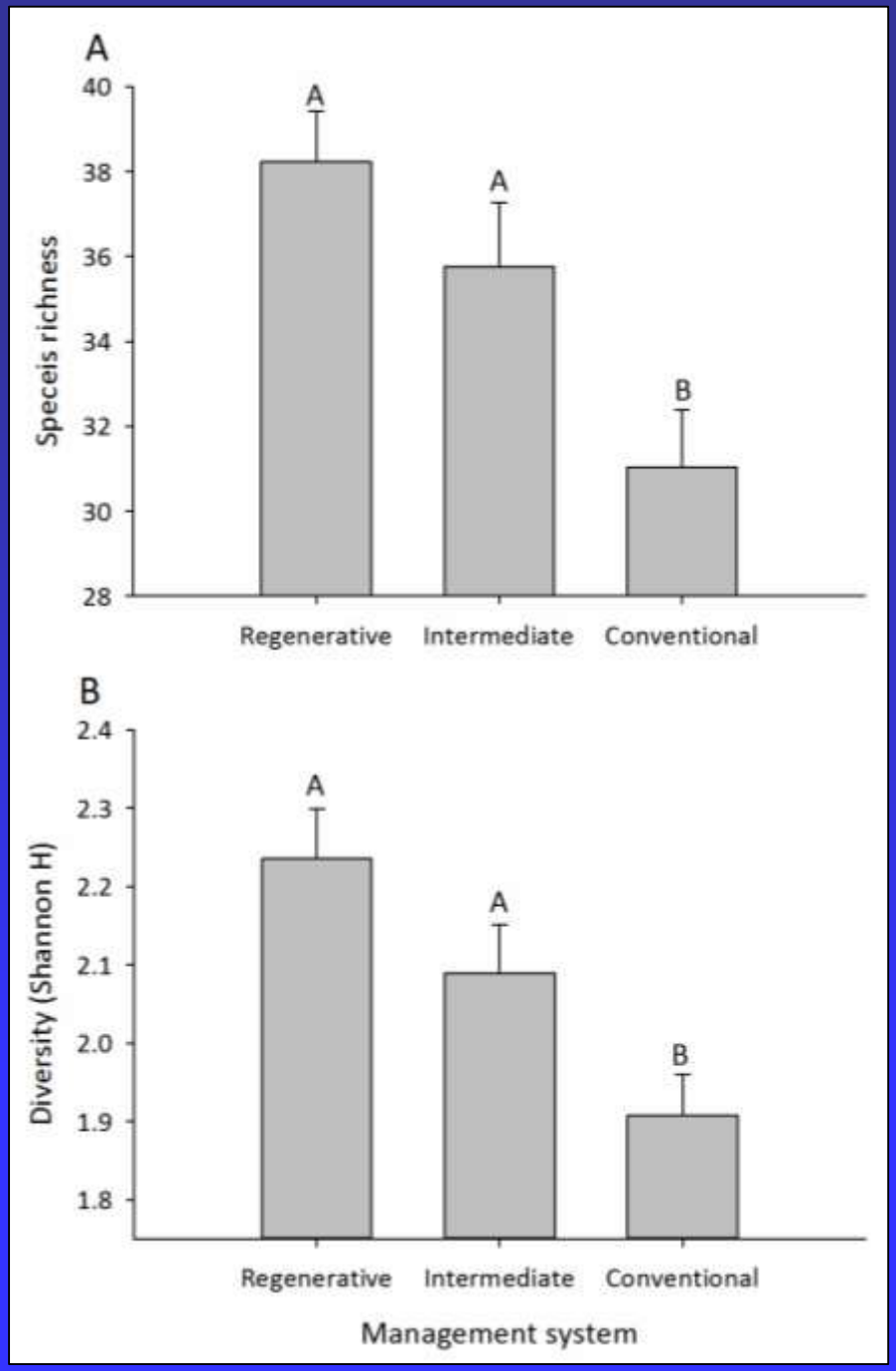
<5 AU per ha

Moved after 30 d

Avermectins twice per year

Intensively surveyed the insect communities in the dung

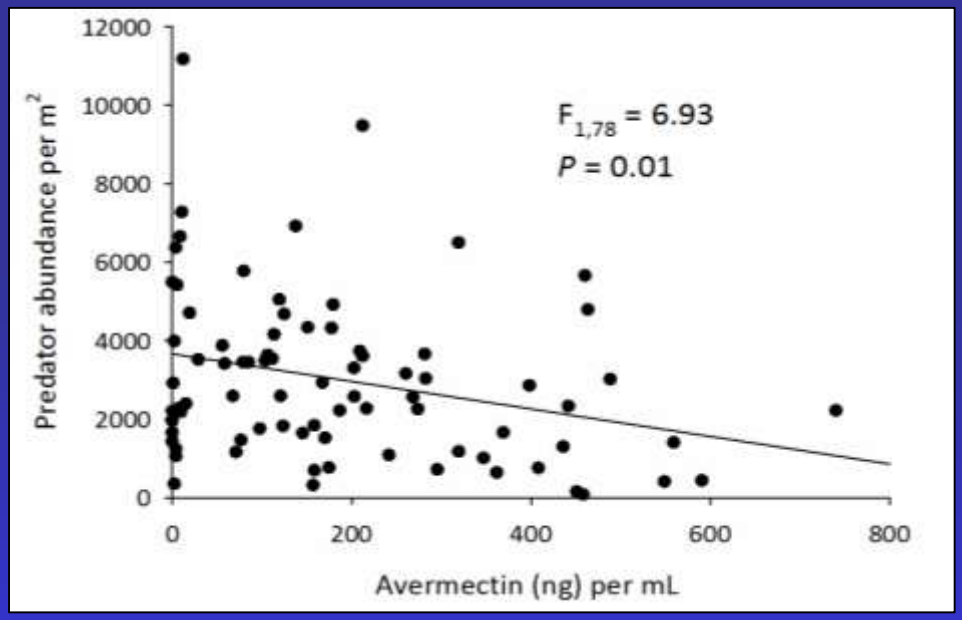

Insect Community
116,000 insects identified to species level
Roughly 400 insects per pat
172 species identified
Pecenka and Lundgren. 2018. PeerJ 6: e5520
Pecenka and Lundgren. 2019. Basic Appl Ecol 40: 19



Insect community

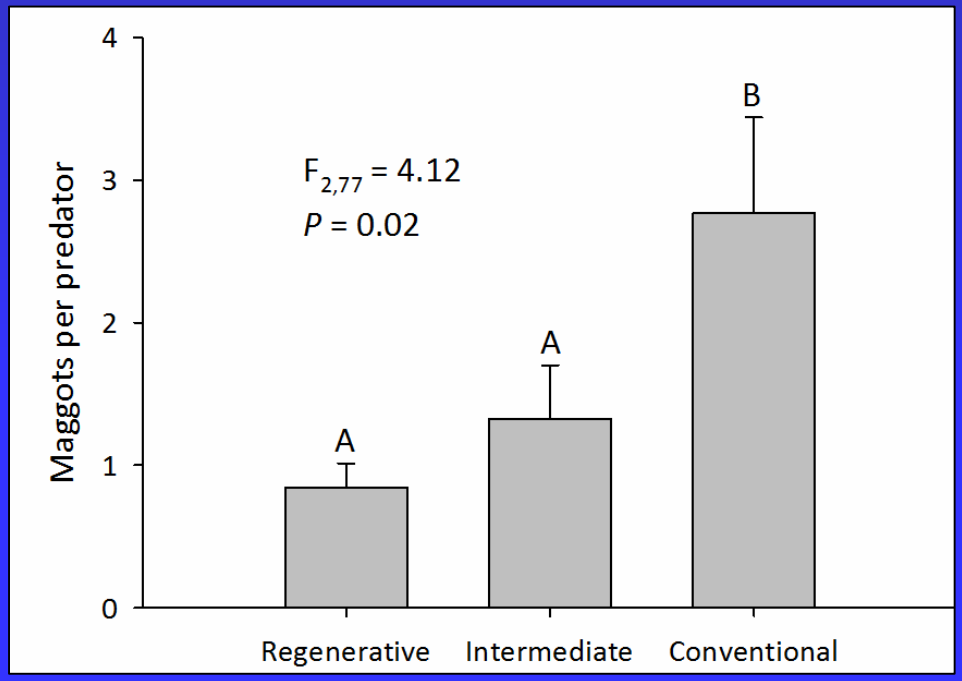
Species diversity was encouraged by regenerative herd management

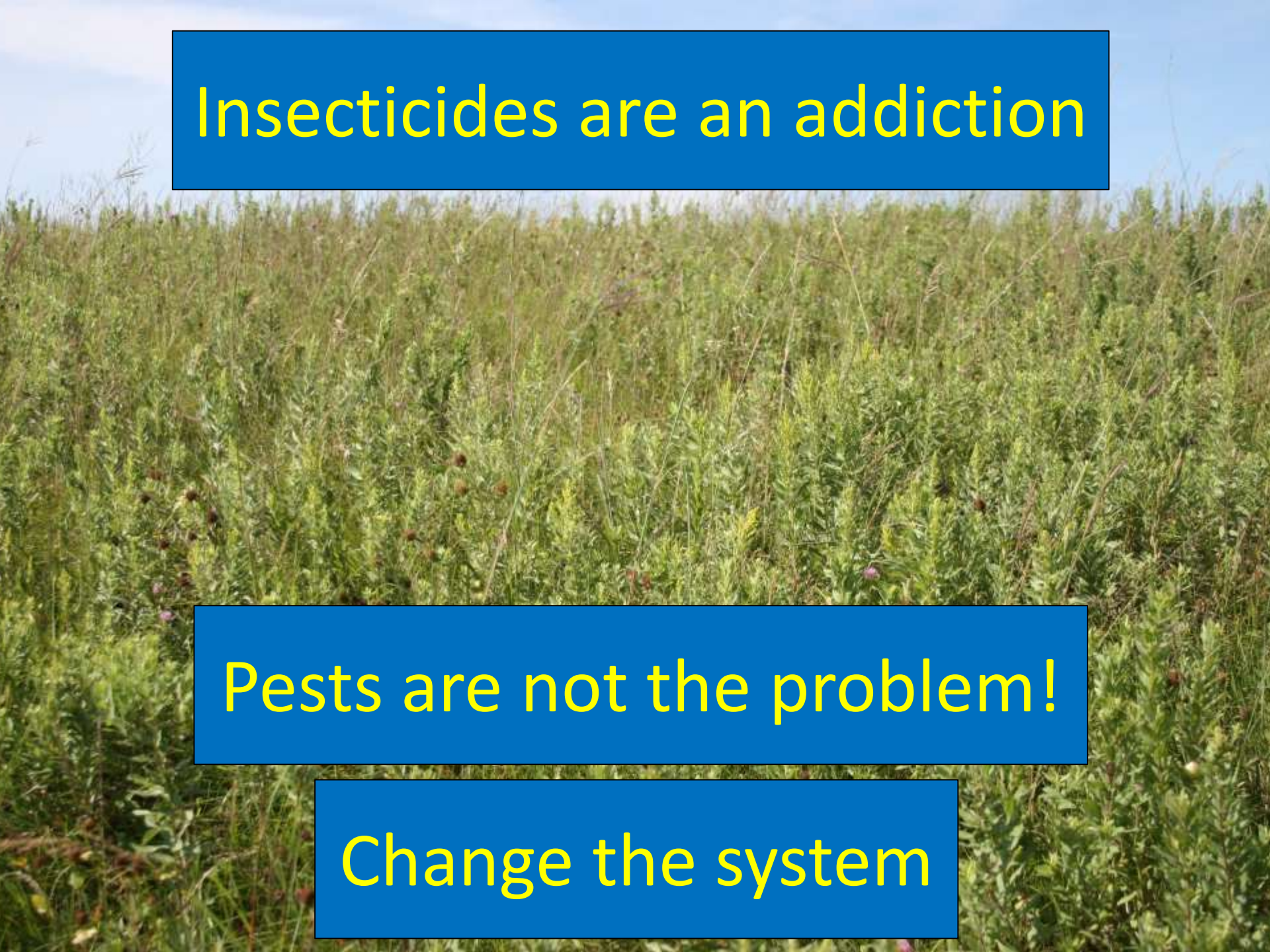
Pecenka and Lundgren. 2018. PeerJ 6: e5520
Pecenka and Lundgren. 2019. Basic Appl Ecol 40: 19



Predators

Predators in dung were favored by regenerative herd management




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!

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