Effects of cover crops on the structure and function of soil arthropod communities

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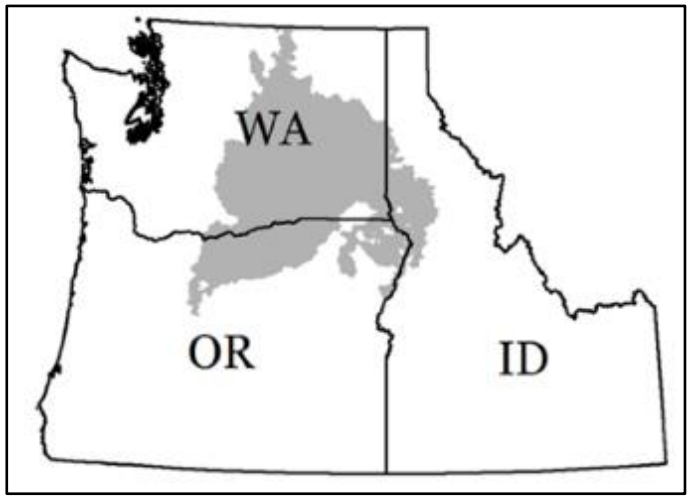
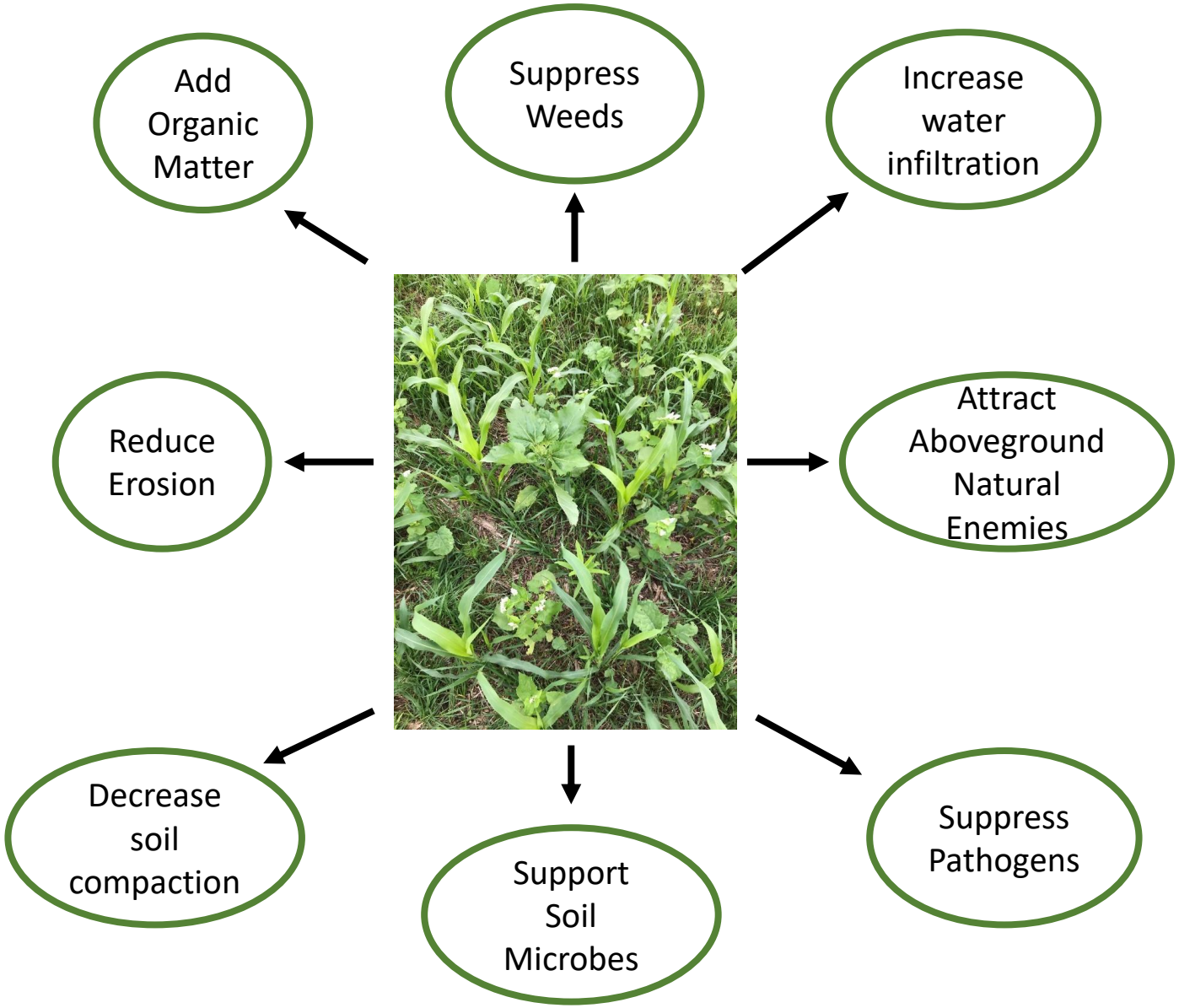
Agricultural Diversification

- The inland Pacific Northwest cereal production region
- Agricultural diversification in response to climatic variability in the inland Pacific Northwest (Kirby et al. 2017)
- Reduce the expansion of fallow (Kaur et al. 2017)
- Soil health: “the ability of a soil to function as a living ecosystem that sustains plants, animals, & humans.”



Cover Crops

- Incorporation of cover crops into rotations
- Cover crop = plants that are grown but not harvested
- Multiple benefits for sustainable agriculture (Western SARE 2019)
- Species and diversity matters
- Soil arthropods?



Cover Crops & Soil Arthropods

- Soil arthropods drive ecosystem processes that influence soil health (Nielsen 2019)
    - Decomposition
    - Nutrient cycling
    - Predation/biocontrol
    - Facilitate microbial activity
- Vital to assess how cover crops influence soil arthropods


Symphyla (detritivore)


Staphylinidae (predator)


Staphylinidae (predator)


Collembola (detritivore)


Collembola (detritivore)


Protura (detritivore)


Collembola (detritivore)


Acari (predator)


Acari (predator)


Diplura (predator)

Soil Arthropods as Soil Health Indicators

- Soil Biological Quality Index (QBS-ar) (Menta et al. 2018)
- High number of arthropod groups well adapted to soil habitats = healthy soil
  - Uses morphological characters that indicate adaptation to soil
- Sensitive to land use change and short-term variations in management


Dermaptera (Forficulidae)

No adaptation to soil=Score of 1


Collembola (Entomobryidae)

Moderate adaptation to soil=Score of 6


Collembola (Onychiuridae)

Maximum adaptation to soil= Score of 20

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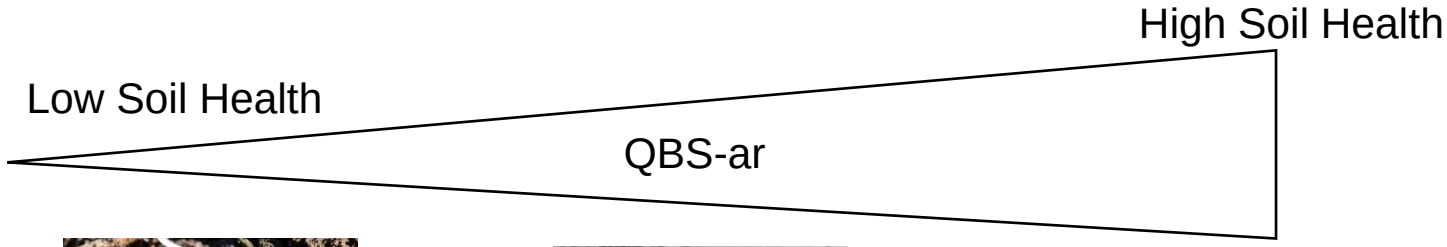


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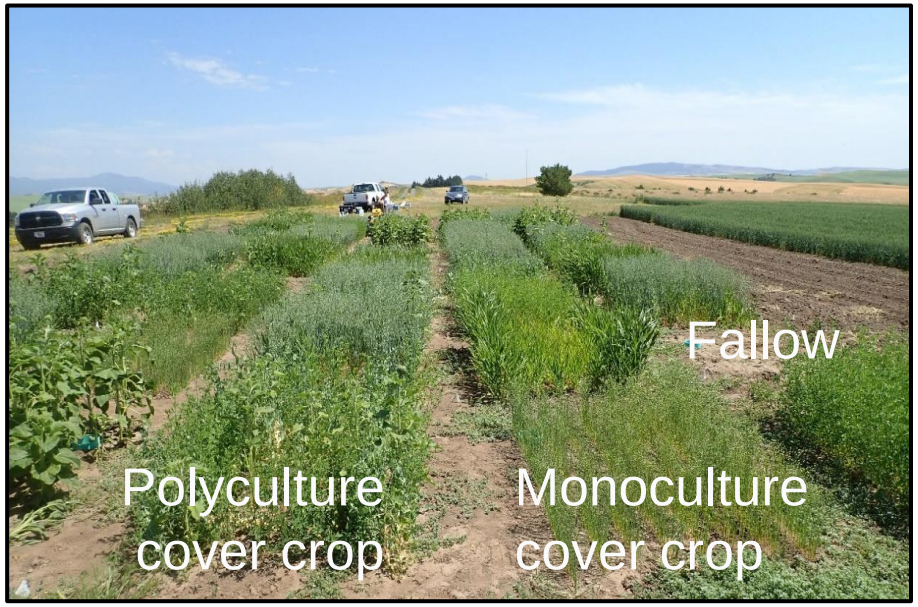
Objectives & Hypotheses

Obj. 1: Determine how cover crops influence diversity and richness of soil arthropod communities.

H1: Cover crops > diversity vs. fallow.

H2: Polyculture cover crops > soil arthropod richness vs. monoculture and fallow.



Obj. 2: Can we assess soil health/cover crop treatment effects using arthropods as bioindicators (QBS-ar)?

H: QBS-ar can detect treatment effects and inform their impacts on soil health.

Study Methods

- Small-scale replicated cover crop plots (2.0x2.5 m^2) in Pullman, WA

- Cover crop monocultures vs polyculture
  - Each species planted individually
  - Polyculture of all species
  - Fallow control

- Representative of cover crops used in inland Pacific Northwest

Fallow

Pea

Clover

Sunflower

Flax

Polyculture

Study Methods

- Arthropod communities sampled for 3 weeks during peak cover crop growth in 2019 and 2020.
- Communities sampled at a depth of 12cm
- Soil volume = 2000 cm^3
- Extracted using Berlese funnels
- 46 taxa characterized; 13,000+ individuals

Polycultures increase arthropod diversity

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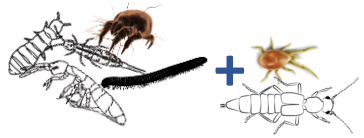


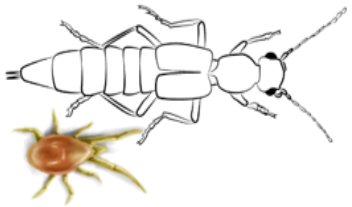
$F_{5,102}$=2.9; p=0.01

Arthropod H' / 2000 cm^3 Soil

2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00

A AB AB AB AB B

Fallow Flax Sunflower Pea Clover Poly



$F_{5,102}$=4.6; p=0.0008

Predatory Soil Arthropod H' / 2000 cm^3 Soil

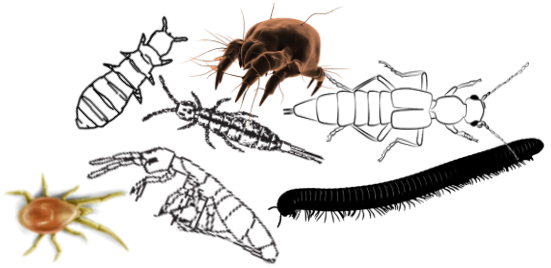
1.50
1.25
1.00
0.75
0.50
0.25
0.00

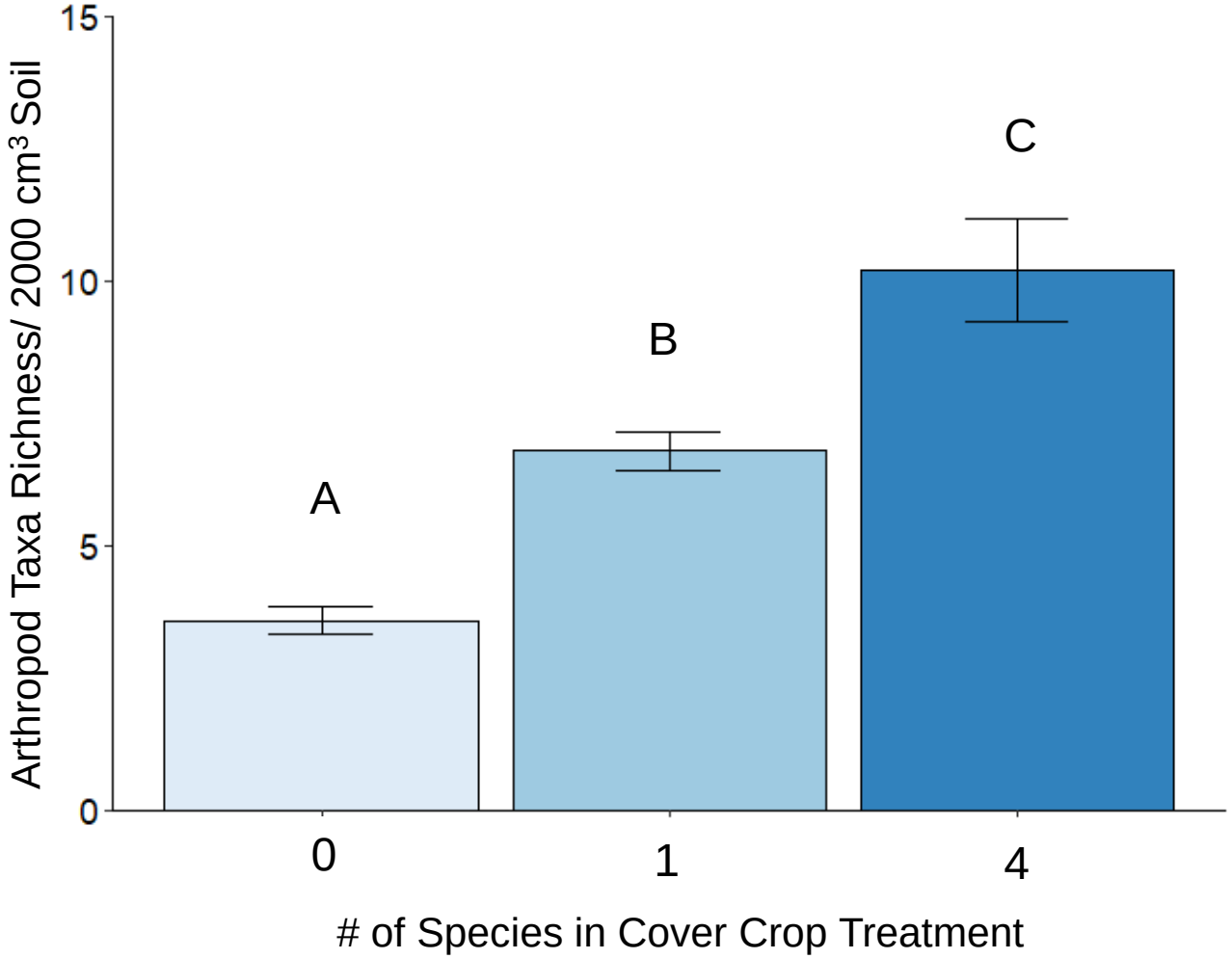
A A AB A AB B

Fallow Flax Sunflower Pea Clover Poly

Cover crop richness begets arthropod richness

1: Determine how cover crops influence diversity and richness of soil arthropod communities.
H2: Polyculture cover crops > soil arthropod richness vs. monoculture and fallow.





$F_{2,105}$=9.1; p=0.0002

Cover crops increase QBS-ar

2: Can we assess soil health/cover crop treatment effects using arthropods as bioindicators (QBS-ar)?
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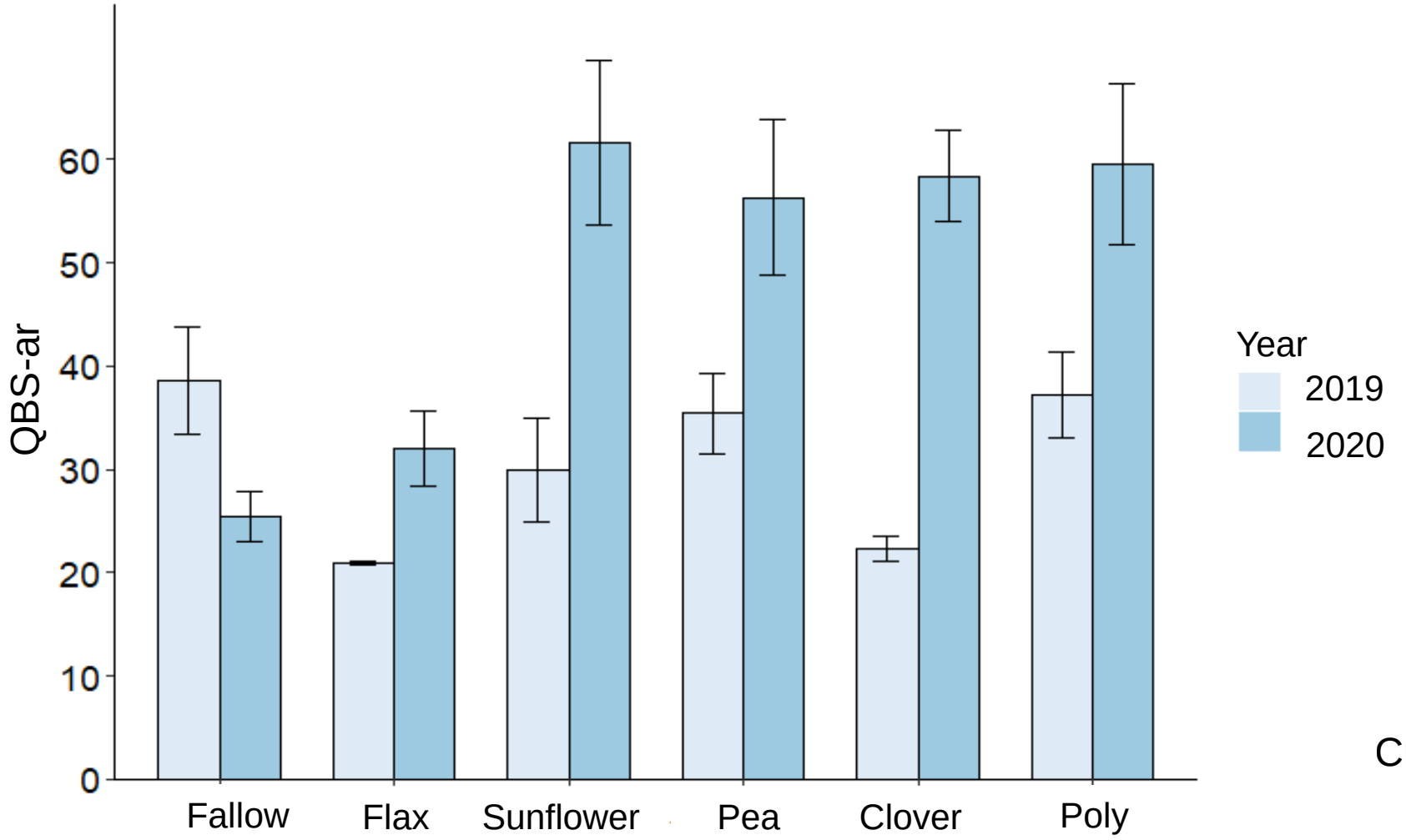

Crop x Year: $F_{5,96}$=5.96; p<0.0001

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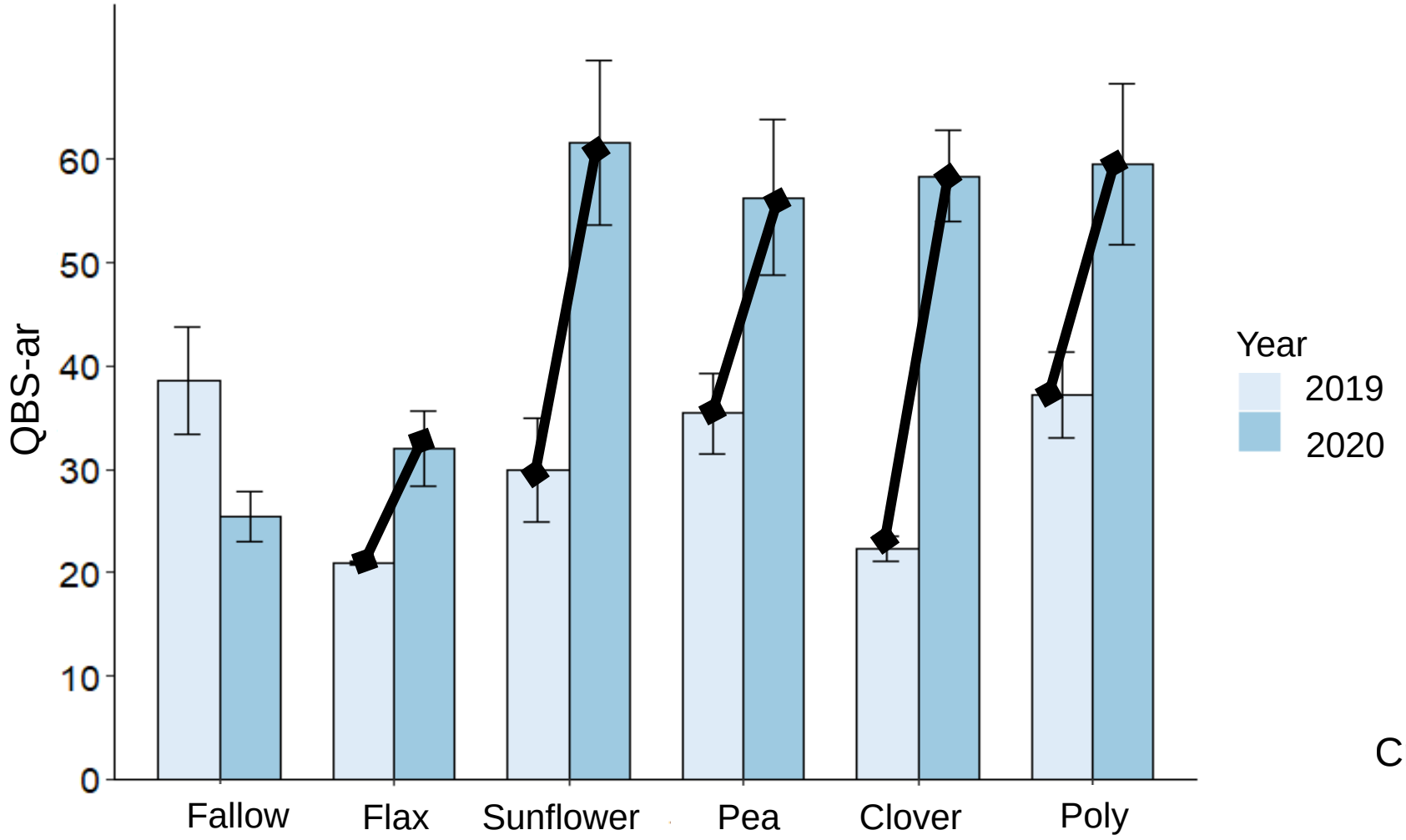

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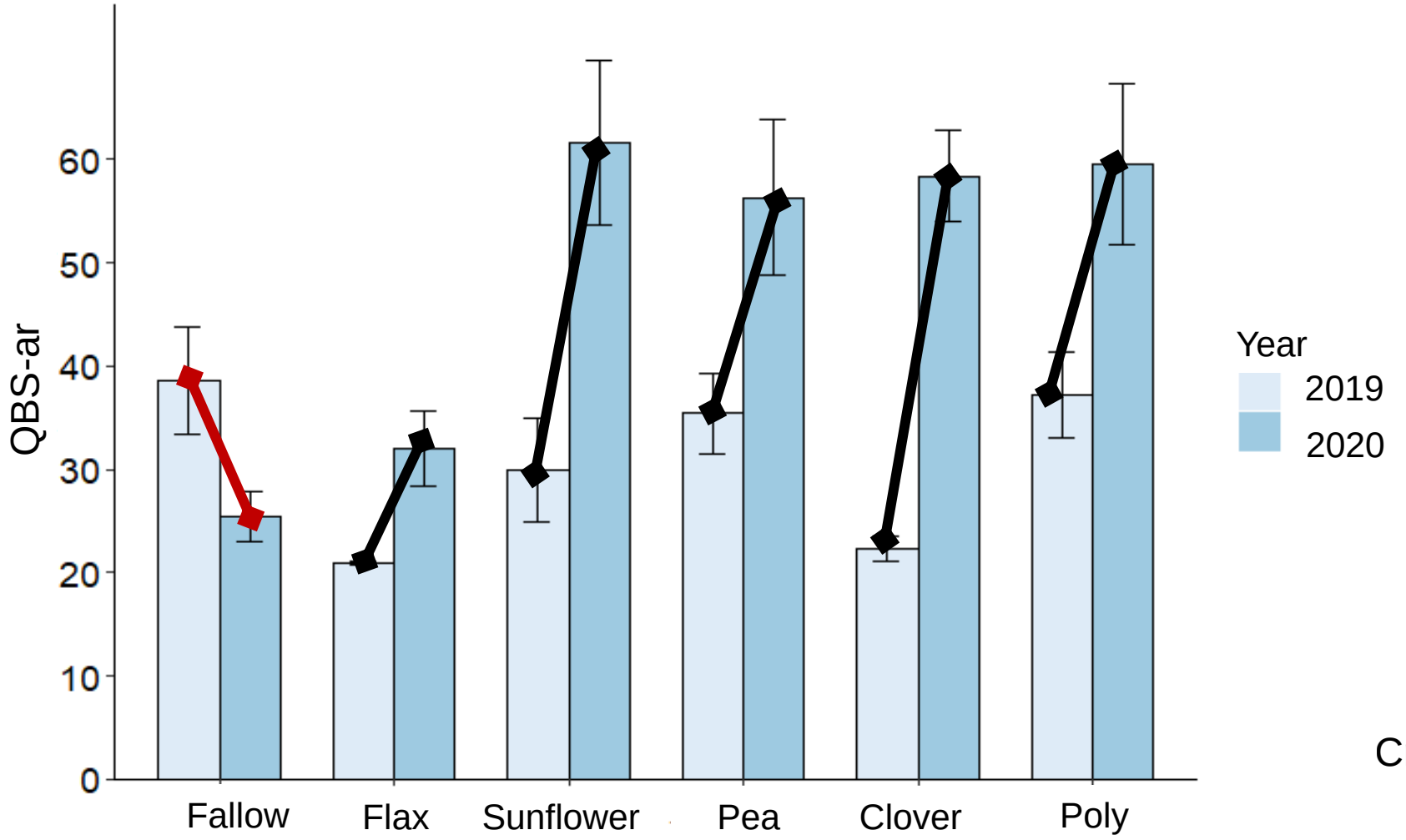

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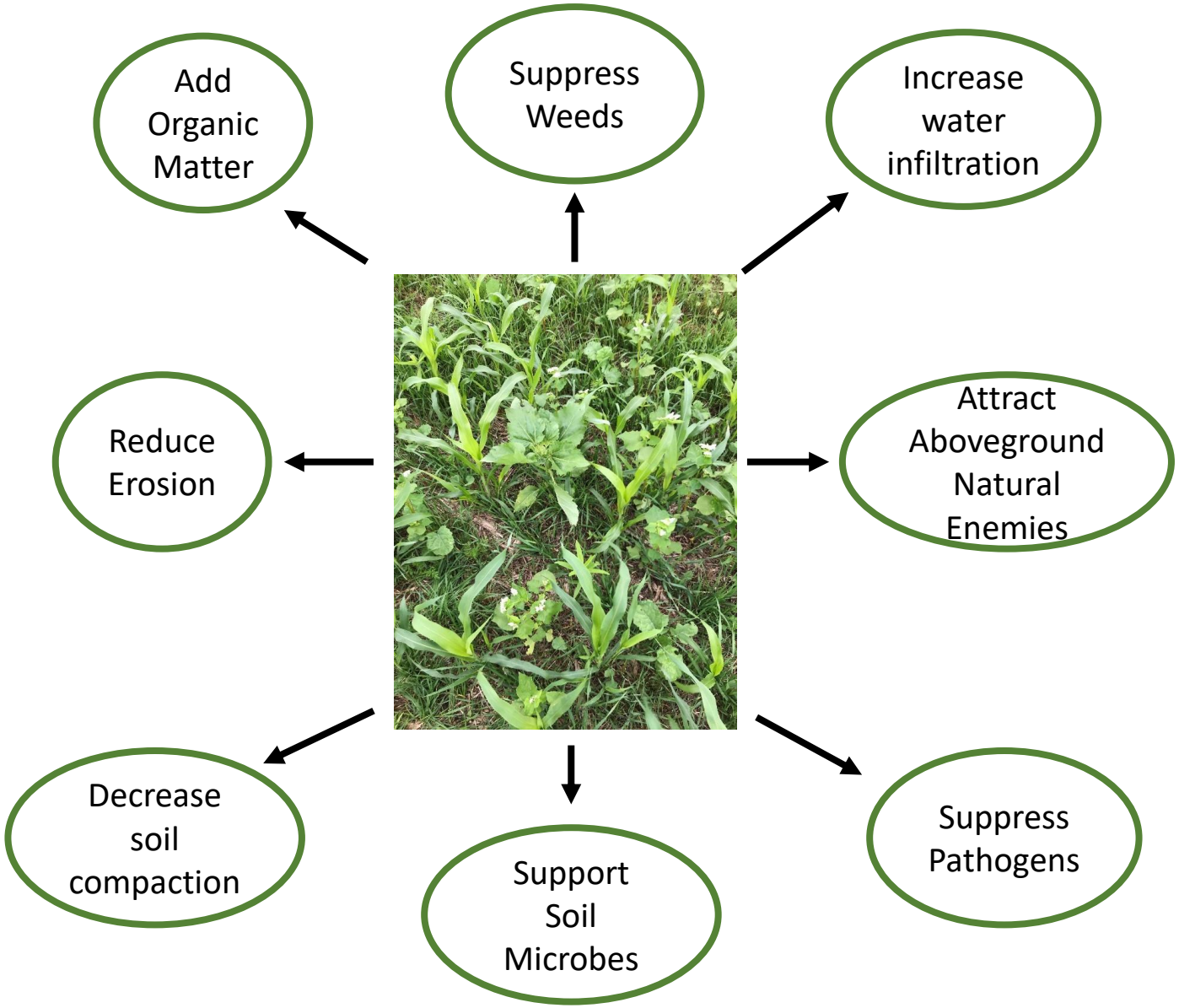
Conclusions

- Cover crops increase soil arthropod diversity; polycultures augment functional diversity of beneficial predatory soil arthropods that are important for biological control

- Aboveground plant richness drives belowground arthropod richness.



Conclusions

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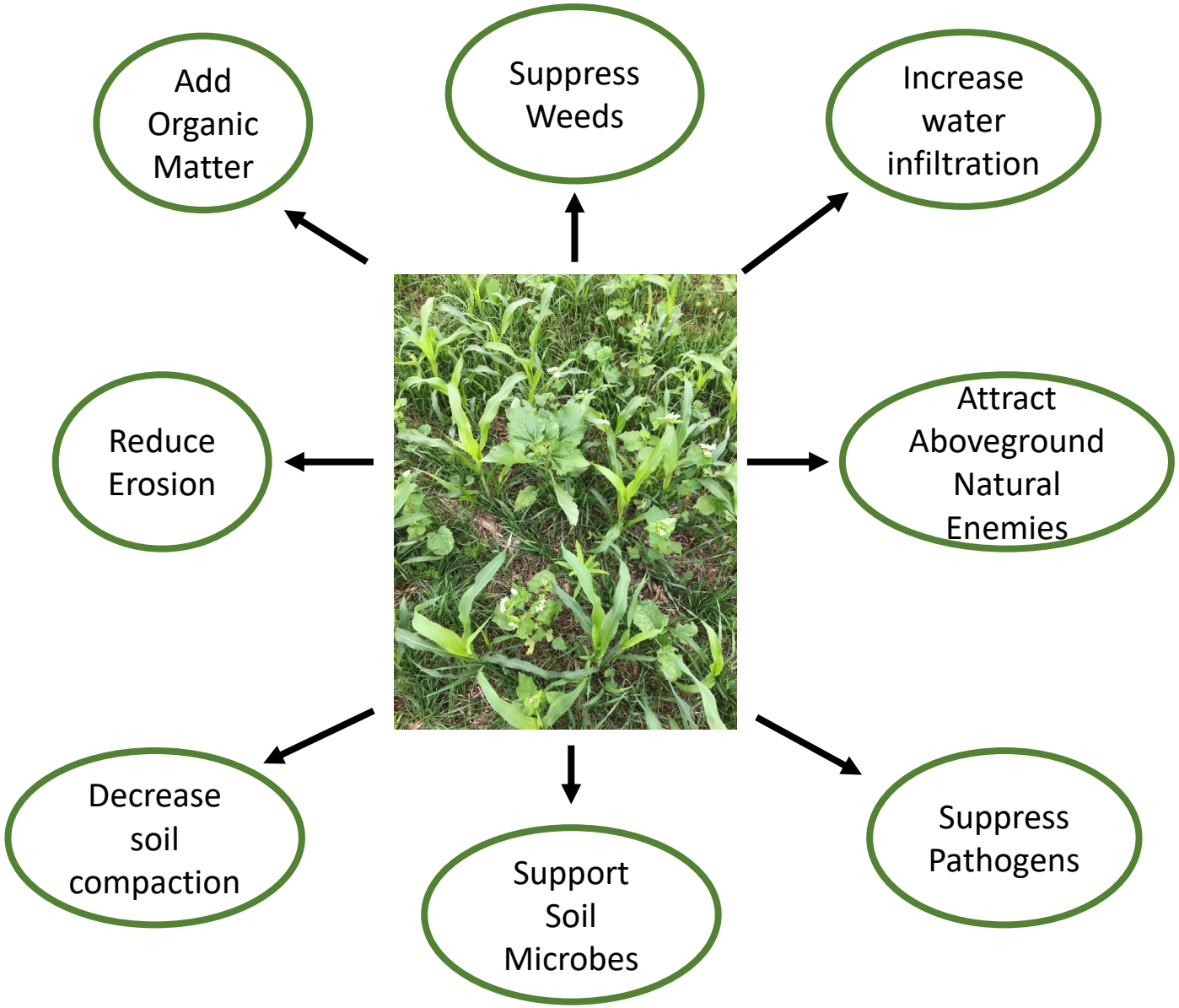
- Information about community responses to cover crops is novel
- Valuable to producers



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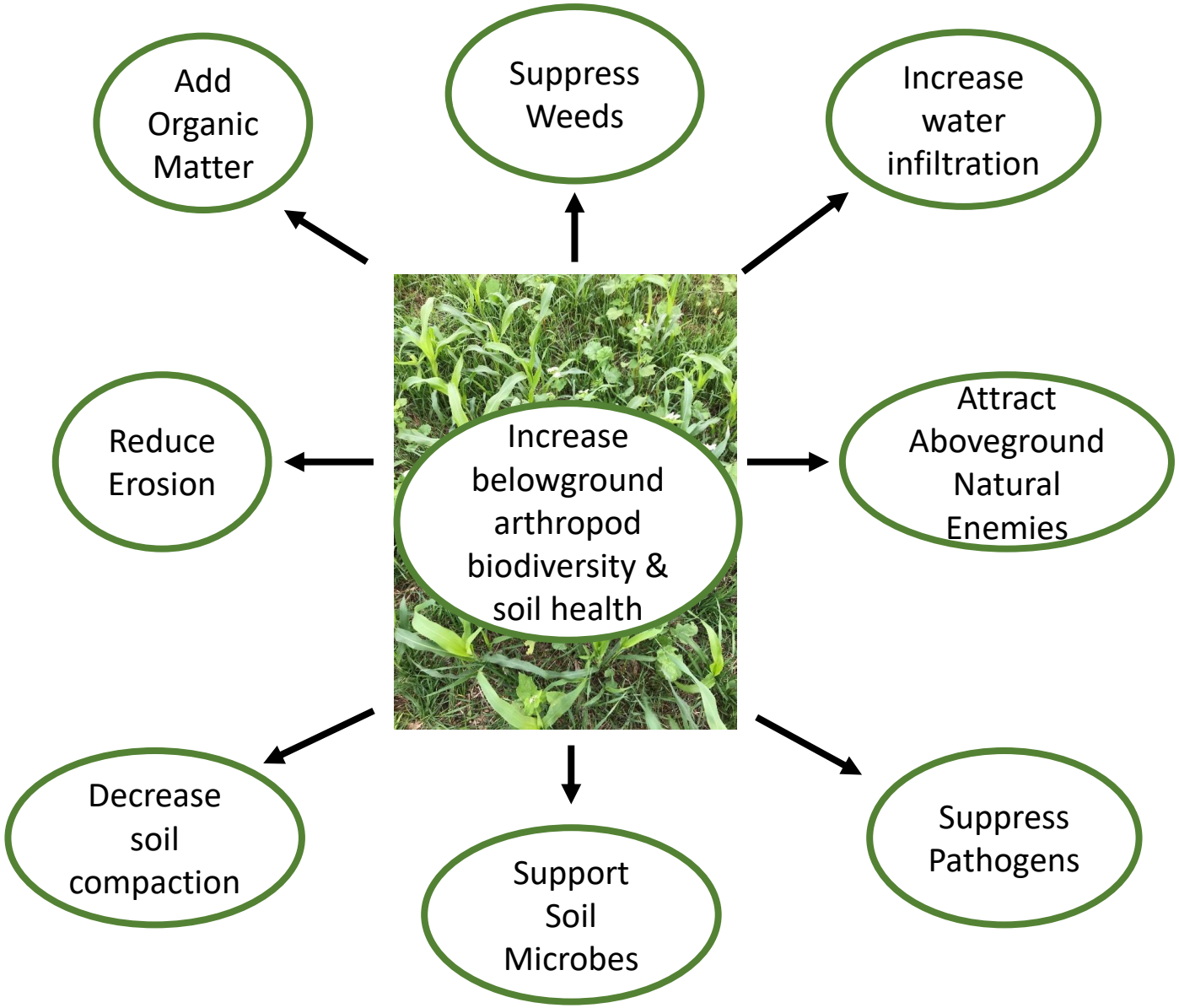

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QUESTIONS?

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