

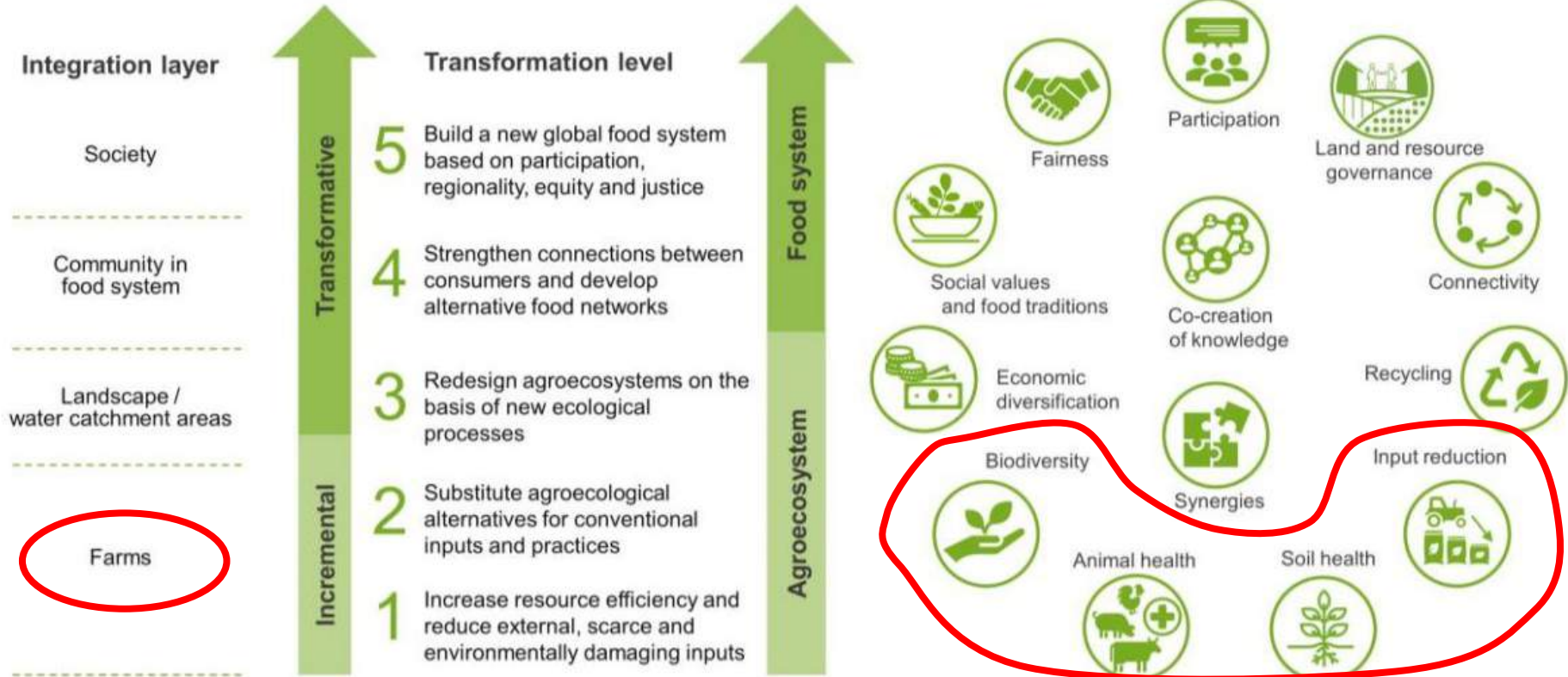
Polycropping & foliar feeding 101

11 March 2023



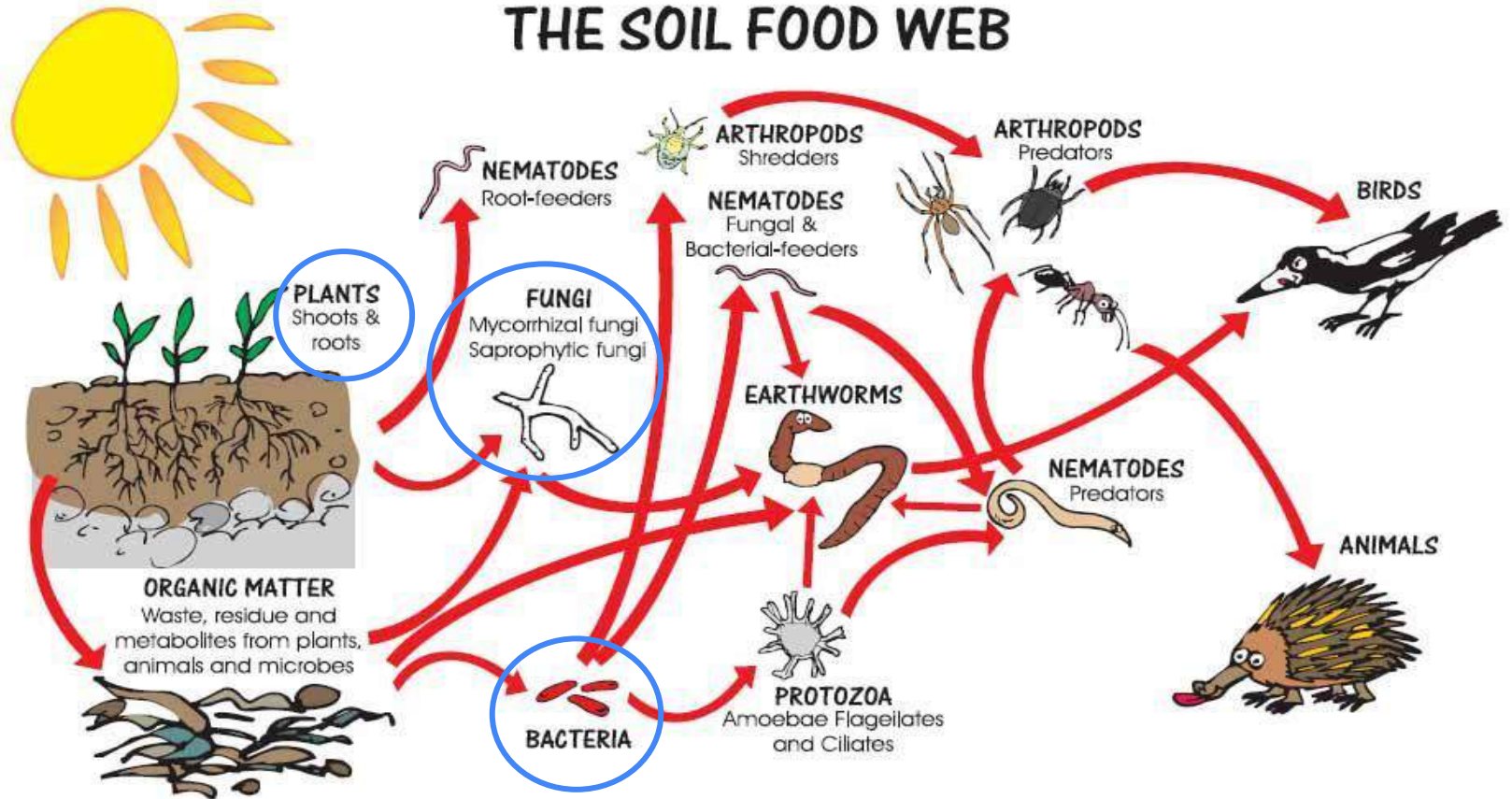
What is agroecology?

- Agro (agriculture)= farming to grow crops or rear animals
- ecology= the study of relationships among living organisms and their physical environment.



13 principles (HLPE, 2019) building on the 10 elements of the FAO (2018), and 5 levels of agroecology (Gliessman, 2014).

THE SOIL FOOD WEB



FIRST TROPHIC LEVEL:
Photosynthesizers

SECOND TROPHIC LEVEL:
Decomposers Mutualists
Pathogens, Parasites,
Root-feeders

THIRD TROPHIC LEVEL:
Shredders
Predators
Grazers

FORTH TROPHIC LEVEL:
Higher level predators

FIFTH & HIGHER TROPHIC LEVELS:
Higher level predators

What is polycropping?

Monocropping= 1 crop



This bed contains seven different crops: courgette, beetroot, rocket, lettuce, radish, kale, celery

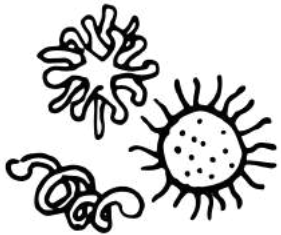
Polycropping= >1 crops

Why polycropping?

Polycropping can strengthen soil health and productivity by:

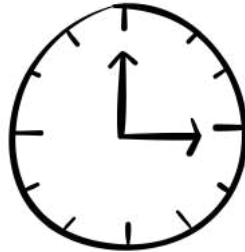
Supporting soil biodiversity

Different soil microbes have associations with different plant species. The more different plant species, the more diverse the soil food web - and we want complexity!



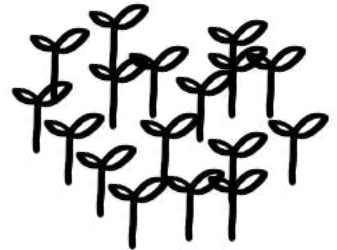
Reducing time soil left bare

By planting crops that mature at different rates, you might get a lettuce harvest and a broccoli harvest from the same bed without having to flip it in between.

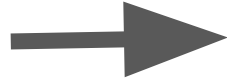


Increasing number of plants

By planting quick, small 'side-kick' species in the gaps between your hero crop plants, you can fit more in the bed.



Myth



Closer to the truth

Competition>collaboration

Plant growth is mostly limited by competition (eg for water, nutrients)

Nutrients out of a bottle

Plants consume chemicals sitting in the soil through their roots eg NPK, that we can apply from a bottle

Weeds are evil

Weeds are bad because they compete with the plants I want to grow

Collaboration>competition

Most plants send 30-50% of the sugars produced through photosynthesis into the soil to feed the soil food web . Plant growth more strongly correlated with the ratio of fungi:bacteria than with nitrogen, phosphorus, potassium or organic matter (Dr Johnson). Access to sunlight is important though!!!

Nutrients out of a bum aka the poop loop

Plants consume bio-available nutrition in the form of poo and bodies of soil microbes

Weeds are welcome 'volunteers'

Weeds are good because they add to the diversity of the ecosystem and strengthen the soil food web

Advantages

- Ecological resilience
- Faster soil cover
- Less evaporation
- Higher photosynthesis
- Higher productivity*
- Bare soil less often
- Opportunity for creativity and experimentation



Disadvantages

- More planning at start
- Can be challenging to have all seedlings ready to plant at the same time
- Slower harvesting speed
- Needs close attention so harvest crop at best time

Planning your polycrop

- Consider crop characteristics (shape & size, days to maturity, light needs etc)
- Work out which family the crop is from - we want a range of families not just species)
- Consider how crop harvested (pick- toms/beans, cut-lettuce/courgette, pull- beets/carrot)
- A simple way to begin is to think about 'heroes', 'sidekicks' and 'beaus'



Heroinex



Sidekick



Beau



Hero



Sidekick



Beau

	Heroes	Side-kicks	Beaus
Habit	Longer lived, larger crops that will come to dominate a bed over time	Smaller, shorter-lived crops that fill the gaps between the heroes while the heroes are small	Small or skinny, longer-lived crops that won't dominate the bed, but will remain after side-kick crops have been harvested
Planning	We plan our hero crops carefully; how many beds of that crop we'll need and when to plant them	We sow side-kick crops weekly so we always have some available to team up with whatever hero crop seedlings are ready to plant	We plan our beau crops based on what will suit a hero crop best in terms of size and days to maturity as these crops will stay in the bed together for longer together
Examples	Kale, broad beans, broccoli, cauliflower, cabbage, peas, Tomato, courgette, cucumber, eggplant, corn, pumpkin, watermelon, green beans, potato	Lettuce, rocket, bok choy, beetroot, carrots, radish, coriander, turnip, tatsoi, spinach, spring onion	Parsley, celery, silverbeet, leek, fennel, onions, carrot, basil, silverbeet, orach

Polycropping tips and tricks

- Experiment!
- Aim for 6+ different crops, all from different families
- Consider including crops that serve other purposes besides food eg clover as a nitrogen-fixing ground cover
- Plant closer than you'd expect (aim to cover all the soil asap)



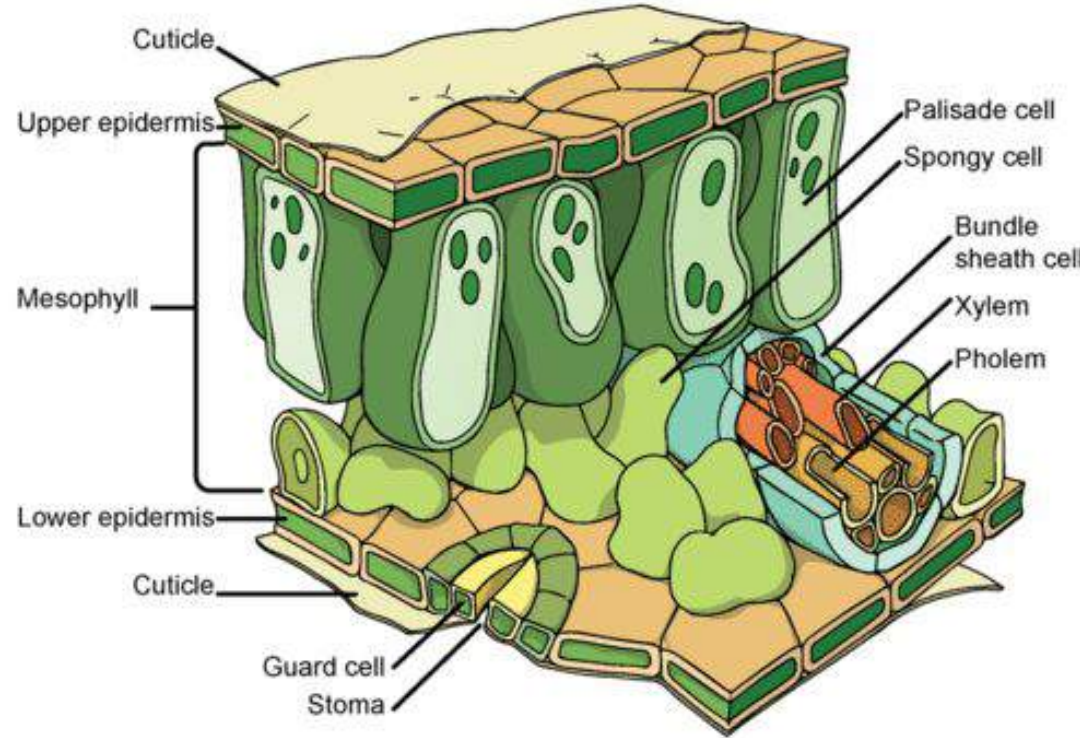
According to some geeks... ideal polycrop includes legumes, brassicas, chenopods, cereals and grasses, and 12-16+ species (but this is more about growing pasture, not vegetables). (If you are a pastoral geek, check out the JENA Project)

What is foliar feeding

Conventional definition: ‘feeding plants by applying liquid fertilizer to leaves’

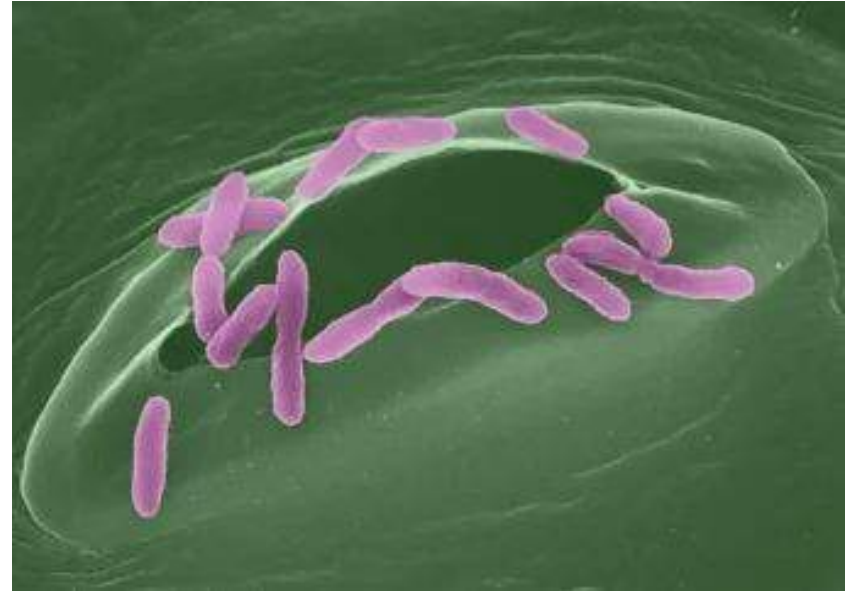
Phoebe’s version: ‘innoculating leaves with microbes and their lunchbox to protect from pathogens and boost ecological health’

- microbes can live on and inside the leaf. The spaces on the leaf most colonized by bacteria are the grooves, trichomes (surface cells), vein cells (xylem/phloem/ bundle sheath cells), and regions near the stomata
- requires application of feed as a mist or fine droplets (large droplets will roll off)



Life in the phyllosphere/ living on leaves

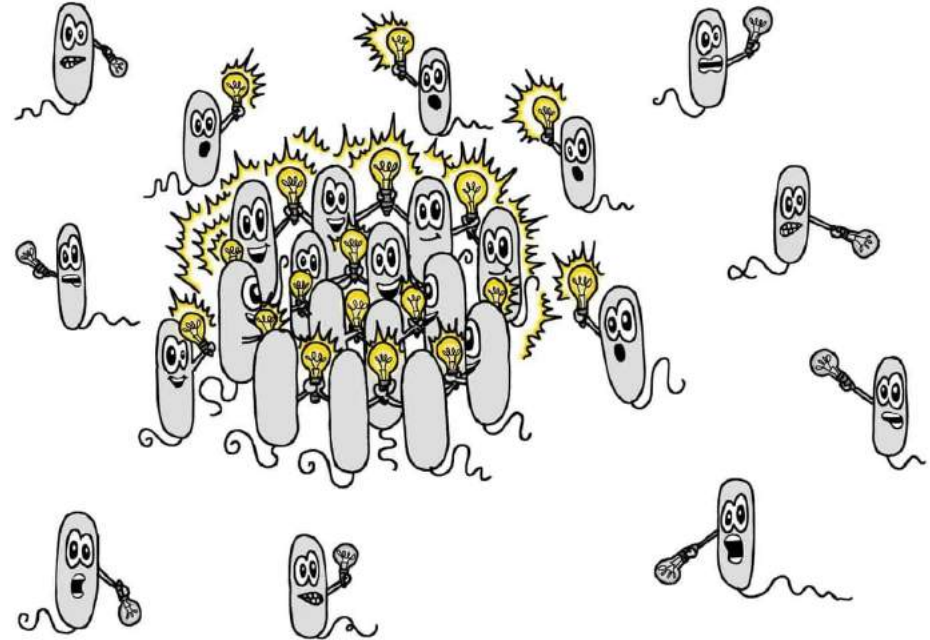
- 1 gram of fresh plant leaf may harbor 100 million+ bacteria (Remus-Emsermann&Schlechter, 2018)
- Friendly microbes on leaves= 'epiphytes'.
- Deadly microbes on leaves = 'foliar pathogens'
- Having a strong community of epiphytes can help protect plants from pathogens eg fungal endophytes of oak tree were found to help the tree resist powdery mildew (Jakuschkin et al., 2016).



Pseudomonas bacteria entering a plant leaf through stomata.

Quorum sensing and quenching: why bacterial numbers matter

- Bacteria can use **quorum sensing** to coordinate group behaviour. The behaviour only happens when the group of microbes reach a quorum (the chemical signal they are sending reaches a high enough concentration) eg *Rhizobium* bacteria fixing nitrogen in root hairs of host legume plants
- Bacteria can use **quorum quenching** to disrupt the QS signal to influence group behaviour of other species



Advantages

- Helps give a boost of protection to a plant/crop going downhill fast as plants can absorb through leaves faster than through roots
- Less volume required compared to soil drenching



Disadvantages

- Can take longer than soil drenching
- Not worth doing during heavy rains, high winds or strong sunlight

Lactobacillus Inoculum

Instructions

Make rice wash

1. Place rice and water in smaller bucket and stir vigorously until the water is cloudy white., or let it soak for an hour, stirring every 15 mins.
2. Strain to separate rice from water. Keep the liquid. Compost the rice..
3. Place lid on bucket but do not fully seal it so brew can breathe. (You can also use cheesecloth with rubber band).Store in a cool, dark place for 5 – 7 days. It's ready when it starts to smell sour and form three visible layers:a) Top layer: floating carbohydrates leftover from fermentation and possibly molds b) Middle layer: Lactic Acid and other bacteria. We will use this layer. c) Bottom layer: Starch, byproduct of fermentation
4. Extract the middle layer using a siphon.

Equipment

- 1 x 4 L bucket (with lid)
- 1 fine mesh strainer
- 1 x 20 L bucket (with lid)

Ingredients

- 1 cup of rice
- 1 L of water
- 10 L of milk (dairy)
- 4 tsp of black-strap molasses (sulfur-free)

Culturing (growing) Lactobacillus

5. Add the serum to 10L of dairy milk in a 20L bucket. Leave this blend in a dark place to culture for another 5 – 7 days. Again, put the lid on the bucket but do not completely seal it..(Or use a sealed container and a one way valve).
6. At the completion of this process, there will be a layer of curd sitting on the top. Skim off the curd and compost or eat. The pale yellow serum that remains is your unactivated inoculum
7. Now add 4 teaspoons of blackstrap molasses to provide enough food to just keep the lactobacillus ticking over. This serum must now be refrigerated or stored in the cold room and will have a shelf-life of around 12 months.

Activating and applying the inoculum

8. The completed lactobacillus inoculum is activated by adding 1 part serum to 20 parts unchlorinated water. The dilution is then added to the soil or foliar sprayed.

Foliar feeding tips and tricks

- Strain your fluid before putting in hand-pump sprayer (need mesh size >400 micrometers to allow fungi and nematodes to pass through)
- Wear a face mask when spraying- we don't want to inhale the bacteria ourselves
- Spray before 10am or after 3pm (strong UV rays kill bacteria)
- Turn spray applicator upside down so spray parachutes onto leaves
- Aim for >70% coverage of leaves, top and bottom

