

Nature provides four things for free

Rainfall
 Sunlight
 Carbon
 Nitrogen

Those farmers who are able to maximise what they get for free are better able to ride season variability.

As land managers we are expected to <u>manage</u> four things

Listed below in order of importance

Air
 Wate
 Decay
 Nutrient

How do farmers make Carbon?

Sunlight + Water

Both are FREE "Bags and Bottles" are not

Farm in a way that maximizes the amount of sunlight and water you collect.

Aim = improvement of SOM, biology, biomass, growing carbon, catching maximum water and sunlight to turn into either a cash crop or soil organic matter for future cash crops

CARBON THE KEY



SAME FIELD NO HERBICDE



MULTI SPEICES INTERCROP



Same field 15/10/2014



	Free-living nematodes/200 g soil				
	1 month	3 months	7 months		
Nil	705 c	1333 bc	966 bc		
4-species mix	3836 a	4111 a	1083 bc		
8-species mix	4559 a	4045 a	1499 bc		

Interaction table showing the effects of treatment (intercropping with multi-species mixes)

	Nematodes/200 g soil					
	Root-lesion	Root-knot	Spiral	Stunt	Stubby	Dagger
Nil	189 a	5 a	58 a	14 a	29 a	1 b
4-species mix	86 b	34 a	56 a	4 a	63 a	8 a
8-species mix	116 ab	12 a	19 b	3 a	39 a	5 ab

Effects of growing multi-species mixes as an intercrop for three successive years on populations of plant-parasitic nematodes

Plant-parasitic nematodes are one of the most important soilborne pests of sugarcane

Lesion nematode (*Pratylenchus zeae*)

 Lesions girdle the root and destroy the fine root system





Root-knot nematode (*Meloidogyne* spp.)

Terminal galling stops
 elongation of primary roots

These nematodes cost the sugar industry \$80 million per year

The reason plant-parasitic nematodes multiply to high populations is that sugarcane soils have lost their capacity to suppress the pest

In a properly-functioning soil food web, naturally-occurring parasites and predators will suppress nematode pests

Specific suppression

- A highly specialised parasite attacks the pest and keeps it under control
 - e.g. *Pasteuria*, a bacterial parasite of root-knot and lesion nematodes)

General (organic matter-mediated) suppression

- Is due to the combined effects of many parasites and predators
- The presence of these natural enemies is dependent on inputs of organic matter

Key message 1. Soil is the most complex ecosystem on earth

Organism	Approx. numbers per gram of healthy soil
Bacteria	100 million
Actinobacteria	10 million
Fungi	1 million propagules; 2 km of hyphae
Algae	10,000
Protozoa	10,000
Nematodes	50

Many other small animals are also present

Mesofauna (mites, springtails, symphylans, potworms). Mite populations are often > 100,000 per square metre

Macrofauna (isopods, centipedes, millipedes, spiders, beetles, termites, ants, earthworms)

Key message 2. The root-soil interface is a zone of intense microbial activity

- Significant quantities of sugars, amino acids and other labile compounds are exuded by roots
- Populations of microbes on the root surface may be 100 times higher than in soil 1 mm away

Why do plants leak photosynthates?

- They are attracting beneficial microbes and soil fauna to
 - improve the plant's nutritional status
 - defend the plant from pests and pathogens

Key message 3.

Carbon from plants is the energy source that sustains the soil biological community

- All soil organisms ultimately depend on organic matter derived from plants
 - Living plant material
 - Detritus on the soil surface
 - Exudates from roots
 - Decomposing roots
- The carbon in organic matter is either consumed by microbes, or is passed along the food chain via predators

Environmental factors influence the activity of soil organisms

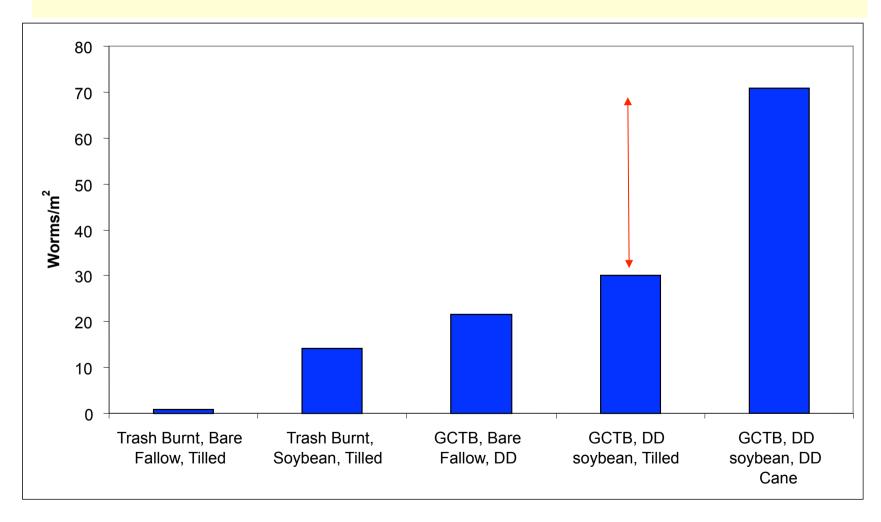
The major factors that influence achievable populations of soil organisms are:

- Temperature, moisture, soil texture, aeration and pH
- But..... soil organisms also modify their environment
 - For example, they enhance aggregation and create macropores, thereby changing soil water-holding capacity and improving drainage

There are no silver bullet solutions to soil health problems

- A soil with 1.2% organic C contains about 25 tonnes of organic matter/ha.
 - Is an organic additive applied at 100 kg/ha likely to make a difference?
- Introduced organisms must compete with enormous numbers of indigenous organisms
 - Thus, biological products are usually ineffective, or have no more than short-term effects
- Since there is little scientific evidence that soil improvers, microbial inoculants and organic products are useful, growers wishing to test such products should:
 - Establish replicated strips (product v untreated control)
 - Measure the impact on yield
 - Undertake a cost-benefit analysis

Some of the biggest effects are on soil macrofauna like earthworms

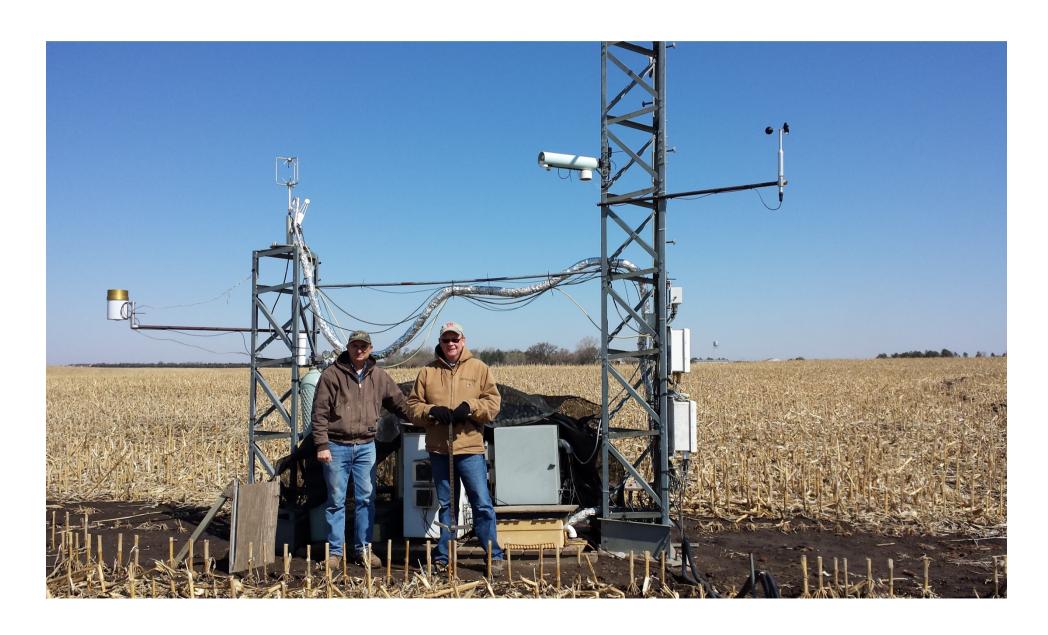


Earthworm numbers increase rapidly after a soybean break crop, particularly if it is not cultivated

WHAT IS A DIRTY ORCHARD

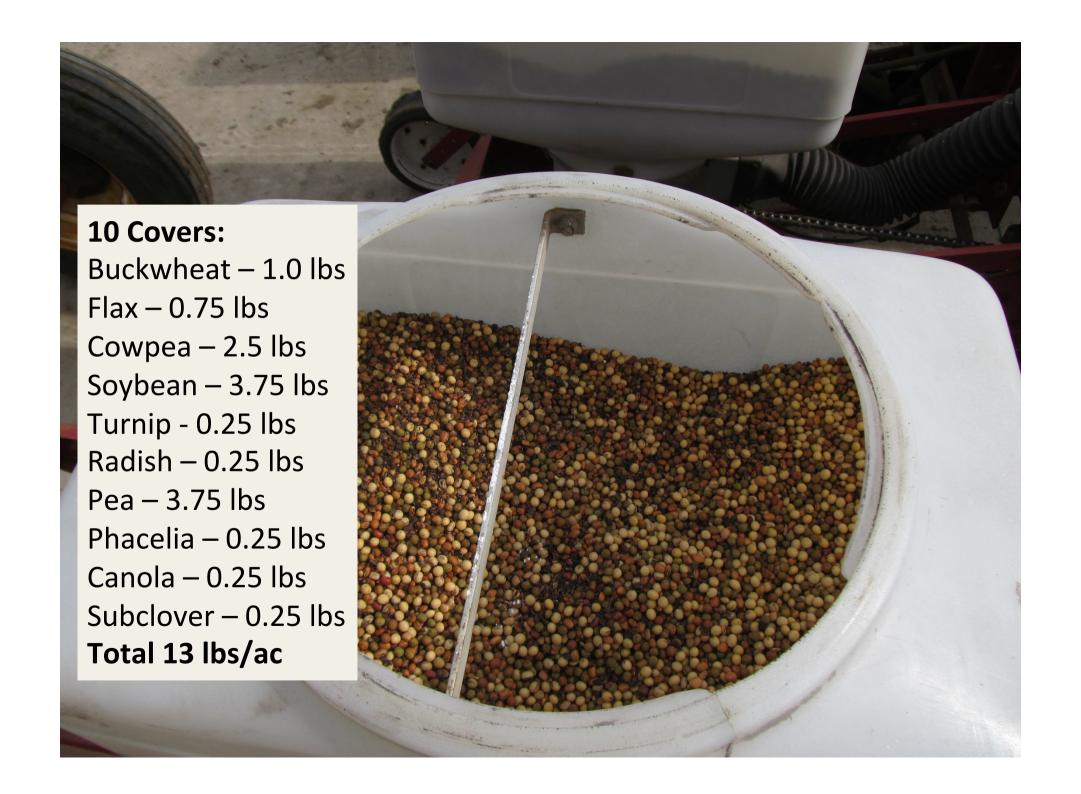


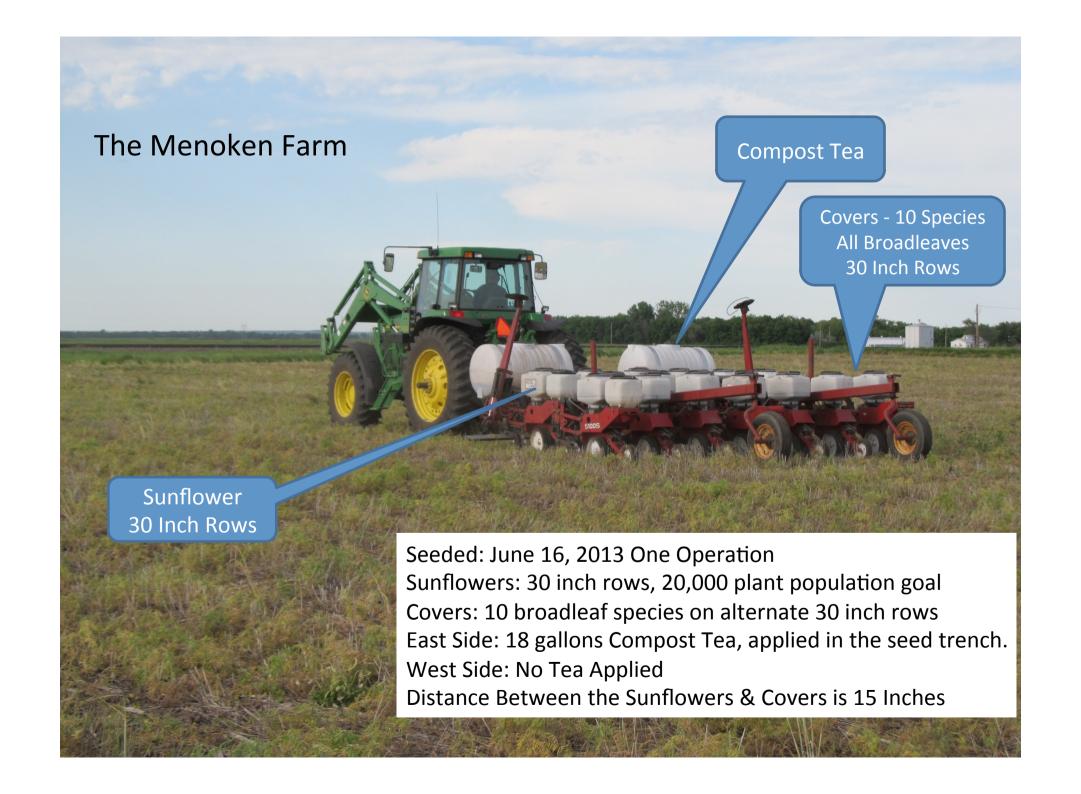
BUILDING SOIL CARBON



POLYCULTURE









Plant diversity the key to natural systems, enables biological diversity and nutrient cycling.



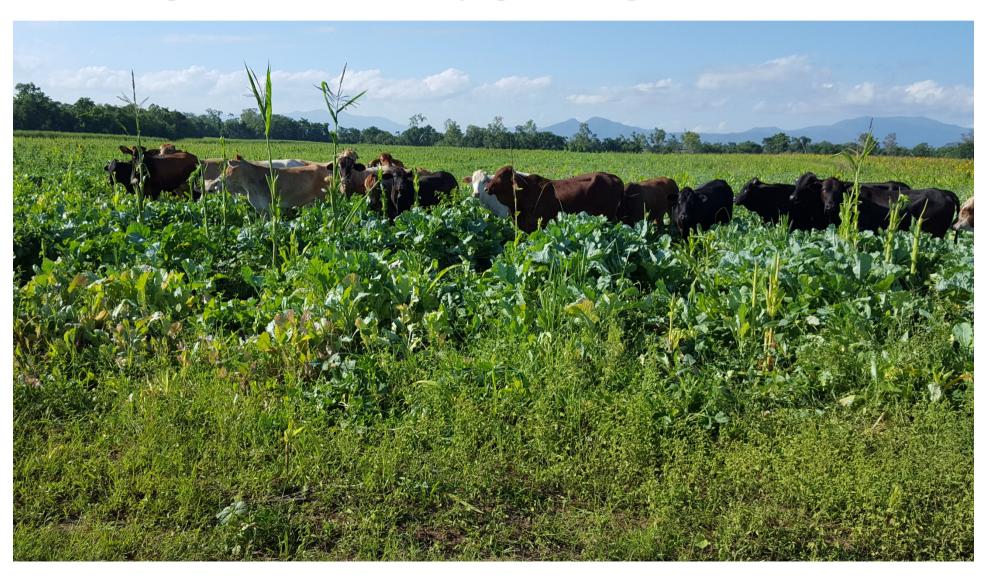
Harvesting sunflower over the top of plant cane a first for Australia. Companion cropping for profit, and soil health.



Field yielded 2.2tph soybean April 2015, planted to cane and sunflower May 2015 sunflower yield 1.7tph, cane went on to yield 112tph 11 months later.



Multi species cover crop on cane fallow being harvested by grazing cattle.



THE POWER OF NUFFIELD

