Notes from:

For the love of soil

A regenerative system of soil management is one that encourages the soil to look after its self. You are there to tickle rather than micromanage the system!

Nicole Masters

Soil Health Principles

- Maintain soil groundcover and protection
- Living roots for as long as possible
- Incorporate livestock and/or their manures where feasible
- Diversity, diversity, diversity
- Optimise plant photosynthesis
- Reduce disturbances
- Manage for what you want rather than what you don’t want
- Factor in climate and circumstances

Living Soil

Air

Water

Food

Shelter

Nematodes

- Canary in coal mine for soil health
- Bigger than other microbes - can sometimes be pathogens
- Create space in soil

Fungi

- Hold soil together
- AMF relationship with plants
- Buffer against pollution, remediating soil
- Create communication chanels for nutrient transfer
- Water holding & carbon building
- Sensitive to disturbance

Bacteria

- Eat green matter (simple sugars)
- Soil clean-up crew
- Release heat from metabolism (steamy compost)
- Bacterial soils retard plant growth
- Bacterial soils are constipated in dry areas and have diarrhea in wet zones

Protists

- Flaggelates, amoebae & cillates
- Main group responsible for nutrient cycling
- Eat bacteria & fungi to maintain B:F ratio

Microbes & Soil Chemistry

The soil is a living chemical factory & recycling plant:

- Microorganism create new chemistry as a result of their metabolic processes
- Microorganisms break-down and digest chemicals, often in a way that makes nutrients more bioavailable for plants.

Chemistry

Nitrate removal

With humates, milk, fish hydrolysates and vermicast

Calcium

Improves environment for beneficial soil microorganisms. Essential for plant growth

Fungi play an essential role in making calcium available to plants, poor soil fungal activity leads to an increase in disease

Plant communication to evade attack

- Benzoic Acid
- Methyl Salicylate
- Chitosan
- Plant hormones - auxins, gibberellins, strigolactone, cytokinins, abscisic acid, ethylene and Jasmonic, salicylic and b-aminobutyric acids.

Humic Acid & Humates

Found in worm casts & compost. Increase communication pathways - Quorum Sensing

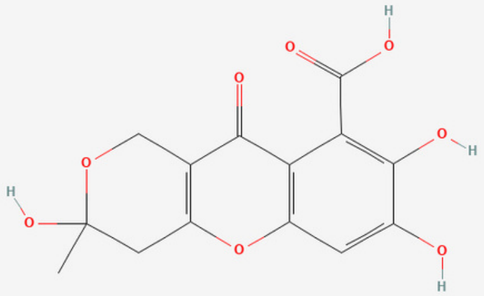
Soluble Nitrogen (input)

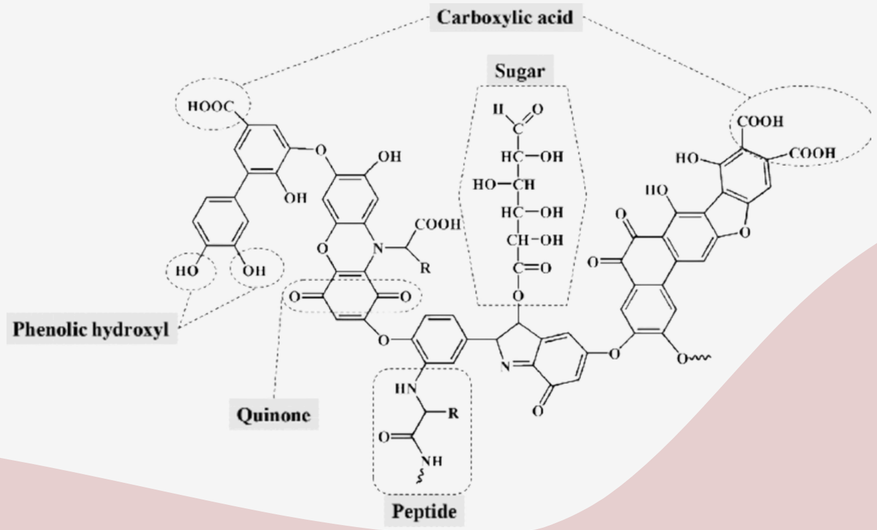
- Applying nitrogen as an input delivers deminishing returns.
- Creates entropic system (disordered/ chaotic)
- Encourages breakdown of soil carbon and humus.
- Alters soil microbiology shifting it to a more bacterial dominant environment
- Decrease in carbon can lead to an increase in compaction
- Reduced BRIX
- If you add Nitrogen, you have to add Carbon

Every time we disturb the soil, microbes wake up hungry and if we don't feed them, bacteria will become dominant as they feed upon the soil carbon.

Solution: RIP & DRIP.
molasses & humic acid spray

Humic & Fulvic Acids





Humates are formed as a product of plant decomposition and are coloured chemicals with tones ranging from yellow through brown and black. Humates are a major contributor to organic matter in soils and sediments on both land and sea. They play a major role in cationic exchange of minerals.

Fulvic acid compounds are also formed from the break-down of biological matter. Fulvates have disease-fighting qualities.

Both humates and fulvic acids are natural chelating agents, increasing nutrient uptake & promoting beneficial soil microbes.

Polysaccharides - Laminarin & Fucoidan

Kelp

When using whole kelp and seaweed there could be an issue with arsenic and iodine over time

Seaweed Solutions

Fish lysates

Polysaccharides are carbohydrates & are made up of many sugar units bound together. Both Laminarin & Fucoidan have antixodiant, anti-inflammatory & anti-viral actiions, both in the soil & for human health. These molecules occur in soil crusts & microalgae where they play an important role in helping soil retain moisture. Fucoidans also play an important role in long-term carbon sequestration.

Reference: Karuppusamy S, Wanigasekara J, Fitzpatrick S, et al. Investigation of Biological Activity of Fucoidan and Laminarin as Bioactive Polysaccharides from Irish Brown Macroalgae. Cells. 2024;13(23):1938. Published 2024 Nov 22. doi:10.3390/cells13231938

2) Wei Li, Jichen Chen, Yuan Feng, Xu Li, Guang Gao,
Production and ecological function of fucoidans from marine algae in a changing ocean,
International Journal of Biological Macromolecules,
Volume 283, Part 4, 2024, 137944, ISSN 0141-8130, https://doi.org/10.1016/j.ijbiomac.2024.137944.
https://www.sciencedirect.com/science/article/pii/S0141813024087555)

Nutrient cycling starts with effective communication

Microbes bring life to the soil and through them and make it possible for whole ecosystems to form. Healthy microbial communities communicate via Quorum sensing.

Early colonisers of soil include moss & lichin on rocks, algae, fungi, bryophytes & cynobacteria as well as complex communities called cryptogams. These are essential soil protectors.

Biological Soil Crusts

Cryptobiotic soil crusts/ Cryptogams

The cyanobacteria and bryophytes photosynthesise, adding carbon to the surface layers of soils. Cyanobacteria also fix nitrogen, taking it from the air and converting it into a form that can be used by plants.

Biological soil crusts protect the soil from erosion and other adverse weather events. They even reduce the intensity of fire as a result of them reducing the germination rate of weedy grasses.

Ref: https://www.bushheritage.org.au/news/biological-soil-crusts?srsltid=AfmBOor_iIAhtR3dSDC3LmO_mz8Maehe60s2kVu9xu8UeTgnc2jJNIgE

Quorum Sensing

Humic acid

Vermicast

Fulvic Acid

Microbial cells communicate via a process called Quorum Sensing. To do this, microbes secrete signalling chemicals which are picked up by neighbouring microbes who respond, forming a communication network. Quorum sensing is important in the formation of biofilm formation - a process that enables microbial communities to protect soils from erosion. Quorum sensing also facilitates the secretion of other chemicals including those useful for the health and vitality of the community.

Soil Digestion

Without good digestion your nutrient cycles grind to a halt.

Soil can be constipated, have diarrhea, indigestion or gas

Worm Farm

The perfect worm farm makes no liquid. This liquid is undecomposed food waste & tells you the farm is bacteria dominant & more carbon rich materials are needed. Good quality worm teas are made by flushing water through vermicasts. Should be chocolate or yellowy in colour. Stable for a year and have no real smell.

Biofertilizers

Nitrogen fixers: rhizobia, mycorrhizae, azobacter, azospirillum, phosphate solubilising bacteria. Soluble humates, compost extracts, vermicast, fulvic acid

Every time we disturb the soil, microbes wake up hungry and if we don't feed them, bacteria will become dominant as they feed upon the soil carbon.
RIP & DRIP = molasses, humic acid only about 1 cup per acre molasses + 1 litre humic

Soil Carbon

Acts like a giant sponge, soaking up water. This water then activates the microbes to start working.
2 main carbon cycles in soil. Top 6 inches in soil. Short (digests roots & dead plants). Long - deep draw-down of carbon into soil. Carbon captured by photosynthesis and stored in soil from root exudates. Stored 150-200mm. Fungi in soil can also make rock - weddelite ((CaC2O4·2H2O)), Calcium oxalate (Cac2O4 - also found in kidney stones along with weddelite) & glushinskite (Mg(C2O4)•2(H2O))

Soil Management Strategies

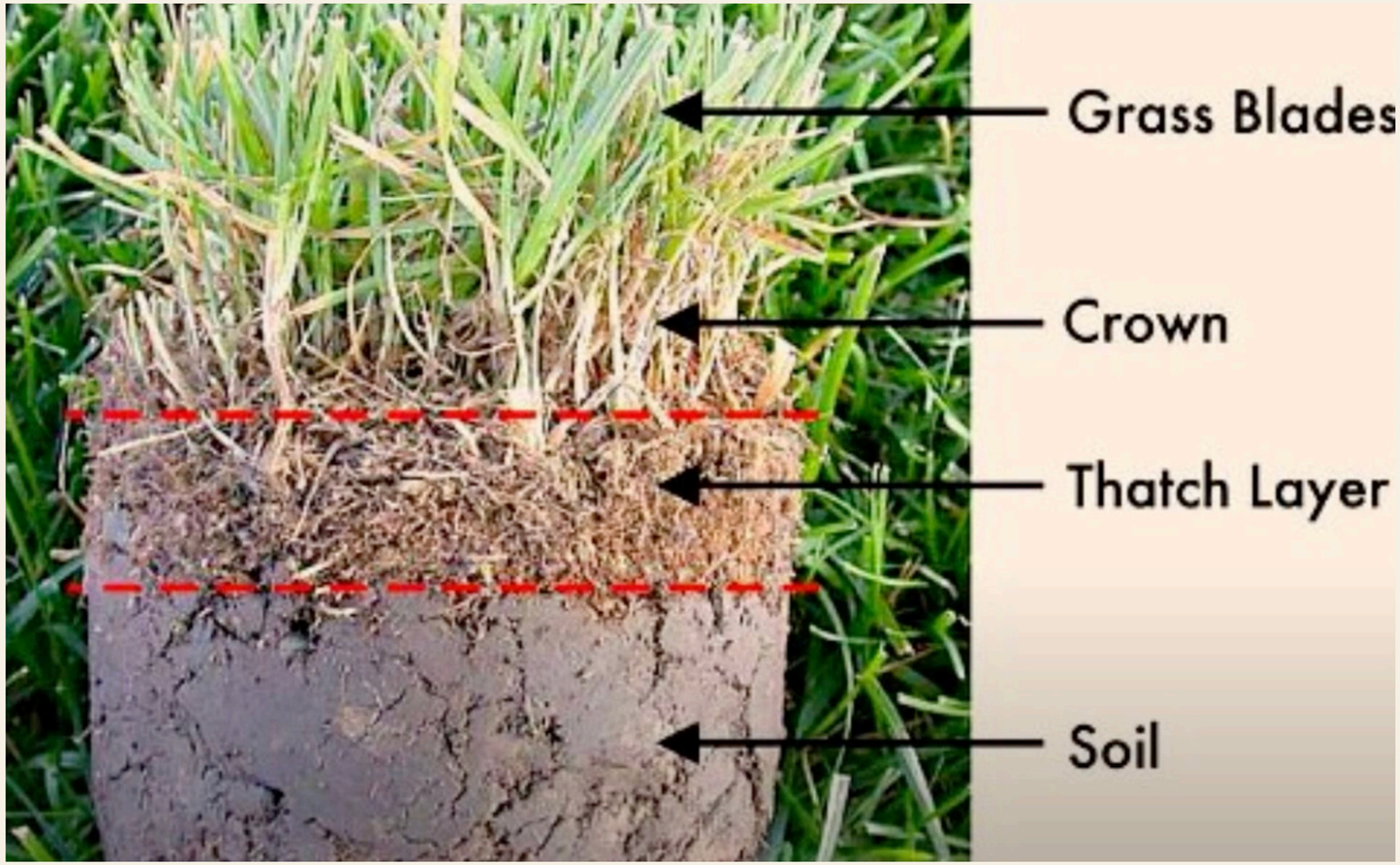
Nicole's book is great for helping us understand and identify potential problems in our soil. Biologically-friendly solutions are also presented as case-study narratives.

Without measurement there is no management

This includes observations/ narrative measures.

- Brix = plant health
- Total microbes = carrying capacity (the soil has food but what's it feeding)
- Fungi:Bacteria ratio = Conditions & nutrition & Management
- Compaction = Air in soil
- Water holding capacity = living soil needs to hold water
- pH = microbes and plants have preferred pH levels
- Temperature.

Thatch



Thatch is a dead layer of plant in between crown and soil. This reduces root infiltration & creates an anaerobic system which can become compacted. Can also reduce photosynthesis. Can happen when tall grasses fall over.

Solve thatch by a) building soil back up and covering roots or b) re-sod

Dethatch pasture using animals - chickens scratch ground and that helps. Pigs can do that too.

Temperature

Testing & recording soil temperature is a quick, cost-effective and efficient way to evaluate your soil. Bare soil is more likely than covered to fluctuate widely in temperature with very high and very low readings being likely to reduce microbe activity, especially when the soil is devoid of plant matter.

Brix

An approximate measure of a crops sugar content. Taken from the juice

Degrees Brix (symbol °Bx) is a measure of the dissolved solids in a liquid, based on its specific gravity, and is commonly used to measure dissolved sugar content of a solution.[1] One degree Brix is 1 gram of sucrose in 100 grams of solution and represents the strength of the solution as percentage by mass. If the solution contains dissolved solids other than pure sucrose, then the °Bx only approximates the dissolved solid content. For example, when one adds equal amounts of salt and sugar to equal amounts of water, the degrees Brix of the salt solution rises faster than the sugar solution, because it is denser. The °Bx is traditionally used in the wine, sugar, carbonated beverage, fruit juice, fresh produce, maple syrup, and honey industries. **Ref:** Wikipedia

Use Brix to check what's happier - **weeds** or desired species

Higher Brix in target plants, lower spoilage by **insects** aiming for over 12 for grasses, 14 for legumes

Weeds

- Colonise bare soil
- In response to low organic matter
- To open up compacted soil
- In response to mineral availability
- Microbial stimulation
- As a safety valve for toxins

- Purslane (portulaca oleracea), Scrambling fumitory (Fumaria spp), Field Bindweed (Convolvulus arvensis), Spotted spurge (Euphorbia maculate)
- Fleabane, Dandelions, Cape daisy, knapweed, Mayweed, Hawkweed, Yellow alyssum, Leafy spurge (Euphorbia esula)
- Clubmoss, Dock (Rumex), Buttercup, Thistles, Pennyroyal rushes, Sedges, Chamomile, Pennyroyal (Mentha pulegium)
- Nitrate & release valve weeds) Black nightshade, Cape Weed, nettles, Kochia, Fat hen (Chenopodium album), Foxtail barley grass, milk thistle
- High potassium, low phosphorus: Dandelions, PLantain, Thistle, tansy, Wild radish, Purslane, Nightshade, St Johnswort, Inkweed.
- Foxtail barley (hordeum jubatum), Couch (elymus repens), Wild Oat, Cheat grass, Barnyard Grass (Echinochloa)

Fungal or Sleepy Soils

Blackberry, wild rose, poison oak, hemlock, Foxglove, hollyhock, hawkweed, bloodroot, wormwood, mullein, St Johns wort, Houndstongue, matagouri, bracken, gorse, broom, rabbitbrush, sagebrush, willow, sweet briar, african boxthorn, mesquite

Non-mycorrhizal/ disturbed habitat

Sedges, reeds, brassica, shepherds' purse, pigweed, tumbleweed, stinging nettles, lupins, protaeceae (Macadamia/ bottlebrush)

In Phosphorus limited environments there's cyperaceae, haemodoraceae, proteaceae and restionaceae

Monitoring Indicators

Soil

Structure/ porosity

Colour & # of mottles

Soil colour/ carbon

Earthworms/ dung beetles

Soil smell/ taste

Infiltration rate

Water holding capacity

Surface relief

Temperature

Penetrometer (compaction)

pH/ EC (Electrical conductivity)

Soil mineral tests

Enzyme Acticity

Respiration

Fungi:Bacteria ratios

Mycorrhizal colonisation

Biological diversity

Plant Indicators

Sap BRIX/ EC/ pH

Plant growth

Plant diversity

Legumes (Nodules red)

Weeds/ pests/ disease

Plant colour

Urine/ manure patches

Pasture utilisation/ palatability

Rhizosheath development

Root length and root density

Area of bare ground

Drought stress

Input costs to maintain production

PLant tissue tests: minerals RFV, ADF, Crude protein

Storage & Digestibility

Near Infrared spectroscopy