

NTS
Nutri-Tech Solutions®

Nutrition Farming Explained – Day 1

Profit Building with Minerals, Microbes and Humus

By Graeme Sait

www.nutri-tech.com.au

Visit one of the world's most popular regenerative ag resources featuring:

1. Links to **The Nutrition Farming Podcast** – a global phenomenon
2. **A wealth of information** covering soil health, plant nutrition, and wellness.
3. **Crop specific tips** and strategies via the website search engine.
4. **Soil and tissue testing services**, and free on-line agronomy consultations.
5. Sign up to **Nutrition Matters** – the hugely popular weekly blog by Graeme Sait.
6. Updates of **seminars** and **workshops** across the globe
7. Detailed **guidelines** for the world's largest range of biological inputs.



Increasing Chemical intervention

Every year for the past ten decades we have applied more **chemicals** to our soils and crops, and every year, there is an increased global need for chemicals.

Putting on more and more, for less and less response is the definition of **unsustainable**

It is also the perfect example of the bankruptcy of a **symptom-treating** response

The relative health of the next generation should be a major guideline as to the success of any system. Progressive **degeneration** and degenerative **disease** have become the hallmark of the millennials.



The Wake Up Call

A global awakening is underway. We are finally recognising the unsustainability of this symptom-treating approach and many are seeking change.

The drivers of this revolution include the following:





1. The current **chemical experiment** perfectly fits the definition of “unsustainability” i.e. more chemicals are used every year and yet overall pest and disease pressure increases each year (**1.1 million tonnes** of chemicals are applied annually.

2. A fair marker for the relative success of a society is the **health of children**. Previous US research has involved 1400 school children who were monitored for the presence of the **13** most commonly used farm chemicals. To the horror of the researchers, every child had **unacceptable levels** of every farm chemical.

The Wake Up Call

3. At our current rate of topsoil loss, there is just **60 years** until zero remains.

4. We've lost **2/3** of our humus and that carbon is now the lion share of the CO_2 blanket trapping more heat and changing our climate.

5. The recent trend involving the monitoring of **soil life** has revealed a **decimation** of key creatures in the soil. This includes earthworms, protozoa, cellulose digesters, N-fixers, phosphate solubilisers and many organisms responsible for **nutrient delivery** (glyphosate).





Alarming Loss of Precious Topsoil

- We are losing topsoil at the rate of **7 to 12 tonnes** per hectare per year. At that rate, we have 60 years until zero soil remains.
- The thin veil of topsoil that feeds us, is the single most **precious** of commodities and we treat it like dirt.
- **Algal blooms** have created dead zones in our ocean, larger than small countries. These blooms are largely linked to erosion of topsoil and the N and P it contains.
- **Soil loss** is accelerating globally, with the rise and rise of weather extremes.
- It will be illegal to leave soil bare at some point soon! **Chemical fallow** is anti-science.







Mismanagement of Water

Water is rapidly becoming **“the new gold”**, but it is a poorly managed resource. Trillions of litres are lost through evaporation in increasing heat waves.

There is often a large **carbon footprint** in moving water to the farm and in applying it. Flood irrigation, center pivots and overhead irrigation involve more losses.

Drip irrigation, mulch and cover crops are the new essentials, as we struggle to minimize the impact of the **drought** choking large areas of Australia.

We are now sourcing irrigation water from depths that will not **recharge** in our lifetimes, or for many generations to come.

The Wake Up Call

6. Our food has become a **shadow** of its former self, with less flavour, shelf life, and medicinal qualities.
7. **Degenerative illness** associated with compromised nutrition has become our largest killer.
8. There is a global movement towards '**putting a face to your food**' which is the basis of the global farmers market phenomenon, and a direct-to-consumer, supermarket model in Japan.
9. Poor **soil nutrition** is poor animal and poor human nutrition (Recent WHO report). Mineral delivery is a function of both mineral and microbial **balance**.





10. Conventional agriculture is the biggest single contributor to greenhouse gases including **25%** of the worlds CO_2, **60%** of methane and **80%** of nitrous oxide (310 x more potent than CO_2).

11. If the world were to reduce CO_2 emissions by **100%** tomorrow, then in **200 years** time we would be down to the atmospheric CO_2 levels of **1975** (still too high). We are locked into self-destruct mode and the only saviour is **agriculture**.



12. **Carbon credits** for building humus in the soil are an urgent necessity and an absolute certainty. Building **1%** humus in US soils removes 4.5 billion tonnes from their **8 billion** tonne contribution to the problem.

13. Building humus is a **biological process** so anything that is detrimental to that process will be viewed as **unacceptable** at some point.





Loss of Biodiversity

If we are to work with **Nature,** rather than against her, then we must surely abide by the central principle in Nature**.**

That central organizational and operational principle involves the importance of **biodiversity.** Our embrace of **monoculture** is contrary to that central principle**.**

Cover crop research demonstrates that different plants feed different soil microbes which, in turn, provides different outcomes.

Monoculture feeds just one group of organisms and resilience is seriously compromised. Diversity above ground sponsors diversity below ground.





An Insect Armageddon

There are over **900,000** different Insect species, accounting for **80%** of all known species. They are a hugely important part of the food web upon which natural systems are based**.**

Insects aerate the soil, **pollinate** our crops, control pests, recycle minerals, and they are part of the decomposition process building humus.

They are also a valuable **protein** source for livestock and humans and they are a source of important substances like silk and honey**.**





The Loss Of Precious Insects

- A research project, completed in Germany in 2020, revealed a loss of **75%** of flying insects, over the previous **27 years** (check your windscreens).

- **Pollinators** like bees, beetles, moths, and butterflies, do much more than pollinate our food. They are integral to an energy-rich, food web, and the wheels fall off without them.

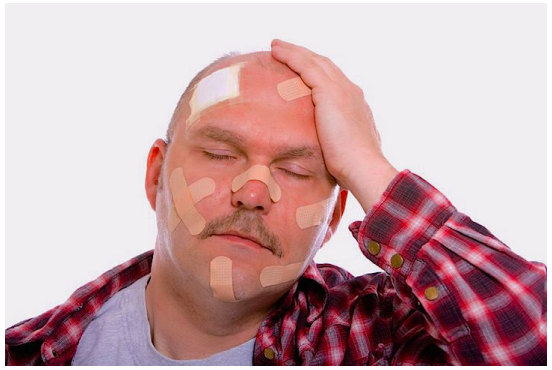
- **Beneficial insects** are some of the most underappreciated, underutilised, and environmentally impacted creatures in the farming/ gardening landscape.





Getting Back To Root Causes

- Poor quality crops and increasing pest pressure are never an **accident** or a question of bad luck.
- A fungal disease is not a **deficiency of a fungicide.**
- Medicine, veterinary science and agricultural science have all become based upon the **treatment of symptoms**.
- The problem is not solved. The chemicals serve as a temporary **bandaid**.
- Nutrition Farming is all about getting back to the **root cause** and solving the problem.









Start With a Good Soil Test

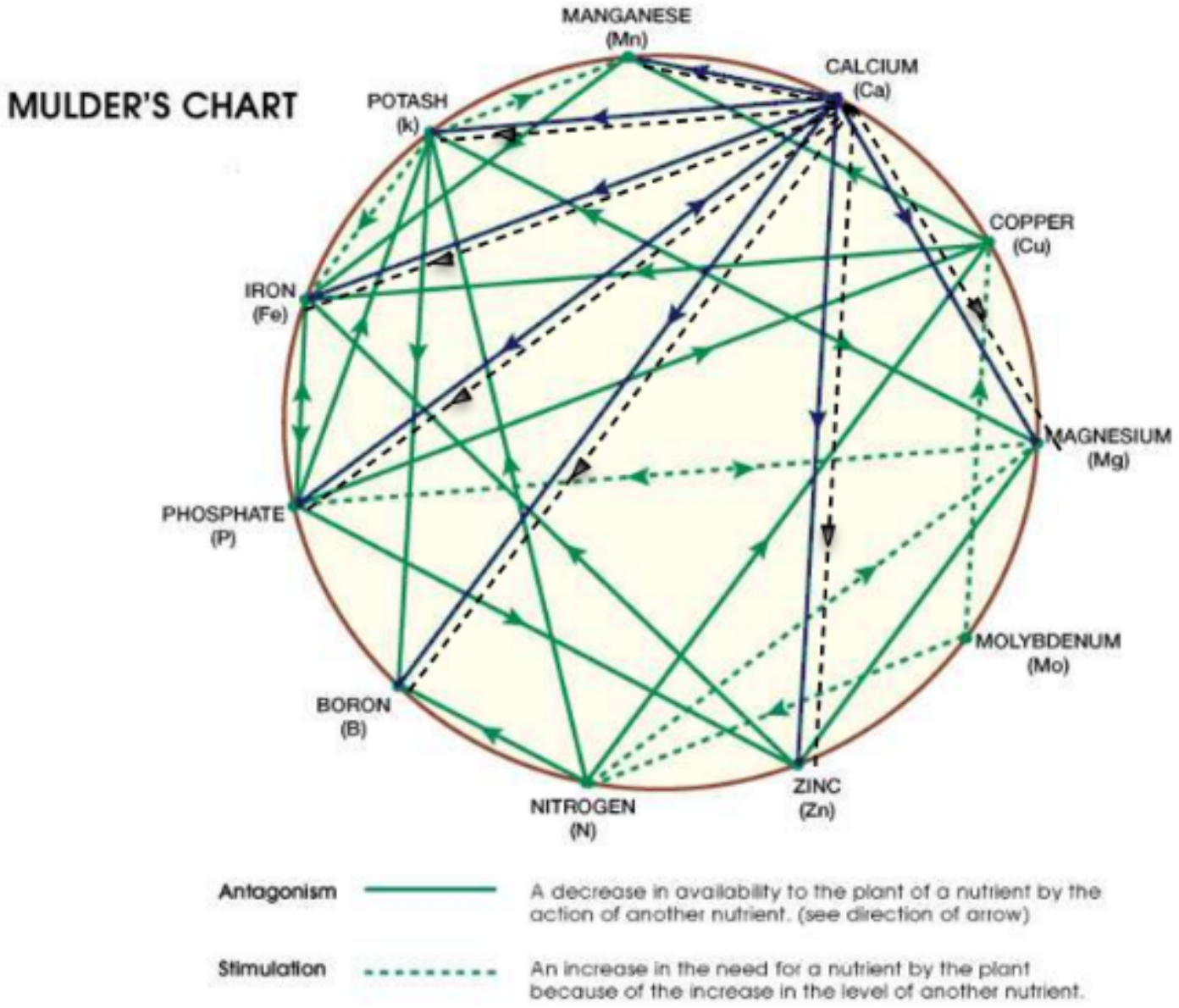
Crop nutrition should never involve guesswork. Informed nutrition is essential to avoid driving blind.

There is a **specific balance** between soil minerals that determines productivity.

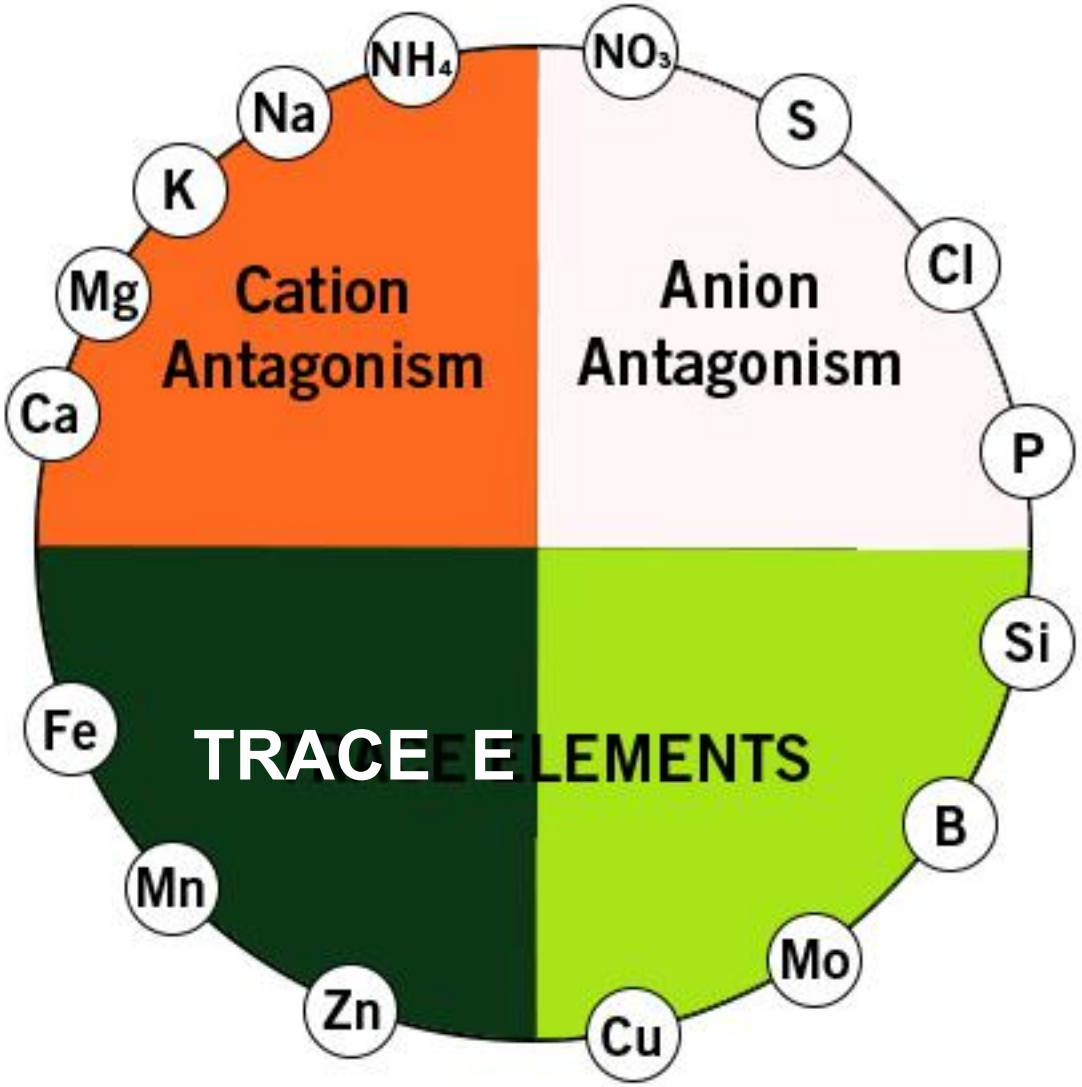
Seek a lab or consultant (NTS Soil Therapy™, Brookside, etc) with an understanding of how to achieve this productive state of **balance**.

If necessary corrections are unaffordable then liquids can be used for **crop nutrition** (liquid inject and foliars).

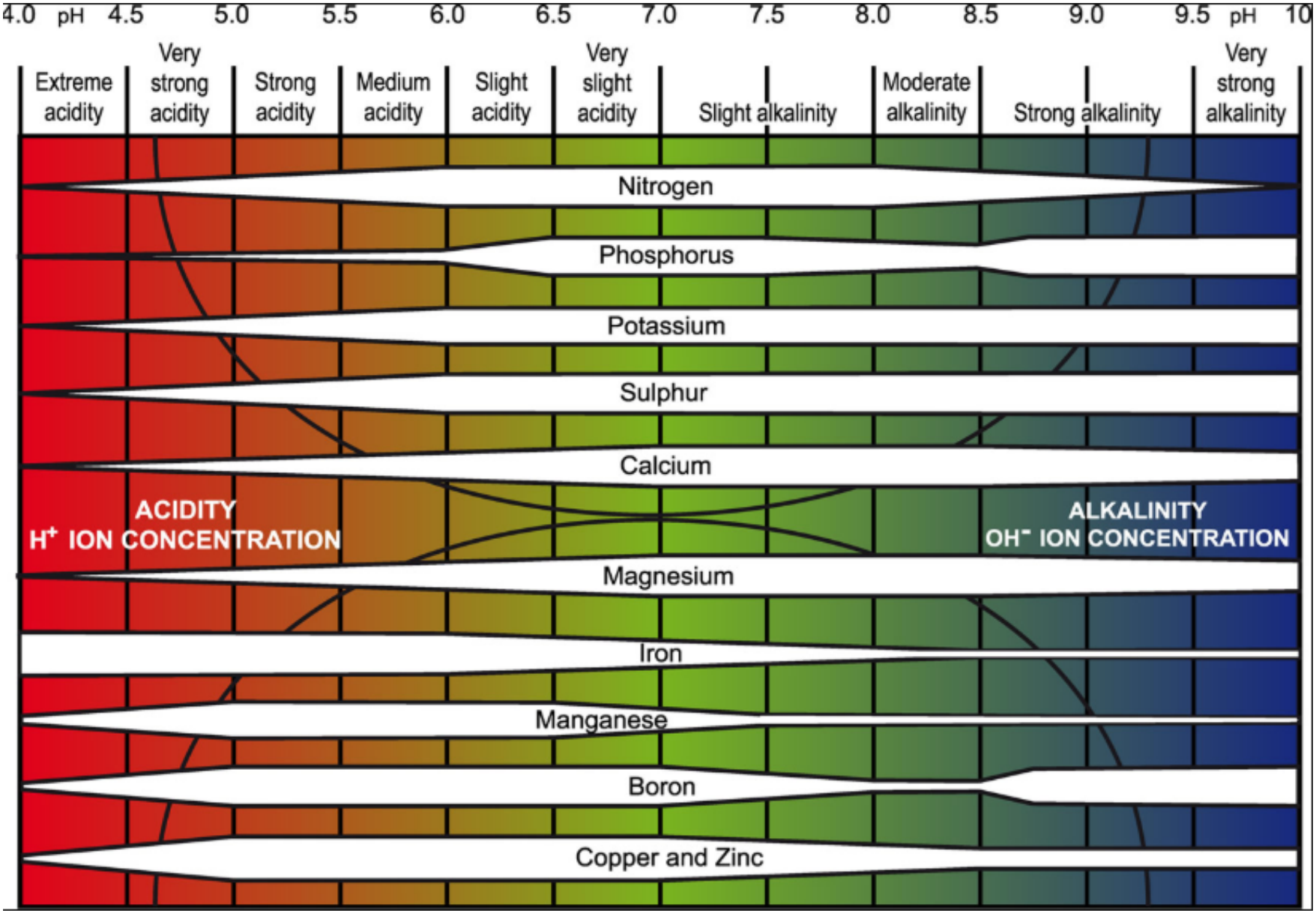
The Regenerative Revolution



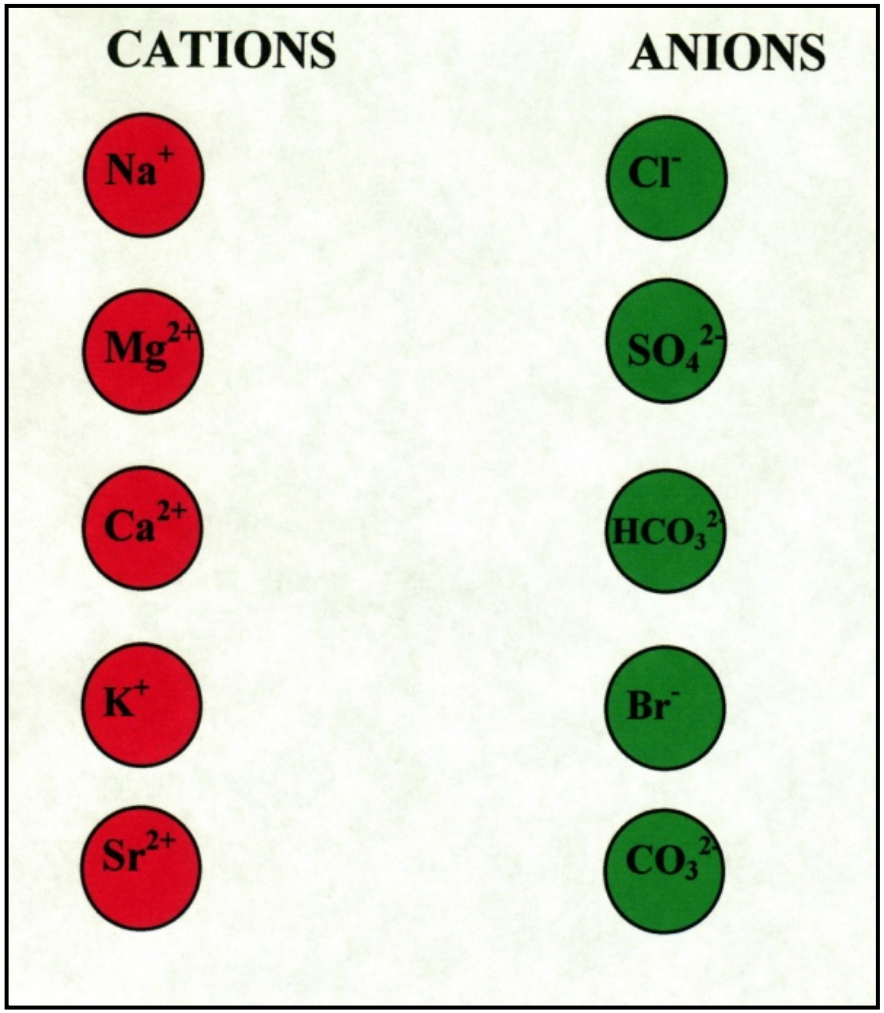
- This pie chart highlights how the minerals **impact** one another.
- Too much of any major cation or anion will **shut down** another mineral in the same group.
- Everything within each quartile **directly impacts** everything else within that segment of the pie i.e. too much gypsum effects phosphorus, chloride, and nitrate nitrogen uptake.



The Regenerative Revolution



Critical Terms and Concepts



- When minerals are broken down to their smallest component, they are termed **ions**.
- There are two types of ions based upon their electrical charge. Positively charged ions are called **cations**, while negatively charged ions are called **anions**.
- Their respective charges determine the storage, plant availability, and interplay between minerals in the soil.

MAJOR CATIONS:

Calcium	Ca^{++}
Magnesium	Mg^{++}
Potassium	K^{+}
Sodium	Na^{+}
Hydrogen	H^{+}
Aluminium	Al^{+++}
Ammonium	NH_4^{+}

MINOR CATIONS:

Zinc	Zn^{++}
Iron	Fe^{+++}
Manganese	Mn^{++}
Copper	Cu^{++}
Cobalt or Co^{+++}	Co^{++}

MAJOR ANIONS:

Phosphate	PO_4^{3-}
Sulphate	SO_4^{2-}
Nitrate N	NO_3^{-}

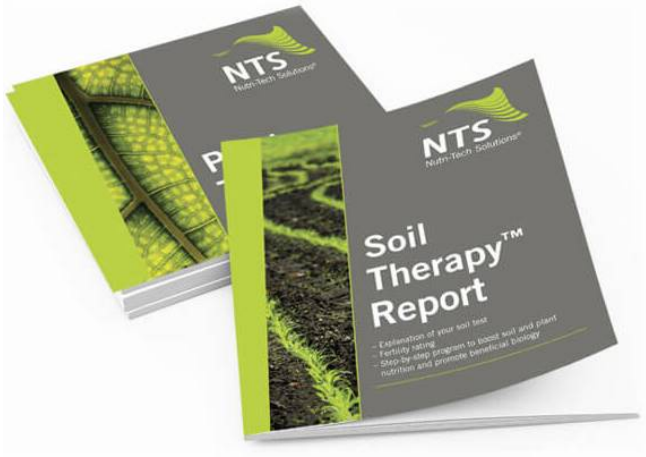
MINOR ANIONS:

Borate	BO_3^{-}
Molybdate	MoO_4^{2-}

Note the abbreviations and number of their charges.

Minerals, Microbes and Humus

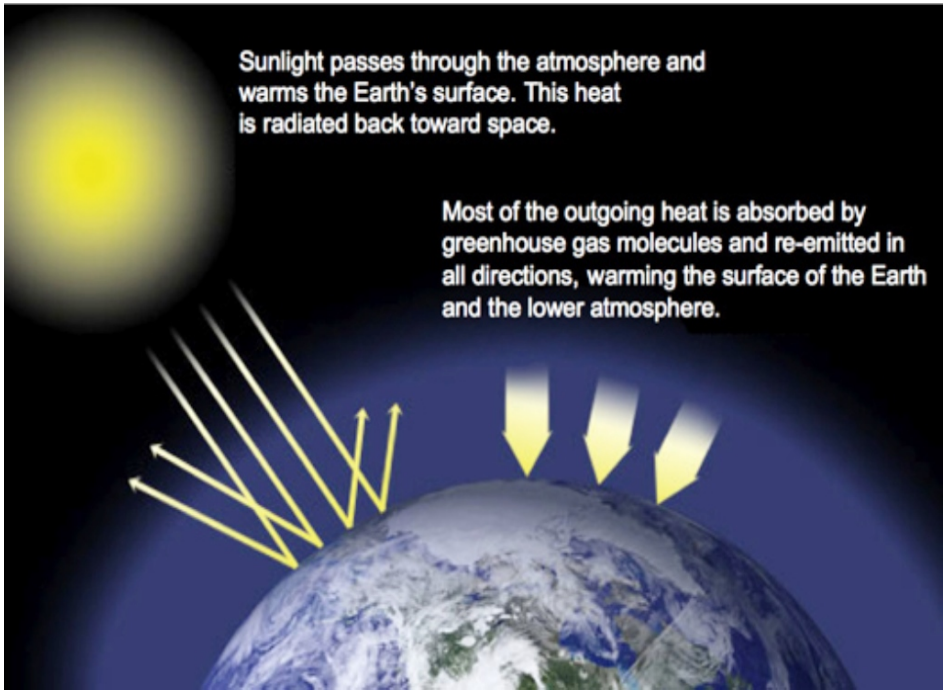
- The interplay between minerals, micro-organisms and the humus that is their mutual storehouse is the essence of a **Nutrition Farming** approach.
- We have identified **ideal levels** of minerals in the soil and in the plant and several **key ratios** that determine mineral efficiency.
- We have discovered an effective way of looking at plant tissue analysis where we strive to achieve luxury levels of **four key minerals**.
- We also utilise a system of in field monitoring that enables much more **precision** in mineral nutrition.





6) Nitrogen Abuse

- Agriculture and horticulture together account for **80%** of the nitrous oxide gas in the atmosphere.
- While it is only small percentage of the greenhouse blanket trapping the heat, warming our oceans and dramatically changing our world, it has **310 times** more impact than CO2.
- **Nitrogen abuse** is also a major player in the humus loss that accounts for the lion's share of CO2 in the atmosphere.





6) Nitrogen Abuse

Radioactive tagging has revealed that every **1 kg** of applied nitrogen, over and above the plants requirements at that time, burns **100 kgs** of carbon from our soils.

Nitrates, (a proven carcinogen) have **contaminated** most of our waterways and much of our food.

Nitrates are up taken with water and this has a nutrient dilution effect within the plant.

Insect pressure involves the **garbage collectors** performing their role and removing the rubbish.





Mastering Microbes

Soil micro-organisms are the **hidden workforce** which determine farming success.

They have been **assaulted** on all fronts in modern agriculture and there can be tremendous gains in their regeneration.

The **microbe management** component of Nutrition Farming involves the following:

1. Developing practices that are **microbe friendly** (including reduced tillage, buffering salts and chemicals etc.)

2. Introducing new microbes with **compost** and microbial inoculums.





Mastering Microbes

3. Feeding soil life with **cover crops** and stubble digestion

4. Creating optimum conditions and stimulating microbes with **humates**

5. **Foliar fertilising** to more rapidly increase chlorophyll that generates exudates

6. Eliminating the most **damaging chemicals**

7. Bringing back **earthworms**





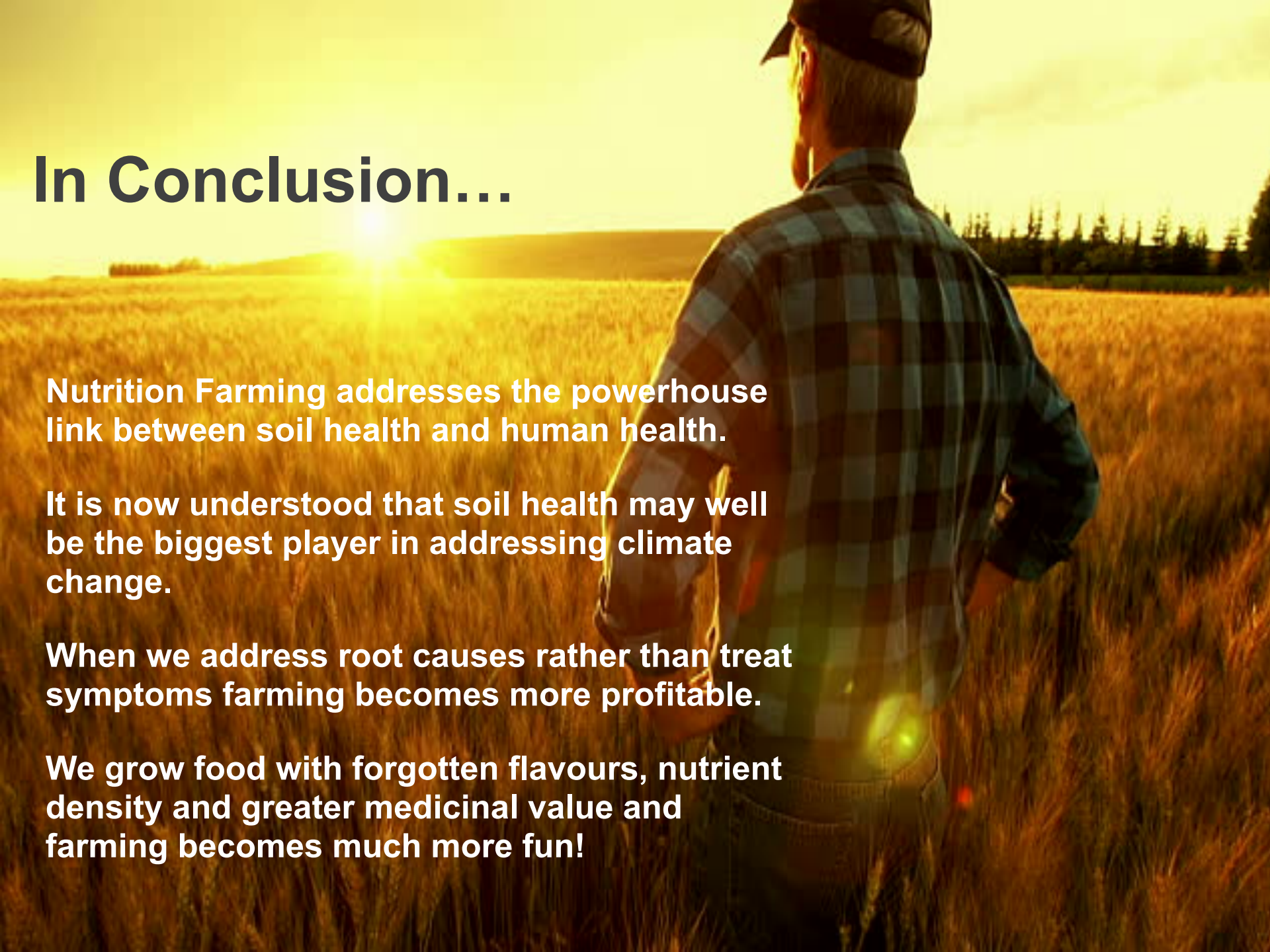


The Critical Importance of Humus

- Humus is the sweet smelling, chocolate coloured substance, produced by micro-organisms that serves as their **home base** and support system.
- It is also a **storage** medium for all minerals.
- Microbes are the **bridge** between the soil and the plant.
- There is a microbe behind every **mineral**.

The Critical Importance of Humus

- Humus is our greatest **water management** tool.
- Humus improves the **nutritional value,** and reduces chemical contamination of our food.
- Humus is a major driver of soil and **plant resilience.**
- The higher the humus levels in the soils the less the need for **chemical intervention.**
- Humus **cleanses** soil contaminants and prevents nitrate leaching.
- Humus is the **glue** that prevents top soil loss and it sponsors soil structure/gas exchange.



In Conclusion…

Nutrition Farming addresses the powerhouse link between soil health and human health.

It is now understood that soil health may well be the biggest player in addressing climate change.

When we address root causes rather than treat symptoms farming becomes more profitable.

We grow food with forgotten flavours, nutrient density and greater medicinal value and farming becomes much more fun!



NTS
Nutri-Tech Solutions®

Carbon Capture

The Multiple Benefits of Harnessing Humus

Accepting The Challenge

- Our only response to the **global warming challenge** has been to 'talk' about reducing CO_2 emissions.
- If we were to cut emissions by **100%** tomorrow morning, then in 200 years time we would drop down to the atmospheric CO_2 levels present in **1975.**
- These levels are too high and the oceans continue to **heat and acidify**.
- There are very few scientists that would agree that we have **200 years** left.
- So, is it **all over** bar the shouting?





Accepting The Challenge

- The answer is a resounding ‘no!’, but there are **5 key understandings.**

1. We cannot make new carbon – the planet’s finite reserves move between the soil, living things, and the atmosphere, as part of the **carbon cycle.**

2. The lions share of this carbon is **stored in the soil** – in fact, there is almost double the amount found in the soil compared to that found in the atmosphere (1550 vs 800 gigatons).

3. **Two-thirds** of the carbon that used to be found in the soil, as humus, is now in the atmosphere. Organic matter levels have dropped from **5%** down to **1.5%** due to industrial agriculture.





Accepting The Challenge

4. This carbon lode from the soil is the **chief culprit** in thickening the blanket of greenhouse gasses which trap the heat, warm the oceans and dramatically impact our climate (**250 gigatons** from industry etc., **476 gigatons** from our soils).

5. The solution is to **put the carbon back**, from whence it came. When we build organic matter in our soils, we are effectively stepping into the carbon cycle and **sequestering** carbon that would have otherwise returned to the atmosphere.



Fungi To The Rescue

- '**Active' carbon** produced by bacteria (lawn clipping compost) has a short shelf life in the soil. It oxidises and returns to the atmosphere as CO_2 within 12 months.
- **Stable humus** is manufactured by fungi through creating a stable bond between clay and humus colloids.
- This form of carbon remains in our soils (and out of the atmosphere) for at least **35 years**.
- The sad story relates to the **disastrous loss** of cellulose digesting fungi from our farming soils.
- For example, there are just **10%** of **mycorrhizal** fungi remaining in our soils.







The Top Ten Humus Building Hints

1. **Don't burn down your cover crop** – a herbicide burn down results in losses of the three key nutrients that can become gasses - carbon, nitrogen, and sulphur. It is a much better strategy to work the cover crop into the **A horizon** (the top few inches of your soil).

2. **Include legumes in every pasture and under every cereal crop** – legumes, like clover, tend to feed fungi. These creatures generate the larger aggregates that create **crumb structure** (better infiltration and gas exchange). The clovers under your cereal crops also deliver nitrogen and they release acid exudates to prize apart calcium and phosphorus (the two most important minerals for **photosynthesis**).





The Top Ten Humus Building Hints

3. **Plant cocktail cover crops** – we now understand that the combination of five plant families in a blend, sponsors the release of phenolic compounds into the soil. These antioxidants spark beneficial soil-life.

- **Soil structure** changes, humus creation hastens, and **soil**-**life** thrives.
- The **five families** include: grasses, cereals, brassicas, legumes and chenopods.
- **Chenopods** and **brassicas** should only make up 1 - 5% of the blend, as they release chemicals that dissuade friendly fungi.





The Top Ten Humus Building Hints

4. **Discover humates** – humic acid is the most powerful promoter of the beneficial humus building fungi that are missing in most soils. Humates also sponsor **crumb structure** that can help reclaim the humus building apparatus of your soil.

5. **Embrace compost –** compost provides vast diversity and numbers of beneficial organisms to reclaim humus building capacity. There can be **5 billion** organisms in a teaspoon of compost, involving over **30,000** different species. Compost increases soil carbon by many times more than the carbon it contains.









The Top Ten Humus Building Hints

6. **Minimise tillage –** fungi do not favour the intrusion of cold steel. In fact, tillage slices and dices beneficial fungi. Every time we open our soil, we oxidise carbon and the negative impact is **quadrupled** in the wet.

- The major issue with no-till farming is that it involves **glyphosate**, amongst the most toxic chemicals ever applied to our soils.

- When this chemical is inevitably banned, roller crimpers, cover crops, and alternatives will come to the fore. **Human initiative** always delivers.





Collateral Damage

- **Glyphosate** was originally patented as a chelating agent and can wrap around cations and make them unavailable.



- '**Yellow flash**' on soybeans is a glyphosate induced **manganese** deficiency.
- Glyphosate also reduces the population of **soil organisms** responsible for making **manganese** and **iron** available.
- In one of Professor Don Huber's studies there was a **90%** reduction in manganese reducing organisms. In another, where just **2.5%** of the applied glyphosate reached the soil, there was an **80%** reduction in manganese uptake and **50%** reduction in the uptake of iron.

Glyphosate and Your Health

- **Chronic illness** – exposure to glyphosate correlates with chronic illness. Sick people have substantially higher levels of glyphosate in their system.
- **Beneficial gut bacteria** – glyphosate destroys these organisms – this is well researched in chickens and cattle. It may be linked to an increasing rate of allergies and gluten intolerance.
- **Magnifies vaccines** – glyphosate makes vaccines more toxic. Exposed children are much more likely to react badly.





Glyphosate and Your Health





- **Reduced nutrient uptake** – glyphosate is a chelating agent that kills plants through shutting down nutrients, it works the same in humans. Glyphosate-induced vitamin deficiency may have a cancer link.
- **Non-Hodgkins lymphoma** – exposure to glyphosate doubles the likelihood of B-cell lymphoma.
- **Debilitates cytochrome P450** – this is the longevity gene related to detox enzymes.
- **Kidney failure** – Sri Lanka has just banned glyphosate due to an overwhelming number of liver and kidney problems.

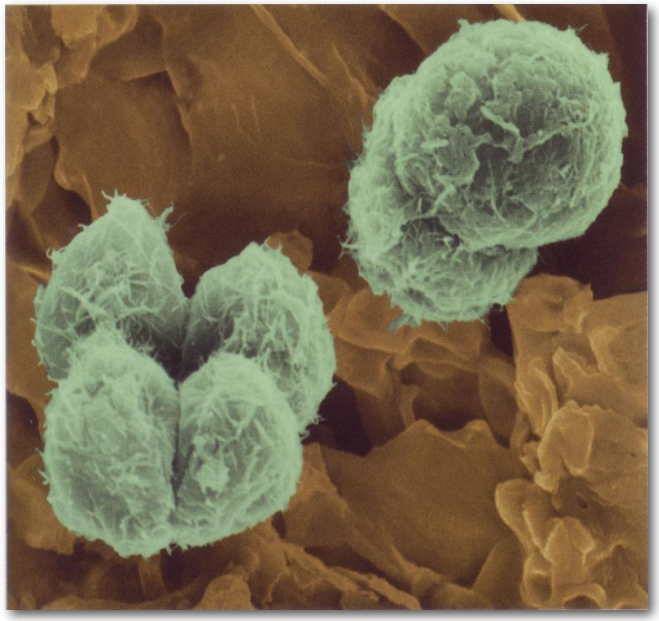
Huber's Other Findings

- New research has linked glyphosate to **spontaneous abortion** in animals but the research has yet to be done for humans.
- Professor Don Huber has directly linked **40 plant diseases** to the use of glyphosate.
- ***Pseudomonas fluorescens*** is one creature that is killed by glyphosate. This bacteria protects against take-all and several other diseases.
- Glyphosate locks up trace minerals and creates a **disease susceptible** plant.
- The World Health Organisation have recently completed an in depth analysis of the safety of glyphosate. They have formally recognised that glyphosate is a carcinogen.



Collateral Damage

- **Algae** are plant-like creatures that serve as an important **food source** for fungi and bacteria.
- **Herbicides** like glyphosate kill algae and shut down this food supply.
- Algae are found in the **top 6 inches** of the soil so despite the loss of the top layer of organisms (found on the surface to access sunlight for **photosynthesis**) there is a good chance they can regenerate.
- However, if the herbicide remains in the soil then this **regeneration** is compromised.



Reducing The Damage

- **Glyphosate** takes at least **6 months** to biodegrade in the soil, but then it becomes AMPA, a more damaging and persistent chemical (11 years minimum).
- There is a strategy to make glyphosate **less damaging**.
- It involves the following trio:

1. **Combine Soluble Fulvic Acid Powder** with glyphosate at the rate of 150 grams per hectare. The 1400 CEC fulvic absorbs the glyphosate, magnifies its uptake, and speeds it's decomposition (the honeypot effect).
2. **Reduce the pH** of the diluted herbicide **down to 2.9** with citric acid. This can immediately reduce the herbicide requirement by 30%.
3. **Add a sticker/penetrant** (like Cloak Spray Oil™) to increase efficiency.









The Top Ten Humus Building Hints

7. Bring back your earthworms – Earthworms are missing in most soils, and there is a price to pay for this loss.

- Earthworms create humus **4 times** more rapidly than standard decomposition.
- They also produce a **fertiliser** from their rear ends, featuring 10 times more potassium, 7 times more nitrogen, 5 times more phosphorus, 3 times more magnesium, and 150% more calcium.
- If you can achieve the holy grail of **25** earthworms per shovelful, they will produce **300 tonnes** of earthworm castings per hectare annually.
- Earthworms also **incubate** a unique group of beneficial organisms that will be lacking in your soil, if the earthworms have gone.

Vermi-composting – Worms do the Work

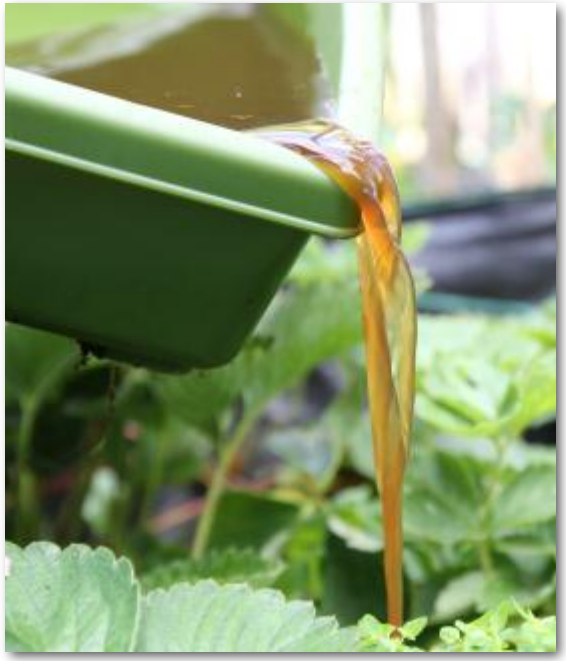




- **Vermi-composting** involves special composting worms as well as bacteria and fungi.
- Worms do the turning, and **aerating**.
- But **NO heating stage** meaning weed seeds and stable pathogenic spores may become an issue.
- Raw feed stock may need to be **pre-composted** for this reason.

Vermi-composting – The Benefits

- The "**worm juice**" (residual liquid from watering the pile) can be collected and used as a fertiliser/bio-inoculum.
- Vermi compost is the most effective compost known. It is highly effective at just **one tonne per acre** (2.5 tonnes per hectare).
- Research at the now defunct Gatton Field days revealed that vermi-compost was around **20 times** more potent than composted cow manure (1 tonne = 20 tonnes).
- The microorganisms **incubated** in the worms gut are unique to these creatures and of **great value** in the soil. If you don't have earthworms in your soil, you don't have these organisms.



Expanding Earthworms on your Farm

- Earthworms are a little **fertiliser machine** that aerates and changes soil structure and we should all strive to build their numbers.
- A great on-farm strategy involves allocating a paddock to **earthworm production**.
- This area should ideally contain a combination of legumes, grasses and cereals and should be slashed regularly to **feed the worms** (native earthworms are involved here, not composting worms).





- Ideally, It should be irrigated and treated with **humates** and **fish** on a regular basis along with protozoa tea made from **lucerne**.
- Earthworms can be easily transported from this haven to areas of the farm that need **rehabilitation**.

Carbon Capture – Learn to Harness Humus

8. Incorporate livestock – Rudolph Steiner believed that a farm was not a farm in the absence of cattle. Pasture cropping and cell grazing combined are proving to be powerful humus building tools.

Gabe Brown from North Dakota has been a no-till farmer for 20 years. He heads a group called the “Carbon Cowboys” who have been working with Brazilian Agronomist Dr Ademir Calegari.

Gabe has championed the potential of **cocktail cover crops** and **cell grazing**.



Case Study – Gabe Brown – Results

1. He has reduced fertiliser inputs by 90%.

2. He has trebled and quadrupled organic matter.

3. Gabe has reduced herbicide use by 50% (and falling).

4. Water infiltration has increased from ½ inch per hour to 8 inches per hour.





Case Study – Gabe Brown – Results

5. He has **dramatically increased** stock holding capacity with cell grazing and pasture cropping. In 1991 his carrying capacity was 65 cow/calf pairs and 20 yearlings. In 2012 this had increased to 400 cow/calf pairs and 800 yearlings.



Case Study – Gabe Brown – Results

6. Gabe favours a cocktail incorporating cool season grasses and broadleaves, alternating with warm season grasses and broadleaves.

7. Species include pearl millet, sorghum, sudan grass, proso millet, buckwheat, sun hemp, oilseed radish, turnips, peas, rye grass, canola, phacelia, cow peas, soy beans, sugar beets, red clover, sweet clover, kale, rape, lentils, mung bean & subterranean clover.





Carbon Capture – Learn to Harness Humus

9. **Enhance stubble digestion –** In a living soil, residues should be fully decomposed within 6 weeks.

- If this is not happening, then you need some **help**.
- **Trichoderma** is a great multi-function option to speed stubble breakdown and associated humus formation. It also provides disease protection, root stimulation and phosphate solubilisation.
- The other option is to enlist the anaerobes. **BAM™** is proving a highly efficient, cost-effective input for stubble digestion.
- **Fungal-dominated** compost teas are another option.
- In all cases the inoculums should be combined with **humic acid** (the lunch box approach).





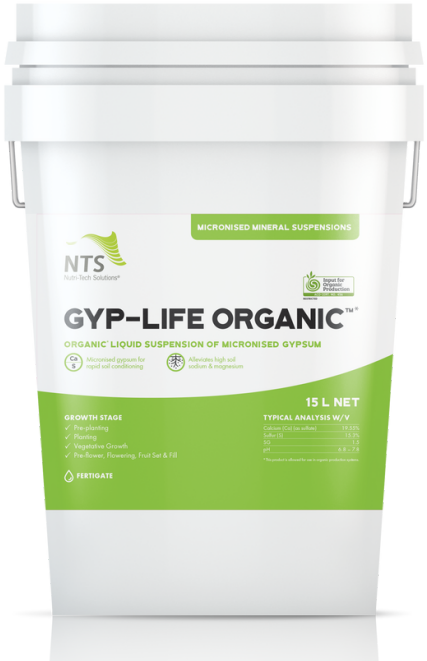
Carbon Capture – Learn to Harness Humus

10. **Provide oxygen for your humus builders –** oxygen is the single most important element for crop vigour and resilience.

- Management of **gas exchange** is a key role in crop production.
- The calcium to magnesium ratio governs the **breathing** of the soil.
- **Gypsum** is of great value in tight, closed soils.
- Micronised liquid gypsum can be used to impact the immediate root zone, via **liquid injection,** in heavier, broad acre soils.
- Fungi create **aggregates** to improve oxygen flow.
- Interplanting **legumes,** stimulates fungal crumb structure.









In Conclusion…

We are confronted with the greatest challenge in our history.

Humus can save the day, and farmers are the saviours.

The good news is that the building of humus in our soils is the ultimate win-win scenario.

We increase profitability, sustainability, and farming fun, when we address this most important facet of soil productivity.

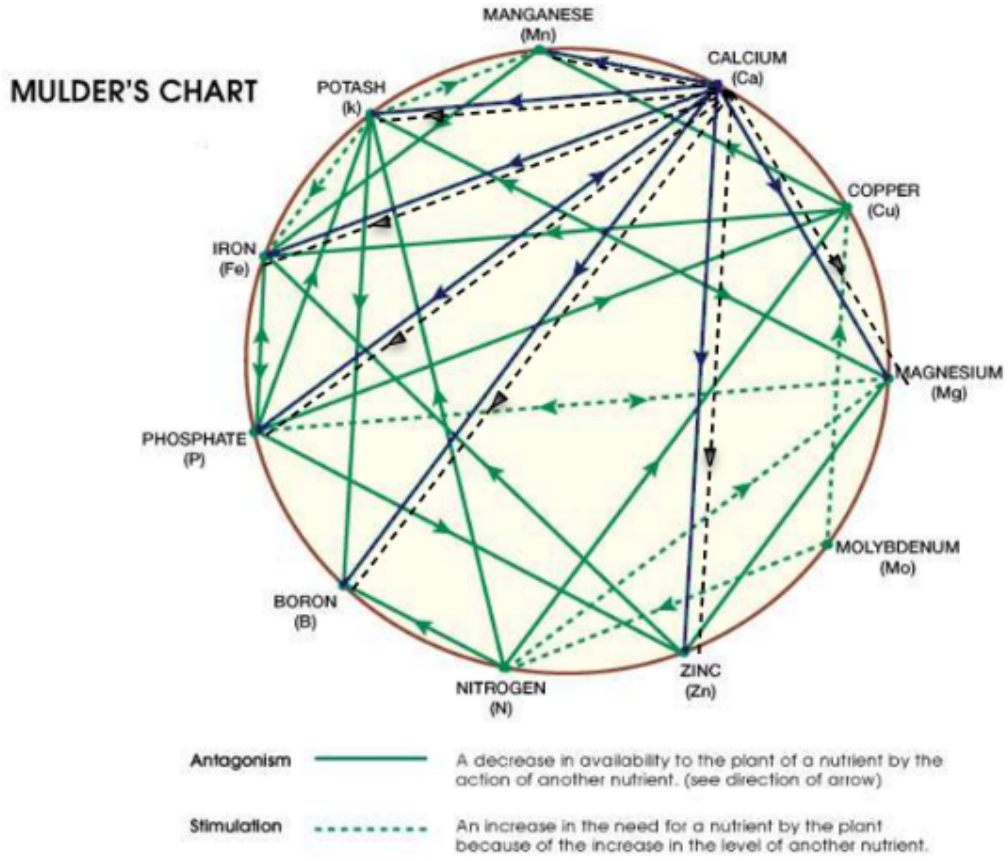


NTS
Nutri-Tech Solutions®

Calcium, Boron & Silicon

Building the Protective Platform.

Calcium – The Foundation Mineral



- **Calcium** is the foundation mineral that plays multiple roles. It is the first thing to correct on a soil test because it has so much impact upon the uptake and availability of other minerals.
- **Mulders chart** highlights the need to get calcium right. Too much calcium negatively impacts the uptake of seven other minerals, while too little has the same effect.
- **Calcium** stimulates the uptake of **seven minerals**, so if it is missing, nutrition and associated resilience will be compromised.

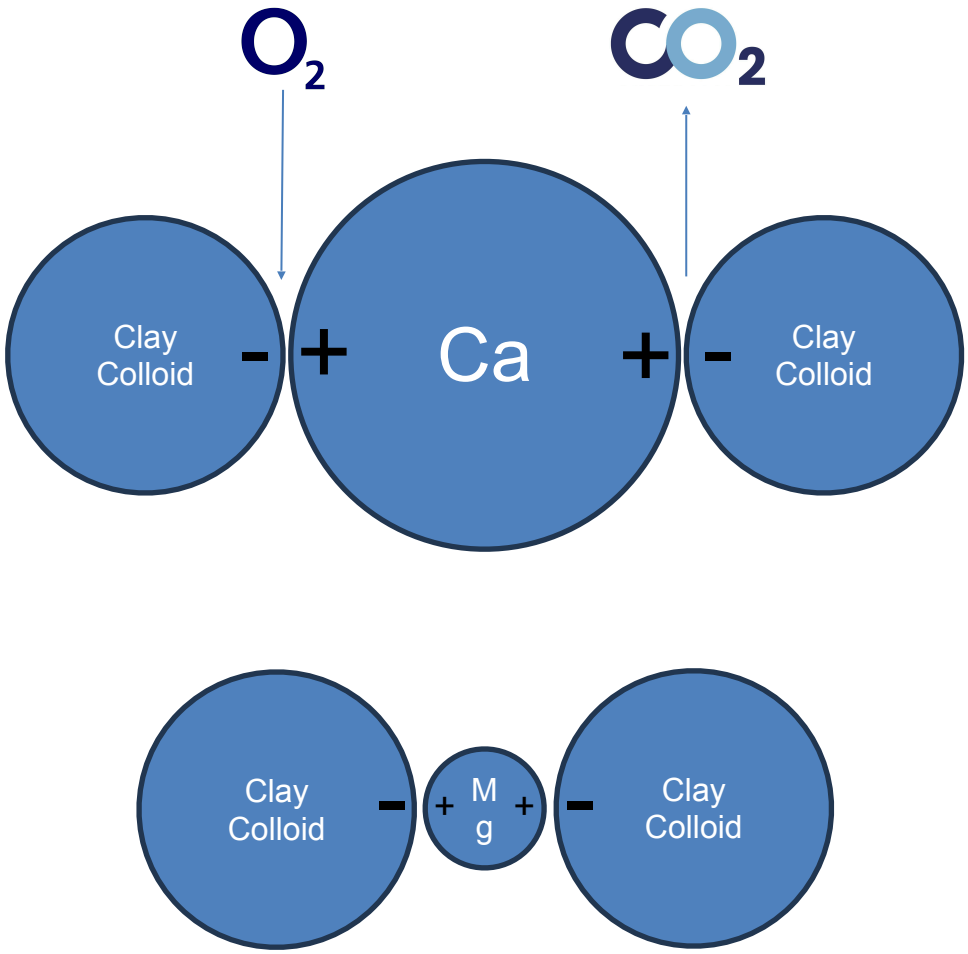
Your Critical Roles as a Farmer

- **Calcium** is critical to the two most important management tasks in high production fertility.
- These include **gas exchange** and **chlorophyll management**
- The better you manage your soils **breathing** capacity and your crops **sugar factories**, the better you will do.





A Breathing Soil is a Productive Soil



Let's first look at **gas exchange**:

- The most important element for plant and soil health is not N,P, K or Ca. It is **oxygen**

Here's how calcium impacts the way your soil **breathes**:

- Calcium is a large, positively charged ion (**a cation**). Think of a beachball with positive charges on either side.
- These charges are magnetically attracted to clay particles (**colloids**) that are negatively charged
- The beach ball effectively pushes apart the clay to create **breathing** space. This is called **flocculation**. Oxygen diffuses in, CO2 diffuses out, and your soil is breathing.

High Magnesium Soils

- The **calcium to magnesium ratio** is the physical indication of how well your soil breathes
- **Magnesium** also has two charges to attach to clay particles on either size
- However this mineral is a golf ball compared to the beachball. Magnesium pulls the clay in tight, closes the soil and **restricts breath**. A tight, high-clay soil needs 50% more N.
- You might think, ”Let’s forget about magnesium then. Let’s open up the soil with calcium!”
- However, you can’t ignore magnesium because it is the centerpiece of chlorophyll, and your second major role is **chlorophyll management.**





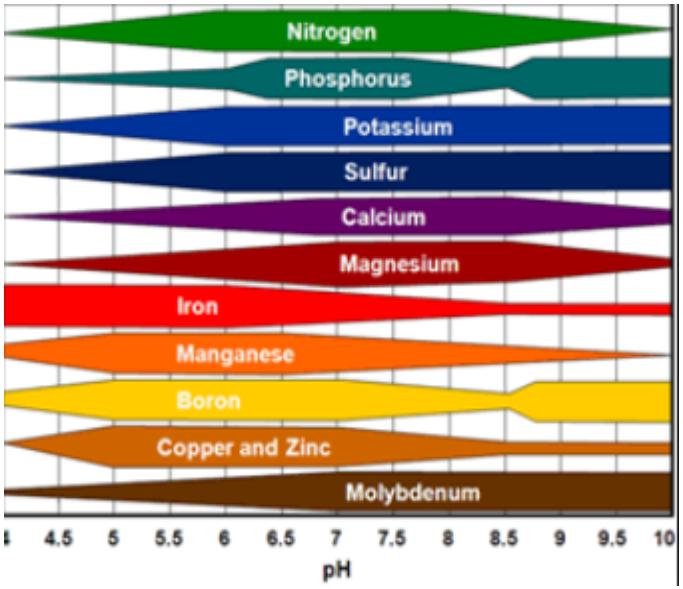
The Calcium to Magnesium Ratio





- The ideal **cal/mag ratio** for your soil ensures both minerals are optimized and the soil breathes at its best.
- That ratio varies based upon the clay component. i.e in sandy soils it might be 3:1, while in heavy clay it might be 7:1. Your ideal will be somewhere in between.
- Calcium is a huge player in **managing chlorophyll**, as it directly affects the uptake of the minerals that determine chlorophyll density. Chlorosis (blotches, stripes and pale colours) is strongly impacted by too little, or too much calcium.
- Foliar sprays of **magnesium sulphate** with fulvic acid are beneficial chlorophyll boosters on most plants.

Calcium in the Soil





- Aside from improving soil structure there are other key soil benefits in optimising calcium including:
- **Soil pH** - calcium is the most abundant cation and it has most impact on optimising soil pH. Nutrient availability is hugely influenced by soil pH.
- **Countering salinity** - calcium displaces sodium on the clay colloid and it opens the soil to flush
- out excess salts.
- **Neutralises toxicity** - calcium counters aluminium toxicity and can open soils to flush chemical residues.
- **Calcium for soil life** - microbes breathe better and are more resilient with strengthened cell walls.

Calcium in the Plant

- **Cell wall strength** - calcium and boron form the protective armor-like substance, called calcium pectate, which increases resilience against disease and insects.
- **Cell membrane function** - calcium is the most important mineral for membrane-based, nutrient transport and cell integrity – hence, “The trucker of all minerals”.
- **Signal transduction** - calcium is a critical secondary messenger in the plant. When abiotic or biotic stressors occur, calcium ions increase and this triggers the plants response .i.e. closing stomates in the heat, triggering an immune response when pathogens arrive.





Calcium in the Plant

- **Enzyme activation** - magnesium is number 1 as a mineral cofactor in multiple enzymes, zinc is second, iron is third and calcium is number 4. Calcium is more of a trigger for multiple enzymic reactions.
- **Fruit development and quality** - calcium is critical during fruit development due to its role in cell division. It is also critical for fruit quality. Fruit can uptake chelated calcium when foliar applied
- **Root and shoot development** - again calcium-dependent cell division drives growth





Calcium – The Slug of all Minerals

- Calcium is the most **immobile** of all minerals and foliar applications bypass this sluggish movement into and around the plant.
- This immobility is then amplified by **mineral imbalance** as calcium is the big loser in several relationships
- For example, high **magnesium**, potassium and sodium all impact calcium availability
- High **nitrogen** and phosphorous do the same
- From a biological perspective, **fungi** are hugely involved in calcium delivery, and beneficial fungi are missing in most soils. **Earth worms** supply plant-available calcium to the rootzone.





Calcium Sources

- The best calcium source for your soil depends upon several factors but options include:
- 1) **Limestone** . 40% calcium, which will release over 1 to 2 years
- 2) **Dolomite** - 20% calcium and 10% magnesium.- only ever appropriate if you need magnesium.
- 3) **Gypsum** - 20% calcium and 15% sulphur - for heavy, sulphur deficient soils.
- 4) **Rock phosphate** - 30% calcium and 12% P. Works best in more acidic soils that need calcium.
- 5) **Micronised mineral suspensions (MMS)** - offer fast food, lime, guano, dolomite and gypsum.





A New Calcium Strategy

1. The central maxim of calcium management acknowledges the powerful synergy between **calcium** and **boron** i.e calcium is the trucker of all minerals and boron is the steering wheel.

2. A new super productive strategy involves this **synergy**, along with an inexpensive calcium input.

3. The combination of **hydrated lime**, boron and humic acid has doubled the pack-out size of fruit crops in North Queensland, while also helping manage disease issues.

Potent New Calcium Recipe:

Utilising a 1000L IBC attached to a fire fighter pump that circulates the solution, include the following:

- 950 L Water

- 10kg calcium hydroxide (builders lime)

- 1kg of Solubor (sodium borate)

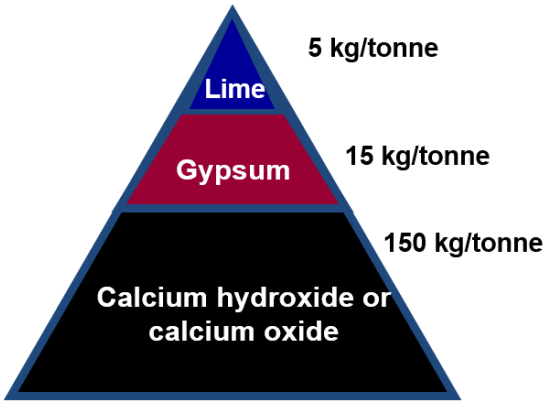
- 10L of DIY humic acid







Ca Availability from Input



Direct Inject Your Calcium

- There is no mineral that has greater need for **foliar delivery** than this super immobile mineral that is so widely impacted by other minerals. Foliar options include:
- 1) **Commercial Chelates** - EDTA has problems. Glycine chelation is super effective
- 2) **DIY Chelates** - 2-3 kgs of calcium nitrate with 400 grams of Soluble Fulvic acid powder per hectare creates a highly effective calcium fulvate. amino acids, and kelp can also chelate Ca.
- 3) **Organic DIY** - micronised lime can be fermented with BAM for 4 weeks with the addition of 1:200 wood vinegar. This creates an effective calcium lactate with all of the additional benefits of BAM and Wood Vinegar (ACC)
- 4) **Milk** - highly effective for powdery mildew (with BAM) but also a great calcium source with all the cofactors





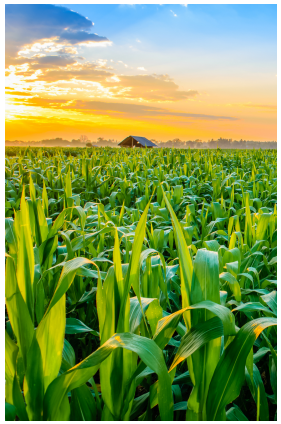
Nitrogen and Calcium

Nitrogen mismanagement impacts calcium in three ways:

1) **Rapid Vegetative growth** - calcium can not keep up with the required cell division
2) **Competition** - ammonium nitrogen competes with calcium at the root level for plant uptake.
3) **N acidification** - ammonium nitrogen acidifies the soil and calcium is less available

Phosphorous can also limit calcium uptake. High N and P are often linked to calcium-based issues, like blossom end rot and poor pest resistance from weak cell walls.







Calcium Strategies



- **Timing** is critical with foliar calcium
- There are **four** key times when foliar calcium will be most beneficial

1) **Early in the crop** - during early vegetative growth, where rapid cell division is sucking calcium.

2) **Pre-flowering and early fruit development** - combine with boron as a pre-flowering foliar. Calcium improves fruit set and quality.

3) **During periods of high growth** - following rain for example.

4) **Post stress events** - calcium applied with kelp can speed recovery from climatic extremes.



The importance of Ca to soil microbes is evidenced by Elaine Ingham's Ca Retention Pot Trial:

CALCIUM RETENTION AND FUNGI

Elaine Ingham's Classic Experiment



Sterilised Potting Mix

No Calcium Retention



Added Bacteria-Dominated Compost

2% Calcium Retention



Added Fungi-Dominated Compost

100% Calcium Retention!

Typical Ca Deficiency Symptoms

Immobile in plants: Symptoms first noticed in younger leaves:

- **Stunted** root system
- Leaves of grasses do not open properly – tips **stick** to lower leaf
- Premature **flower drop** and poor seed set
- Susceptibility to **rot** & other diseases
- **Blossom-end rot** tomatoes & capsicums
- **Cavity Spot** in carrots
- **'Bitter Pit'** in apples & pears







10-08-01 Tomato Block Pre-Treatment

ELEMENT OR CATEGORY	YOUR LEVEL	ACCEPTABLE RANGE	DEFICIENT	ACCEPTABLE	EXCESSIVE OR TOXIC
N - Nitrogen	3.2 %	3.1 - 5.5 %			
P - Phosphorus	0.44 %	0.4 - 0.9 %			
K - Potassium	3.52 %	3.0 - 5.0 %			
S - Sulfur	1.03 %	0.2 - 1.0 %			
Ca - Calcium	1.33 %	1.5 - 3.0 %			
Mg - Magnesium	0.36 %	0.4 - 0.8 %			
Na - Sodium	0.05 %	< 0.4 %			
Cu - Copper	12 ppm	5 - 15 ppm			
Zn - Zinc	39 ppm	24 - 200 ppm			
Mn - Manganese	49 ppm	50 - 500 ppm			
Fe - Iron	88 ppm	100 - 300 ppm			
B - Boron	49 ppm	30 - 100 ppm			

14-08-01 Tomato Block Post-Treatment

ELEMENT OR CATEGORY	YOUR LEVEL	ACCEPTABLE RANGE	DEFICIENT	ACCEPTABLE	EXCESSIVE OR TOXIC
N - Nitrogen	3.4 %	3.1 - 5.5 %			
P - Phosphorus	0.6 %	0.4 - 0.9 %			
K - Potassium	4.76 %	3.0 - 5.0 %			
S - Sulfur	1.99 %	0.2 - 1.0 %			
Ca - Calcium	3.54 %	1.5 - 3.0 %			
Mg - Magnesium	0.63 %	0.4 - 0.8 %			
Na - Sodium	0.13 %	< 0.4 %			
Cu - Copper	31 ppm	5 - 15 ppm			
Zn - Zinc	95 ppm	24 - 200 ppm			
Mn - Manganese	340 ppm	50 - 500 ppm			
Fe - Iron	260 ppm	100 - 300 ppm			
B - Boron	75 ppm	30 - 100 ppm			

Determining Calcium Inputs

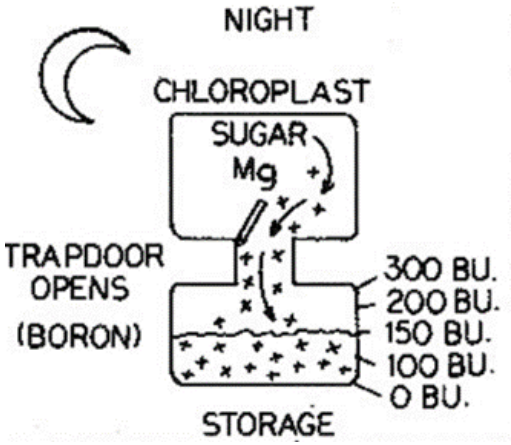
800 ppm is the maximum amount of calcium to be applied per annum. This is equivalent to **4.5 tonnes of lime (@40% Ca) per ha.**

Or, the 800 ppm can incorporate a mixture of the following depending on suitability:

- Soft-Rock (20% calcium)
- Gypsum (20% calcium)
- Dolomite (20% calcium)
- Guano (20 – 35% calcium)



Boron Basics



Boron – This is the most important calcium synergist. It is a highly leachable anion, and is only stored on the humus colloid. Ideal soil levels are
1 ppm – 3 ppm.



- Boron is deficient in most leaf tests we analyse, and it is most effective as a **foliar spray** directly **before flowering**. It is critical for grain and fruit formation.
- Boron opens the **trap door** in the chloroplast to allow translocation of glucose around the plant and down to the roots. 30% of this is fed to soil microbes. If the door remains shut, the microbes suffer.
- A **refractometer** can help identify a boron deficiency (Brix should always be lower in the morning).
- Boron should always be applied with **humic acid** to stabilise and magnify the mineral.

Boron (B) Dynamics

- Over **90%** of the boron in a plant is found in the cell wall.
- As important as **calcium and silicon** for cell wall strength.
- We should be aiming for **1 ppm** of boron in the soil.
- Plant available B is negatively charged therefore it is stored in the soil on the **humus colloid.**
- It is notoriously deficient in sandy soils or soils with low SOM.





The Roles of Boron

1) **Root Growth** - Boron deficiency dramatically inhibits root elongation, due to impaired cell division. Important to start a crop

2) **Misshapen fruit** - this impaired cell division also leads to deformed flowers and fruit.

Classic **symptoms of boron deficiency** include bumpy, misshapen fruit, hollow broccoli stems), crosswise cracking of celery stalks, shot berries in grapes, internal and external cork in apples, cracked carrots and flower shedding in multiple varieties.

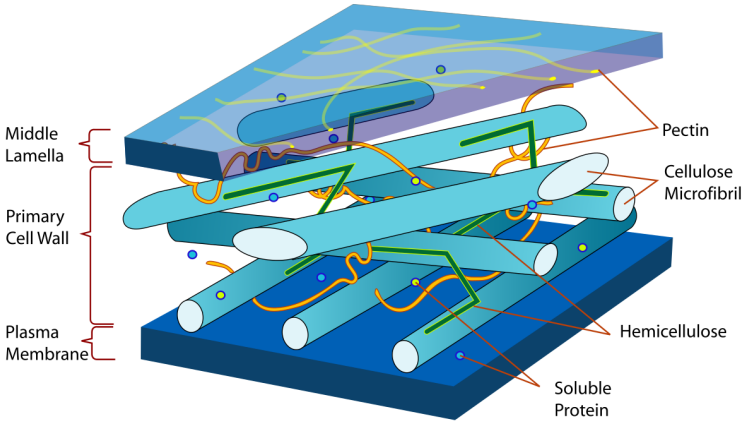
3) **Improved fruit to flower ratio** - boron has a major impact on lengthening the pollen tube, which can dramatically impact pollination, and improve the fruit to flower ratio.





The Roles of Boron

4) **Boron**, the steering wheel - this mineral is a hugely important calcium synergist. A great example of that synergy relates to the **middle lamella**. This is the cement-like lining between adjacent cells. Boron drives the formation of **calcium pectate** that strengthens that lining. Cell walls become much more resistant to maceration by fungal pathogens, when good levels of calcium pectate are present.



5) **Improved mineral uptake** - boron sponsors ion fluxes of minerals across the cell membrane and into, and out of, the cell. Research has demonstrated that these improved ion fluxes are particularly relevant to **calcium**, potassium and phosphorous. However, boron also increases uptake and availability of other plant nutrients, including nitrogen, zinc, iron and copper.



The Roles of Boron

6) **Nitrogen fixation** - in legume crops, boron is an essential requirement for nitrogen fixation in both rhizobium and actinomycetic symbiosis. The lack of a pinkish, red interior in legume nodules is a classic sign of boron deficiency, and it is a signpost of poor nitrogen fixation.



7) **Protein formation** - boron also plays a pivotal role in nitrogen metabolism, as it is required (along with molybdenum) for the nitrate reductase enzyme that converts nitrates through to plant protective protein.

8) **Photosynthesis** - boron deficiency can also negatively impact the most important of all plant processes, photosynthesis. This occurs due to disruption of chloroplast (the sugar factory) membranes and messing with the stomatal openings required to capture CO2 for photosynthesis.



The Roles of Boron

9) **Disease protection** - boron complexes with phenolic compounds to provide protection from free radicals and disease. In it's absence, there is a damaging excess of certain phenols.

10) **Filling the seed head** - boron can have a big impact upon filling the seed head. When cereal grains like corn and wheat are lacking boron, the top of the seed head fails to fill. There is also much less likelihood of seed sterility in wheat fertilised with boron.



Little Known Boron Tips

1) **Don't include boron with fungal brews** - it can be fungicidal in concentrated form.

2) **Azotobacter** love boron, zinc and molybdenum. Include these with N fixing brews.

3)) **Boron deficiency** in the soil can limit leaf uptake - foliar and fertigate to cover both.

4) **Boron increases fungicide efficacy** - Boric acid can increase the efficacy of fungicides including benomyl and zineb

5) **Boron boosts natural fungicides** – a study by Duffy et al, showed trichoderma were more effective when boron levels in the leaf were good.





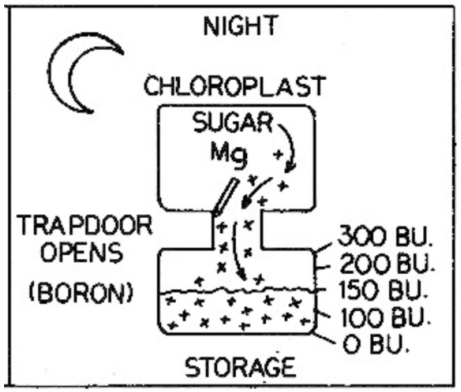
Little Known Boron Tips

6) **Boron can become toxic** at certain applications. 15 kgs per hectare of borax in low Ca soils or 25 kgs when Ca is adequate fact, it can even be used as a herbicide.

7) **Boron opens the trapdoor** that moves daily sugar production around the plant. Monitor with a refractometer.

8) **Compromised medicinal qualities** - . Boron deficiency sponsors lower levels of vitamin C and glutathione within the plant. This is due to a drain on both of these antioxidants through constantly neutralizing the excess free radicals created by this deficiency. This also creates a less resilient plant, with a greater need for chemical intervention.

9) **Potassium/boron link** -While too much potassium can shut down boron, too little boron can **limit the transport of potassium** to the stomates where it is required for stomatal opening.





Boron Deficiency Symptoms

Very **immobile** element in the plant, therefore growing points or fruit symptoms are often noticed first:

- **Terminal buds die** & **shoot internodes shorten.**
- **Reduced flowering** & **fruiting.**
- Excessive **shedding of squares** and bolls in cotton
- Flower shedding with **deformed** & bumpy fruit in pawpaw
- **Hollow** stems in broccoli & cauliflowers

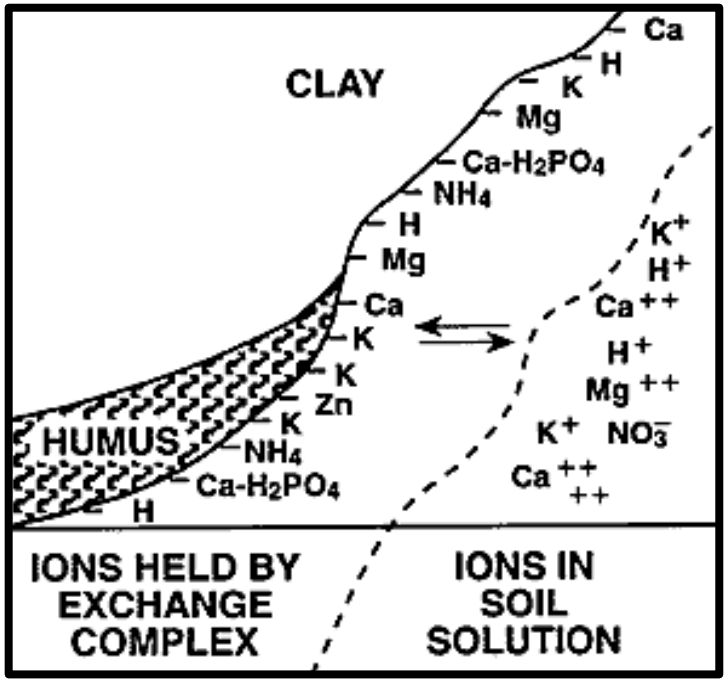






Boron – In The Soil

- Boron (B) is an **anion**, (negatively charged), therefore not attracted to the clay colloid.
- It is found mainly in the **soil solution** or complexed with humus, (which can hold both positive & negative ions).
- The lower the OM, the higher the need for applied B as you have lost "the boron storehouse".
- Deficiencies occur in **long dry spells** or very **wet spells** & in **high pH** soils.



Boron Soil Inputs

Generally a maintenance dose is required each year on many tree/vine crops.

Soil application:

- **Borax** with 14% B (max 25 kg/ha)
- **Calcium borate/ulexite** with 10% B
- Complexed boron (with humate) e.g. **NTS Stabilised Boron Granules™**









NTS
Nutri-Tech Solutions®

Silicon – The Cell Strengthener

The Dynamics of Silicon – Si

- While Si has not been proven to be an “essential” nutrient for many plant species, but this status may soon change!
- Increased **photosynthesis** from improved leaf strength & presentation – more sugar means more root zone activity (AM) and more **mineral uptake**.
- Less **lodging** in cereals, due to increased stem strength.



Top 10 Benefits of Silica

1) **Improved Plant Structure**: Silica helps strengthen plant cell walls, making them more resilient to physical stress such as wind, rain, and handling.

2) **Increased Resistance to Pests**: Silica can help plants develop a natural defense mechanism reducing damage from pests like aphids, mites, and borers.

3) **Enhanced Disease Resistance**: It improves resistance against fungal pathogens such as powdery mildew and root rot.

4) **Improved Drought Tolerance**: Silica enhances the plants ability to retain water and tolerate drought conditions by reducing water loss through transpiration.

5) **Improved Nutrient Uptake**: Silica can enhance the uptake of essential nutrients like nitrogen, potassium, and phosphorus by strengthening root systems.





Top 10 Benefits of Silica

6) **Boosts Photosynthesis**: Silica-treated plants often exhibit improved chlorophyll content, leading to enhanced photosynthesis and growth.

7) **Reduces Abiotic Stress**: It helps plants cope with environmental stresses such as salinity, extreme temperatures, and heavy metal toxicity.

8) **Enhanced Yield and Quality**: Silica contributes to higher yields and better-quality crops, especially in fruits and vegetables, due to its strengthening effects.

9) **Balances Soil Health**: Silica contributes to soil structure improvement, aiding in better aeration and water retention.

10) **Improves Post-Harvest Longevity**: Crops with enhanced silica content tend to have longer shelf lives due to improved structural integrity.





Mineral Uptake – The Silicon (Si) Link

- Silicon (Si) constitutes the **2nd most common element** found on earth, and yet it is a missing link in many nutrition programs. Soil tests often reveal a shortage of plant-available silicon (silicic acid).
- Once incorporated into a cell, Si is **immobile** therefore it needs to be in constant supply to growing tips.
- Pasture accumulates **1% to 4%** silicon, (rice contains up to 16% Si!).



Silicon – Inputs

Dry Broadcast Inputs:

- **Soft Rock**: ~25% Si; 20% Ca; 10% P
- **Guano**: ~35% Si, with Ca & P
- **Diatomaceous Earth (DE)**: ~40% Si
- **Basalt Crusher Dust:** 55% Silica

Liquid Inputs:

- **Potassium Silicate**:
  17.3% Soluble Si; 15.3% K
- **Photo-Finish™**: 10.4% Si;
  10.5% K; kelp, humic acid
- **Dia-Life Organic™**: micronised
  DE in liquid suspension 12.5% Si; 0.7% B



DIY Silica – BD 508

Rudolf Steiner was way ahead of the game in terms of the recognition of the value of silica.

One of the most productive BD preps (**BD 508**) is based upon the highest source of plant silica – **horsetail.**

In Australia, in the absence of this weed, we use **Casuarina** (the 'horsetail tree') as a substitute.

The leaves are dried and then boiled for 60 minutes, to create a **silica tea**.

We have found considerable benefits in then lacto-fermenting this brew, with **BAM**, to magnify the silica response.

The end product has a shelf life of two years, and is applied at **10 - 20L per hectare**









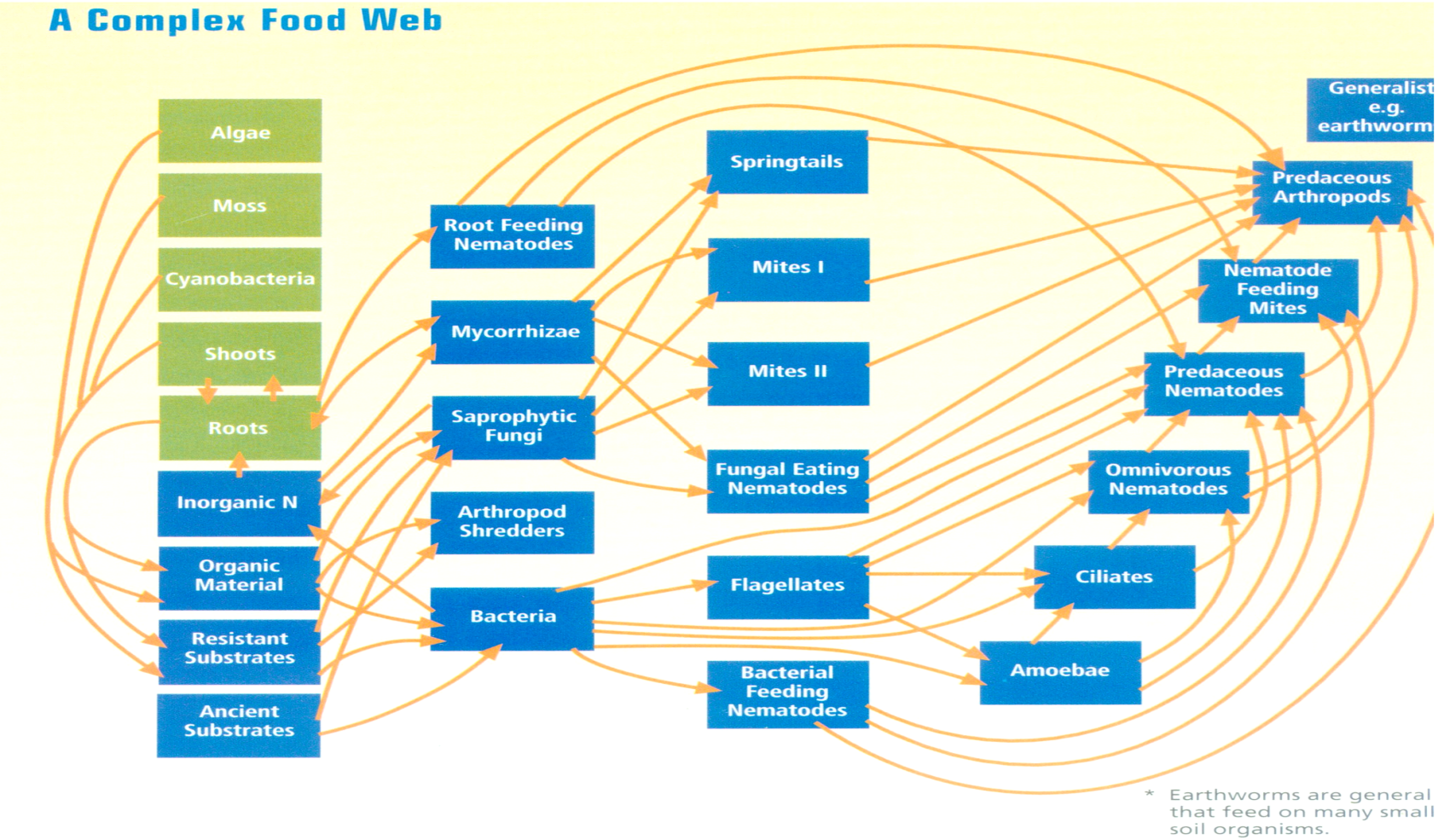
NTS
Nutri-Tech Solutions®

Microbe Management

Understanding your Invisible Workforce

By Graeme Sait

Microbe Management - Understanding your Invisible Workforce



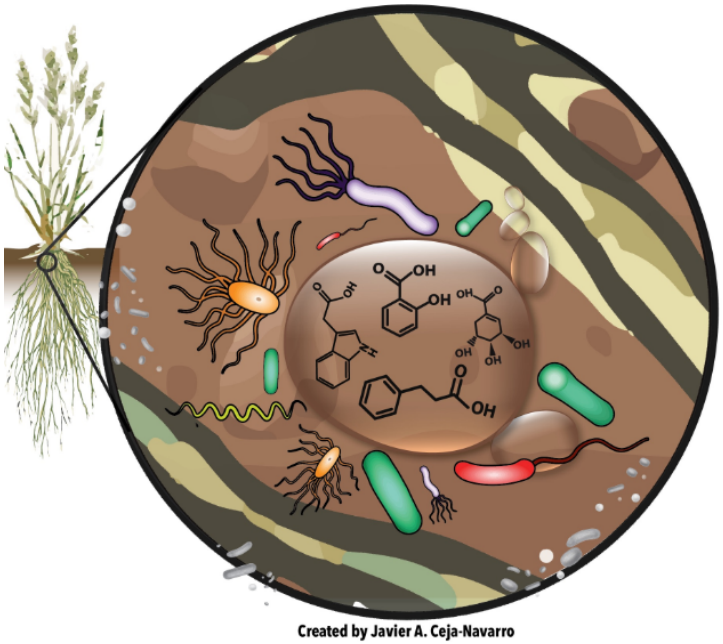
The soil foodweb is a major apparatus by which plants get their food.
If this amazing **soil foodweb** is kept **well fed**, well **mineralised** and **protected** from toxins, then there is **zero soil disease** and plant **health is maximised**.

The Primary Producers

- It is important to understand that plant roots don't produce **enzymes**. They are essentially sponges that rely on soil microbes to make their food available.

- It's not a one-way street – plants feed **30%** of their total sugar production to the **root zone microbes**.

- The plant understands the **importance** of these creatures – why else would it sacrifice almost a third of its energy production to the soil.



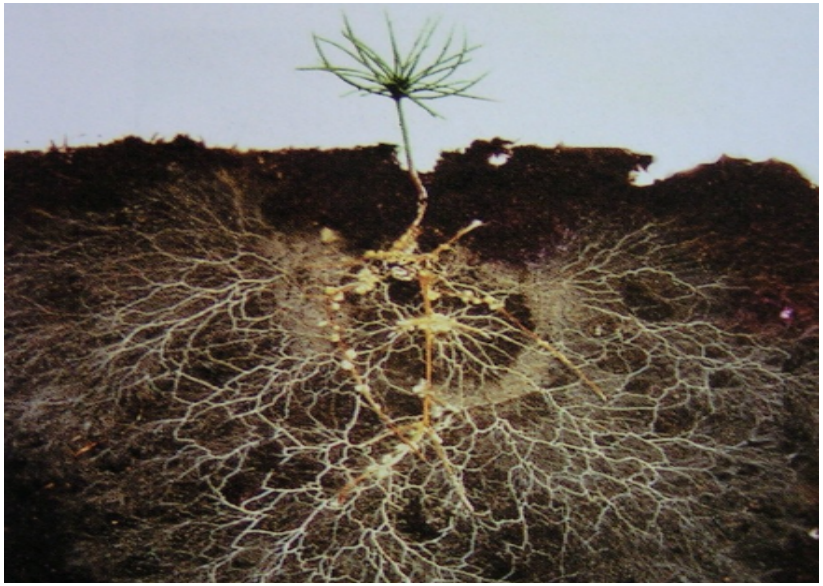


Plants in Control

- **Plants** vary their **exudates** based upon what they require at any particular point in the crop cycle. i.e. nitrates for vegetative growth, phosphate for fruit/seed filling. It's comparable to **fishing** with different bait for different fish.

- A **vicious cycle** can develop with the use of commercial **nitrogen** and **phosphate** fertilisers. i.e. the plant no longer produces exudates to encourage nitrogen fixers, phosphate solubilisers or mycorrhizal fungi.





Salt Negatives

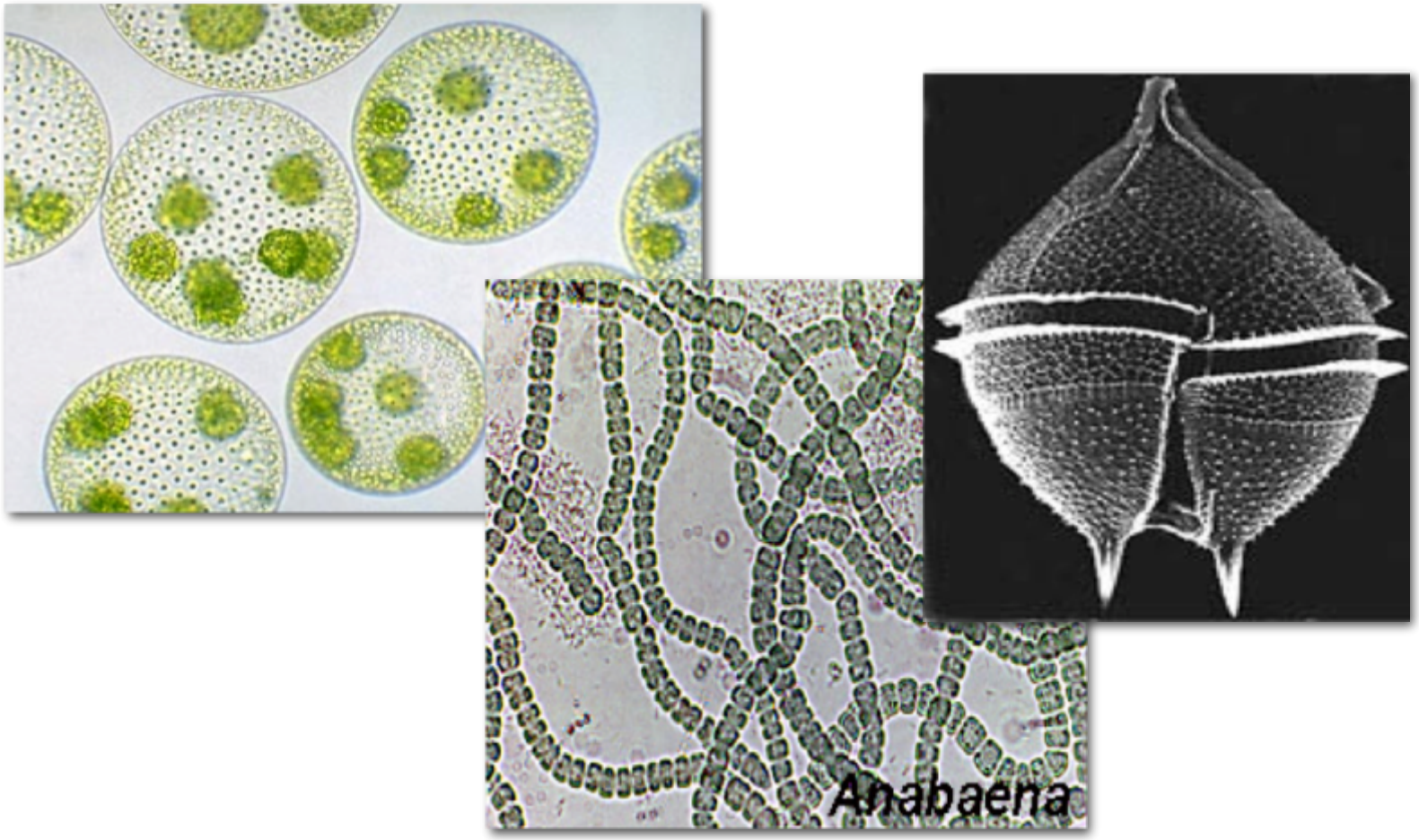




- **Salt fertilisers**, applied unbuffered, dehydrate fungi and bacteria. Protozoa and nematode decline then earthworms also depart (irritated by salt and less food).
- Soil **structure** deterioration.
- Water retention is compromised – **oxygen** and **CO_2** pathways reduced.
- **Pathogens** can thrive unchecked.
- Growing becomes **more work** and more dangerous than it need be.

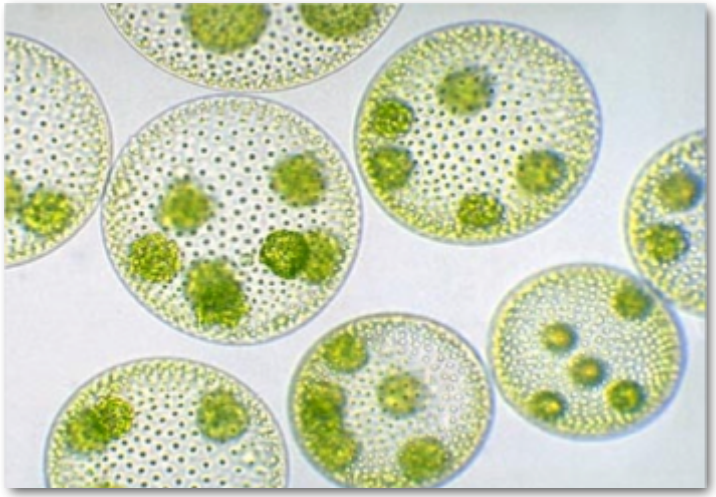

The Star Actors
Algae
Bacteria
Fungi
Nematodes
Protozoa
Arthropods
Earthworms

Character Sketch: **Algae**

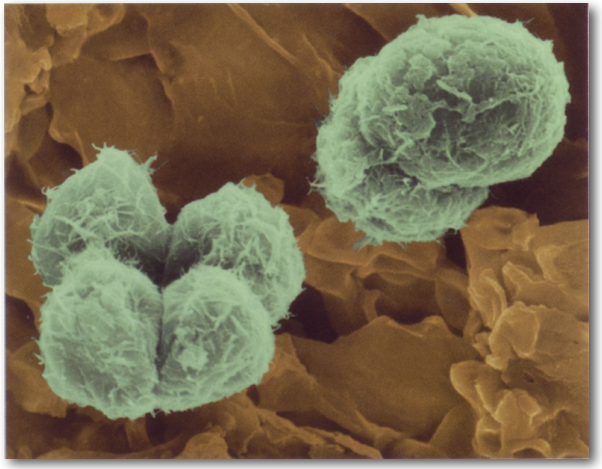


Algae

- Range from small single-celled forms to complex **multicellular** forms;
- They contain **chlorophyll** and perform photosynthesis;
- Need light, water and carbon dioxide;
- Good soils have **1 – 10 billion** algae per square metre 15 cm deep, or
  50 – 600 kg per hectare.





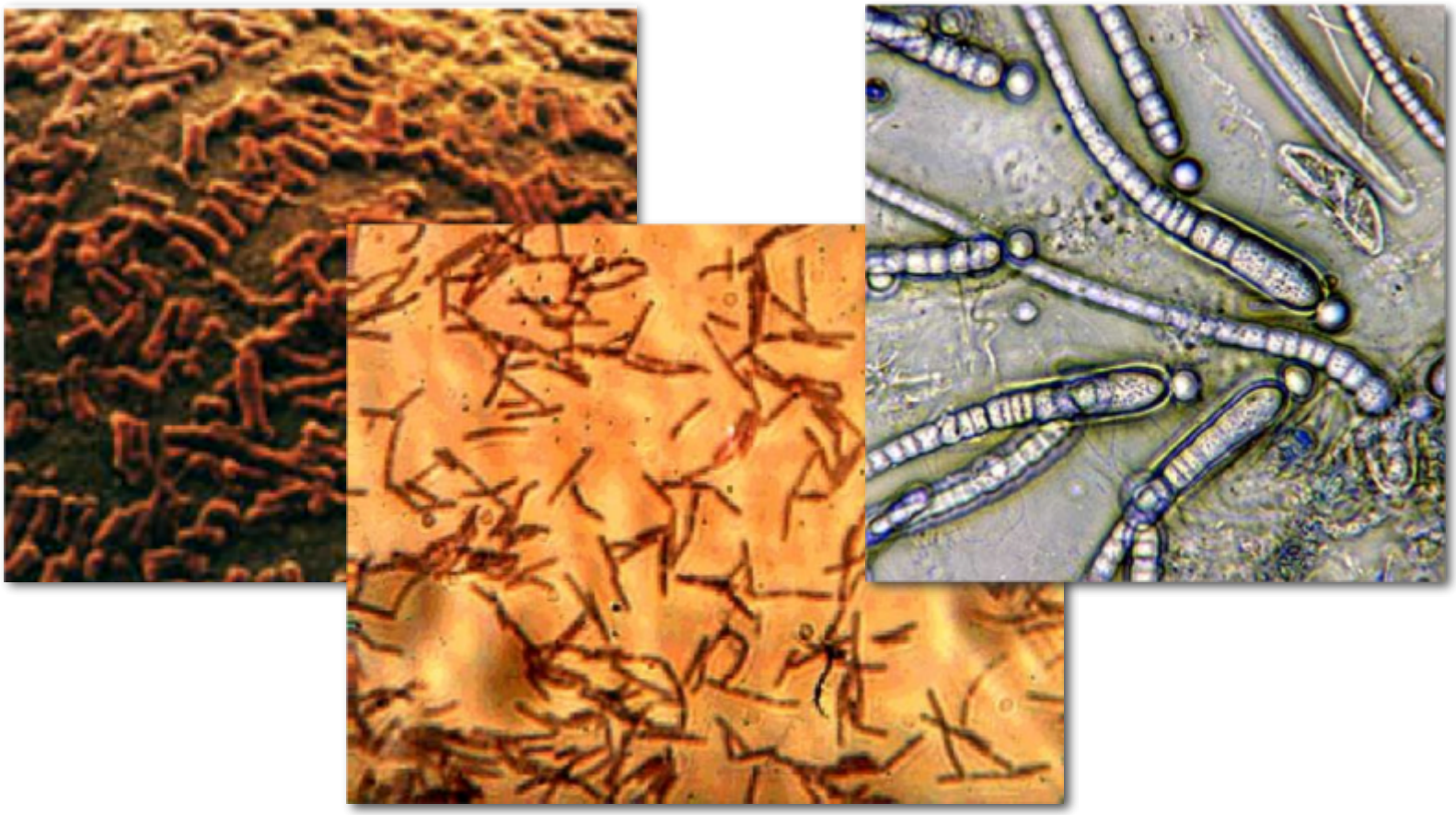




Algae

- **Algae** help to form soil by producing carbonic acid which causes rock to weather.
- Blue green algae use the enzyme **nitrogenase** to fix nitrogen. This is how rice plants can get nitrogen from the water in which they grow.
- Algae **excrete sugars** which feed fungi and bacteria and are also eaten by certain nematodes.
- Like bacteria they **exude sticky substances** which help to bind and aggregate soil particles.

Character Sketch: **Bacteria**



Bacteria

- Microscopic **one-celled** organisms;
- Consume simple **carbon compounds**;
- **500,000** fit on a pinhead. **30,000** different species amongst the 1 billion bacteria found in a teaspoon of productive soil. This is equivalent to the same mass as **5 cows** per hectare.





Bacteria – Good and Bad

- There are three basic kinds: ***Coccus*** (spherical or oval), ***Bacillus*** (rod shaped) and **spiral**.
- **Anaerobic** bacteria don't require oxygen and thrive in compacted soils or those with poor structure.
- They can smell bad via production of **hydrogen sulfide** (rotten eggs) or butyric acid (vomit).

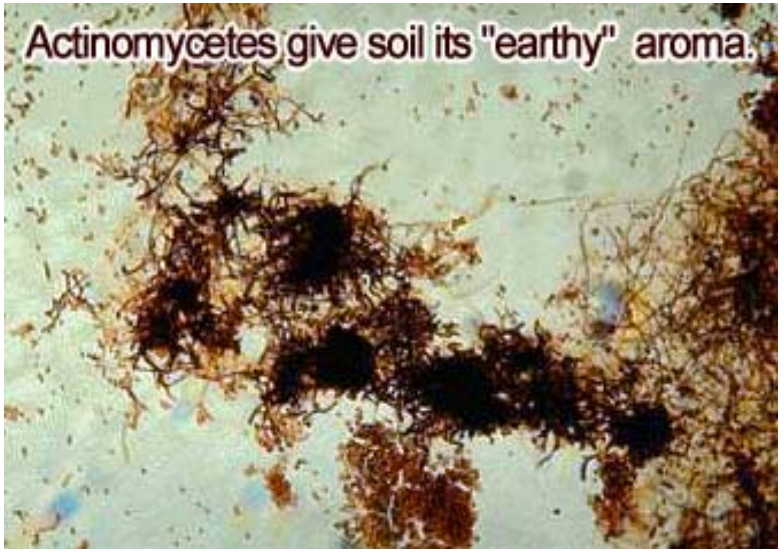


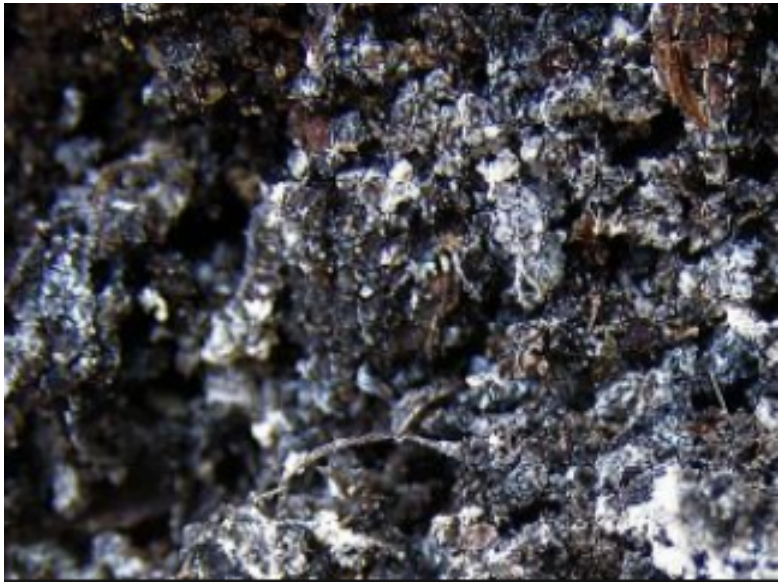
- **Facultative anaerobes** can survive with or without oxygen – *E.coli* etc.
- **Aerobic** organisms don't produce bad smells. In fact, one species is responsible for the great smell of good soils – ***Actinomycetes***.



The Sweet Scent of Good Soil

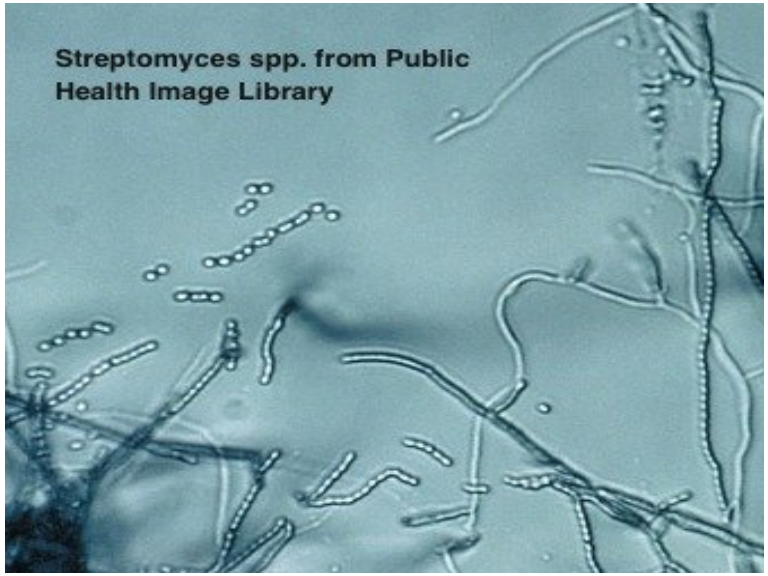
- ***Actinomycetes*** grow filaments almost like hyphae and tie themselves to soil particles to become too big for *Protozoa* to eat.
- These creatures produce **volatile chemicals** giving the fresh, healthy earth smell.
- Unlike other bacteria they are very good **cellulose** and **chitin** digesters (cellulose makes up 50% of plant mass and chitin makes up the outer shell of arthropods and fungi).
- They also live in a far wider **pH range** than other bacteria.





The Sweet Scent of Good Soil

- ***Actinomycetes*** are a sign post organism, hence your nose knows about your overall soil health.
- The ***Streptomyces*** family are forms of *Actinomycetes* and they are also key sources of antibiotics. They are hugely important to maintain a healthy balance of soil bacteria. Streptomyces produce 2/3 of clinically useful antibiotics.
- The ***Frankia*** family are free-living nitrogen fixers included amongst the multiple forms of Actinomycetes. These creatures are responsible for 15% of total nitrogen fixation.
- There are 160 plants that form symbiotic relationships with Frankia, and they are called **actinorhizal** plants.





Bacteria

General Characteristics:

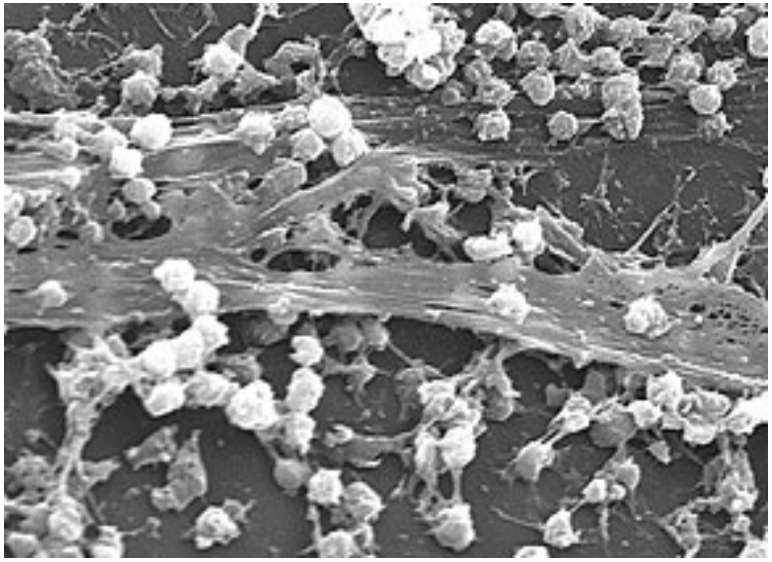
- The bacterial slime layer has a pH **above 7**;
- Bacteria have a carbon: nitrogen ratio of **5:1**; they are, in fact a nitrogen receptacle (i.e. 17%).
- Bacteria sequester **nitrogen** as a component of their body, which is released on death.
- They produce **by-products** that are essential to plant growth. These include vitamins, enzymes and natural growth hormones.





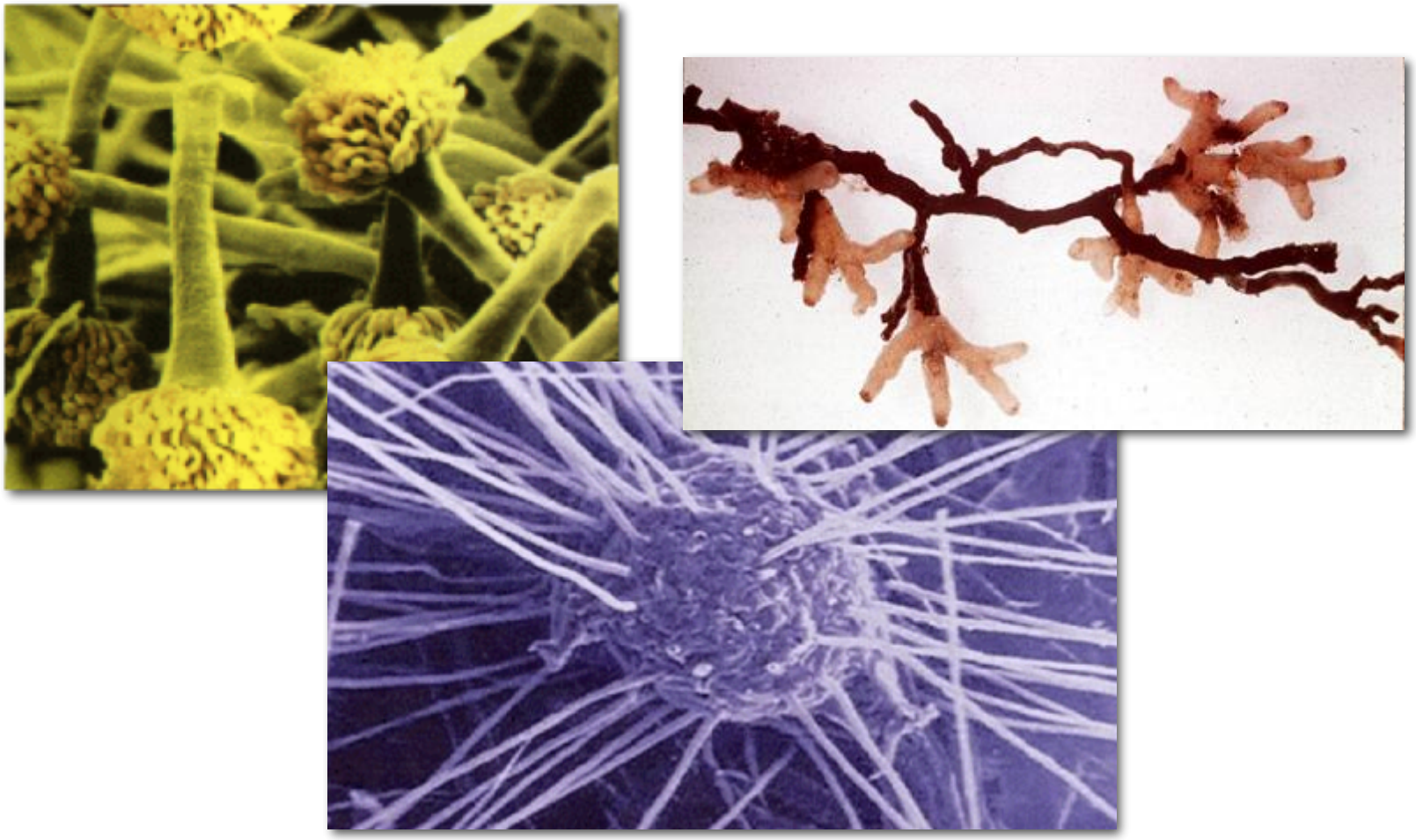
Benefits of Bacteria

- **Bacteria digest cellulose** but can't manage lignin. i.e. *cellulomonas* release enzymes that break up long chain carbons.
- Carbon, nitrogen and sulphur are all **recycled** by bacteria.
- Bacteria **retain nutrients** in their bodies reducing **leaching**. Recycling happens right in the rhizosphere – 2 mm from roots.
- Bacteria can remove most toxins from the soil.
- Bacterial **biofilm** acts like water crystals to **retain moisture**. Communities living in a sticky globe of biofilm are far more protected.





Character Sketch: **Fungi**



Fungi

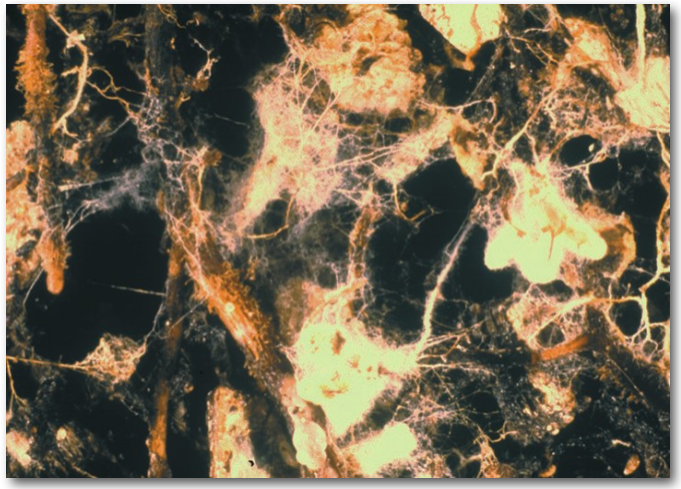
- Microscopic cells that usually grow as long threads or strands called **hyphae**;
- Hyphae sometimes group into masses called **mycelium**, and can make up fruiting structures such as mushrooms.
- Fungi convert **hard-to-digest** organic material into forms that other organisms can use.





Fantastic Fungi

- **Fungi** are much more **mobile** than bacteria allowing greater access to nutrients. They can grow up to **40 micrometres** in a minute. Bacteria travel **6 micrometres** in their entire life.
- They produce **phenol oxidase** – a powerful enzyme which can even digest lignin (miraculously their own chitin-based cell wall doesn't digest).
- When fungi die their **hyphae** leave a subway system of tiny **tunnels** in the soil.
- The constant release of acids is the principle generator of biologically available **phosphorus**.
- **Nitrifying bacteria** reduce as acidity builds in fungal-dominated soils. i.e. ammonium nitrogen reigns in these soils.



Fungi

General Characteristics:

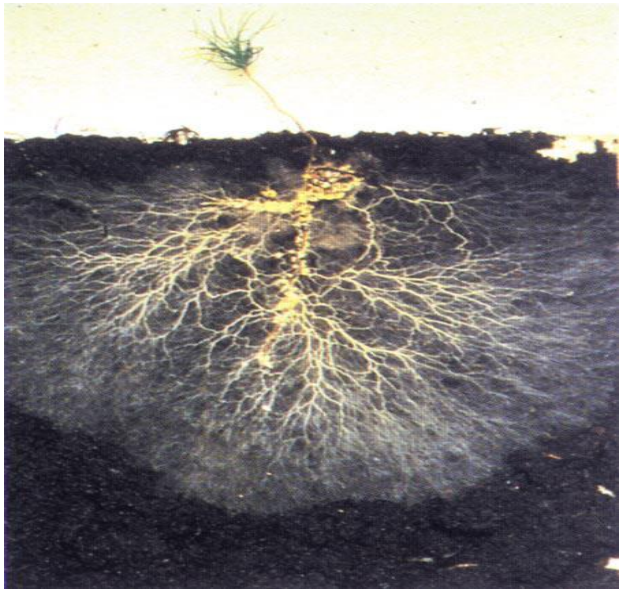
- Fungi **reduce the pH** of their surrounding environment through the release of organic acids.
- Fungi **retain nutrients** in their hyphal mass which reduces **leaching**.
- **Bacteria** can be stimulated with simple household **sugar**, but they should not be stimulated without also feeding fungi.
- **Fungi** prefer complex carbohydrates. **Kelp**, **humic acid** and ***Aloe vera*** are ideal fungal promotants.
- Like bacteria, fungi are decomposers, nutrient cyclers, soil structure builders and plant protectors. They also produce **vitamins and antibiotics**.





Symbiotic Fungi

- **Lichen** are a combination of green algae and a certain fungi living symbiotically.
- ***Mycorrhizal* fungi** burrow into the plant root and deliver moisture and nutrients in return for plant exudates.
- These fungi are **fragile** – herbicides, fungicides and tillage destroys them as does salt fertilisers like DAP/MAP. i.e. mushrooms don't grow after urea.



- ***Ectomycorrhizal*** fungi form webs around the roots but don't penetrate them. They colonise roots of hardwoods and conifers.
- ***Endomycorrhizal*** fungi penetrate vegetables, grasses, softwoods and orchard crops. 90% of plants have a *mycorrhizal* relationship.



A Living, Underground Internet

- It's an **information super-highway,** that fast-tracks communication between plants and plants, microbes to microbes, and between plants and microbes.
- The same highway also doubles for **hard goods delivery**.
- We are not talking about a new **internet** hybrid.
- We are talking about the amazing, **Mycorrhizal Network** (**MN**).





The Mycorrhizal Marvel



- Nineteenth century, German biologist, **Albert Bernhard Frank,** coined the term, 'Mycorrhiza'.
- He was describing the **partnership** between specific fungi and plant roots.
- **Paul Stamets**, the world's most accomplished mycologist, describes 'earth's natural internet' in his 2008 TED Talk.
- Mycorrhizal fungi effectively provide a **1000%** increase in root surface area, boosting all things **roots can offer** (including nutrient foraging and water access).



The Mycorrhizal Marvel

- AMF colonises **90%** of plants, excluding brassicas and chenopods.
- Their **benefits** include; scavenging for immobile minerals like phosphorus and zinc, mining potassium, delivering calcium, immune elicitation, nematode protection, and nitrogen supply.
- The big story is **glomalin**, the sticky carbon substance, responsible for 30% of all humus production.
- In 2010, **Ren Zen Zang,** from South China Agriculture University, found that when attacked by pathogens, plants release chemical signals (on the MN), that **warn** their neighbours.





Your Gains from Reclaiming your MN.

- In 2013 **David Johnston,** and colleagues from the University of Aberdeen, showed broad beans shared the news of aphid attacks on the MN.
- Again, those beans with mycelium, activated their **anti-aphid** chemical defences.
- Those without, **did not**.
- The plants were encased with plastic above ground, to prevent **atmospheric messaging**.
- “The warning was definitely transferred via **mycorrhizal networks**” concluded Johnston.





What has Killed Off 90% of Our Mycorrhizal Fungi?

This invisible network is particularly fragile and has been decimated in modern agriculture. The major culprits are:

1. **Tillage** slices and dices The MN**.** Minimum till is the best option



1. Unbuffered, **high salt index fertilizers,** dehydrate the mycelium

1. **DAP/MAP,** unbuffered, can frizzle the MN like putting a blowtorch to human hair.



1. **Nematicides**, of all kinds are particularly toxic to mycorrhizal fungi. This is ludicrous, if you can recognise that the best known natural control of root knot nematodes in **AMF.**

What has Killed Off 90% of Our Mycorrhizal Fungi

5. **Fungicide-treated seed** makes it very difficult for AMF to colonise and begin their massive 6-week expansion effort



5. **Long fallows** are a horror show for Mycorrhizal fungi, as they have no food source.



5. **Glyphosate** has been recently found to be compromising mycorrhizal fungi - minimize inputs and fast-track the breakdown.

5. **High N and P fertilisers** sponsor a plant shutdown of glucose to fuel hyphae growth - why do I need you?



5. Genetically modified, **BT crops** release exudates that impact AMF.

Reclaiming Our Mycorrhizal Networks

1. **Seed treatment** in broad acre crops can cost as little as $7 per hectare. This will not give full colonisation, but the network will begin to form.

2. **Seedling treatment** for orchard crops is the perfect way to colonise from day one.

3. Treating introduced seed when **pasture cropping,** can reduce the cost of pasture re-colonisation.

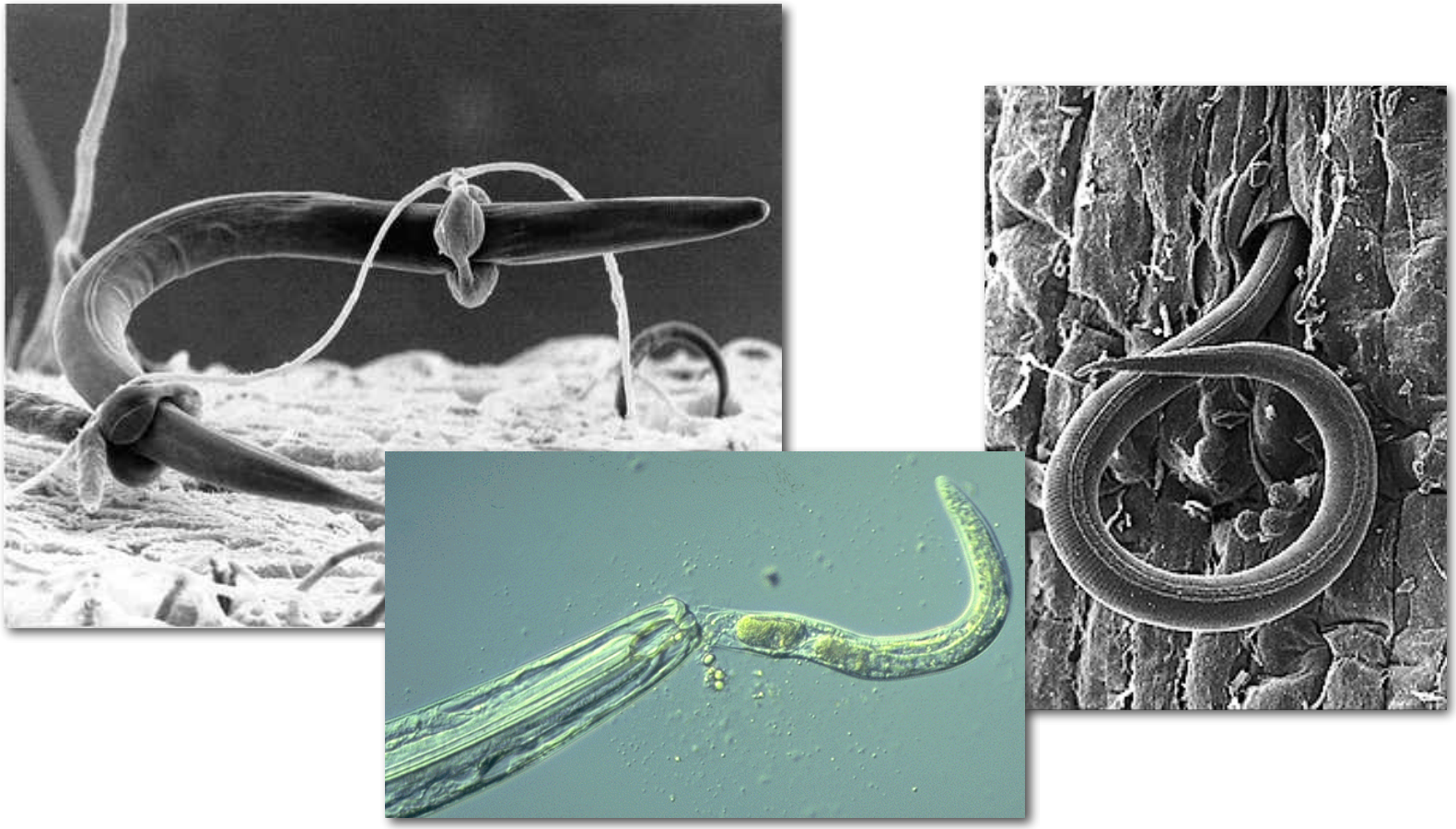
4. Using mycorrhizal fungi as a highly effective **nematicide,** reduces the vast damage otherwise associated with this chemical option.

5. **Oats** and **crimson clover** are a cover crop combination that stimulates mycorrhizal fungi.





Character Sketch: **Nematodes**



Nematodes

General Characteristics:

- Nematodes are non-segmented, blind roundworms;
- Some feed on plants and algae, some on bacteria and fungi, and others on **other nematodes**;
- Like most soil organisms, nematodes can play both **beneficial** and **destructive** roles in the soil.
- Are important in **mineralising** or releasing nutrients in plant available forms;
- Nematodes serve as a **transport system** for bacteria which attach to them.





The Nature of Nematodes

- They hunt prey on the basis of **temperature** and **scent** – like a heat-seeking missile.
- **20,000** species known but there may be over **1 million** – about 50 in each teaspoon of good soil (20 Bacteria Eating Nematodes, 20 Fungal Eating, some predators and some herbivores).



Larvae buffet

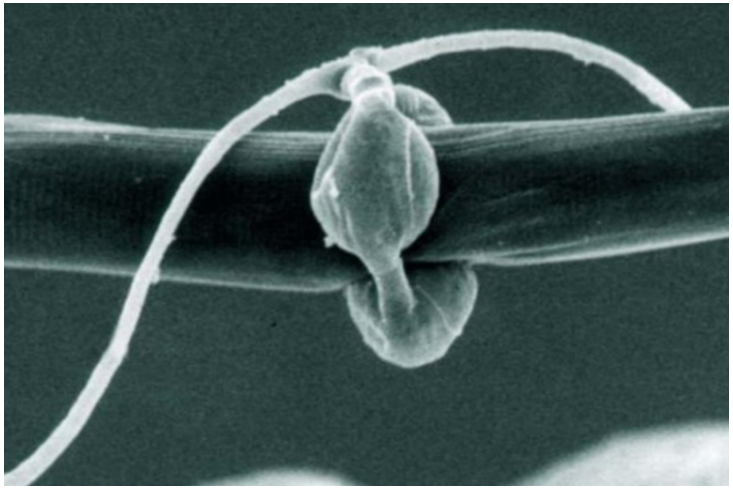
- **Predator nematodes** feed on protozoa, algae, grubs, weevils and other nematodes.
- Nematodes can't travel though **compacted** soils. They disappear and the flow of nitrogen is seriously affected. i.e. more **nitrogen** needed in high magnesium soils.



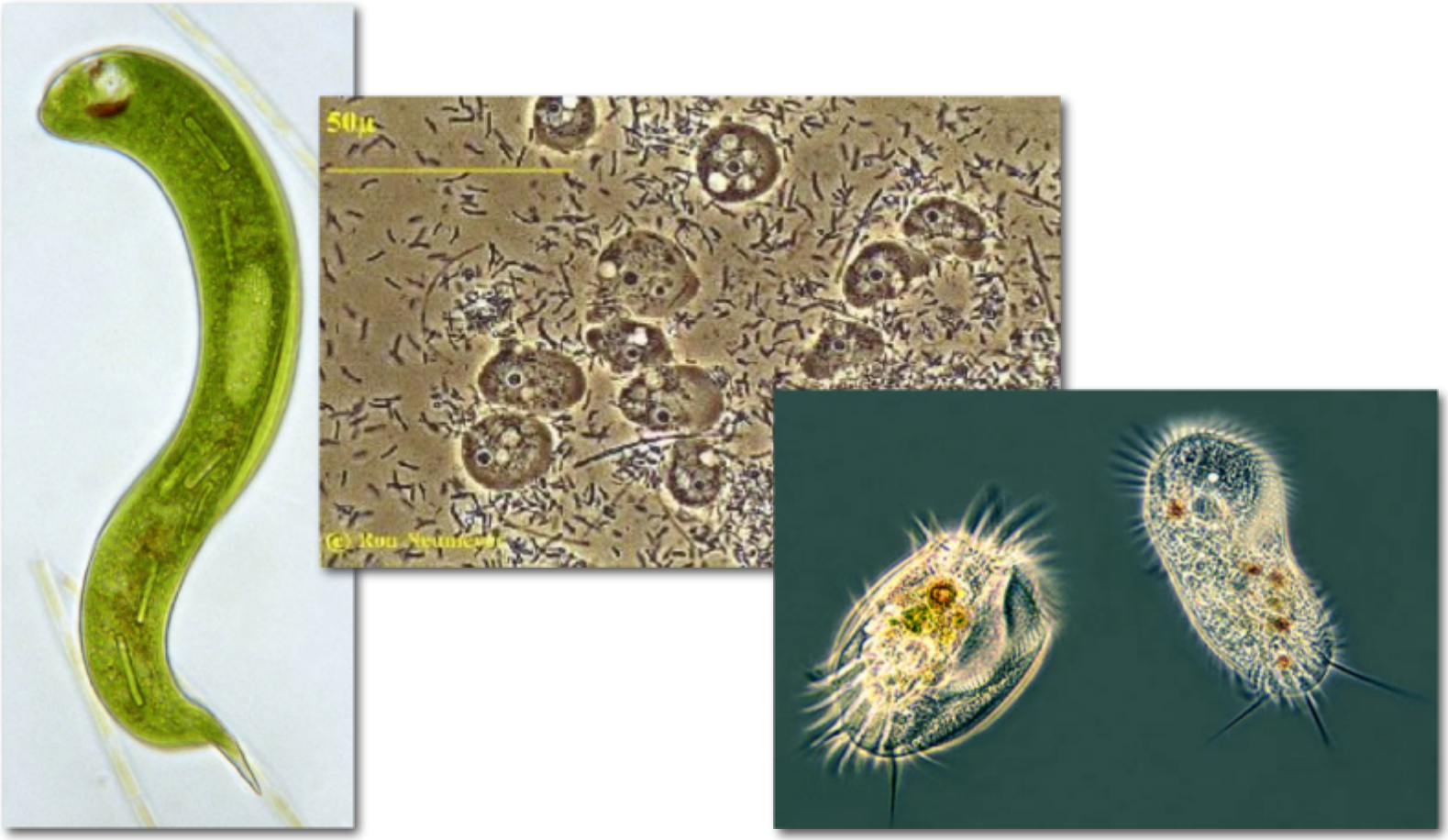
Nematicides – Counterproductive

- **Nematicides** like methyl bromide kill all nematodes – good and bad. These chemicals are very **expensive**. They contribute to **global warming** and they **kill** more people worldwide than any other farm chemical.
- All of the research is there to show that root eating nematodes **breed back** faster than the good nematodes. So, once you start using these chemicals, you'll always need to use them.
- The first line of defence against root-eating nematodes are the **predatory nematodes**.
- The second line of defence are the **mycorrhizal fungi**.
- The third line of defence are **nematode-trapping fungi**.



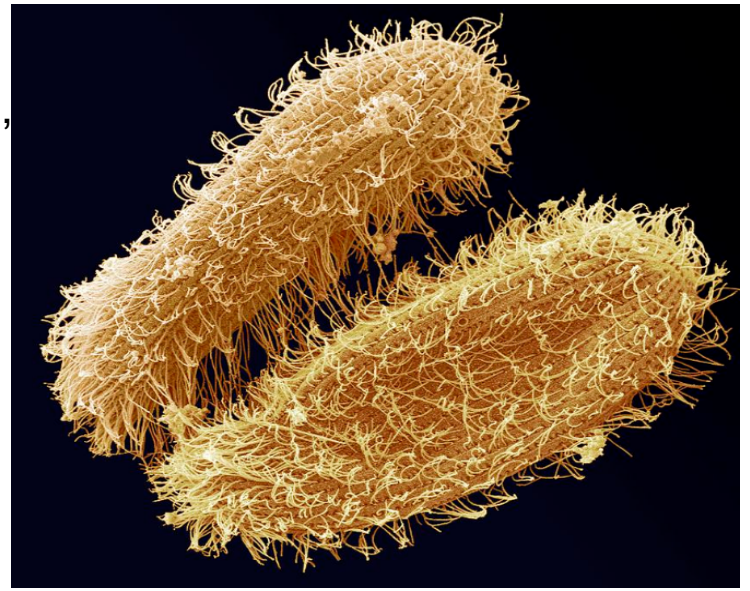


Character Sketch: Protozoa



Protozoa

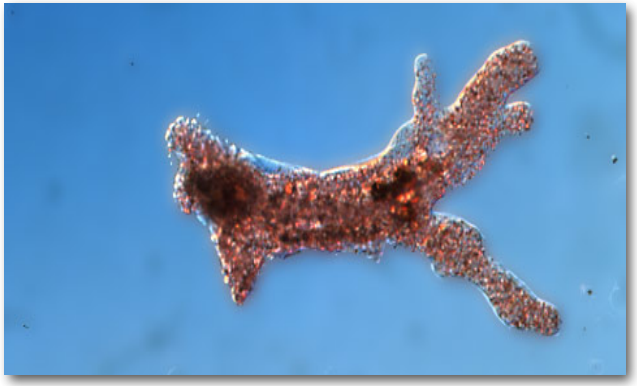
- They are **single-celled** animals that feed on bacteria, other protozoa, soluble organic matter and fungi;
- They are larger than bacteria and help **regulate bacteria** numbers through grazing;
- Protozoa play an important role in **mineralising nutrients** and making them available for use by plants and other soil microbes.
- Protozoa have a carbon:nitrogen ratio of **30:1** and higher.
- Are also an important **food source** for other soil organisms and help **suppress disease** by competing with or feeding on pathogens.
- If a single bacterium was the size of a **pea** then a ciliate protozoa would be the size of a **watermelon**.





Protozoa

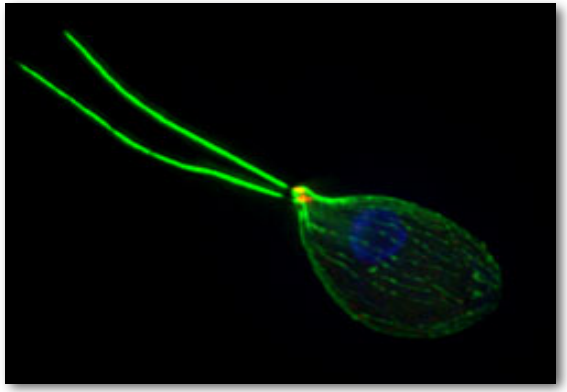
- **60,000** known kinds of protozoa in three basic models – amoebae, ciliates and flagellates.
- **Amoeba** are the largest. They ingest bacteria by surrounding them and engulfing them in gas bubbles laced with digestive enzymes before absorbing them and spitting out the waste.
- **Ciliates** are covered in rows of hairs (like paddles propelling them to food or away from enemies).
- **Flagellates**, the smallest, have one or two whip-like hairs for propulsion.



Amoeba



Ciliates

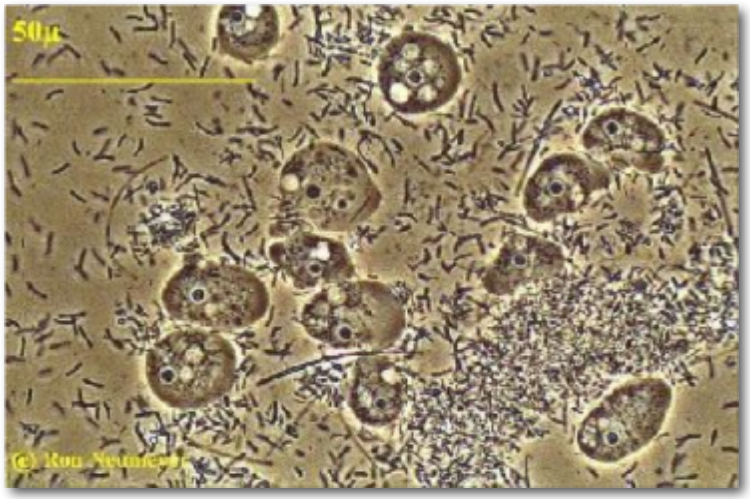


Flagellates

Protozoa

Benefits of Protozoa

- These creatures play a major role as population police. They eat **10,000** bacteria each day.
- **Flagellates** move in first followed by ciliates then amoeba. As bacteria numbers decline **amoeba** eats the other protozoa allowing bacteria numbers to bounce back.
- **Protozoa** also eat nematodes and compete with them for limited resources (including root knot nematodes).
- They are a principle **food source** for earthworms and nematodes, earthworms often disappear in the absence of protozoa.





Protozoa Potential

- There are over **1,000,000** per gram in healthy soil and as low as **1,000** per gram in a struggling soil.
- The ‘grazing’ of bacteria by protozoa stimulates **nitrogen fixing bacteria**, just as pruning stimulates your fruit trees.
- Protozoa are a major architect of **root structure -** there is much more branching and root surface area particularly in pastures and cereal crops.
- Bacteria are more than a N tank. Protozoa **recycle all minerals** found in their bacterial prey.



Arthropods



- **Invertebrates** that include insects, arachnids, crustaceans etc.;
- Range from **microscopic** to many centimetres long;
- **Several thousand** different species may live in a square mile of forest soil;
- Most eat **fungi**, worms or other **arthropods**.
- Arthropods tend to increase the **surface area** of organic matter accessible to microbial attack;
- Like protozoa, some arthropods tend to graze on **bacteria** and **fungi**;
- They help **transport** smaller microbes throughout the soil profile.

Character Sketch: **Earthworms**



Biology Basics – The Mighty Earthworm





- **7000 species** of earthworm are involved in the shredding of organic matter and the aeration of the soil.
- They **aggregate** soil particles and move organic matter and microbes throughout the soil.
- They also introduce **new microbes** to the soil and aid plant root growth.
- They are also major **decomposers** of organic matter.
- The **colloid mill** (a sand filled gizzard) reduces particle size. But, there are no enzymes produced. Digestion is based upon bacteria in the worm's gut

7 Reasons to Bring Back Your Earthworms

1. Earthworms are **fertiliser machines**. Vermicast contains 7 times more phosphorus, 10 times more potassium, 5 times more nitrogen, 3 times more magnesium and 1.5 times more calcium than the surrounding soil.
2. They will seriously increase the **infiltration** and **water holding** capacity of your soil.
3. If you could consistently find 25 earthworms per shovelful of your soil they would be contributing **300 tonnes** of castings per year.







7 Reasons to Bring Back Your Earthworms

4. Earthworms are a **limeworks** – they have a calciferous gland, which adds calcium carbonate to everything.
5. Earthworms **transport minerals** from deep in the soil up to the root zone.
6. Earthworms **compost 4 times faster** than normal composting.
7. Earthworms **incubate bacteria** that are invaluable in the soil and only found in earthworms.





The Soil Foodweb

FOOD – THE FEEDING FRENZY

Carbon : Nitrogen Ratio

- Bacteria 5 : 1
- Fungi 20 : 1
- Protozoa 30 : 1
- Nematodes 100 : 1
- Humans 30 : 1
- Lettuce 30 : 1
- Wood 500 : 1





NTS
Nutri-Tech Solutions®

Foliar Feeding

Problem Solving and Fast-Tracking Productivity with the Direct Route

Feeding Through the Foliage

- Foliar fertilising is **10-15 times** more efficient than soil based applications.
- Small inputs can produce **big results** at a low cost due to this increased efficiency.
- A more rapid response means more effective **chlorophyll management** with flow-on effects to soil life.
- This technology was originally favoured by those involved in more intense horticulture. However, it is now regarded as a **problem solver** and **yield booster** for all crops, including pasture and broadacre.









Seven Reasons to Foliar Spray

1. **To rapidly correct deficiencies –** particularly important in short cycle crops.

2. **To relieve crop stress –** events like transplant, drought, frost, heat, water-logging and pest pressure can be countered with direct inject.

3. **To bypass soil-based issues –** this might include lock-ups from excesses, deficiencies, leaching in light soils, and nutrient competition.

4. **To boost yield** – this is particularly relevant to the use of plant growth promotants and natural hormones.

Yield Building with Brix-Fix™



- We have discovered a group of **synergists**, which further enhance the many benefits of Triacontanol.
- This super-concentrate is used at just 2 L per hectare in all crops at a cost of less than **$10 per hectare.**
- Aside from the dramatic boosting of photosynthesis, Brix-Fix™ is a major new tool to increase the **medicinal compounds** in plants, and to increase the potency of essential oils.
- For example, the studies have shown increased **curcumin** in treated turmeric, higher carotene content in all crops, higher morphine extraction from opium poppies, and higher **essential oil** yields in multiple crops (with enhanced actives).



- Brix-Fix™ is also an exciting new input to help counter climate change. It is a major **rescue remedy** helping to counter climate extremes incl; cold, drought, salt, flooding and transplant stress.

Yield Building with Brix-Fix™

- **Damian Sutton** farms 25 hectares of tomatoes, cauliflower and broccoli near Gatton in SE Qld.
- There were three applications of triacontanol, fertigated at 300 mL per hectare, involving a total of 900 mL per hectare, per season.
- The results revealed a yield increase of **35.6% over the control -** This yield boost represented an increase of **17.8 tonnes** per hectare (AUD $35,000 per hectare).
- The foliar trial involved just two applications of **50 mL** per hectare. Here, there was effectively 9 times less triacontanol involved, but the yield increase was still **17.6%** over the control. This represented a yield boost of **8.8 tonnes** per hectare, or an extra AUD $17,600 in bankable profit.





Seven Reasons to Foliar Spray

5. **To improve crop quality and associated resilience –** foliar fertilisers are the most effective way to lift brix levels, to increase nutrient density and disease resistance.

6. **To swing the crop from vegetative to reproductive** - this is often required, if we have overdone vegetative minerals like nitrate nitrogen.

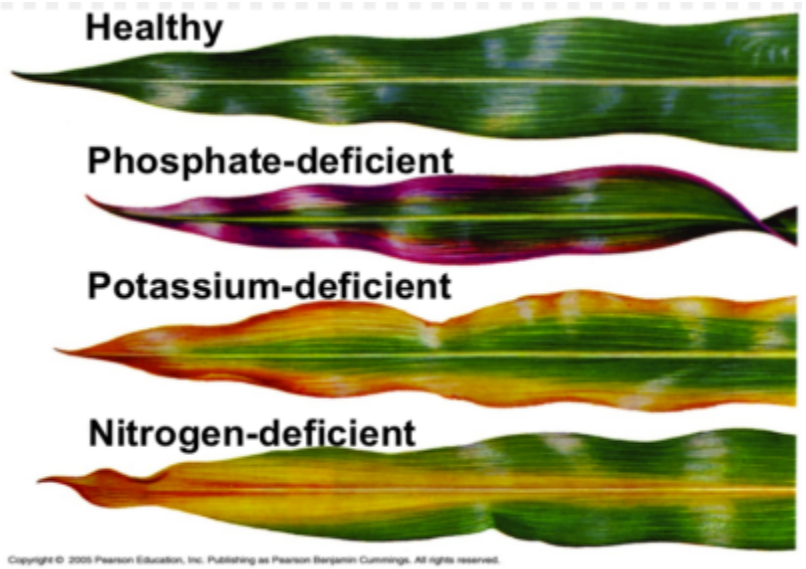
7. **To build nutrient density and protein levels in pasture –** this is a highly effective way to increase stock weight and animal health, when finishing stock or improving fertility levels.





Determining what is required

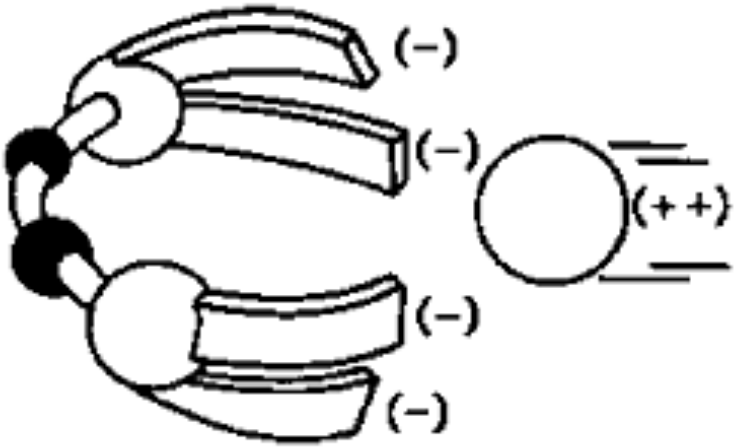
- **Visual monitoring**, in-field testing, and leaf analysis, can all help to determine **what** is required, and **when**.
- **Visual monitoring** involves checking for blotches, pale colours and stripes. Stem strength, leaf size and thickness, root health and visible microbial activity are all helpful indicators.
- **Photographing** your deficiency (determined by a leaf test) with your mobile phone, enables an ongoing reference point.
- The goal is to **recognise key deficiencies** immediately, to facilitate a rapid response.





Achieving the Best Foliar Response

- There are a **series of strategies** to ensure optimum foliar response.
- These include; **chelation**, microbial support, pH factors, adjuvants, appropriate rates, variable mineral mobility, and the importance of timing.
- **Chelation** involves neutralising a positively charged cation, to facilitate **better uptake,** via a negatively charged plant surface.
- It essentially involves avoiding a **traffic jam** (clogging of the stomates), to ensure easy entry.





Achieving the Best Foliar Response

- **Chelation** can involve patented chemical chelating agents like EDTA.
- These materials can have problems, because they introduce an alien, **chemical contaminant** into the plant (EDTA is now considered a POP).
- There are much better, more **cost effective**, natural alternatives.
- These include; fulvic acid, amino acids, mannitol from kelp, and the **Shuttle® Mineral Delivery System**.







DIY Chelation

- **Fulvic acid** is the most powerful natural chelating agent, and **DIY chelation** is as simple as adding soluble powder to sulphate-based trace minerals or calcium nitrate etc.
- The rate that is generally sufficient for effective chelation is **300-400 grams** per hectare of Soluble Fulvic Acid Powder.
- Every shed should contain a bag of **NTS Fulvic Acid Powder™,** because it can be added to virtually anything, to magnify uptake by one third.
- Fulvic acid doubles as a **plant growth promoter**, **hormonal promotant,** and it is a powerhouse **microbial stimulant,** so you are achieving several things at once.





Amino Acids and Kelp

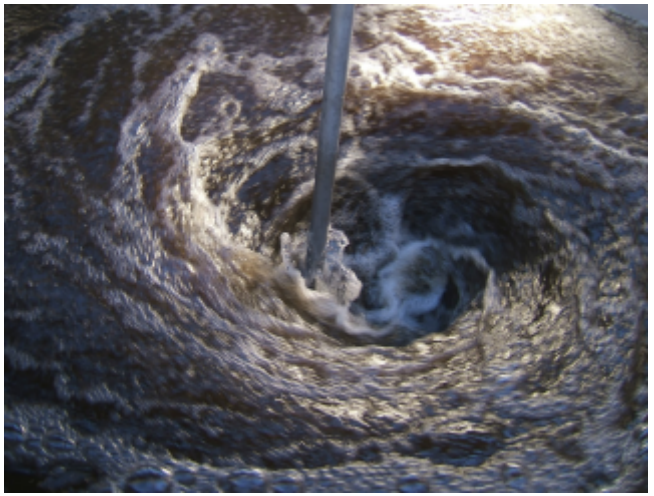
- **Amino acids** are all capable of chelation but the single most effective is glycine.
- **Glycine** is the smallest amino acid and it can deliver minerals into the plant incredibly rapidly due to its tiny size.
- **Kelp** contains mannitol, a powerful chelating agent.
- All **74 minerals** found in kelp are naturally chelated, but there is sufficient mannitol present to chelate other additives.



Achieving the Best Foliar Response

1. Putting the microbes behind the minerals

- It is always a **wasted opportunity** to apply any microbial inoculum, without some nutrition.
- Similarly, the addition of minerals added to compost, **dramatically increases** the fertilising response.
- Part of the **enhanced foliar response** is linked to a stimulation of stomatal openings, following a sudden influx of **CO_2** (from 5 billion organisms per teaspoon).
- The concept of microbial enhanced nutrient delivery (**MEND™**) can result in significant fertiliser reduction and associated savings.





Achieving the Best Foliar Response

2. Understanding the pH factor

- The **pH** of the spray solution can impact the end result.
- The **ideal pH** for a vegetative response is **7**, while the perfect pH for a reproductive response is **6.**
- A **fruiting response** can be sponsored with a more acidic brew, but this is based upon acid shock.
- A bag of **citric acid,** and a **waterproof pH meter,** are essential tools to modify pH of the spray solution.







3. Achieving a reproductive push

Flowering Recipe

Apply **Super Phosphate** at 250 – 300 kg/ha around roots.

Apply an acidic foliar spray with reproductive minerals:

- **Nutri-Sea Liquid Fish™** (max. 5 L/ha)
- **Aqua Ammonia** (5 L/Ha)
- **Phos-Force™** (pH <2) (max. 4 L/ha)
- **Manganese Sulphate –** 2 kg/ha
- **Fast Fulvic™** (max. 3 L/ha)
- **Cloak™** Spray Oil



Achieving the Best Foliar Response

4. DIY Foliar Strategies

There are several productive combinations when designing your own cost-saving foliars. These include:

1. **The combination of urea and humic acid** – this buffers the salt content and increases N uptake by one third. Foliar urea is the most sustainable N boost.
2. **The combination of citric acid with farm chemicals –** the vast majority of chemicals work much more efficiently in acid conditions i.e. glyphosate - 2.9 pH, diathane - 5.2 pH.
3. **The combination of kelp or fulvic acid with trace minerals** – both are powerhouse chelating agents, with many other benefits.
4. **Calcium nitrate combined with fulvic acid** – this fusion creates a low cost, but highly effective, chelated calcium, of value to all crops.





Achieving the Best Foliar Response

5. Choosing rates that will reward

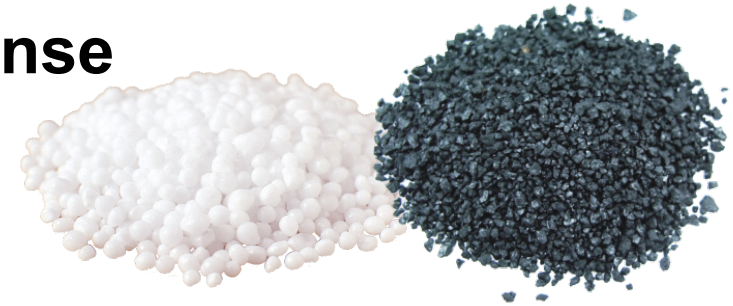
It is important to apply at **rates** that will achieve optimum results. Here are some guidelines:

1. **Calcium nitrate** and **fulvic acid** – apply 1 kg per acre with 200 grams of Soluble Fulvic Acid Powder.
2. Apply both soluble **kelp powder** and **fulvic acid** at 1 gram per litre.
3. **Seaweed** can be productive at lower than label rates, as the hormonal component kicks in at very low rates. I.e. kelp study where 1:500 was as effective as 1:100.
4. **MMS products** can be productive at just 1 litre per acre (but always include DIY Humic Acid at 4 L per acre).





Achieving the Best Foliar Response



6. Boosting Nitrogen Efficiency

- The single most efficient application technique for nitrogen is the use of urea as a foliar spray.
- Nitrogen en route to plant protein, undergoes **an energy-intensive** (10% of energy) conversion to amines, then amino acids, then protein.
- Urea begins life as an **amine** but is rapidly converted to ammonium nitrogen in the soil. Foliar urea enters the plant as an amine and is much more easily converted to **protein**.
- Foliar urea should always be combined with humic acid to **buffer and magnify**.
- A 10 kg urea foliar can equal 6 x that amount when applied to the soil.



Achieving The Best Nitrogen Response



HUMIC ACID:

- Urea and Humic Acid are **perfect partners** with a rare compatibility. Together they create a stable **urea humate**.
- There is less volatisation and **less leaching** due to a lower conversion rate to nitrate nitrogen.
- Humic Acid should be used at a ratio of **1:20 (5%)** – i.e. for every 100 kg of urea, use 5 kg of **NTS Soluble Humate Granules™**.
- Humic acid provides **multiple benefits**. It is a microbial food source, a root stimulant and a soil conditioner. It is also a powerful chelating agent.





Achieving the Best Foliar Response

7. Understanding mineral mobility

- Minerals **vary** in the speed at which they move into and around the plant.
- The most mobile minerals are **NPK**, magnesium and manganese.
- The least mobile of all minerals is **calcium**.
- Most crops will benefit from a foliar spray of **chelated calcium**, as this mineral is of such importance.
- Foliar calcium can even move directly **through the skin**, into the fruit, to boost quality and shelf-life.





Achieving the Best Foliar Response

8. Getting your timing right

Timing is critically important with foliar sprays. This could involve the time of the day, time of the month, or the stage of the crop cycle. Here are some guidelines:

1. The best time of the day is **early morning**, or evening. Stomates open in the morning to absorb the dew. Avoid spraying in the heat of the day, when stomates are closed.
2. **Microbial inoculums** are the perfect partner for **nutrition**. When we put the microbes behind minerals, there is always an enhanced response (CO_2 stimulates stomatal opening).





Achieving the Best Foliar Response

8. Getting your timing right

3. There can be considerable gain in foliar spraying according to **moon cycles**. The best time to spray is during any of the **6 days** leading up to a full moon. The least productive time, is any of the 6 days leading up to a new moon. There is more movement of plant sap, leading up to a full moon (like tides).
4. It can be very productive to foliar feed **young foliage**, as there is more rapid translocation. Some growers begin with very small amounts of nutrients at the two-leaf stage.
5. A leaf analysis, **prior to flowering,** will provide an indication of nutrition action for the business end of the season. **Boron,** applied before flowering, is of value for virtually every crop. There is also a massive potassium draw-down after flowering.





9. Include a Sticker/Synergist

- **Increased target penetration** – oils bond with leaf surface, magnifying the penetration and absorption of foliar nutrients = increases **systemic** response.
- **Drift reduction** – creates more uniform droplet size.
- **Rain-fast enhancement** – The natural oils ensure the spray is rain-fast.
- **Odour reduction –** Encapsulates unwanted smells
- **Foliar synergist -** optimises the performance of foliar fertilisers and farm chemicals

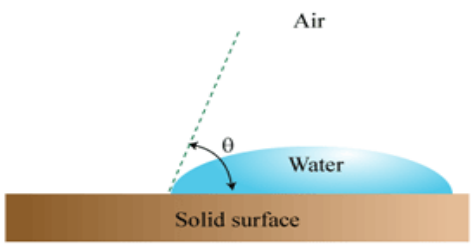


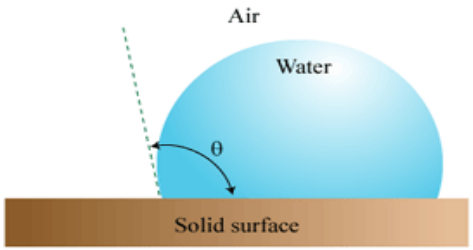


Tsunami Super Spreader

- **Improved spreading capacity** – helps overcome droplet surface tension on waxy surfaces.
- **Increase efficacy** of foliar nutrients and farm chemicals
- **Contains plant-available silica** to provide all the benefits of this missing mineral.
- **Drys foliar fertilisers** more quickly and they become more adhesive.
- **Climate resistance** – helps counter the effects of extreme weather events
- **Insecticidal at high water rates** – effective against mites







Foliar mistakes – what not to do

1. It is hugely important to understand **compatibility issues,** to avoid blockages and equipment damage.

- **Humic acid**, for example, can only be combined with urea, potassium, and sodium borate.
- **MKP** and **calcium nitrate** are incompatible, because insoluble calcium phosphate can form.
- **Calcium** will precipitate with phosphate, sulphate, and carbonate ions.
- **Phosphate** will react with most trace minerals (zinc, copper, iron and manganese).
- **Urea** should never be mixed with liquid lime







Foliar mistakes – what not to do







Compatibility rules

- Adding minerals to **hard water** can cause precipitation, or reduce pesticide efficacy.
- **Alkaline kelp powders** are only soluble with a high pH. Use fermented liquid kelp with acidic inputs.
- **Low pH liquid fish** (phosphoric acid) is not compatible with humic acid.
- **Potassium Silicate** is only soluble in alkaline solutions.
- **Fulvic acid** is incompatible with the additives in some forms of Roundup (I.e. CT Extra).

Tank Mix Sequence



The order of tank mixing can also determine whether or not ingredients dissolve.

Recommended **tank mix sequence:**

1. Fill tank half-full with water
2. Water conditioners e.g., pH adjusters
3. Least soluble ingredients e.g., potassium sulphate – agitate until completely dissolved
4. More water soluble ingredients
5. Liquids
6. Wetters/stickers e.g., Cloak™ Spray Oil
7. Microbial products



Jar Tests

- Always jar test combinations!
- Water properties, dilution factors and addition of buffering agents, can influence compatibilities.
- Use the same water source that you intend to use for fertiliser application.
- Add the intended dilution of each input to a small jar, mix, and let sit.
- Does any solid material settle to the bottom of the jar?
- If the solutions were clear before combining, is the mixed solution cloudy or milky looking?









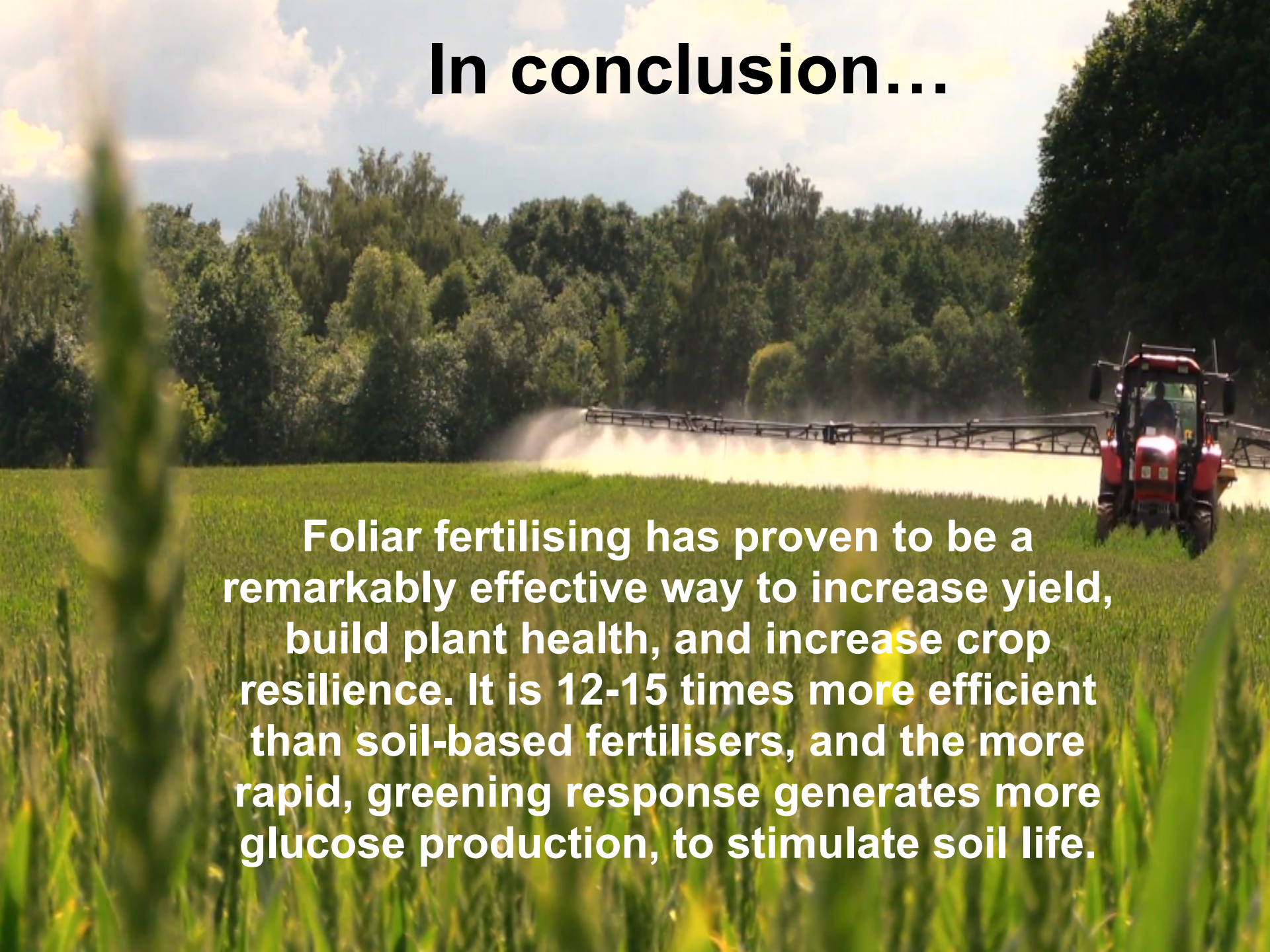
Foliar mistakes – what not to do!

2. Foliar nutrition is best up taken with a **small droplet size,** due to the very small size of the stomates, positioned under the leaf.

3. When foliar spraying pasture, there must be at least **4 inches of growth,** to provide the surface area for foliar uptake. Spraying on a pasture grased down to a table top, amounts to a liquid fertiliser application, rather than a foliar.

4. Don’t spray **unbuffered** salt or acid fertilisers. The most effective carbon-based buffering agent is **humic** or **fulvic** acid. Molasses can also be of value.

In conclusion…



Foliar fertilising has proven to be a remarkably effective way to increase yield, build plant health, and increase crop resilience. It is 12-15 times more efficient than soil-based fertilisers, and the more rapid, greening response generates more glucose production, to stimulate soil life.



NTS
Nutri-Tech Solutions®

The Magic and Myth of Cover Cropping

By Graeme Sait

Seven Reasons To Cover Crop

1. **To provide biodiversity** – this is a central rule of nature. Plants all do better in the presence of other plants. This is the fatal flaw in the monoculture model.
   In one large scale US study, comparing different cover crop inclusions, it was found that, in every case, it was **"the more the merrier"**.
   Part of this improved crop response relates to increased **biological activity,** but there is more involved.



Seven Reasons To Cover Crop

2. **To help manage weeds** – Nature is messaging us about the need for plant cover, because weeds come up whenever there is a vacuum.
   Our response has been to use and abuse **herbicides** to the point that they have become amongst the most destructive chemical inputs.
   Cover crops **interplanted** in field crops can reduce the need for herbicides, simply because they outcompete the weeds.



Seven Reasons To Cover Crop

3. **To feed soil-life** – It can be argued that a bag of seed can be of more value than a bag of fertiliser.

   The cover crop provides enhanced photosynthesis and **30%** of the sugars produced are pumped into the soil to feed beneficial microorganisms.

   Different plants feed different microbes, so the greater the **biodiversity** above ground, the greater the biodiversity below.



Seven Reasons To Cover Crop

4. **To build humus** – Cover crops can stimulate humus-building soil-life, converting sugar (carbon) exudates into humus.

   When the cover crop is slashed, or compressed with a **roller crimper**, it can decompose and further increase organic matter levels.

   The **oxygen pathways** introduced by crops like daikon radish further stimulate humus-building organisms.





Seven Reasons To Cover Crop

5. **To prevent erosion** – This precious top-soil enters the ocean along with the P and N it contains and creates algal blooms, which have created massive dead zones in our oceans.

In the US the average top-soil loss per year is **3 – 5 tonnes per acre**.

The problem is worsening with weather extremes, because rain is a major cause of erosion.



Seven Reasons To Cover Crop

6. **Management of pests** – Crops like **mustard** and **marigolds** are very effective nematicides and other cover crops can reduce root disease.

   Cover crops can also serve as trap crops for pests and/or they can host beneficial predators.

   These crops can also attract **pollinators**, which are essential for most fruiting crops.





Seven Reasons To Cover Crop

7. **To supply nitrogen** – high protein legume plowdowns can provide up to **100 kg of N** per hectare (200 kg of urea per Ha).

   The nitrogen is rapidly delivered due to the **10:1** up to **15:1** C:N ratio of legumes.

   Even crops like winter rye, annual rye grass and wheat, can have a **15:1** C:N ratio before flowering.





Growing Your Own Nitrogen

It can be handy to understand the **equation** that allows you to calculate the **amount of N** you are producing with a cover crop.

- As a rule of thumb, **100%** ground cover, at 6 inches high, equates to **2.2** tonnes of dry matter per ha.
- You add **150 kg** per ha for each additional inch.
- The equation is: **Dry matter per ha x % of N.**





Growing Your Own Nitrogen

N-content of Cover Crops

Annual Legumes	Perennial legumes	Grasses
Pre-bloom: 3.5-4% N	Pre-bloom: 2.5-3% N	Pre-bloom: 2-3% N
Post-bloom: 3-3.5% N	Post-bloom: 2-2.5% N	Post-bloom: 1.5-2.5% N

Lets try the equation (Dry matter per Ha x % of stand x % of N):

Assuming that you have 100% ground cover of a pre-bloom annual legume, grown to a height of 12 inches, here is how you do it…

2,200 kg + 6 x 150 kg (900 kg) x 100% x 4% N
= 124 kg of N or 260 kg of Urea

Cover Cropping Cautions

1. Always watch out for **nitrogen drawdown** with high carbon crops.

   Allow **three weeks** minimum before planting and use cellulose digesters if necessary.

   Additional nitrogen may also be required.

2. **Turning-in** a green manure crop will always provide more N than no till, because there is always gaseous N lost following **herbicide burn down.**



Cover Cropping Cautions

3. When working in the cover crop keep in the **A horizon** (top few inches). Deep tillage buries N and it may leach before the roots arrive (Howard Rotavator).

4. Combine lower N higher C grasses with legumes to slow down the **N release**.

5. Rye, wheat, oats, hairy vetch and brassicas are all known to have an **allelopathic** effect, so mix them up and alternate to avoid a build up of these bio-chemicals.





A Multi-Benefit Brassica

The term **“tillage radish”** is clever marketing to capitalise on the potential of a cover crop brassica called Daikon Radish. These benefits include:

1. The radish can grow beyond 30 inches and is a powerful **N scavenger**, absorbing 150 kg of N in Autumn and releasing it in Spring.

2. It breaks **hard pans** and suppresses Spring weeds.

3. It produces **glucosinolates**, bio-chemicals that discourage root disease and root knot nematodes.





Cover Crop Principles

1. **The more the merrier** – nature embraces biodiversity, e.g., four legumes under cereals works much better than one. Four grasses under legumes outperforms a single grass.
2. **Cover crops as a drought tool** – it may seem counterintuitive, but the associated fungal stimulation produces macro-aggregates to dramatically improve water absorption. A living soil can absorb 8 – 20 inches of rain in an hour, compared to flow-off, erosion and floods.
3. **Use cover crops to stimulate AMF** – combination is the secret here. Dr Wendy Taheri has demonstrated that the combination of oats and crimson clover is a powerful mycorrhizal stimulant. The effect is even more powerful if you include white and yellow clover.



Cover Crop Principles

4. **Tips to improve wheat –** add 2.5 kg of daikon radish with Winter wheat seed**.** It will only get pencil thin before Winter, but will accumulate calcium, boron and zinc and deliver this kick-start in spring as the wheat breaks dormancy.

5. **Determining seeding rates** – surprisingly, higher seeding rates are better in dry conditions because the plants cool the soil down and provide the capillary action to harvest banked moisture. 30 – 40 kg might be applicable in dry conditions, while 10 – 15 kg is more appropriate in wet, heavy clay soils.



Cover Crop Principles

6. **Practice pasture cropping – Colin Seis** – the goal is to get direct-drilled cover blends to account for 40% of species, then things really change. The associated fungal diversity from multiple clovers makes much better use of urine and manure. **Leaf chicory** is like a pre-biotic for the rumen. **Plantain** is a deep-rooted nutrient accumulator that is anti-parasitic.

7. **Don't overdo seeding rates** – always remember "less is more, and more is too much". Many cover crops have failed through over-seeding.

8. **Keep a below-ground focus** – the biological dynamics are the key, not a leafy show. You might be boosting biology with the young plant or soaking up mineral excesses and stabilising leachables with the older plant.





Plant Specific Purposes

1. **Barley** is mycorrhizal in the Spring. At this time it also releases exudates that increase P and K availability.
2. **Cereal Rye** is a real N scavenger in early Spring, saving that mineral for later release. This can impact weed pressure, as some weeds germinate in Spring in the presence of 50 ppm of nitrogen. Soy beans need extra N at pod fill, so the decomposing rye gives just what they want when they need it.
3. **Triticale** is related to cereal rye but its different release pattern enables spoonfeeding of the cash crop for a much longer time.







Drought-proof Your Farm With Cover Crops

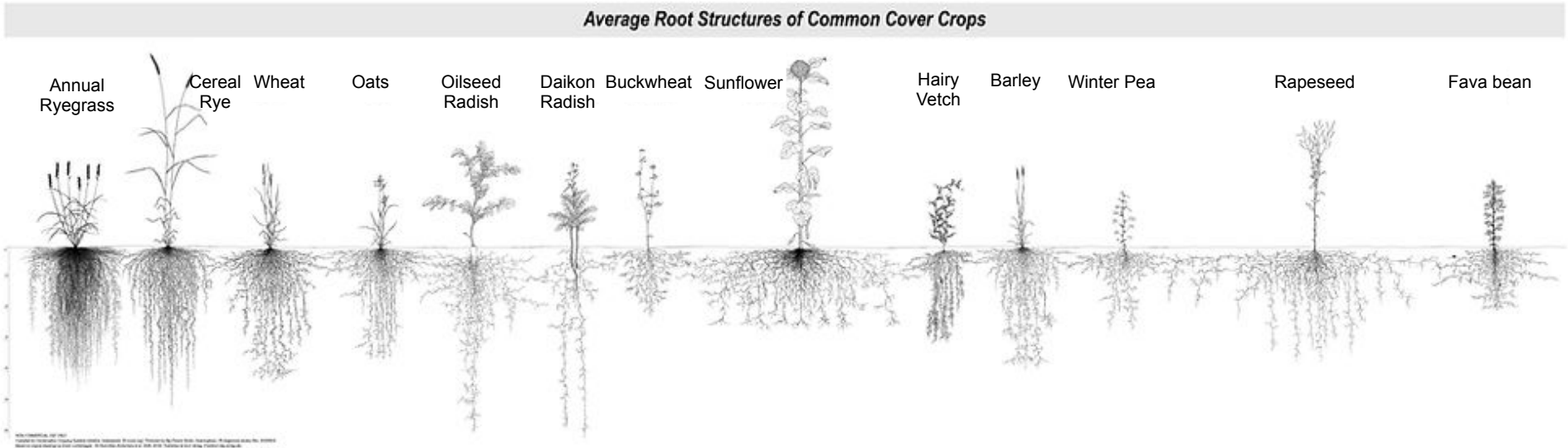
The **Paul Scherrer Institute** of Switzerland researched the mechanics
of drought-proofing with cover crops. Their findings include:

1. Soil with a few mm of roots has **30%** more moisture due to water crystal exudates of microbes in the root zone.
2. Roots themselves are **90%** water.
3. Roots excrete a gel-like mucilage (mucigel) that can absorb **10 times** their own dry weight in water.
4. **40** tonnes of crop residue digests down to 10 tonnes, increasing organic matter by 1%, (worth over **$2000** per ha in nutrients).



Root Depth Rewards

- The greatest opportunity for building **organic matter** is the below ground portion of the plants as the roots lie in the midst of all the biological action.
- Unfortunately, modern hybrids have been largely developed for showy above ground vegetation, but with **smaller root systems**. This obviously impacts our potential to build all-important humus.
- **Multi-species cover crops** provide much greater **root biomass**, and associated carbon building potential.
- Deeper roots also have greater **access to nutrients and moisture**, which will be recycled when the cover crop is turned in, or dies.

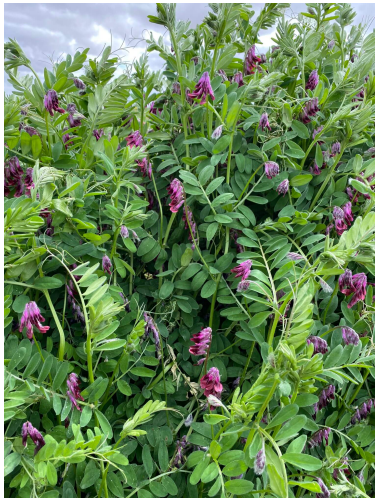


Ecosystem Functions of Key Species

- **Legumes** (i.e. clover, vetch, lucerne, beans, peas etc) house rhizobium to harvest free nitrogen. They also improve the C:N ratio in the soil to elevate humus formation. A functioning legume also releases phosphorus and the acid exudates favour **fungal proliferation** in that root zone.
- **Brassicas** (i.e. radishes, turnip, etc) – this species can help with soil compaction alleviation, improving water infiltration and gas exchange. They are also renowned nutrient scavengers, particularly adept at harvesting nitrogen from deep in the soil. Brassicas can also release **glucosinolates**, which suppress soil diseases.







Ecosystem Functions of Key Species

- **Grasses/Cereals** (i.e. Rye and Oats) – these fibrous root systems **stabilise the soil,** reduce erosion, and protect from water and wind damage. They establish quickly and **outcompete weeds**. They strongly associate with mycorrhizal fungi, which increase access to **phosphorus** and other immobile minerals. Grasses also vigorously pump glucose into the root zone feeding all soil life.
- **Sunflower** – deep root systems penetrate compacted soil layers, improving soil structure and water infiltration. They can recover potassium from deep in the soil. Sunflowers attract pollinators and predatory insects and they can also help with heavy metal phytoremediation. Sunflowers host AMF better than most species







Ecosystem Functions of Key Species

- **Buckwheat –** This rapidly growing cover crop provides rapid **ground cover** for weed suppression and soil protection. The flowers attract pollinators to enhance insect biodiversity. However, the most economically significant attribute of buckwheat is its capacity to **solubilise phosphorus**. Buckwheat also produces good levels of glucose exudates to stimulate all soil life.
- **Phacelia –** the roots of this plant create **biopores** which improve soil aeration and water infiltration. Its flowers attract pollinators and predatory insects. Phacelia also support highly aerobic nitrogen fixing organisms by improving the **breathing capacity** of the soil.





Ecosystem Functions of Key Species

- **Chenopods** (i.e. the beet family, quinoa, spinach, amaranth) – The tap root helps to break-up **compacted** soils and accesses nutrients deeper in the profile.
- Plants like sugar beet boost **organic matter** as they decompose. Valuable in **saline soils** to help remediate these conditions. Scavenges nitrogen from deep in the soil. Chenopods can stimulate **nitrifying bacteria** which convert ammonium into nitrate nitrogen, to improve nitrogen use efficiency.





Part of the rationale for cover cropping relates to suppression of weeds. Lets have a closer look at this pest:

The Weeds' Message

- Understand that weed seeds can last many decades in the soil. Their germination in any given season is based upon specific conditions.
- Specific weeds identify with acidic soils, neutral soils, alkaline soils and salty soils.



- Wet soils, hot conditions, cold conditions, day length and soil compaction can all determine weed species.
- Some weeds flourish in productive, fertile, aerated soils. i.e. Lambs Quarters and Pigweed.

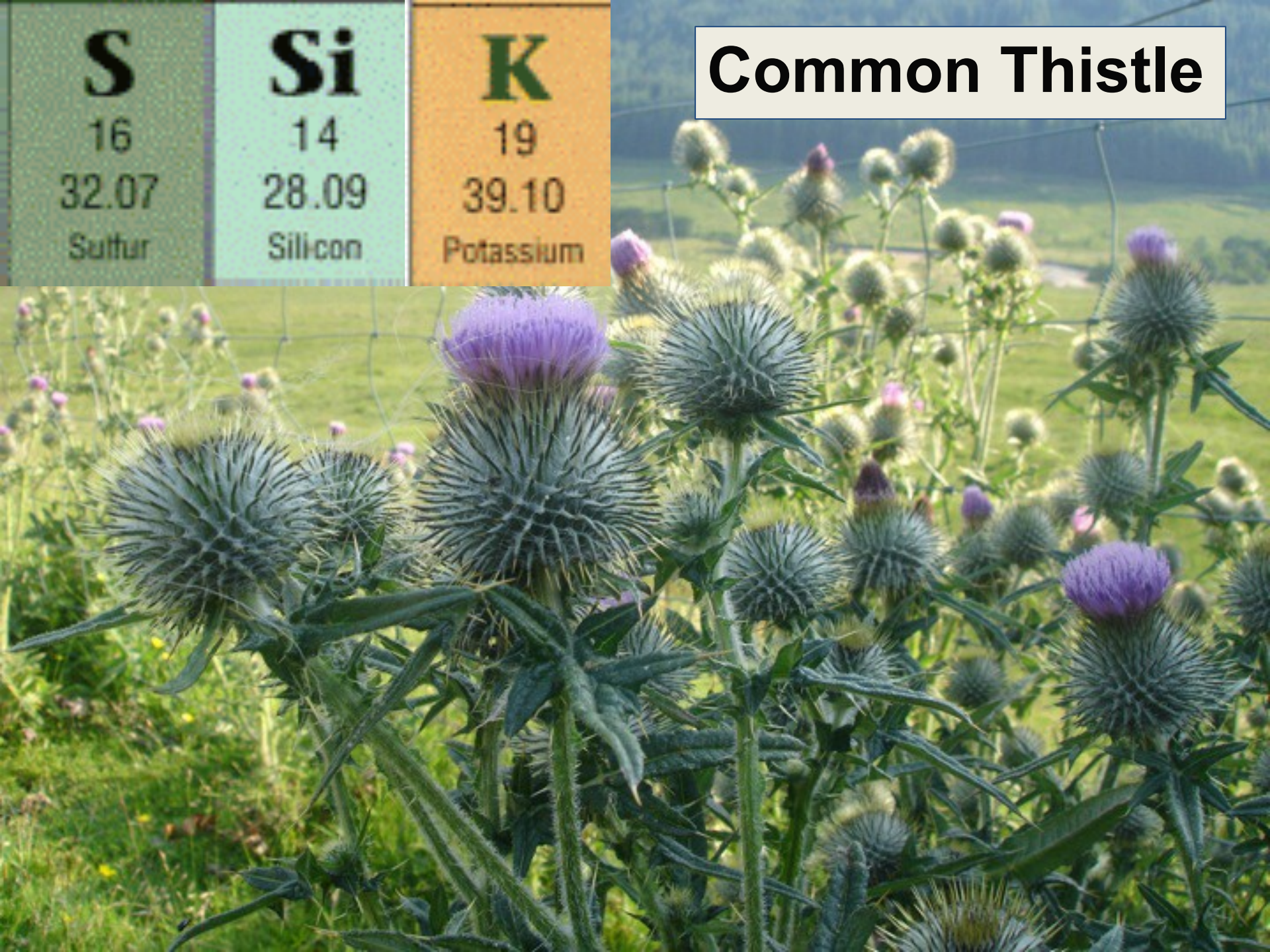
Signposts of Mineral Imbalance

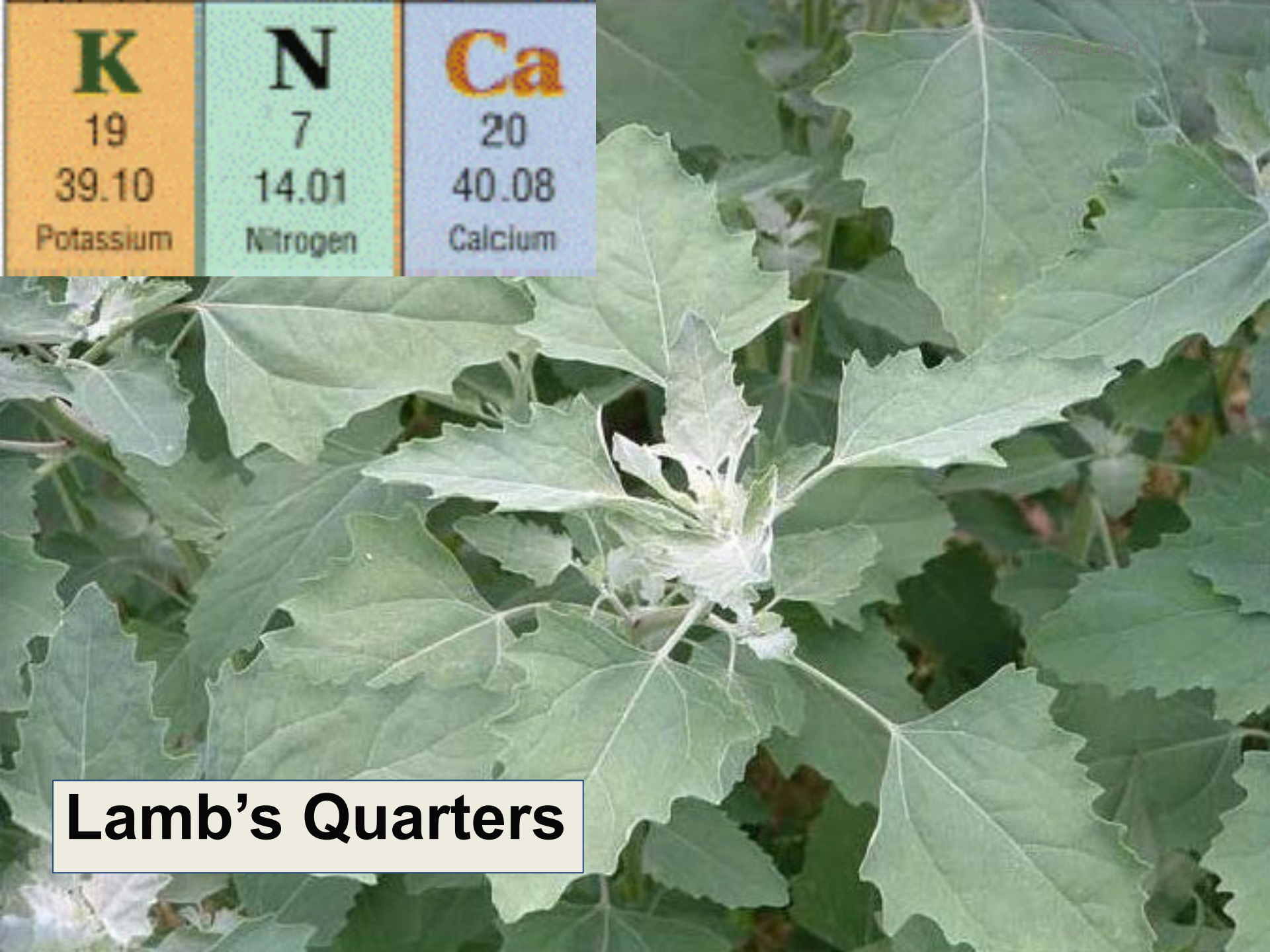
- Nettles – magnesium, iron, phosphorus, calcium and amino acids are needed.
- Wild Hops, Soda Apple – nitrogen and potassium are too available.
- Cobbler's Pegs – Nitrogen and potassium are too available.



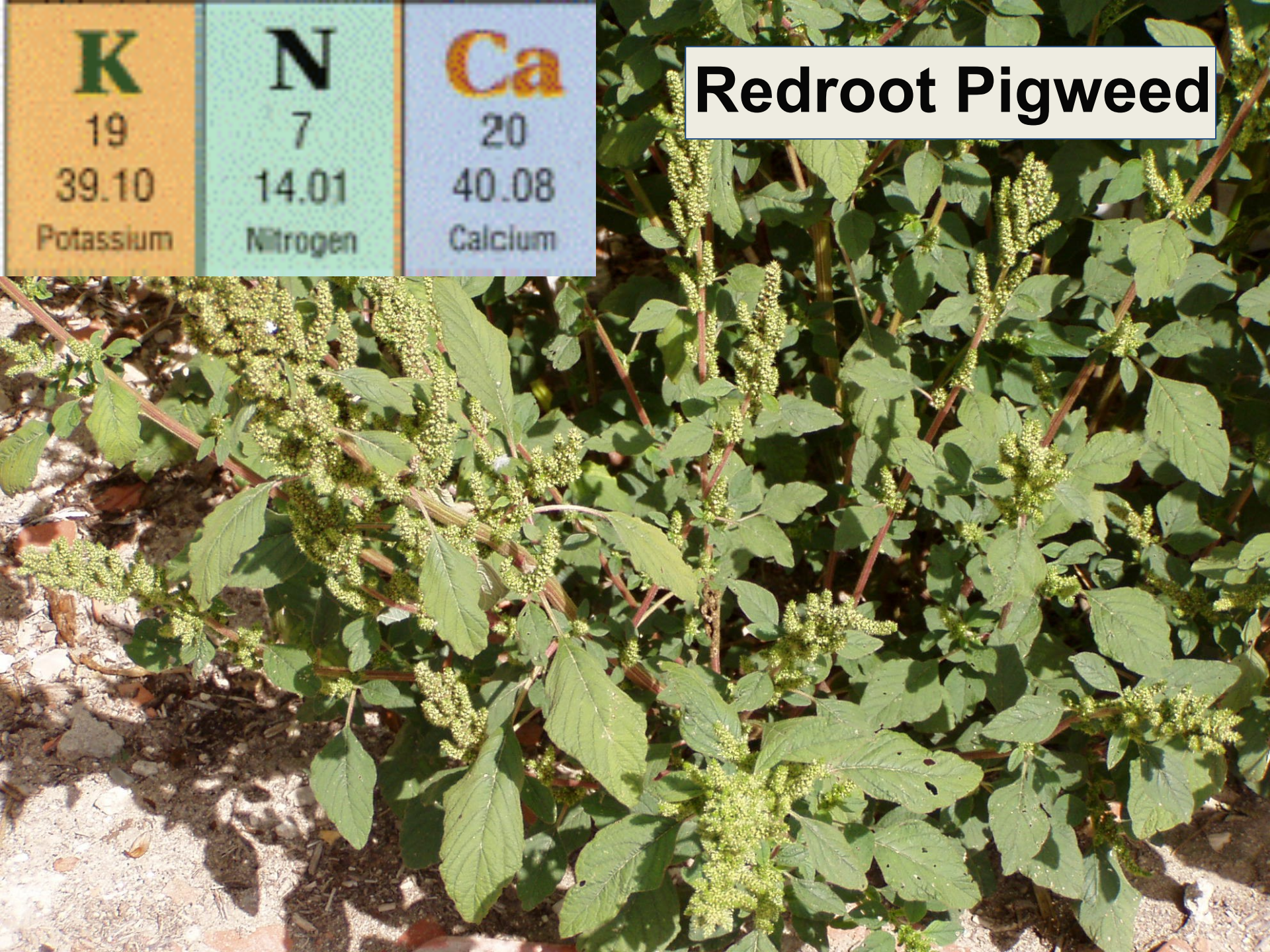





S
16
32.07
Sulfur
Si
14
28.09
Silicon
K
19
39.10
Potassium
Common Thistle



Lamb's Quarters


K
19
39.10
Potassium
N
7
14.01
Nitrogen
Ca
20
40.08
Calcium
Redroot Pigweed

Mineral Imbalance – Case Study

- Klaas Martens and Mary Howell farm several hundred acres, organically, in New York state.
- They have achieved exceptional weed control using a combination of mineral balance, crop rotation and timely cultivation.
- From a mineral perspective they find that high magnesium soils encourage summer annuals, which become resistant to herbicide.
- The use of gypsum to neutralise magnesium and improve soil structure has had almost miraculous results. i.e. where the fertiliser spreader missed a strip it looked almost like the spray rig had stopped a row and the foxtail flourished.





Rotation – Case Study

- The Howell-Martens contend that their organic approach is more cost- effective than herbicides.

- Rotations play a major role in their weed management.
- A typical rotation might look like this:

  1) Plant a heavy cover crop of medium red clover in Winter.
  2) Rotovate the clover in Spring and plant corn.





Rotation – Case Study

3) Soybeans would follow corn, which would be worked in in Autumn prior to planting Winter wheat or spelt (inter-planted with red clover). Clover is used with all cereal grains.

4) After the 2nd red clover crop, a vegetable crop like snap beans or cabbages is planted for diversity.





Control with Cultivation – Case Study

- The goal of mechanical control of weeds is to get as much differential size between the crop and the weeds.
- The Howell-Martens, for example, cultivate 3 times and the timing is critical.
- They believe that blind cultivation is absolutely essential. This is early cultivation immediately after planting just before emergence.





Control with Cultivation – Case Study

- Blind cultivation involves stirring the entire surface of the soil introducing air which causes germinating weed seeds to dry out.
- You are taking advantage of the difference in seed size (between weeds and crops) and also the difference in depth of emergence to take out the first flush of weeds.





Control with Cultivation – Case Study

- The second flush of weeds is detached with a finger weeder after the crop is up.
- There are minor crop losses involved, but with the removal of the 2nd flush the crop is well ahead of the weeds by the time the third flush arrives.





Control with Cultivation – Case study

- The third flush can be cultivated quite aggressively and very rapidly.

- The Howell-Martens have recently won the Farm Journal “Tight Wad of Weeds” contest for the most cost-effective weed control.





A Different Perspective on Weeds

- A new practice among consultants is to identify the **dominant weed** on the farm and then identify potential commercial crops of the same family.
- The assumption is that if the weed thrives in those conditions then so will the **cash crop**.
- Anecdotal reports suggest that the weed often dies out when competing with the new cash crop. Examples of this include:

1. **Brassica family** - If wild mustard and shepherds purse reign on your farm it is generally and indication of nutrient-rich, disturbed soils.

Brassicas like **canola**, mustard and cabbage may thrive here as they have similar tolerances for soil pH, fertility and moisture levels.





A Different Perspective on Weeds

2. **Asteraceae family**, Canada thistle, and common ragweed are found in disturbed soils with moderate fertility.

Sunflower, **lettuce** and **chicory** are the Asteraceae family with similar ecological and nutrient preferences.

3. **Poaceae family** (grasses) – barnyard grass and **foxtail** are common weeds where moisture is abundant.

Crops from this family, like **corn**, wheat and sorghum, may thrive under the same conditions.





A Different Perspective on Weeds

4. **Chenopodiaceae** – Lambsquarters is a widespread weed which thrives in disturbed, nutrient-rich soils.

Crops from the same family include, spinach, beets and quinoa, and they perform well in similar conditions.

5. **Fabaceae** – Vetch thrives in well drained nitrogen deficient soils. Peas, beans or lentils perform well in similar environments where nitrogen fixation is required.







In Conclusion

Cover Crops are a multi-purpose wonder.

You can build humus, change soil structure, counter drought, reduce weed pressure and feed your soil life with this simple addition of bio-diversity



NTS
Nutri-Tech Solutions®

Nutrition Farming Essentials

Seven Key Inputs for the Regenerative Farm

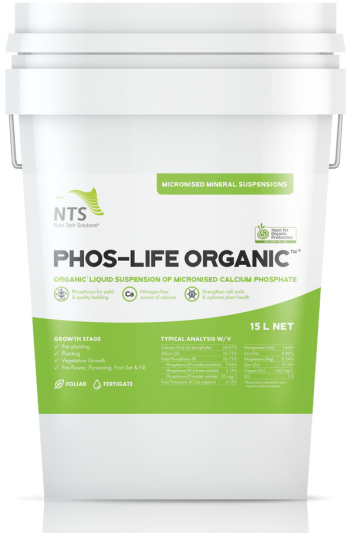
By Graeme Sait

Nutrition Farming Essentials

In our approach, there is a stronger emphasis upon **knowledge** rather than inputs, as your source of **empowerment**.

However, **inputs** are essential tools in high production fertility and it is important to understand their dynamics and rationale.

Here we will discuss **seven nutrition farming essentials**, including, humates, kelp, amino acids, micronized minerals, triacontanol, wood vinegar, and compost extracts.







Humates

- The term **humates** refers to the powerhouse natural substances, humic and fulvic acid.
- **Humic acid** may well be the most important input in regenerative agriculture because it is the most powerful stimulant of **cellulose-digesting fungi.**
- Both acids impact both **mineral** and **microbe** management and they are user-friendly tools to compensate for the serious loss of humus in our soils (5% down to 1.5% in just ten decades).
- Concentrated **soluble powders** or granules are the most cost effective way to utilise humates.







Top Ten Benefits of Humic Acid



1. **Increased nutrient uptake** - Humates increase the permeability of the cell membrane (called “cell sensitization”) to allow a **30** to **34%** increase in nutrient uptake.
2. **Natural chelation** – humates are also the most powerful natural **chelating agents**, further magnifying the performance of applied and existing soil minerals.
3. **Improved soil structure** – humic acid helps bind soil particles into aggregates, increasing aeration and water retention.
4. **Enhances root growth** – humates stimulate root development with an auxin-like hormone. Bigger roots provide greater resilience and nutrient access.
5. **Boosts microbial activity** – humic acid is the most powerful fungal stimulant, while fulvic acid is the most powerful bacterial stimulant



Top Ten Benefits of Humic Acid

6. Reduced plant stress - humic acid creates greater resilience against drought, salinity, and temperature extremes.

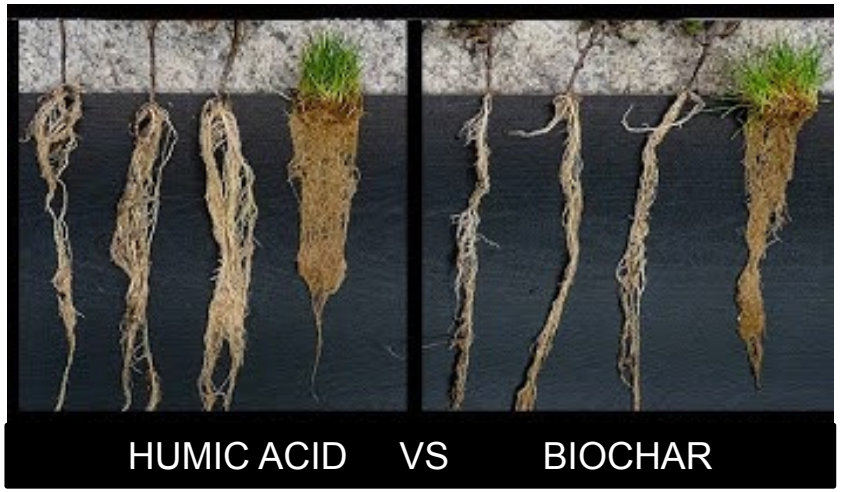
7. Enhanced seed germination – humic acid improves germination and kick starts the young crop

8. Heavy metal detox – humic acid can bind to toxins like cadmium to help neutralise their negatives.

9. Increased organic matter – fungi, stimulated by humic acid build stable humus with a 35 year soil life.

10. Increased nutrient retention – humic acid has a CEC of 450, so is wonderful in light soils to hold leachable minerals, like, nitrogen, potassium, sulphur and boron.





Fulvic Acid – More Than a Foliar

- Promotes root growth
- Dissolves minerals
- Prolongs production
- Provides growth promotion
- Serves as a ‘second sun’
- Detoxifies pollutants – “fulvic flush”
- Magnifies nutrient uptake
- Improves moisture retention
- Stimulates bacteria
- A powerful electrolyte (capable of facilitating electrical reactions)



The Fulvic Phenomenon

- Fulvic acid is **compatible** with everything and can be combined with anything to magnify uptake by one third.
- This could include **glyphosate**, phosphorous acid, trace minerals etc.
- Fulvic acid combined with calcium nitrate creates a **calcium fulvate** – one of the most inexpensive, yet effective calcium delivery tools.
- Fulvic acid can also be used at higher rates to **neutralise chemical residues** and heavy metals. The result can be profound.
- Trial **30 grams** of fulvic acid applied to **100 square metres** of soil and observe the results.





Humate Tips and Strategies

1. **Full cycle P** – ‘NTS Soluble Humate Granules’, combined with DAP/MAP at a rate of 5% creates a phosphate humate that provides available P for the full crop cycle.
2. **Trial higher rates** – trials with 20kg per hectare with DAP produced a 49% yield increase over the control. South African trials with 10kgs of soluble fulvic acid powder generated a disease-free carrot crop with a 47% yield increase.
3. **Young plants** are more responsive to both humic and fulvic acid. Younger tissues have more active transport mechanisms to move nutrients to sites of metabolic activity. **Foliar application** is most successful is this context.
4. A **combination of humic and fulvic acid** has been shown to be most effective for promoting root growth (FulvX)







Humate Breakthrough - FulvX



1. **Humic acid** is a strange, natural acid, that is only soluble in alkaline conditions. It is extracted from certain types of brown coal using potassium hydroxide (caustic soda).
2. Consequently, humic acid has a pH of **11.5** and hence it is **incompatible** with most agricultural inputs, which are based on sulphuric acid, phosphoric acid and nitric acid.
3. Many farmers have experienced the **clogging** of irrigation filters associated with the phenomenon.
4. NTS has recently released a 100% soluble powder consisting of **50/50 humic and fulvic acid** that is compatible with everything.
5. **FulvX** provides the best of both worlds – the complexing and stabilising capacity of **humic acid** with the chelating and bio-stimulating capacity of **fulvic acid**.



Livestock Benefits of Sodium Humates

- **Increases mineral uptake –** Boosts cell membrane permeability
- **Stress management** – Reduces production of stress hormones, super relaxed animals
- **Inhibits pathogens** – Including staphylococcus and candida
- **Boosts immunity** – Improves balance of T cells and Killer Cells
- **Anti-inflammatory** – Binds to collagen fiber to repair damaged tendons and bones
- **Boosts liver function** – In 1 study, rats livers regrew over a 6 month period
- **Improves digestion** – Visible changes in animal poo and odour





Kelp – PGP, Immune Elicitation, Rescue Remedy

Kelp Components

- **Mannitol**, a powerful chelating agent
- **70 minerals** derived from seawater
- 4 natural **growth promotants** - cytokinin's, gibberellins, auxins and betaines
- **Complex carbohydrates** - fungi feeders
- **Vitamins** - required by plants, microbes and humans





Kelp – Key Benefits

- **Kelp** is a remarkable tool to alleviate **abiotic stresses** associated with climate extremes.
- It is often called the "**rescue remedy**" as it is so effective at countering stress, ranging from heat waves, transplant shock, frost, hail and flood.
- It is also an effective tool to counter **salinity**.
- The hormonal component provides **germination** enhancement and a **kickstart** for all crops.





Kelp – Key Benefits

- Several studies have reported improved **root development** following kelp supplementation. It is particularly effective in root crops like potatoes and carrots.
- Kelp is a powerful **fungal stimulant** that can help improve soil structure through creation of crumb structure associated with fungal proliferation.
- Kelp can help build brix levels and Tasmanian studies have demonstrated that when sprayed before a frost there can be 3 – 5C degrees **frost protection**.
- Kelp also enhances shelf life. Produce can be sprayed before harvest or even dipped in a kelp solution post harvest, to delay senescence and **extend shelf life**.
- Kelp is also a very productive **livestock supplement**, providing the full range of trace minerals, a high vitamin component and it is a rare source of **iodine** and **selenium**.





Kelp Studies

- In a study by, **Heins et al**, entitled, **“Can kelp reduce emissions in dairy cows”**, the researches reported that feeding livestock kelp could reduce methane emissions by **20 – 30%** while also boosting immune function and reproductive health.
- In a study by **Lopez-Mosquera et al**, entitled, **“Effects of seaweed on potato yield and soil chemistry”,** significant yield increases, soil nutrient improvements, and enhanced crop performance were reported.
- In a 1991 study by **Crouch and Van Staden**, entitled, “Evidence for rooting factors in seaweed”, the researchers reported that the auxins and cytokinin's in kelp promoted **root development** and overall plant health.
- A study by **Temple and Bonke**, entitled, “Effects of kelp on soil chemical properties and crop response”, reported enhanced nutrient availability and significantly increased **microbial activity**.





Kelp Breakthrough – Tri-Kelp



1. NTS have developed a synergistic blend of three kelp varieties in a **100% soluble powder**, called Tri-Kelp.
2. We have shown that this blend will **outperform** any single species kelp input.
3. **Tri-Kelp** can be used effectively at just 1g per litre and it performs well in broadacre and pasture scenarios at the rate of **100g per 100L** as a foliar.
4. A little known fact about kelp relates to hormonal performance at very low rates, i.e. in one study of liquid kelp, **1:100 was equivalent to 1:500** in terms of root growth enhancement and productivity.



3. Plant Growth Promotants & Immune Elicitors

Triacontanol – Boosting Photosynthesis

- **Chlorophyll management** is the principle role of growers. The greater the chlorophyll density, the higher the production and the lower the problems.
- A **refractometer** can be used to monitor dissolved solids (brix levels) in the crop leaves and this is, in effect, a guideline as to **chlorophyll density**.
- **Triacontanol** is a substance found in the outer waxy coating of the lucerne plant and can also be sourced from the wax of bees working lucerne plantings.
- Prize-winning, US rose growers often wax lyrical about the use of **alfalfa tea** to improve health and production. They are inadvertently using lacto fermentation to dissolve the triacontanol from the lucerne.



3. Plant Growth Promotants & Immune Elicitors

Triacontanol – Boosting Photosynthesis



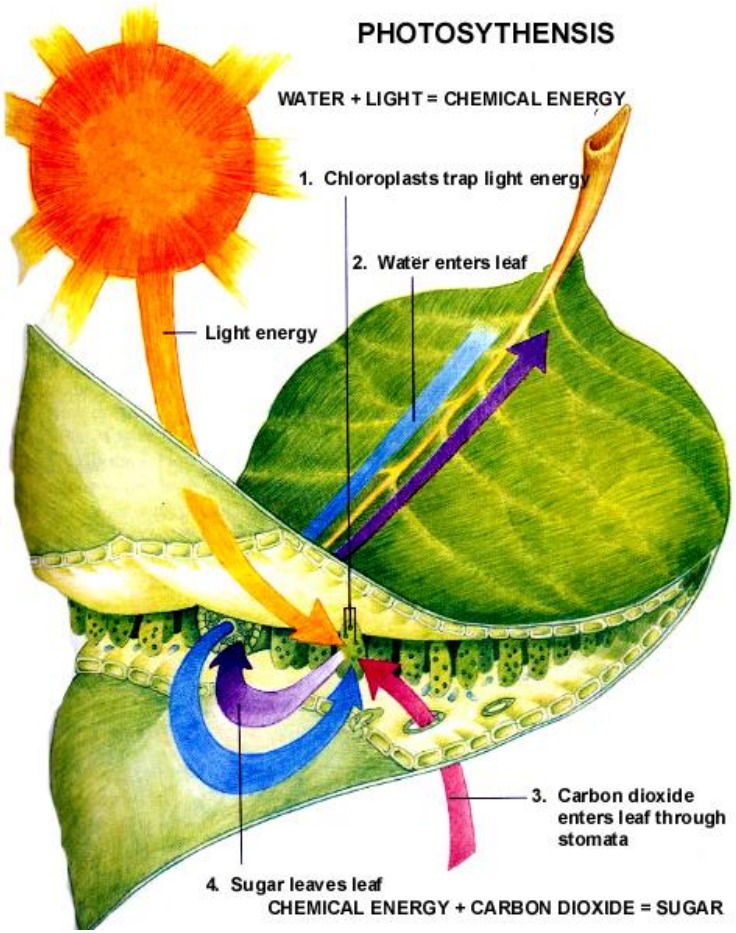
- **A plant growth promotant** first isolated from lucerne in 1977.
- Has been shown to increase **crop yields** at very low concentrations.
- Long chain fatty alcohol that is a useful addition to liquid fertilisers.
- **Benefits** include – increased growth rate, increased CO_2 fixation, increased protein content, more flower buds, early maturity and increased resilience.



3. Plant Growth Promotants & Immune Elicitors

Triacontanol – Boosting Photosynthesis

- If you could imagine the **perfect PGP**, it would involve something that boosted every aspect of the most important process on the planet – **photosynthesis**.
- That is the **principle** mode of action of triacontanol.
- The effect of **triacontanol** on photosynthesis was well documented by Ries in 1985. In a series of trials, the average chlorophyll increase was **37%**.
- Part of this effect involves an increase in **CO_2 fixation**. For example, one trial showed that maize seedlings treated with triacontanol fixed **43%** more CO_2 than the control. (Menon et al, 1984).



The Benefits of Wood Vinegar

- Wood vinegar is destined to become a regenerative **agriculture essential**.
- It is the smoke condensate that is a byproduct of making **Biochar**.
- It contains over **200** active biochemicals.
- One of these is called **Karrikins**, derived from the Aboriginal word for ‘smoke’, which is ‘Karrik’.
- These are the substances that generate the **germination** of native seeds following a bush fire.
- It is now recognised that these compounds impact seed germination in most species.





The Benefits of Wood Vinegar

- One Karrikin study published in the journal of Plant Growth Regulators 2019 reported that **carrots** grown from pre-soaked seed were bigger, heavier, and had higher carotene levels.
- Seeds should be treated in **1:200 to 1:400** solution of wood vinegar.
- The second major benefit from wood vinegar relates to **pest protection**.
- There have been studies where the inclusion of wood vinegar has dramatically enhanced the capacity of **insecticides**.
- It also has stand alone capacity and there is impressive research regarding control of **poultry mites**.





The Benefits of Wood Vinegar

- Wood vinegar has shown to be **lavacidal** and **pupicidal**.
- An NTS study involving brassicas at a local agriculture college revealed impressive control of **cabbage caterpillars**.
- Following weekly foliar applications of Activated Char Condensate (**ACC**) at the rate of **1:300** there was zero pest pressure compared to the control, which was decimated.
- There is also research to support the **nematicidal** capacity of wood vinegar. It **kills** the nematodes directly and **boosts** nematode trapping fungi.
- It is fertigated at 1:300 for this purpose.





The Benefits of Wood Vinegar

- In 2009 a researcher called Lindqvist reported control against both **slugs and snails** using wood vinegar.
- Wood vinegar can enhance **fertilizer response** and it is also widely used to reduce **glyphosate** requirements.
- The mode of action of this enhancement relates to a change in the structure of water to make it a **better carrier**.
- It can reduce the cluster value of water by **66%** and this smaller mass means water is more easily absorbed.
- One Malaysian study reported dramatic improvements in **fertilizer response** when 2 litres of wood vinegar was fertigated with every 20kg of soluble fertilizer.





The Benefits of Wood Vinegar



- **Fungal disease protection** - researched by Calemsan in 2009 and Jung in 2007 have confirmed efficacy against Alternaria, rhizoctonia, sclerotinia, pythium, and phytopthera.
- In 2020 Wardyo reported an **89%** control of **anthracnose** on capsicum plants.
- Wood vinegar is also a powerful **microbial stimulant.**
- One Chinese study reported substantial increases in bacterial numbers and diversity when wood vinegar is applied to the soil at **1:500.**
- We have seen some of the biggest jumps in **microbial biomass** following treatment with wood vinegar.



The Benefits of Wood Vinegar

- Wood vinegar enhances **plant growth** and increases crop quality.
- The Thai government is very supportive of this input. They suggest application rates between **1:500 and 1:1000** will stimulate plant growth, increase brix levels, counter excessive nitrogen, improve plant metabolism, boost photosynthesises, and increase crop resilience.
- NTS has just released an advanced wood vinegar product called **Activated Char Condensate (ACC).**
- This is unique in that includes an activator called **Lipo-Zoom**.
- It also contains nanoparticles of **Biochar** which further enhance the positive impact.





Micronized Mineral Suspensions (MMS)

- NTS have pioneered the concept of reducing natural mineral fertilisers down to a miniscule particle size of just **5 microns**.
- This dramatically increases **surface area** and associated microbial and plant availability.
- This strategy also allows **concentrated delivery** of just the mineral required with no unwanted tag-ons
- For example, soluble calcium is typically available as calcium nitrate with 18% calcium. **Lime-Life**, contains **44%** calcium without the nitrates.
- **Mag-Life** delivers **28%** magnesium, vs 10% magnesium in magnesium sulphate.

PLANT THERAPY™

DATE:	02.04.2009	**LAND USE:**	Rye Grass
NAME:	Mr Sample	**PADDOCK:**	Sample Paddock
ADDRESS:	-	**SAMPLE REC:**	28.03.2009
		CONTACT NO:	xx xxxx xxxx

ELEMENT OR CATEGORY	YOUR LEVEL	ACCEPTABLE RANGE	DEFICIENT	ACCEPTABLE	EXCESSIVE OR TOXIC
N - Nitrogen	4.5 %	2.3 - 4.2 %			
P - Phosphorus	0.15 %	0.2 - 0.5 %			
K - Potassium	3 %	1.5 - 3.5 %			
S - Sulphur	0.54 %	0.2 - 0.45 %			
Ca - Calcium	0.11 %	0.2 - 0.6 %			
Mg - Magnesium	0.14 %	0.16 - 0.4 %			
Na - Sodium	0.3 %	< 0.7 %			
Cu - Copper	8 ppm	5 - 12 ppm			
Zn - Zinc	20 ppm	15 - 50 ppm			
Mn - Manganese	100 ppm	50 - 300 ppm			
Fe - Iron	55 ppm	50 - 60 ppm			
B - Boron	3 ppm	5 - 15 ppm			
Mo - Molybdenum	0.16 ppm	0.15 - 0.5 ppm			
C - Carbon	%	N/A	N/A		



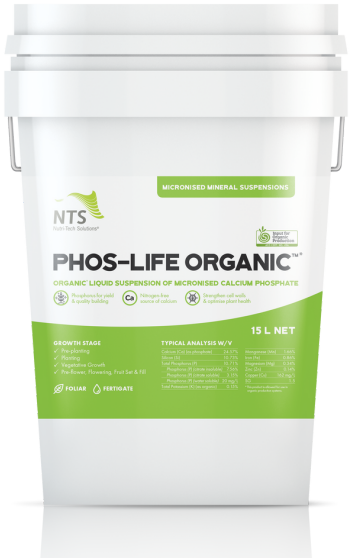


Micronized Mineral Suspensions (MMS)

- **Micronized guano** can be particularly effective as it delivers both calcium, phosphate, silica, and a rich load of trace minerals.
- It is particularly effective when used in **liquid injection** in broadacre cropping.
- Phos-life also allows the rare combination of **calcium and phosphate** in plant available form (i.e. these minerals are usually incompatible).
- **Dia-Life**, based on micronized diatomaceous earth, has been shown to boost plant levels of **silica** more effectively than any other input.







Benefits of Amino Acids



- **Amino acids**, often extracted from soy are becoming and increasingly popular input in regenerative agriculture. Here's why:

1. **Enhanced photosynthesis** – glycine and glutamic acid boost chlorophyll production, which enhances plant and microbe health.
2. **Improved nutrient uptake** – amino acids are powerful chelating agents. They can also be used in conjunction with commercial nitrogen to boost nitrogen use efficiency.
3. **Stress tolerance** – amino acids like proline have been shown to help plants retain moisture in drought conditions.
4. **Improved root development** – amino acids are precursors to auxins, the plant hormones which promote root growth.



Benefits of Amino Acids

5. **Enhanced pollination** and seed formation – amino acids have been shown to improve the **fruit and flower ratio**. This is particularly important where pollination is a limiting factor, i.e. boron and amino acids sprayed on avocado trees directly before flowering can be super productive.

6. **Better fruit quality and yield** – amino acids like methionine are involved in the synthesis of ethylene. Modulation of this hormone can improve fruit size, colour and taste.

7. **Faster recovery from environmental extremes** – amino acids can speed metabolic processes and help the plant resume normal growth following drought, heat or frost

8. **Reduces selective herbicide stress** - can counter potential damage from selective herbicides.







Conclusion

In the regenerative movement, where we strive to reduce the need for chemical crutches, there are some invaluable tools.

These include humates, kelp, amino acids, wood vinegar, triacontanol and others.

Some of these tools are tailor made for the brave new world of climate change farming because they enhance resilience.