NTS
Nutri-Tech Solutions®

The Soil Foodweb

By Graeme Sait

The NTS Story – From Soil Health to Planetary Health

- Nutrition Farming is an integrated, holistic system, recognising the profound links between soil health, crop resilience, animal vitality, farmer's health and planetary wellness.

Nutrition Farming®

Anatomy of an Awakening

NTS is now consulting with major organisations and Governments globally.

This has included:

- Training **The Dole Corporation, Greenyard Farms** and **Driscoll's Berries** in the US.
- Training the entire **Agriculture Departments** in Laos, Singapore, Malaysia, Vietnam and Brazil.
- Meeting **Agriculture Ministers** in Canada, India, and the UK.
- Training growers from **Supermarket chains** in South Africa and the UK.
- Mentoring Climate Change **action groups,** like Kiss The Ground.
- Consulting globally with large **grower cooperatives.**

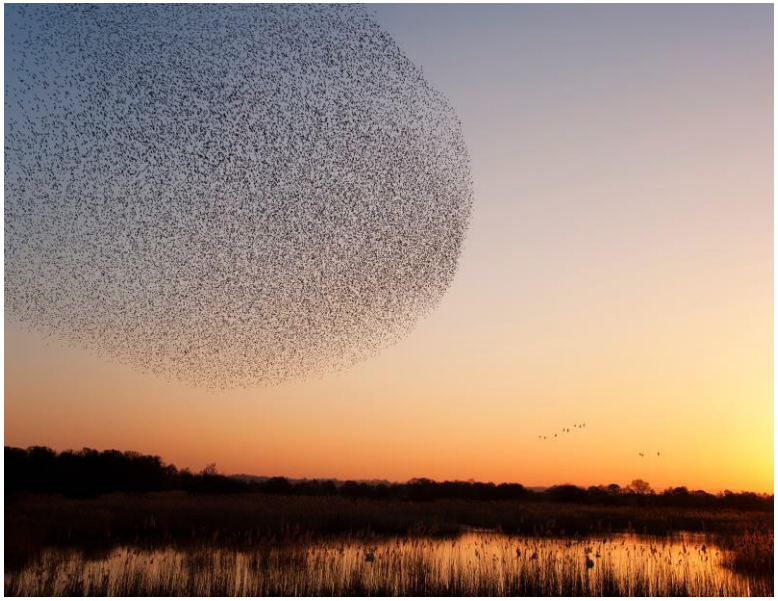
The Chemical Experiment

For the past ten decades, we have employed a **chemical, extractive model** for our food production.

We began this experiment by dumbing down crop nutrition to just **3 minerals**, while removing a little of all 74 minerals, with each season.

Soon after adopting this **simplistic nutrition**, we experienced unparalleled pest pressure and science stepped up to the plate.

The **toxic rescue chemicals** became our saviour, but we have increased their use every year thereafter.



Seven Drivers For The Wake Up Call

1. Top soil is eroding at **7-12 tonnes** per hectare per year. In 60 yrs, zero remains.

2. For 10 decades, we have applied **more chemicals** each year, but each year, pest pressure increases.

3. Soil life monitoring reveals considerable **collateral damage** from the extractive approach.

4. Agriculture provides **25%** of CO_2, **60%** of the methane, and **80%** of the nitrous oxide, that thickens the blanket, traps the heat, and changes our world.

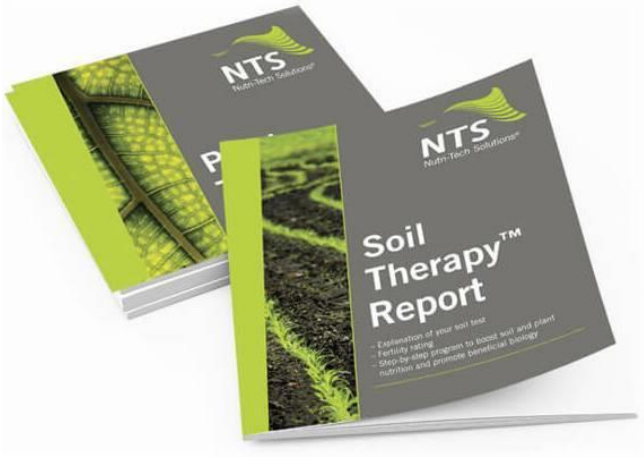
5. Chemical residues in our food chain have compromised the health of our children. **Bioaccumulation** and the **cocktail effect** were never factored into the MRL equation.

6. **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.

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

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.
- Lets look at the Soil Foodweb.

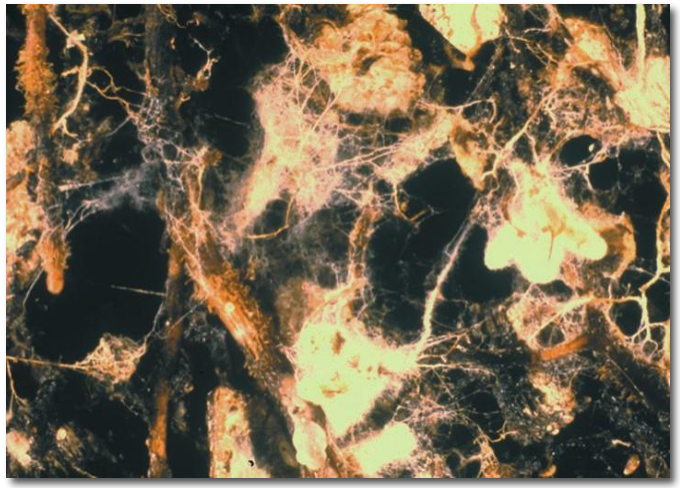


Fungi

- 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 thesesoils.



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**.

A Living, Underground Internet

- Its 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

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

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

4. **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

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

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

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

9. 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.

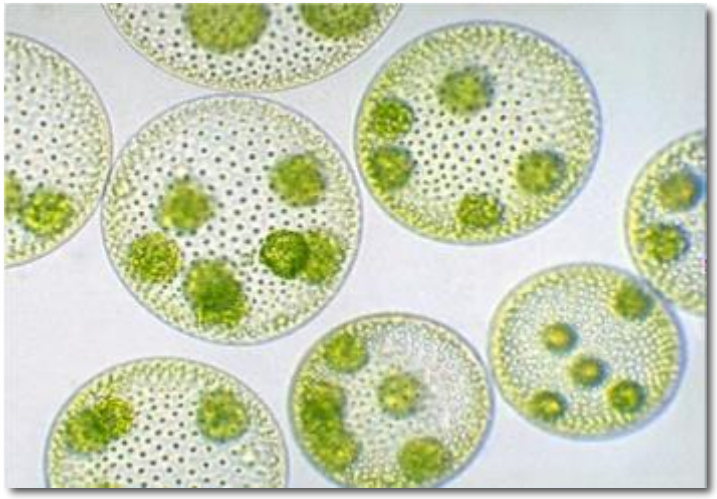
3. Treating introduced seed when **pasture cropping,** can reduce the cost of pasture re-colonisation.

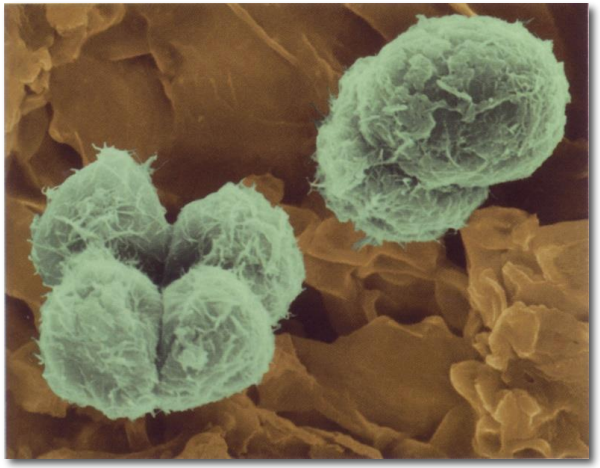
4. Using mycorrhizal fungi as a highly effective **nematicide,** reduces the vast damage otherwise associated with this chemical option.

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

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.

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.

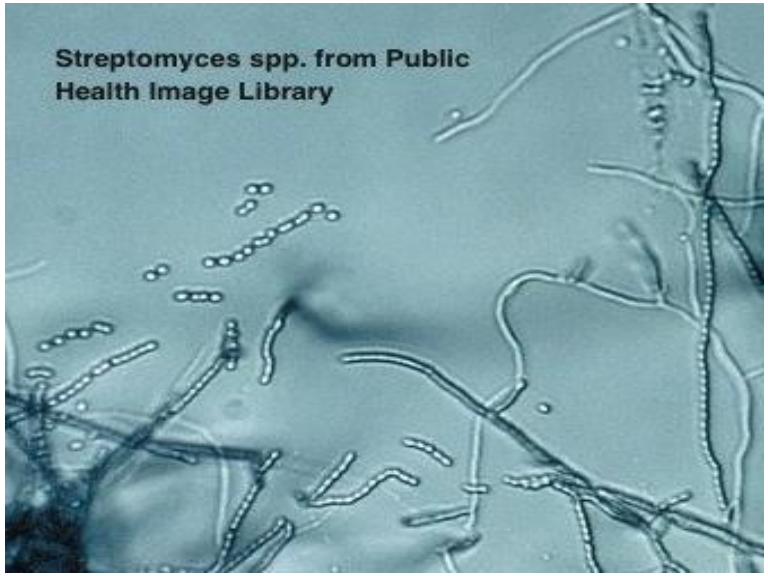
The Sweet Scent of Good Soil

- ***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.



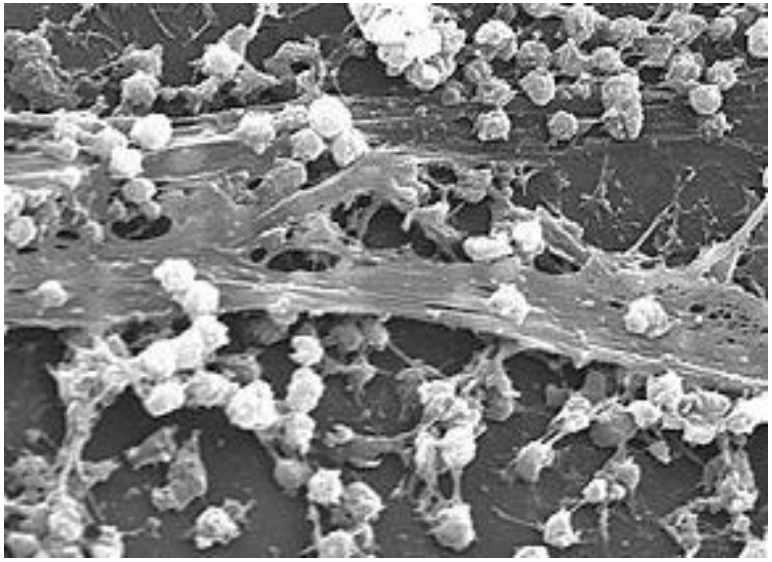
Bacteria

General Characteristics:

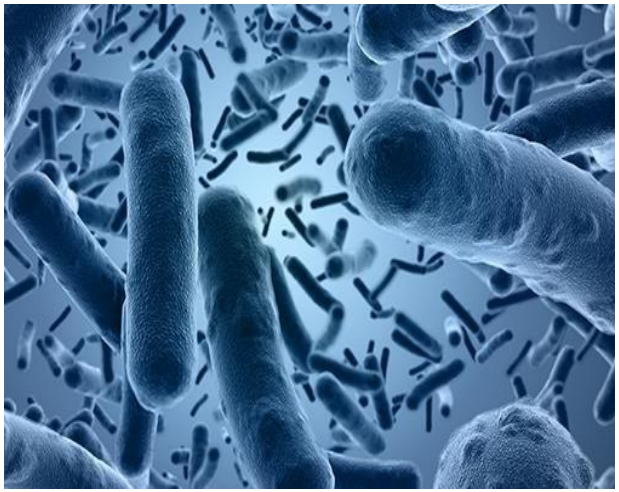
- The bacterial slime layer has a pH **above 7**;
- Bacteria have a carbon: nitrogen ratio of **5:1**; they are, in fact a nitrogen receptacle (i.e. 17%).
- Bacteria sequester **nitrogen** as a component of their body, which is released on death.
- They produce **by-products** that are essential to plant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



The Many Benefits of *Bacillus*



1. ***Bacillus*** species **replicate rapidly**, they are highly resistant to adverse environmental conditions and they have a broad spectrum of **biocontrol** ability.
2. They produce **antibiotics** including iturins.
3. The **iturins** cause cell-leakage, and create pores in the hyphae of pathogens.
4. They also produce hundreds of **peptides** with a proven antifungal impact.
5. When applied to the seed, *Bacillus* species feed off **root exudates**, depriving pathogens of food.
6. They also inhibit pathogen **spore germination**.

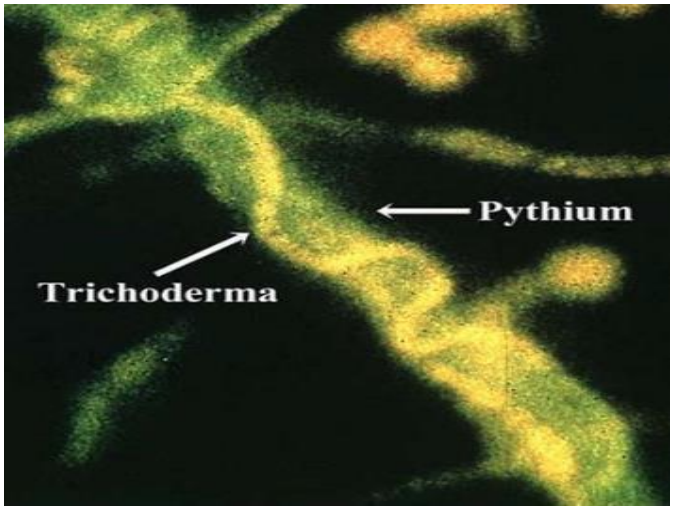
Trichoderma – Understanding the Versatile Freak

- ***Trichoderma*** is a beneficial fungi that can improve multiple processes in your growing enterprise.

- It was originally thought that the key benefits included **antibiosis** and **mycoparasitism.**

- However, it is now thought that **Induced Systemic Resistance (ISR)** may provide the lion's share of the benefits.

- Trichoderma infects and **colonises** the outer layer of plant roots, and establishes **chemical communication** with the host plant.

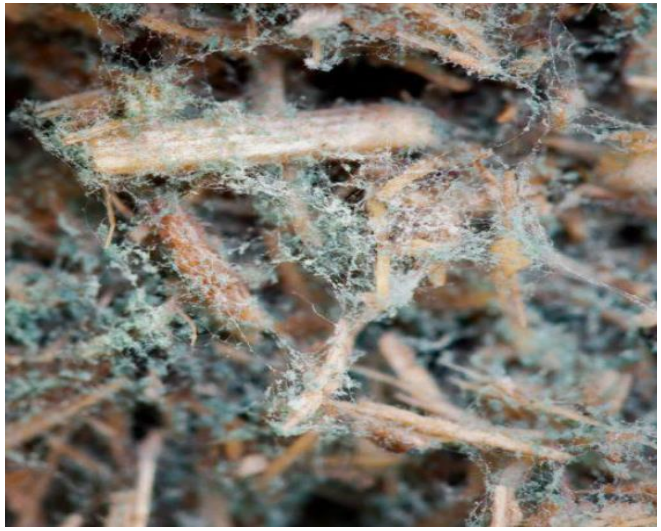


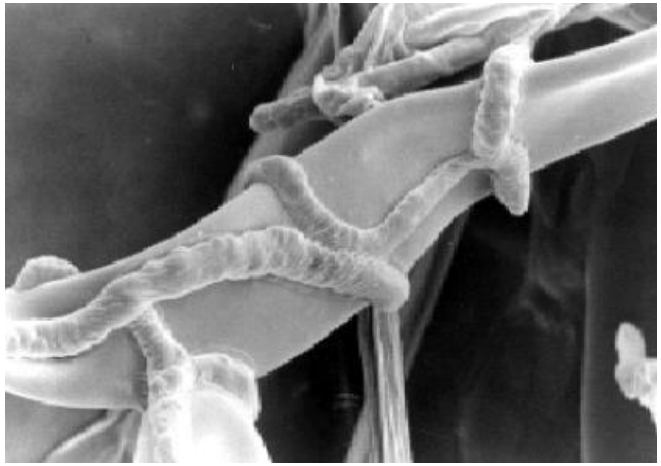
Key Roles of *Trichoderma*

1. **Humus creation –** trichoderma is a veracious cellulose digesting fungi that can convert fibrous organic matter into stable humus.

2. **Parasitising disease organisms** – they attack and feed upon many destructive disease organisms including: *rhizoctonia, phytophthora, pythium, xanthomonas, fusarium, verticillium, alterneria, sclerotinia, pseudomonas syringae and botrytis.*

- *Trichoderma* uses **remote sensing** to locate the pathogen. It then coils around the disease organisms and releases **chitinase** to ensure ease of hyphal penetration, before consuming the host.



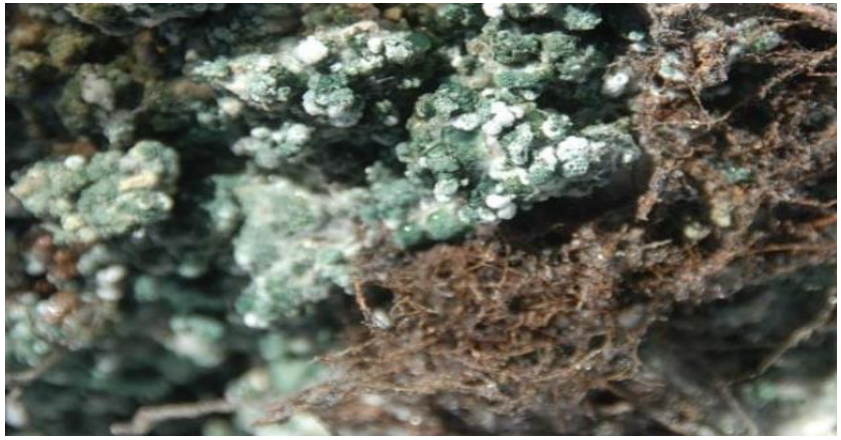


Key Roles of *Trichoderma*

3. **Out-competing pathogens** – *Trichoderma* are one of the most successful rhizosphere inhabitants (10,000 propagules per gram).

- Their success relates to a **high reproductive capacity**, resilience and unfavourable conditions, capacity to modify their surrounds, efficiency in **nutrient utilisation**, and antagonism to pathogenic fungi.

- Part of this advantage relates to their capacity to chelate and utilise available **iron** in the root zone. Pathogens have a strong requirement for iron, and they struggle when *Trichoderma* have consumed limited iron reserves (**Pythium** is controlled in this manner).



Key Roles of *Trichoderma*

4. **Stimulate root and shoot growth –** *Trichoderma* release auxin-like hormones that provide a profound effect. Astute nursery growers have realised the multiple benefits of adding *Trichoderma* to potting mix.

5. **Boosting plant immunity –** *Trichoderma* triggers a measurable increase in phytoalexins within the plant (the equivalence of antibodies in human immunity).

6. **Solubilising phosphorus –** the acid exudates from this organism break the bond between locked up calcium and phosphate, and deliver both minerals to the plant.

Key Characteristics of *Trichoderma*

1. This organism is **compatible** with other beneficial inoculums including mycorrhizal fungi, bacillus subtilis, and BAM™, increasing versatility.

2. It is highly effective in **substrates**, particularly cocoa peat.

3. *Trichoderma* can be used as a **post-harvest treatment** to prevent rotting diseases, like anthracnose.

4. *Trichoderma* can be used for **bioremediation** of chemically contaminated soils. These organisms can degrade a wide range of insecticides, organochlorides, organophosphates, carbonates.

5. *Trichoderma* helps with **salt and drought stress** – it is a good combination with *Bacillus subtilis* to help counter climate change.

Key Characteristics of Trichoderma

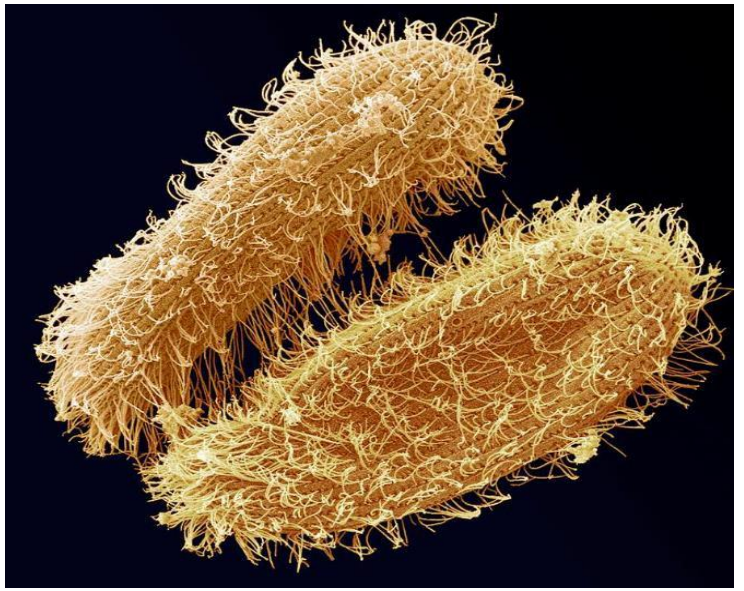
6. Trichoderma can be added to a **compost** in the later stages to create a disease-suppressive end-product.

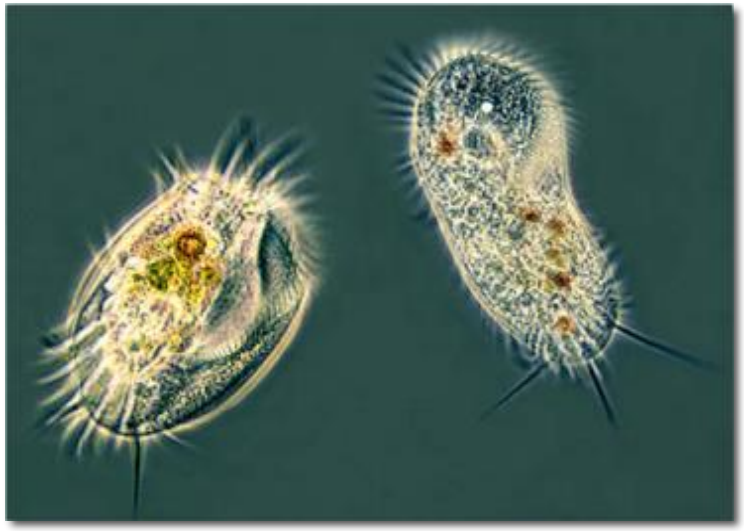
7. A good growing medium to **expand *Trichoderma*** involves diatomaceous earth, wheat flour, and molasses.

8. A major tool in **propagation**. When soaking cuttings in water, the addition of *Trichoderma* can be more powerful than rooting hormone.

Protozoa

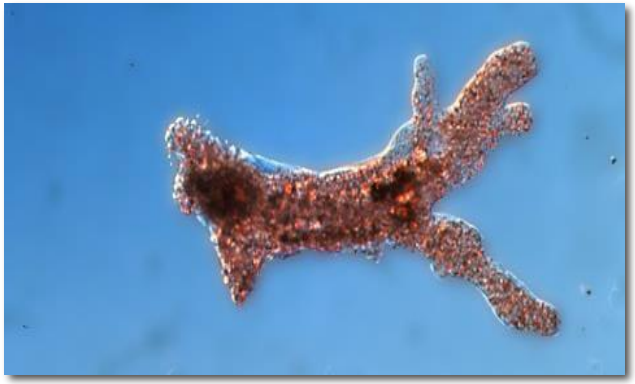
- They are **single-celled** animals that feed on bacteria, other protozoa, soluble organic matter and fungi;
- They are larger than bacteria and help **regulate bacteria** numbers through grazing;
- Protozoa play an important role in **mineralising nutrients** and making them available for use by plants 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**.





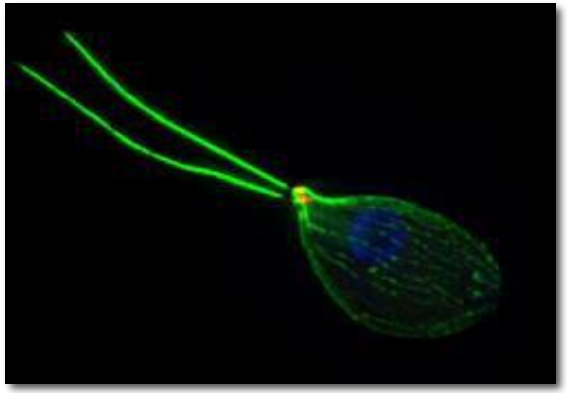
Protozoa

- **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

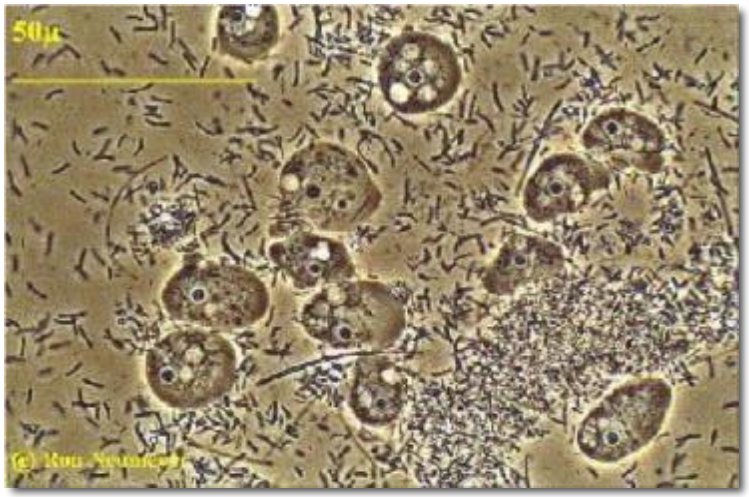


Flagellates

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.



In Summary…

If we can master the management of key beneficials in the root zone, we are far better equipped to build both productivity, and profitability, without the cost of chemicals.

NTS
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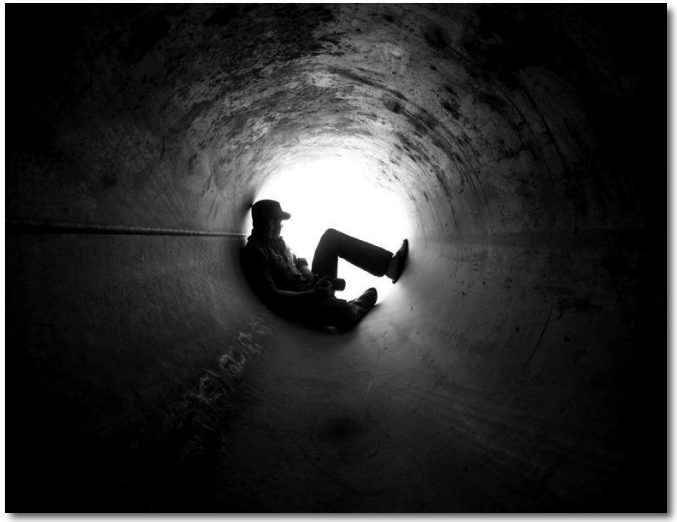
Microbe Management and Humates

'The Subterranean City'

By Graeme Sait

The Problem with Paradigms



- The more **closed-minded** and judgemental, the less the potential for progress, productivity and profitability.
- The **paradigm** involved in conventional agriculture often ignores **natural laws**.
- The big change in mindset or **paradigm shift** required, is to accept that we are dealing with a **living system** (the soil) and that every management decision will have an **impact** (negative or positive) on that system.

Making the Shift

Basic Principles to Accept

1. **Conventional agriculture is a self-serving, input-driven system.**
   You are advised to apply an unbalanced fertiliser to an unbalanced soil to help sustain a state of imbalance, which will then require constant chemical intervention.

2. **Success in regenerative farming is more knowledge-driven than input-driven**. Knowledge is power. The conventional approach simplifies the complex, interrelated system. You need to understand that system to become master of your trade.

Making the Shift

3. Accept that there is a direct relationship between **nutrition** and **pest** and disease pressure. Then we begin to address **causes** rather than treating **symptoms**.

   Chemicals treat **symptoms**.

   This is a failed system where we have become a bunch of pitiful **leak-pluggers**.

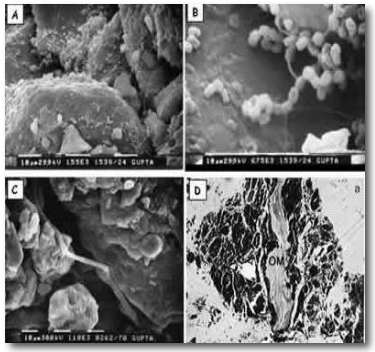
   For ten decades we have applied more and **more chemicals** each year, for less and less response.

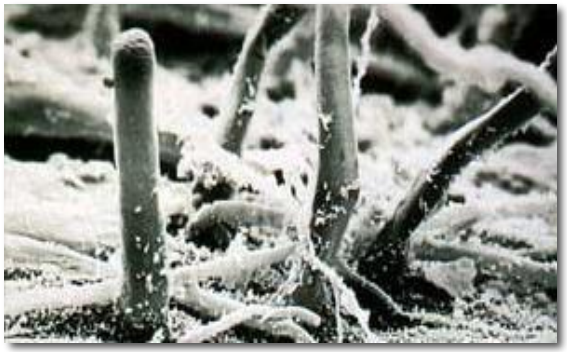
- **We need to rediscover the pleasure principle in farming.** Life is so short, we all need to have fun in our chosen professions.
- **Pride**, **satisfaction**, **purpose** and **passion** are all part of the tapestry that makes farming a pleasure.
- Farming with nature is **fascinating**.
- Farming against her is dominated by **fear**.
- **Understanding** is the **antidote** for fear.
- There is little room for **passion** in **poisons**.

Microbe Management

"Microorganism activity in one healthy ***hectare*** *uses the same energy in soil preparation as* ***10,000 people*** *would burn for the same work. We must nourish, protect and stimulate this* ***invisible workforce****."*

– Prof William Jackson





Microbe Management and Humates – Workplace Health and Safety

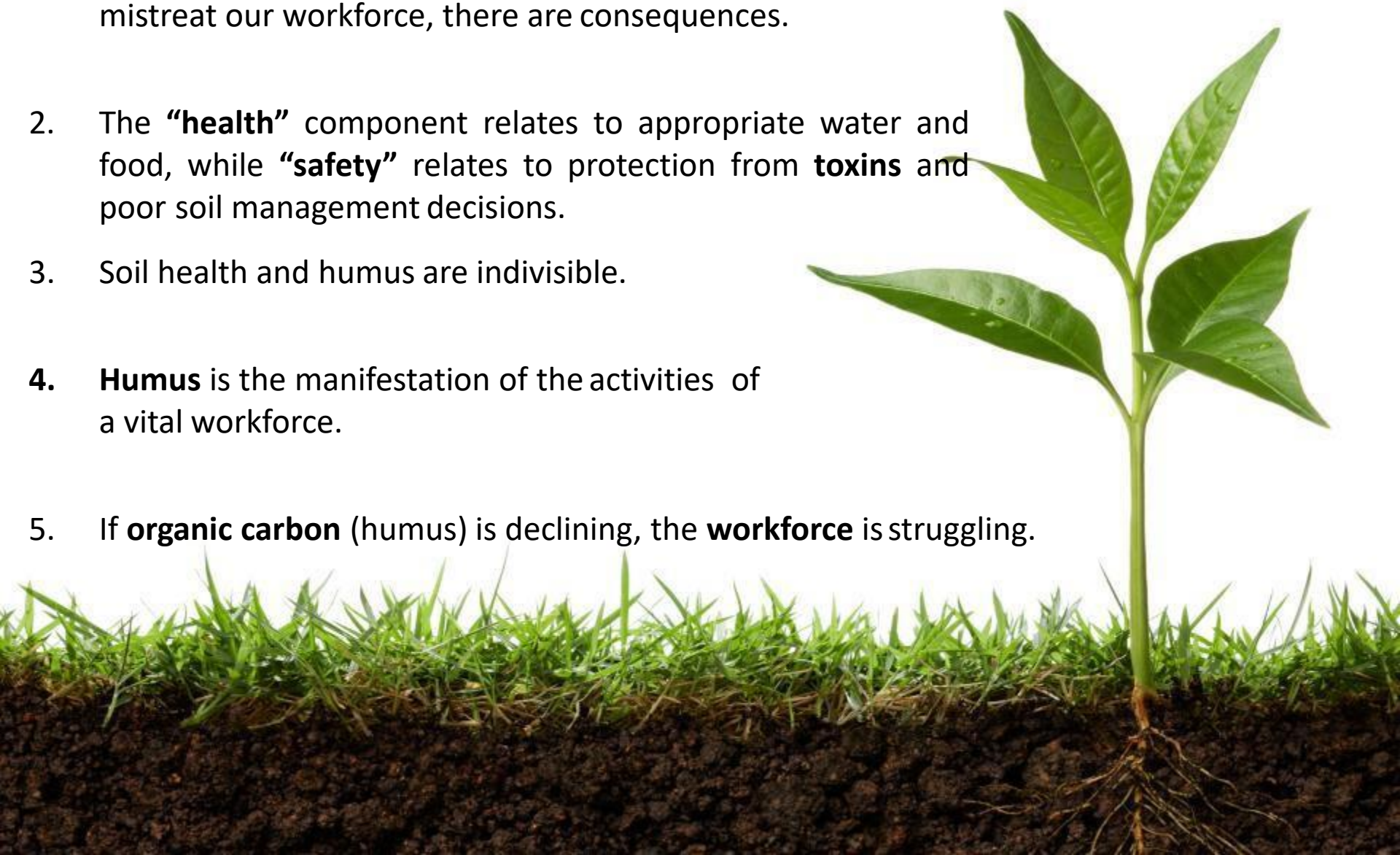
1. Microbe Management is essentially a **workplace health and safety** issue. If we mistreat our workforce, there are consequences.

2. The **"health"** component relates to appropriate water and food, while **"safety"** relates to protection from **toxins** and poor soil management decisions.

3. Soil health and humus are indivisible.

4. **Humus** is the manifestation of the activities of a vital workforce.

5. If **organic carbon** (humus) is declining, the **workforce** is struggling.



Organic Matter (Humus)

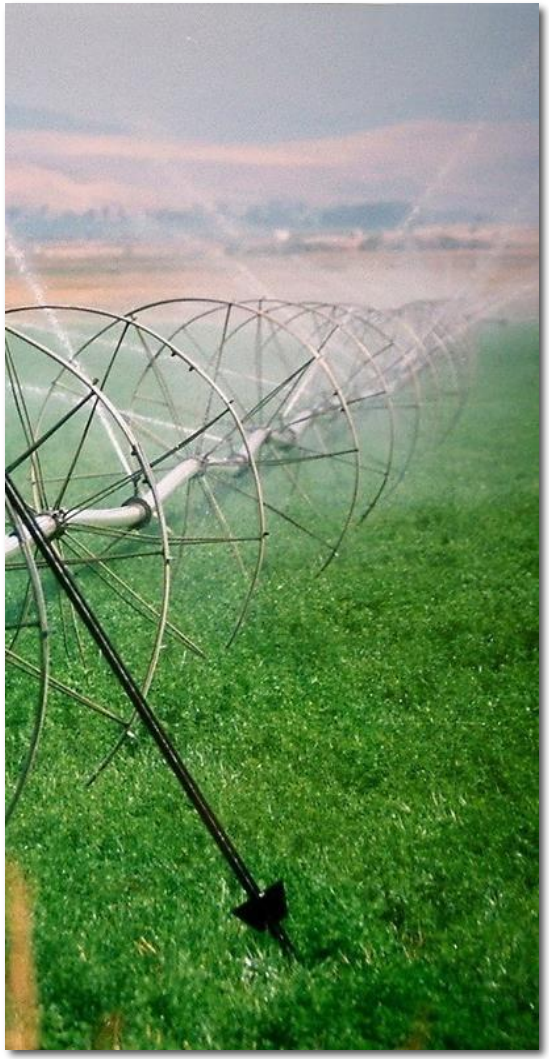
- Soil humus is **organic matter**, but not all organic matter is **humus**.
- The **organic matter** reading on a soil test should be divided by 1.7 to get an **organic carbon** equivalent.
- **Organic matter**, as measured on most soil tests, is actually a combination of three different materials:

1. **Raw organic matter**
2. **Active Humus**
3. **Stable Humus**

Microbe Management and Humates – Humus

	Raw organic matter	Effective humus	Stable humus
NATURE			
Source	Wastes, residues, and remains of living organisms.	Decomposed raw organic matter.	Decomposed raw organic matter or effective humus.
Composition	Complex organic compounds, such as proteins, cellulose, lignins, fats, starches and sugars.	Characterized by high ratio of fulvic acids (small, soluble molecules).	Mostly long-chained humic acids, or humins bonded to clay particles.
Characteristics	Heterogeneous, coarse, lumpy material.	A colloid; more homogeneous in texture and color.	Homogeneous; resistant to chemical action.
FUNCTION			
Physical	Improves aeration, drainage and moisture retention. "Trash mulch" protects soil from weathering. If too coarse and abundant, may hinder seed preparation.	Creates "crumb structure"—spongy, porous and sticky—that makes an excellent soil conditioner. Dark brown color improves heat retention by soil.	Same as effective humus.
Chemical	Provides some soluble nutrients, especially from manures. Leaves a reserve supply of nutrients in the soil. Releases much carbon dioxide as it decomposes.	Mobile in soil; readily releases nutrients to plants. Holds nutrient anions in a form available to plants, but safe from leaching. Increases cation exchange capacity.	Provides long-term nutrient storage and maintains good cation exchange capacity. Toxic substances (as well as nutrients) can be chelated and prevented from entering the ecosystem.
Biological	Provides food for microbial decomposers. However, if too carbonaceous, can over-stimulate microbes and lock up available nitrates.	Provides nutrients to microbes as it decomposes. Releases vitamins, hormones, antibiotics, and other biotic substances.	Provides microbial habitat and evidence of healthy biological activity.

Benefits of Humus



- **Drought Resistance** – Holds 80% to 90% of its weight in water. Microbes, which live in **stable humus**, emit a gum-like mucilage, which also helps to retain moisture in the root-zone.
- **pH Buffering –** pH extremes have a profound effect on **nutrient** availability. Humus can neutralise the negatives associated with these extremes.
- **Mineral Retention** – Humus has a Cation Exchange Capacity (CEC) of 250 and can complex minerals to prevent them from **leaching**.
- **Crumb Structure** - The sticky exudates secreted by microbes in the process of forming humus, 'glue', soil particles together to create a highly desirable crumb structure.

Benefits of Humus

- **Soil Detoxification** – Heavy metals and chemical residues can be **isolated** and **immobilised** to reduce damage to both plants and microorganisms.
- **Root-Zone Chelation** – The humic and fulvic acid component in humus chelates minerals to enhance **mineral uptake**.

- **Plant Growth Promotion** – Humus is a storage system for all of the beneficial microbial exudates, including enzymes, vitamins, hormones and antibiotics.
- **Solubilisation of Mineral Fertilisers** – Materials like rock phosphate, lime, gypsum and rock dust are **solubilised** far more rapidly when humus levels are good.

- **Sodium Management** – Humus **buffers** the damage to plants and microorganisms associated with high-salt fertilisers or saline irrigation water.

At this point it is appropriate to discuss the relevant benefits of **humic acid**. **DO YOU NOTICE ANY SIMILARITIES?**

Benefits of Humic Acid

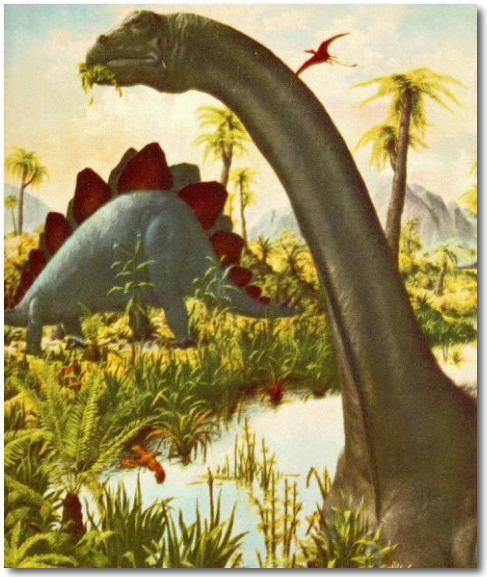
- pH-Buffering
- Mineral Retention
- Soil Detoxification
- Root-Zone Chelation
- Promotes Crumb Structure
- Plant Growth Promotion
- Solubilisation of Mineral Fertilisers
- Sodium Management

Humates: Nutrient Density & Energy

Humates are derived from **prehistoric** plant matter, which has been compressed and preserved through the eons as brown coals called **lignite** and **leonardite**.

This ancient organic matter retains the **dense mineralisation** that was a feature of the massive forests that pre-dated the dinosaur era.

The 30-tonne brontosaurus feeding from this **flora** was able to sustain this phenomenal body mass despite possessing a mouth the size of a horse's.



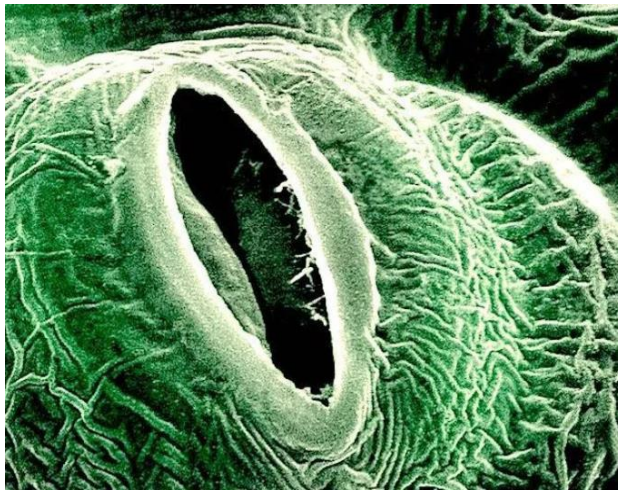
Humate Energy

Part of the tremendous soil response linked to humates comes from the **68% carbon** found in these coals. Part comes from this **dense mineralisation** and a significant kick comes from the humic and fulvic acid component.

However, there is a theory that the **intense vitality** found in prehistoric plants has been somehow retained within the **humates**.

Humates – Mineral Magnifiers

- From a mineral uptake perspective, humates have two principle functions: they are both **magnifiers** and **stabilisers** of minerals.
- Magnification works on two levels – **membrane permeability** and **chelation**.
- The increased permeability of plant cell membranes allows the plant to uptake **30 – 35% more** through the roots or leaf if applied fertiliser is combined with humates.



Humates are powerful, **natural chelating agents**.

Chelation **neutralises** the positive charge of cations to facilitate their **easy entry** into the root or leaf.

'**Traffic jams**' at the stomatal entry point are avoided.

Humates – Mineral Stabilisers

- Anions like **sulfates** and **boron** are stored on the **humus colloid**, which contains positively charged sites.
- Unfortunately, in the last 50 years, humus levels have fallen from a **5%** average to less than **1.5%**.
- Humic acid can **complex** highly leachable anions like boron, forming a stable **boron humate** in the process.
- Humic acid has an affinity for **iron**. The obvious greening effect is related to an increase in iron uptake.

Humates – Buffering

- When mineral excesses are a problem, humic acid has a remarkable **buffering effect**.
- **Magnesium** and **sodium** levels are often in excess.

- Humic acid has been very effective in reducing problems associated with **excessive sodium** in horticulture.
- The soil in the photo has a sodium base saturation of **27%.**

Humic Acid & Urea

- Urea can bond to the humate colloid creating a stable **urea humate**.
- European research highlights a prolonged urea response (up to **80 days** longer).
- Recent Malaysian research demonstrated a **60%** increase in the performance of urea when combined with humic acid.
- There is much less **volatisation** and **leaching** when urea and humates are combined and the uptake of nitrogen is boosted by 30%.
- This pair can be combined in liquid or granule form.

Types of Humic Substances

- **Humic acid** has a molecular size ranging from 10,000 to 100,000. Humic acid readily forms complexes with all minerals, which are then more available to **plants** and **microbes**. Humic acid has a CEC of 450.
- **Fulvic acids** have a molecular size ranging from 1,000 to 10,000. They have more carboxyl and hydroxyl groups, making them more **chemically reactive**. Their small size means they can rapidly enter the plant. Fulvic acid is the most effective, carbon-containing, chelating agent known so it is perfect as a **foliar additive**. Fulvic acid has a CEC of 1400.
- **Humates** are mineral salts of humic acids. There is a huge variation between different humates based upon the different mineral deposits from which they were derived.

Differentiating Between Products

- It is widely accepted that **leonardite** is the most bioactive and productive source of humates and the more oxidised the better.
- Australian brown coals are **lignites** and they also perform better if they have been **oxidised**. i.e., stockpiled for several months after mining and turned occasionally.
- It is difficult for growers purchasing **humates** to differentiate between different products based upon visual characteristics or analysis. The best test is always **bioactivity** in the field. Even then, there remains the question of product consistency from batch to batch.

9 Hot Tips to Profit from Humates

1. **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.

2. **Humates** are excellent **brix-builders** – enhanced carbohydrate production can be detected with a refractometer within 24 – 48 hours (increased quality and yield).

3. A **combination** of humic and fulvic acid has been shown to be most effective for promoting **root growth**.

4. It may take up to **three applications** of soluble humates to achieve sufficient concentration in the roots to allow 20 – 30% of the humic acid to be transported through the shoots and leaves. i.e. You will always see **root growth** before shoot growth when top dressing humates.

5. Humates can be used to lower **nitrate levels** or prevent the accumulation of nitrate in plants with obvious stock health benefits. In this situation humates also increase **potassium uptake** which is normally inhibited by excess nitrates.

RECIPE FOR NITRATE REDUCTION:
2% Magnesium sulfate (2 kg per 100 L) 150 g Sodium Molybdate
150 g Fulvic Acid Powder

6. If **carbon sequestration** is to be a new income stream in agriculture, then humates are a major tool. **Humates** are the most profound promotant of the creatures that build stable carbon in the soil (cellulose-digesting fungi).

Microbe Management – 9 Hot Tips to Profit from Humates

7. Don't discard the insoluble sludge (**15%**) when dissolving **Soluble Humate Granules** as it is the sponge-like, mineral-dense humin fraction which is an excellent fertility builder.

8. Humic acid is a powerhouse tool for **drought resistance**. The large surface area and internal electrical charges help hold water in the root zone. Humates serve as sponges which can hold **7 times** their volume in water. That stored water also facilitates nutrient transfer. i.e. potassium deficiencies in droughts.

9. The combination of **humic acid** with **liquid lime** liberates CO_2 from calcium carbonate providing a **photosynthetic boost**.

Using Humates to Improve Soil Structure

- Beneficial soil organisms lack the **photosynthetic** apparatus to capture energy from the sun, so they rely upon residual carbon compounds in the soil for their energy source. **Fulvic acid** is the most powerful known stimulant for beneficial bacteria, who release sticky polysaccharides that create mini aggregates (**soil crumbs**).
- Humic acid is the most powerful known fungal promotant. **Fungi** bunch together in mini aggregates and create a larger particle.
- This "**crumb structure**" is the most desirable of all soil structures. There are no hard pans and the plant roots can move freely in this naturally friable soil. Oxygen can readily enter and there is no "**puddling**" (and associated loss of nitrogen).

Humates as Fertility Builders

Russian research cited by **Dr Boris Levinsky** included the following data in relation to **yield increases** following humate applications:

Wheat	13 – 25%	Brassicas	25 – 35%
Barley	15 – 17%	Citrus	30 – 60%
Corn	20 – 30%	Potatoes, Carrot	
Pasture	75 – 95%	& Beetroot	25 – 40%
Tomatoes	20 – 30%		

Quality increases included the following:

Vitamin C in Beetroot	+ 90%	Riboflavin in Cabbage	+ 14%
Carotene in Beetroot	+ 95%	Phosphorus in Cabbage	+ 28%
Niacin in Beetroot	+ 79%	Vitamin C in Tomatoes	+ 45%
Niacin in Cabbage	+ 42%	Starch in Potatoes	+ 18%

The Effects of Humates on Soil Fertility

- Humic and fulvic acids react with metals and clay minerals in the soil to form **organo-metal** and **organo-clay** complexes.
- These reactions **modify** the permeability, porosity, water retaining capacity, absorption characteristics, surface area and cation exchange reactions.
- They also affect the degradation and the **decomposition** of rock minerals including rock phosphate, lime and gypsum and the **flocculating** capacity of calcium.

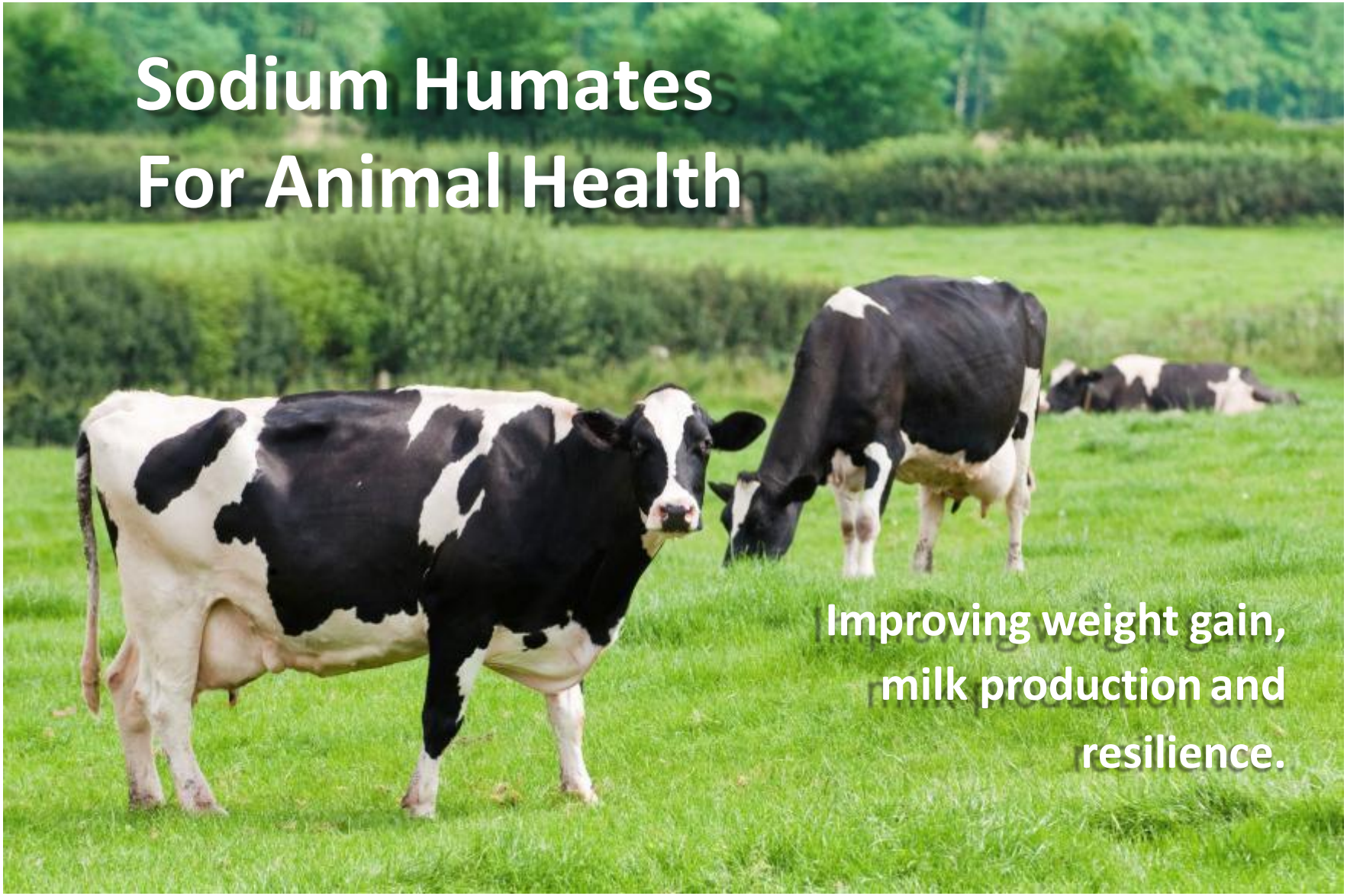
- Humic acid can break up clay soils through its **dissolving effect** on clay minerals. Humic acid bonds onto the surface of clay platelets while **fulvic acid** is small enough to penetrate the spaces between the platelets and complex the minerals held within.

Humic Substances & Soil Microbes

- **Soil enzymes** can be stabilised and inactivated by humates. Pathogens often release enzymes to break down the plant's **defense system**. These enzymes can bind to humates and as a result the pathogens are unable to invade potential host plants.
- **Soil temperature** and water **evaporation rates** are stabilised by humates. The insulating properties of humates helps maintain soil temperature uniformity. This is important in cold spells and heat waves and serves to **support soil life**.
- Humates also regulate the **membrane permeability** of microorganisms, allowing them to utilise nutrients more effectively. The complexing effect of humates on trace minerals also increases their **availability** to microbes.
- Humates promote the production of plant **root exudates**, which provide a food source for microbes.

Using Higher Humate Rates

- In recent research we trialed **10 kg**, **20 kg** and **50 kg** per ha of humates as standalone fertilisers in corn.
- The **20 kg** rate produced a **20.2%** increase in yield while the **50 kg** rate decreased yield by 9%. At an investment of **$64.00** per ha the corn increase was worth an extra **$4,200.00** per ha.
- In a second trial we compared maize planted with **20 kg** of **DAP** vs a crop planted with the same rate of DAP combined with **20 kg** of **NTS Soluble Humate Granules™**.
- In this phosphate deficient soil the **DAP** alone produced a **21%** yield increase over the unfertilised control.
- However, the fusion blend with the humates produced a massive **49%** yield increase over the control.


Sodium Humates
For Animal Health
Improving weight gain,
milk production and
resilience.

Chinese Humate Research

- Dairy cattle produced **790 mL** more milk per day when fed 30 grams of sodium humate per day.
- **0.1%** Sodium Humate in feed increased egg production from 186 to 322 eggs per hen per year – 73% increase.
- **0.5%** Sodium Humate in total feed piglets increased an average of **520 grams** per day, compared to the control group of 476 grams per day – a weight increase of **9%**.
- **A saving of 24 kg of feed for every 100 kg of weight gain was recorded.**

Russian Research

Dr Boris Levinsky

Dec 2001

- Poultry weight gains of **10 – 30%**.
- Cattle fed 10 mg per **10 kg** of live weight – calves born to these cows increased in weight by **13.4%** over 4 months over and above the control.
- Bull calves fed with humates recorded a **21.2%** increase in weight over the control.

University of Leipzig

Germany 2000

- A substantial increase in **weight gain** in pigs.
- Sodium humates stabilise **intestinal flora**.
- Bind *E.Coli* bacteria and their **endotoxins** very strongly.
- Form a **protective film** on the gastro intestinal tract, preventing infections, toxins and water loss.
- Support **immune system** receptors.

Multiple Benefits of Sodium Humates

- **Detoxification** – Removes heavy metals, nitrates, organo phosphates etc.
- **Stops scours** – In calves and lambs
- **Reduces Mastitis** – Well researched in dairy cows
- **Reduces Ammonia Emissions** – In stock sheds
- **Inhibits Pathogen Growth** – Mycotoxins in stock feed
- **Powerful Prebiotic** – Improves feed utilization and weight gain
- **Anti-viral** – A rare input to counter viral diseases
- **Boosts blood oxygen** – Improves energy and speeds healing

Multiple 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

Sodium Humate Case Studies

1. In a 56 day feed lot trial, Dr Chirase, from Texas A & M reported **12% feed efficiency**, increased blood levels of hemoglobin and antioxidants, and a **64%** reduction in ammonia emissions from animal waste.

2. In a 30 day US chicken trial, the treated birds gained **1.5 pounds more mass** and there was a profound impact upon behaviour. The chooks became cruisy and relaxed compared to the frantic behaviour of untreated birds.

3. In other trials, Angoras produced wool with longer staple and more lanolin.
   In a 4 week dairy trial, treated cows produced **2 pounds more milk** per day while consuming **2 pounds less food** (5% reduction). Their poo was of healthier quality with less odour.

In Conclusion…

Humates are now considered as essential tools in regenerative agriculture. They can help overcome imbalances and abioticand biotic stress.

They can magnify nutrition inputs and help counter the negatives associated with chemicals.

They can help create crumb structure – the most desirable feature of productive, fertile soils.

Most importantly, humates can help address the climatechange challenge, as triggers for humus creation, as soil detoxifying agents and as nitrogen stabilisers.