BASE (UK)
January 2014

Michael Harrington
Agronomy & Soil fertility Consultant

" You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete"

- *R. Buckminster Fuller*

BASE (UK) – Helping to create a New Paradigm

The methods and tools we have available to farm are incredibly diverse

Sustainable Intensification!

Urea v Nitrate

Foliar fertilisation

Disease resistance to chemicals

Plant health

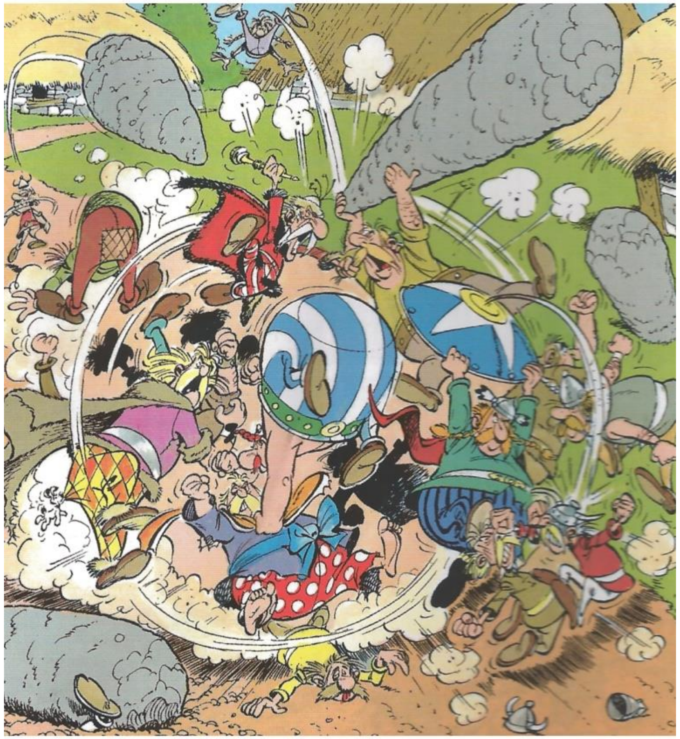
Yields v Profit

Zone tillage

Mob grazing

Conflicting advice

Rotations v Continuous



GM

Insect resistance to chemicals

Cover cropping

Organic farming
Carbon driven

Intensive chemical agriculture
Nitrogen driven

Biological farming
Balanced approach

Fertility
Elements or Components of

Rotations

Weed resistance to chemicals

Minimum tillage

Ploughing

Direct drilling

What is Fertility?, do we have we a definition?

Natural production capacity of a field (without intervention)

‘We have become even more accustomed to regard the soil as a real equation of nutritive values. Such an equation would as a matter of fact, be correct if it included ***all*** the factors. The modern farming system has become one of one sidedness and is an improper equation: Soil plus additional fertiliser equals soil plus yield’
Ehrenfried Peifferer 1938

He believed the proper equation, from the point of view of life should be:

‘Natural fertility plus production capacity equals the sum of biological functioning of: Soil, climate, manuring, humus, tillage, rotation, weather conditions, quality of seed, and a number of environmental factors’

‘The consideration, or neglect of ***any*** one of these factors is just as important as the whole fertiliser equation. What then can the farmer do in order to be fair in all these, and maintain at a high level his living organism, ***the farm*****?**’

Lancrop Laboratories

Analysis Results (SOIL)

Customer

Distributor EDAPHOS LTD - OXFORDSHIRE
THE WHITE HOUSE
LETCOMBE REGIS
WANTAGE
OXFORDSHIRE
OX12 9JL

Sample Ref COT LANE
Sample No E006425/01
Crop GRASS (CATTLE)

Date Received 27/06/2012
Area 18

Analysis	Result	Guideline	Interpretation	Comments
pH	6.5	6.0	Normal	Adequate level.
Phosphorus (ppm)	7	26	Very Low	**(Index 0.7)** 60 kg/ha P2O5 (48 units/acre).
Potassium (ppm)	53	121	Very Low	**(Index 0.8)** 60 kg/ha K2O (48 units/acre).
Magnesium (ppm)	52	176	Low	**(Index 2)** PRIORITY FOR LIVESTOCK HEALTH.

Additional Comments

The analyses and interpretation for P & K has been carried out using according to MAFF RB209. PLEASE NOTE: The recommendations can be adjusted if organic manures are used. See RB209 for more information.

Low Phosphate, low potassium, low magnesium = weevil, poor rhizobium, no nitrogen and poor root exudates

Lancrop Laboratories

Analysis Results (SOIL)

Customer

Distributor THACKER FARM SERVICES
YEW TREE
LONDON ROAD
BLEWBURY
OXFORDSHIRE
OX11 9PF

Sample Ref ASHLEY WARREN

Sample No D018572/01

Crop BARLEY (SPRING)

Date Received 06/01/2012

Area 1

Analysis	Result	Guideline	Interpretation	Comments
pH	7.8	6.5	High	Possible interference on availability of P, K, Mn, B, Cu, Zn and Fe.
Phosphorus (ppm)	22	16	Normal	**(Index 2.6)** 50 kg/ha P2O5 (40 units/acre). Maintenance.
Potassium (ppm)	201	121	Normal	**(Index 2.6)** 40 kg/ha K2O (32 units/acre). Maintenance.
Magnesium (ppm)	50	50	Normal	**(Index 1.9)** Adequate level.

Additional Comments

The analyses and interpretation for P & K has been carried out according to MAFF RB209. The fertiliser requirements are based on a spring crop 6 t/ha with straw removed. PLEASE NOTE: The recommendations can be adjusted if yield is larger or smaller, or if manure/slurry applications are used. See RB209 for more information. Check the soil is maintained at Index 2 by soil sampling every 3-5 years.

Soil analysis – 22nd June 2010

Phosphorous – 26ppm (index 3.7)
Potassium – 230ppm (index 2.9)
Magnesium – 270ppm (index 5.1)

Analysis	Result	Guideline	Interpretation	Comments
pH	6.7	6.5	Normal	Adequate level.
Phosphorus (ppm)	40	26	Normal	(Index 3.7) Adequate Level.
Potassium (ppm)	230	241	Slightly Low	(Index 2.9) 0-25 kg/ha K2O (0-20 units/acre). Maintenance.
Magnesium (ppm)	270	50	High	(Index 5.1) Possible interference on availability of Potassium.
Calcium (UK) (ppm)	4722	1600	Normal	Adequate level.
Sulphur (ppm)	18	10	Normal	Adequate level.
Manganese (ppm)	22.0	55.0	Very Low	PRIORITY FOR TREATMENT.
Copper (ppm)	6.9	2.1	Normal	Adequate level.
Boron (ppm)	1.79	1.60	Normal	Adequate level.
Zinc (ppm)	8.3	2.1	Normal	Adequate level.
Molybdenum (ppm)	0.14	0.40	Very Low	Low priority on this crop. Other crops may be affected.
Iron (ppm)	1257	50	Normal	Adequate level.
Sodium (ppm)	29	90	Very Low	Not a problem for this crop.
C.E.C. (meq/100g)	22.0	15.0	Normal	Cation Exchange Capacity indicates a soil with a good nutrient holding ability.

Tissue analysis – 19th July 2010

Phosphorous - 53%
Potassium - 77%
Magnesium - 25%

Analysis	Result	Guideline	Interpretation	Comments
Nitrogen (%)	1.83	3.00	Low	PRIORITY FOR TREATMENT.
P[illegible]horus (%)	0.14	0.30	Very Low	PRIORITY FOR TREATMENT.
Potassium (%)	0.67	3.00	Very Low	PRIORITY FOR TREATMENT.
Calcium (%)	0.81	1.00	Slightly Low	Low priority. See comments below.
Magnesium (%)	0.15	0.20	Slightly Low	Consider foliar applications of MAGNESIUM
Manganese (ppm)	12.4	25.0	Very Low	PRIORITY FOR TREATMENT.
Boron (ppm)	18.2	25.0	Low	PRIORITY FOR TREATMENT.
Zinc (ppm)	22.7	20.0	Normal	Adequate level.
Iron (ppm)	433	50	Normal	Adequate level.
Copper (ppm)	5.6	7.0	Slightly Low	Low priority. See comments below.
Molybdenum (ppm)	1.03	1.50	Low	Consider foliar applications of molybdenum.
Sulphur (%)	0.14	0.20	Low	PRIORITY FOR TREATMENT.

Soil Type: Clay

Index analysis:
pH – 7.1
Phosphate – 4.2
Potassium – 3.0
Magnesium – 3.1

			TARGET	Index & Lle / ACTUAL / Jul-02
		pH		7.1
UK STANDARD AVAILABILITY TEST (INDICES)		Phosphate		4.2
		Potassium		3.0
		Magnesium		3.1
		CEC		18.7
CATION EXCHANGEABLE NUTRIENTS	CATIONS (CEC %)	Ca	65 - 70	73.2
		Mg	10 - 15	19.8
		K	3 - 5	1.9
		Na	0.5 - 2	0.6
		H	3 - 10	0.0
		Others	Variable	4.4
	ANIONS (kg/Ha)	Phosphate	250 to 350	477
		Sulphur	50 to 75	26
BIOLOGY		OM	3 to 6	3.2
		Organic Carbon	1.5 to 3.5	1.1
		Humus	30 to 60	8
		Ergs	150 to 250	128
FUNCTIONALLY AVAILABLE PLANT SOLUBLE NUTRIENTS		Calcium	2000 to 3000	1144
		Magnesium	250 to 350	199
		Ca:Mg ratio	8:1	6:1
		Potassium	150 to 250	82
		Phosphate	150 to 250	157
		Nitrate N	30 to 50	28
		Ammoniacal N	30 to 50	10

ANALYSIS	TEST LEVEL	GUIDELINE LEVEL	INTERPRETATION very low	low	slightly low	normal	high
Nitrogen	2.37 %	3.00 %			✗		
Phosphorus	0.17 %	0.30 %		✗			
Potassium	0.84 %	3.50 %	✗				
Calcium	1.33 %	0.40 %				✓	
Magnesium	0.34 %	0.12 %				✓	
Manganese	22.6 ppm	35.0 ppm		✗			
Boron	7.5 ppm	6.0 ppm				✓	
Zinc	11.0 ppm	25.0 ppm	✗				
Iron	96 ppm	50 ppm				✓	
Copper	4.5 ppm	7.0 ppm		✗			
Molybdenum	1.37 ppm	0.10 ppm				✓	
Sulphur	0.40 %	0.25 %				✓	

The current soil index test has a reading of 3, good levels of potassium

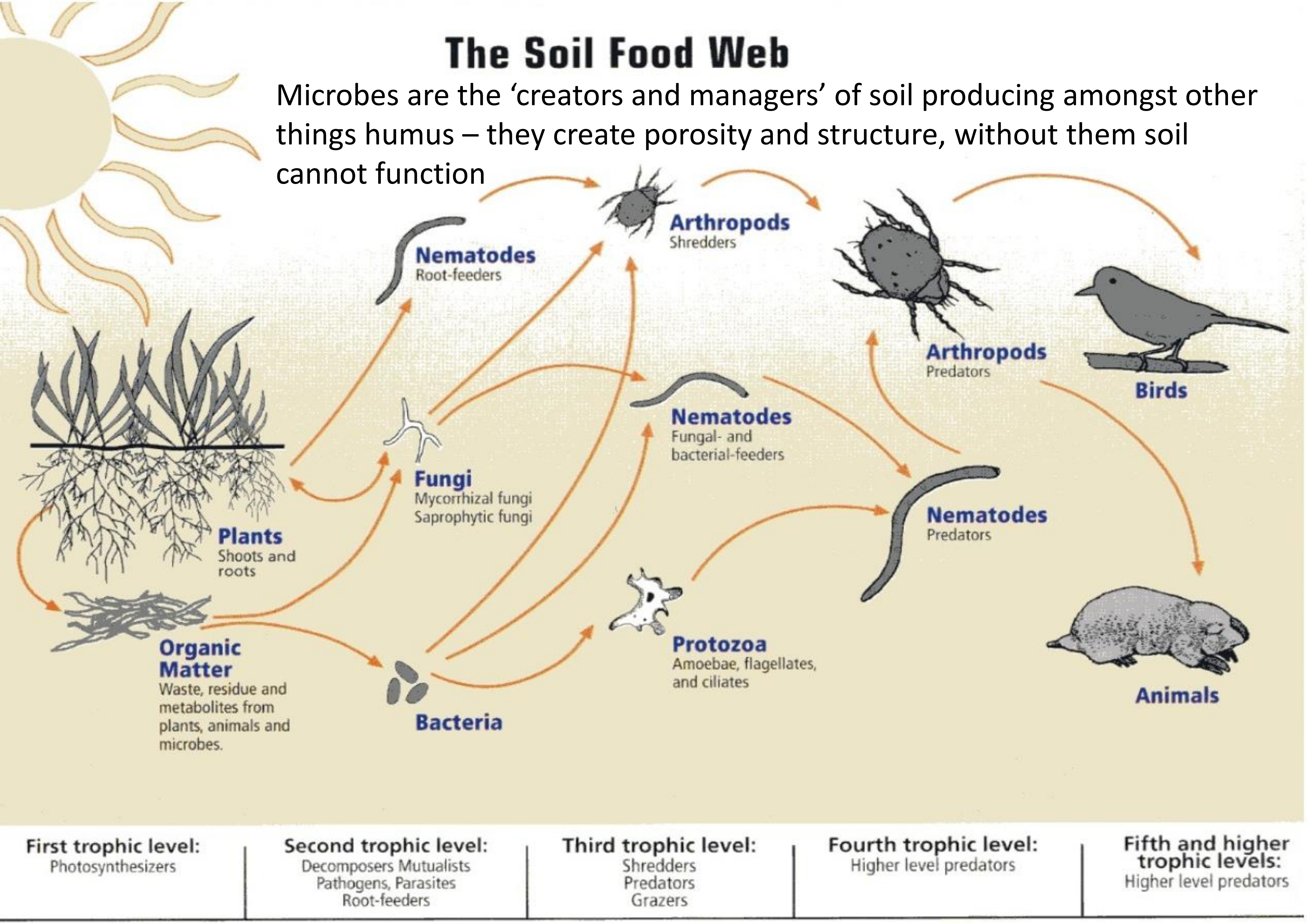
The opposite is actually true. The soil is dominated with magnesium and there is little room for potassium on the exchange sites

The biology is very poor, low organic matter and lack of air restricts nutrient cycling to a poor root system

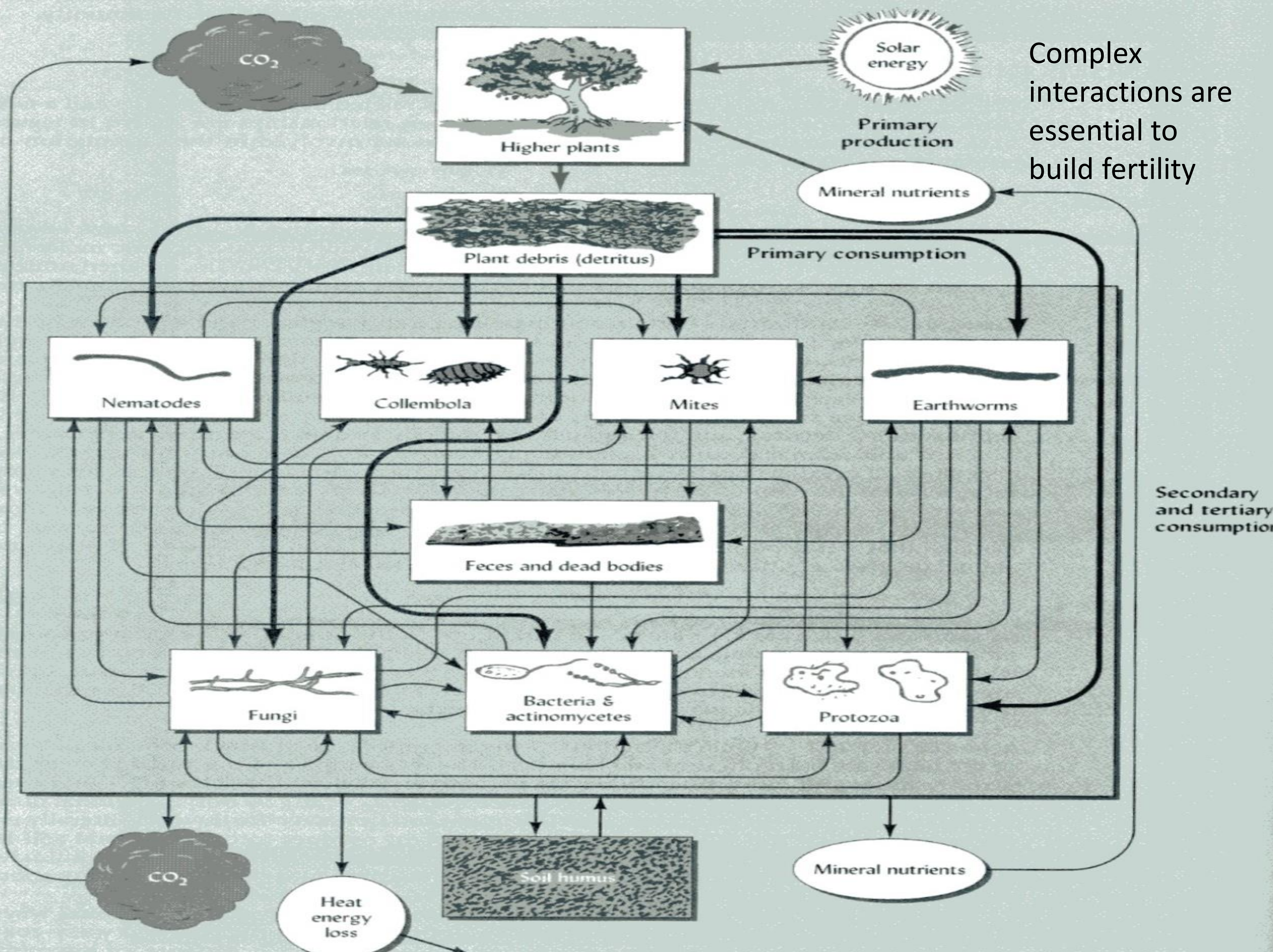
Can we really expect to farm successfully in an inert dead medium like this EVEN with chemicals and soluble fertilisers!

The Soil Food Web

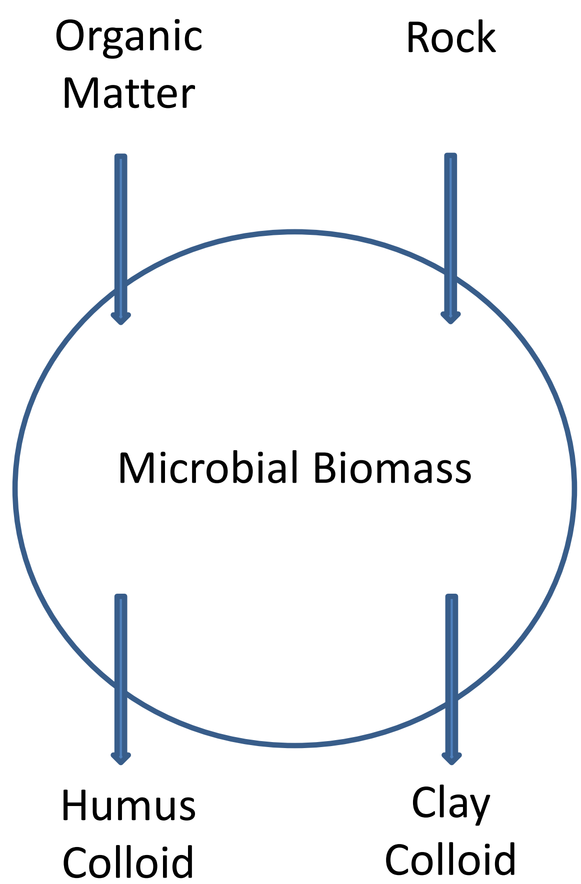
Microbes are the ‘creators and managers’ of soil producing amongst other things humus – they create porosity and structure, without them soil cannot function



Complex interactions are essential to build fertility



Microbes <u>create</u>, <u>manage</u> and <u>maintain</u> soil



Higher pH - Bacterial dominated

Lower pH - **Fungal dominated**

Bacteria cycle - **Minerilisation**

Fungi cycle - **Humification**

Bacterial-dominated plants (most row and vegetable crops; annuals		**Equal Fungi to Bacteria Ratio plants**		**Fungal-dominated plants** (most trees and shrubs; perennials)	
0.3 - 0.7	Broccoli	0.8 - 1.0	Maize	2 - 5	Strawberry
0.5 - 0.8	Kale	0.8 - 1.2	Wheat	3 - 5	Grape
0.5 – 0.8	Oilseed rape	1.0 - 3.0	Tobacco	2 - 5	Kiwi
0.5 - 0.8	Lettuce	0.65 - 1.1	Lilies	2 - 5	Roses
0.45 - 0.65	Onions	0.8 - 1.0	Tomato	2 - 10	Rhododendrons
0.5 - 0.75	Lawn grass	0.5 - 1.0	Carrots	5 - 10	Banana
0.5 - 0.65	Bermuda	0.75 - 1.2	Turf grass	10 - 100	Deciduous trees
0.75 - 0.9	Ryegrass	0.9 - 1.2	Bentgrass	5 - 100	Apple orchard
		0.75 - 1.0	Fescue	5 - 100	Citrus
				10 - 100	Oak
				100 - 1000	Conifer

Soil Food Web Structure - Through succession, increasing productivity

Bare parent rock material
100% Bacterial

Cyanobacteria
True Bacteria
Protozoa
Fungi
Nematodes
Micro-arthropods
F: B ratio 0.01

Weeds
- High NO3
- Lack of Oxygen

F: B ratio 0.1

Early grasses
Brome, Bermuda
F: B ratio 0.3: 1

Mid grasses – veg
F: B ratio 0.75: 1

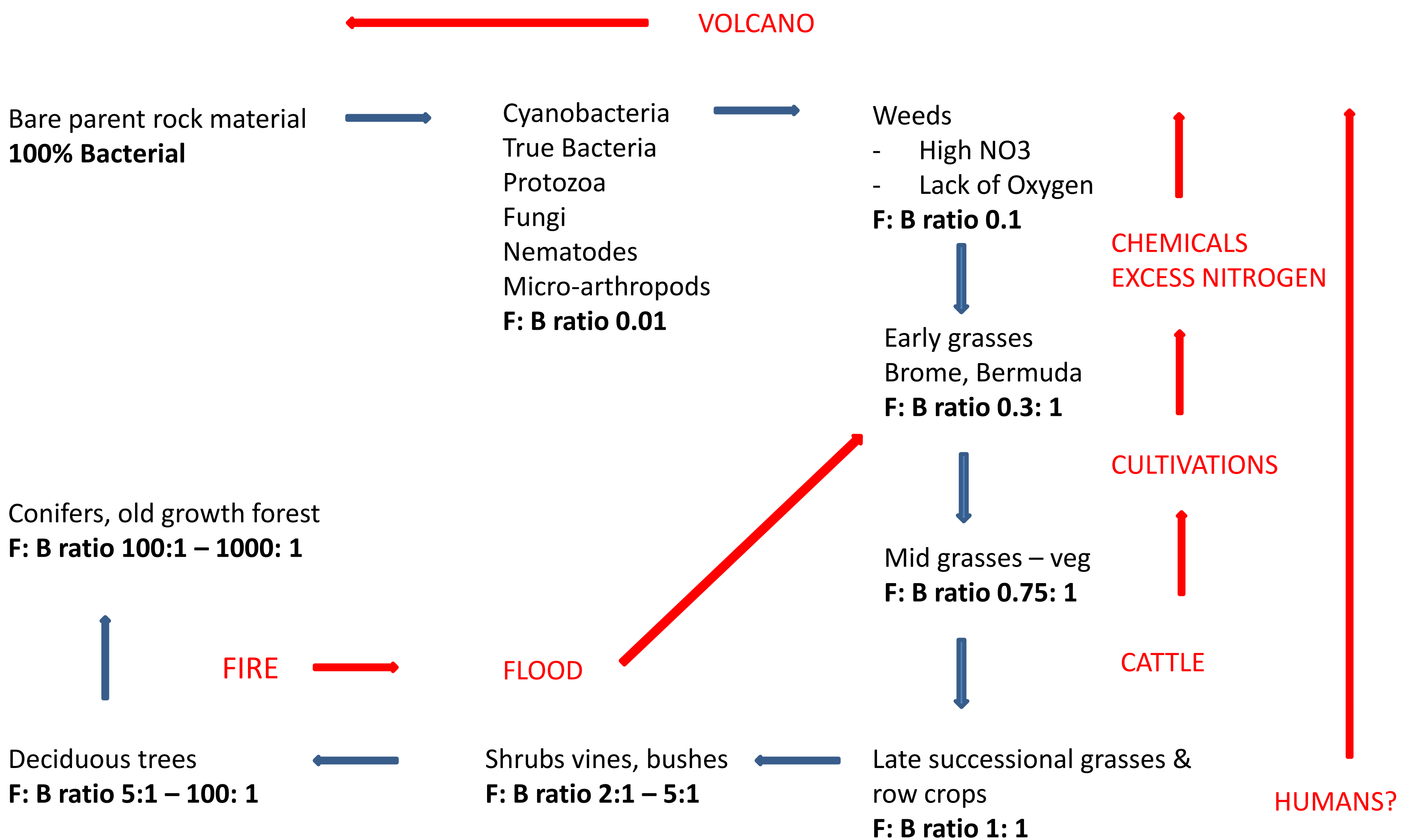
Late successional grasses & row crops
F: B ratio 1: 1

Shrubs vines, bushes
F: B ratio 2:1 – 5:1

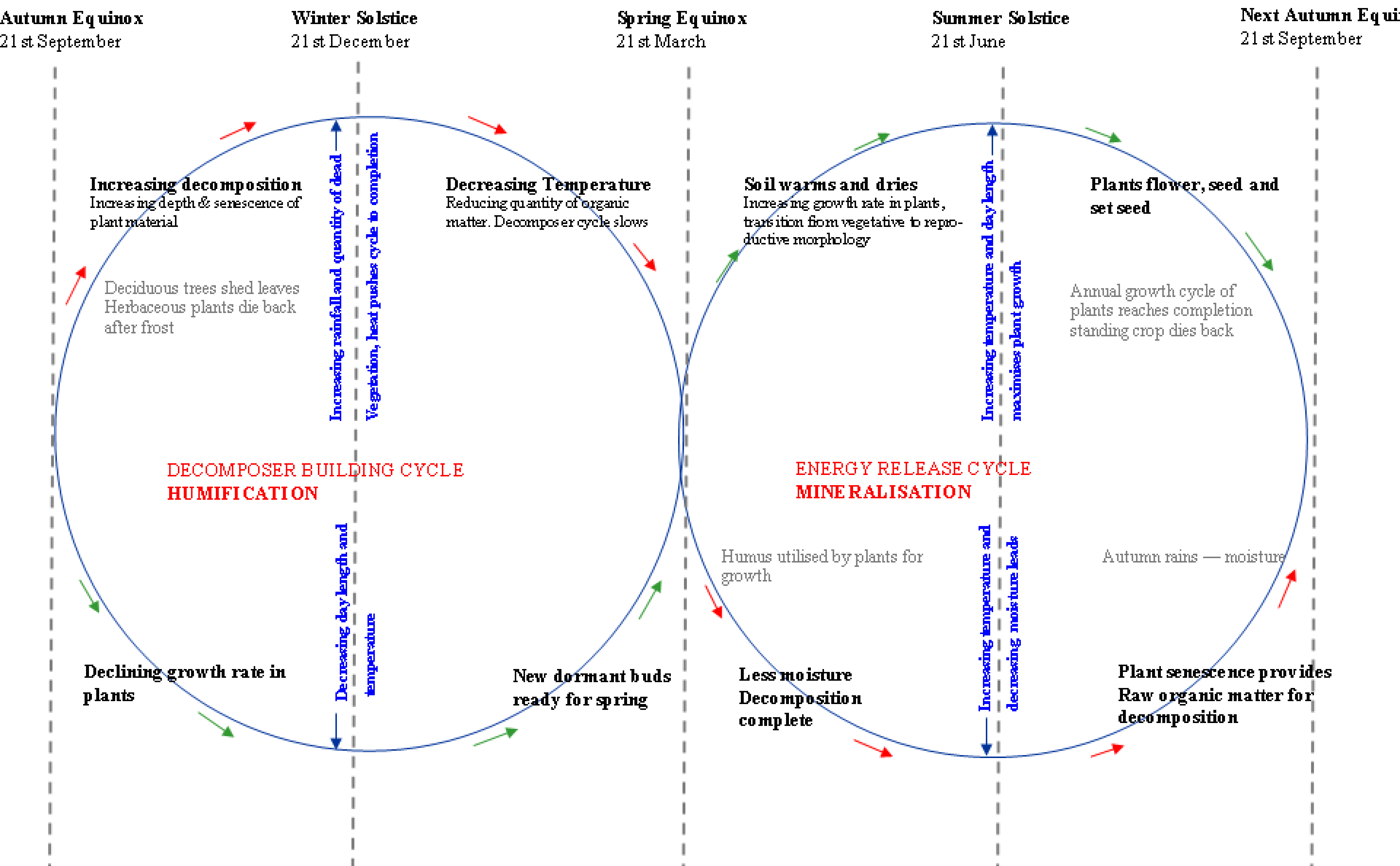
Deciduous trees
F: B ratio 5:1 – 100: 1

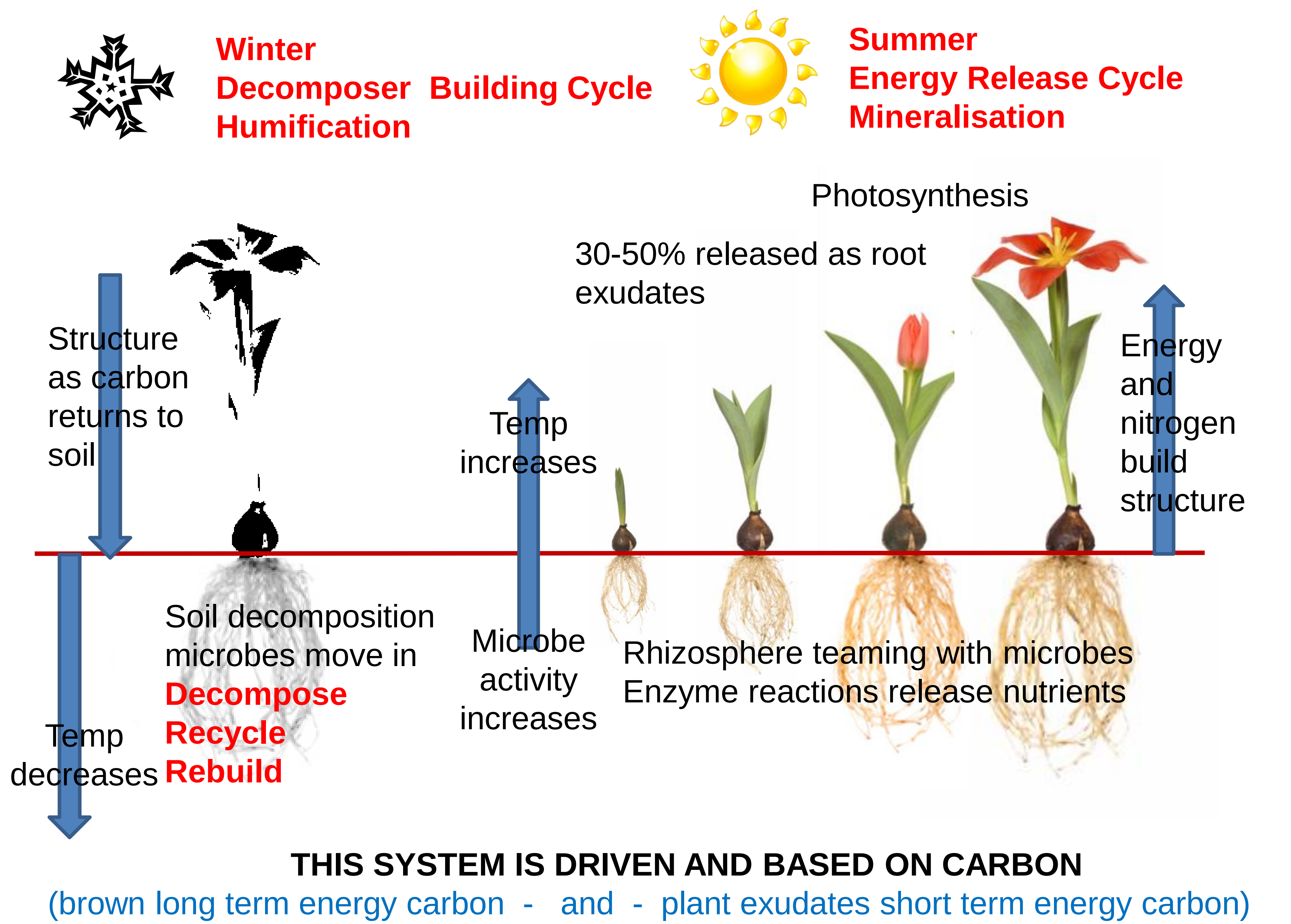
Conifers, old growth forest
F: B ratio 100:1 – 1000: 1

Soil Food Web Structure - Through succession, increasing productivity



The Decomposer Cycle (Northern Hemisph




Winter
Decomposer
Humification
Building Cycle
Summer
Energy Release Cycle
Mineralisation
Photosynthesis
30-50% released as root exudates
Structure as carbon returns to soil
Temp increases
Energy and nitrogen build structure
Soil decomposition microbes move in
Decompose
Recycle
Rebuild
Microbe activity increases
Rhizosphere teaming with microbes
Enzyme reactions release nutrients
Temp decreases
THIS SYSTEM IS DRIVEN AND BASED ON CARBON
(brown long term energy carbon - and - plant exudates short term energy carbon)

THIS SYSTEM IS DRIVEN AND BASED ON NITROGEN

High nitrogen usage – CO_2 released

Organic materials replaced by nitrogen – reduced carbon input

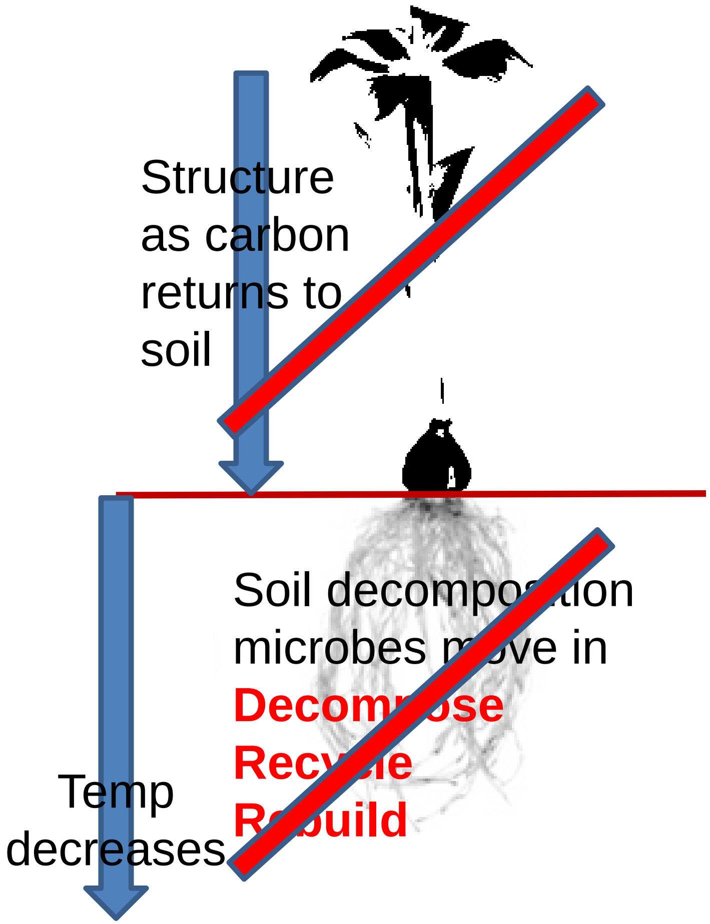
Straw removed – CO_2 taken away

Straw burning – CO_2 released

Livestock rotations reduce – reduced carbon input

70’s cheap fuel highly oxidised soil – $C0_2$ released

High fungicide usage, high cultivations - damages fungal degraders, mycorrhizae, worms

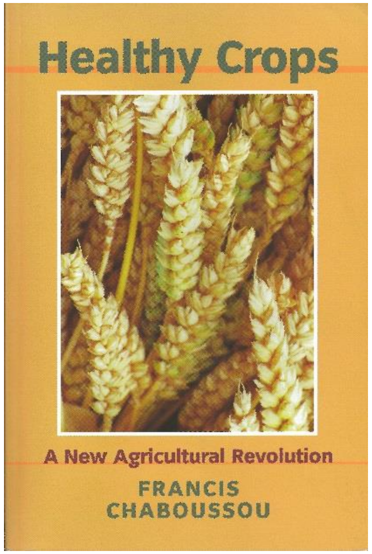


Decades of the above leads to:

Low organic matter, low humus
Higher density, anaerobic, pathogenic conditions
Holds more water in the winter, less water in the summer
Poorer root systems, poor nutrient utilisation
High cultivation cost, poorer seedbeds
More chemicals, more soluble fertilisers

POOR SOIL CANNOT BE IMPROVED BY MORE N-P-K

in other words more N, P, K does not increase soil fertility, it merely bypasses it

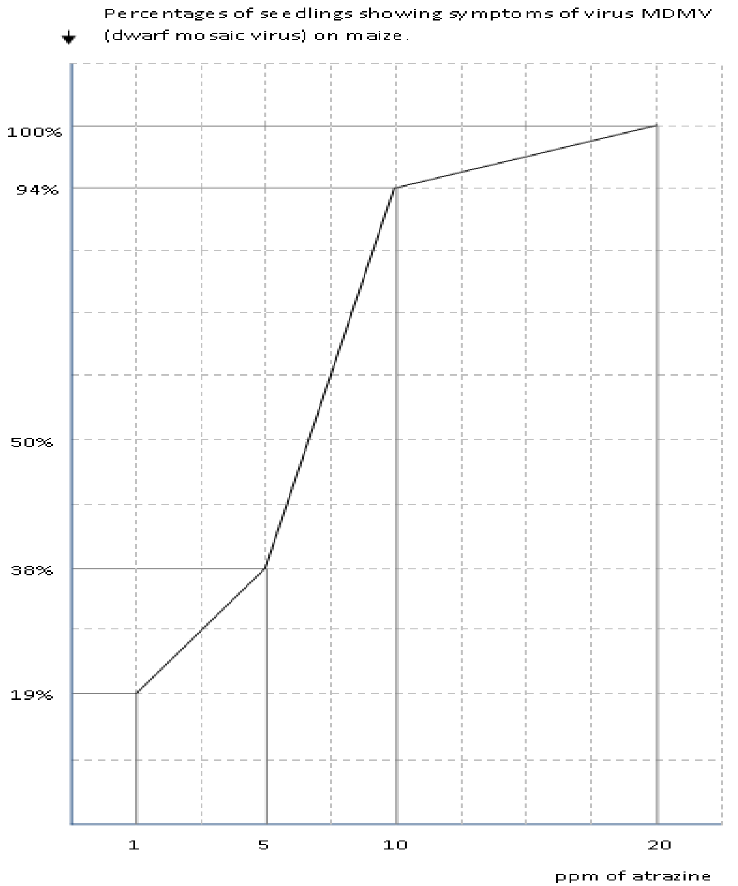


- Any deficiency, especially in micro-nutrients, leads to an inhibition of protein synthesis with a corresponding increase in free amino acids. It is known that manganese is crucial for the absorption of nitrates; manganese deficiency sensitises plants to bacterial infections by inhibiting protein synthesis.

- The relations between plant and parasite are above all nutritional in nature; this suggests that a plant will only be attacked when its biochemical state corresponds to the nutritional (trophic) needs of the parasite in question. These are found in the soluble compounds of intermediate metabolism: soluble nitrogen (free amino acids) and reducing sugars. Where the process of protein synthesis dominates over protein breakdown in a plant, disease resistance is strongest.

- Applied nitrogen often creates this state, more taken up than the plant can deal with. We in fact create a nutritional imbalance slowing down efficient cycling into proteins and plant secondary metabolites. All pesticides have an effect on the plant as well as the intended target, even strong wetting systems breaking down leaf surface wax can have a detrimental effect on the plants own immune system, and herbicides can inhibit trace elements that play an essential role in enzyme reactions both for disease prevention and protein synthesis.

Repercussions of Atrazine, according to soil, levels, on the level of symptoms of MDVM (mild dwarf mosaic virus) on maize



- Abscissa: ppm of atrazine mixed with the soil (laboratory trials)
- Cf. McKenzie,Cole H., and Ercegovitch, C.D.:phytopathology (1968) p. 1058.
- N.B. 20 ppm is the standard dose of the herbicide (cf. Oka and Pimental).

It is the herbicides that, through their specific and drastic effects , provide the greatest insight into the relationships between these three factors: the pesticide, the physiology of the plant, and the activation of viral diseases. McKenzie et al. (1968) were able, by means of controlled experiments on resistant or semi-resistant maize, to show that the susceptibility to the virus MDMV increase with the proportion to doses of atrazine.

A 100% manifestation of the symptoms is achieved with a dose of 20ppm of atrazine

As to the effects of 24-D, spider mites and corn borers increase, along with susceptibility to leaf stripe disease

It will be interesting to see what the effects of stacking the 24-D gene on top of Glyphosate might be?

- First, we need to overcome the idea of the ‘battle’: that is, we must not try to annihilate the parasite with toxins that have been shown to have harmful effects on the plant, yielding the opposite effect to the one desired. We need to stimulate resistance by dissuading the parasite from attacking.

- This implies a revolution in attitude, followed by a complete change in the nature of research

- Bill Clark talks about the increasing difficulties of controlling septoria. In the coming years we will be using 4 way tank mixtures of SDHI, CTL, Triazoles and Stobilurins applied frequently to manage the problem!

- In other words: septoria cannot be eradicated or perhaps even managed, so the outcome will be similar to the blackgrass scenario. It is inevitable!

Lancrop Laboratories

Analysis Results (LEAF)

Customer EARLS COURT FARMS

Distributor EDAPHOS LTD - OXFORDSHIRE
THE WHITE HOUSE
LETCOMBE REGIS
WANTAGE
OXFORDSHIRE
OX12 9JL

Sample Ref CLEEVE HILL
Sample No E081725/01
Crop BARLEY (SPRING)

Date Received 22/05/2013

Analysis	Result	Guideline	Interpretation	Comments
Nitrogen (%)	6.43	2.80	High	Above normal range.
Phosphorus (%)	0.35	0.35	Normal	Adequate level.
Potassium (%)	3.82	3.00	Normal	Adequate level.
Calcium (%)	1.28	0.50	Normal	Adequate level.
Magnesium (%)	0.19	0.15	Normal	Adequate level.
Manganese (ppm)	77.7	30.0	Normal	Adequate level.
Boron (ppm)	6.4	6.0	Normal	Adequate level.
Zinc (ppm)	46.2	20.0	Normal	Adequate level.
Iron (ppm)	216	50	Normal	Adequate level.
Copper (ppm)	15.3	6.0	Normal	Adequate level.
Molybdenum (ppm)	0.34	0.10	Normal	Adequate level.
Sulphur (%)	0.36	0.20	Normal	Adequate level.

Additional Comments
Underlined nutrients should be treated as a priority. However where these are adequate, treatment of deficient low priority nutrients may bebeneficial. For any product applied, always refer to manufacturers advice for rates and timing of application. PLEASE NOTE : The guideline levels quoted should be regarded as the absolute minimum at which crop yield or quality may be affected. Treatment of deficient low priority nutrients may be beneficial if all sensitive nutrients are adequate.

Please Note
Whilst every care is taken to ensure that the Results from Analysis are as accurate as possible, it is important to note that the analysis relates to the sample received by the laboratory, and is representative only of that sample. No warranty is given by the laboratory that the Results from Analysis relates to any part of a field or growing area not covered by the sample received. It is important to ensure that any soil, leaf, silage or fruitlet sample sent for analysis is representative of the area requiring analysis and that samples are obtained in accordance with established sampling techniques. A leaflet containing instructions on how to take soil, leaf, herbage, silage and fruit samples for analysis is available from the laboratory on request.

Wellington Road
The Industrial Estate
Pocklington, York, YO42 1DN
Tel: + 44 1759 305116
www.lancrop.com

Date Printed : 24/05/2013

Edaphos Ltd

Agronomy and Soil Fertility Consultants

Tissue Analysis Report

Date: 28th May2013
Sample:
Field: Cleeve Hill
Crop: Summer Barley 30/31

Customer: Earls Court Farms

Report - percent	Normal	Adjusted	Results	Deficiency ⟵ Balance ⟶ Excess
Total Nitrogen	2.80%	230%	6.43%	•••••••• (excess)
N: S ratio			18:1	

Report - percent	Normal	Adjusted	Results	Deficiency ⟵ Balance ⟶ Excess
Phosphorous	0.35%	0.81%	0.35%	•••••••• (deficiency)
Potassium	2.80%	6.44%	3.82%	•••• (deficiency)
Calcium	0.50%	1.15%	1.28%	
Magnesium	0.15%	0.35%	0.19%	••••• (deficiency)
Sulphur	0.20%	0.46%	0.36%	• (deficiency)
Sodium	0.00%	0.00%	0.00%	

Report - ppm	Normal	Adjusted	Results	Deficiency ⟵ Balance ⟶ Excess
Boron	6.00	13.80	6.40	••••••• (deficiency)
Manganese	30.00	69.00	77.70	
Copper	6.00	13.80	15.30	
Molybdenum	0.10	0.23	0.70	••••••••••••• (excess)
Iron	30.00	69.00	216.00	•••••••••••••• (excess)
Zinc	20.00	46.00	46.20	• (excess)

In Field	Results
Chlorophyl	
Sap pH	
Brix	
ergs mS/cm	

Plants can only grow to the extent of their most deficient element - we need to consider what is the biggest limiter to growth

The White House
Letcombe Regis
Oxfordshire.
OX12 9JL

01235 768668
07983 387302
edaphos@btconnect.com
www.edaphos.co.uk

Sometimes, results don't give you the answers

Sometimes, we have to start from scratch and change the system

Lancrop Laboratories

Analysis Results (LEAF)

Customer

Distributor EDAPHOS LTD - OXFORDSHIRE
THE WHITE HOUSE
LETCOMBE REGIS
WANTAGE
OXFORDSHIRE
OX12 9JL

Sample Ref JARGATES BOTTOM
Sample No E081721/04
Crop WHEAT

Date Received 06/06/2013

Analysis	Result	Guideline	Interpretation	Comments
Nitrogen (%)	1.53	3.00	Low	PRIORITY FOR TREATMENT.
Phosphorus (%)	0.15	0.30	Low	PRIORITY FOR TREATMENT.
Potassium (%)	2.00	3.50	Low	PRIORITY FOR TREATMENT.
Calcium (%)	0.24	0.40	Low	Low priority. See comments below.
Magnesium (%)	0.07	0.12	Low	PRIORITY FOR TREATMENT.
Manganese (ppm)	45.2	35.0	Normal	Adequate level.
Boron (ppm)	1.5	6.0	Very Low	Consider treatment with Boron.
Zinc (ppm)	11.5	25.0	Very Low	PRIORITY FOR TREATMENT.
Iron (ppm)	66	50	Normal	Adequate level.
Copper (ppm)	4.9	7.0	Low	PRIORITY FOR TREATMENT.
Molybdenum (ppm)	0.13	0.10	Normal	Adequate level.
Sulphur (%)	0.10	0.25	Very Low	PRIORITY FOR TREATMENT.

Additional Comments

Underlined nutrients should be treated as a priority. However where these are adequate, treatment of deficient low priority nutrients may bebeneficial. For any product applied, always refer to manufacturers advice for rates and timing of application. PLEASE NOTE : The guideline levels quoted should be regarded as the absolute minimum at which crop yield or quality may be affected. Treatment of deficient low priority nutrients may be beneficial if all sensitive nutrients are adequate.


Great Plains




DAMAGED SOILS CONTRIBUTE LESS

This soil is in a state of de-generation

- Lacks structure, OM and humus
- Poor root system – low surface area
- Leaching of applied fertilisers
- Poor uptake of trace elements
- Unbalanced growth susceptible to deficiencies, disease and lodging
- Increased costs
- High levels of anaerobic and pathogenic microbes
- Straw does not breakdown, anaerobic microbes create formaldehyde, alcohols, aldehydes - preservatives
- Loss of ammonia and sulphur to the atmosphere

LIVING SOILS GIVE MORE

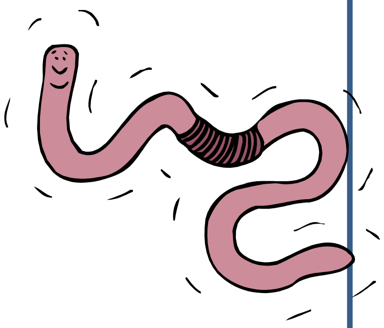
This soil is in a state of re-generation

- Good aggregate structure and humus
- Effective large root system -large surface area
- More efficient use of fertilisers – free ammonium nitrogen can be utilised from air!
- Balanced growth – higher resilience to stress and disease
- Healthy more productive plant
- Higher nutrient retention and cycling
- High levels of aerobic microbes and associated life – pathogens inhibited
- Straw is digested and nutrients recycled – end product humus promotes root growth and buffers nutrients.
- Retention of nutrients especially ammonia and sulphur


49 casts

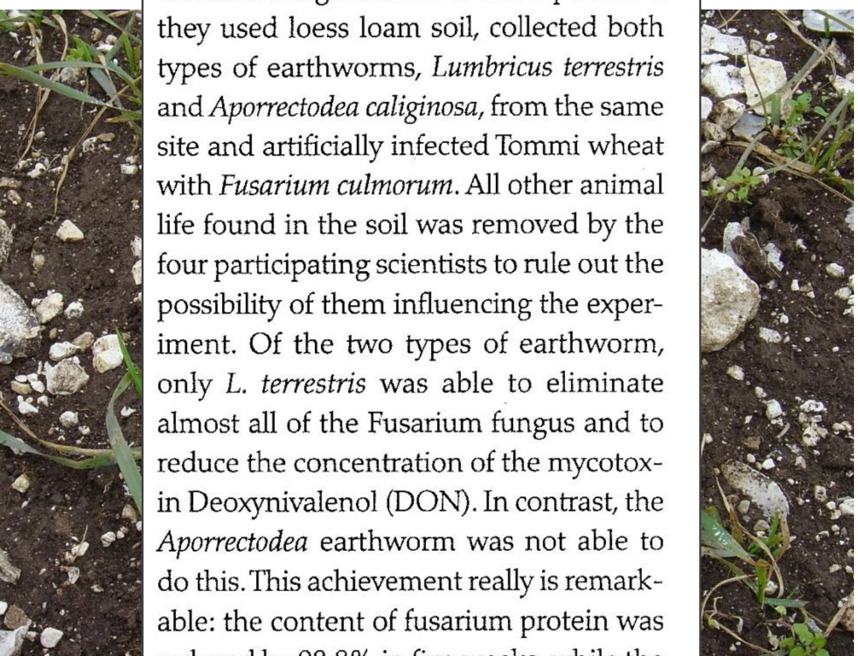
Worms can make a big contribution to nutrient availability

- **5 times** as rich in the available nitrate nitrogen
- **7 times** as rich in available phosphorous
- **11 times** as rich in exchangeable potassium
- **Twice** as rich in exchangeable magnesium
- **Increase** in structural stability
- **Increase** in Cation exchange capacity
- **Reduction** in bulk density



- **25 earthworms per cube foot = 1 million worms = 30 tonnes earth casts/year/acre**

Can we afford to ignore the contribution of natures unseen workers ?



EARTHWORMS RENDER FUSARIUM HARMLESS

Earthworms, those most helpful of creatures for good farming, are a true digestive miracle: They not only eat their way through plant remains or carrion, but are even able to render phytopathogenal and toxic fungi harmless. This finding was confirmed by a working group from the Johann Heinrich von Thünen Institute and from the Julius-Kühn Institute in Braunschweig, together with the plant protection department from the Hanover chamber of agriculture. In one experiment they used loess loam soil, collected both types of earthworms, *Lumbricus terrestris* and *Aporrectodea caliginosa*, from the same site and artificially infected Tommi wheat with *Fusarium culmorum*. All other animal life found in the soil was removed by the four participating scientists to rule out the possibility of them influencing the experiment. Of the two types of earthworm, only *L. terrestris* was able to eliminate almost all of the Fusarium fungus and to reduce the concentration of the mycotoxin Deoxynivalenol (DON). In contrast, the *Aporrectodea* earthworm was not able to do this. This achievement really is remarkable: the content of fusarium protein was reduced by 98.8% in five weeks, while the DON content was reduced by 99.7%. ■

How Earthworms Enhance Soil Quality

Shred and increase the surface area of organic matter, thus stimulating microbial decomposition and nutrient release

Improve soil stability, porosity, and moisture holding capacity by burrowing and aggregating soil

Turn soil over, prevent disease, and enhance decomposition by bringing deeper soil to the surface and burying organic matter

Inprove water infiltration by forming deep channels and improving soil aggregation

Improve root growth by creating channels lined with nutrients

A lar asses through the guts of earthworms. They can turn over the top six inches of soil in ten to twenty years

Is it possible to rejuvenate worn out pastures?



What are the options to capture carbon?

- Grass
- Crimped Maize
- Cover crops/spring cropping
- Mycorrhizal Fungi
- Compost – Limited by nutrients
- Manures – Limited by nutrients
- Sludge – Limited by nutrients

What are the benefits of planting a cover crop!

PRIMARY REASON IS TO IMPROVE SOIL FERTILITY

Process of aerobic microbes cycling carbon creates soil

Suppressing weeds

Protecting soil from rain or runoff, reducing erosion

Improving soil aggregate stability

Increasing Soil organic matter

Reducing surface crusting

Adding active organic matter to soil

Breaking hardpan

Fixing nitrogen

Suppressing soil diseases and pests

Offers a host of environmental benefits above and below ground to the farm

Suppressing soil diseases and pests

Increasing the availability of nutrients

Offers a host of environmental benefits above and below ground to the farm

Scavenging soil nitrogen

Scavenging soil nitrogen

Increasing the availability of nutrients

How much is a good cover crop worth?

With a good legume cover crop we would expect to mulch back an estimated 6,000kg per hectare of organic material, we would also expect that material to have a protein level of around 18%. This means we have around 3% actual nitrogen giving us 180kg nitrogen purely within the top growth of the legume; this does not take into account the contribution from the nodules and root systems. We would estimate that around 50% of the total N in the legume will be available for the following crop. A legume producing 6 tonnes per hectare of organic material would also have around 1.5 - 2% potassium which would be a contribution of 90-120kg per hectare, 30kg phosphate, 100kg calcium and 100kg magnesium all in available forms. This is true cycling of minerals which have contributed in the capture of carbon to then return a very powerful mix of nutrients back to the soil just right for the next crop and microbes to utilise.

We believe this to be true biological farming, balancing output of mineralisation with inputs for humification, essentially manage the soil to manage the plant; we cannot bypass this system without severe consequences.

Plant Microbe Communication - PGPR (Plant Growth Promoting Rhizobacteria

Microbes release MVOCs that the plant roots take up as phytohormones

Exudates

Phytohormones

Plant releases VOCs - volatile organic compounds as extremely complex root exudates

PLANT GROWTH PROMOTION

BIOTOLERANCE
- Tolerance to salinity, drought and cold

BIOCONTROL
- Bioactive compounds
- Competence
- Parasitism

BIOFERTILISERS
- Nutrient solubilisation
- Nutrient transport
- Enhanced root absorptive capacity

BIOPROTECTION
Activation of innate immunity
- Induced systemic response
- Acquired systemic resistance
- Priming

IMPROVED PRODUCT QUALITY

Mycorrhizae for Increased Nutrient Use Efficiency, Reduced Nitrogen & Phosphorus Leaching

The study reported here has tremendous implications for Best Management Practices for the more efficient use of fertilizers and the significant reduction of water pollution in growing operations. The results support those found in another recent study where mycorrhizal inoculation significantly increased corn biomass while reducing runoff and fertilizer concentration in leachates.

by Lea Corkidi, Donald J. Merhaut, Edith B. Allen, James Downer, Jeff Bohn, and Mike Evens

SIGNIFICANT RESULTS

• Mycorrhizal-inoculated plants grown with half and full rates of fertilizer were significantly larger than nonmycorrhizal plants.

• Shoots from mycorrhizal-inoculated plants averaged 30% higher nitrogen content and a whopping 300% higher phosphorus content than shoots of nonmycorrhizal plants.

• Perhaps most importantly, the authors document a significant reduction in the nitrates, ammonium and phosphates found in leachates for the full rate of fertilization. Ammonium and phosphate losses were reduced 30% with mycorrhizal inoculation.

Mitigation of nitrogen (N) and phosphorus (P) runoff has become a major goal of the nursery industry. Woody and herbaceous ornamental plant production is a significant source of surface water and ground-water nonpoint source pollution.

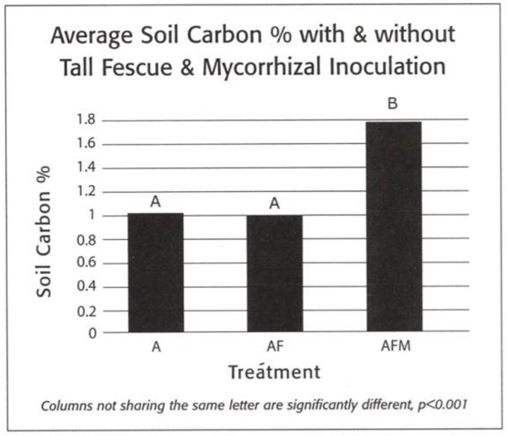
Plant production is very intensive process: one acre of land can be occupied by numerous containers, and nursery cultural practices, such as the use of soilless mixes and frequent irrigation, are highly conductive to nutrient leaching.

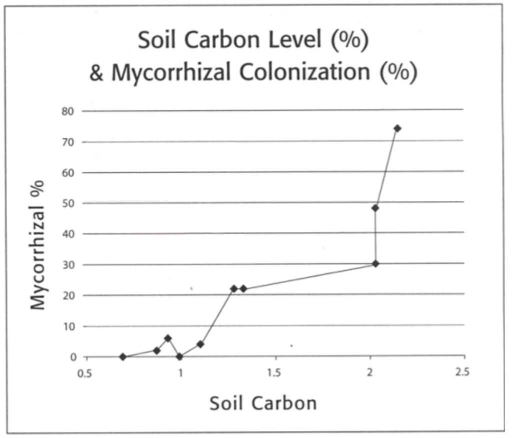
A number of Best Management Practices (BMP) have been proposed to maximize production and minimize groundwater contamination from runoff and leaching losses. These practices vary with particular nursery conditions, but most encompass proper irrigation and fertilizer programs to optimize nutrient use efficiency.

Inoculation with arbuscular mycorrhizal (AM) fungi can also be included as an important component of nurseries' cultural programs to reduce nutrient runoff while maintaining plant quality and yield. AM fungi are a group of microorganisms specialized to colonize

Building soil organic matter biologically

Study to examine tall fescue grown with and without mycorrizal inoculation and to determine the level of carbon and glomalin in the soil at the end of one year.





Study findings

AM fungi nearly doubled soil carbon percentage in just one year, while no increase was seen with tall fescue that was not inoculated.
Glomalin production was a likely contributing factor to the increase in soil carbon, as glomalin concentrations increased with increased mycorrhizal colonisation. The strongest effects were seen between 0 and 30% colonisation; colonisation rates higher than 30% produced only small additional increases in both soil carbon and glomalin.
This study indicates that soils and perennial grasses are a potential powerful sink for accumulating carbon in soil organic matter when mycorrhizal fungi are present.

Trials finalised 11th July 2008
Mike Amaranthus, Jeff Anderson, Zack Amaranthus and Dave Perry
Lab Oregan State University

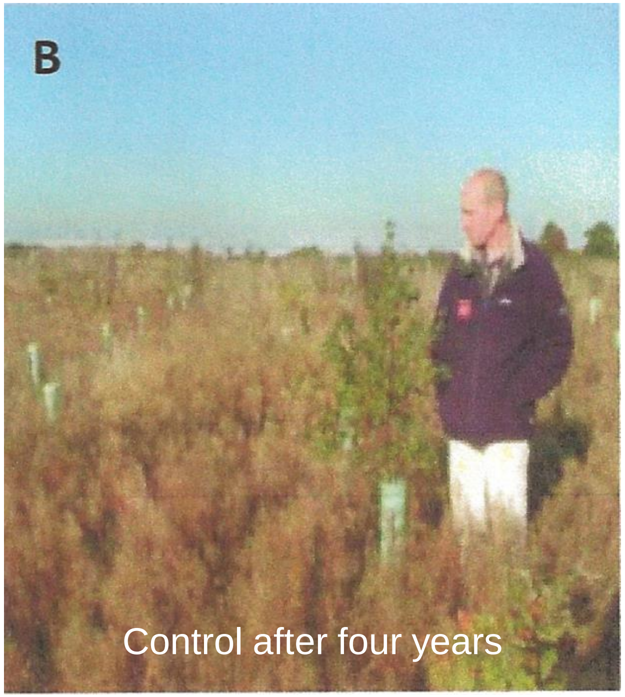
Crimson King Maple Trial

Bio-roote – Mycorrhizal inoculant

The Plants on the left of each picture have been grown in a compost/re-mineralising rock product with Bio-roote

The plants on the right of each picture have been grown in the ‘industry standard’ of compost and CRF (controlled release fertiliser)

The White Horse Project – Kent County Council



The planting area consisted of 25,000 mixed native trees, of these 24,000 were treated with UK origin mycorrhizal fungi and 1,000 were left untreated to act as a control

Mortality and growth differences in both groups was recorded after four years and again at seven years.

Four years after planting mortality in the treated groups was below 2%. Untreated trees showed mortality above 20%

Bangor University - Samples were taken from the roots of Mycorhrizgl treated grass plants to establish colonization rates:

Measurements is % of root hairs colonized with AMF Control		**Bio-Roote**	**% increase**
Grass roots	6.52	29	**+ 344%**

The figures for colonization percentages show that there is some natural occurring AMF in the soil but not enough to make a difference. This difference is in the plants vigour and also in its nutritional content.

Forage analyses of the grass has highlighted Increases in Nutritional values. Table 1

%	Control	Bio-Roote	Increase %
Phosphate	0.36	0.47	**30.56**
Magnesium	0.17	0.28	**64.71**
Calcium	0.61	0.89	**45.90**
Sodium	0.3	0.58	**93.33**
Potassium	3.58	4.09	**14.25**
Chloride	2.23	1.5	**32.74 less**
Mg/Kg			
Manganese	133.5	207.9	**55.73**
Copper	7.6	14.2	**86.84**
Zinc	29.8	39.1	**31.21**
Colbalt	0.39	0.73	**87.18**
Iodine	0.94	1.42	**51.1**

5th Feb 2010
Average 68% increase in DM over the control

11th March 2010
Average 68% increase in DM over the control

12th April 2010
Average 24% increase in DM over the control

Magnesium: an increase of **64%** over control
Potash: an increase of **14%** over control
Copper: an increase of **86%** over control
Iodine: an increase of **51%** over control
Cobalt: an increase of **87%** over control

All from a soil that is deficient in these elements. This shows how the interaction of the AFM and the plant helps to overcome the plants deficiencies.

Bio-roote treated grass

Organic grass ley drilled five weeks ago in Newbury, Berkshire. Picture taken 10th October 09 - Bio-roote applied at 1 kg per hectare

Exceptional root and top growth. The rhizosphere (biological activity feeding off root exudates) is highly active showing soil particles clumped to the root system allowing for highly efficient nutrient exchange. Active new growth can be seen as white tips on the end of the roots.

Treated

Untreated

Date: 14th June	Control	Treated	Difference
Brix - %	11	16	31.25%
Chlorophyll	47.91	50.03	4.23%
Average yield	6.4 tonnes/ha	6.90 Tonnes/ha	8.2%
Nitrate - ppm	340	390	12.8%
Top growth – 20 stems/ears - grams	176	238	26.1%
Harvest TGW	34	46	35%

	Control	Treated	Difference
Nitrogen	4.79	6.24	30%
Sulphur	0.29	0.33	13%
Phosphorous	0.39	0.42	7.6%
Potassium	4.01	3.62	-10.7%
Calcium	0.37	0.48	29%
Magnesium	0.14	0.15	7%
Iron - ppm	120	150	25%
Manganese - ppm	26	30	15%
Boron	5.3	6.6	24%
Copper	7.7	6.4	-20%
Zinc	23	23	Same

Mineral Values in food have dropped drastically in the last sixty years!

1940: Two food scientists, McCance and Widdowson, were asked by the Medical Research Council to analyze the mineral content of UK grown fruits and vegetables.

1991: 51 years later they are asked to repeat their tests by the Ministry of Agriculture, Fisheries and Foods.

1999: Top nutritionist, David Thomas compares their figures. Over the 51 year period he finds vegetables have lost **46% of their calcium, 24% of their magnesium, 27% of their iron and 76% of their copper**

“If these figures are correct, why are mineral levels becoming depleted?”

“Intensive farming methods have reduced the absorption of these and many other minerals like selenium and zinc into our fruits, vegetables and grains. Mass produced fertilisers generally only contain three minerals, but there are more than 84 known minerals and trace elements, **21 of which are vital for good health.** If they’re not in the soil they are not going to make in into our food“ say’s Thomas.

Of the 67 minerals needed for perfect health, farmers replace just 3, nitrogen, potassium and phosphorous because without them nothing would grow!

Quote: Article from the Sunday Times

Organism Biomass Data		Dry Weight	Active Bacterial (µg/g)	Total Bacterial (µg/g)	Active Fungal (µg/g)	Total Fungal (µg/g)	Hyphal Diameter (µm)
Results		0.770	45.1	101	**0**	**57.0**	3
Comments		In Good Range	Excellent	Good	Low	Low	
Expected Range	Low	0.45	15	100	15	100	
	High	0.85	25	300	25	300	

		Protozoa Numbers/g			Total Nematodes #/g	Percent Mycorrhizal Colonization	
		Flagellates	Amoebae	Ciliates		ENDO	ECTO
Results		**1794**	**0**	**41**	**2.00**	**0%**	**0%**
Comments		Low	Low	Low	Low	Low	Low
Expected Range	Low	10000	10000	50	20	40%	40%
	High			100	30	80%	80%

Organism Biomass Ratios		Total Fungal to Total Bacterial	Active to Total Fungal	Active to Total Bacterial	Active Fungal to Active Bacterial	Plant Available N Supply (lbs/acre)
Results		**0.56**	**0**	0.45	**0**	<25
Comments		Low	Low	Good	Low	
Expected Range	Low	0.8	0.25	0.25	0.75	
	High	1.5	0.95	0.95	1.5	

Dry Weight: Check plant requirements, but moisture appears to be fine

Photographs taken on 13th June 2013

13th of June 2013 of samples taken from the 2nd fairway of the Centenary Course, the venue of the 2014 Ryder Cup. Due to the cold late spring the first biological products were applied the week prior to the pictures being taken.

Photographs taken on 23rd October 2013 of sample taken from the sample area on the fairway.

5 applications of Gaia Complex Tea (Bactolife DP 104), plus 4 applications of Gaia Fungal Digester along with the necessary food source A reduction in the depth of thatch of 25% and as impressive the friability had improved out of all recognition.

Before treatment 15cm thatch
250kg Nitrogen applied

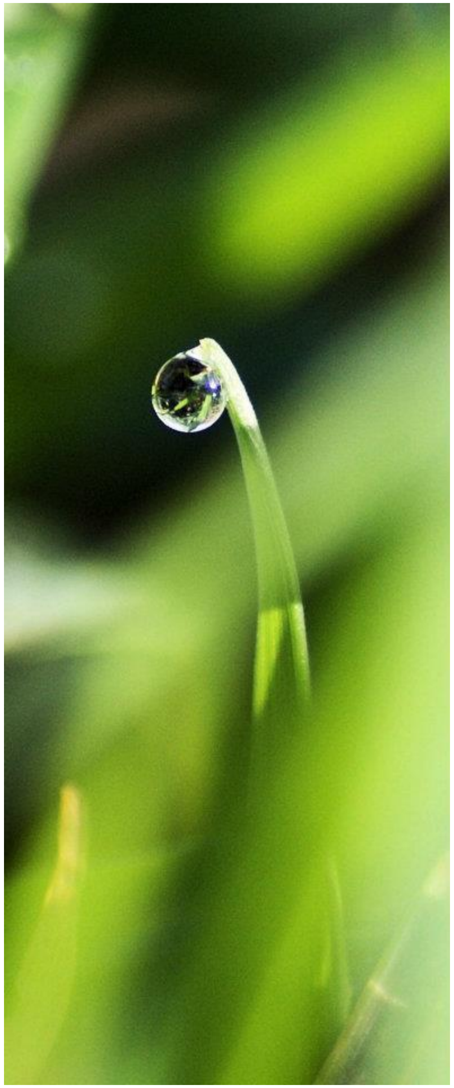
After treatment 8 cm thatch
18kg Nitrogen applied

Big issues to consider – are our modern farming systems actually sustainable?

Biologically driven

Chemically driven

Carbon is the natural driver of biological systems NOT nitrogen



Edaphos

Biological Solutions for Agriculture

Michael Harrington.
MBPR. FACTS BETA. M.rad

Office: +44 (0) 1235 768668
Mobile: +44 (0) 7983 387302

Email: edaphos@btconnect.com
Webpage: www.edaphos.co.uk

The White House,
Letcombe Regis,
Wantage,
Oxfordshire,
England
OX12 9JL