Sustainable Soil Management

Solutions for Eco-nomically Sustainable Farming

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Ending the weeds winning streak

The Impact of a Chemically dependant system

- **The problem with weeds**
- **Chemical and cultural control options**
- **Crop competition**
- **Germination / Dormancy**
- **The importance of soil structure**
- **Impact of chemicals**

Blackgrass 2-20 heads per plant

- **100 seeds per head**
- 500 heads/m2 can easily get to 50000 seeds / m2
- **12 plants /m2 can cause a 5% yield loss in winter wheat.**

"Control of Blackgrass populations of 1 plant/m2 may be justified in high risk situations."

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Blackgrass control measures

Herbicide resistance: HGCA

- Multiple-herbicide resistance now occurs virtually on all farms.
- No new herbicides are likely to become available.
- Some existing herbicides may withdrawn for regulatory reasons

http://www.hgca.com/crop-management/weed-management/black-grass.aspx

Prevent seed return

CTM weed surfer or

Is this acceptable?

GS59 glyphosate

Cultural control

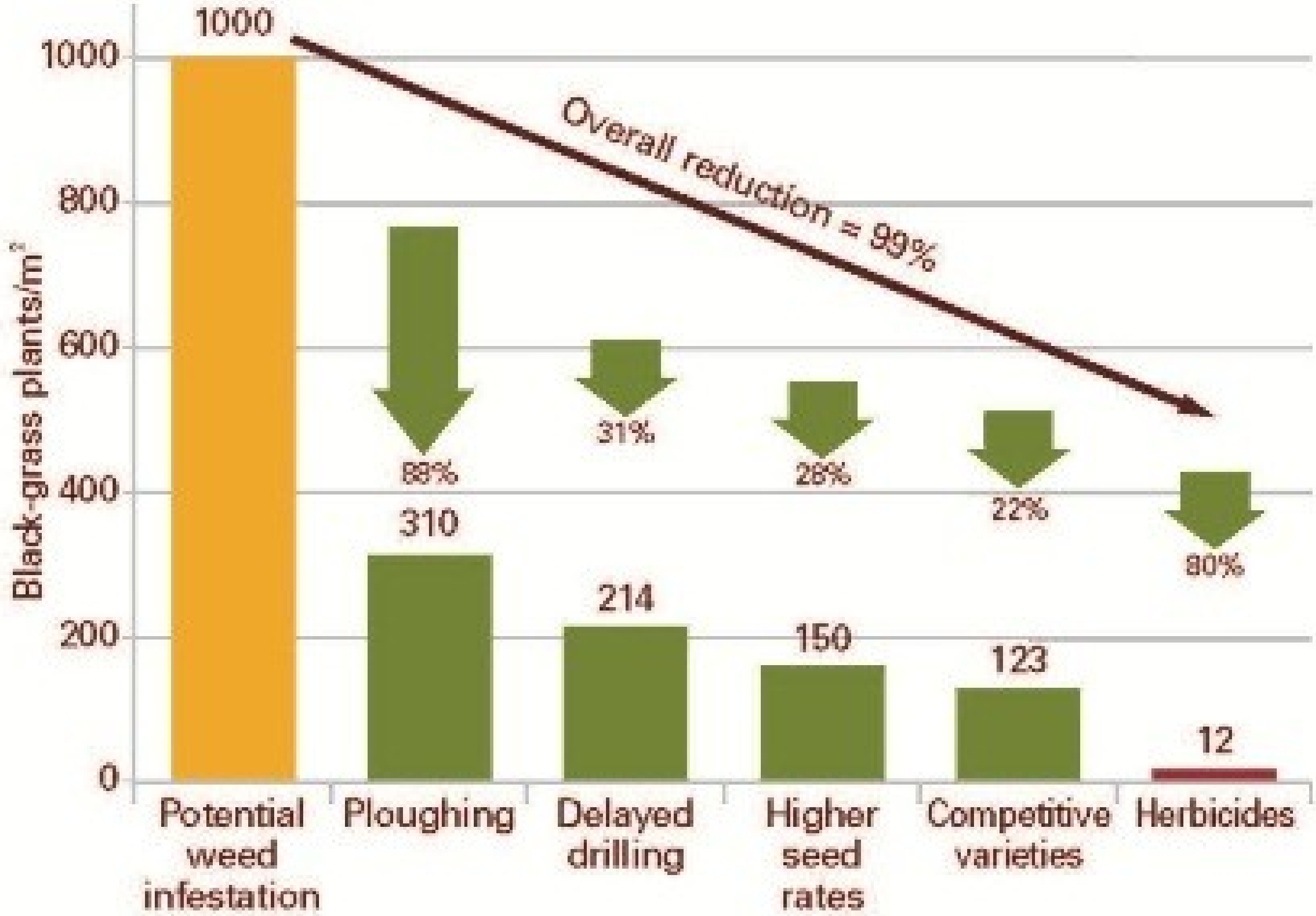
Ploughing
= 69%

Delayed autumn drilling by 3 weeks = 31%

Higher seed rates
= 26%

Competitive cultivars
= 22%

pring cropping
= 88%



HGhttp://www.hgca.com/crop-management/weed-management/black-grass.aspxCA

Chemical stacking practised now at full rates

500 seeds/m2 at 99 % control

will still leave 5 seeds/m2

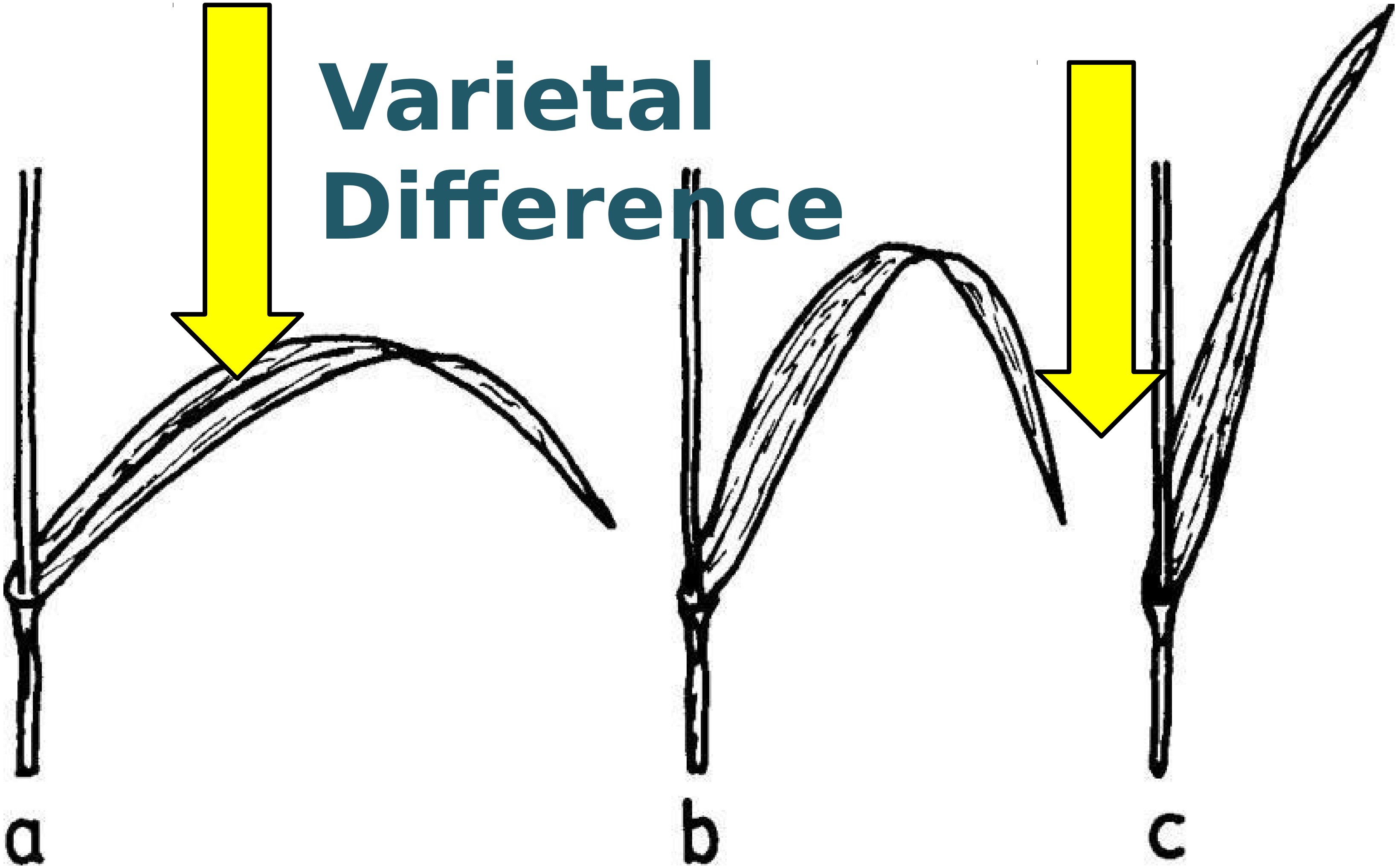
Each seed can produce 20 heads with 100 seeds / head.

The problem goes on!

Crop Competition

Depth of drilling Effects the emergence and therefore the speed to create competition on weeds.

Varietal Difference



Planophile

ectophile

Control Techniques

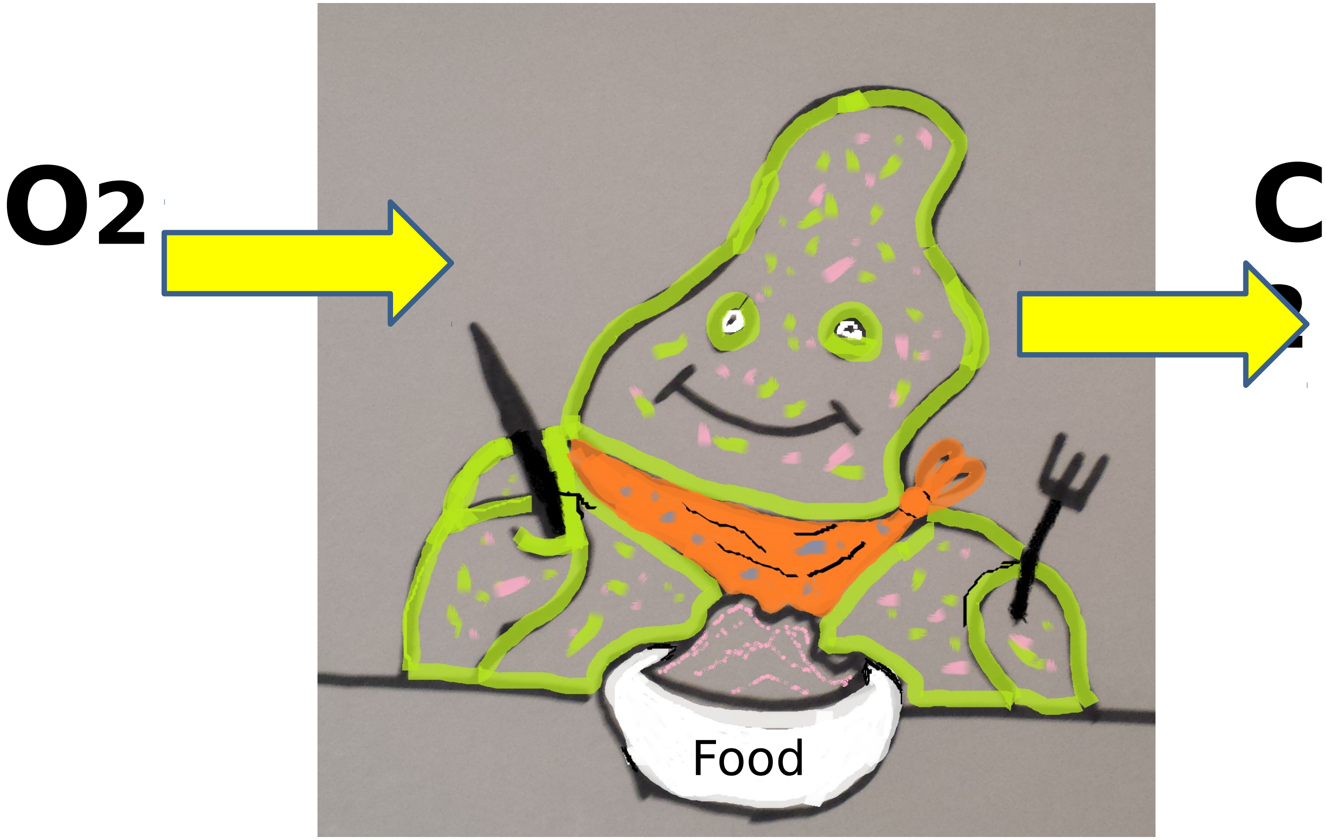
crease Blackgrass Germination?

or

ncrease Blackgrass Dormancy?

- Blackgrass dormancy is linked to temperatures in late June and early July
- Hot weather giving seed of very low dormancy and high germination
- while cool temperatures give seed of high dormancy and low ge

Add air to soils

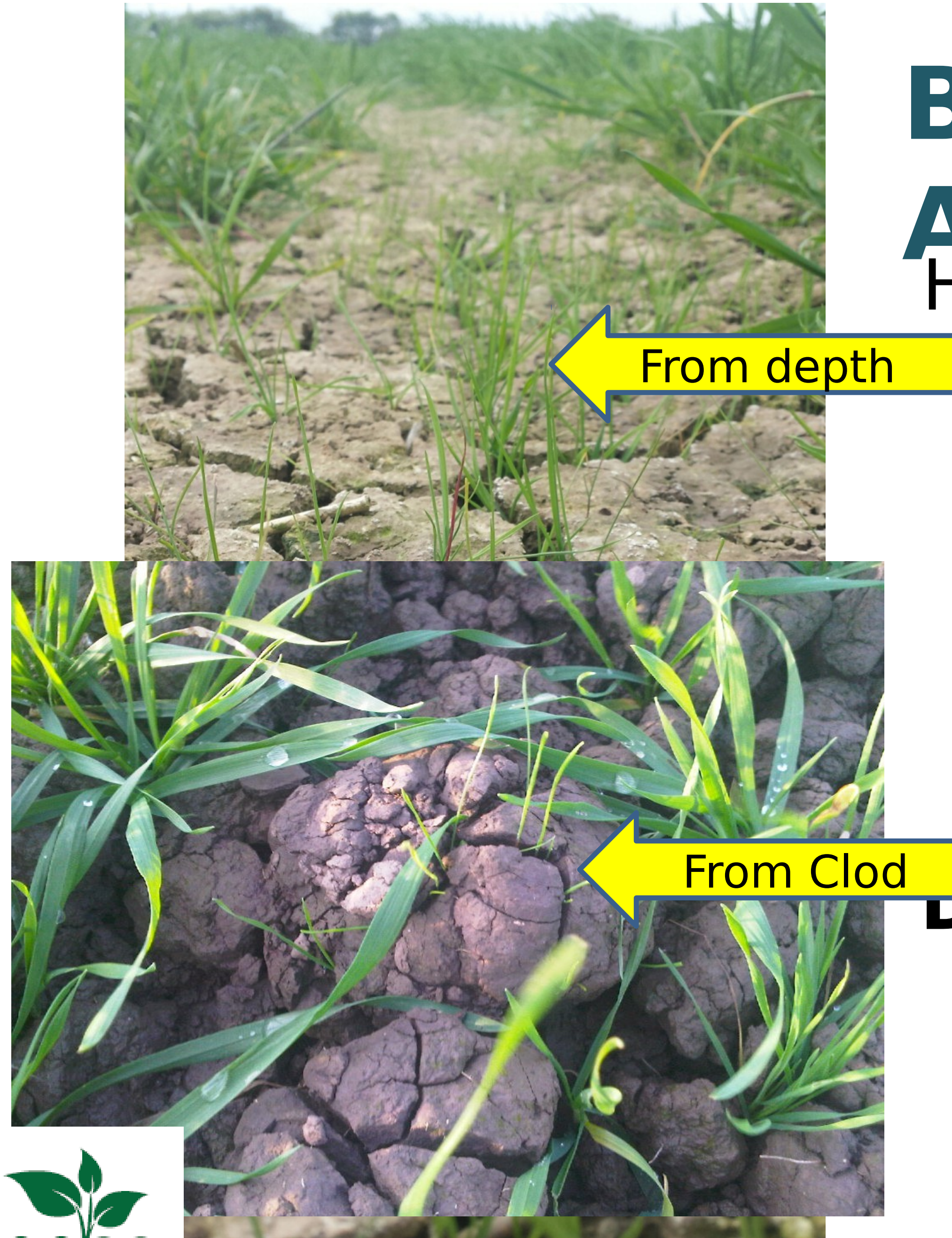


CO_2 increases germination of seeds

(Baskin & Baskin 1998)

Closed Vent Open

Blackgrass - April



Heavy shrinking Clay soil

High Magnesium / Calcium

Wet / Cold

Dormant seedlings low Co2

Resistance or Just poor soil Management?

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Blackgrass a marsh weed Anaerobic soils promotes dormancy.

Increase Co2

Increase levels in the soil atmosphere by 2-5% might

Promote seed germination.

Breaks Dormancy

(baskin & Baskin 1998)

Reduced CO2

Increases dormancy of seeds.

Min till = 5 times less co2 released due to less cultivations.

Wet cold anaerobic soils increase dormancy of Blackgrass (a marsh weed)

74% / Year Reduction in longevity of seeds in the soil.

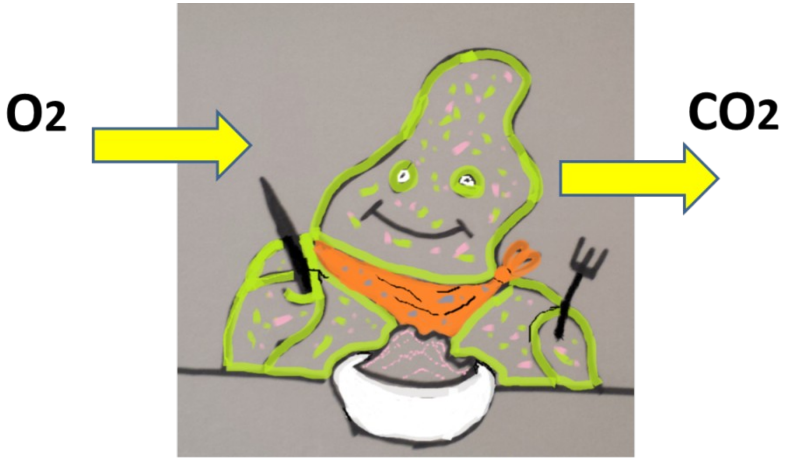
- Buried seeds > 3 inches Survival 20-30% per year

- Therefore after 3 years 1-3% will still be viable.

Maybe Fallow is the answer?

ry time you move soil you get a CO2 Rele

"Direct drilling releases 2.85t/ha **less** **CO_2 / year than conventional tillage"**



"Non plough based systems release 5 times less CO2 in the 19 days after establishment."

Dr Jordan. Chief executive of the soil management initiative

Canada are receiving carbon credits for such practises.

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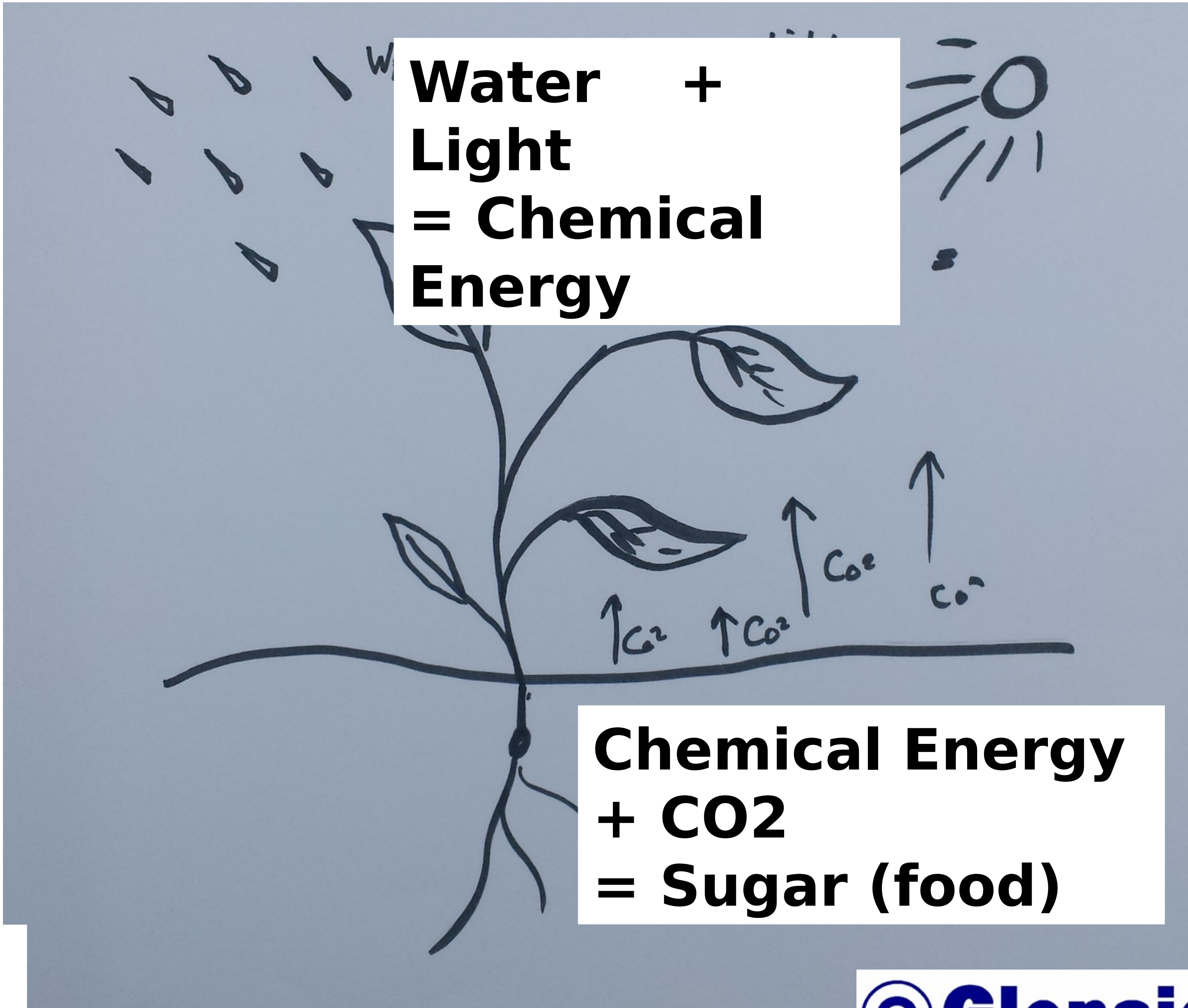
Water + Light
= Chemical Energy



Chemical Energy
+ CO2
= Sugar (food)

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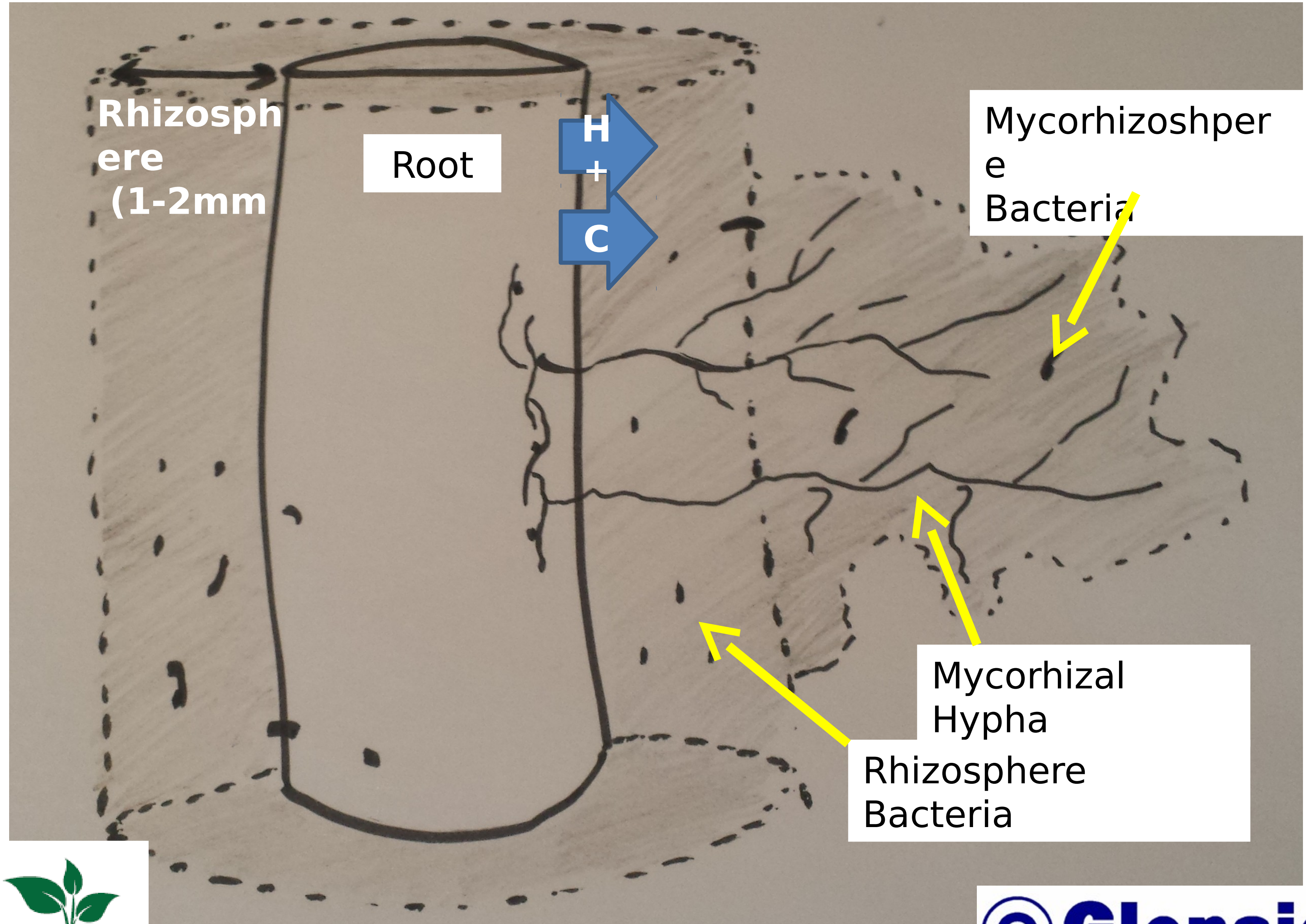
Feed the Rhizosphere



Dr. Albrecht's simple answer:

- Use the correct Chemistry
- **Build as closely as possible the correct physical structure.**
- which in turn supplies the proper environment for the biology (roots, worms, microbes, etc.).

Chemistry

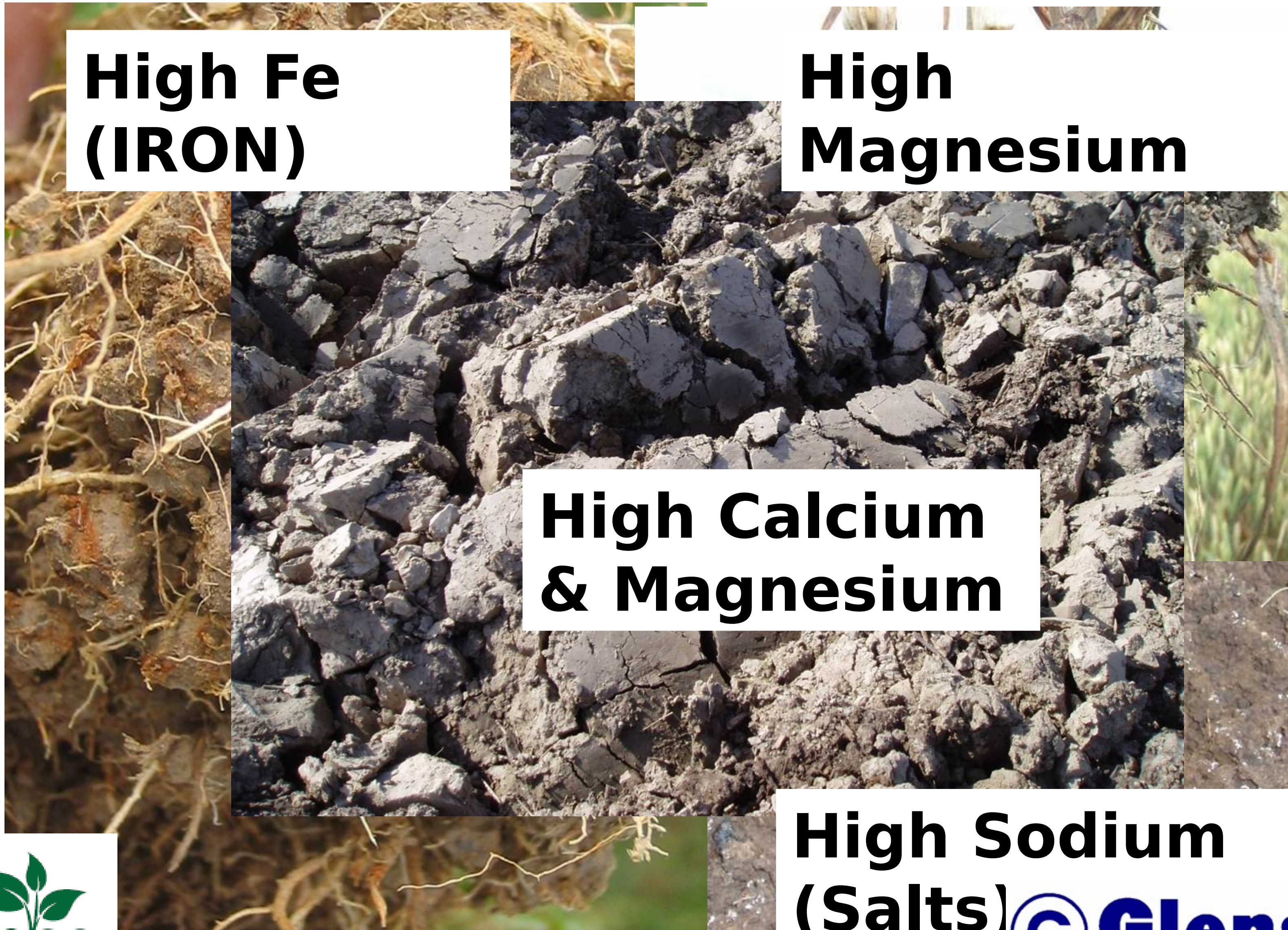
↓

Physical

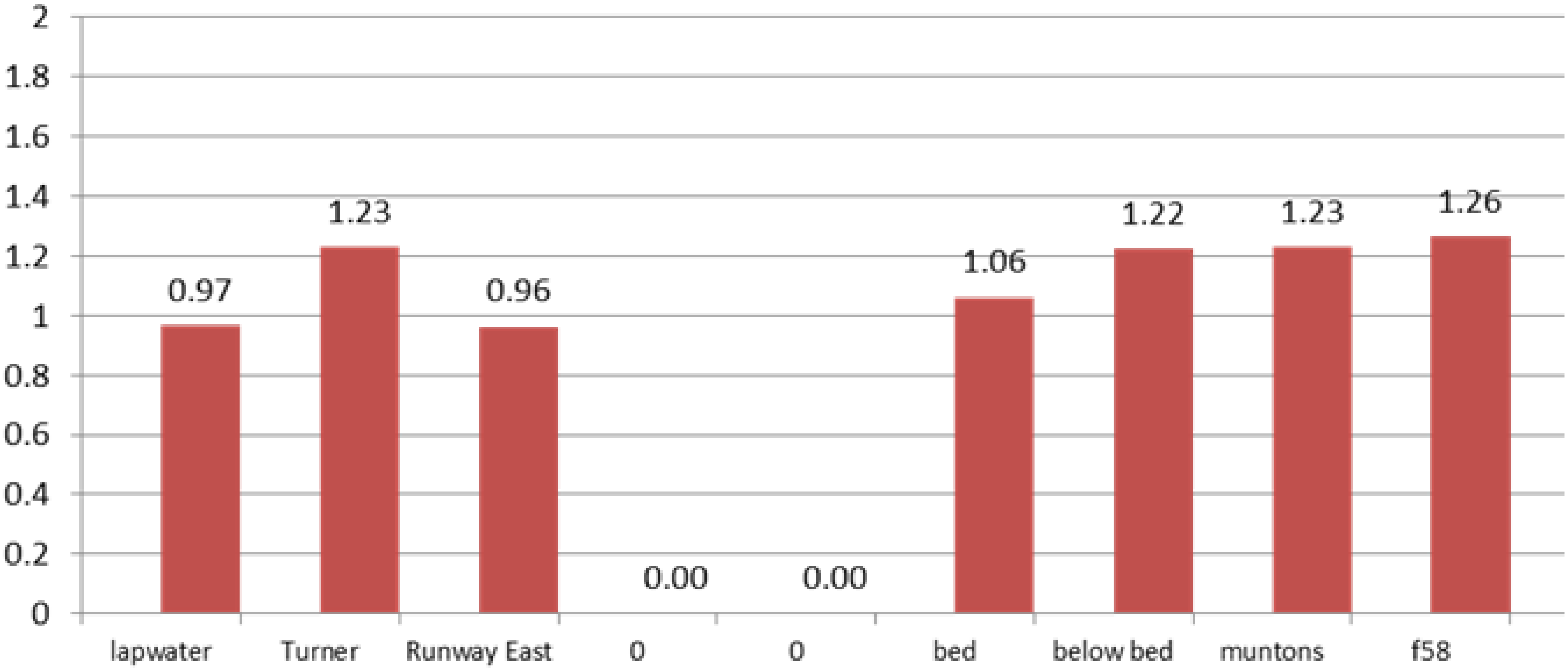
↓

Biology

Soil Chemical Restrictions



Bulk density of the soil
Over 1.4 is restrictive to

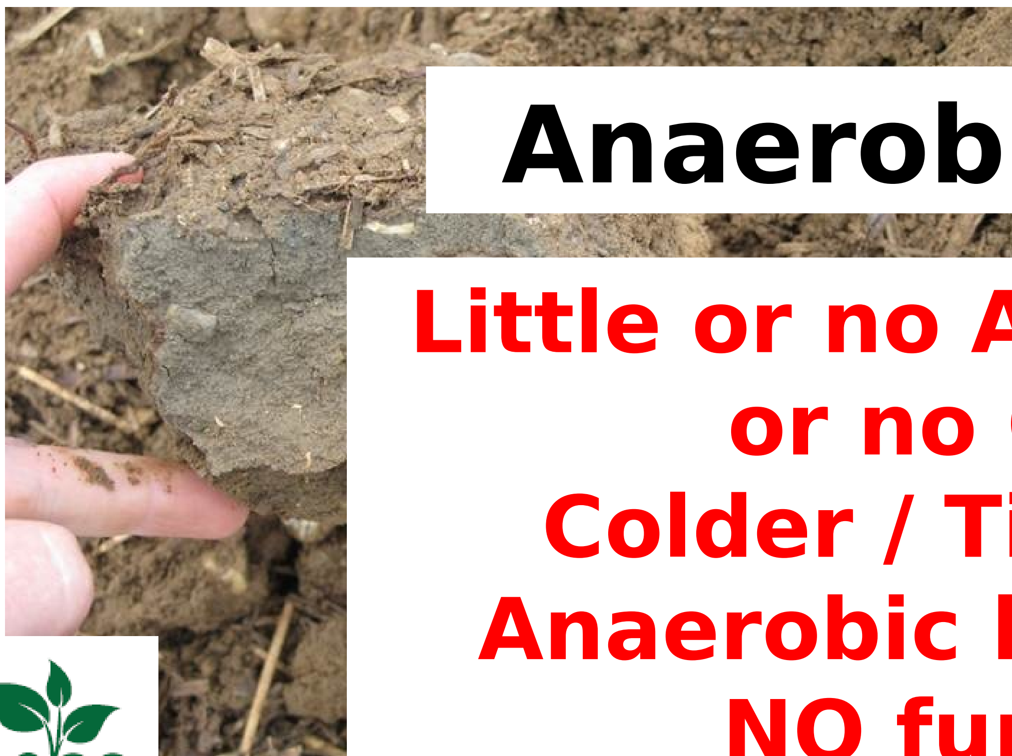


"Bd of 1.5 – 1.6 restricts worm activity and rooting"

Air - O2 – Warmer – Looser
Aerobic bacteria – Fungi

Ideal for seed germination

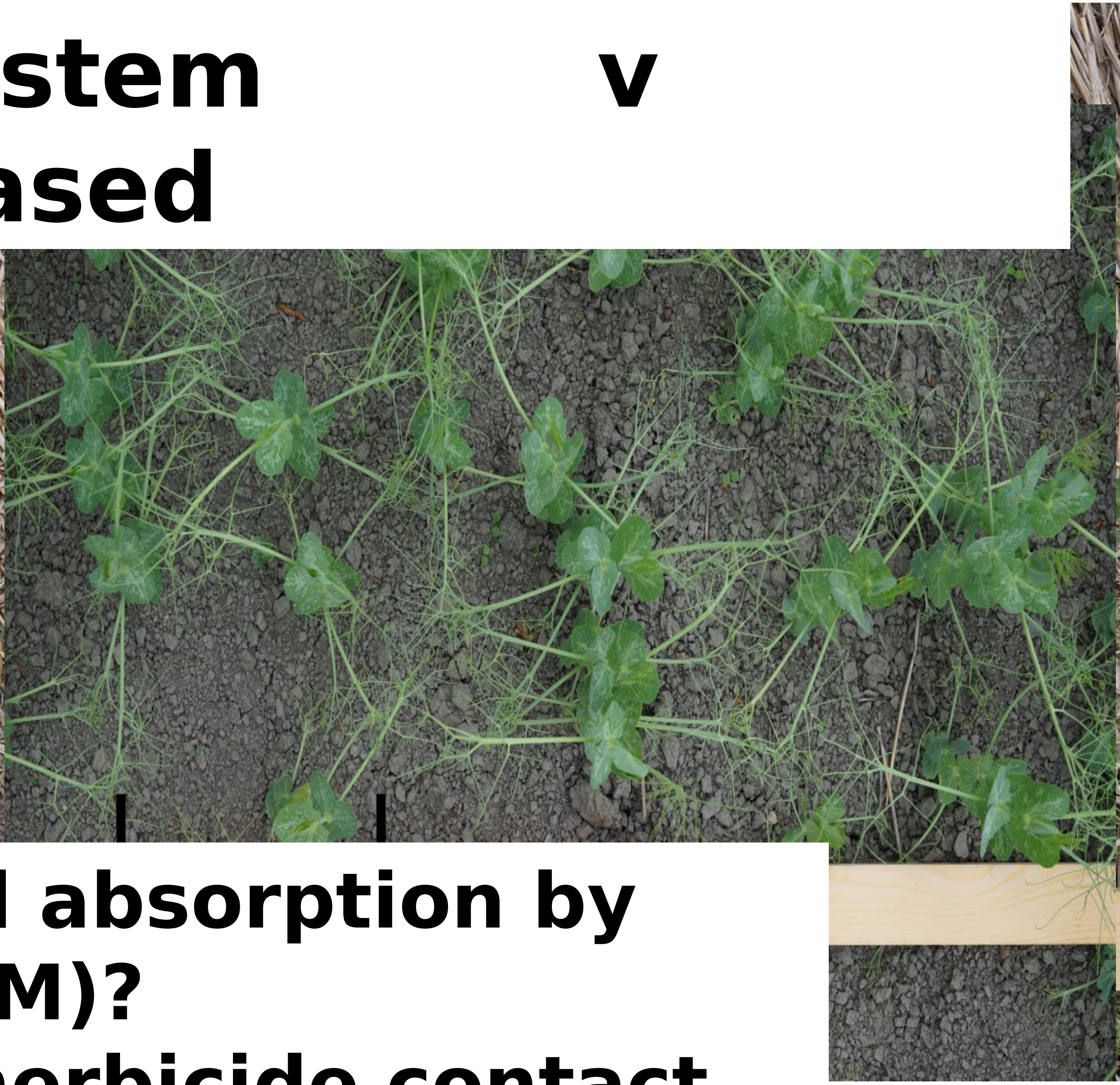
Aerobic soil



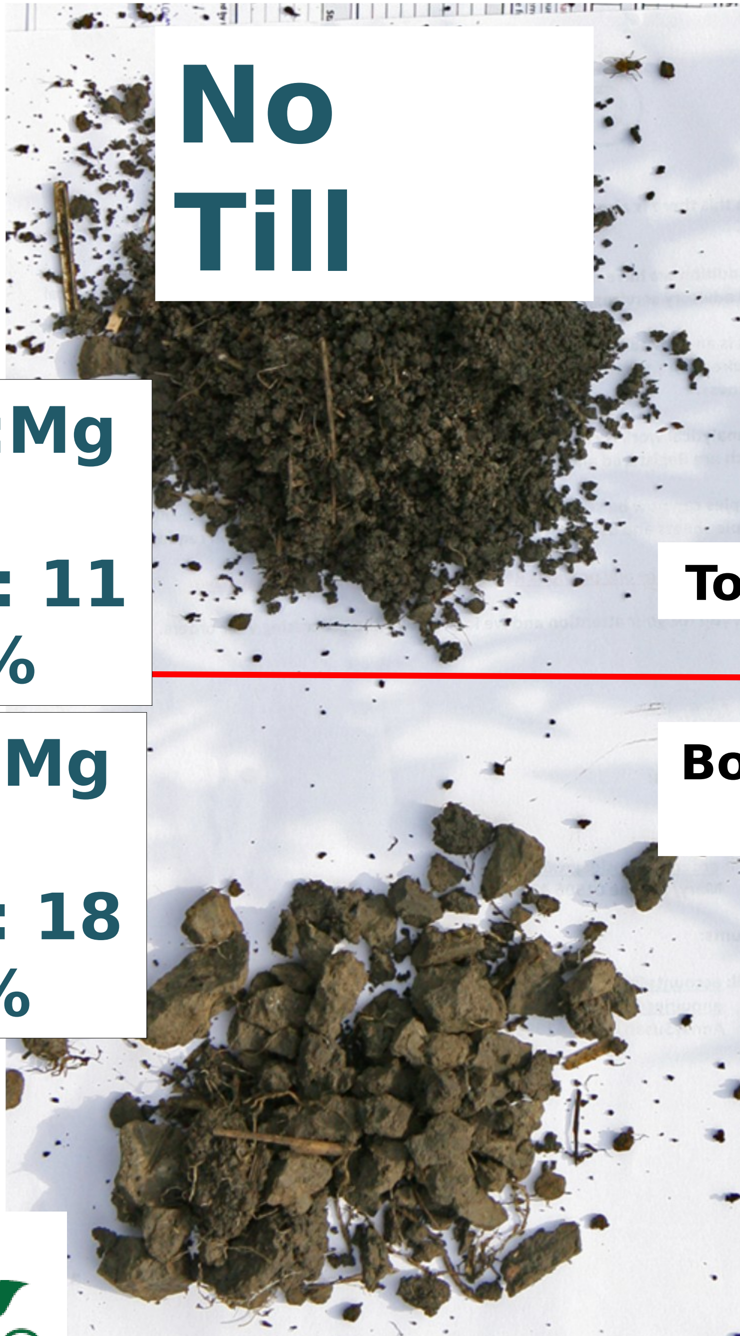
Anaerobic Soil

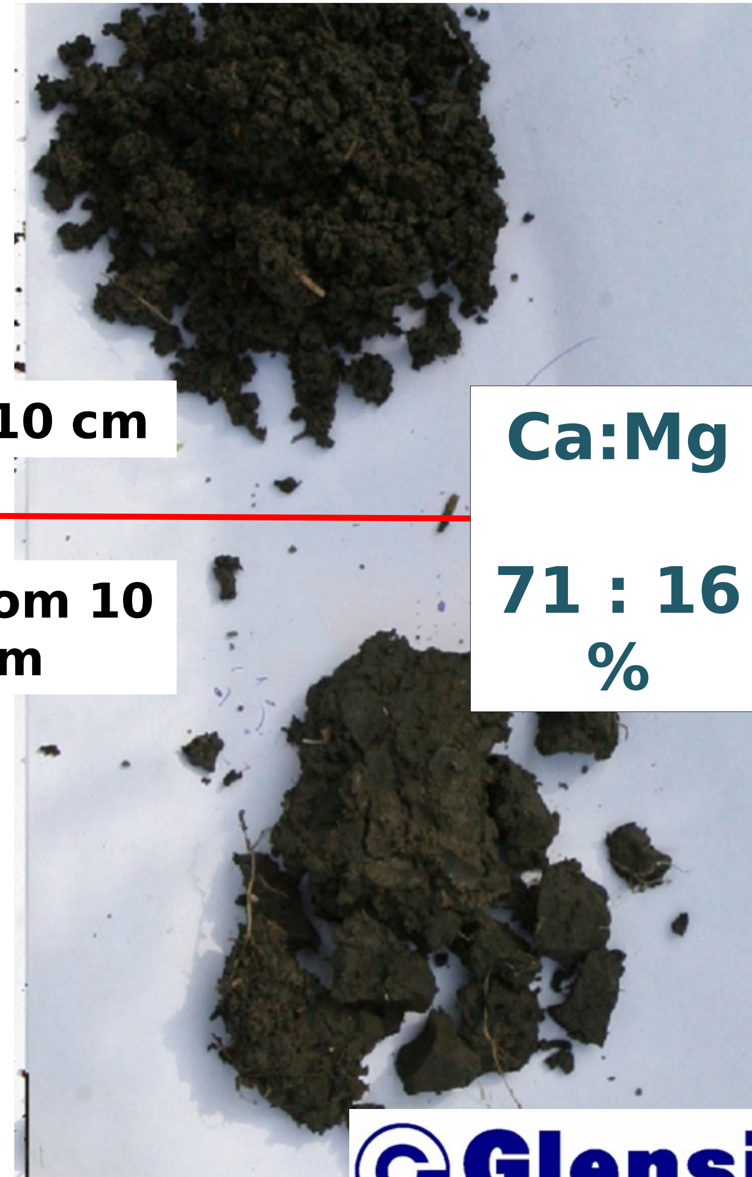
Little or no Air - Little or no O2
Colder / Tighter
Anaerobic bacteria
NO fungi

No Till System v plough based



Chemical absorption by straw (OM)?
Lack of herbicide contact with soil?


No Till
Ca:Mg
79 : 11 %
Ca:Mg
62 : 18 %
Top 10 cm
Bottom 10 cm


Plough based
Ca:Mg
71 : 16 %

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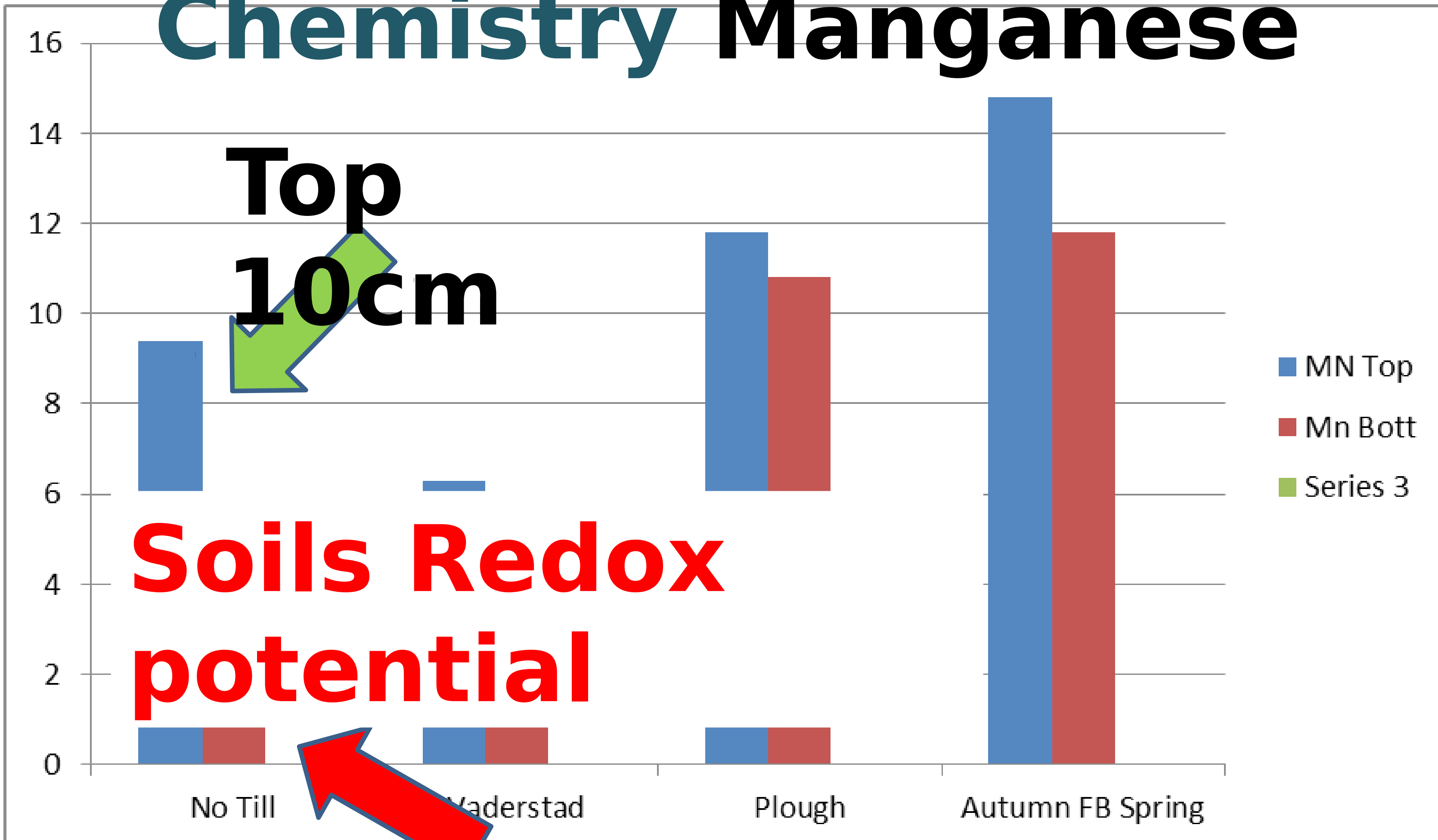
Nutrient availability v Soil Chemistry **Manganese**



Top 10cm

Soils Redox potential

Bottom

Maintain root hairs

Root Hairs access

Maintain Soil Structure Calcium : Magnesium ratios %

Soil Structure

65-75% Calcium

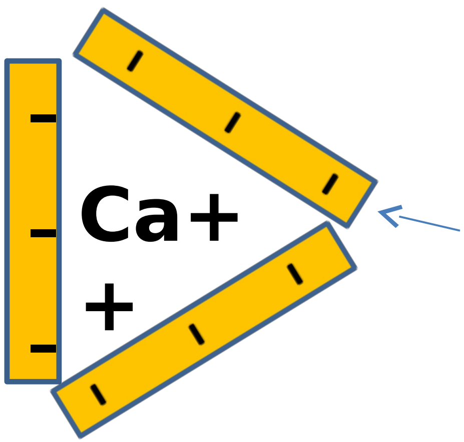
Looser

High Calcium soil.
- More oxygen
- Drains freely
- Aerobic breakdown of OM.

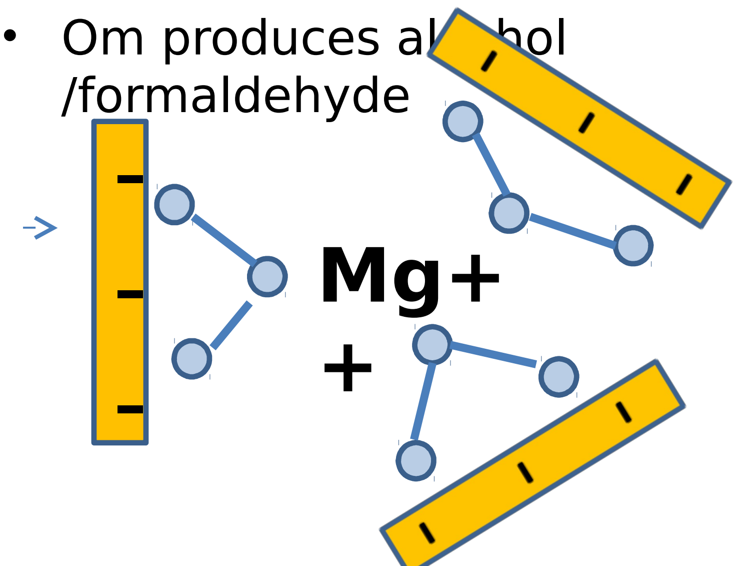
10-15% Magnesium

Tighter

High Magnesium soil.
- Less Oxygen
- Drains slowly
- Poor OM decomposition if at all.
- Om produces al[illegible]hol /formaldehyde



Clay Particles



Too High Calcium soil.
- Loose granulation and structure
  Interfere with available nutrients
  Aerobic breakdown of OM.

Soil Structure

65-75% Calcium

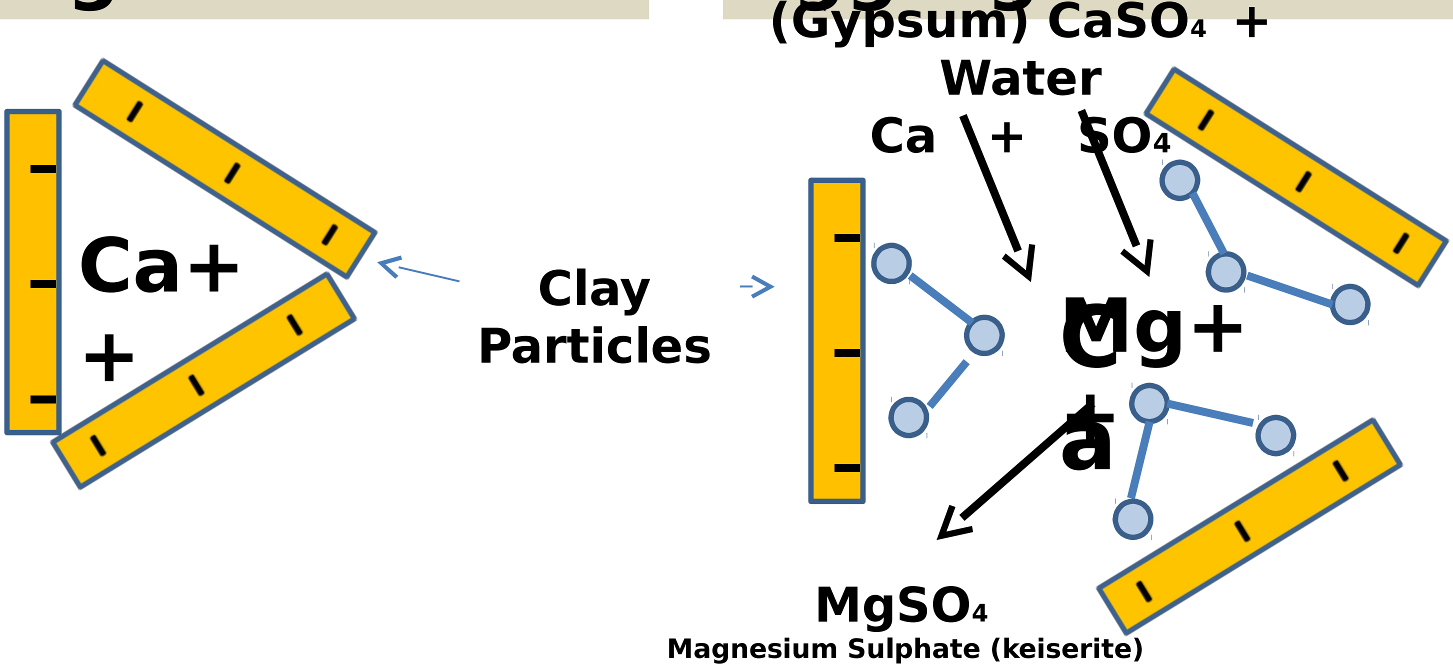
Looser

10-15% Magnesium

Tighter

Flocculated / Aggregation

Dispersed aggregates



Comprehensive soil analysis?

pH				
Phosphorus (ppm)	64	16	Very High	**(Index 4.7)** Possible interference with availability from the soil of Fe,Cu,Zn.
Potassium (ppm)	230	121	Normal	**(Index 2.9)** 300 kg/ha K2O (240 units/acre).
Magnesium (ppm)	91	51	Normal	**(Index 2.8)** 40 kg/ha MgO (32 units/acre).
Sulphur (ppm)	5	10	Low	CONSIDER TREATMENT.
Calcium (ppm)	1750	2000	Slightly Low	CONSIDER TREATMENT.

Laboratory Sample Reference	Field Details			Index			mg/l (Available)		
	No.	Name or O.S. Reference with Cropping Details	**Soil pH**	**P**	**K**	**Mg**	**P**	**K**	**Mg**
42938/14	1	**SAMPLE 2** *6 acres* *Grass Reseed into Grazing*	**7.8**	**3**	**2+**	**2**	**32.2**	**235**	**52**
42939/14	2	**SAMPLE 3** *11 acres* *Spring Oats into Grazing*	**7.3**	**5**	**3**	**3**	**77.4**	**286**	**137**

No Calcium

No Sodium

Very basic limited information

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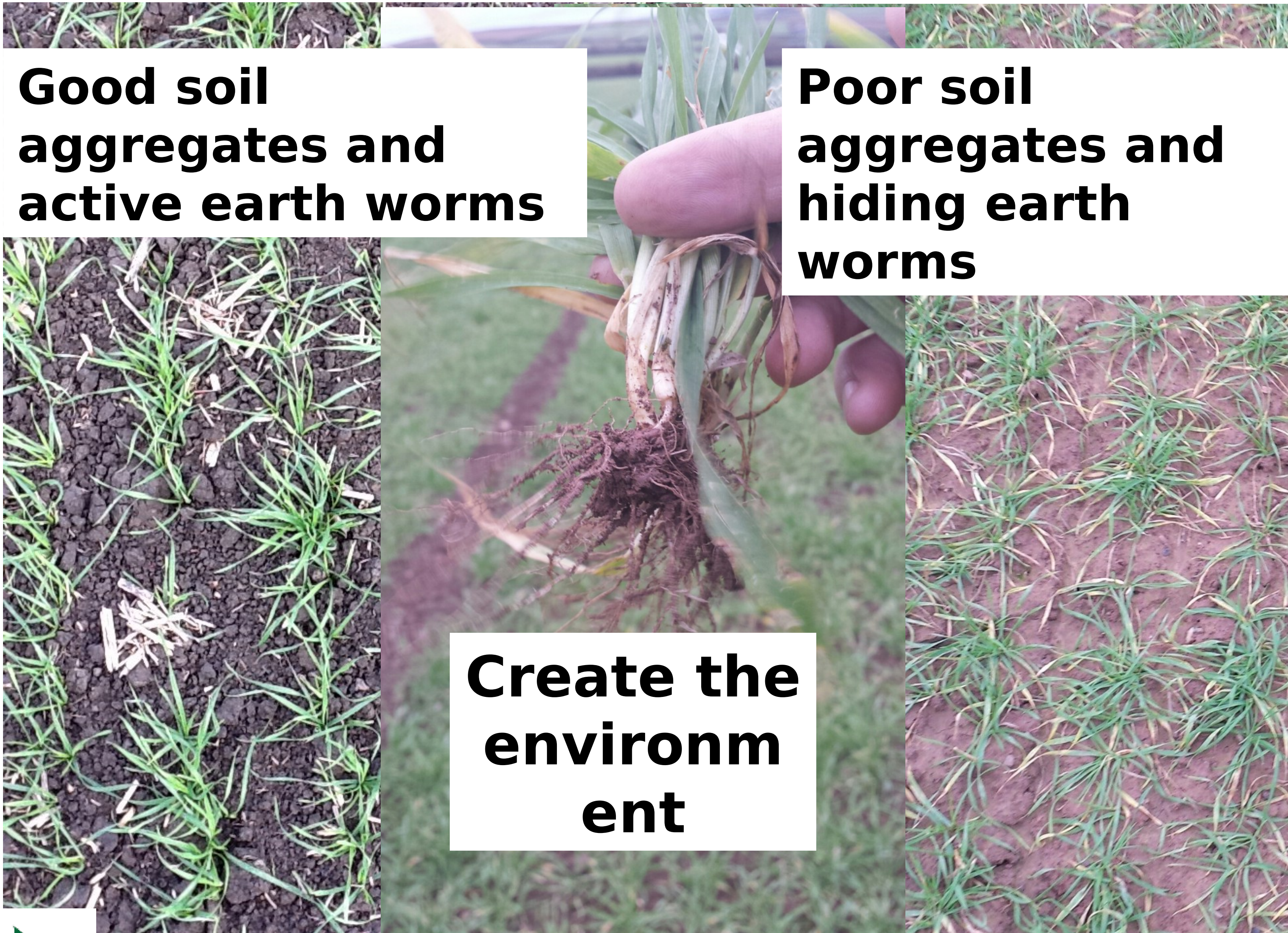
No percentages

Analysis	Result	Guideline	Interpretation	Comments
pH	6.0	6.5	Slightly Low	Adequate for this crop. Other crops may require lime.
Phosphorus (ppm)	17	16	Normal	**(Index 2.1)** 170 kg/ha P2O5 (136 units/acre).
Potassium (ppm)	143	121	Normal	**(Index 2.1)** 300 kg/ha K2O (240 units/acre).
Magnesium (ppm)	92	51	Normal	**(Index 2.8)** 40 kg/ha MgO (32 units/acre).
Calcium (ppm)	1622	2000	Slightly Low	CONSIDER TREATMENT.
Sulphur (ppm)	2	10	Very Low	CONSIDER TREATMENT.
Manganese (ppm)	94	20	Normal	Adequate level.
Copper (ppm)	8.1	2.1	Normal	Adequate level.
Boron (ppm)	1.44	1.60	Slightly Low	CONSIDER TREATMENT.
Zinc (ppm)	5.0	4.1	Normal	Adequate level.
Molybdenum (ppm)	0.11	0.60	Very Low	Low priority on this crop. Other crops may be affected.
Iron (ppm)	900	200	Normal	Adequate level.
Sodium (ppm)	41	90	Very Low	Not a problem for this crop.
C.E.C. (meq/100g)	14.0	15.0	Slightly Low	Cation Exchange Capacity indicates a slightly low nutrient holding ability - soil applied nutrients could be readily leached. Where possible foliar applied nutrients should be recommended.

Reference: **10078/42939/14** Field Name: **SAMPLE 3**	Result	(*)	Deficient	Marginal	Target	Marginal	Excessive
EDTA Extractable Copper mg/l	26.0						
Hot Water Soluble Boron mg/l	1.2						
Ammonium Nitrate Extractable Sodium mg/l	25.6	7					
EDTA Extractable Zinc mg/l	15.4	8					
Ammonium Nitrate Extractable Calcium mg/l	2184.9	2					
DPTA Extractable Iron mg/l	96.9	3					
Organic matter (LOI) %	2.9	4					
fer Extractable Sulphate mg/l	11.9	5					
ble Manganese mg/l	8.2						
on Exchange Capacity meq/100g	16.9	6					

Ensure excessive chemicals (Fe) don't effect rooting and pH


Good soil aggregates and active earth worms
Create the environm ent
Poor soil aggregates and hiding earth worms

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Create the environment:

- Use the correct chemistry
- **Build as closely as possible the correct physical structure.**
- which in turn supplies the proper environment for the biology (roots, worms, microbes, etc.).

Chemistry

Physical

Biology

Whats the Impact of chemicals & Herbicides?

They act in different ways

1. **PSII** – Photosystem **inhibitors** (prevent photosynthesis)
2. **EPSP** – **inhibits** the biosynthesis of aromatic acids (Glyphosate)
3. **AHAS – ALS** – Catalyses valine/leucine/isoleucine (only exist in plants)
4. **PPO** – **inhibition**
5. **ACC** – acetyl-CoA Carboxylase **inhibitors**
6. **GS** – glutamine synthesis
7. **IAA** – acting on **Auxin receptors** (hormone s - 2,4-D)

Sodium / Copper

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Anaerobic Soil Organic

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- **Organic Matter Decomposition**

May result in **phytotoxic and volatile compounds**

called Bio-fumigation (stapleton et al 2000a)

- **Bio fumigation**

Isothiocyanates (ITC) from turnip rape mulch

ppresses blackgrass, and

Chemical Half life

pesticide	Active ingredient	Optimal pH of Spray Mix	Water pH of spray mix	Water pH of spray mix
Insecticide	Chlorpyriphos	pH 5 = 63 days	pH 7 = 35 days	pH 8 = 1.5 hrs
	Cypermethryn	pH 4		pH 9 = 35hrs
fungicide	Dithane	pH 5	pH 5 =20days	pH7= 17 hrs
Herbicide	Roundup	pH 5	pH 5 =optimal	
	Fusilade	pH 4	pH 4 = 500days	pH 7 = 150days
	Pendamethlin		Stable over wide range	
h	Cerone	pH 3		

What's your water pH?

The Impact of a Chemically dependant system

- **Chemicals act in very different ways to perform there functions**

- **A Debate on there effects on soil biota.**

- **Direct -** Harm due to direct contact
- **Indirect** - Changes caused to the environment of the organism

-

- **Short**
- **Long Term**

Due to the resilience of the soil logical populations to come back (Angus et al. 1999)

Biological Detox:
Of chemical compounds and substances

Micro-organisms degrade and detoxify pesticide residues.

- Physicochemical processes
- Microbiological decomposition
- Absorption by higher plants and the soil fauna.

Soils are rich in micro-organisms,

- Actinomycetes, fungi and bacteria.

Detoxified by their adsorption to

umus and other colloids or the formation of

stable complexes in the

Detoxification – Bioremediation

a natural process which relies on bacteria, fungi, and plants to alter contaminants as these organisms carry out their normal life functions

1. Attenuation –

1. **Attenuation** - weaken the concentration

Natural attenuation relies on natural conditions and behaviour of soil microorganisms that are indigenous to soil.

2. **Biostimulation**
3. **Bioaugmentation**

Detoxification – Bioremediation

a natural process which relies on bacteria, fungi, and plants to alter contaminants as these organisms carry out their normal life functions

1. **Attenuation –**

Natural attenuation relies on natural conditions and behaviour of soil microorganisms that are indigenous to soil.

2. **Biostimulation –**

Consists of adding nutrients and other substances to soil to catalyze natural attenuation processes

3. **Bioaugmentation –**

Introduction of exogenic microorganisms (sourced from outside the soil environment) capable of detoxifying a particular

Microorganisms have limits of tolerance for particular environmental conditions

Nutrient Availability

- Nitrogen, and phosphorus are necessary for microbial activity and cell growth

Moisture Content

- All soil microorganisms **require moisture for cell growth** and function
- **Excess moisture**, such as in saturated soil, is undesirable because it reduces the amount of available oxygen for aerobic respiration

Microorganisms have limits of tolerance for particular environmental conditions

Soil pH

- Soil pH can affect availability of nutrients

- **Most microbial species can only survive within a certain pH range**

Typical ratios of fungi to bacteria observed in systems requiring few or no inorganic chemical inputs

Higher pH - Bacterial dominated ← → Lower pH - Fungal dominated

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

Dr. Albrecht devised a simple answer:

- **Use the correct Chemistry**

- **Build as closely as possible the correct Physical structure.**

- **Which in turn supplies the proper environment for the Biology**

  (roots, worms, microbes,).

Chemistry

↓

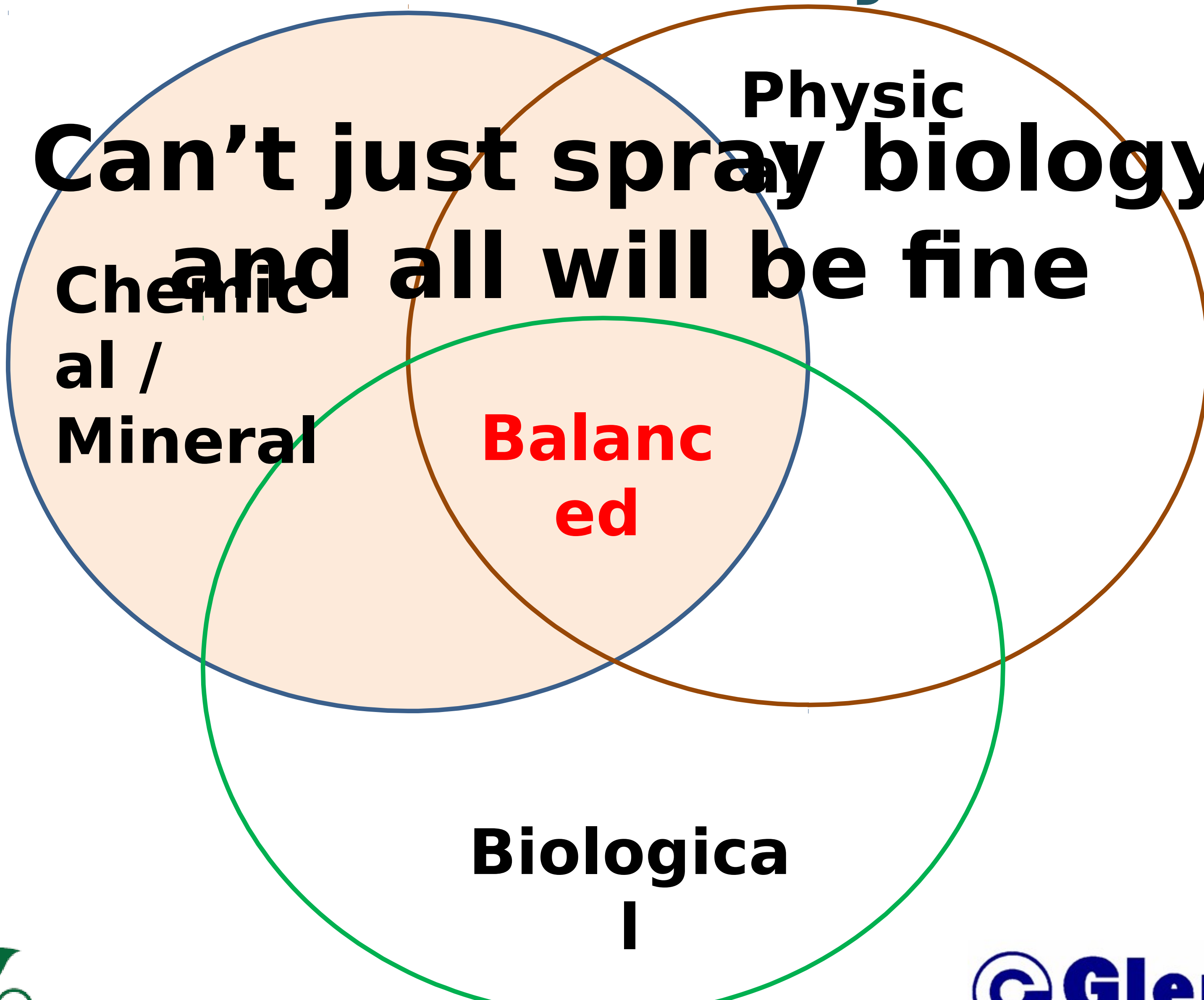
Physical

↓

Biology

Balance the system?

Can’t just spray biology and all will be fine

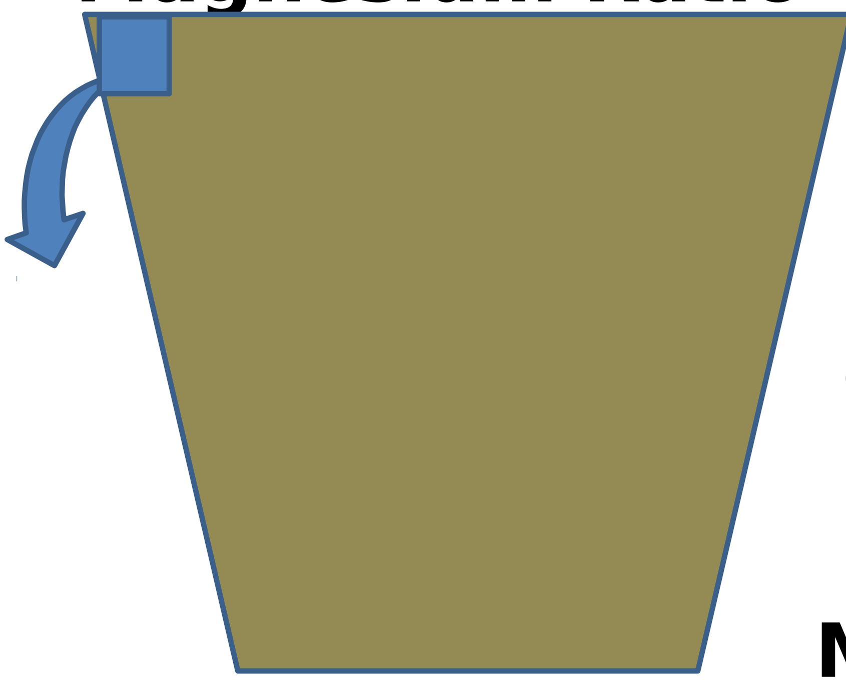


Get the best soil test you can?

Kn

of soil?

Magnesium Ratio



Balanced Nutrients

Sodium

Organic Matter

pH

Moisture content

SSM Recommend!

- Understand, Measure & use c rrect & appropriate chemi

- Create as clo e the correct physi o your soils

- pply the proper ment for **Biology** *(s, worms, microbes, etc.).*

Comprehensive soil test

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Sustainable Soil Management

Solutions for Eco-nomically Sustainable Farming

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