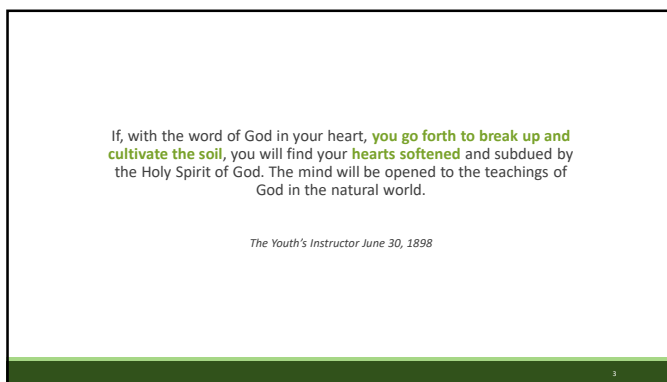




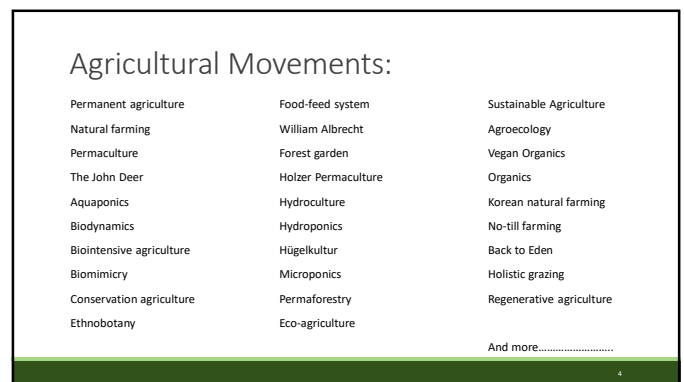
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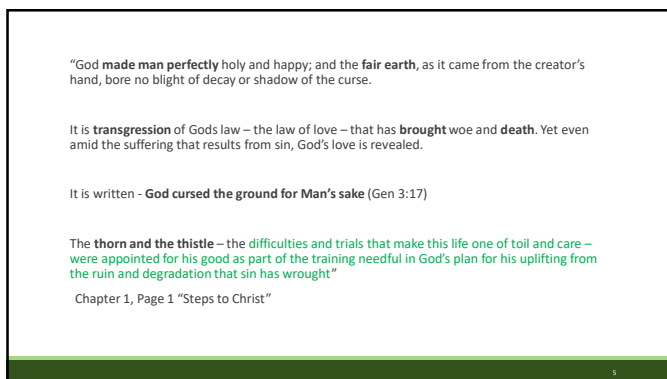
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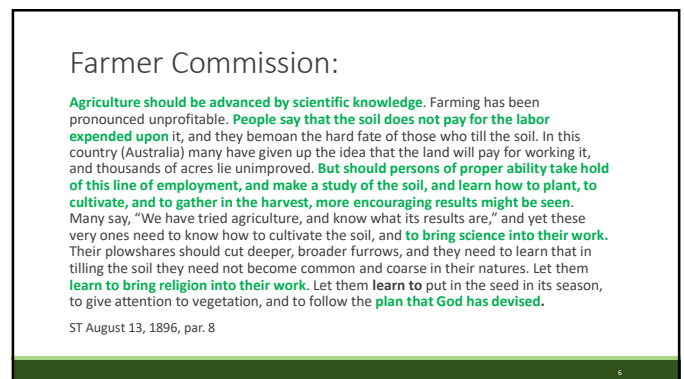
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4



5



6

God's plan for restoration:

"He who taught Adam and Eve in Eden how to tend the garden **would instruct men today**. There is wisdom for him who holds the plow and plants and sows the seed. The earth has its **concealed treasures**, and the Lord would have thousands and tens of thousands working upon the soil..."

Adventist Home p. 143.1

7

God's plan for restoration:

"...if God's people **followed His instruction**, their land would be **restored** to fertility and beauty. God Himself gave them directions in regard to the culture of the soil, and they were to co-operate with Him in its restoration"

Adventist Home p. 143.2

Provided instruction:

"There is much mourning over unproductive soil, when if men would read the Old Testament Scriptures they would see that the Lord knew much better than they in regard to the proper treatment of land. After being cultivated for several years, and giving her treasure to the possession of man, portions of the **land should be allowed to rest**, and then the crops should be changed"

Fundamentals of Christian Education 323.2

8



Agricultural History

9

Problems in Agriculture

1. Thorns and thistles – introduction of cultivation
2. Plant diseases and Pests – Land required Rest/Rotation
3. Lack of water supply – No rivers flowing to water the garden (irrigation)
4. Lack of yield and prosperity
5. Lack of farmer – to keep and tend

We have all these problems

Tools were invented to deal with each problem

10

Inventions of Man Kind

There are many inventions and improvements, and labor-saving machines now that the ancients did not have. **They did not need them....**

The greater the length of time the earth has lain under the curse, the **more difficult** has it been for man to cultivate it and make it productive. As the soil has become more barren, **and double labor has had to be expended upon it**, God has raised up men with inventive faculties to construct implements to lighten labor on the land groaning under the curse. **But God has not been in all man's inventions**. Satan has controlled the minds of men to a great extent and has **hurried men** to new inventions which has led them to forget God.

1089.7 SDA Bible Commentary, vol. 1

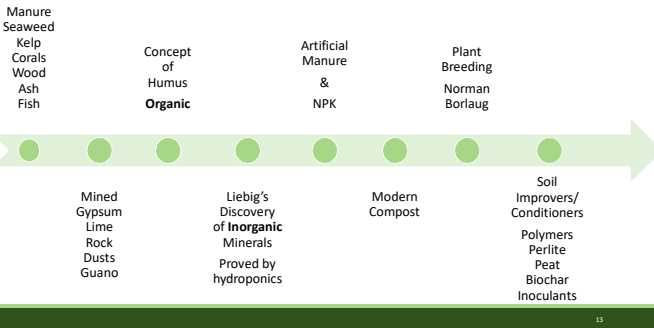
11

Problems Arise

1. Thorns and thistles – introduction of cultivation → **Plow, Herbicides**
2. Plant diseases and Pests – Land required Rest/Rotation → **Pesticides/Fungicides, Plant Breeding**
3. Lack of water supply – No rivers flowing to water the garden (irrigation) → **Politics and automation**
4. Lack of yield and prosperity → **manures** → **Synthetic manures** → **stimulants, plant Breeding**
5. Lack of farmers – to keep and tend → **Bigger farms – automation**

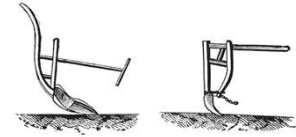
12

History of Fertilisers:



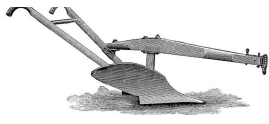
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History of tillage: The Plow!



<https://www.easydigging.com/garden-hoes/faq/types-of-hoes.html>

14



History of tillage: The Plow!

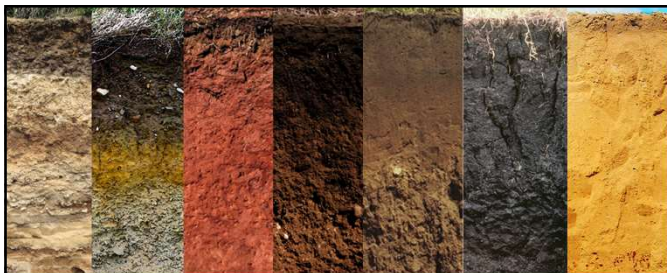
15

History of tillage:

1. We made very powerful tillage tools
2. Burning soil carbon – release nutrients
3. Stopped working because we reach 1% organic matter, oops
4. Then fertiliser use increased because we needed to make up for what organic matter was not supplying
5. A dust bath
6. Something had to change
7. Conservation Agriculture - Edward H. Faulkner in 1943, an agronomist who wrote a book "Plowman's Folly"
8. Zero till system



16



The building blocks to Soil Health

17



Air



Water

Balanced
Nutrition

Sunlight

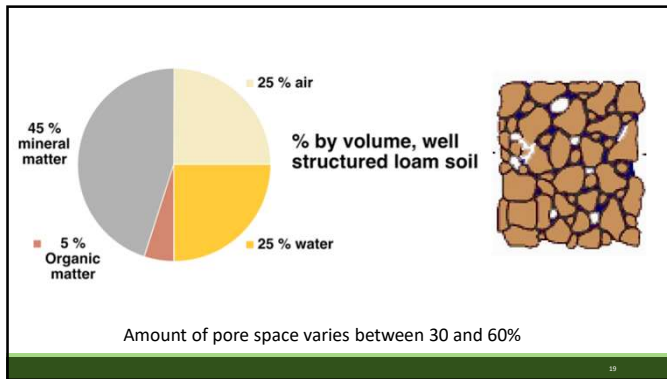


BioActive

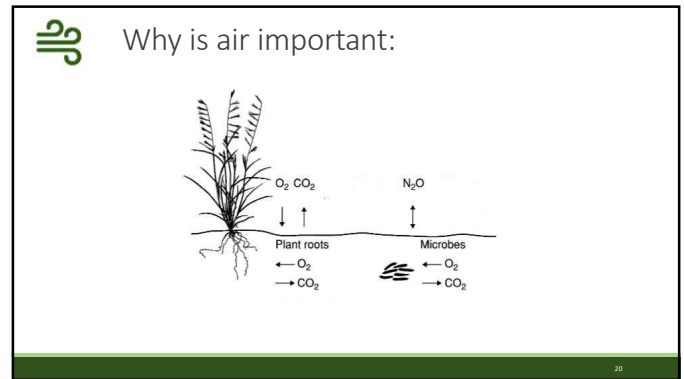
Rest &
Rotation

Soil Health Principles

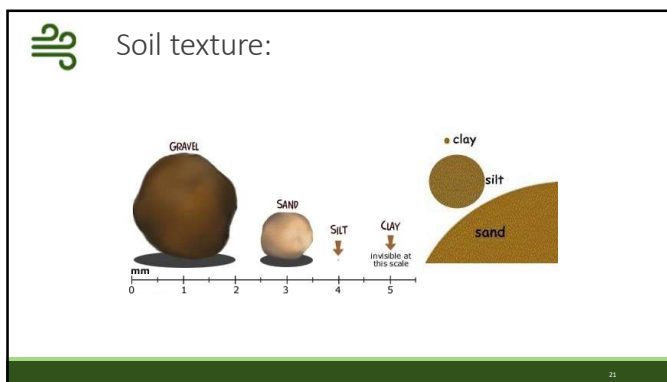
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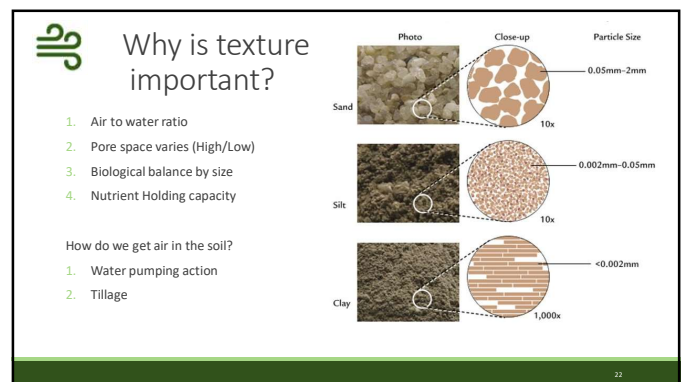
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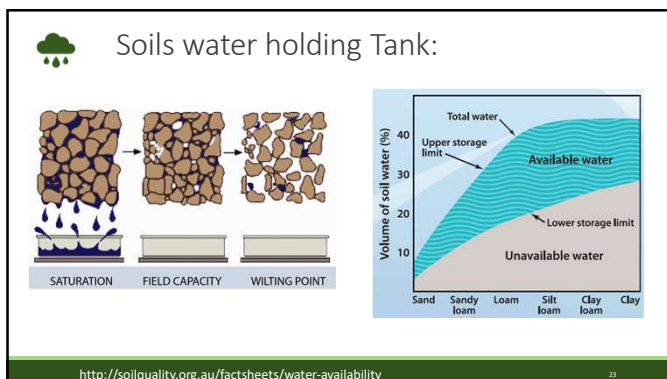
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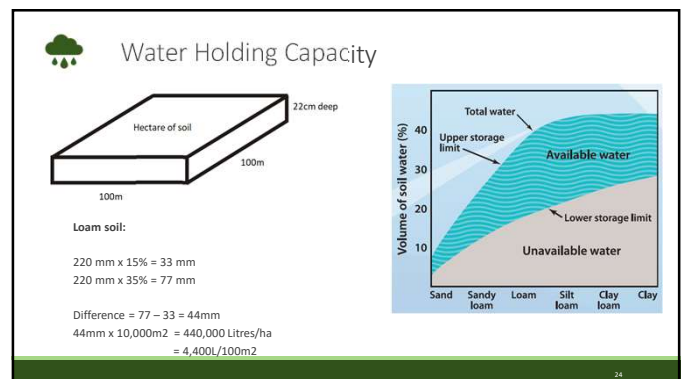
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23



24



1. Resilience to drought – Rooting Depth

Effective Rooting Depth for Various Crops at Maturity in Homogeneous Deep Soils

Crop	Stage (cm)	Crop	Stage (cm)	Crop	Stage (cm)
Lucerne	90-180	Grains	60-150	Safflower	90-180
Beans	50-90	Grapes	75-180	Soybeans	60-125
Citrus	120-150	Legumes	50-125	Strawberries	20-30
Cotton	75-170	Maize	75-160	Sugarbeet	60-125
Crucifers	30-80	Olives	100-150	Sugarcane	75-180
Cucurbits	75-125	Onions	30-75	Tomatoes	40-100
(cucumbers)		Pastures	60-100	Tobacco	45-80
Deciduous orchards	100-200	Peppers	40-100	Vegetables	30-60
Eggplant (aubergine)	75-120	Potatoes	30-75		

25



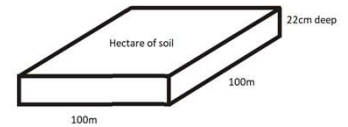
2. Resilience to drought – Soil Carbon

Soil carbon can hold 4 times its weight in water

1 Hectare at 22cm deep = 2.6 million Kilos

1% carbon = 26 tones

Every Extra 1% carbon = 4 x 26 tones
= 104 tones
= 104,000 Liters/ha
= 1,040L/100m²

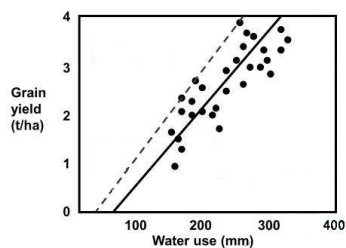


<https://managingwholes.com/soil-carbon-means-water.htm/>

26

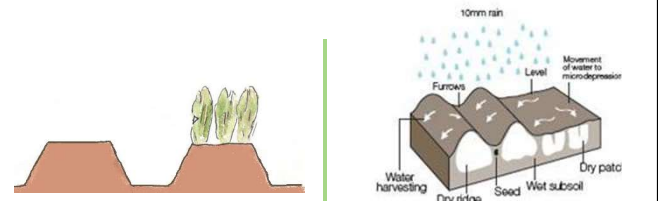


Wheat yields and water use (WA)



French & Shultz Yield formula based on rain

27



Water Problems

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Reflections: Why should we till?

- Increase aeration by breaking up compaction – allows air & water to enter
- Plant roots go deeper
- Biology promoted or retarded
- To incorporate fertilisers/manures
- Soil Solution is affected
- The penetration of plant roots is influenced

Should we till for:

- Residue management
- Seed bed



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Other effects of tillage:

- Creates compaction
- Burns up carbon
- Dries up the soil
- Absorption/retention of heat effected

- Land stability
- Over tillage
- Fuel cost

Other methods of tillage:

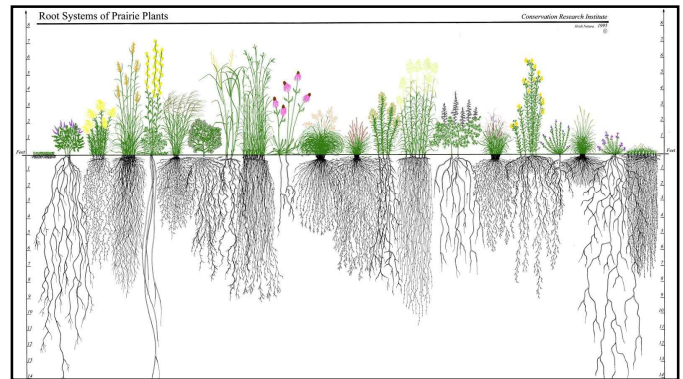
- Tillage radish
- Roots
- Bioturbation

30

Other forms of tillage: Bioturbation

<https://www.youtube.com/watch?v=Mxp1nnrUG0Q>

31



32

Plow often and deep:

"The soil will not produce its riches when worked by impulse. It needs thoughtful, daily attention. **It must be plowed often and deep, with a view to keeping out the weeds that take nourishment from the good seed planted.** Thus those who plow and sow prepare for the harvest. None need stand in the field amid the sad wreck of their hopes."

Christ's Object Lessons p. 88.2

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Deep Repentance:

"The garden of the heart must be cultivated. **The soil must be broken up by deep repentance for sin.** Poisonous, Satanic plants must be uprooted. The soil once overgrown by thorns can be reclaimed only by diligent labor. So the evil tendencies of the natural heart can be overcome only by earnest effort in the name and strength of Jesus. The Lord bids us by His prophet, "Break up your fallow ground, and sow not among thorns." "Sow to yourselves in righteousness; reap in mercy." Jeremiah 4:3; Hosea 10:12. This work He desires to accomplish for us, and He asks us to co-operate with Him."

Christ's Object Lessons p. 56.8

34

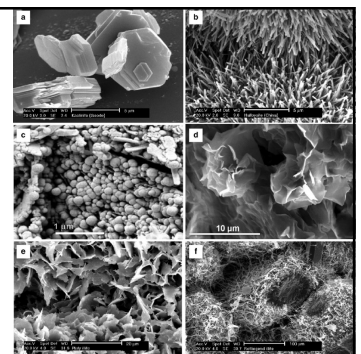
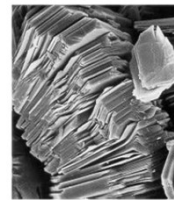
Reflections: What makes good soil structure

- Sand, silt and clay proportions
- Porosity – air and water space
- Soil Biology gluing aggregates and bioturbation
- Soil organic matter levels (another particle size)
- Plant roots forming structure
- Improved structure by colloidal balance (Ca & Mg)

35

Clay Colloid Structure

- Clay crystal or humus



https://www.researchgate.net/figure/SEM-images-of-clay-minerals-a-pseudohexagonal-crystals-of-kaolinite-b-tubular_fig4_311583515

36



37

Balanced Nutrition

- Nutrient Groups
- Nutrient cycles and depletion
- Nutrient Interactions
- Are we feeding the plant or the soil?

38

Why talk about nutrition

1. Basis of growth:
2. The life is in the blood
3. All nutrients are required in specific amounts as building blocks
4. Nutrient deficiency = disease, low quality, low yield
5. An excess of a nutrient = deficiency of another nutrient
6. Nutrients are needed on time – otherwise stunted

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Groups of nutrients

Macronutrients				Micronutrients				Beneficial		
20 Ca Calcium	12 Mg Magnesium	19 K Potassium	11 Na Sodium	5 B Boron	17 Cl Chlorine	25 Mn Manganese	26 Fe Iron	11 Na Sodium	13 Al Aluminum	23 Va Vanadium
7 N Nitrogen	15 P Phosphorus	16 S Sulfur		28 Ni Nickel	29 Cu Copper	30 Zn Zinc	42 Mo Molybdenum	27 Co Cobalt	34 Se Selenium	
No-Mineral Elements										
1 H Hydrogen	6 C Carbon	8 O Oxygen						17 Cl Chlorine	14 Si Silicon	

40

Nutrient Groups

The materials for photosynthesis – the primary job of plants

No-Mineral Elements		
1 H Hydrogen	6 C Carbon	8 O Oxygen

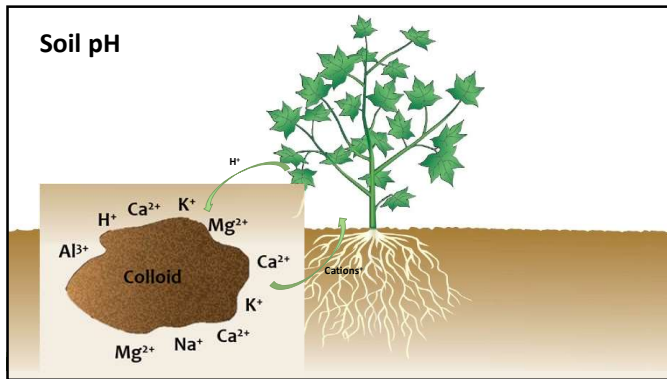
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1. Nutrient Groups

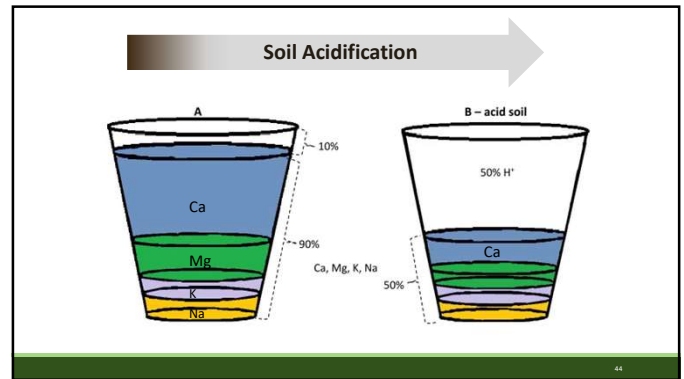
1. The soil environment – structure & pH

Macronutrients			
20 Ca Calcium	12 Mg Magnesium	19 K Potassium	11 Na Sodium

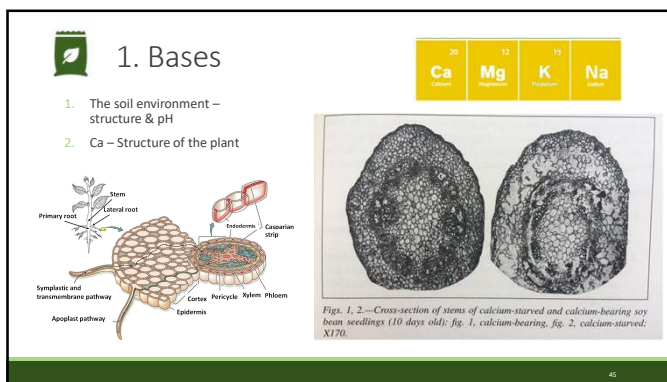
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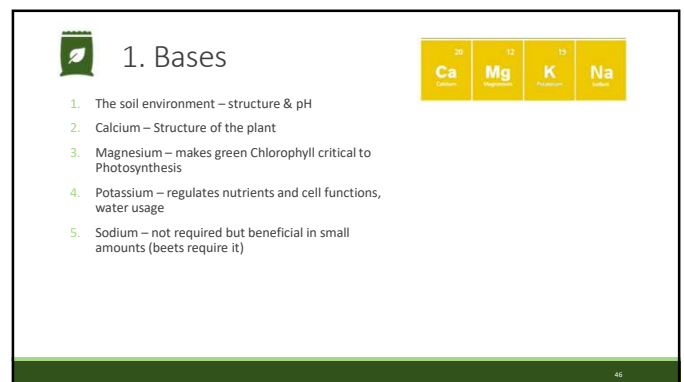
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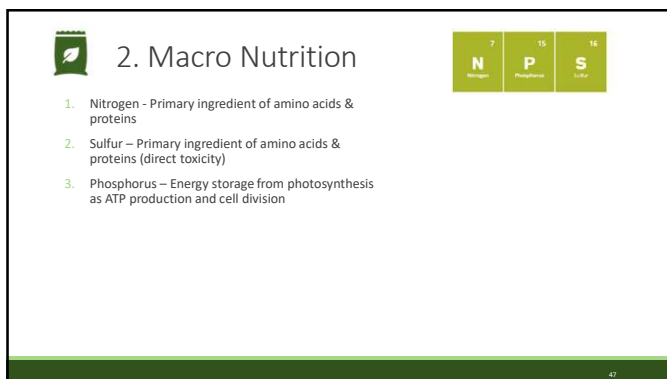
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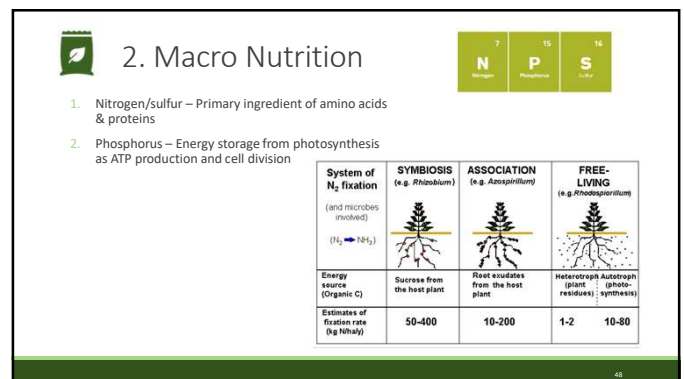
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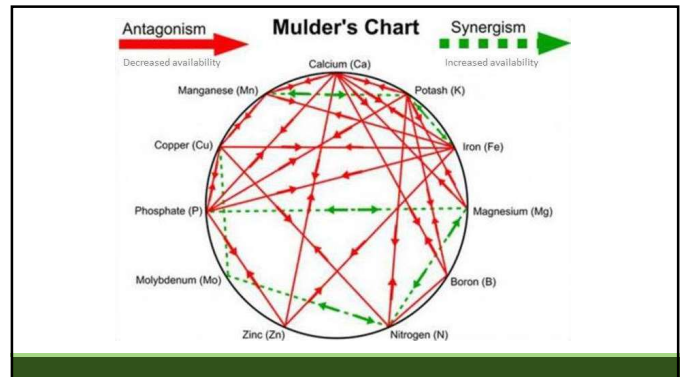


2. Micro Nutrients

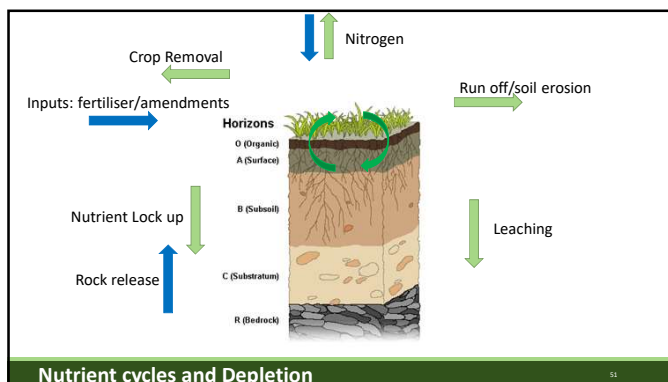
1. Boron – improves calcium mobility, increase flowering viability, increase sugar translocation
2. Zinc – Leaf formation/sizing & water use efficiency
3. Copper – Enzymes supporting lignification & linked to a long list of disease when not functioning (direct toxicity)
4. Iron – Used in creating Chlorophyll. Photosynthesis support
5. Manganese – Supports photosynthesis process & linked to a long list of diseases when not functioning
6. Molybdenum – Nitrogen usage & conversion (denaturing of protein coating of viruses)
7. Cobalt – Required by soil biology to fix nitrogen. Forms B12 in soil which is uptaken by the plant.

Micronutrients			
5 B Boron	17 Cl Chlorine	25 Mn Manganese	26 Fe Iron
28 Ni Nickel	29 Cu Copper	30 Zn Zinc	42 Mo Molybdenum

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51



Biological Nitrogen Fixation

System of N ₂ fixation	SYMBIOSIS (e.g. <i>Rhizobium</i>)	ASSOCIATION (e.g. <i>Azospirillum</i>)	FREE-LIVING (e.g. <i>Rhodospirillum</i>)
(and microbes involved) (N ₂ → NH ₃)			
Energy source (Organic C)	Sucrose from the host plant	Root exudates from the host plant	Heterotroph Autotroph (plant residues) : synthesis
Estimates of fixation rate (kg N/ha/yr)	50-400	10-200	1-2 10-80

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Are we feeding the plant or the soil?

Soil	Plant
Colloidal Model – Nutrition in storage	Soil Solution Model – Available nutrition
Remineralisation – Building Fertility	Instantly Soluble Fertilisers
Soils Long term needs	Plants immediate needs
Dr. William Albrecht Model	Current Industry Standard
Colloidal Reserve Hydrogen	Solution Hydrogen
Powerful to restore soil function	Powerful band aid – drip feeding

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Session 3: Planning For Permanent Soil Health

By Ian Mot
I.mot@vitalsoils.com.au
Agronomist



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Sunlight

"The task of agriculture is to transform solar energy, the energy of light, into the potential energy stored in human food. **Sun Light is the basic raw material of the agricultural industry.**"

Principles of Agriculture 1952 by W. R. Williams

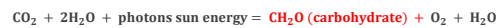
56



Sunlight

Plants - **Industrial settlement:**

- Sap flow provides the materials for construction at each cell
- Every cell is a production station
- The factory is powered by the sun (photosynthesis)

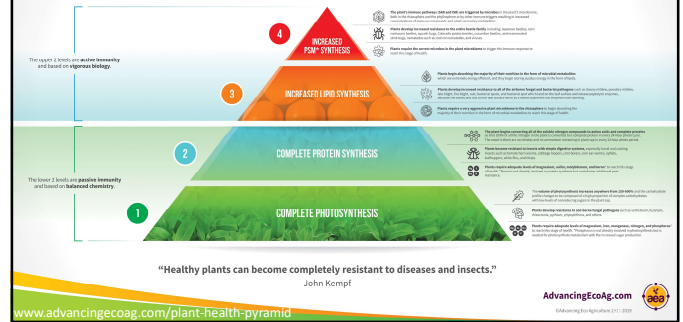


Cell Factory: Carbohydrate + Inorganic Mineral = Organic Molecules

Starch (storage sugar), Amino acids, Proteins, fats, vitamins, acids, hormones etc.

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PLANT HEALTH PYRAMID



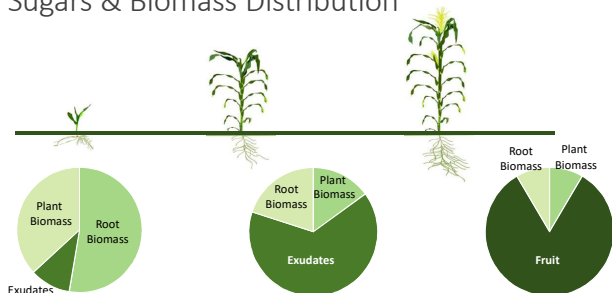
58



Ref.	Plant Species	Plant Part	Refractive Index	Brix (%)	Notes
1	Apple	Fruit	1.335	12.0	
2	Banana	Fruit	1.338	15.0	
3	Carrot	Root	1.332	10.0	
4	Corn	Grain	1.330	8.0	
5	Cucumber	Fruit	1.334	11.0	
6	Garlic	Bulb	1.331	9.0	
7	Grass	Stem	1.328	7.0	
8	Leek	Bulb	1.331	9.0	
9	Lemon	Fruit	1.336	13.0	
10	Lime	Fruit	1.336	13.0	
11	Mango	Fruit	1.337	14.0	
12	Orange	Fruit	1.335	12.0	
13	Pear	Fruit	1.335	12.0	
14	Pineapple	Fruit	1.338	15.0	
15	Plum	Fruit	1.335	12.0	
16	Raspberry	Fruit	1.335	12.0	
17	Strawberry	Fruit	1.335	12.0	
18	Tomato	Fruit	1.334	11.0	
19	Watermelon	Fruit	1.333	10.0	
20	Yam	Root	1.332	10.0	

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Sugars & Biomass Distribution



60

60

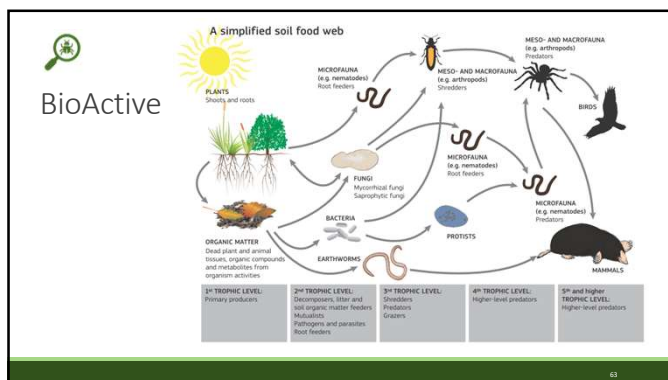
Exudates	Functions	
Organic Acids	Nutrient source Chemoattractant signals to microbes Chelators of poorly soluble mineral nutrients	Acidifiers of soil Detoxifiers of Al nod gene inducers
Amino Acids	Nutrient source Chelators of poorly soluble mineral nutrients Chemoattractant signals to microbes	
Sugars & Vitamins	Promoters of plant and microbial growth nutrient source	
Proteins and Enzymes	Catalysts for P release from organic molecules Biocatalysts for organic matter transformations Plante defense	
Purines	Phenolics Nutrient source	Resistance inducers against phytoalexins
Inorganics and Gases	Chemoattractant signals to microbes	Chelators of poorly soluble mineral nutrients
Phenolics	Microbial growth promoters nod gene inducers and inhibitors in rhizobia	Detoxifiers of Al Phytoalexins against soil pathogens
Root Border Cells	Produce signals that control mitosis Produce signals controlling gene expression Stimulate microbial growth Release chemoattractant	Synthesize defense molecules for the rhizosphere Act as decoys that keep root cap infection-free Release mucilage and proteins

Feth el Zahar Haichar 2014 "Root exudates mediated interactions belowground"

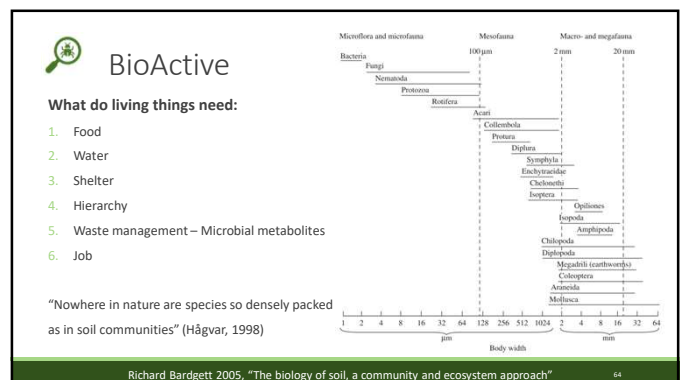
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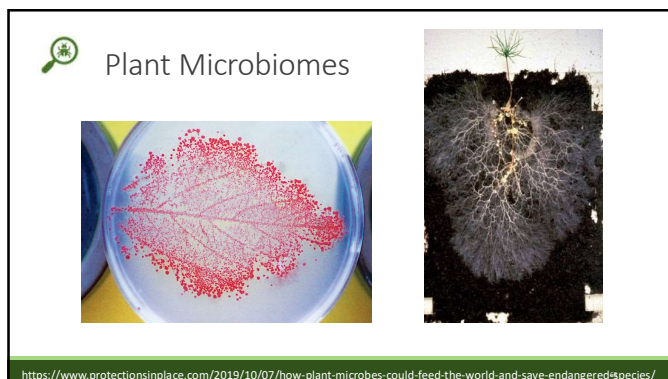


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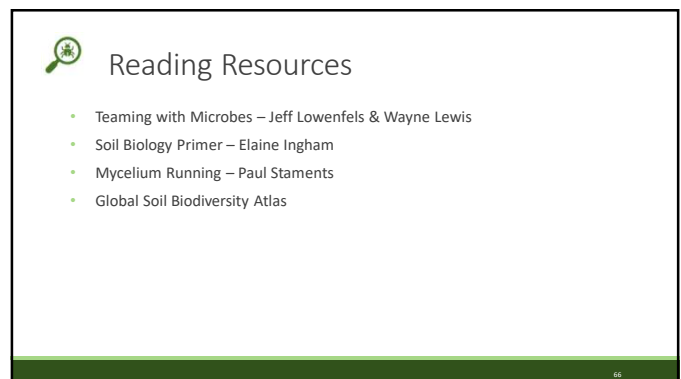


Richard Bardgett 2005, "The biology of soil, a community and ecosystem approach"

64

<https://www.protectionsinplace.com/2019/10/07/how-plant-microbes-could-feed-the-world-and-save-endangered-species/>

65



66

Rest And Rotation:

"Through disobedience to God, Adam and Eve had lost Eden, and because of sin the whole earth was cursed. **But if God's people followed His instruction, their land would be restored to fertility and beauty.** God Himself gave them directions in regard to the culture of the soil, and they were to co-operate with Him in its restoration"

Christ's Object Lessons p. 289.2

"There is much mourning over unproductive soil, when if men would read the Old Testament Scriptures, they would see that the Lord knew much better than they in regard to the proper treatment of land. After being cultivated for several years, and giving her **treasure** to the possession of man, **portions of the land should be allowed to rest, and then the crops should be changed**"

Christ's Object Lessons p. 289.2

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Restorative Rest

1. Why do we rest?
2. Why do we rotate?
3. How much is too much?

68



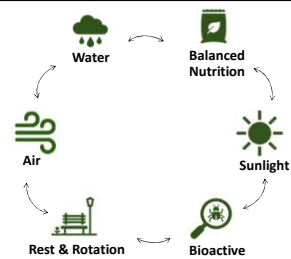
Principles of Rest & Rotation

How much is too much? Soil Capacity to work

"After every season of crops your soil should be in a stronger position then it was before hand"

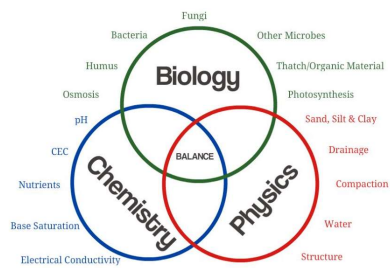
Veg farmer

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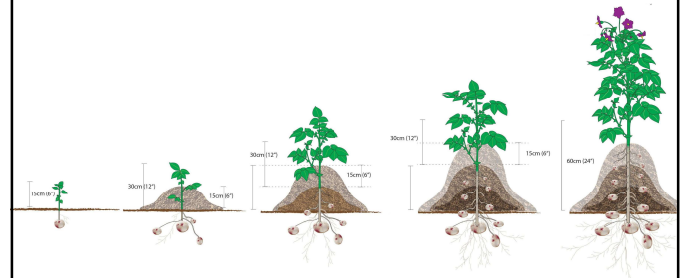
Soil Health Indicators

70



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Session 4&5: Building a Soil Restoration Plan



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How products are invented:

What does a health soil make:

1. Worm castings
2. Probiotics
3. Organic acids – Fulvic/humic acid
4. Exudates – sugars
5. Amino acids – nitrogen
6. Antibiotics

What does my soil need?

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My Garden Case Study:

A family of 4 can grow all its vegetable requirements for a year on 200m²

20m x 5m = 200m²

50m²/person/year

Not accounting for Corn or Potato

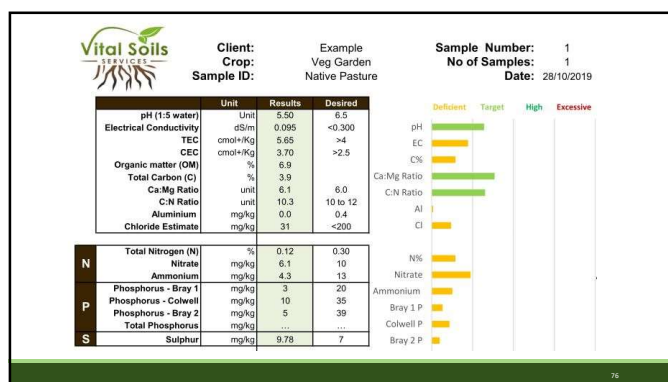


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Asses the situation:



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What is Soil Testing?

1. Discover "what does my soil need?" Measure what you have.
2. Measuring helps us learn/discover – a detective measuring tool
3. A soil test is free from 100m² up – when setting up a new garden
4. The only way to archive high nutrient density
5. The only way to get rid of diseases and pest with nutrition – using measurement tool(s)

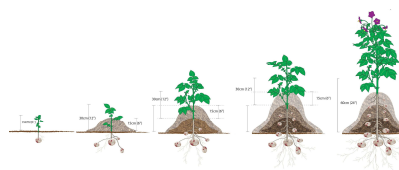
When you are not getting value out of a test:

1. For a mulch garden
2. Growing in Compost
3. Growing in potting mix

77

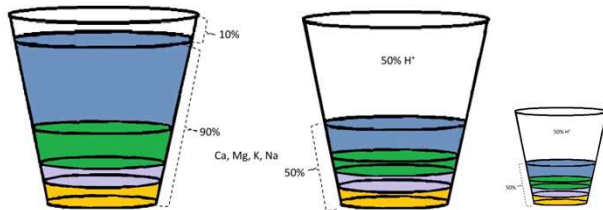
Nutrient Budgeting:

1. Hidden Hunger hides the problem
2. Nutrient demand over time



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1. Soil pH correction & Balancing



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2. Soil Nitrogen, Phosphorus and Potassium (NPK)

Nitrogen Demand

1. Apple tree needs 35 - 70 kg/ha
2. Banana 90 - 140 kg/ha
3. Carrots 100 kg/ha
4. Lucerne 160 - 220 kg/ha
5. Celery 300 - 500 kg/ha

Single Sources of Nitrogen

1. Organic matter release 1% = 10 - 30kg/ha
2. Thunderstorms 0 - 30 Kg/ha
3. Natural fixation 0 - 400 kg/ha
4. Mulch release 0 - 120 kg/ha
5. Compost/manures
6. Feather meal / canola meal
7. Amino Acids
8. Urea
9. Ammonium Sulphate

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2. A compost/manure NPK Solution

Compost Organic NPK

Required Nutrients		kg/ha	Example Compost Analysis				
Nitrogen	70		Moisture (%)	40	Total N	1	%
Phosphorous	80		Bulk density (kg m-3)	700	Total P	0.3	%
Potassium	72				Total K	0.3	%
					(% dry weight basis)		
Compost depth (cm)		Compost m3/ha:		Compost ton/ha:			
Application Rate:		1.0		100		70	
Total nutrient loading from compost							
Majority of NPK nutrients are released over 2 - 3 years, see results below							
		N	P	K			
		420	126	126	kg/ha		
Results							
Year		N	P	K			
		(kg/ha/yr)	(kg/ha/yr)	(kg/ha/yr)			
1		63	56	101	Estimated nutrient contribution from compost (green) each year		
		-17	-30	29	Estimated nutrient deficit (- negative) or excess (+ positive) supplied by compost		
2		42	50	25			

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2. A compost/manure NPK Solution

Manure types:

- Dried Blood 15% N - 1.3% P - 0.7% K
- Bone Meal 3% N - 20% P - 0% K - 30% Ca
- Cow Manure 2% N - 1% P - 1% K
- Sheep Manure 3.5% N - 1.2% P - 3% K
- Kelp Meal 1% N - 0% P - 12% K + trace
- Wood Ash 0% N - 1.5% P - 5% K

Manufactured Manures:

- 10-10-10
- 10-5-8

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3. Soil Micronutrients

Trace Elements	Micronutrient Mixing Quote		\$/area	kg/area	Rate g/m ²	Notes
	Zinc	Zinc Sulphate	\$ 17.10	0.7	3.2	
	Manganese	Manganese Sulphate	\$ -	0.0	0.0	
	Iron	Iron Sulphate 28%	\$ -	0.0	0.0	
	Copper	Copper Sulphate 25.2%	\$ 30.32	0.4	2.0	
	Boron	Eldot 67 20.8% Boron	\$ 13.60	0.6	2.6	
	Molybdenum	Sodium Molybdate	\$ 12.12	0.2	0.7	
	Cobalt	Cobalt Sulphate 21%	\$ 44.25	0.5	2.1	
	Total			2.34	10.63	
	Weight Buffer	Sand or Lime		10.9	54.4	
	Total		\$ 117.38	13.2	65.0	

& Extra Sea minerals

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Application options:

1. Broadcasting
2. Fertigation systems (Drip or sprinklers)
3. Spray Boom



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Venturi Injectors:

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How do we get the biology going?

1. Tree Inoculants – ask nurseries
2. Key biological family for a certain crop
3. Compost teas

Products:

1. General Soil inoculants (add the bugs)
2. Kelp – contains amino acids, hormones which stimulate plant growth. Not a fertilizers
3. Fish Emulsion – stimulate fungi at 2L/ha, or promote photosynthetic bacteria & actinomycetes at 10L/ha
4. Humate – A chelating agent and promoter of fungi
5. Molasses – provides fast energy source for microbes (2 L/ha)

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Garden Budget: 200m²

1. Soil Test with recommendations \$ 154 (\$120 to 300)
2. Lime 265g/m² x 200m² = 53kg \$ 36 (\$12 per 25kg bag)
3. Compost Require 2 cubic meters \$ 80 (\$40 per cubic)
4. Micronutrients \$ 117
5. Sea Water Free

Total \$ 387

Maintenance cost at \$ 30-60

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Parable of the Sower

"And he went forth and sowed seed"

Seed is truth – and the truth shall set you free...

The seed causes the restoration to occur

The seed brings back life

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Rest, Rotation & Green Manures

	Season 1	Season 2	Season 3	Season 4
Bed 1	Nitrogen Producers	Heavy Feeder	Light Feeder	Green Manure
Bed 2	Heavy Feeder	Light Feeder	Green Manure	Nitrogen Producers
Bed 3	Light Feeder	Green Manure	Nitrogen Producers	Heavy Feeder
Bed 4	Green Manure	Nitrogen Producers	Heavy Feeder	Light Feeder

Heavy Feeders require lots of nutrients for growth and will easily deplete soil nutrients to produce a crop

Light Feeders comprise of mostly root vegetables, these need little or no fertilisers when planted in good garden soil

Nitrogen producers are legumes, pea and bean, that fix nitrogen back into the soil.

Green manures:

1. Oats or Barley
2. Field Pea
3. Ryecorn
4. Faba Beans (broad beans)
5. Lupin
6. Tillage radish

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“Making the Most of green Manures”

Types of green manures

1. Nitrogen Fixers – legumes
2. Soil Breakers – Tillage radish
3. Organic matter builders – Dense roots
4. Natural Fumigators - Mustard
5. Annual or Perennial
6. Any plant that grows well (strawberry)
7. Weeds



https://www.youtube.com/watch?v=C8JKi6iWB_Q

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Being Productive

1. Soil Prep – nutrition program
2. **Planting - schedule**
3. Irrigating
4. **Cultivation** - Weeding
5. **Harvesting**

What should not be part of the tasks:

1. Pest/Disease control – identifying and making a plan
2. Sorting good produce from bad produce
3. Extreme weed pressures

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Session 6: Outdoor Soil Health Assessment with a shovel

By Ian Mot
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Agronomist



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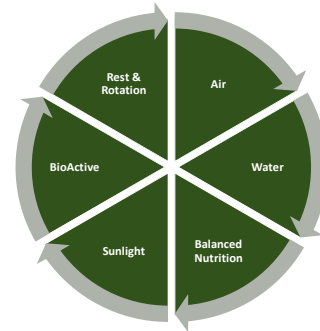
Location & website tool kit:

Soil Health Principles
→
vitalsoils.com.au/Soil-Health-Principles

Sample collection instructions →
vitalsoils.com.au/How-to-submit-a-soil-sample

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