Digging deeper into the soil profile

Understanding subsoil constraints

Texture Contrast Soils

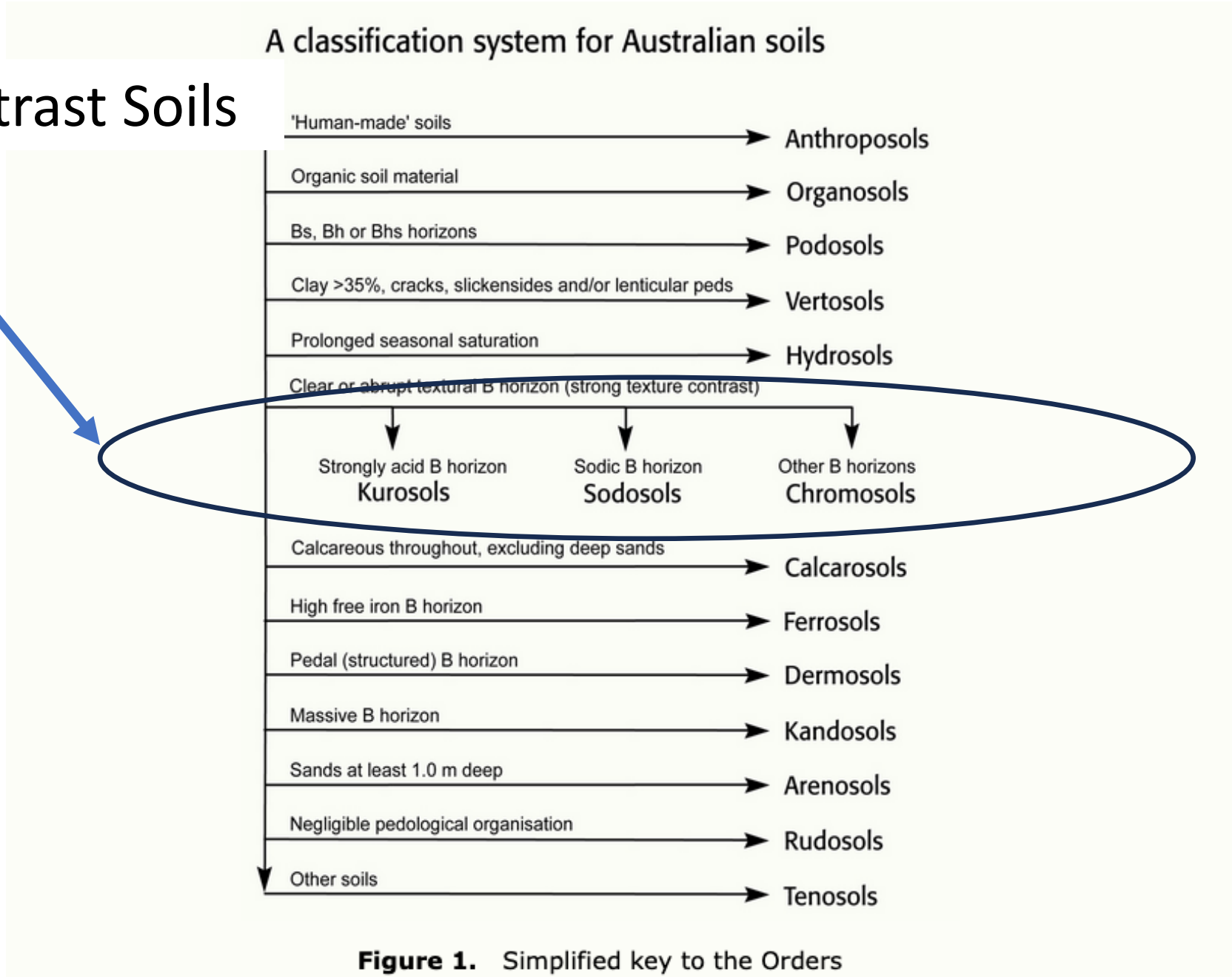
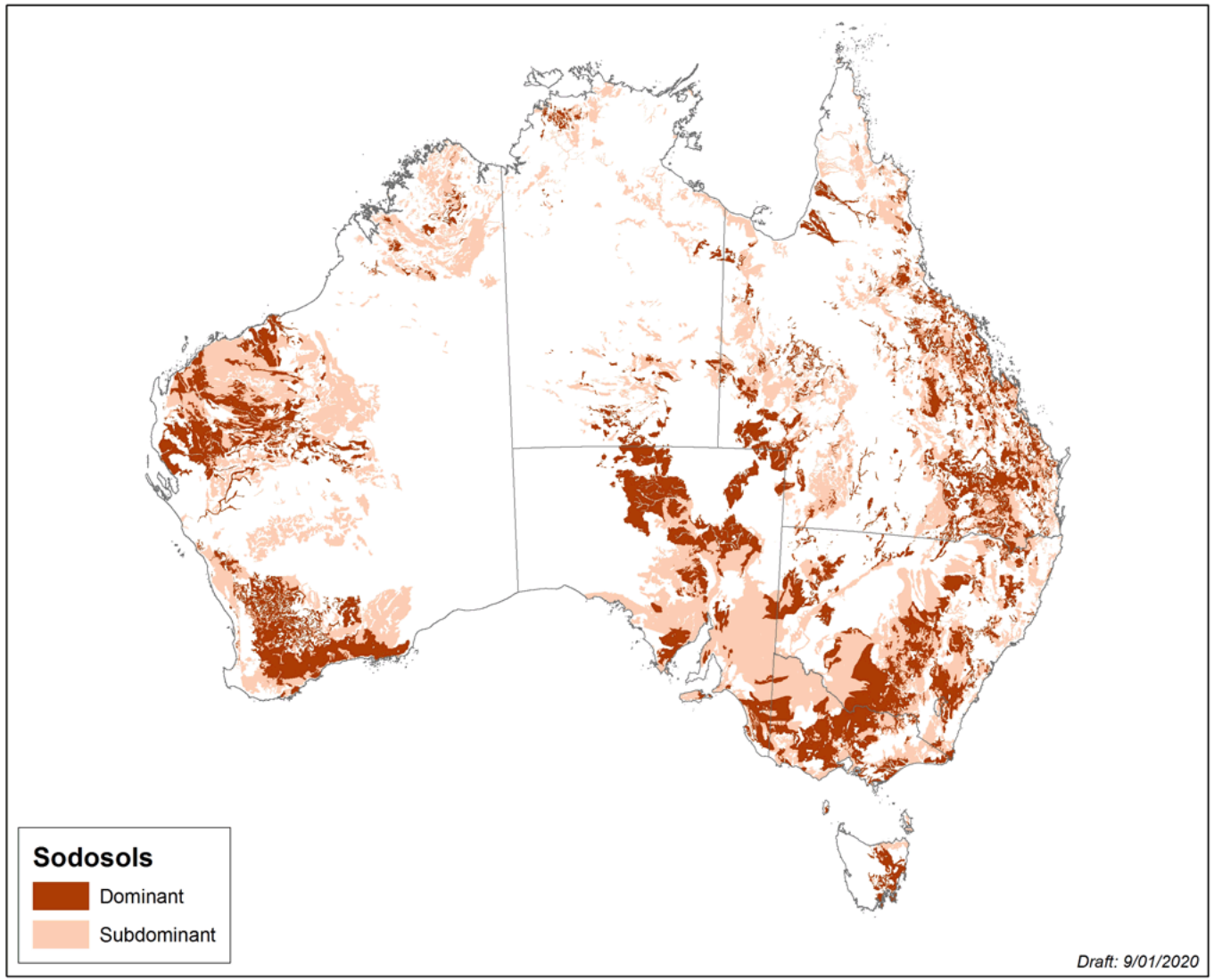
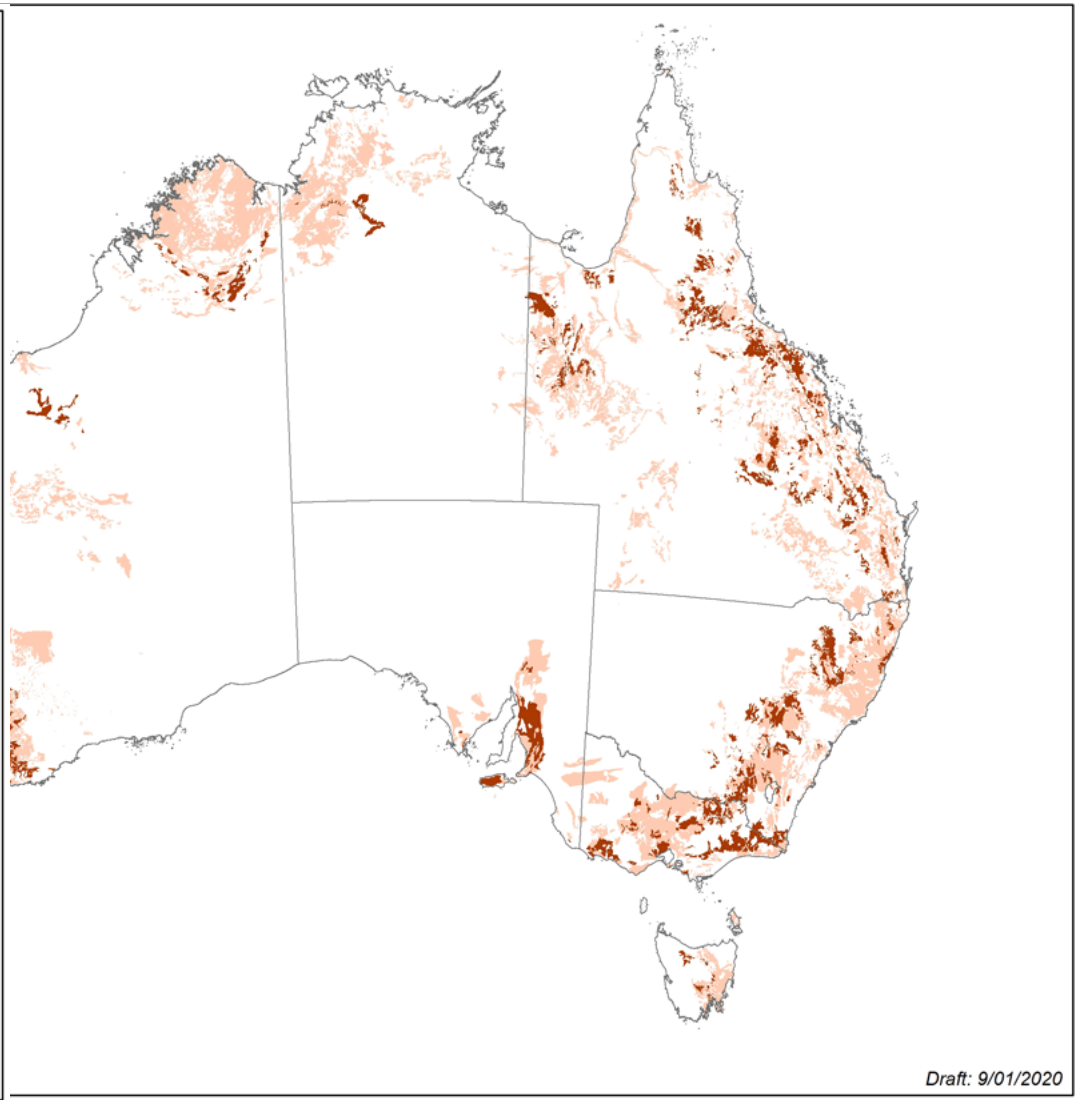


Figure 1. Simplified key to the Orders

Texture Contrast Soils





Texture contrast soil

Sodosol – SW Victoria

Loam surface soil
OC > 2 %

Water logging in wet winters

Reduced yields in dry springs

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Texture Contrast Soils - Amelioration

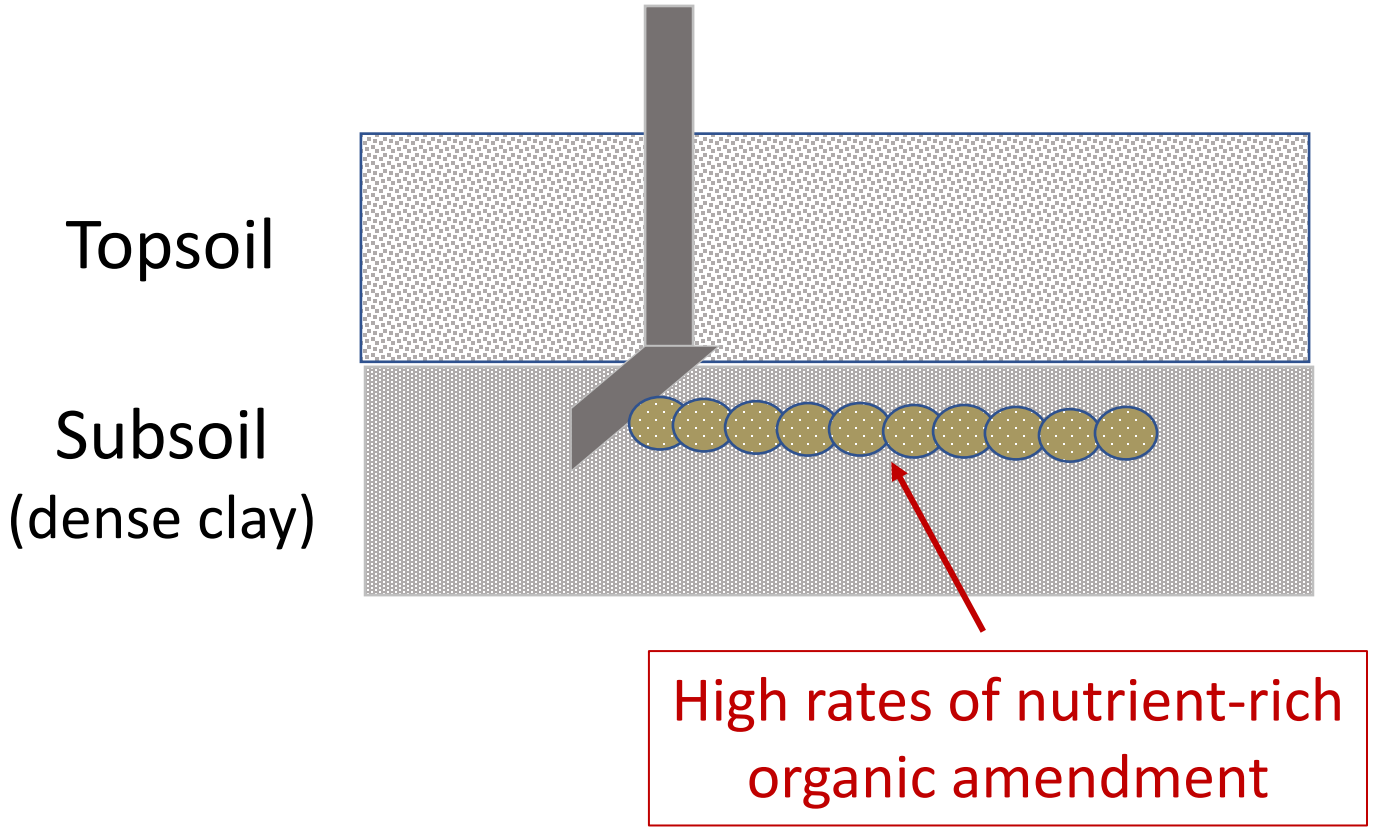
- Deep Rip Gypsum
- Clark 2004
- Limited effect
- Subsoil Manuring – 2005 +

Subsoil Manuring - Outcomes

Year	Site	Crop	Grain Yield (t/ha)			
			Commercial crop	Subsoil manured [1]	Increase in yield	Increase (%)
2005	Ballan	Wheat (1st crop)	7.6	12.5	5.3	**70 %**
2006	Ballan	Wheat (2nd crop)	3.6	5.6	2.0	**55 %**
2009	Derrinallum	Wheat (1st crop)	5.0	9.8	4.8	**96 %**
2009	Penshurst	Wheat (1st crop)	4.8	7.6	2.8	**58 %**
2009	Winchelsea	Barley (1st crop)	4.4	7.7	3.4	**77 %**
2010	Wickliffe	Wheat (1st crop)	9.1	11.6	2.5	**27 %**
2011	Derrinallum	Wheat (3rd crop)	5.0	7.4	2.4	**48 %**
2011	Stewarton	Wheat (1st crop)	5.7	8.1	2.4	**42 %**
		Av. for cereals	**5.6**	**8.8**	**3.2**	**57 %**

[1] Subsoil manured plots received 20 t/ha (fresh weight) of an N-rich organic amendment (less than 20% moisture content) which was incorporated in rip-lines, 80 cm apart, at a depth of 30-40 cm in the subsoil.

Subsoil manuring



Rainfall Use Efficiency

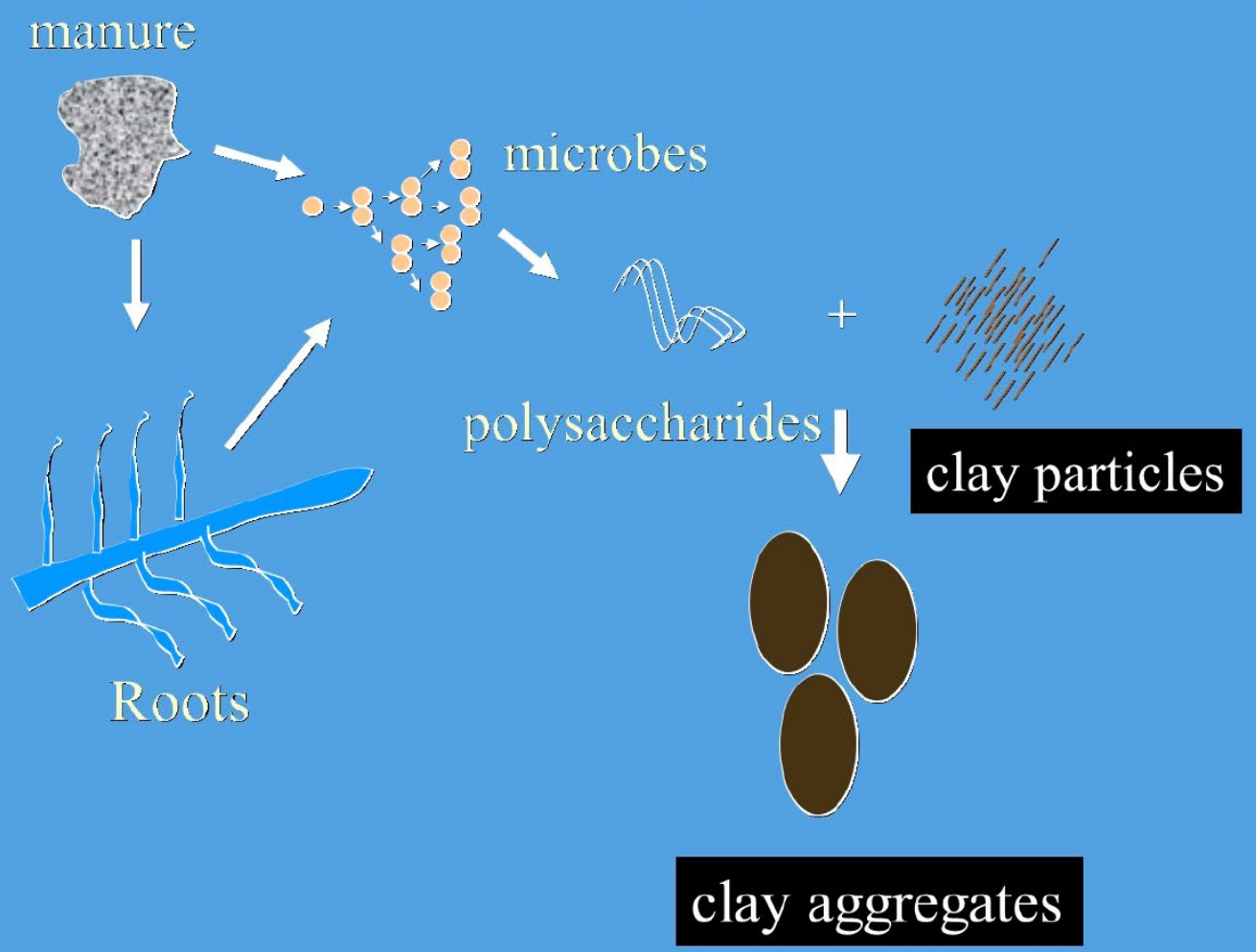
Can Subsoil Manuring increase ~~Water Use Efficiency~~ in crops and pastures ?

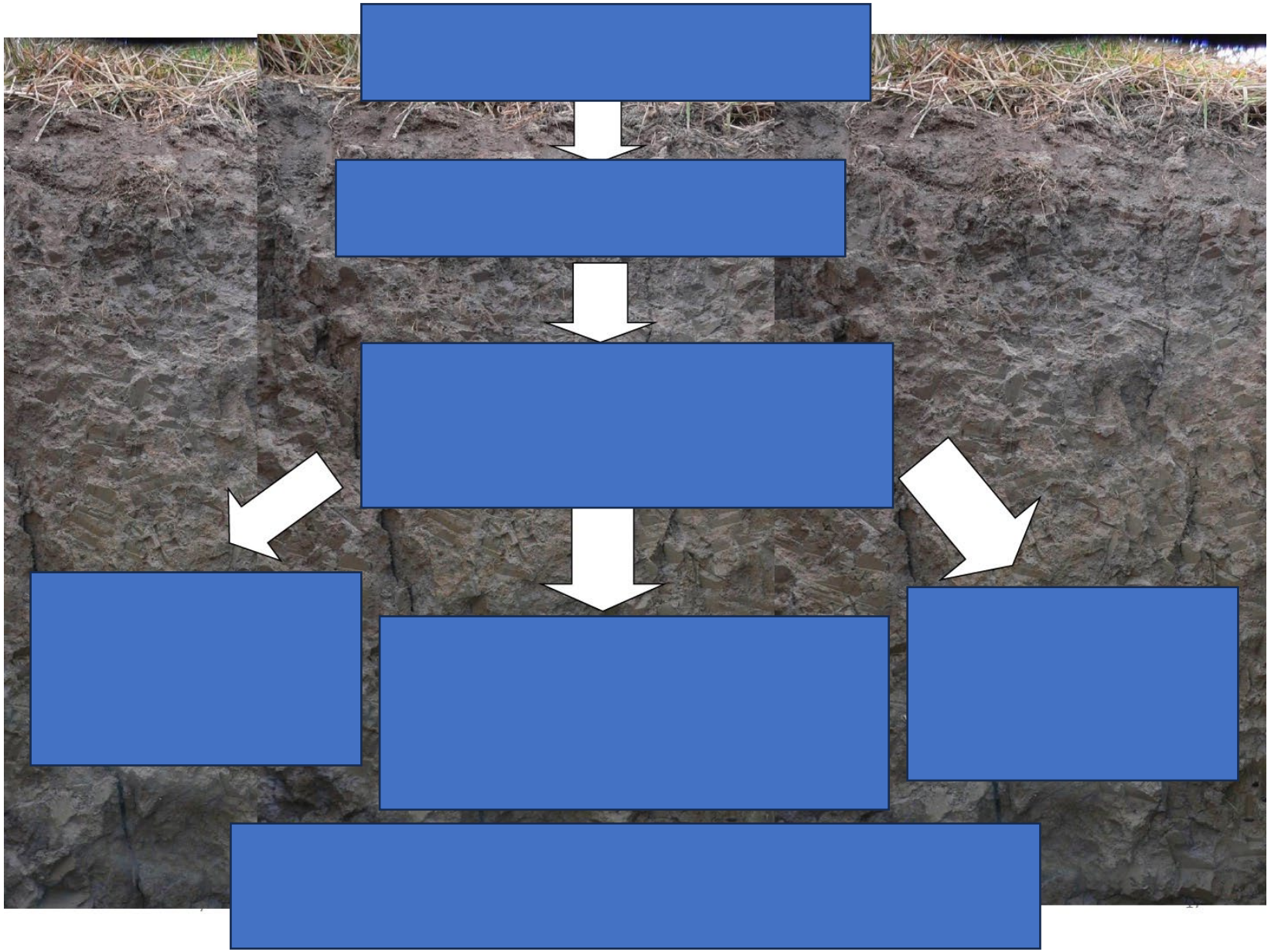
- where subsoils are physically constrained
- in average (rainfall) seasons in the HRZ
- No toxicities in the topsoil or subsoil
- in rain fed CROPS ✔ ✔
- in rain fed PASTURES ? ?

Evidence (19 years) - Subsoil Manuring can …

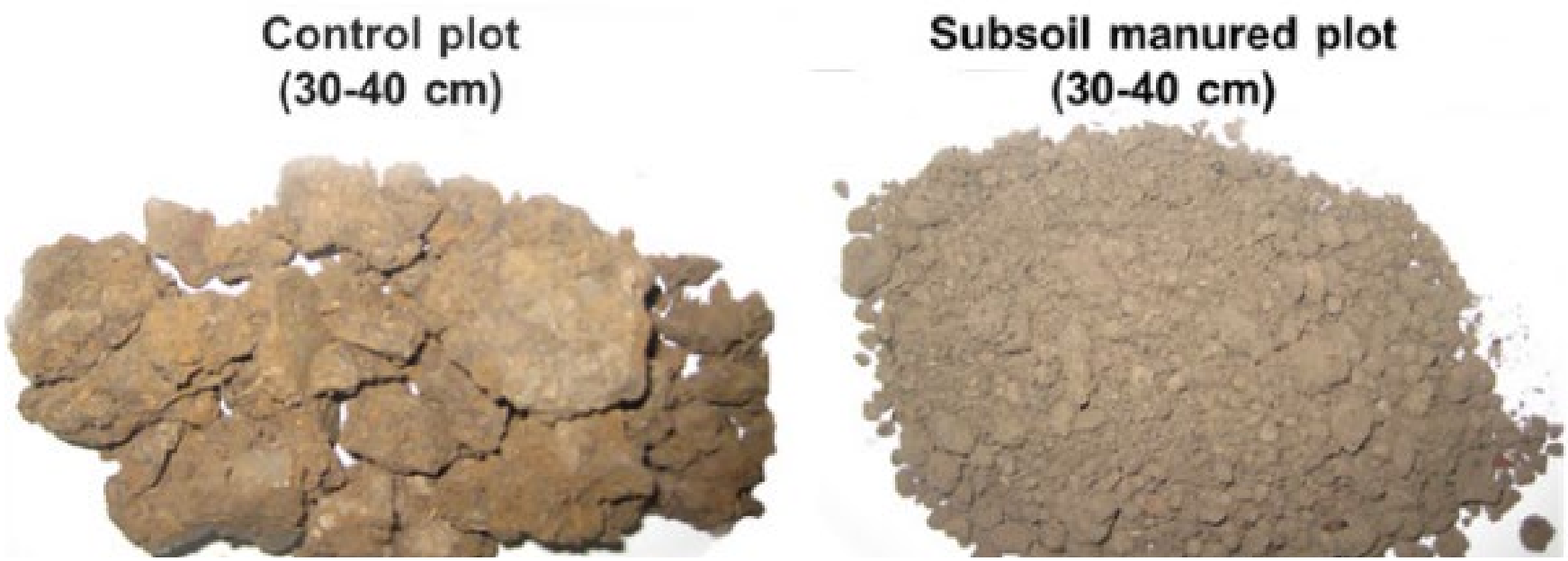
1. “TRANSFORM” the subsoil physically
2. “USE” more subsoil water by crops
3. “CAPTURE” more rain in the subsoil
4. “STORE” more rainfall in subsoil
5. “REDUCE” waterlogging
6. “USE” soil water “more efficiently”.

Why the transformation ?

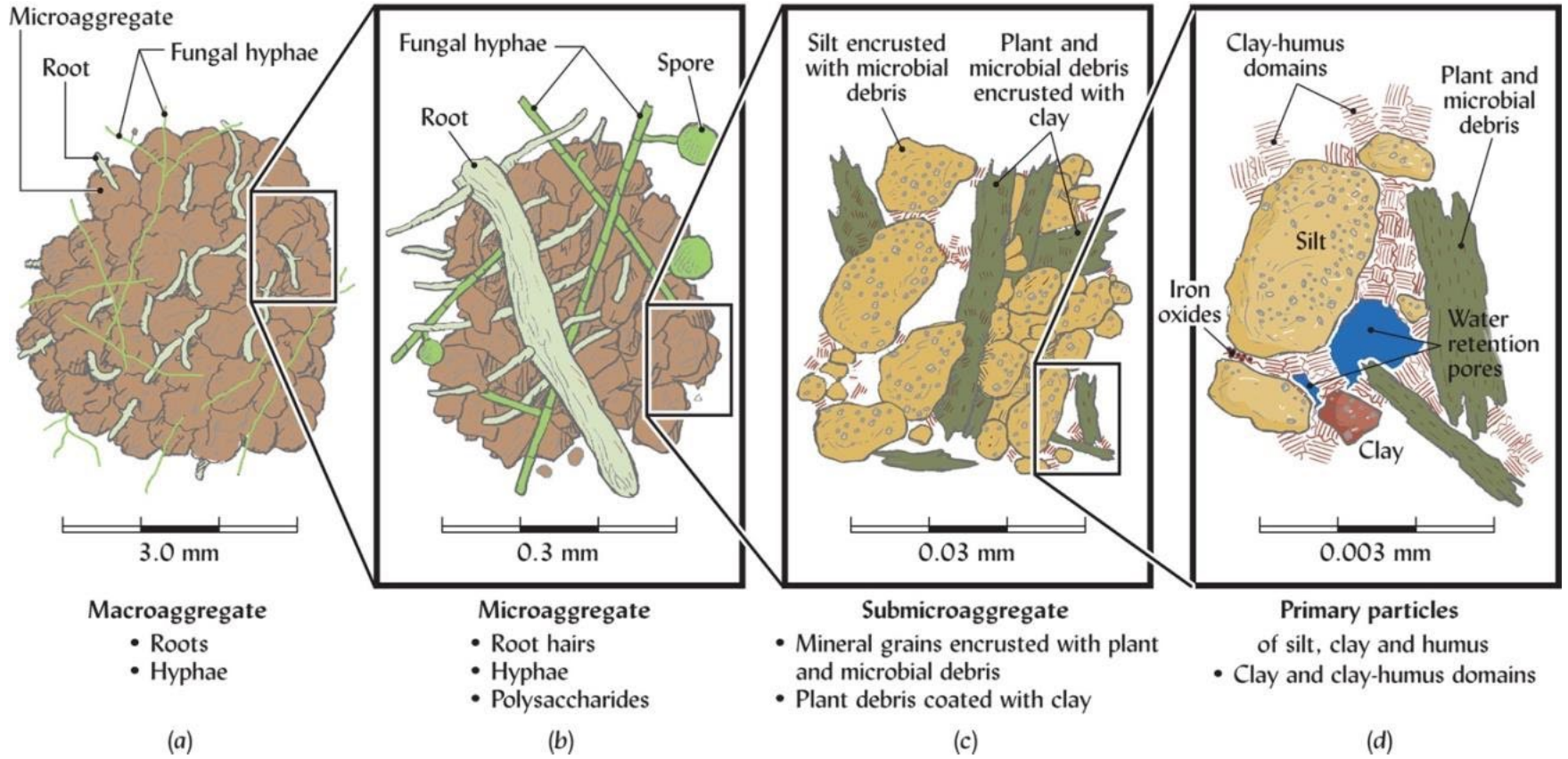




1. “TRANSFORM” the subsoil physically



Nutrients → Root growth + Fungal Hyphae + Dry-Rewet (Shrink-Swell) → Aggregation → Increased Infiltration → Increased ‘Bucket Size’



2. “USE” more subsoil water by the crop

The 2005 wheat crop at Ballan, in SW Victoria

Control 7.1 t/ha
SSM 12.3 t/ha

3. “CAPTURE” more rainfall into the subsoil

During the summer 2005-2006 fallow period
between crops at Ballan, in SW Victoria

Summer/autumn rainfall 200mm

Rainfall capture

Commercial paddock **75 mm**

Subsoil manured pdk. **150 mm**

4. “STORE” more rainfall in the subsoil

After 2012 wheat crop at Stewarton in NE Victoria measured Plant Available Water capacity in soil

Subsoil manured plots

Control plots

Measured soil water
after the crop

“Crop lower limit”
(CLL)

Measured soil water
when watered to capacity

“Drained upper limit”
(DUL)

Plant available water storage capacity = DUL - CLL

(Plant available) Water storage capacity

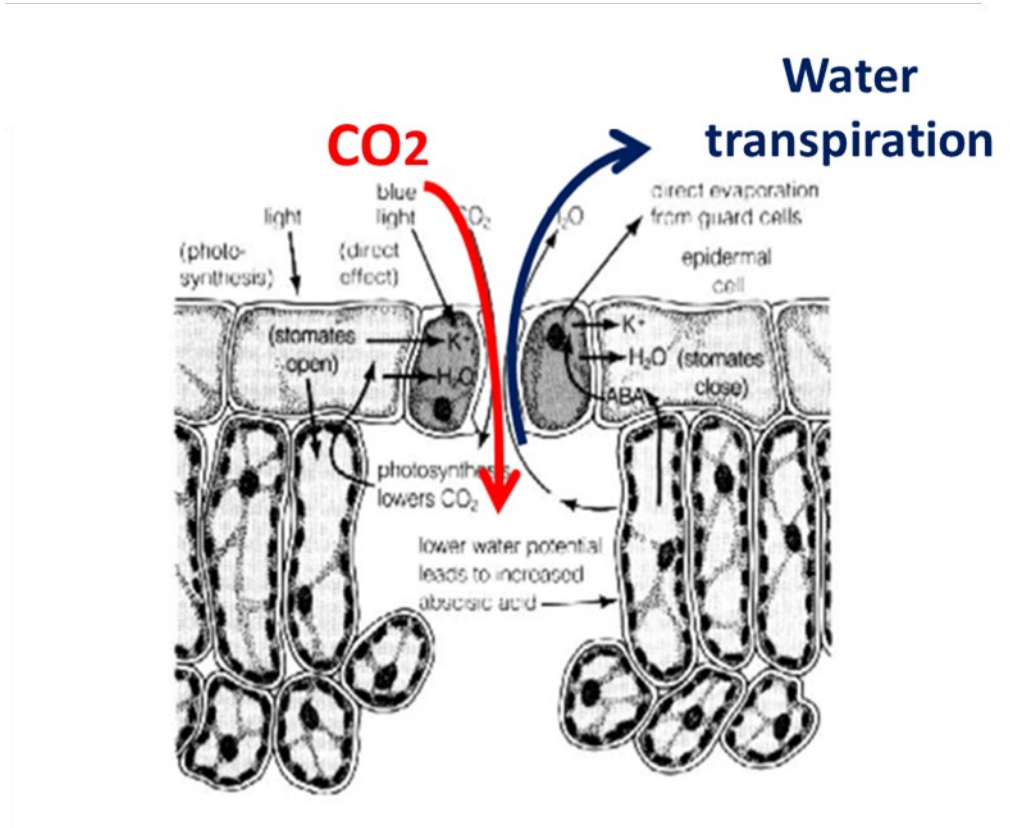
	Control	Subsoil manuring
Topsoil (0-40 cm)	98 mm	104 mm
Subsoil (40-100 cm)	60 mm	138 mm

An extra 78 mm of plant available water in the subsoil enough for extra 3 tonnes wheat/ha

5. “REDUCE” water-logging

Anecdotal observations

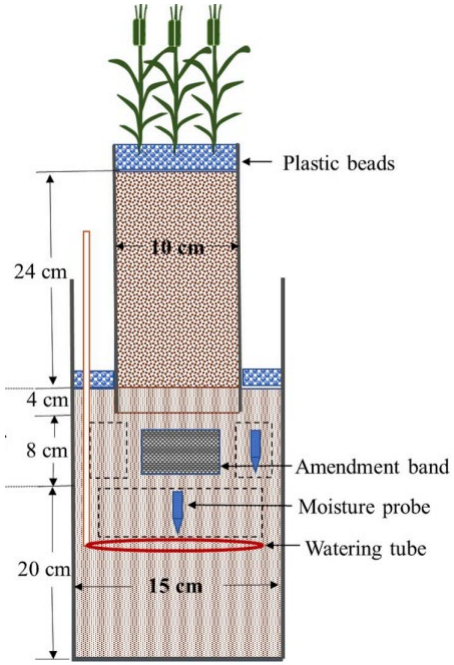
6. “USE” soil water “more efficiently”



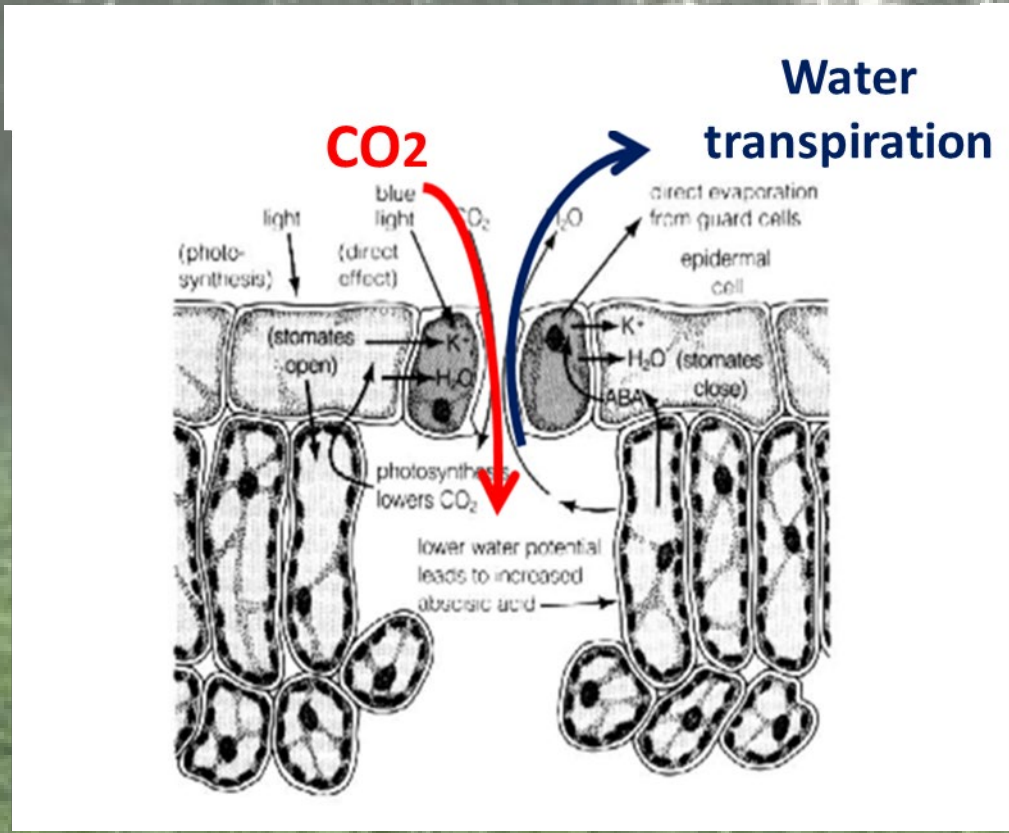
6. Using soil water “more efficiently”

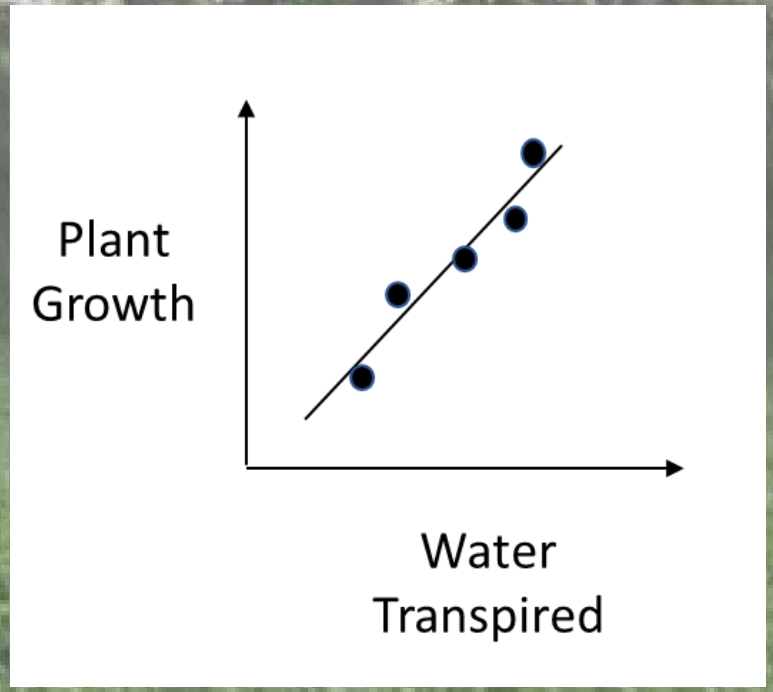
From soil column experiments

	Shoot DM growth (grams)	Water Transpired (litres)	TRANSPIRATION EFFICIENCY (growth/water trans.)
Deep fertiliser (N,P,K,S)	15.4	4.8	**3.19**
Deep nutrient-rich ORGANICS	20.0	4.8	**4.17**



Crop/pasture plants need to use (transpire)
every drop of rain that falls on a paddock….





Rainfall use efficiency in dryland agriculture is a *BIG* deal !

Alternatives to Subsoil Manuring

- Cover Crops?
- Multi-species
- Dense cover = dense root growth
- Species such as ‘Tillage Radish’
- Long-term effect
- Possible By-pass flow
- Eg Lucerne (Gill et al),
- woody vegetation (Yanusa & Newton)

Case study – West Gippsland

Kurosol – Acidic texture-contrast soil profile

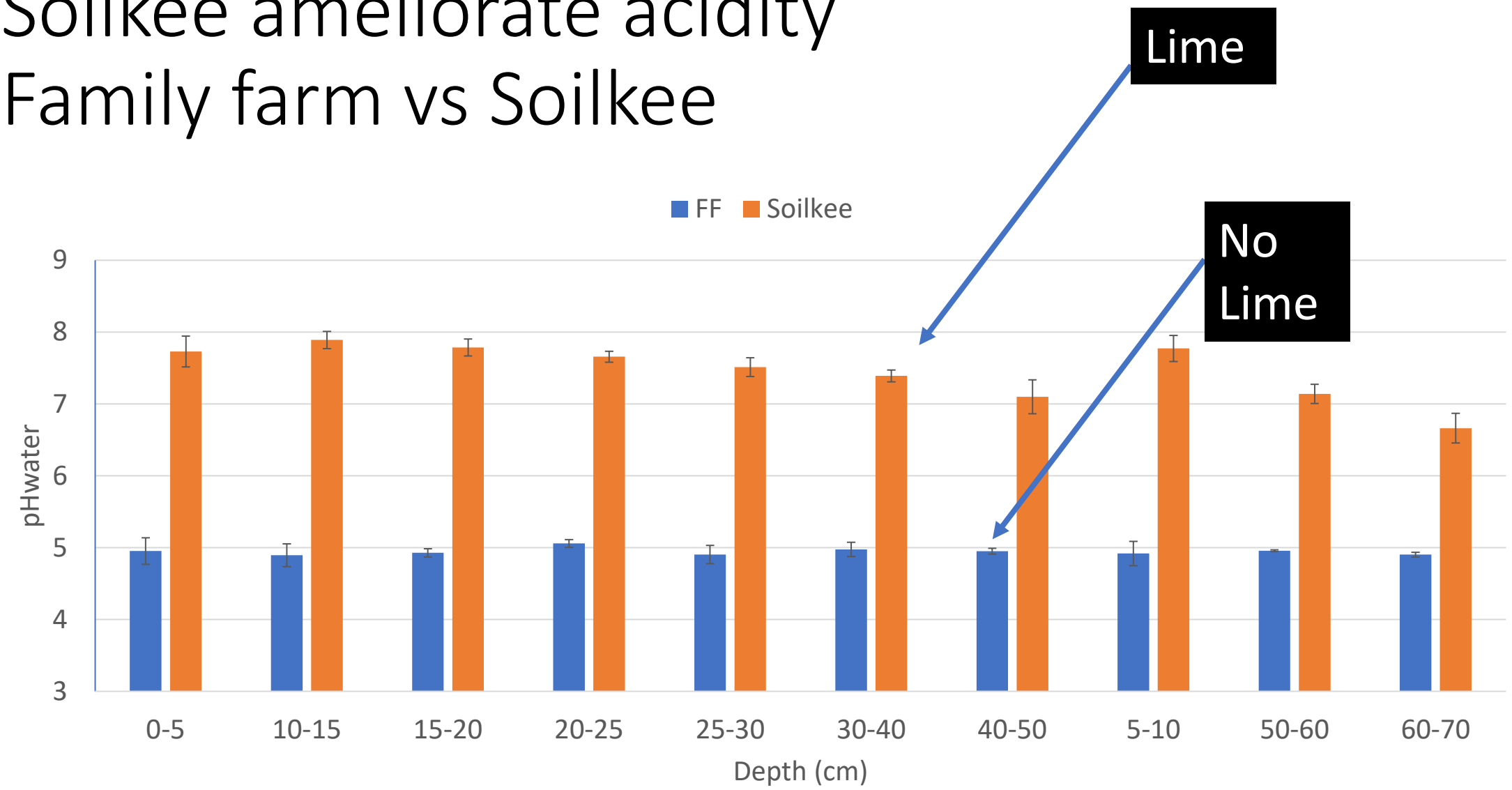
GP56 Profile

Soilkee

- Pasture renovation with cover crop species
- MSCC
- Chaff cut
- Cultivation for seed sowing
- Seed sown
- Autumn
- Spring
- Grazing

Soilkee

Soilkee ameliorate acidity
Family farm vs Soilkee



Soilkee – subsoil improvement

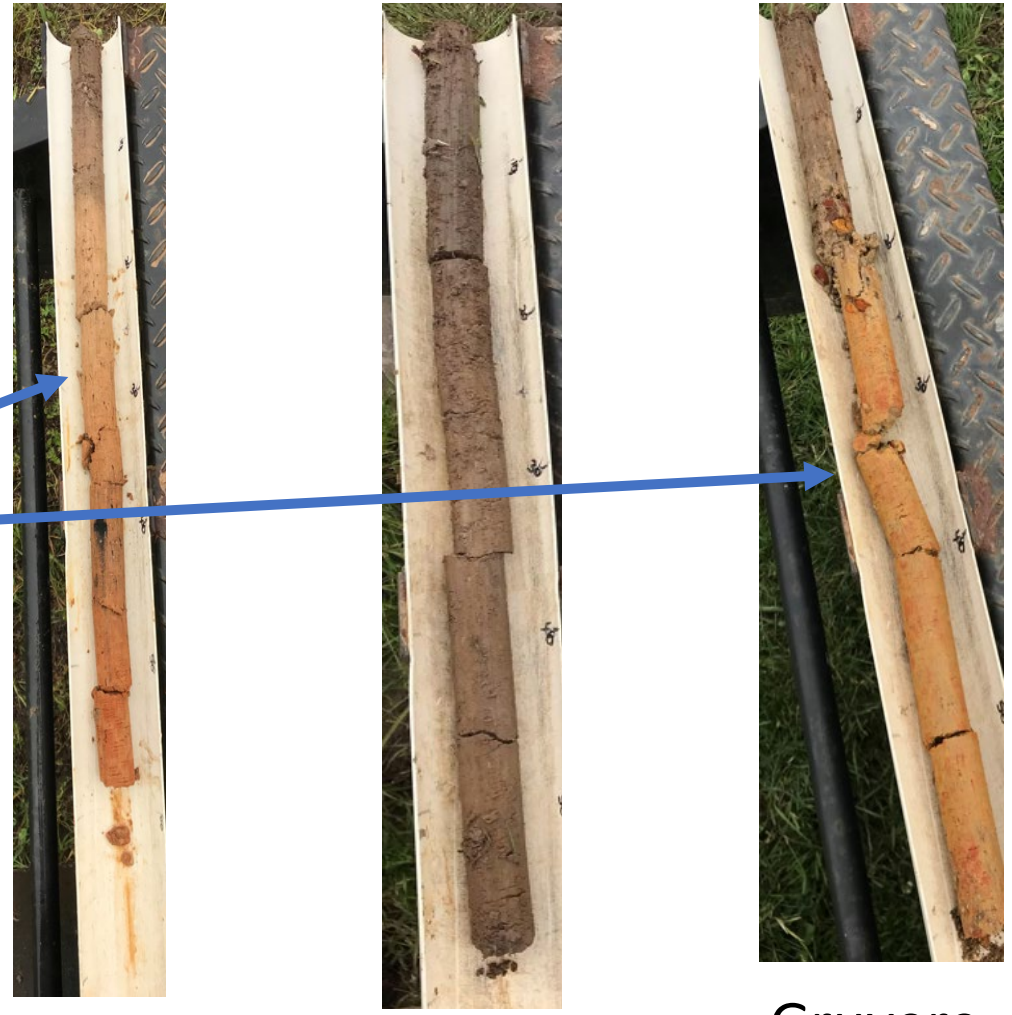
- ~1000 mm rainfall
- Highly acidic soil profile

Synopsis

- Soil carbon increase
- High rainfall
- High input
  - Biomass – twice a year
  - Seed input
  - Cell grazing
  - Dung
  - Urine

Subsoil Constraints – Yarra Valley Grazing

- Grazing restricted in poorly drained paddocks in winter
- Poor drainage due to poorly structured subsoil
- Very mottled subsoils



Booroolite Coldstream Gruyere

Yarra Valley Subsoil Improvement

- Improve drainage
- Careful analysis of soil

Depth (cm)	pH CaCl2	pH water	Exchangeable Al (%)	Extractable Al in KCL (ppm)	Extractable Mn in CaCl2
0-10	4.9	5.6	1.6%	10	-
10-20	4.7	5.4	4.4%	20	-
20-30	4.7	5.4	6.5%	22	-
30-40	4.7	5.3	8.3%	29	-
40-50	4.8	5.5	4.4%	12	-

Booralite

Depth (cm)	pH CaCl2	pH water	Exchangeable Al (%)	Extractable Al in KCL (ppm)	Extractable Mn in CaCl2
0-10	5.1	6.1	< 1.0	< 9	-
10-20	4.5	5.5	**34%**	65	3
20-30	4.4	5.5	**42%**	98	3
30-40	**4.2**	5.5	**50%**	260	4
40-50	**4.3**	5.5	**44%**	290	3

Booroolite

YV Grazing - Solution

- Amend acidity – Priority 1
- Subsoil improvement – Priority 2
- Solution – Trial
- Deep Rip - Strips
- DR + Lime - Strips
- DR + CM - Strips
- Soilkee – Strips @ 90° to Deep Rip strips

YV – Grazing – Sampling

- Biomass Sampling
- Soil Core Sampling
- Strips – paired sampling

Cover Crops and Soil Carbon

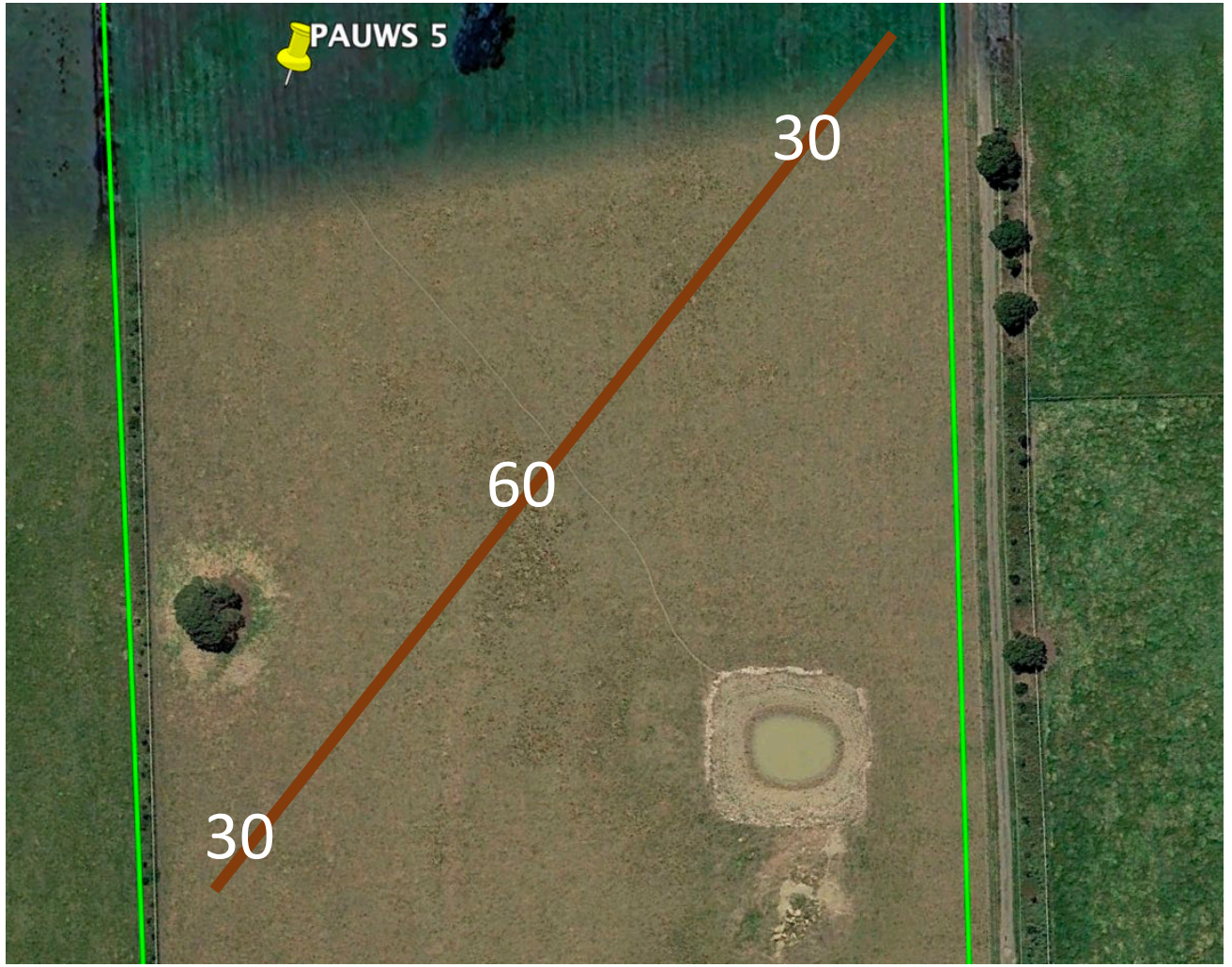
- Increase
- Decrease
- Soil type
- Climate
- Farming system
- Soil health benefits

Decision Making for Producers

- Idea for soil improvement
- Set-up Experiment
- Measure
- Biomass
- Soil measurements
- Replication if possible

Data – Sorts the variation

- Melbourne Poly Farm – Yan Yean
- Transect with students
- Depth to B-horizon (Clay subsoil)
- Trial
- Where to measure?
- Plan to incorporate the variation into sampling plan
- Deep Cores are essential



Soil Health Assessment Missouri

University of Missouri External Soil Health Assessment Center

Sample prep	$2.00 and up	Depends on what kind of prep work is required.
Bulk density*	$15 and up	Depends on what kind of bulk density is required.
pH	$6.00	1:1 Water plus 1:2 .01M CaCl2
% Total nitrogen	$12.00	Combustion analyzer
% Total nitrogen & total carbon	$15.00	Combustion analyzer
% Total carbon	$7.00	Combustion analyzer
% Organic carbon	$7.00	Combustion analyzer
% Inorganic carbon+TC +TOC	$10.00	Total carbon minus Organic carbon
% Organic matter	$7.00	Thermogravimetric Analysis
Exchangeable cations	$13.50	Ca, Mg, Na, K from buffered NH4OAc extract by flame AA
CEC	$13.50	NH4OAc extract; vacuum extraction; direct measure
Exchang. cations + CEC	$25.00	NH4OAc extract; vacuum extraction;
Exchangeable cations	$13.50	Same as above, but from unbuffered NH4Cl extract
CEC	$13.50	NH4OAc extract; vacuum extraction; direct measure
Exchang. cations + CEC	$25.00	NH4OAc extract; vacuum extraction;
Bray1 P	$7.00	
Al or Mn	$15.00	KCl extract
Neutralizable Acidity	$15.00	BaCl2 extract
ElectroConductivity	$7.00	1:1 soil water slurry
Particle Size Determination	$40.00	<2mm size fraction broken down to 8 size categories
Simplified PSD	$18.00	only total % sand, silt, and clay reported for < 2mm
PLFA**	$55.00	Gas Chromatograph
NLFA**	$55.00	Gas Chromatograph
PLFA+NLFA**	$70.00	(Introductory Price) Gas Chromatograph
Mineralizable Nitrogen	$15.00	7-day incubation (Measurement after incubation only)
Mineralizable Nitrogen	$30.00	7-day incubation (Measurement before and after incubation)
Wet Aggregate Stability	$12.00	Sieve dipping method
Active Carbon (POXC)	$12.00	Weil method
Respiration	$15.00	Cornell method

Soil Health - Measurement


Thank You for Listening!