Soil Management for Rehabilitation

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Presentation outline

- Importance of soil quality
- Overview of the soil management process
- A look at some of the more interesting management options
- Topsoil substitutes and alternatives

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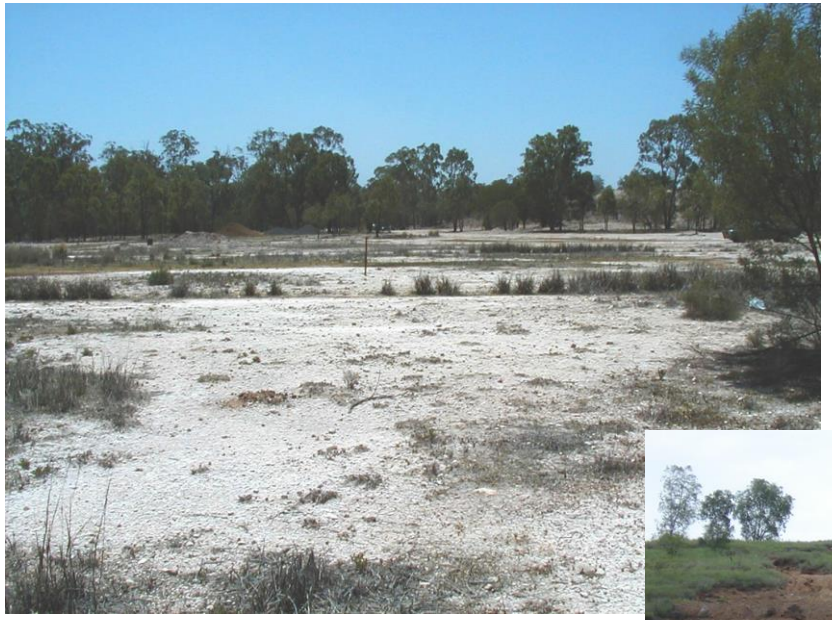
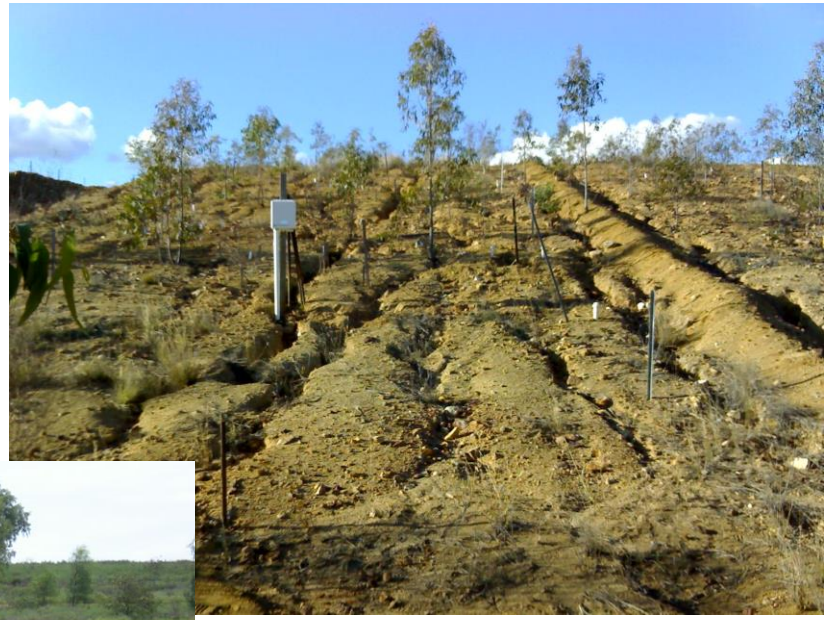
Importance of soil quality ….

If soil is poor, rehabilitation can be difficult, costly, and temporary.





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Defining “good soil” can be a challenge

For example

Low gradient site: low erosion risk, goal of strong grass growth

Heavy clay, high chemical fertility, moderate infiltration is ideal.

Sloping site: high erosion risk, goal of native woodland

A highly erodible heavy clay will be high risk and will tend to favour grass over trees.

So the “ideal” soil can vary considerably, and the key requirement is **“fit for purpose”.**

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The management process

In general, soil management follows a series of steps:

1. Define goals and risks for rehabilitation
2. Set targets for soil
3. Inventory resources available
4. Analyse (characterise)
5. Develop plan to achieve targets
6. Negotiate (if additional resources are needed)

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Management: 1. Goals and risks

These might include:

- Vegetation type and coverage
- Biomass production levels
- Sustainability
- Trafficability
- Aesthetic quality
- Erosion control
- Salinity and deep drainage control
- Runoff water quality

NOTE: Goals and risks vary enormously from project to project!

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Management: 2. Targets (soil)

Determine what soil profile and surface properties will achieve rehabilitation goals and manage the risks. Key soil properties include:

- Water holding capacity
- Nutrient contents and storage capacity
- Likely water balance (infiltration vs runoff and deep drainage)
- Erodibility
- Other additions (rock, vegetation, erosion control products)

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Management: 3. Inventory

Determine what is available, which may include:

- Soil types
- Soil horizons
- Organic wastes (municipal, intensive agriculture)
- Inorganic wastes (mine overburden, tailings, rocky layers from depth)
- Various forms of vegetative material (stripped from site)

There is potential to be creative at this point …

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Management: 4. Analyses

Detailed and thorough analysis is essential. You can't manage something if you know nothing about it! Key points:

- Sample comprehensively and consistently
- Record sampling information
- Use competent accredited laboratories
- Obtain analyses based on genuine soil science
- Ensure analytical suites cover ALL important soil properties

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Management: 5. How to achieve soil targets

There are a lot of options/actions available for an informed soil scientist to achieve the targets set, including:

- Soil and soil horizon selection
- Depth of placement and possible horizons
- Amendment (lime, gypsum, compost and other organic matter)
- Fertiliser (elements, rates, formulations, placement, timing)
- Vegetation (Species, forms, sequencing)
- Rock, tree debris, proprietary covers
- Biological (pixie dust and real stuff)
- Wastes (overburden and tailings – if on a mine)
- Time

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Management: 6. Negotiate, source

In some cases, access to additional or expensive options may need to be negotiated. Depending on sites, extras that may need to be sourced externally include:

- Rock
- Composted manure
- Clay rich materials
- Surface stabilisation materials/products

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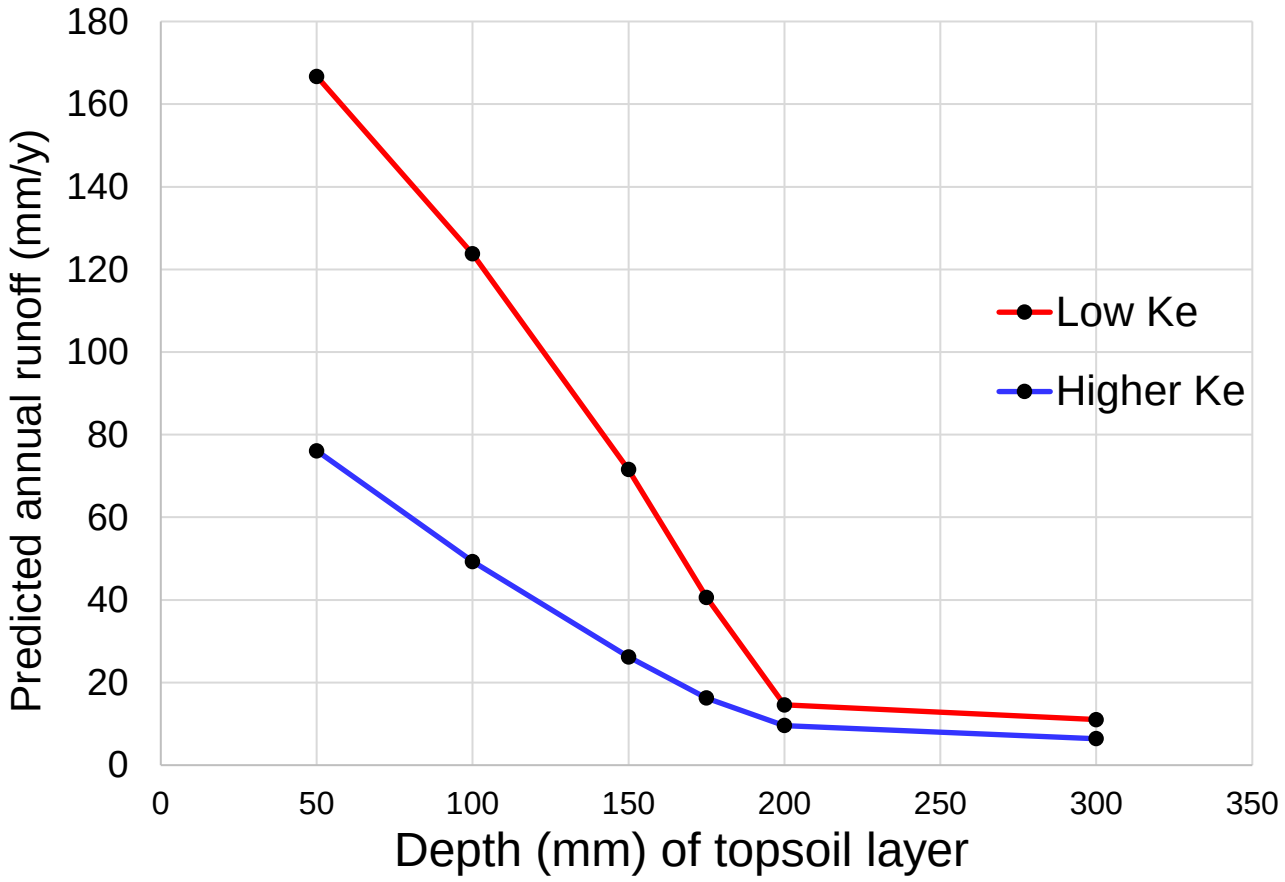
Soil management options – topsoil depth

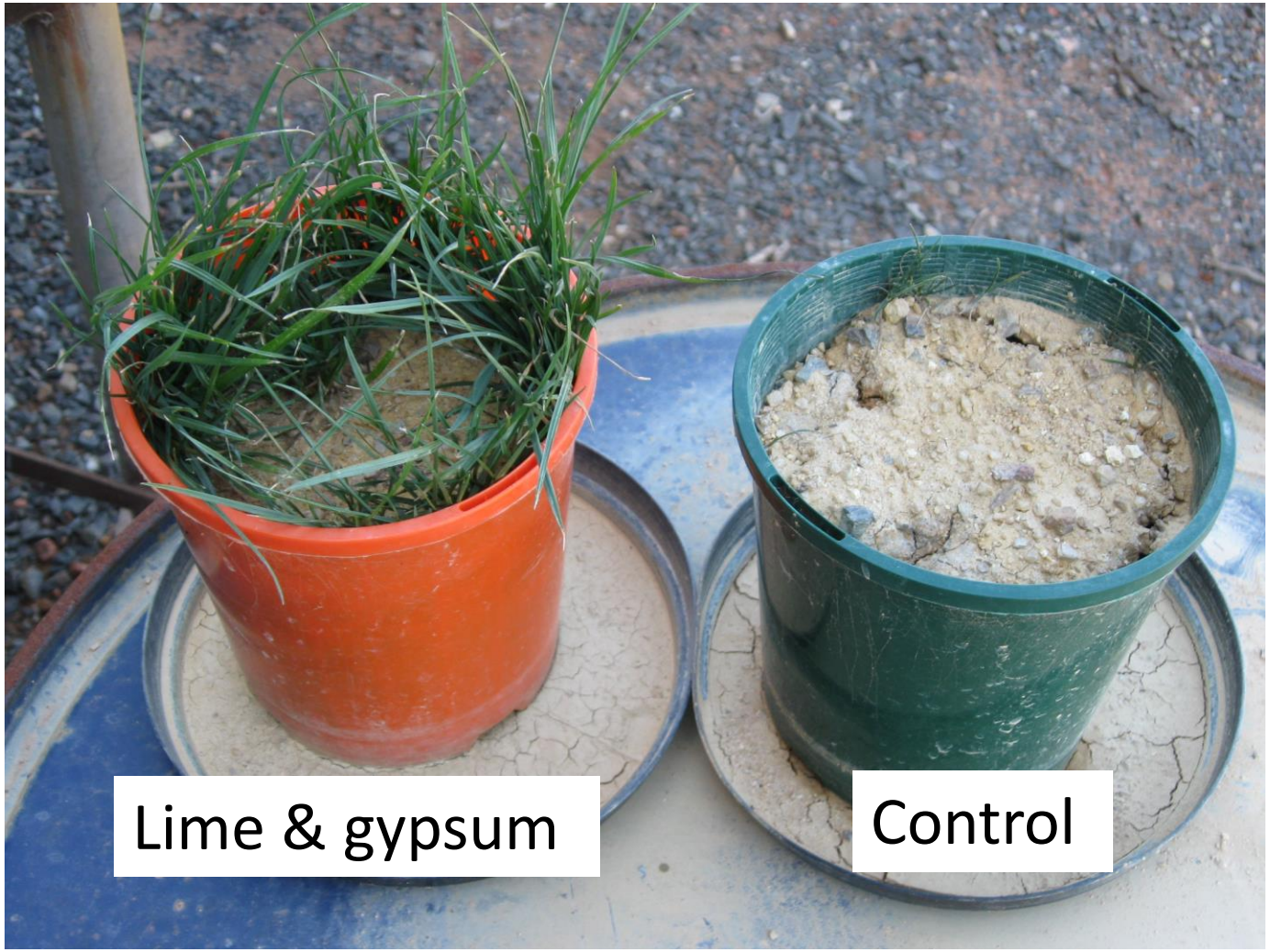
Impact of topsoil depth on runoff and erosion potential.



Victorian site, subsoil infiltration rates of 4.8 (low) and 13.2 mm/h (higher)

Predicted impacts of topsoil depth and subsoil hydraulic conductivity on predicted annual runoff,.

Amendments



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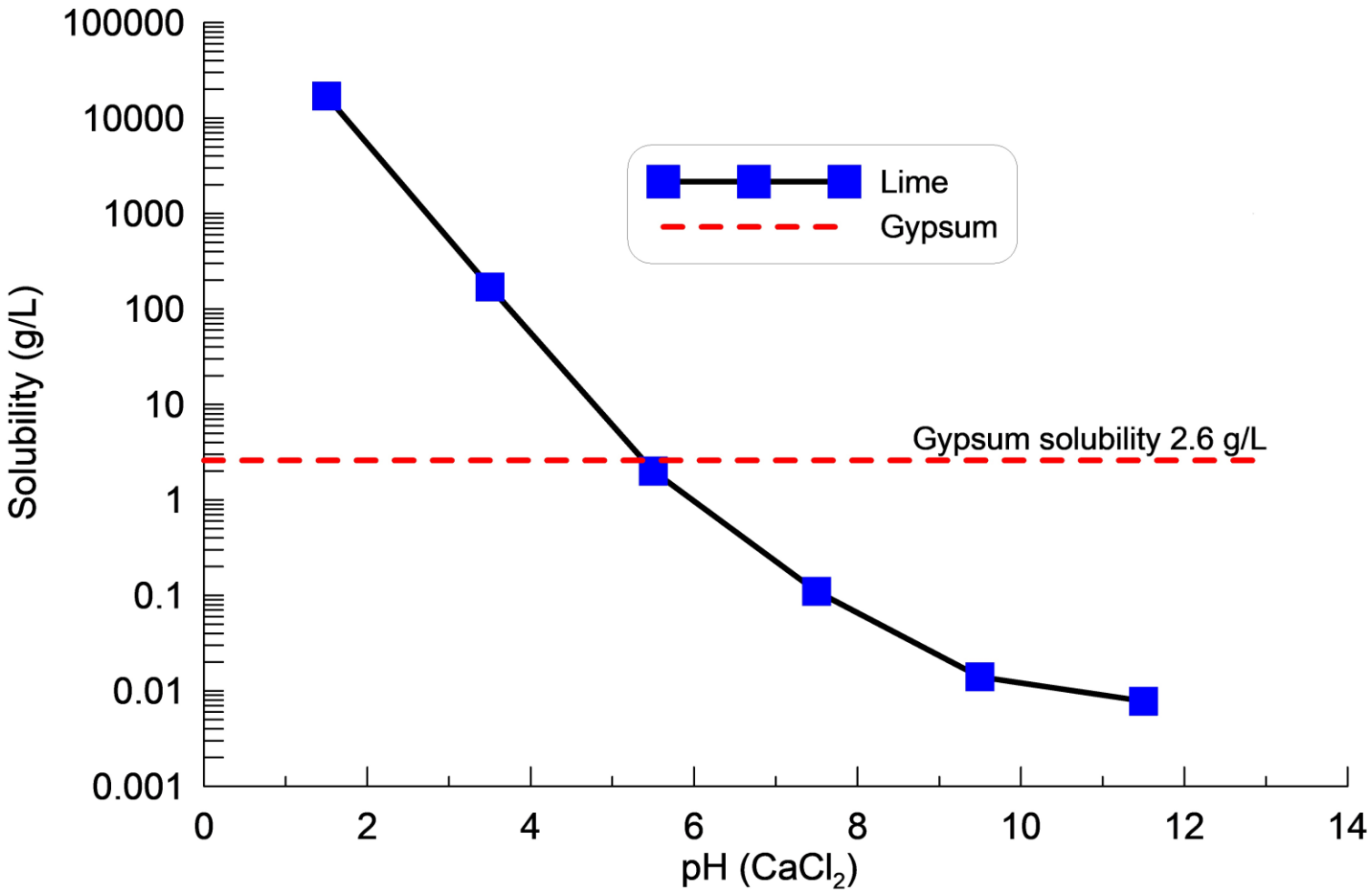
The reason why we use Lime and Gypsum



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Fertilisers – some comments

- Plants need nutrients to grow. (Even native plants!)
- But match nutrition to the plant.
- Understand microbial associations.
- Placement (both depth and timing) is important.
- Consider the aim of fertilizing – to support one year's growth, or to establish a sustainable system?
- Consider options in terms of formulations, coatings, and manures.

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What to do with highly infertile soil?

Example – very low total N

Measured: 350 mg/kg, surface 100 mm.

Target: 1000 mg/kg in the surface layer

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To increase total N of the 100 mm deep layer by 650 mg/kg, (650 kg per 1,000 tonnes), need to apply 650 kg of N.

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As urea (roughly 50% N), that would require 1.3 t/ha of urea.

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What to do with highly infertile soil?

And so we come to the conundrum …

There are limits to the amounts of soluble fertiliser that can be added at one time.

With soluble formulations, we can often only fertilise for 1 – 2 years of growth.

How do we get soil fertility on an increasing path that will eventually get us to our target status?

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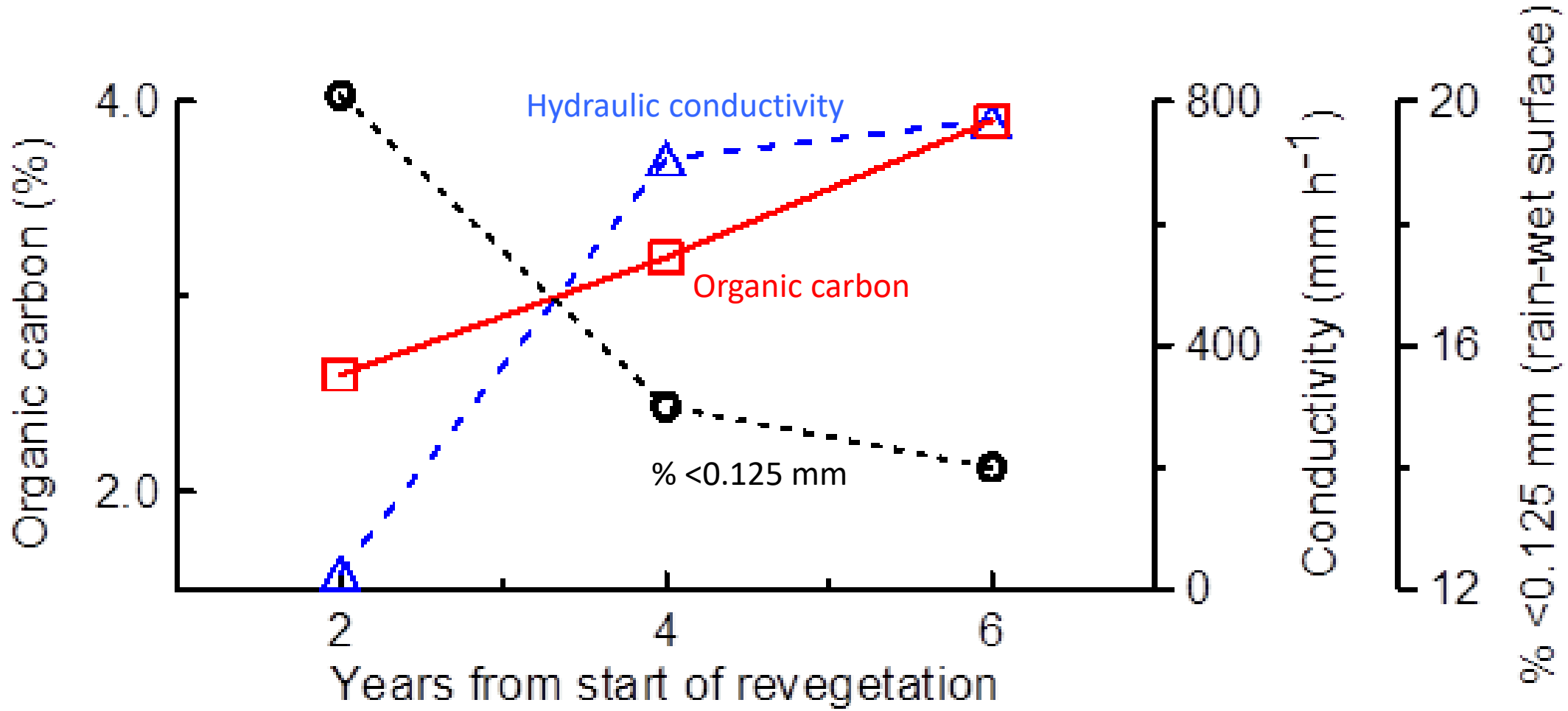
Changes with time



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Aggregation and erodibility (North Parkes Mine)

Batter	RUSLE K (corrected)	Wet Density (g/cc)	% <0.125 mm
Lower (2 yrs)	0.025	1.9	25.94
Upper (1 yr)	0.030	2.2	35.14

16.6% reduction in erodibility due to 1 extra year's plant growth

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Using wastes: an example with tailings

- Proposed Mineral Sands Mine – grazing land
- Existing soils quite infertile and unproductive (shallow sandy A horizon overlying highly dispersive and hard-set B horizon).
- Once the sandy surface layer saturated, runoff was quite high.
- Rehabilitation goal was relatively simple – grow more grass, more reliably.
- A major challenge was to increase overall water entry and storage, and to also increase potential storage of nutrients.

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Strategy

a) Discard dispersive B horizon
b) Find/develop a more suitable subsoil material
c) Detailed study of material properties
d) Pot trial to verify performance of re-constructed soil profiles.

In this case, there were 2 tailings streams available – fine & coarse.

Analyte	Unit	Fine Tailings	Coarse tailings
Coarse Sand (0.2-2.0mm)	**%**	**0.0**	**0.3**
Fine Sand (0.02-0.2mm)	**%**	**36.6**	**95.4**
Silt (0.002-0.02mm)	**%**	**22.3**	**1.1**
Clay (<0.002mm)	**%**	**41.1**	**0.9**

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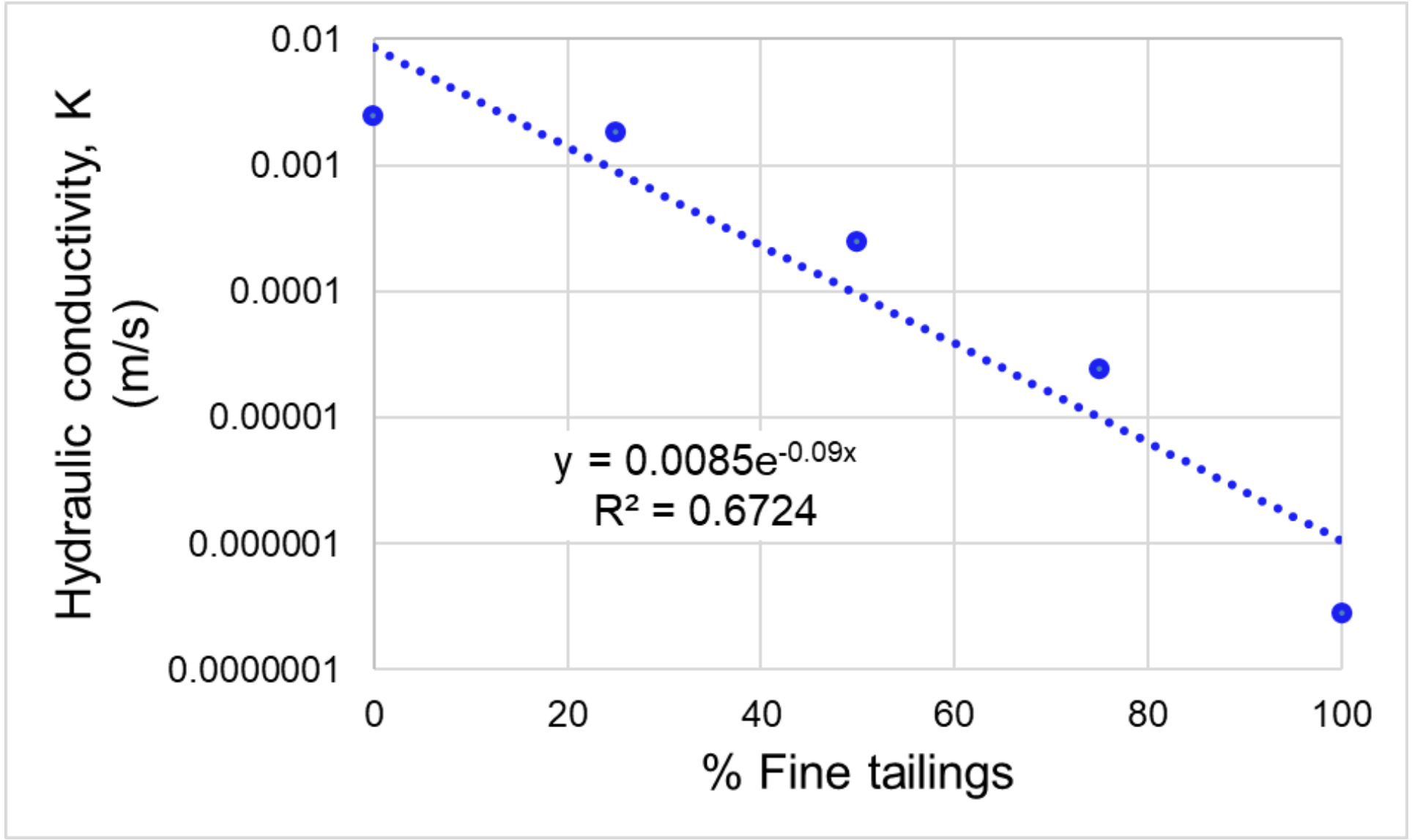
Testing tailings mixes: infiltration



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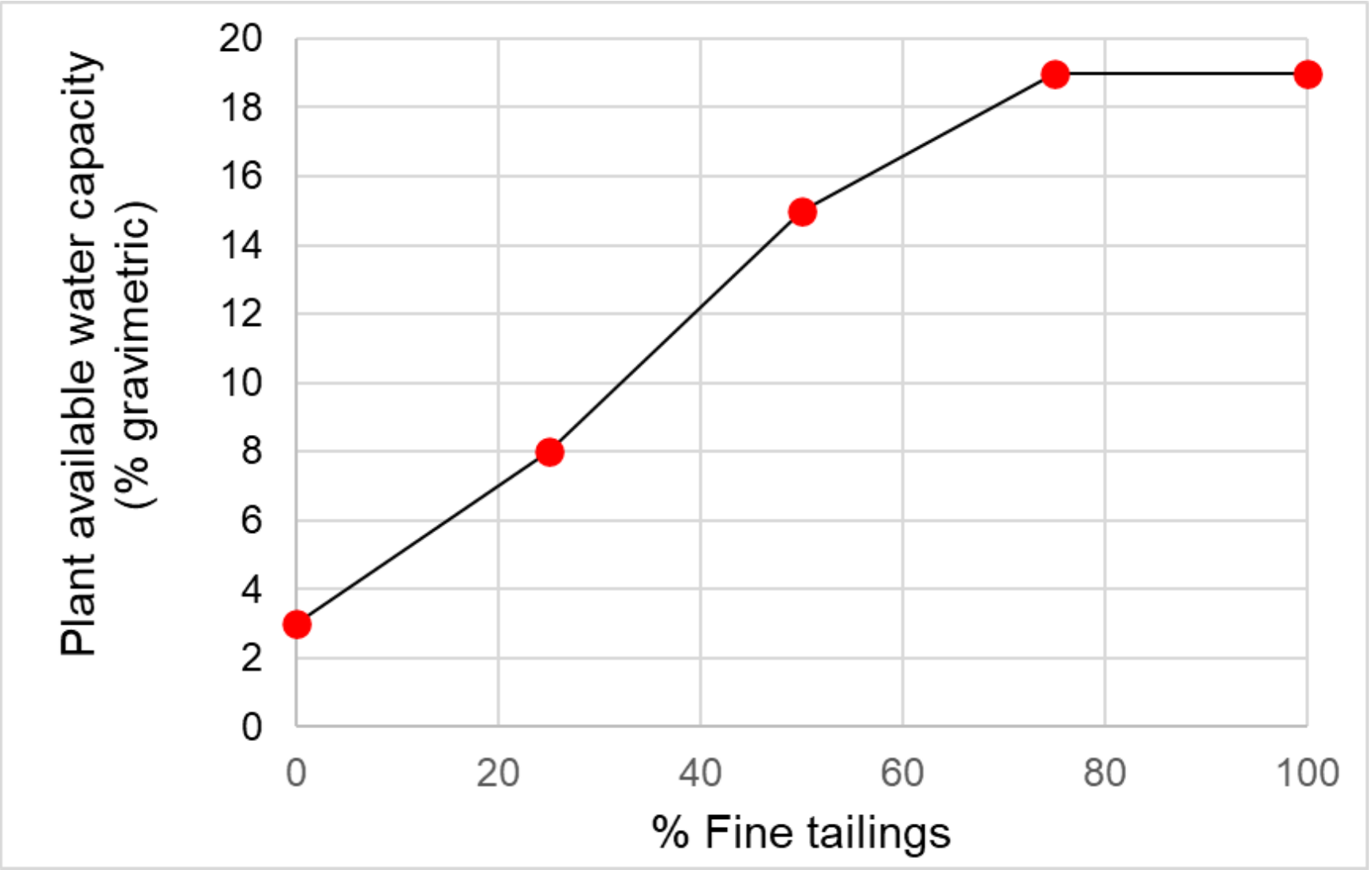
Testing tailings mixes: water storage



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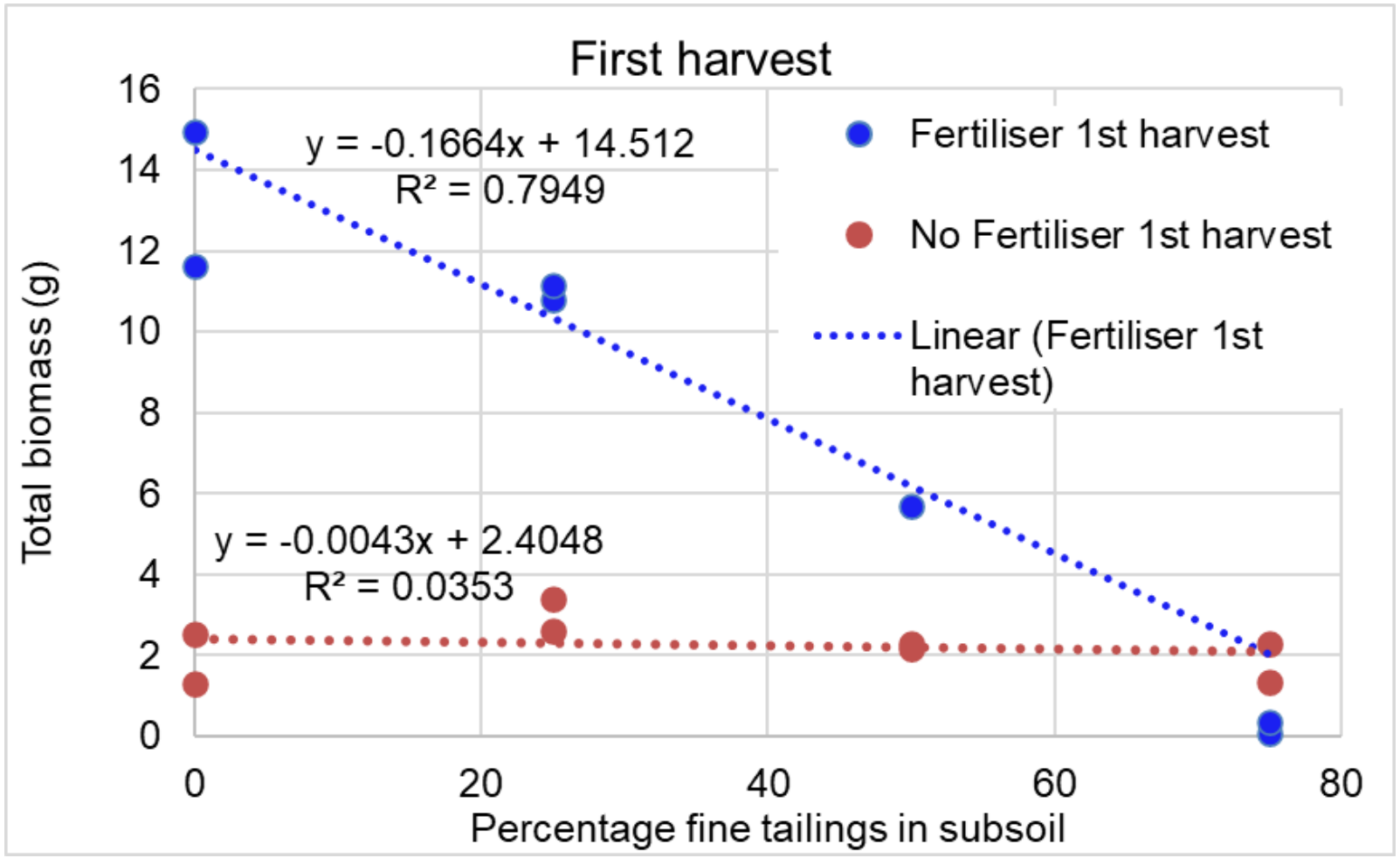
Tailings mixes – plant growth (winter)



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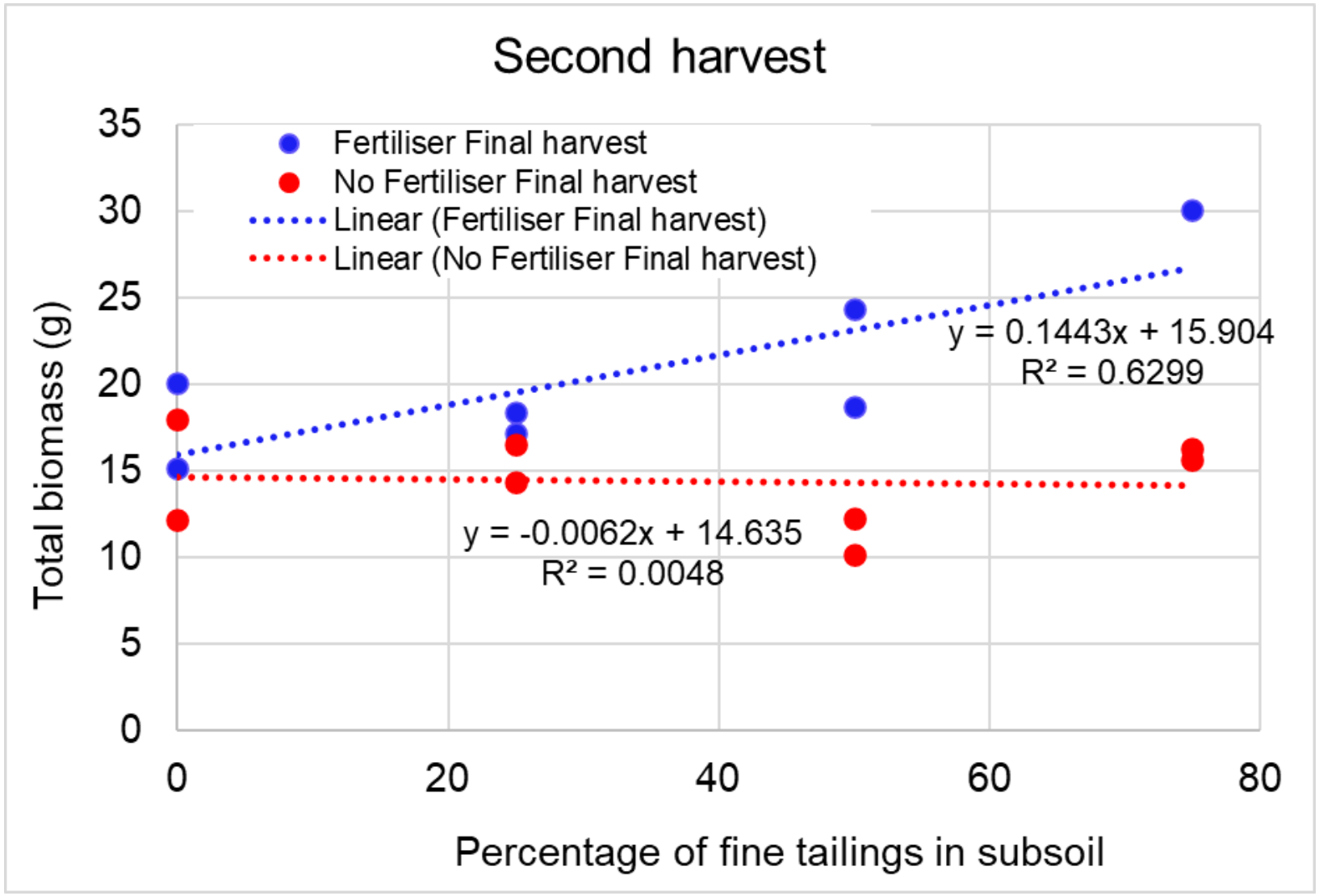
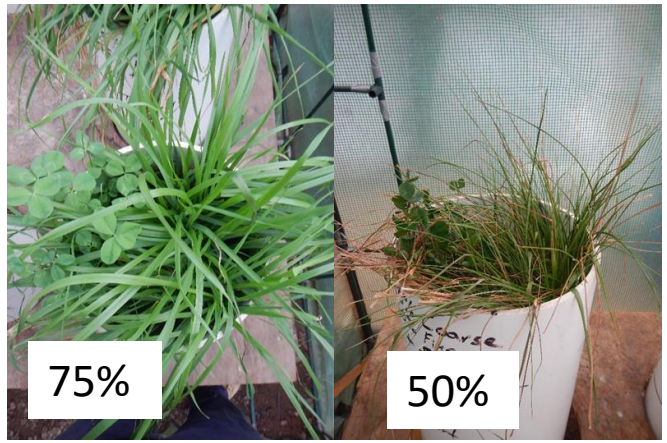
Tailings mixes – plant growth (summer)





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Tailings mixes: study conclusion

- Definitely proved the concept
- Questions remained re: impacts of plant growth and time
- Lot of detail gathered re: management of soil fertility
- Next step was field trials, but project has since been discontinued
- Nonetheless, the studies demonstrated that various mixtures can be planned and assessed objectively, in terms of both:
  - material properties; and
  - design of functional profiles.

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Alternative growth media?

Not a topic for research, but application of detailed soil science is overdue.

A key barrier has been the lack of comprehensive data on the materials that might be used.

Equally, clear definition of “soil” property targets seems to be lacking in many cases.

In general, application of the topsoil management process outlined in this presentation gives a blueprint for development of alternative growth media.

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And the final word?

You can't manage something if you know nothing about it.

Analyses are an investment, not a cost!!!

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