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**Sustainable Development Conference**

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# Assessment of covers for the reclamation of base metal tailings, Cannington Ag-Pb-Zn mine

**Bernd Lottermoser, James Cook University**

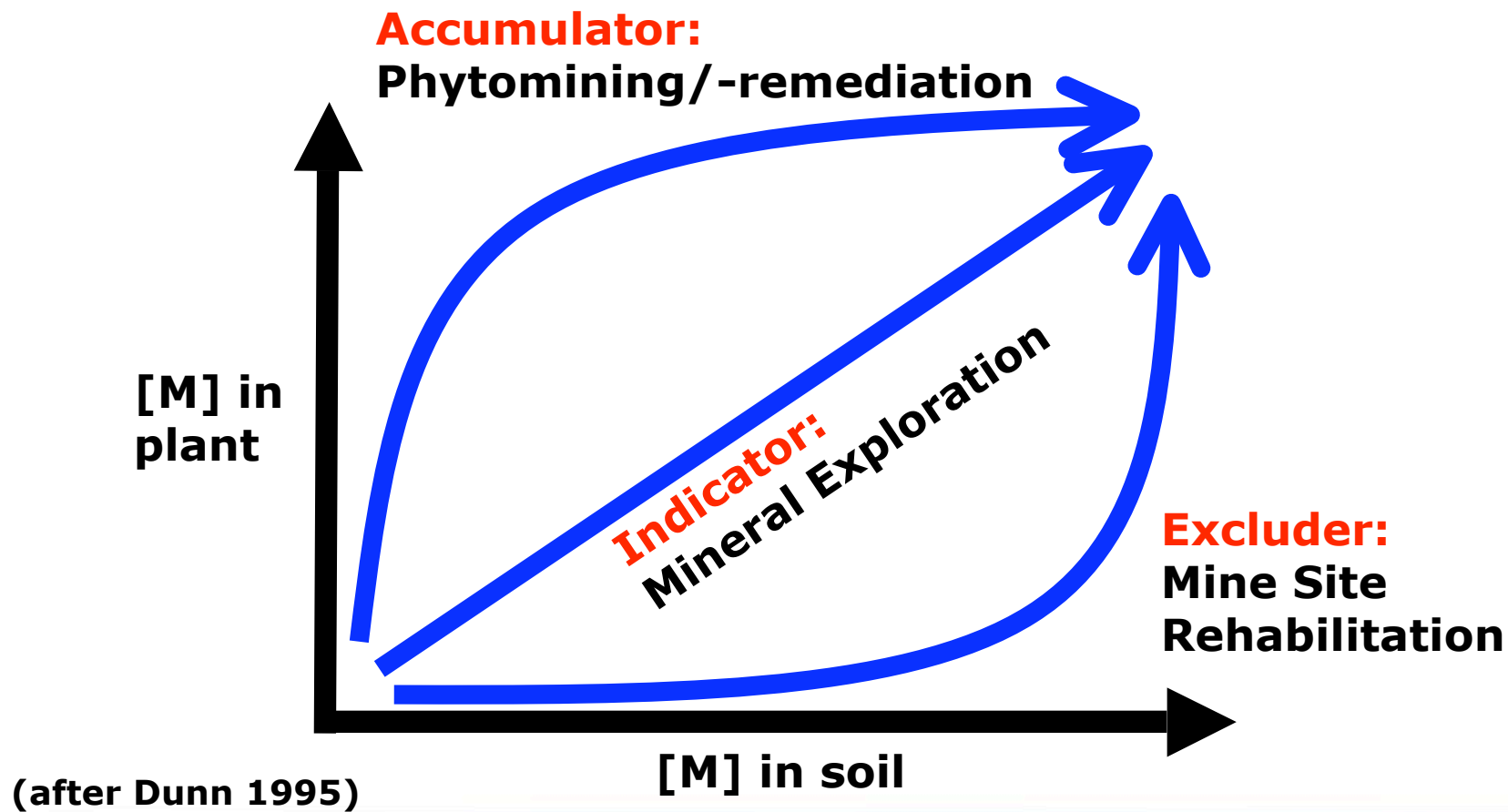
**Mark Daniell, BHP Billiton Cannington**

**Niels Munksgaard, James Cook University**

**Paul Ashley, University of New England**

**SOLUTIONS THROUGH COLLABORATION**

## Plant response to metal [M] enrichment in soils



- **Project objective**
  - **Nature of native plants revegetation potential to colonise dry covers**
  - **Implications for dry cover designs**

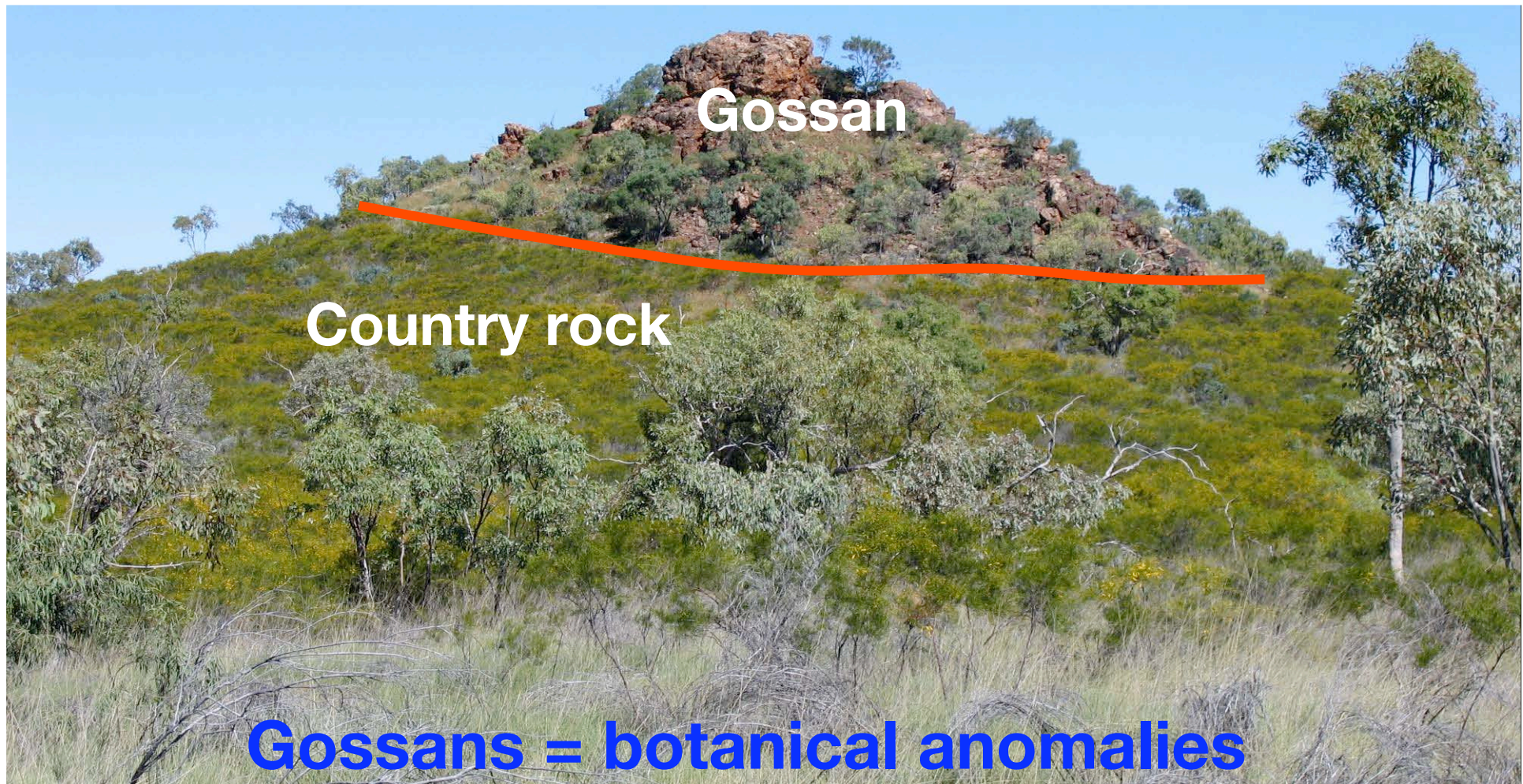
## Project:

**Part 1:** Metallophytes on gossans

**Part 2:** Mitchell grasses on Cannington mine wastes



## Part 1: Gossans near Cannington - metal uptake & growth behaviour



## **Fairmile, Black Rock & Pegmont gossans**

**Weathering depth:**  
**~30 to 50m**

**Bedrock:**  
**Sulfidic banded iron  
formation**

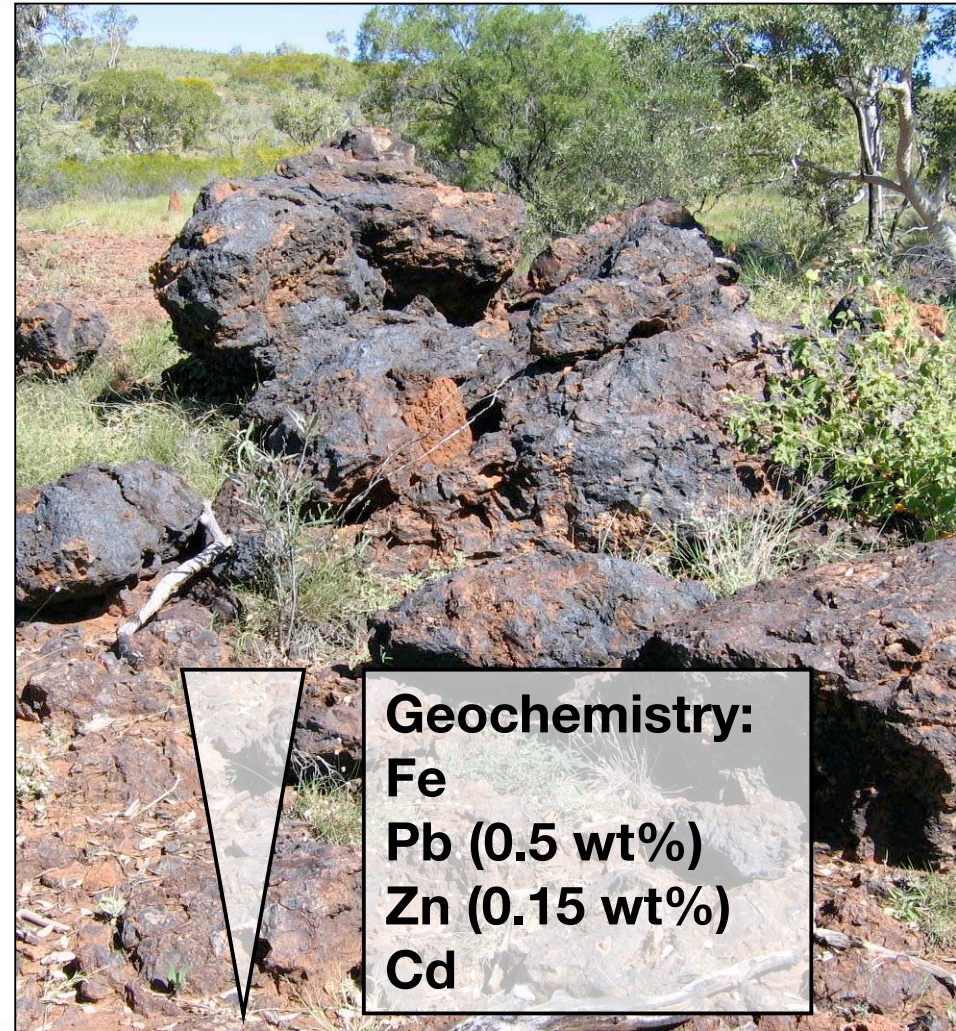


## Gossan soils

### Mineralogy:

- Quartz, goethite
- hematite
- clay minerals
- phosphates
- silicates

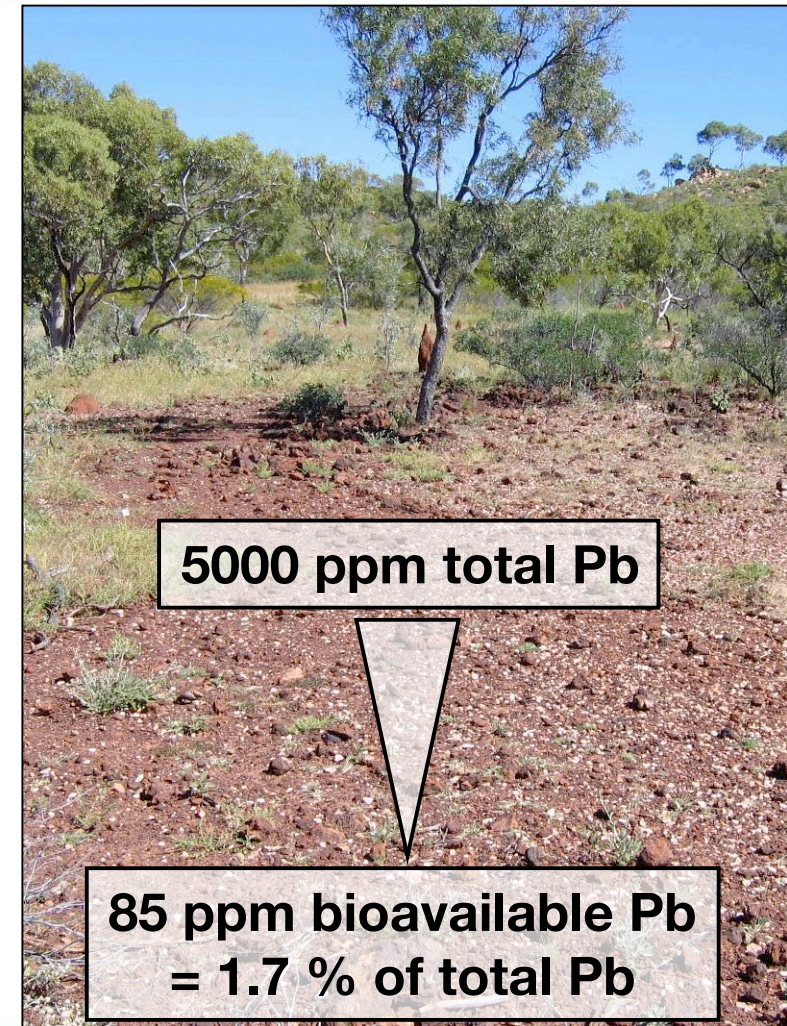
**pH 5.9**



## Gossan soils

### DTPA extractions:

- **Evaluation of metal bioavailability.**
- **Limited bioavailability.**
- **Due to insoluble phosphates & jarosite.**





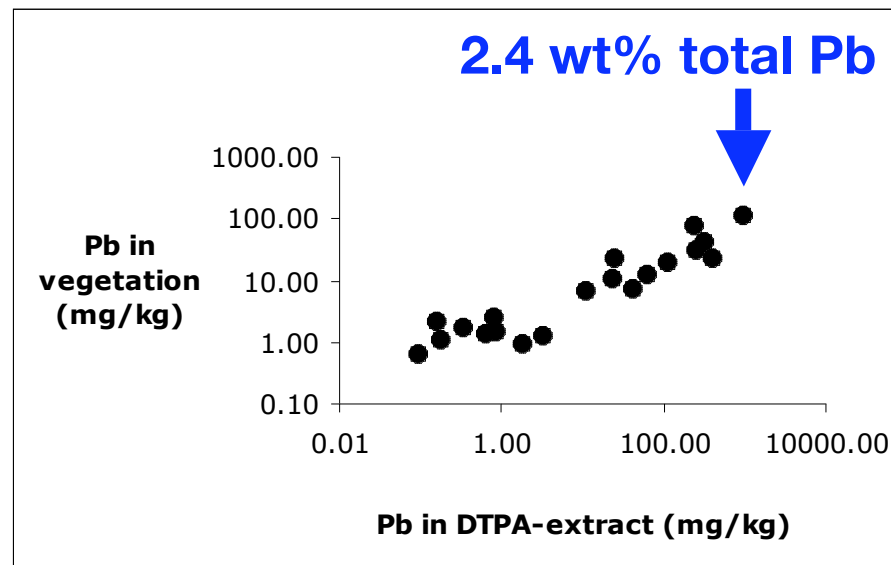
## Geobotany

- **Grass species largely replace spinifex.**
- **Shrub violet, Hairy lollybush and Dainty sedge.**
- **Dainty sedge indicates base metal mineralisation in the region.**

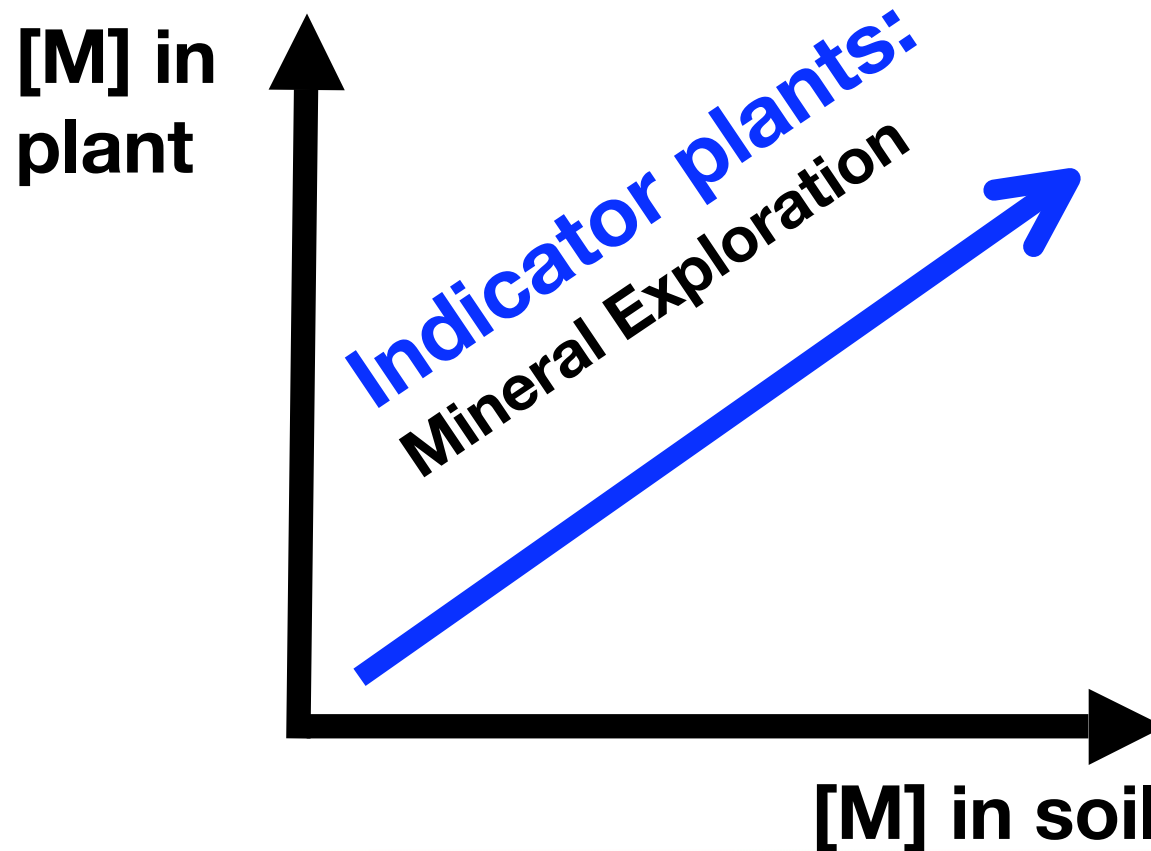


**Indicator:** *Spinifex (Triodia molesta)*

- High Cd, Pb & Zn
- 10-100x > background
- Linear correlation

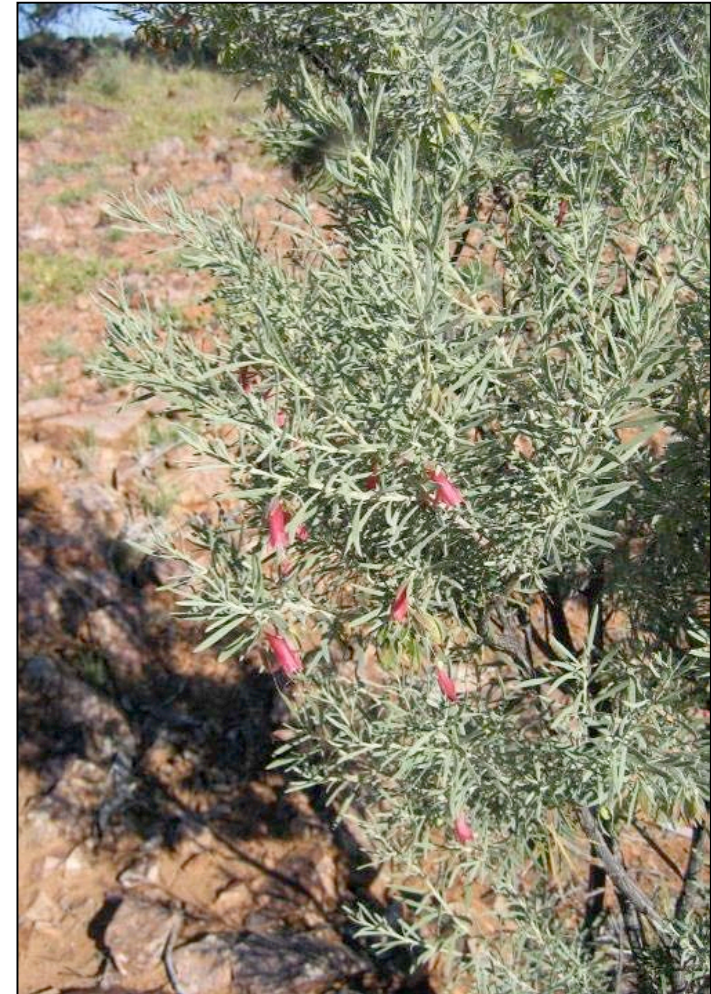
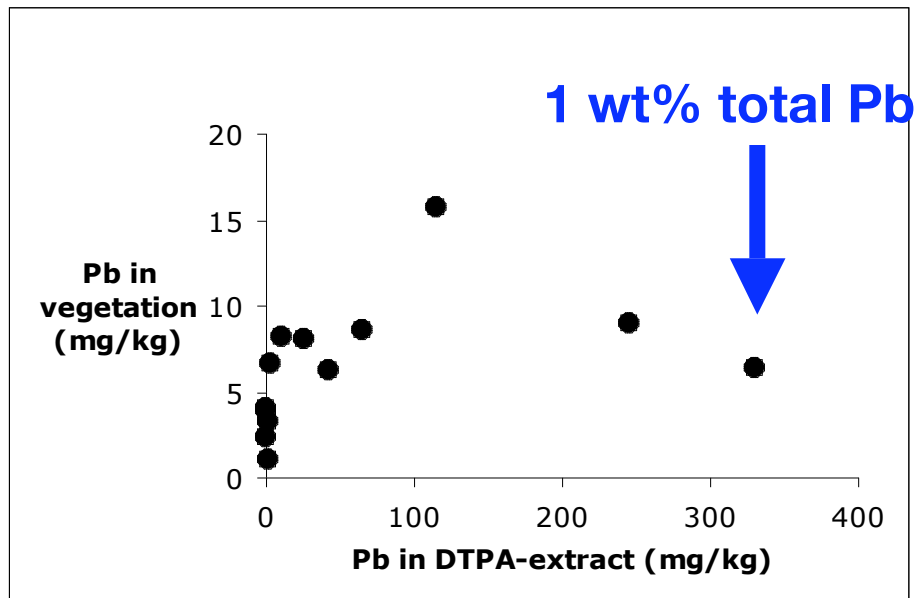


## Spinifex, Wanderrie grass, Tickweed, Sida

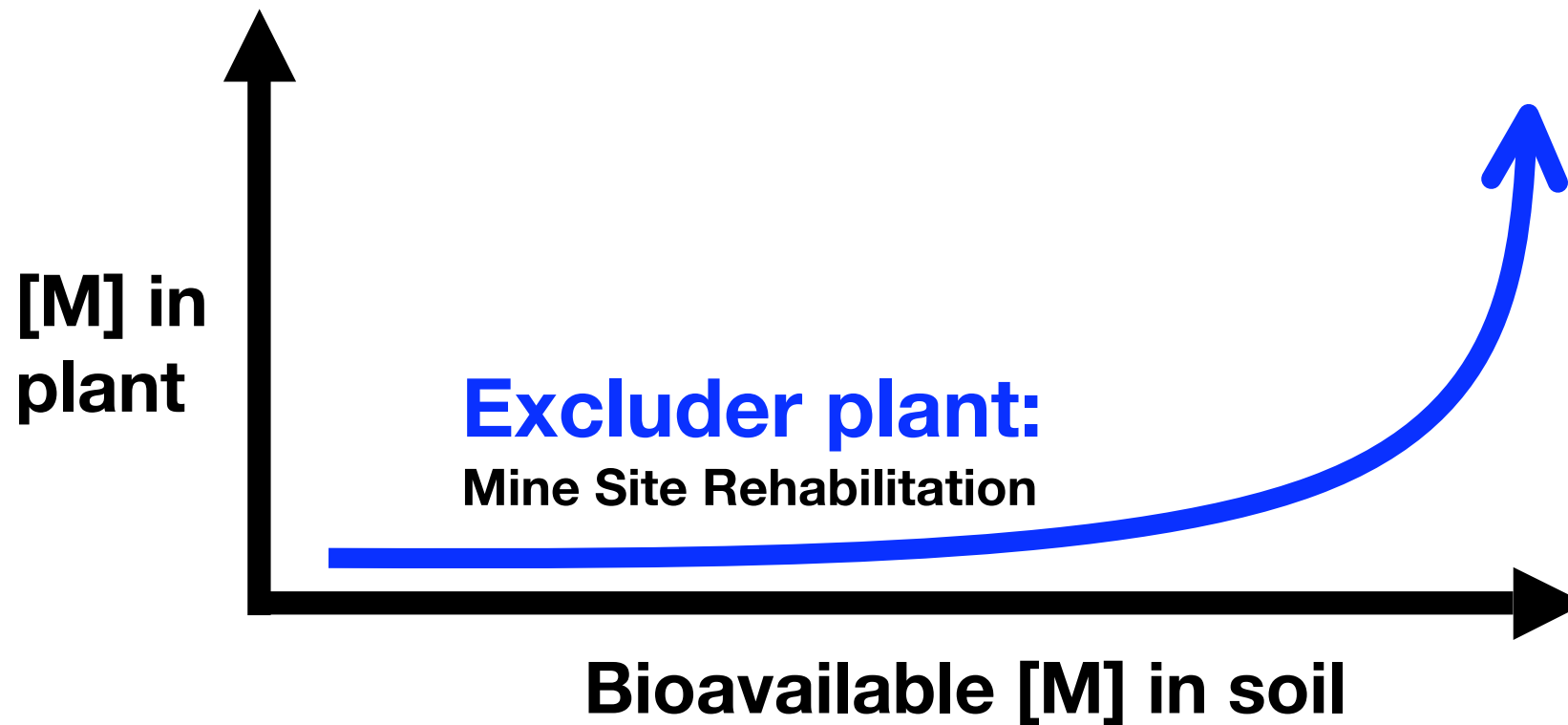


**Excluder:** Crimson Turkey Bush  
(*Eremophila latrobei*)

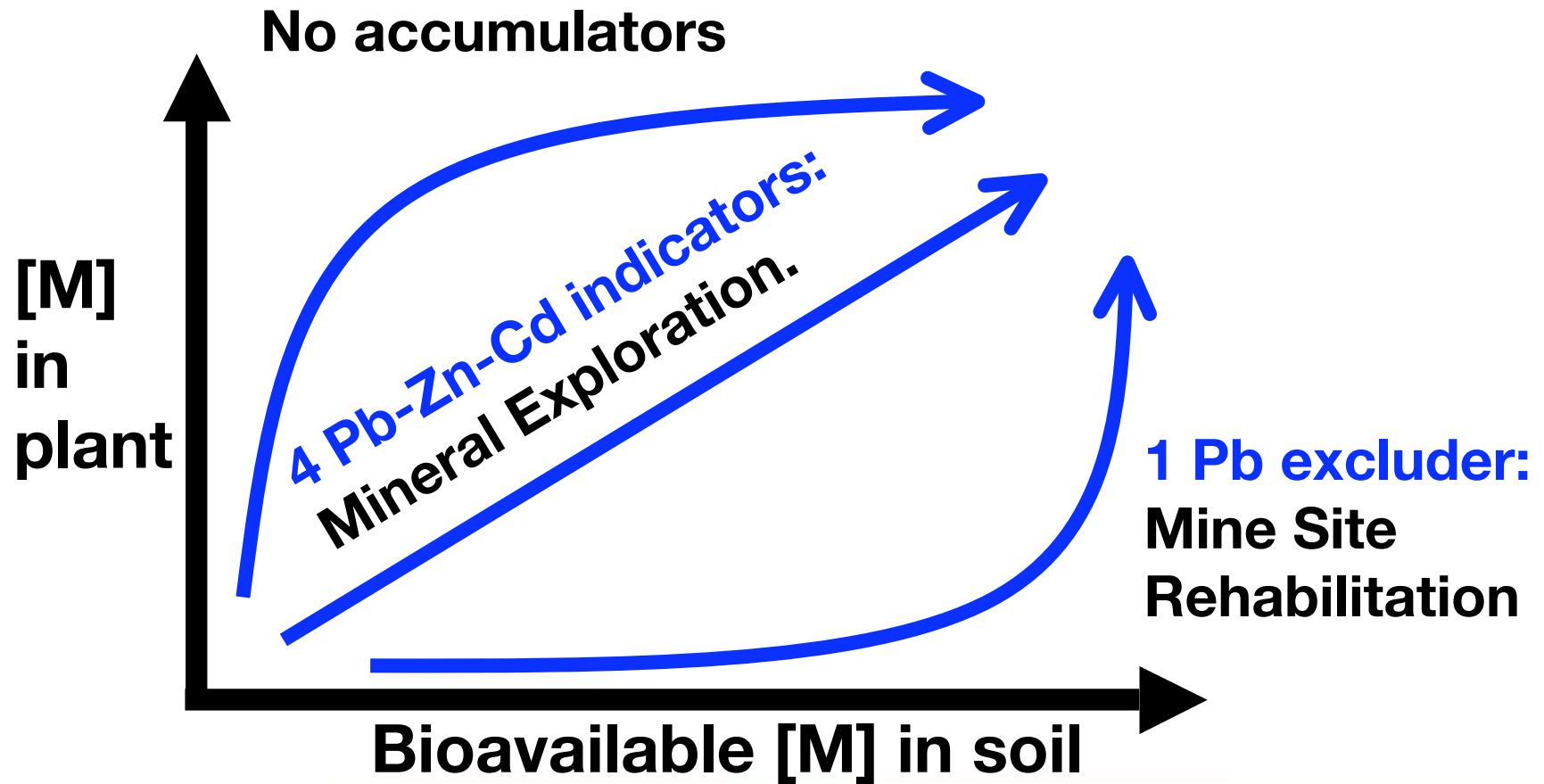
- **Low metal (Pb)**
- **No linear correlation**



## Crimson Turkey Bush



## Summary: Metallophytes on gossans



## Part 2: Mitchell grasses on Cannington wastes Metal uptake & growth behaviour

### Implications for Cannington

- None of the gossan plants occur on the Cannington mine lease
- Mitchell grasslands



## Greenhouse trials

- **Growth of Mitchell grasses on various substrates.**
- **Bioavailability of metals in substrates.**
- **Limit bioavailability of metals by applying limestone or phosphate additives.**
- **Test the suitability of various substrates for Mitchell grasses.**



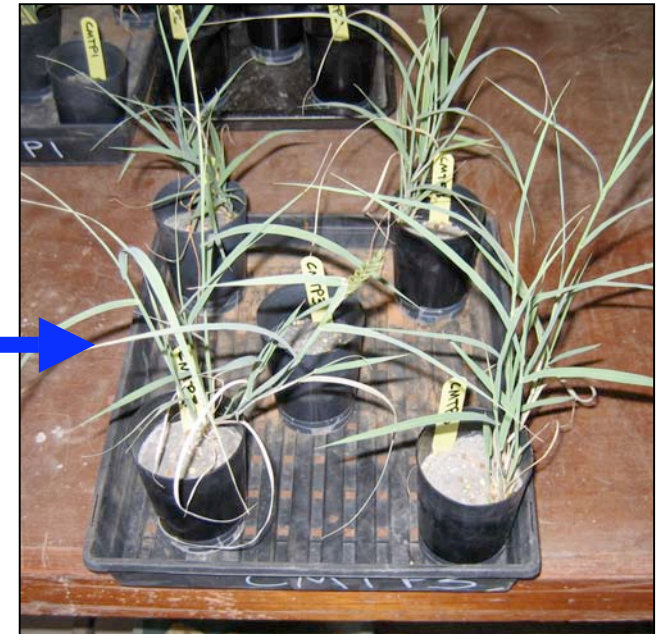


## Greenhouse trials

**Plant growth media:** mixtures of waste rocks, tailings, limestone, siltstone & P-fertiliser



**Mitchell  
grasses  
growing  
on ~1wt%  
Pb tailings**



## Analyses

### Substrate:

- **Total trace elements**
- **Bioavailable elements using DTPA & EDTA extractions (n: 106)**
- **pH**

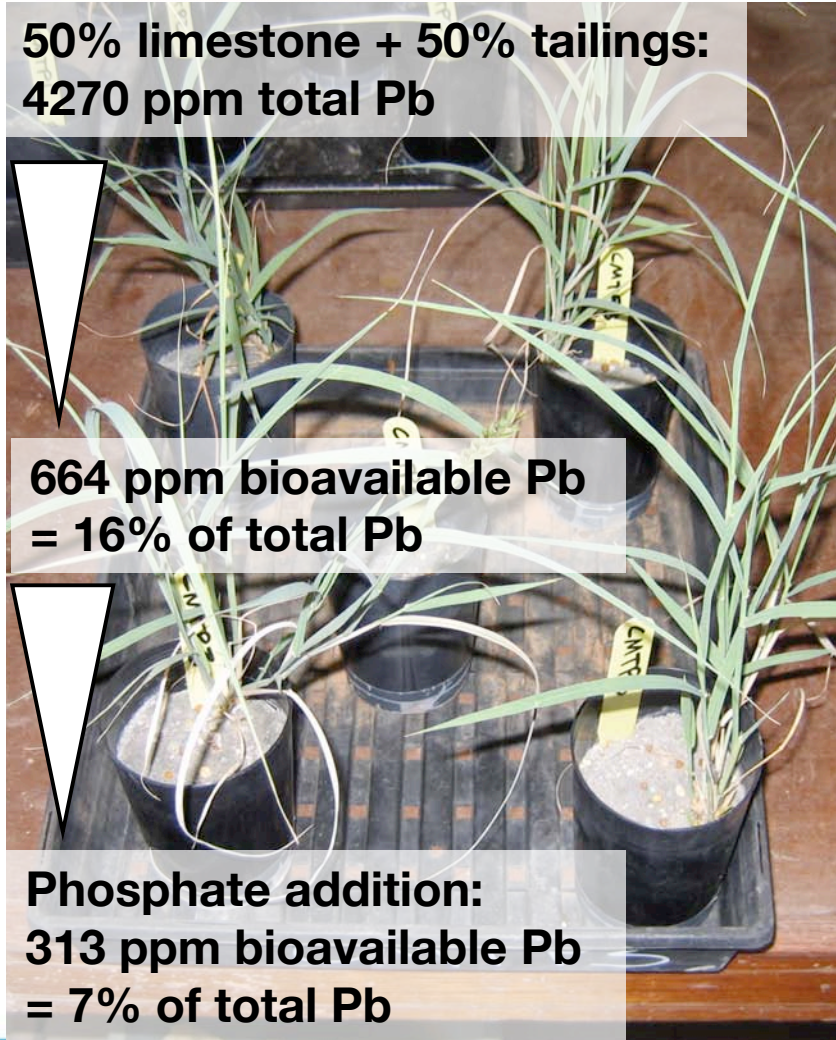
### Plants:

- **Total metals & metalloids (n: 120)**

## Substrates:

### EDTA & DTPA extractions:

- Limited metal bioavailability ⇒ slow sulfide oxidation
- Addition of phosphate reduces metal bioavailability



50% limestone + 50% tailings:  
4270 ppm total Pb

664 ppm bioavailable Pb  
= 16% of total Pb

Phosphate addition:  
313 ppm bioavailable Pb  
= 7% of total Pb

## Mitchell Grasses

### Uptake of metals

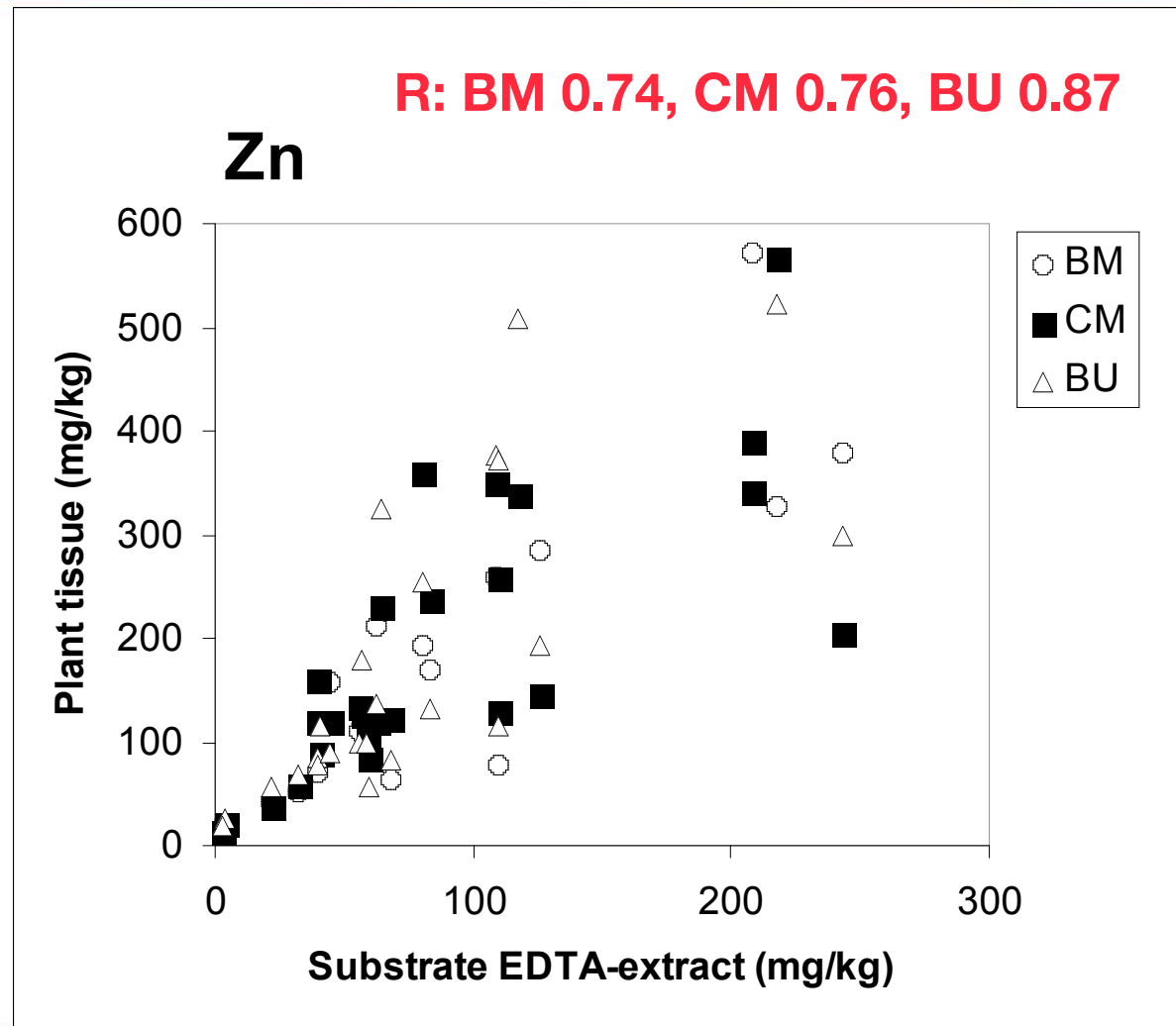
#### In background substrates:

- **Mn > Zn > Cu > Ni > Pb > As > Cd > Co > Sb**

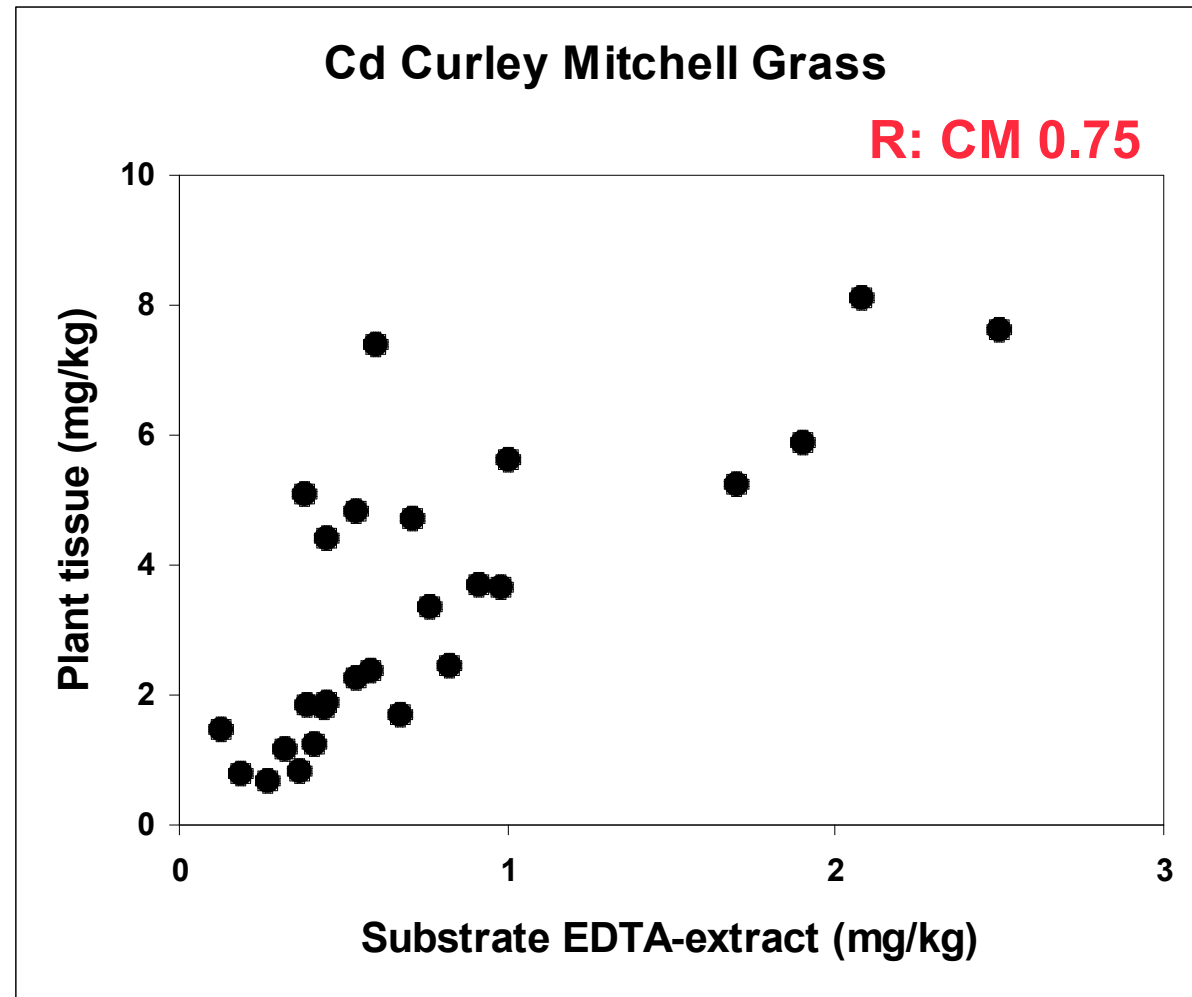
#### In waste rock and tailings substrates:

- **Pronounced uptake of Pb & Zn (10x background).**
- **Maximum uptake in acidic, metal-rich substrates.**
- **Reduced uptake achieved by adding phosphate.**

# Uptake of metals by Mitchell grasses

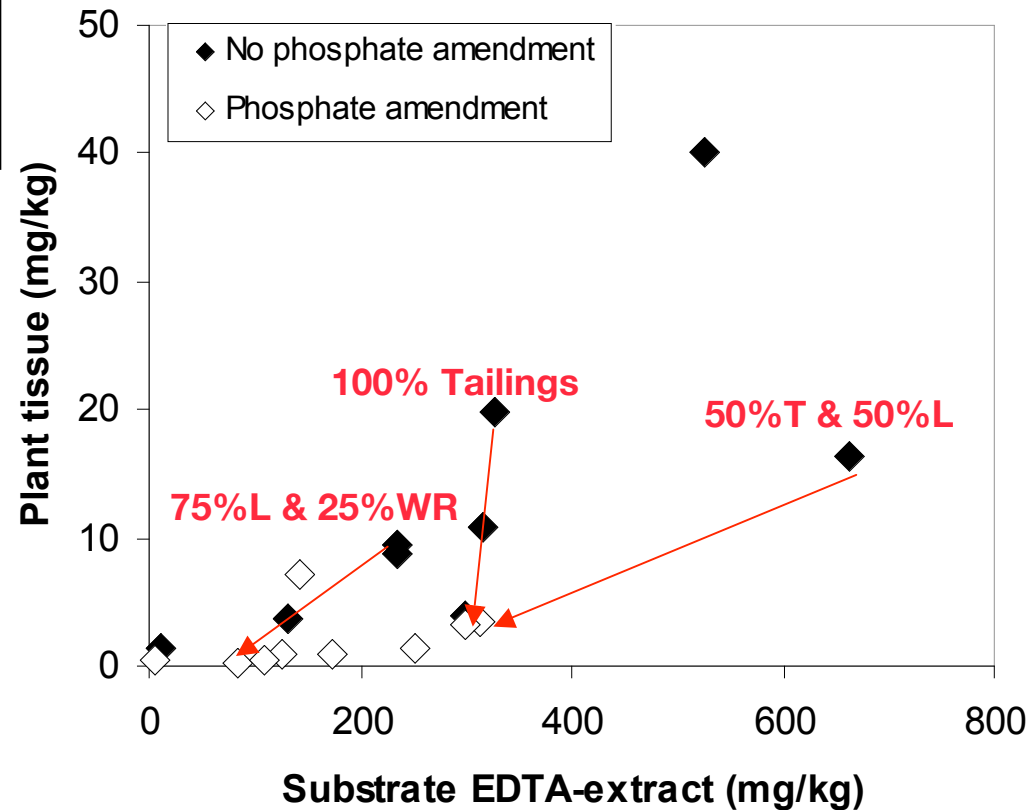


# Uptake of metals by Mitchell grasses

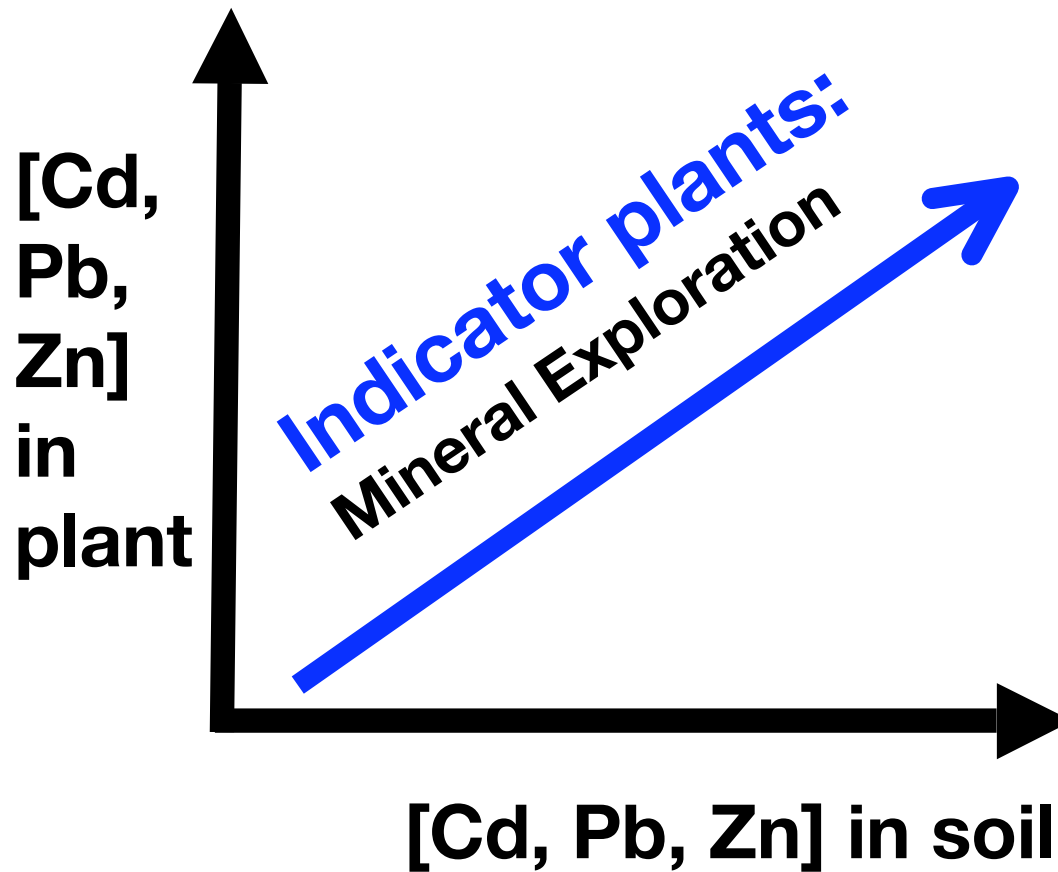


# The effect of phosphate amendment

**Pb Curly Mitchell Grass**



## Mitchell grasses



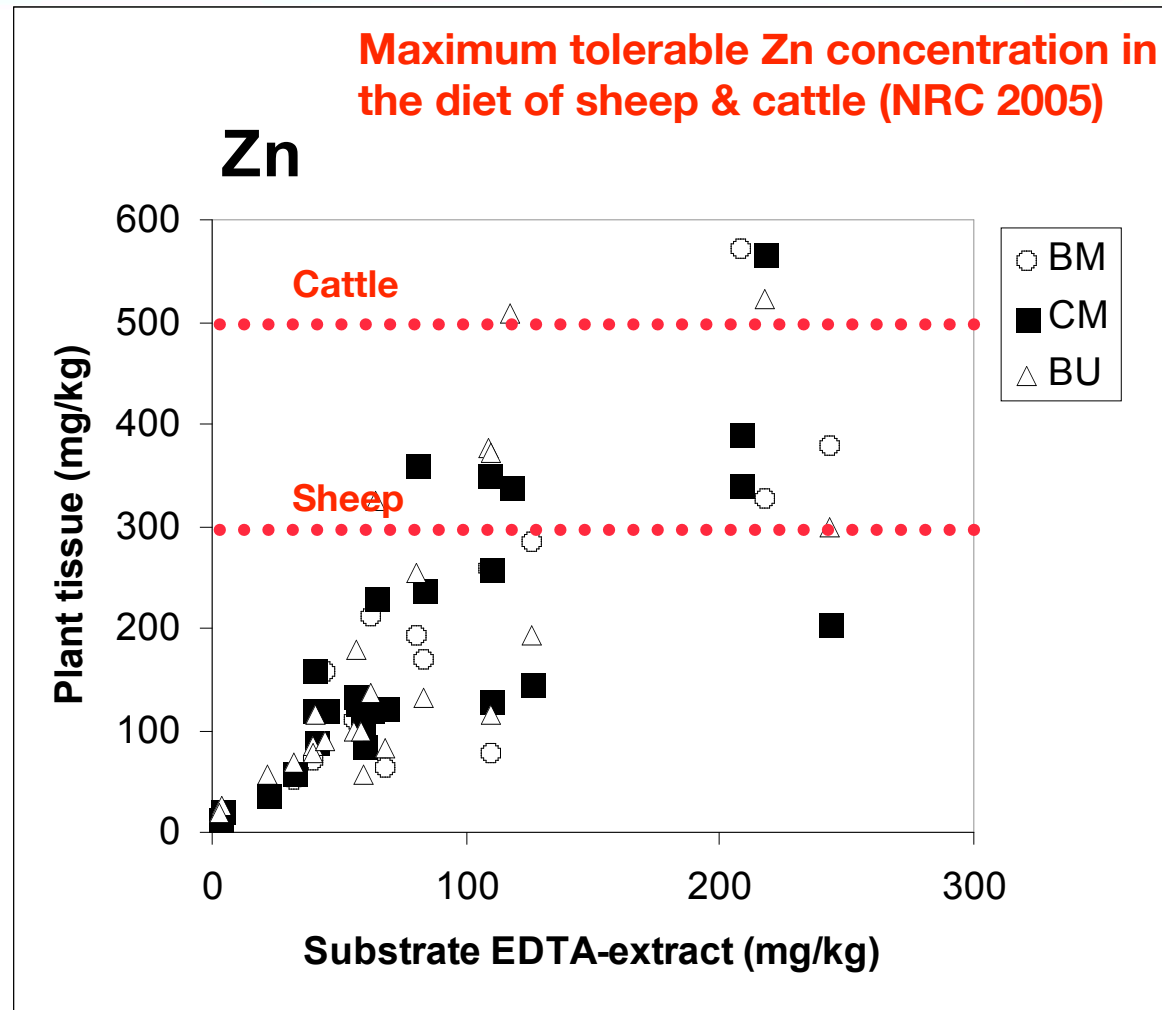


## **Potential for Mitchell grasses to induce zootoxicity**

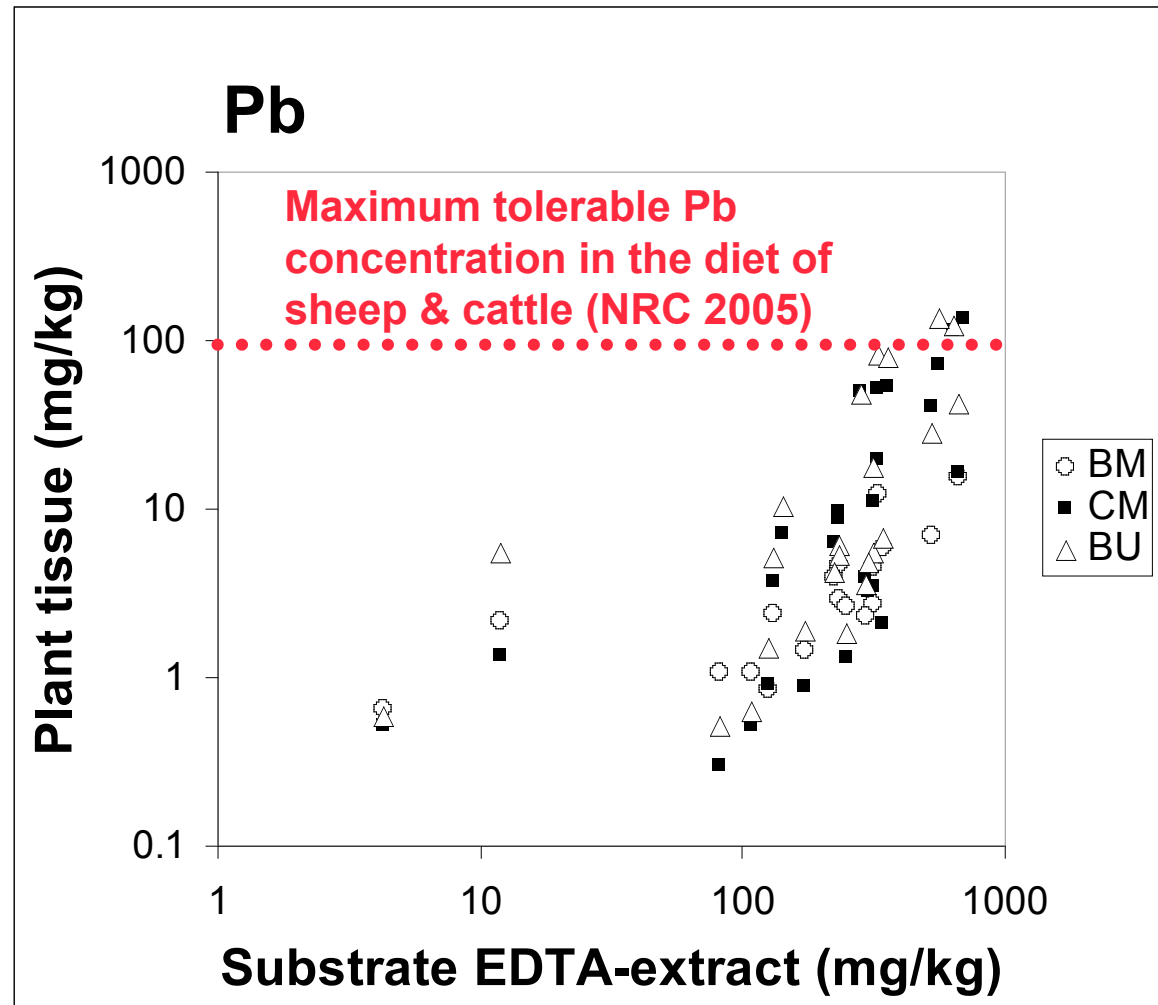
**Maximum tolerable Pb & Zn concentrations in the diet of sheep & cattle (NRC 2005) are exceeded in:**

- **Siltstone-amended tailings & waste rock pot-trial mixtures**
- **Tailings & tailings-limestone pot-trial mixtures**

# Mitchell grasses & their potential zootoxicity

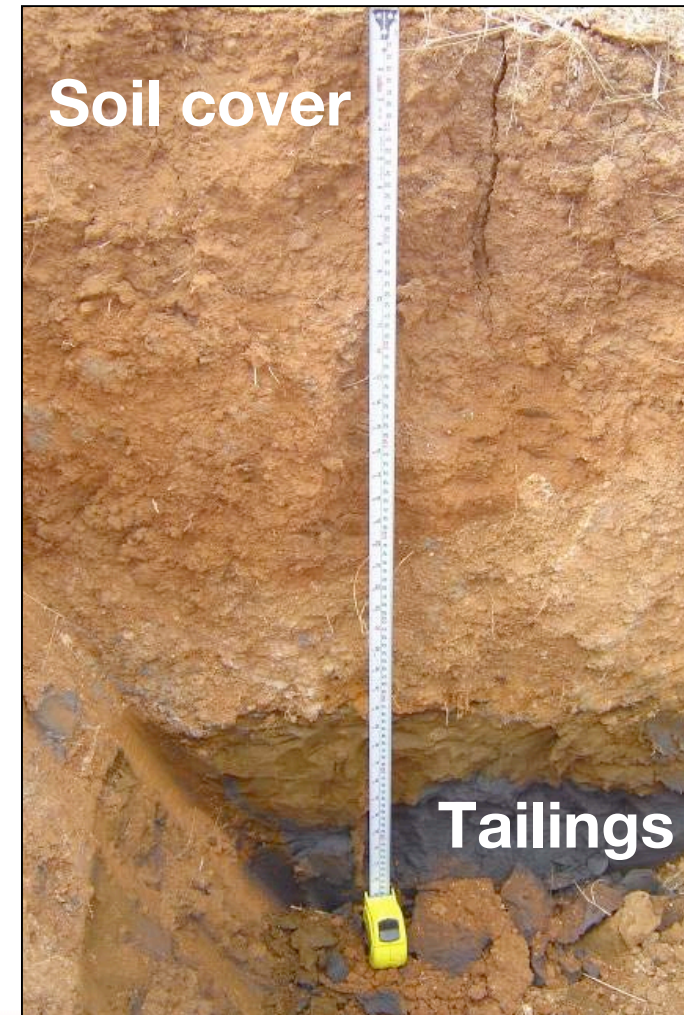


**Mitchell  
grasses &  
their  
potential  
zootoxicity**

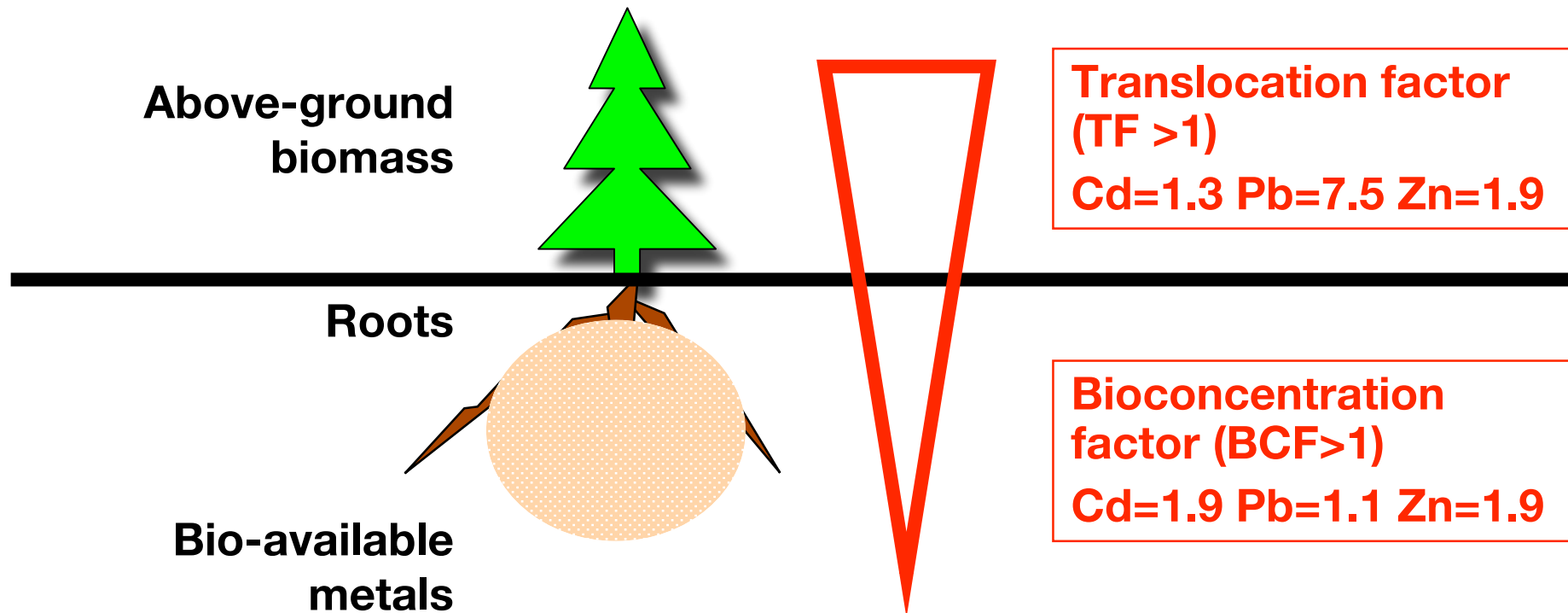


## Field trials

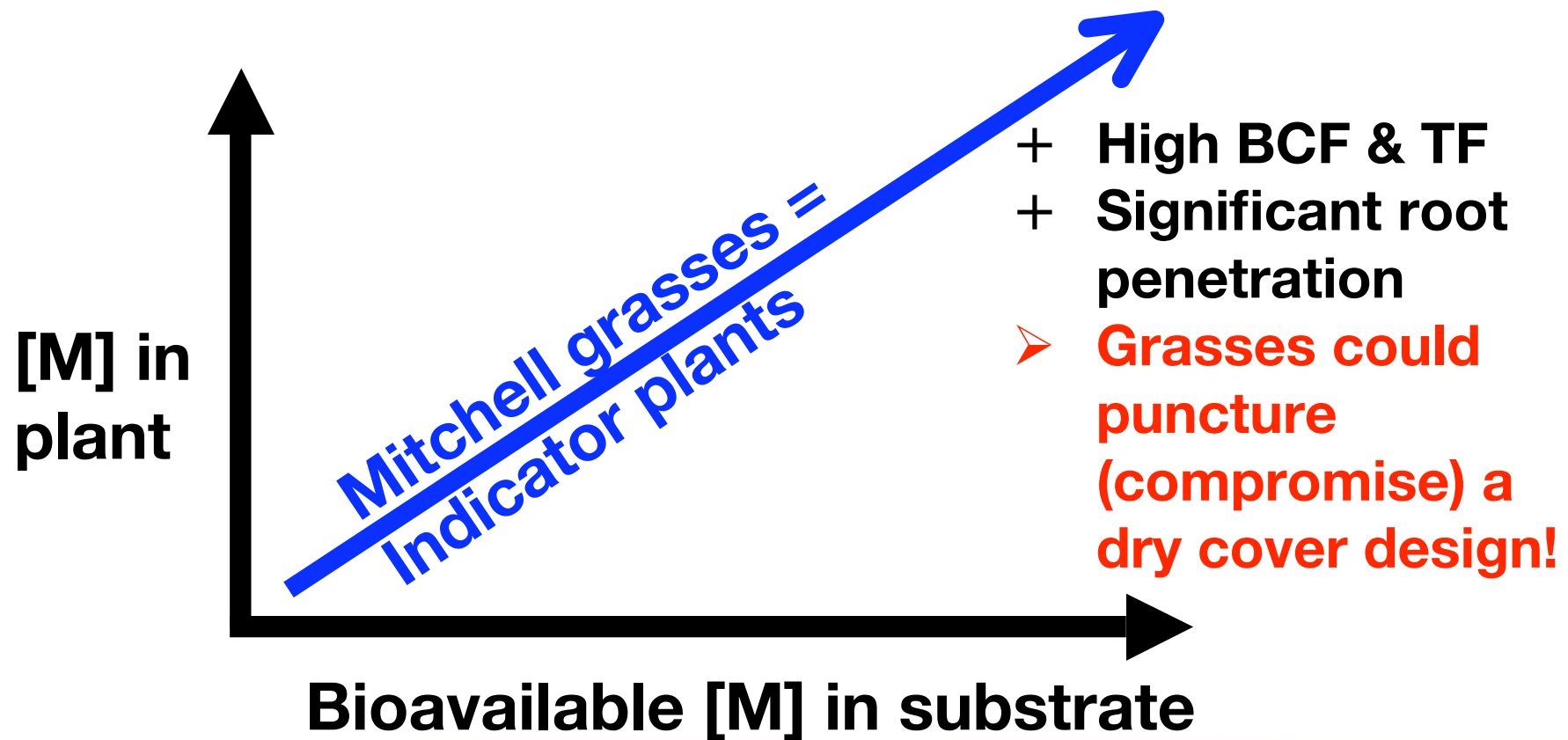
**Significant root penetration depth of Mitchell grasses**



## Mitchell grasses = Metal-tolerant indicator plants with high TF & BCF



## Mitchell Grasses



# Capping strategies using Mitchell grasses



1. Traditional strategy  
⇒ compromised cover

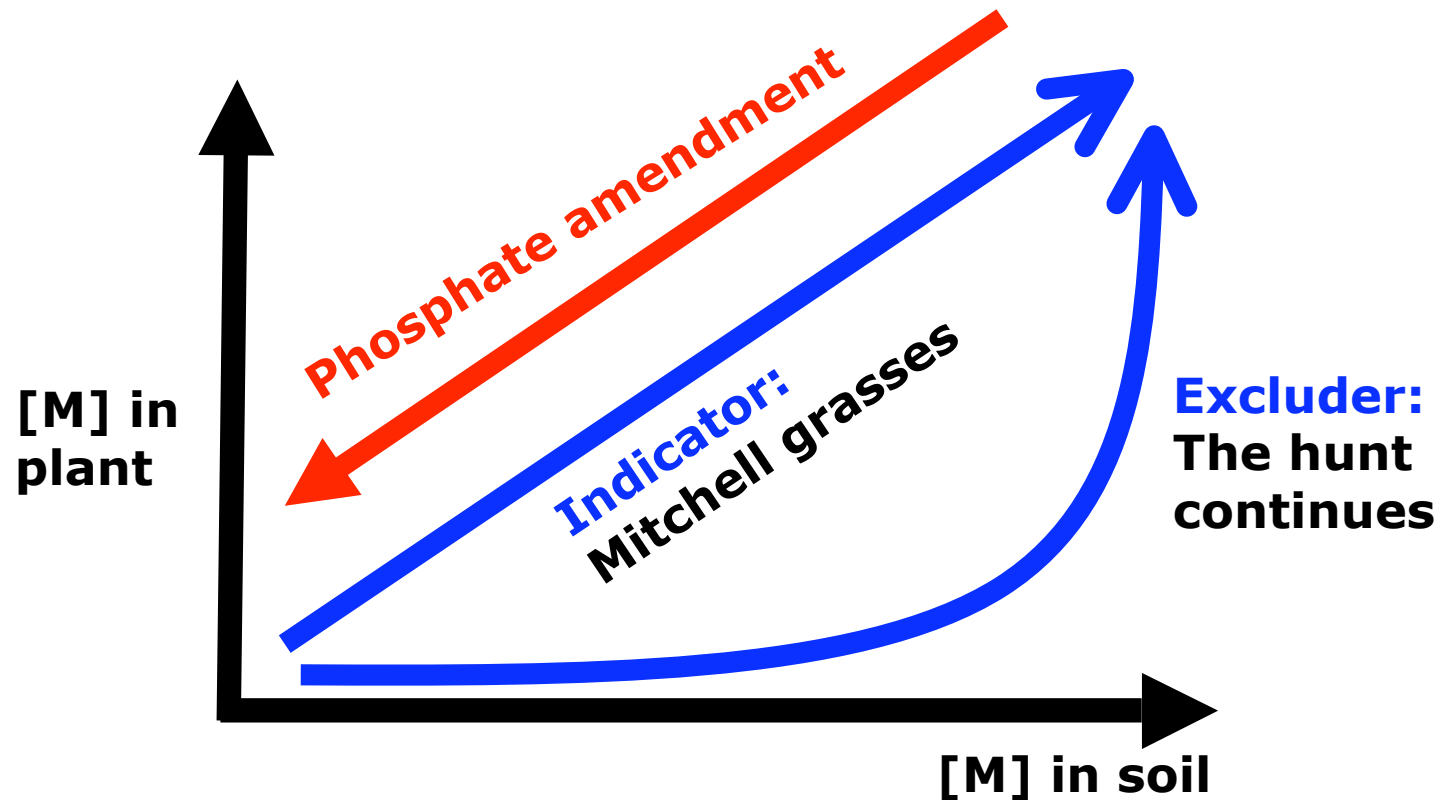


2. Traditional strategy  
⇒ availability / costs?



3. Alternative strategy  
⇒ Our future research

# Summary





## **Acknowledgements:**

- **Australian Research Council**
- **BHP Billiton Cannington**

**Thank you for your interest!**