Atoll Soil Health Management:

Soil nutrients –how to fix what is lacking in your soil

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Australian Government
Australian Centre for International Agricultural Research

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Pacific Community
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TUVALU·MO·TE·ATUA

UNIVERSITY of TASMANIA
AUSTRALIA

THE UNIVERSITY of ADELAIDE

ACIAR -Improving soil health, agricultural productivity and food security on atolls

WHAT DID WE DO? –an overview

- Determined the most limiting nutrients in soil in Kiribati and Tuvalu
- Addressed deficiencies with local resources and materials
- Improved physical parameters of soil with addition of carbon
- Conducted pot and field trials in Kiribati and Australia
- Evaluated alternative production systems to reduce soil and water limitations

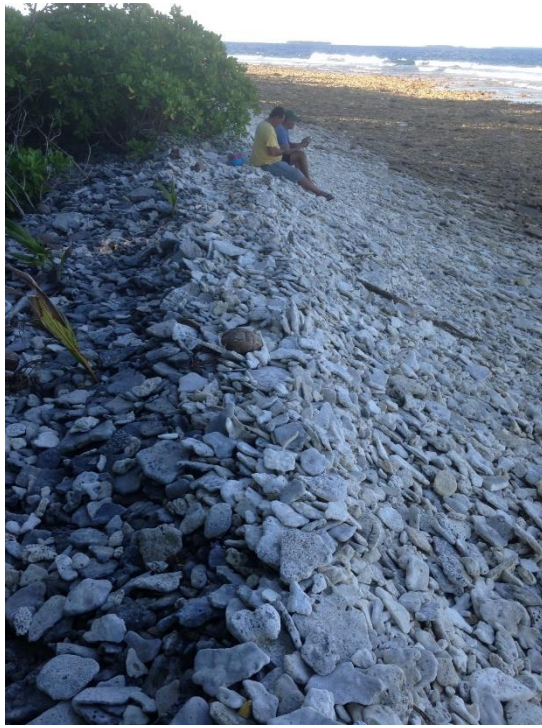
WHAT ARE THE SOIL CONSTRAINTS AND ISSUES ON ATOLLS?

- **Chemical properties** -low nutrients, high pH, low nutrient holding capacity

  -restrictions on using inorganic fertilisers

- **Physical properties** (sandy texture)

  → low water holding capacity, rapid drainage



Benefits of compost - an overview

Chemical

- Source of nutrients for crops
- Nutrients are less easily leached through the soil

Physical

- Helps stop the soil drying out by holding more water (WHC)
- Improved soil structure

Biological

- Contains lots of beneficial soil microbes and bugs
- Can suppress plant diseases

Environmental

- Recycles organic waste and reduces landfill
- Less contamination of ground water (less leaching)

Compost ingredients

Composting works best with alternating layers of carbon-rich (brown) and nitrogen-rich (green) materials.

Carbon-rich material (Brown)

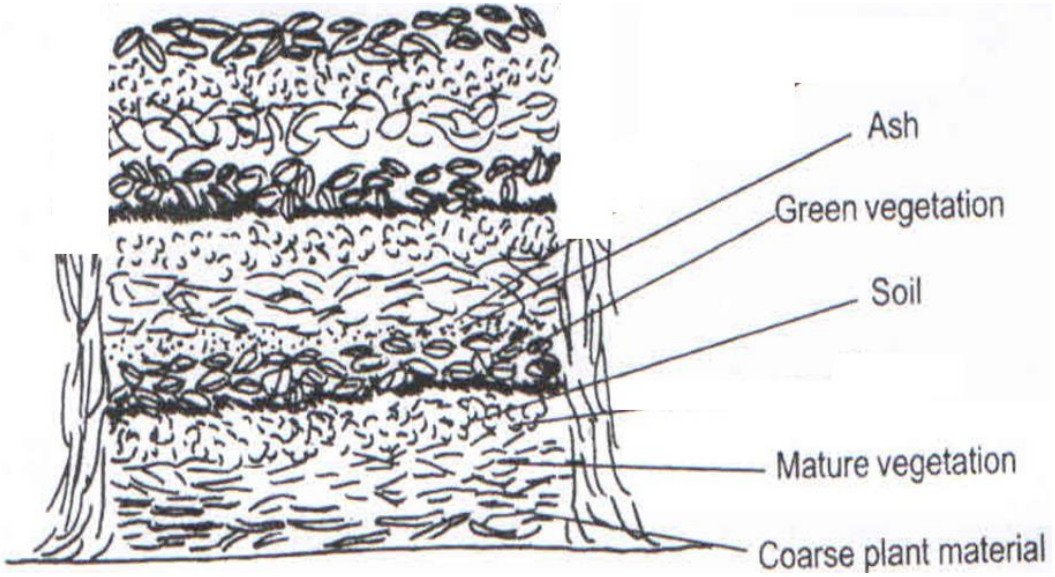
- Dry leaves e.g. breadfruit, *Premna* (te ango, valovalo), *Guettarda* (te uri, pua)
- Paper, cardboard
- Brown seaweed

Nitrogen-rich material (Green)

- Green material e.g. green leaves
- Kitchen scraps
- Manure - chicken, pig

Other

- Ash, black soil, old compost
- Water



Managing a compost heap -Golden rules

- **Water:** Ensure compost is moist, like a squeezed sponge. Water regularly if dry.
- **Air:** If the heap becomes too wet, open it up and spread the materials to dry before re-heaping.
- **Food:** Ensure there is a balanced diet for the microbes.
- **Shelter:** The compost heap needs to be approx. 1 m^3 to retain enough heat at lower temps. A tarp or banana leaves and coconut fronds can also help keep the pile from becoming too wet or drying out.
- **Inoculate:** with soil or old compost
- **T.L.C:** Check the heap regularly

How much nutrient do we need to add to grow a crop?

→ **Do a soil test to see what nutrients we have to start with**

At the very least we need to replace the nutrients we remove at harvest

....otherwise we are mining the soil!

Nutrient removal (dalo corms)

Nutrient	Composition (approx %
N	1.0 %
P	0.3 %
K	1.4 %
S	0.03 %
Ca	0.1 %
Zn	80 mg/kg
Cu	8 mg/kg
Fe	35 mg/kg
Mn	14 mg/kg
B	3 mg/kg

Nutrient analyses of a range of composts sourced from Kiribati and Tuvalu

		min N	P	K	S	Cu	Zn	Mn	Fe	B
Tanaea	**poultry, pig**	**2525**	**3736**	**15800**	**1242**	5.2	**81**	45	10	12
Tanaea	**poultry**	**2453**	**3866**	**16054**	**1272**	10.4	**148**	85	11	11
Funafala	**pig**	430	1400	1200	900	3.1	**130**	35	40	11
Beru	**Sea cucumber**	468	1420	2309	737	0.4	10	4	4	10
Tab N	**Sea cucumber**	605	414	1135	560	0.3	6	2	2	5
Tanaea	**seaweed**	556	461	3900	**4404**	0.7	6	1	13	37

Nutrient analyses of some plant leaves from atolls

				N	P	K	S	Cu	Zn	Mn	Fe
				%	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg
			max-plants	***4.8***	***0.51***	***4.3***	***1.1***	***17***	***125***	***34***	***93***
Breadfruit	*Artocarpus*	te mai	mai	1.1	0.19	**0.2**	0.18	3	12	11	38
False elderberry	*Premna*	te ango	valovalo	1.1	0.28	1.1	**0.10**	6	50	19	40
Beach gardenia	*Guettarda*	te uri	pua	0.8	0.33	**0.1**	0.13	**1**	**1**	4	**9**

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Beach cabbage	*Scaevola*	te mao	gasu	1.9	0.25	0.8	0.33	3	33	10	25
Tree spinach	*Pisonia*	te buka	puka vai	3.7	0.28	1.9	0.36	**17**	19	33	55
Yellow beach pea	*Vicia*	te biin	saketa sega	4.0	0.24	1.4	0.24	6	49	**34**	66
Chaya	*Cnidoscolus*	te tiaia	tiaia	**4.8**	0.38	1.6	0.34	6	48	14	60
Drumstick	*Moringa*	te turam	saitani	4.4	0.39	1.3	**1.12**	5	31	19	48

Nutrient analyses of leaf samples from Kiribati and Tuvalu –Best options

N - chaya, drumstick, purslane, *Vigna,* NFTs, pisonia

P - Yellow ilima, chaya, drumstick, purslane

K - Birds nest fern, purslane, morning glory, pisonia

Cu - pisonia, sea trumpet, purslane, young breadfruit leaves

Mn - *Vigna*, pisonia, castor weed

Fe - purslane, *Vigna*, chaya, pisonia, noni

Zn - purslane, hedge panax, Yellow ilima, *Vigna*


Island Sun
CALROSE RICE
Net Wt. 44 lb
(20 kg)
Island Sun
CALROSE RICE

Nutrient analyses of some other compost ingredients

		N	P	K	S	Cu	Zn	Mn	Fe	B	Na
		%	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%
	max -plants	*4.8*	*0.51*	*4.3*	*1.1*	*17*	*125*	*33*	*93*	*108*	*2.5*
Ash	**te uri**	0.04	0.6	1.2	0.4	16	49	31	**380**	188	2.2
Ash	**c'nut husk**	0.1	**1.6**	**6.3**	0.2	**144**	**183**	**123**	**382**	**365**	**7.5**
Mud	**lagoon**	0.5	0.04	0.1	0.4	4	5	3	114	71	1.2
Algae	**(dead)**	2.5	0.04	0.5	**2.1**	2	1	5	**359**	**451**	**9.1**
Seaweed	***Acanthophora***	1.6	0.10	**4.7**	**4.2**	2	10	5	129	**410**	3.0
Seaweed	***Sargassum***	1.2	0.14	**5.7**	**1.6**	<2	28	27	95	235	2.0
Sea	**cucumber**	**10.2**	0.5	0.4		4	40	44	184		**8.8**
Fish	**meal**	**8.3**	1.1	0.7		5	102	25	**836**		0.3
Manure	**poultry**	2.5	**2.1**	1.3		49	**241**	**492**	**727**	13	0.2

	Compost ingredients -Best bets for nutrients
N	sea cucumbers; fish meal; green leaves (chaya, drumstick, purslane, *Vigna*); manure; vegie scraps
P	manure; ash (coconut husk, shell); Yellow ilima, chaya, drumstick
K	ash (coconut); seaweed (*not seagrass*); purslane, pisonia; manure
Cu	ash (coconut); manure; pisonia, purslane
Mn	manure; ash (coconut); pisonia, *Vigna*, castor weed
Fe	manure; fish meal; ash; algae, most seaweed spp; purslane, *Vigna*, chaya; rusty cans*?*
Zn	manure, ash (coconut); fish meal; purslane, hedge panax, Yellow ilima

Where else can we find nutrients?

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	depth	pH w	OC	*min N*	P	S	K	Cu	Zn	Mn	Fe	B
			%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
'Pig soil'	0-15	8.1	**5.4**	75	63	31	76	0.5	**16**	4.1	10	1.1

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'Pig soil'	0-15	8.1	**5.4**	75	63	31	76	0.5	**16**	4.1	10	1.1
Unimproved Soil	0-15	8.3	3.6	10	61	20	**25**	**0.2**	5	1.5	**1**	0.7

Where and how can we obtain more nutrients?
-Talanoa

Where and how can we obtain more nutrients?

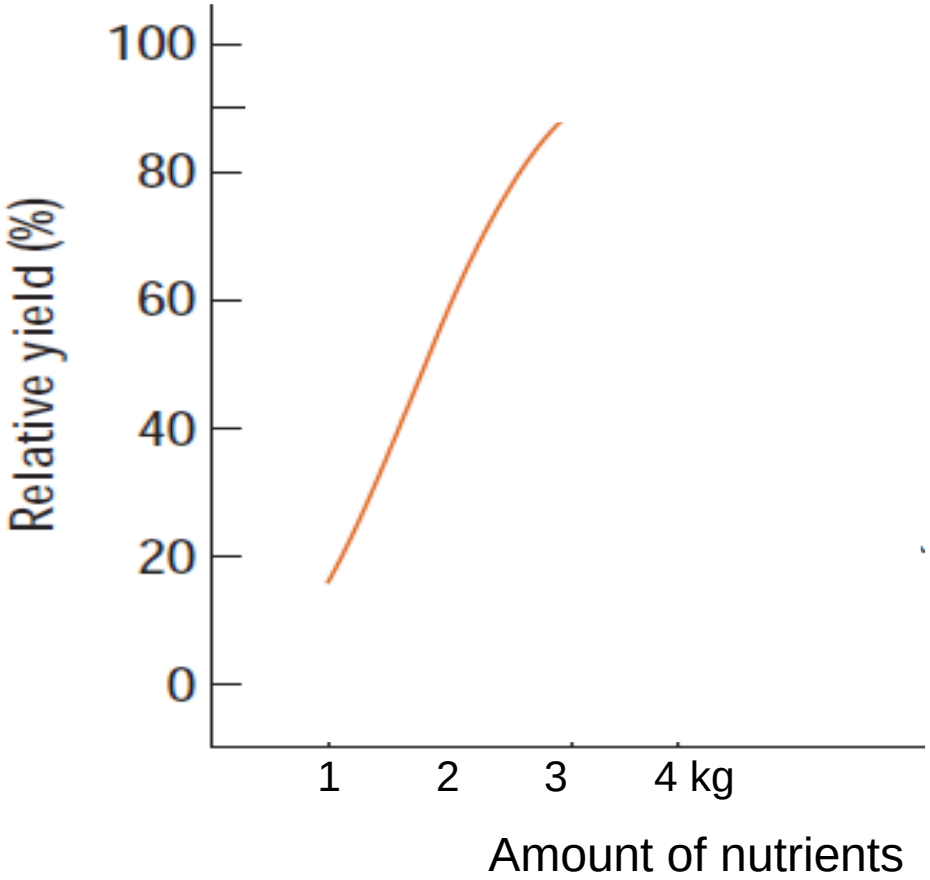
- **Better collection of manure** -Use of pens with concrete bases
- **Develop better local ration formulations for animals** → higher value manure
- **Iron** - rusty metal: burn, bash and screen
- **Fish cannery, copra processing waste**
- **Council green waste** (shredders)
- **Black soil**
- **Grow trees and bushes to harvest the nutrients** e.g. Vigna, chaya, pisonia (Alley cropping)

Evaluating different compost mixes -Trials

Treatments -based on standard 3:3 ratio of brown (*Premna;* te ango) :green leaves (*Scaevola;* te mao)

- **ACIAR compost** -some of te mao leaves substituted with *Vigna*, drumstick, chaya, seaweed **+** ash, mature compost and rust
- **Pig manure** -standard 3:3 + 1 part pig manure
- **Sea cucumber** -standard 3:3 + 1 part sea cucumber
- **Poultry manure** -standard 3:3 + 1 part poultry manure

What happens when you add extra nutrients to your plants?



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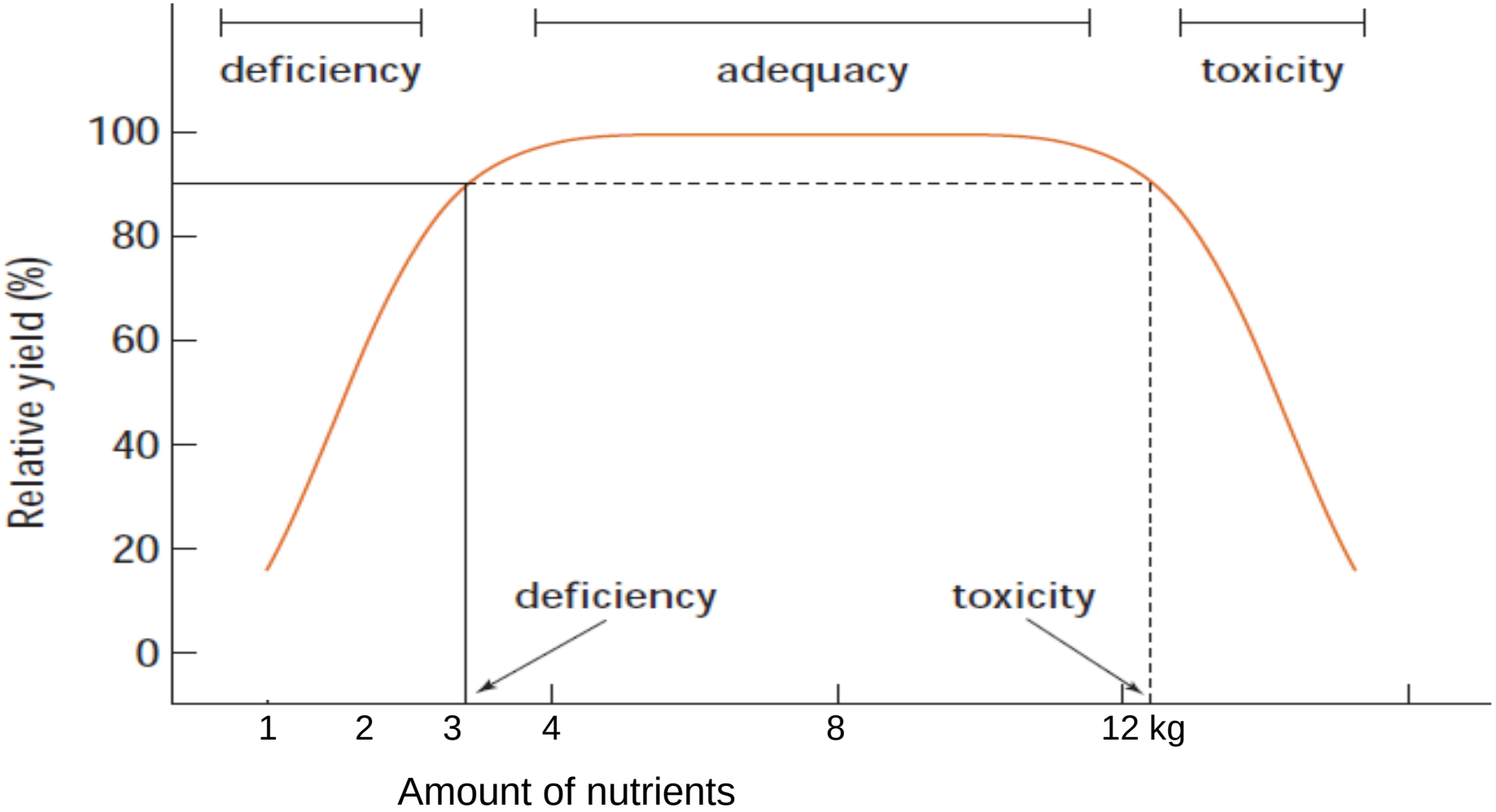
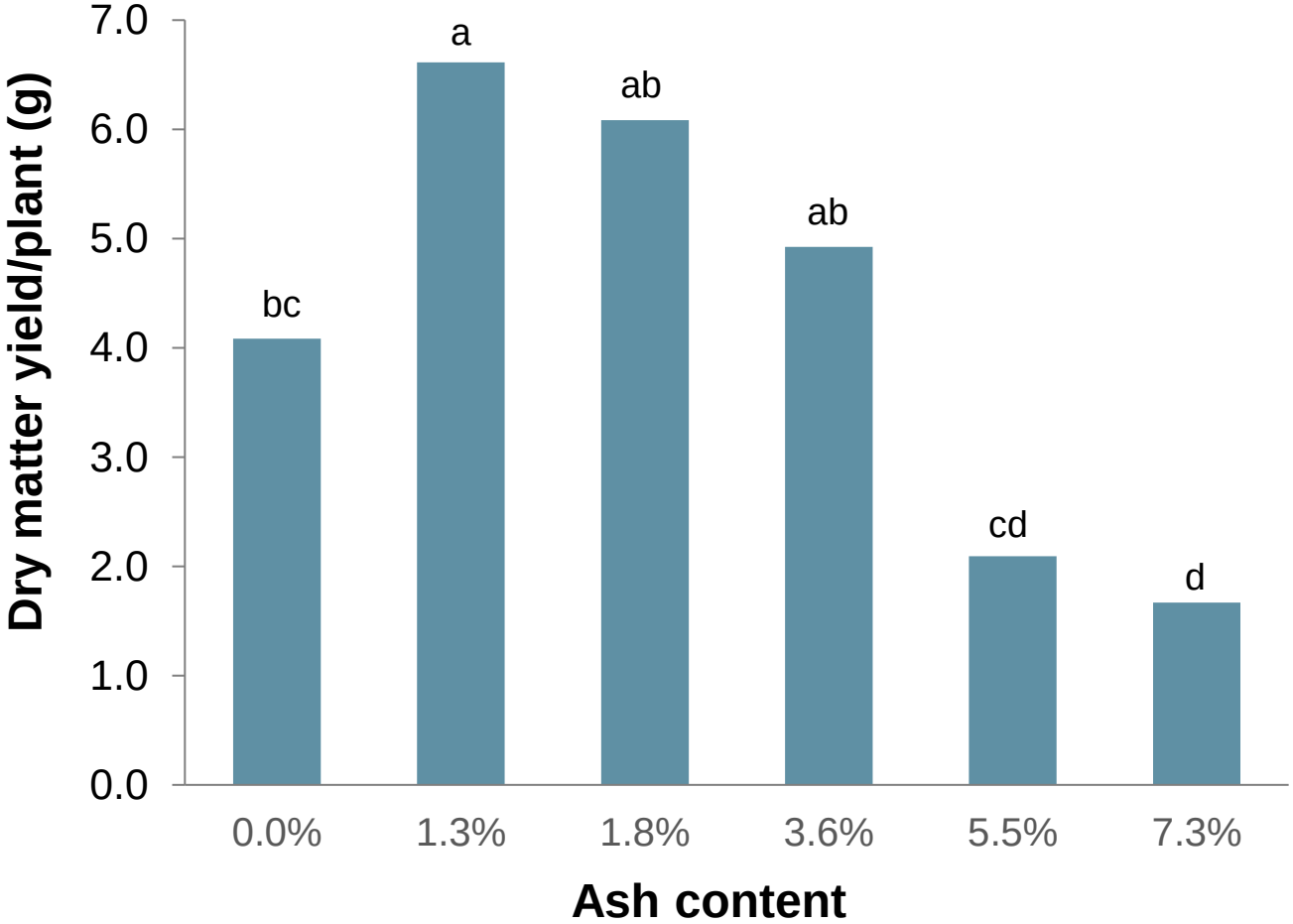


Effect of rate of applied ash on plant growth

Pot trials: Tanaea RS -initial pot trial with 4 rates of ash (0, 5, 10, 20%)
-large reduction in growth above 5% ash (by weight)

Uni of Tas -Honours project; 6 rates of ash;
-Pot mix: 1:2 of compost: soil



Targeted composting

Nitrogen	N	mg/kg	Mineral	45
Phosphorus	P	mg/kg	Colwell	37
Sulphur	S	mg/kg		32
Calcium	Ca	mg/kg	Exch cations	3523
Magnesium	Mg			193
Potassium	K			38
Sodium	Na			21
Copper	Cu	mg/kg	DTPA	0.2
Zinc	Zn			1.1
Manganese	Mn			4.2
Iron	Fe			3.3
Boron	B	mg/kg	$CaCl_2$	0.9

Targeted composting

Next session

- Information on improving soil physical properties (using biochar)
- Trials on different growing media in Foodcubes
- Also, what do you want to discuss in more detail related to soils, nutrients and making compost?

Discuss and get back to Teu/Itaia/Pelenise

Any questions?

Some quotes about soils to discuss:

In one teaspoon of soil there are billions of microorganisms. 70 - 80% of these still have not yet been identified.

Whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country than the whole race of politicians put together -Jonathan Swift

You are what you eat.

The nation that destroys its soil, destroys itself -Franklin D Roosevelt

Ko rabwa and Fakafetai

In a way, agriculture is a dance with nature.

We don't grow plants. We grow soil, and soil grows plants.

Soil is more properly viewed as a living thing. It is an ecosystem.


Ko rabwa
and Fakafetai