SOIL SAMPLING AND VARIABILITY - WHAT DOES THIS MEAN FOR YOUR NUTRIENT DECISION?

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SOIL SAMPLING

(photo from David Weaver)

Gourley CJP and Weaver DM (2019) A guide for fit for purpose soil sampling, Fertilizer Australia, Canberra, Australia

THE BUGGER FACTORS FOR SOIL SAMPLING

NUTRIENT VARYING ACROSS A SMALL AREA

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Stubble

Soil variation

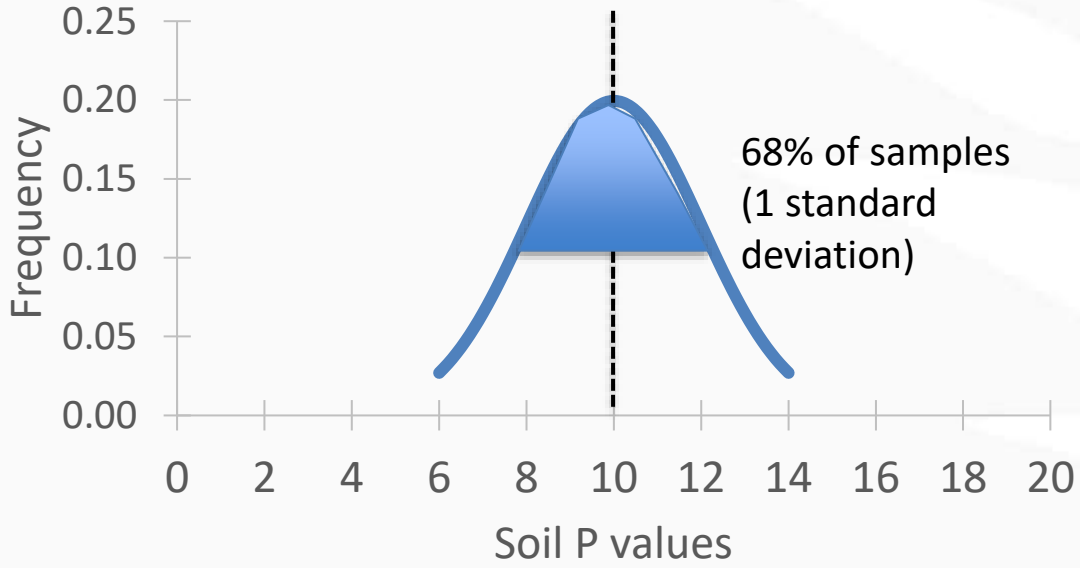
Soil disturbance

Spreaders

Placement of nutrients

LOW VARIABILITY

- **Variability** refers to how spread out a group of data is.
- Defined by Mean, Standard deviation (SD) and Coefficient of variation (%CV)
- %CV = standard deviation / mean x 100



Low variability

Mean = 10 mg/kg
SD = 2 mg/kg P
% CV = 20%

HIGH VARIABILITY

- **Variability** refers to how spread out a group of data is.
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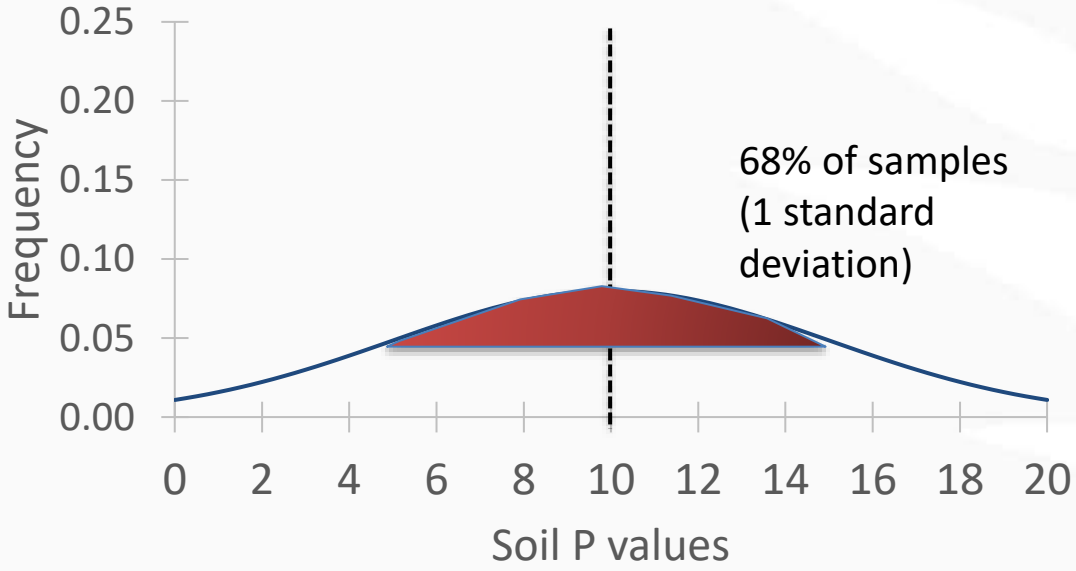


High variability

Mean = 10 mg/kg
SD = 5 mg/kg P
% CV = 50%

HOW VARIABLE ARE NUTRIENTS IN SOIL?

On the row and off the row

- 12 sites – 8 to 16 samples analysed separately
- Soils included : sands, sandy duplex, gravels, loamy duplex and clay

Amelioration

- 3 amelioration trials – 16 samples in control and deep rip
- 1 trial – control and mouldboard 10 sites which are 10 cores bulked

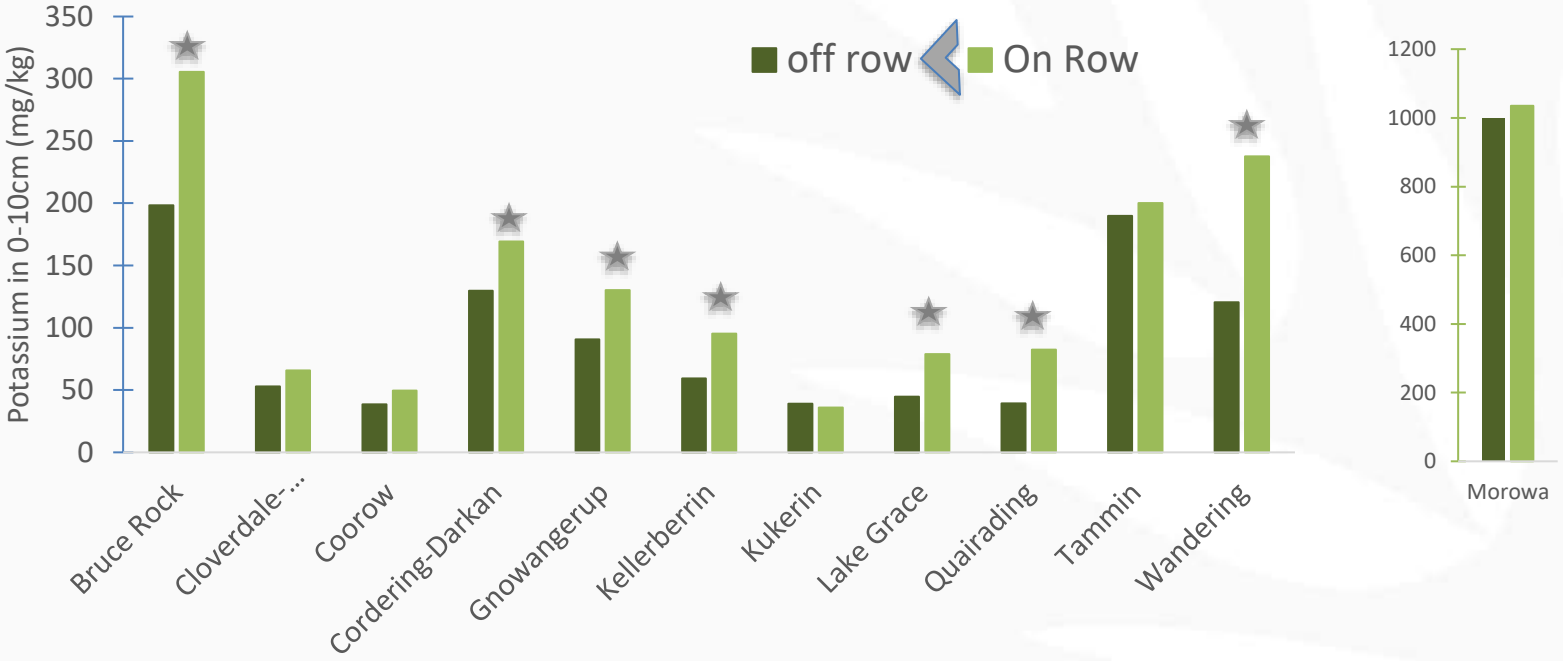
Soil type and summer release from stubble

- 2 sites and 2 soil types at each site sampled In Feb (monthly to finish)
- 10 cores bulked as one sample, 10 locations per soil type

WA Literature

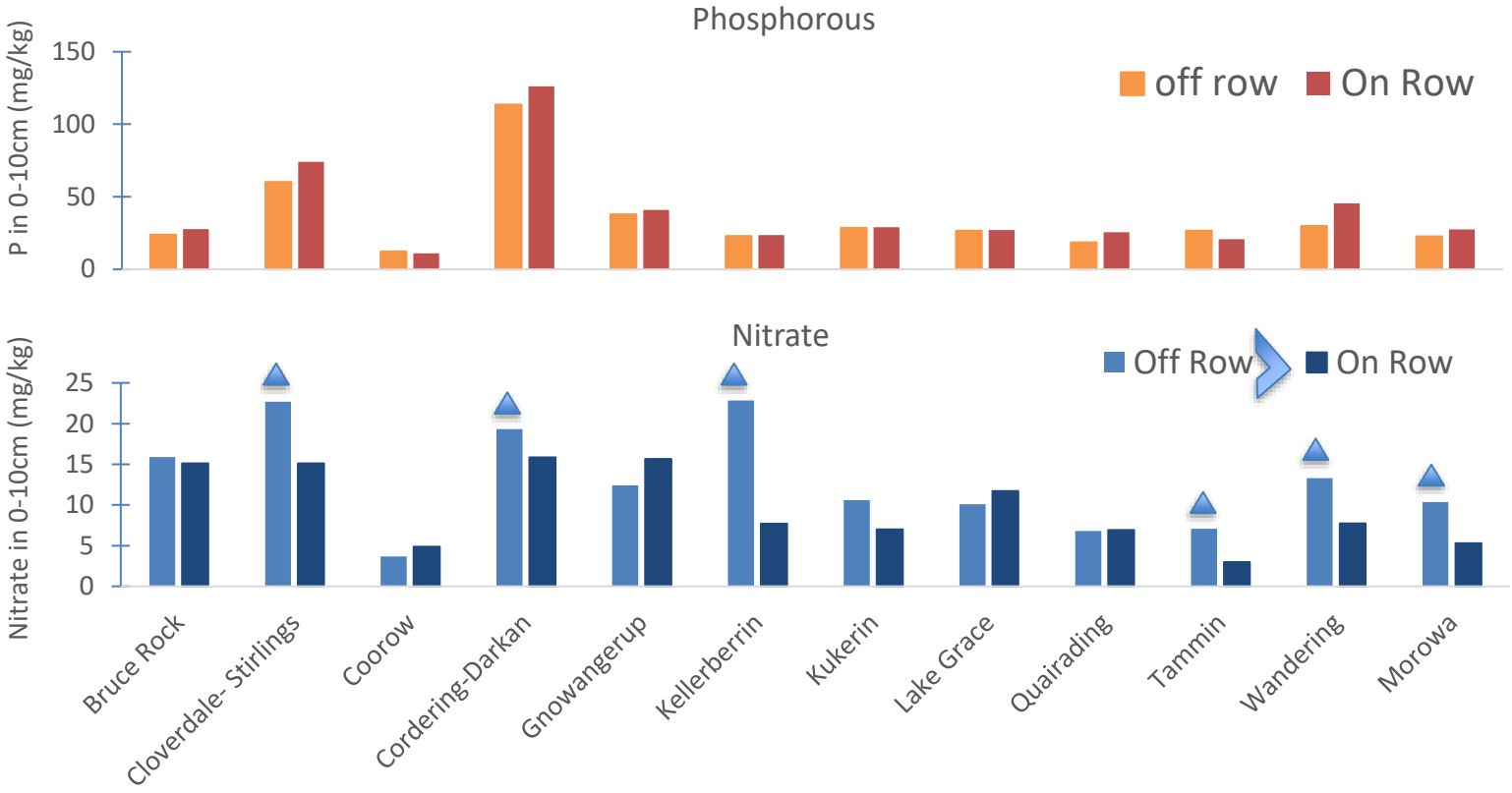
- P in 0-10cm at six locations with very intense sampling (80 cores) in close proximity (Ripper 1989)
- P and K had been assessed at 0-10cm via intense sampling at three locations across an entire paddock (141-516 samples per paddock). Weaver et al 2016

POTASSIUM OFF-ROW VS ON-ROW



More K on the row!!

PHOSPHOROUS AND NITRATE OFF-ROW Vs ON-ROW



SOIL TYPE AND NUTRIENT VARIATION

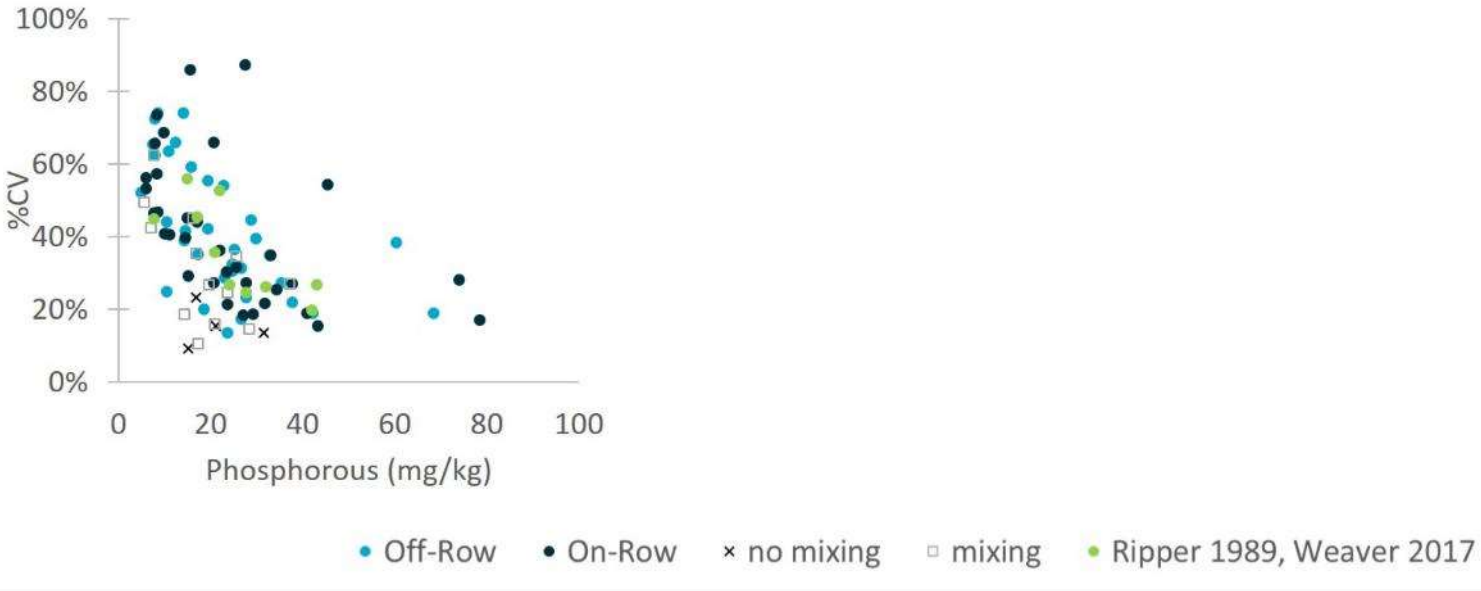
	Sand	Gutless sand
P mg/kg	28	22
K mg/kg	93	37

%CV within a soil type 11-15% P and K

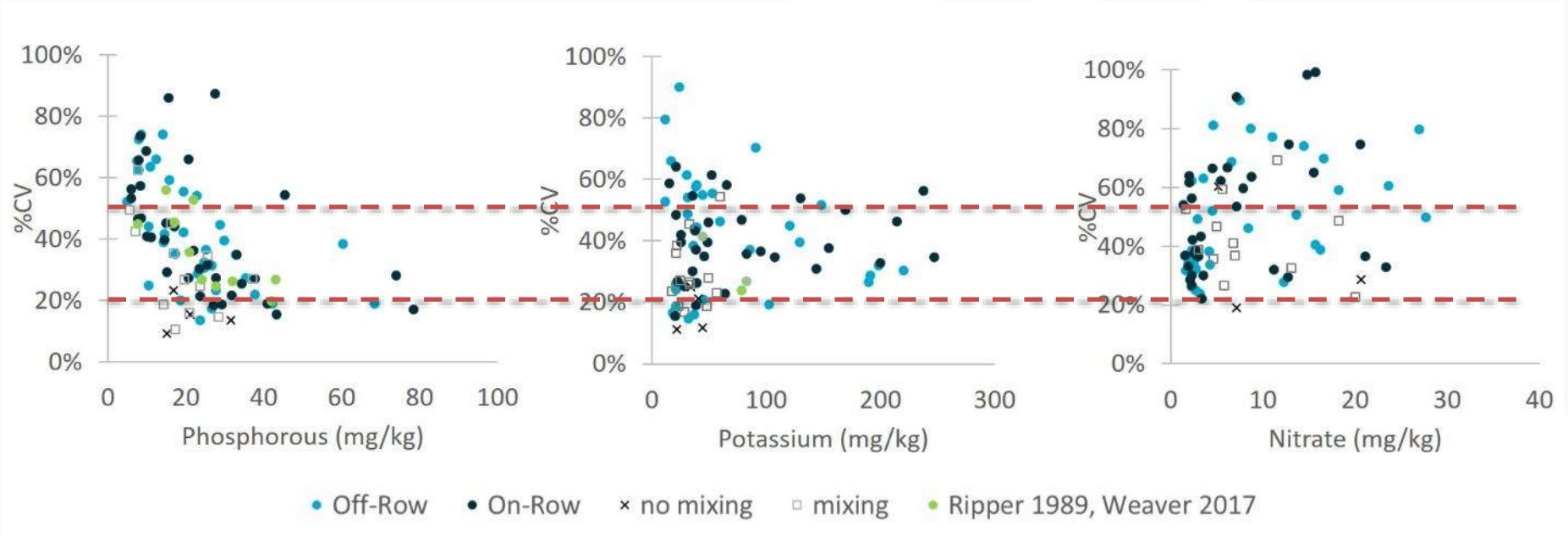
All If samples were combined then
%CV = 18% P and %CV =46% K

Sample to soil type

VARIABILITY AND SOIL TEST VALUES

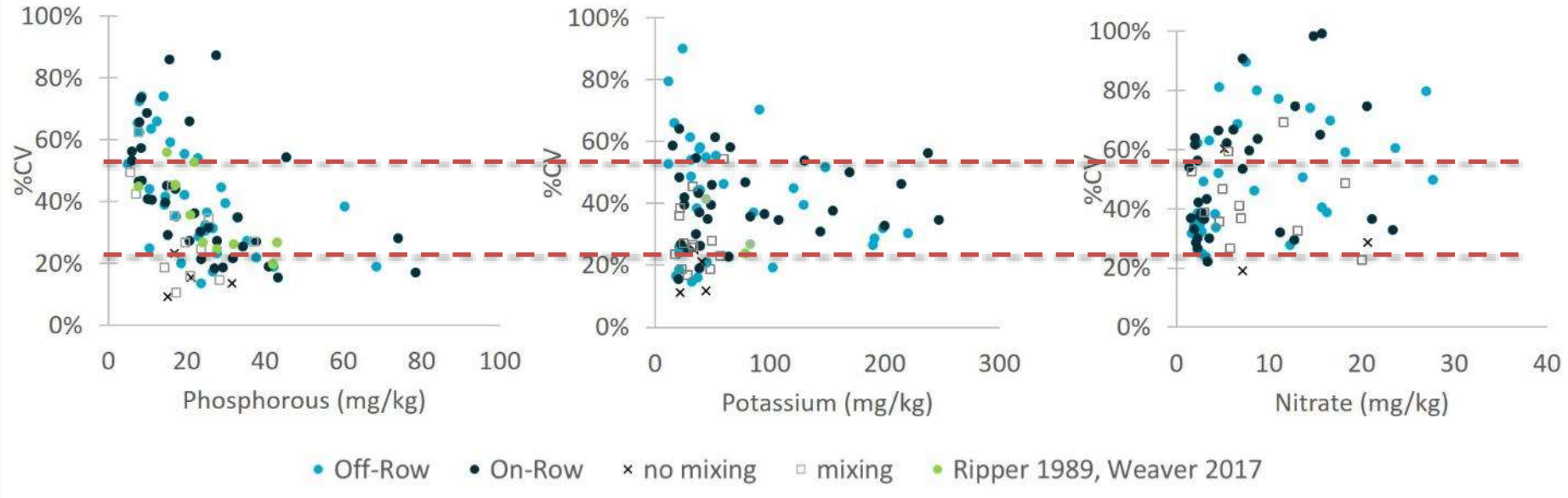


VARIABILITY AND SOIL TEST VALUES



VARIABILITY AND SOIL TEST VALUES

No trend with nutrient concentrations
Controls slightly less variable than deep ripped sites
Need to tease out soil type effects



SO HOW MANY SAMPLES DO I NEED?

- Depends on how accurate you want/need to be
- How much variability there is

We use an economic approach to help decide

HOW MANY SAMPLES TO BULK ?
DEPENDS ON VARIABILITY AND ACCURACY

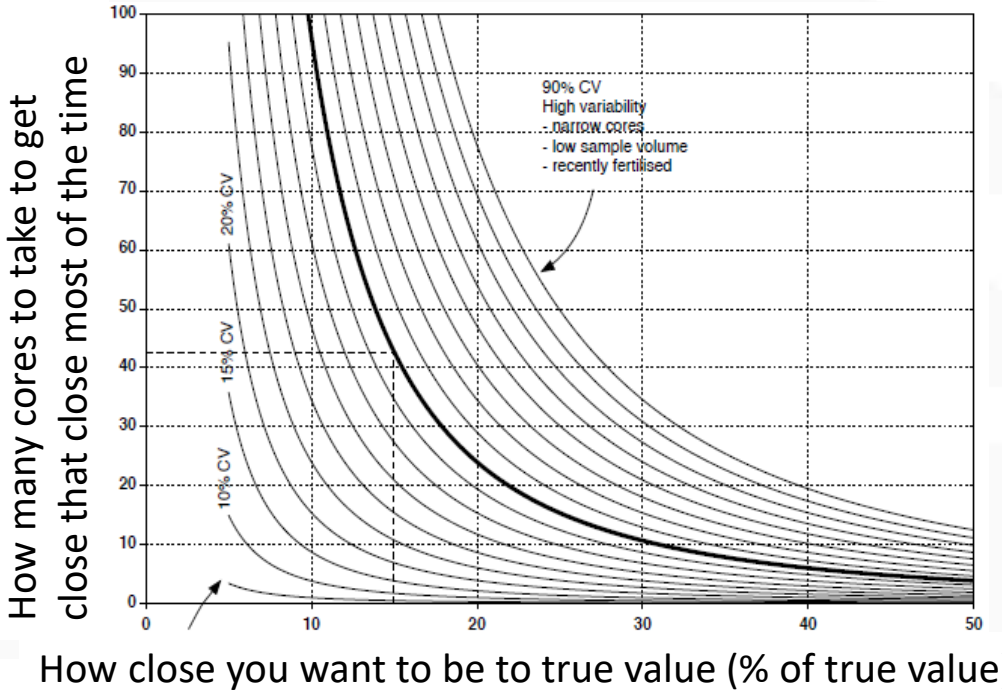


Fig 10 . Gourley CJP and Weaver DM (2019) A guide for fit for purpose soil sampling, Fertilizer Australia, Canberra, Australia

Industry sampling protocol

- 8 - 20 cores at 0-10cm (bulked) = 1 site.
- Less subsoil cores 10-20, 20-30 cm
- Inter-row to in-row cores
  - 9:1 ratio or 8:1 ratio
  - Or not taken into account

HOW MANY SAMPLES TO BULK ?
DEPENDS ON VARIABILITY AND ACCURACY

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The % difference from the mean

Increasing variability →

Increasing number of cores bulked ↓

Number of Cores	Coefficient of variation (%)			
	20%	30%	40%	50%
4	21	30	39	50
10	13	19	25	31
14	11	16	21	26
20	9	13	18	22
30	7	11	14	18
40	6	9	12	16

Actual P could be

5 – 15 mg/kg

10mg/kg P soil test

8.4 - 11.6 mg/kg

Adapted from “Gourley CJP and Weaver DM (2019) A guide for fit for purpose soil sampling, Fertilizer Australia, Canberra, Australia”

COST OF OVER OR UNDER FERTILISING

- Estimate the **P fertiliser** required for the average soil test value of **10 mg/kg P** (we used NP Decide) which uses
  - **P Soil test value mg/kg (Pst),** Potential yield = 2.5 t/ha (A), Crop yield price = $250/t ($Yield), P price - $3.5/kg (P$)
  - Includes parameters that account for soil test to yield relationships (Cstp) and the effectiveness of applied fertiliser (Kp):
- Estimate the Yield when the average fertiliser rate is applied to a **low** or **high** soil test value
  - NP decide using scalars (Psc) which depended on soil test values (Pst), Fertiliser rate of P (Pf), Effectiveness of applied fertiliser (Kp) and factor that relates soil test values to yield (Cstp)

COST OF OVER OR UNDER FERTILISING

- Soil test value of **10 mg/kg P** BUT it could have been **lower** or **higher**
  - depending on the %CV and the number of samples taken

Number of cores	20% CV		50% CV	
	Low P	High P	Low P	High P
4	8.4	11.6	6.3	13.7
10	9.0	11.0	7.6	12.4
14	9.2	10.8	8.0	12.0
20	9.3	10.7	8.3	11.7
30	9.5	10.5	8.7	11.3
40	9.5	10.5	8.8	11.2

COST OF OVER OR UNDER FERTILISING

- **Apply fertiliser rate based on the average soil test value**

- **Soil test value LOW < average = under-fertilise = $ YIELD LOSS**

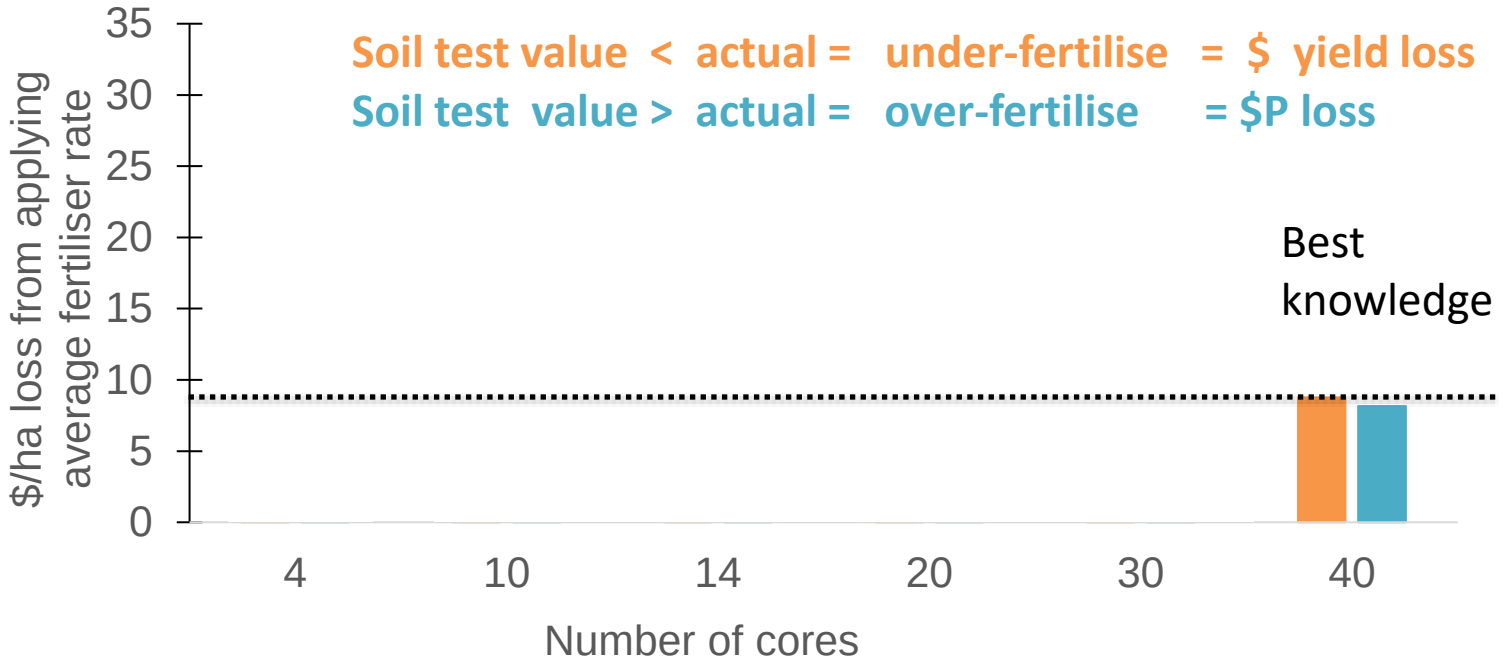
  $ loss ($/ha) = (Yield with average soil test and average fertiliser rate –
  Yield with low soil test and average fertiliser rate) x $grain price

- **Soil test value HIGH > average = Over-fertilising = $ P LOSS**

  $ loss ($/ha) = (Low soil test P - Average soil test P) x $P price

HIGHLY VARIABLE SITE – 50%CV

Range $ loss due to the % difference from mean caused by the % CV and the number of cores taken



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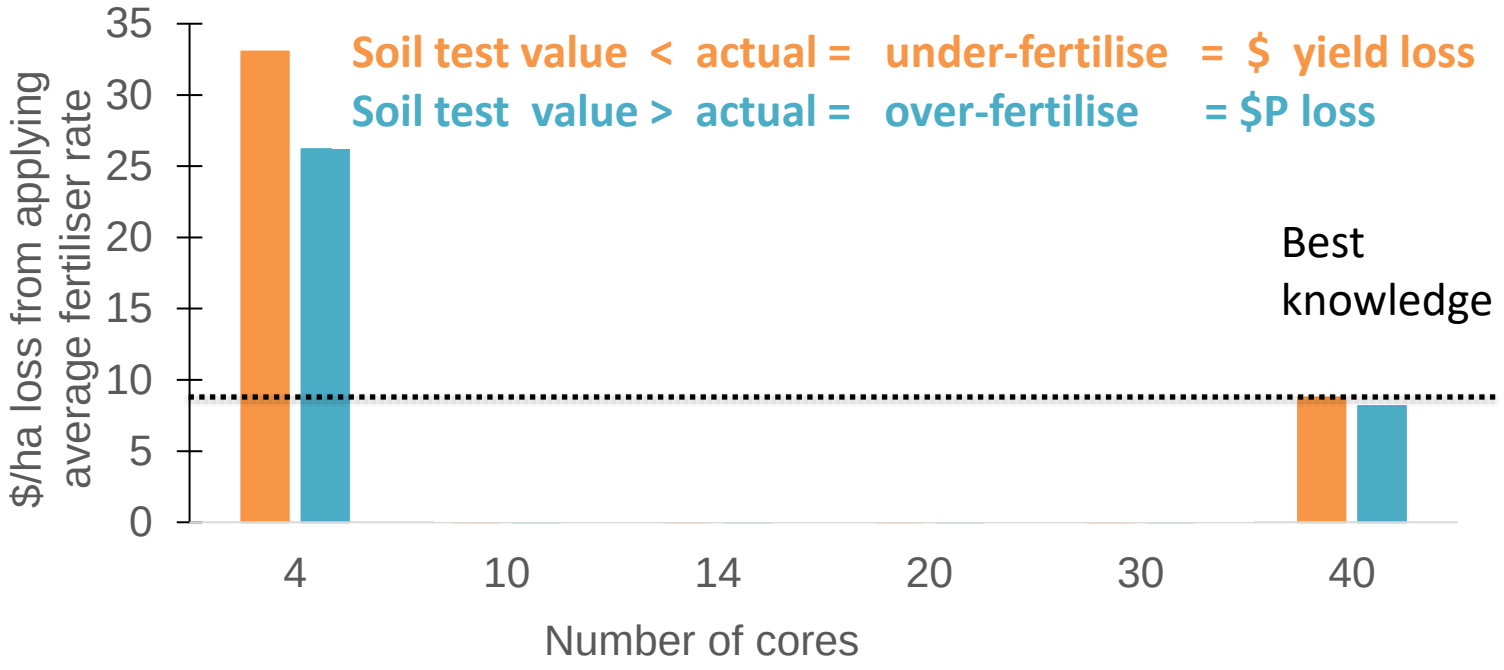

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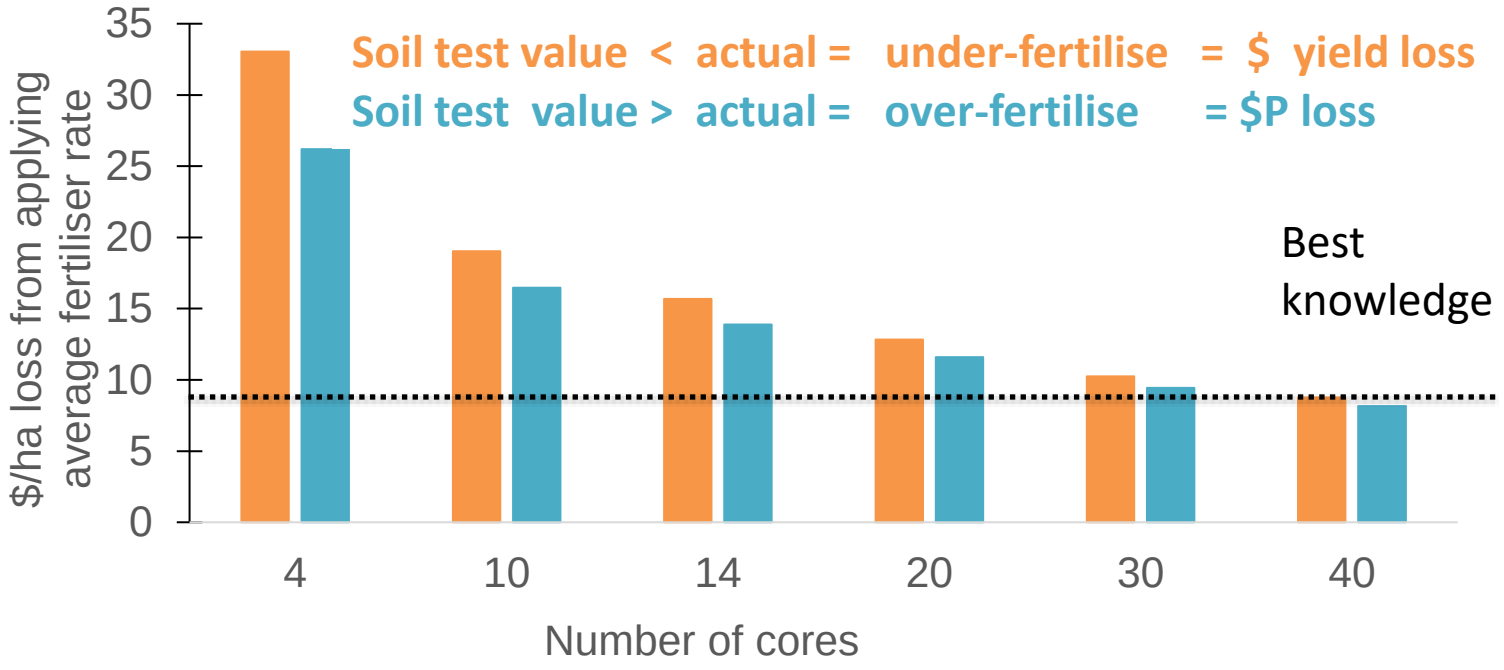
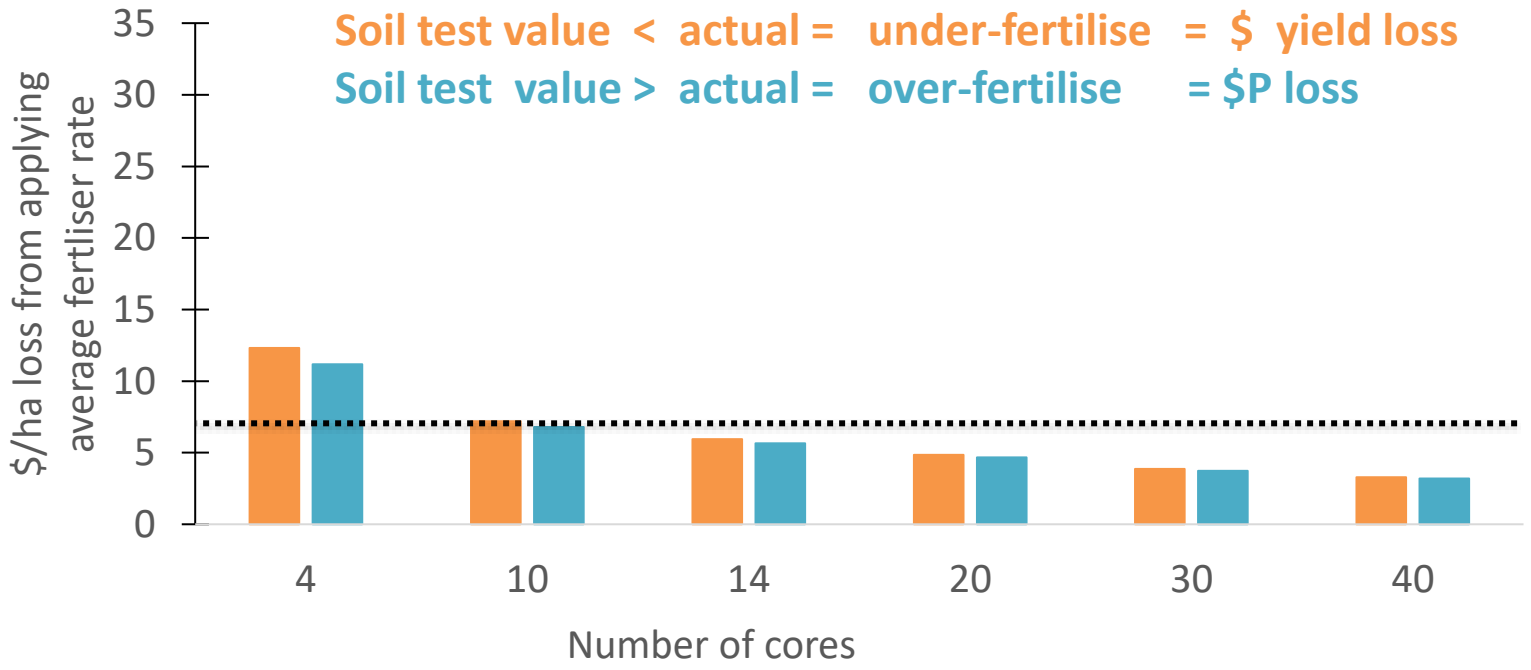


LOW VARIABLITY

Range $ loss due to the % difference from mean caused by the % CV and the number of cores taken



NUMBER OF SAMPLES

- Based on this example of 10mg/kg P
  - Highly variable sites (50% CV) need 20-30 samples bulked
  - Low variability (20% CV) need only 8-10 samples bulked

- This is just a framework to look at variability and $ losses due to not taking enough samples

- If there are increases in price of P, $ yield or soil test P values
  - Increased $ loss from potential areas which are over- or under-fertilised
  - This may require a more accurate soil test value and therefore more cores

CONCLUDE

- Soil sampling can be a useful tool to assist with nutrient decisions and useful for tracking soil changes over time

BUT

- IF you don't take enough samples (and take care where you sample) the soil test number may NOT be correct

SO

- Understand how many samples you take and where you take them
  - Based on variability of the soil (small scale) and variability of soil types

- This was just an example to show the effect of variability and prices due to soil sampling strategies

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