

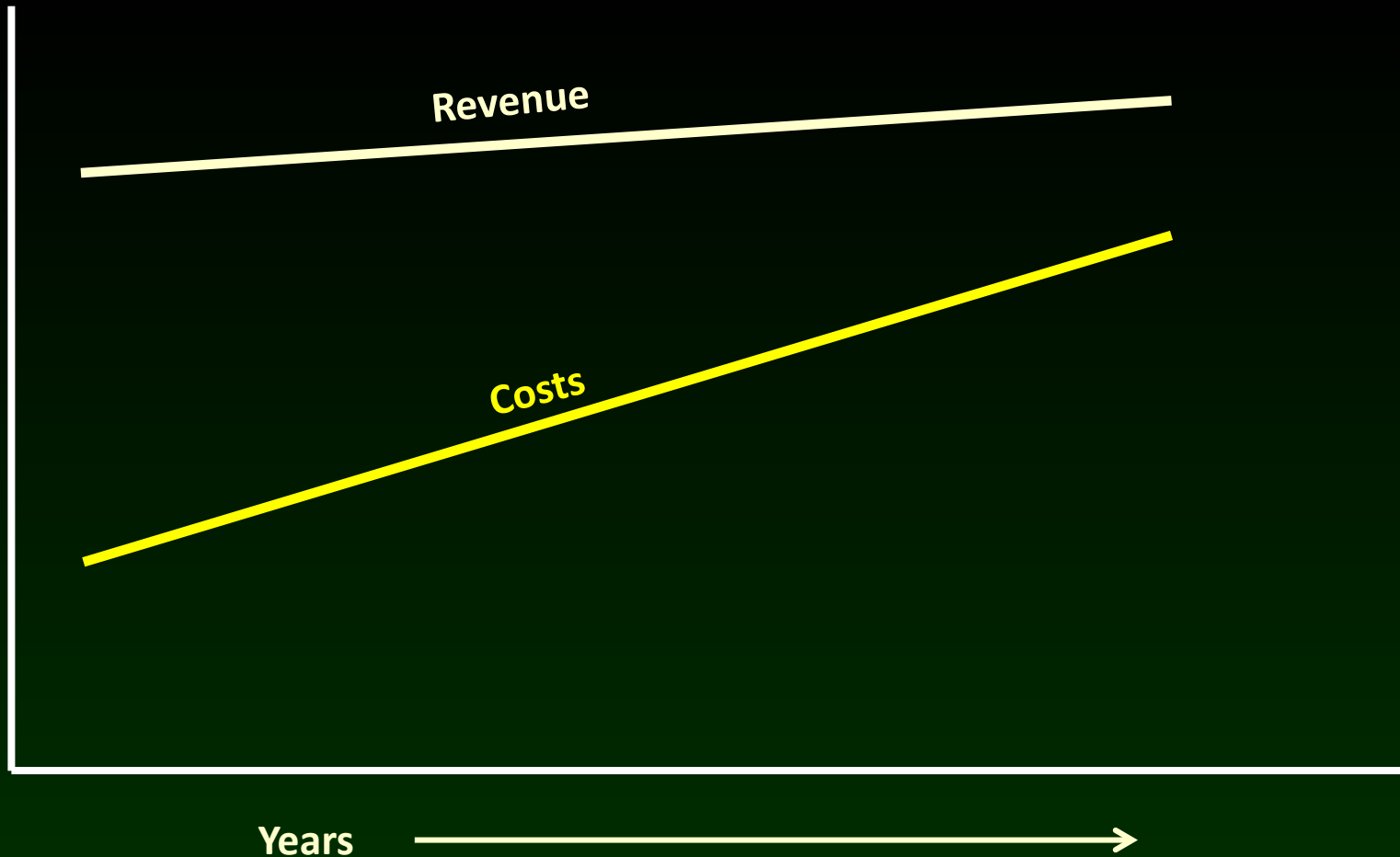
Non-exchangeable potassium in southern African soils: a neglected reserve from a crop nutritional perspective

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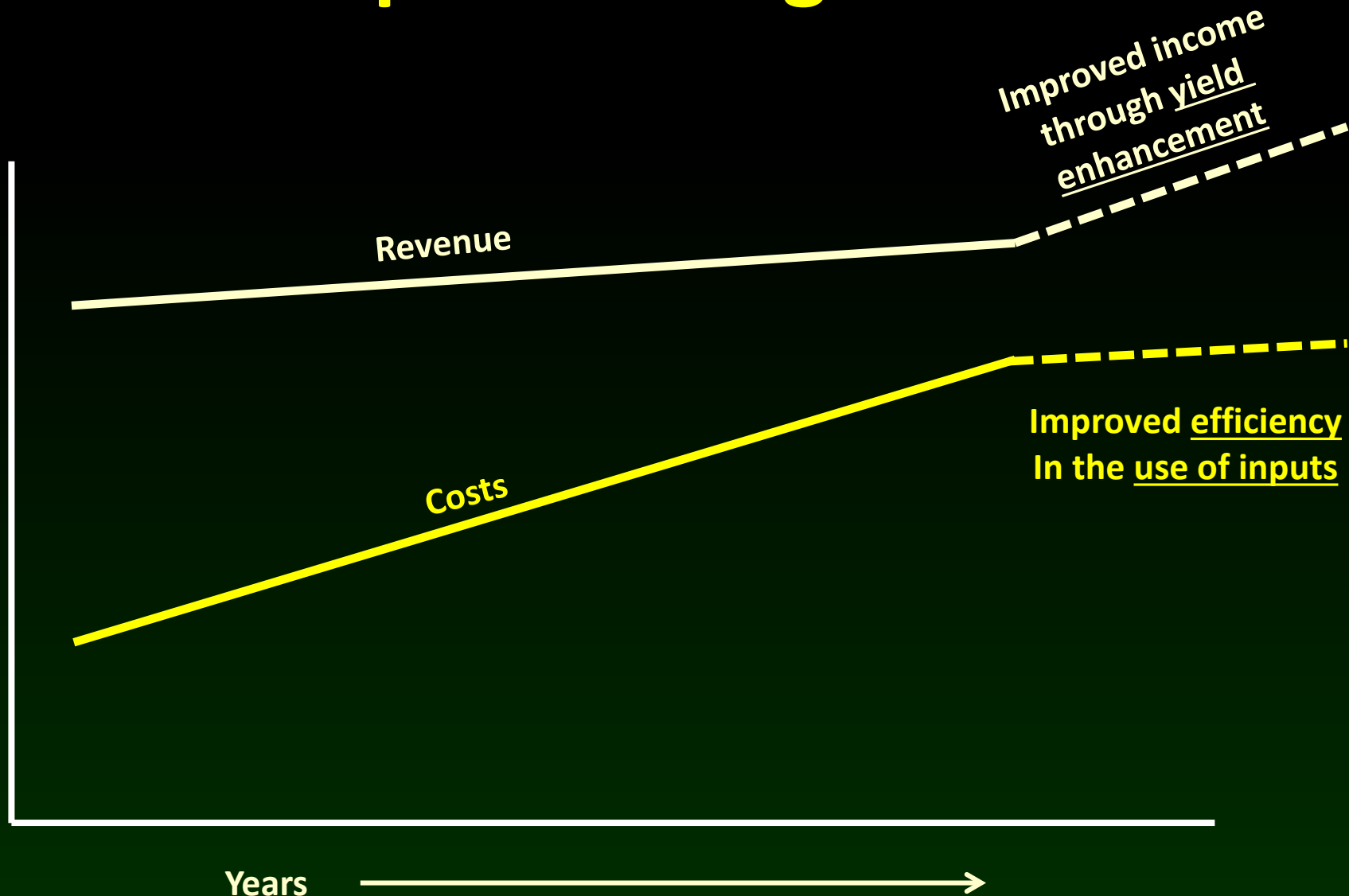
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The cost squeeze in agriculture



The cost squeeze in agriculture



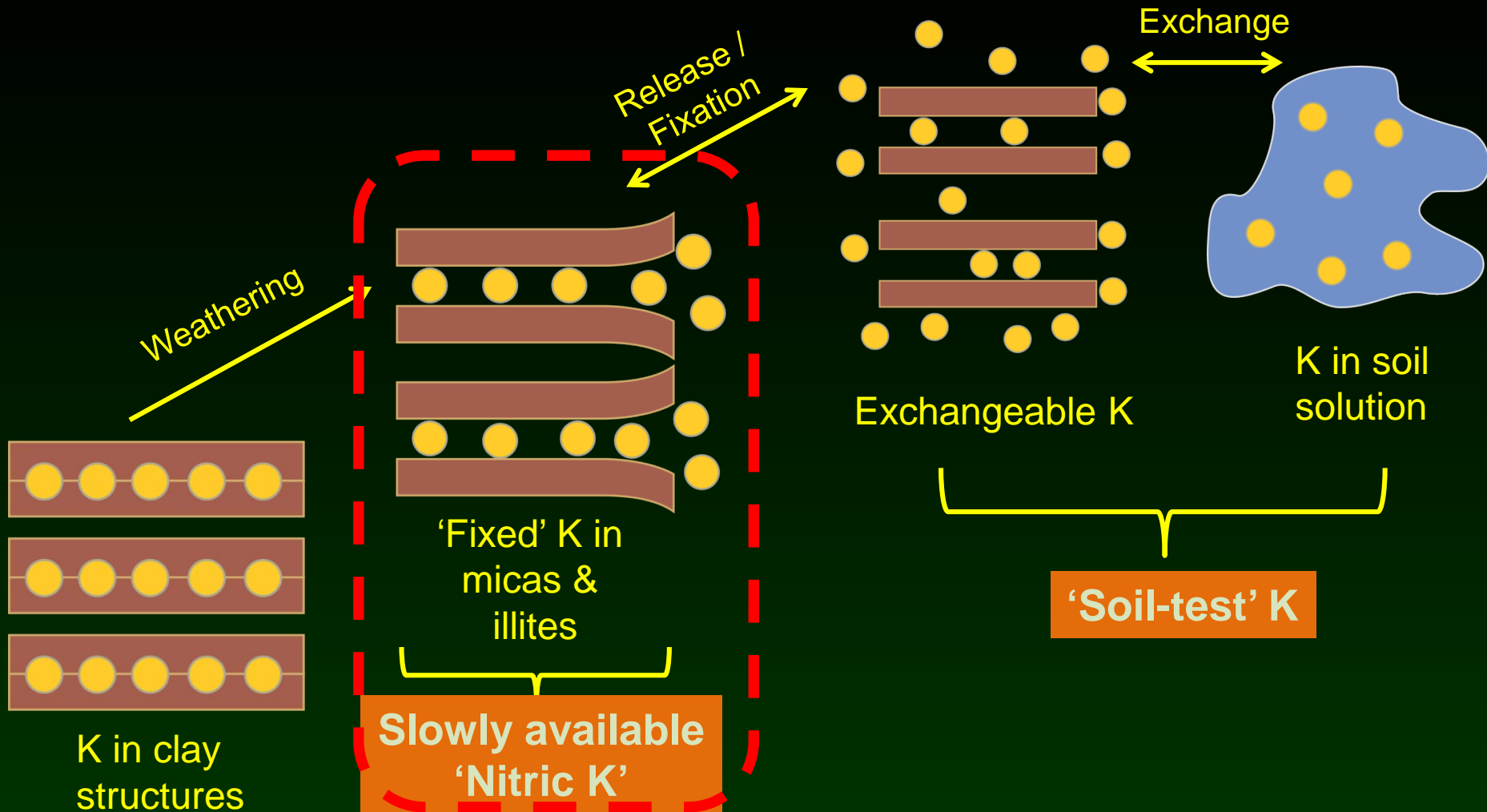
Estimated current annual expenditure on NPK fertilisers in the South African sugar industry

N	P	K	Total
R millions			
448	212	489	1 149

Soil testing for potassium

- Most soils have relatively large amounts of total K, but small amounts of plant-available K.
- Soils may contain minerals (typically micas & illites) that release K slowly and/or 'fix' it.
- Routine soil testing involves extraction of exchangeable / soluble K with salt solutions.
- Slowly-available ('reserve') K may be estimated using boiling HNO₃ or sodium tetraphenylboron extraction.

Potassium pools in soils



The issue.....

- In soils containing micaceous clays, slow release of K is a major reservoir of K for crop growth.
- Although long known, this phenomenon not accommodated in routine soil testing.
- Potential for appreciable savings in K ?

This presentation

- Data from maize and sugarcane field trials
- Boiling nitric-acid extractable K ('nitric K') in 429 topsoil samples from five Southern African countries
- Prediction of nitric K using routinely-measured soil properties and MIR

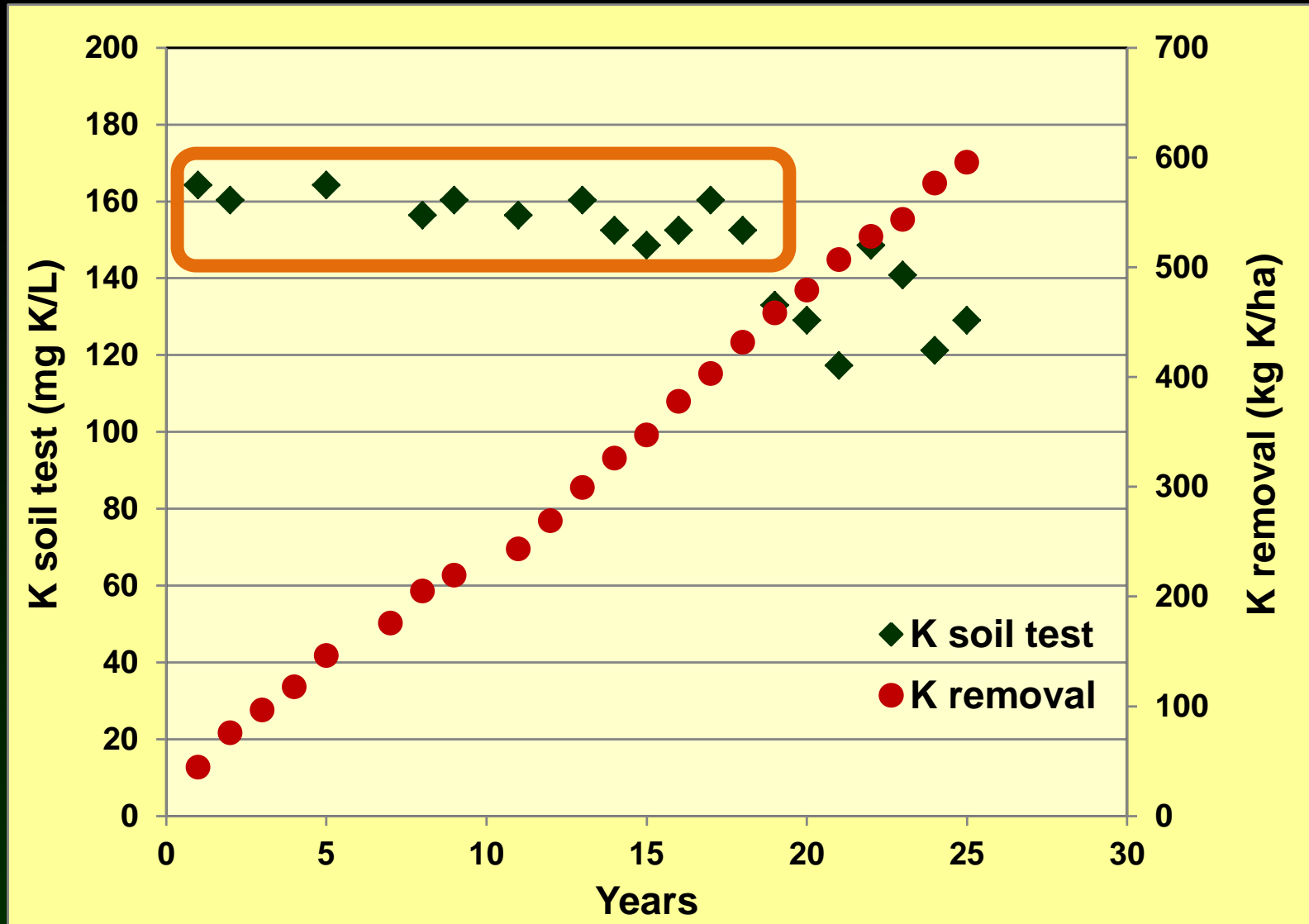
Field trial results...

Long-term maize trial at Bergville

- Avalon soil, 36% clay
- Nitric K = **2.08 cmol_c/kg**
- **No yield response over 25 years** (all stover and grain removed at harvests).



Bergville Maize Trial



Sugarcane response to potassium on a Glenrosa soil in Mpumalanga

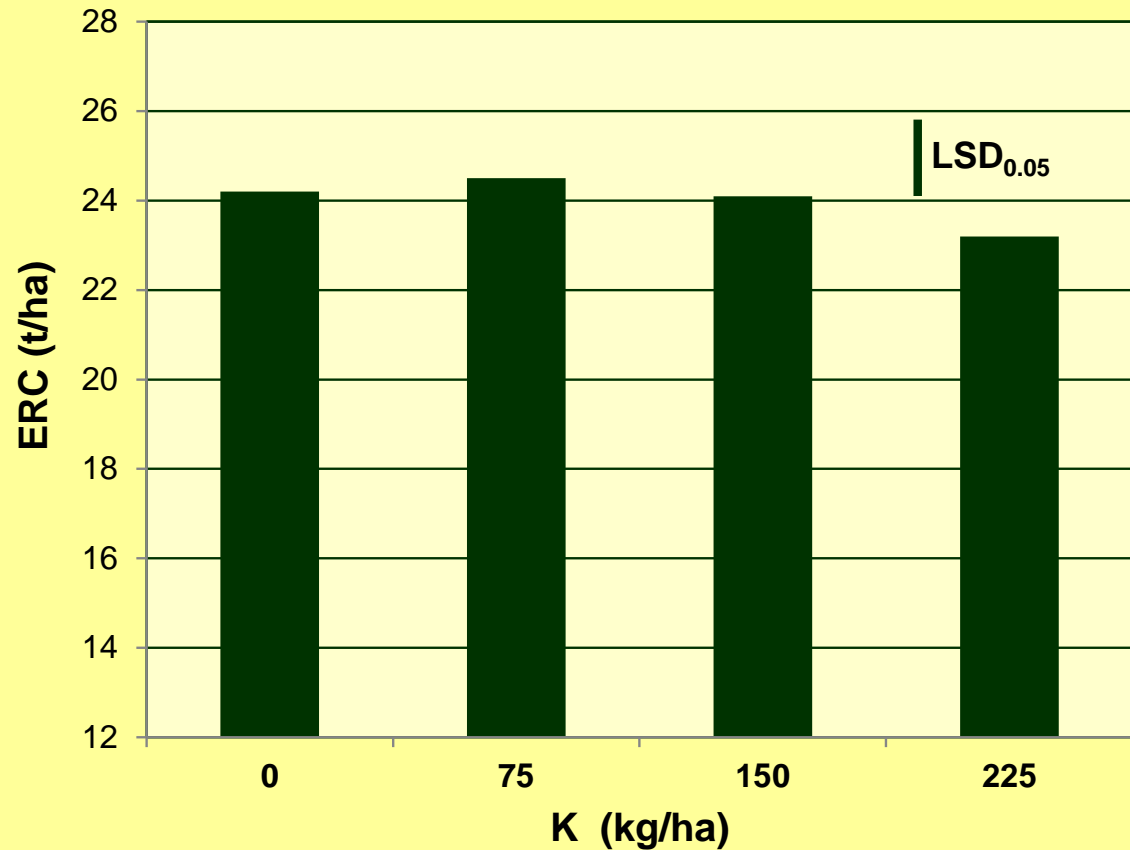
- Initial soil K = 150 ppm
- Nitric K = 2.6 cmol_c/kg



Potassium response of sugarcane on a Glenrosa soil in Mpumalanga

No response to K over three ratoons (estimated annual removal = 250 kg K/ha)

Sucrose yields in third ratoon



Long-term sugarcane trial at Mt Edgecombe (BT1 Trial)

- Arcadia (vertic) soil
- Nitric K = 1.52 cmol_c/kg
- **No response to NPK for 18 years**



Sugarcane trial on the Umfolozi flood-plain

- Dundee (alluvial) soil (42% clay)
- Soil test K: 110 mg/L
- Nitric K = 3.84 cmol_c/kg
- **No response to K for 2 seasons**



Top-yielding farmer: no K for 5 years

So..... no responses to applied K in field trials with nitric K's of 1.5 to 3.8

Overseas field trial findings...?

Criteria suggested for modification of K recommendations in Australia

- Haysom (1971) field trial data interpretation:

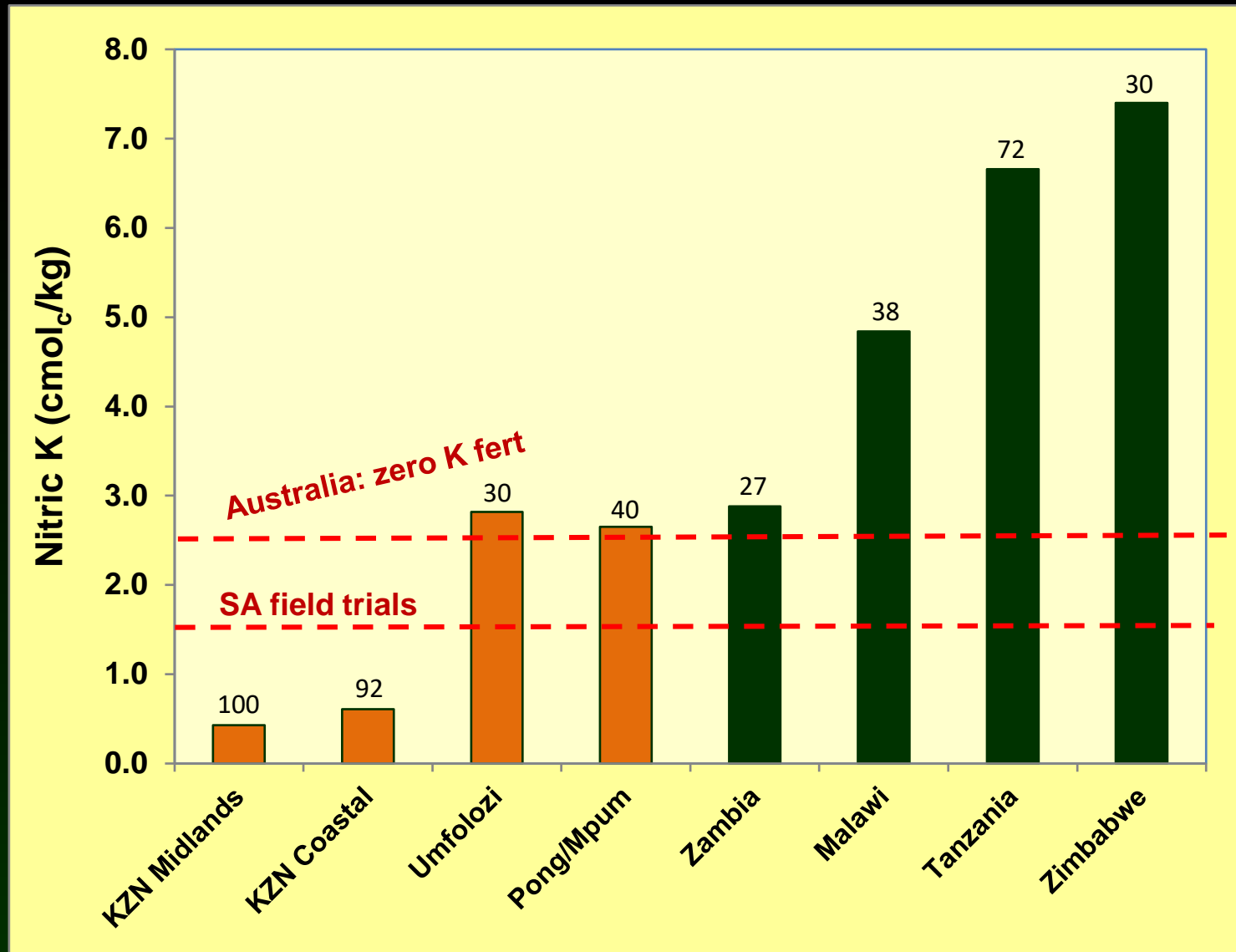
Nitric K (cmol_c/kg)	Category	Recommended K (%)
<0.8	Low	100
0.8 – 1.5	Medium	82
1.5 – 2.5	High	45
>2.5	Very high	0

Never
implemented..?!

- Schroeder et al. (2006): Reduce K recoms by $\pm 20\%$ if nitric K **>0.70**

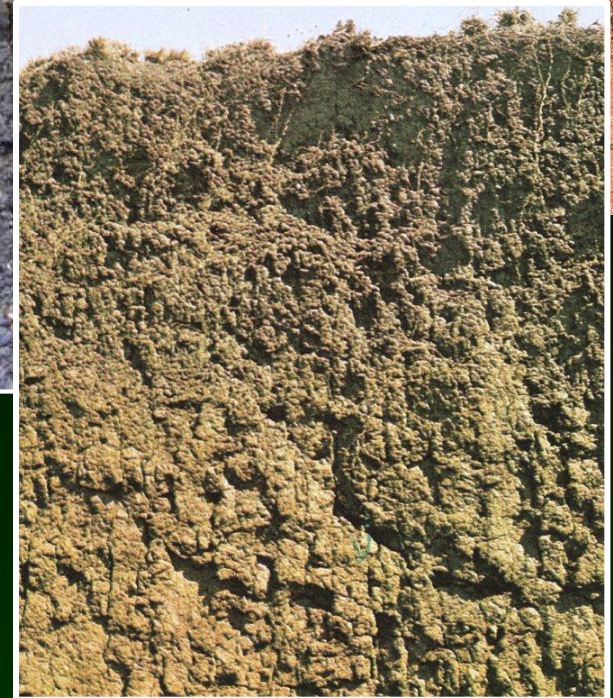
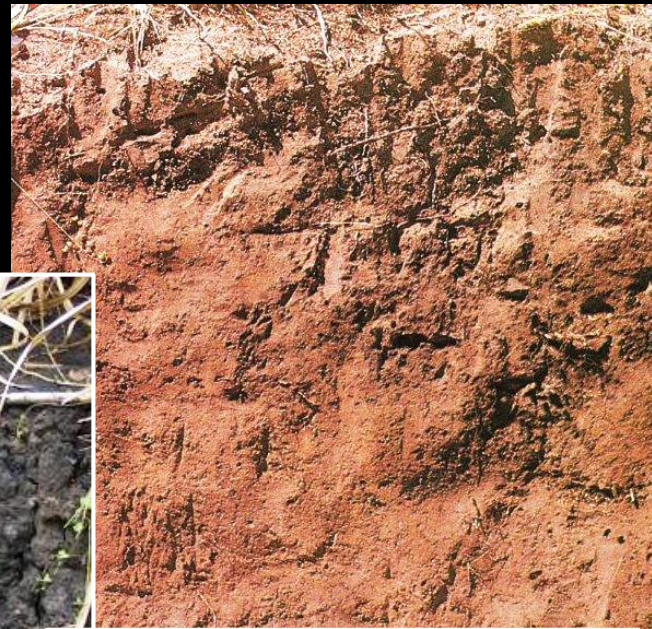
Nitric K levels in Southern African sugarcane topsoils

Median nitric K levels in Southern African soils



Nitric K: which soils have higher reserves?

- Many soils in drier irrigated areas
- Alluvial soils (e.g. Umfolozi flood-plain)
- Structured soils in rainfed areas

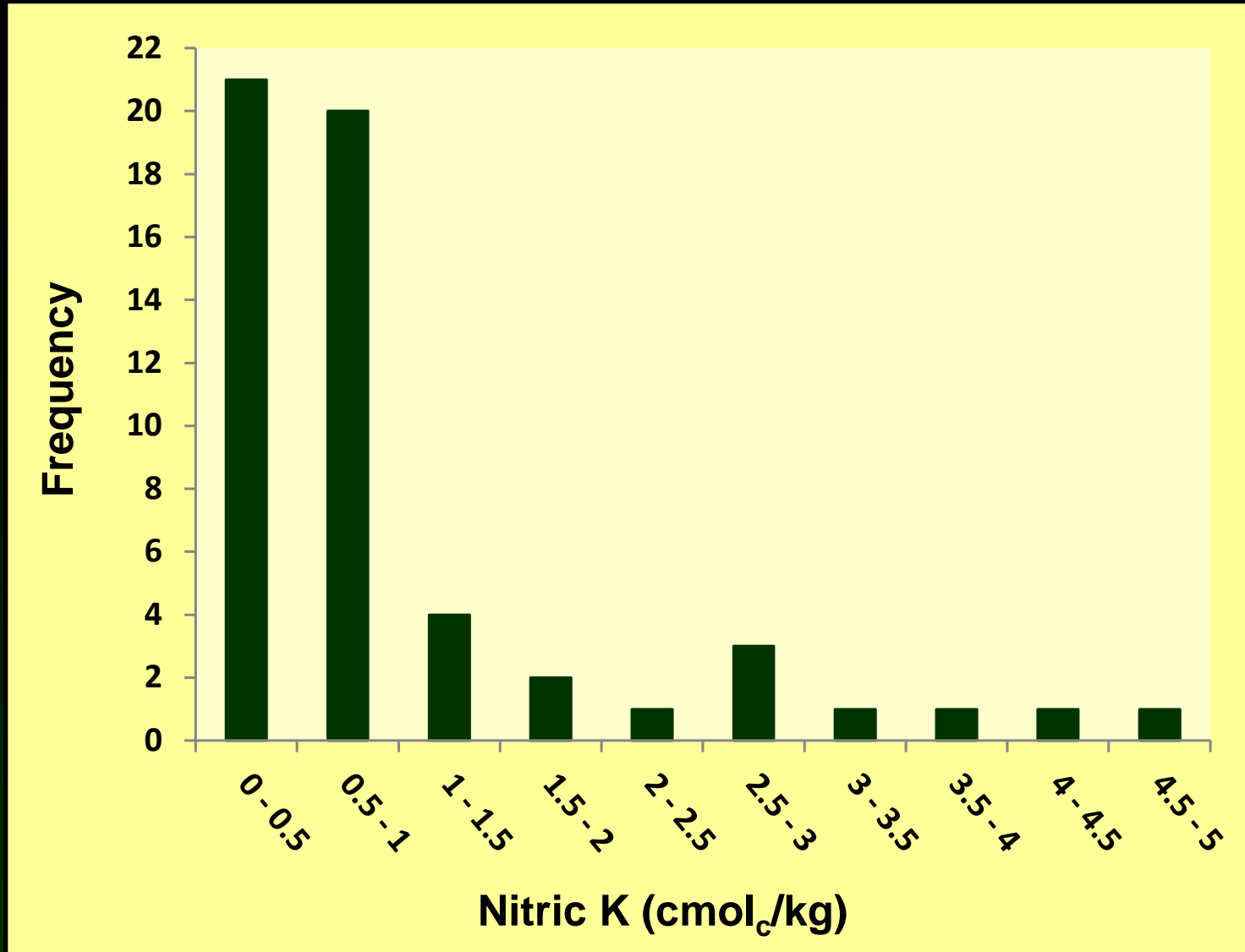


The problem of soil heterogeneity

- Frequent high soil heterogeneity implies marked variations in K reserves over small distances.
- Not possible to extrapolate results over large areas.



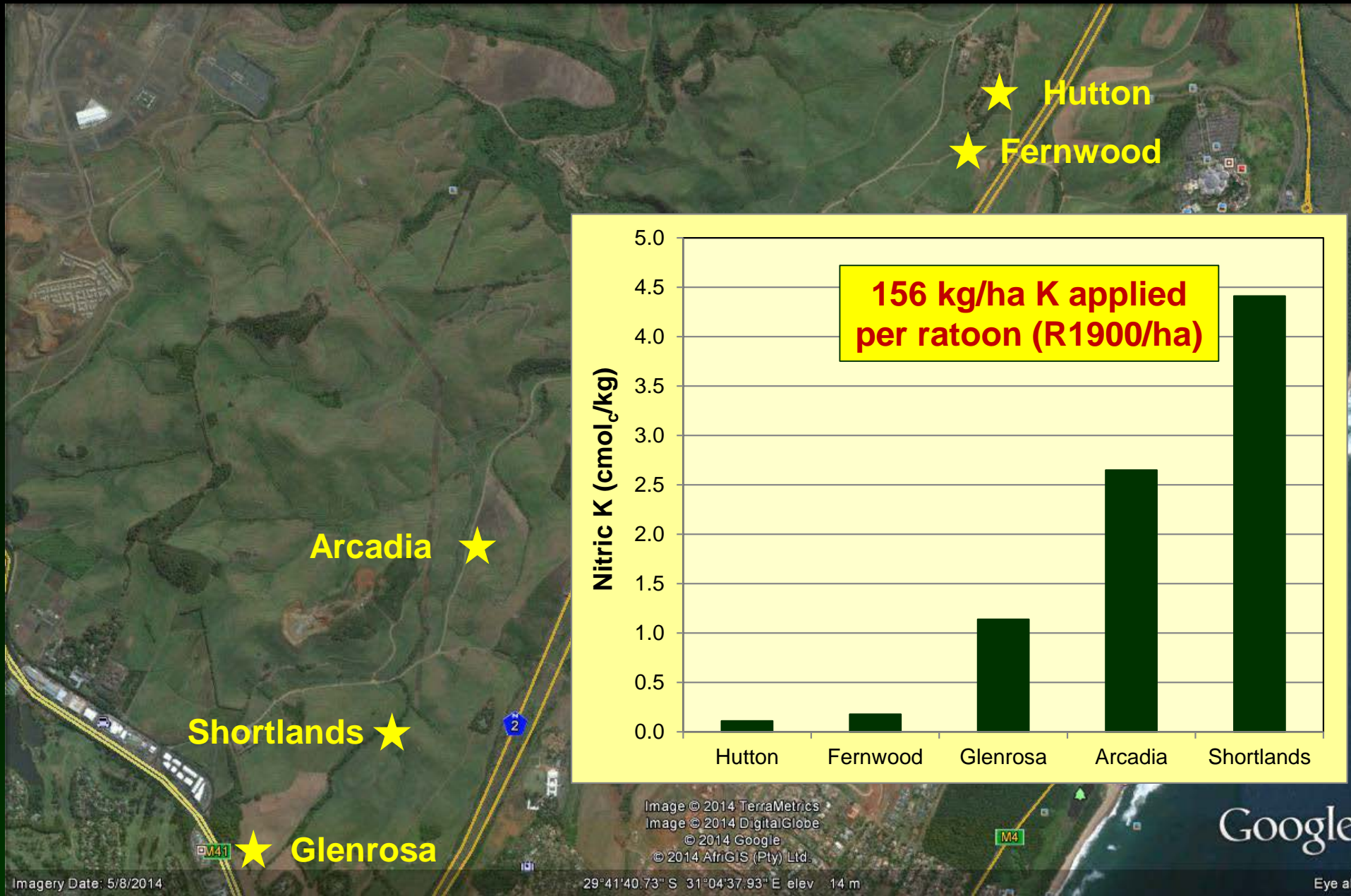
Frequency distribution of nitric K in sugarcane fields on the North Coast of SA



Nitric K in profiles surrounding SASRI



Nitric K in profiles surrounding SASRI



Imperative: the routine prediction of nitric K in order to modify K recoms

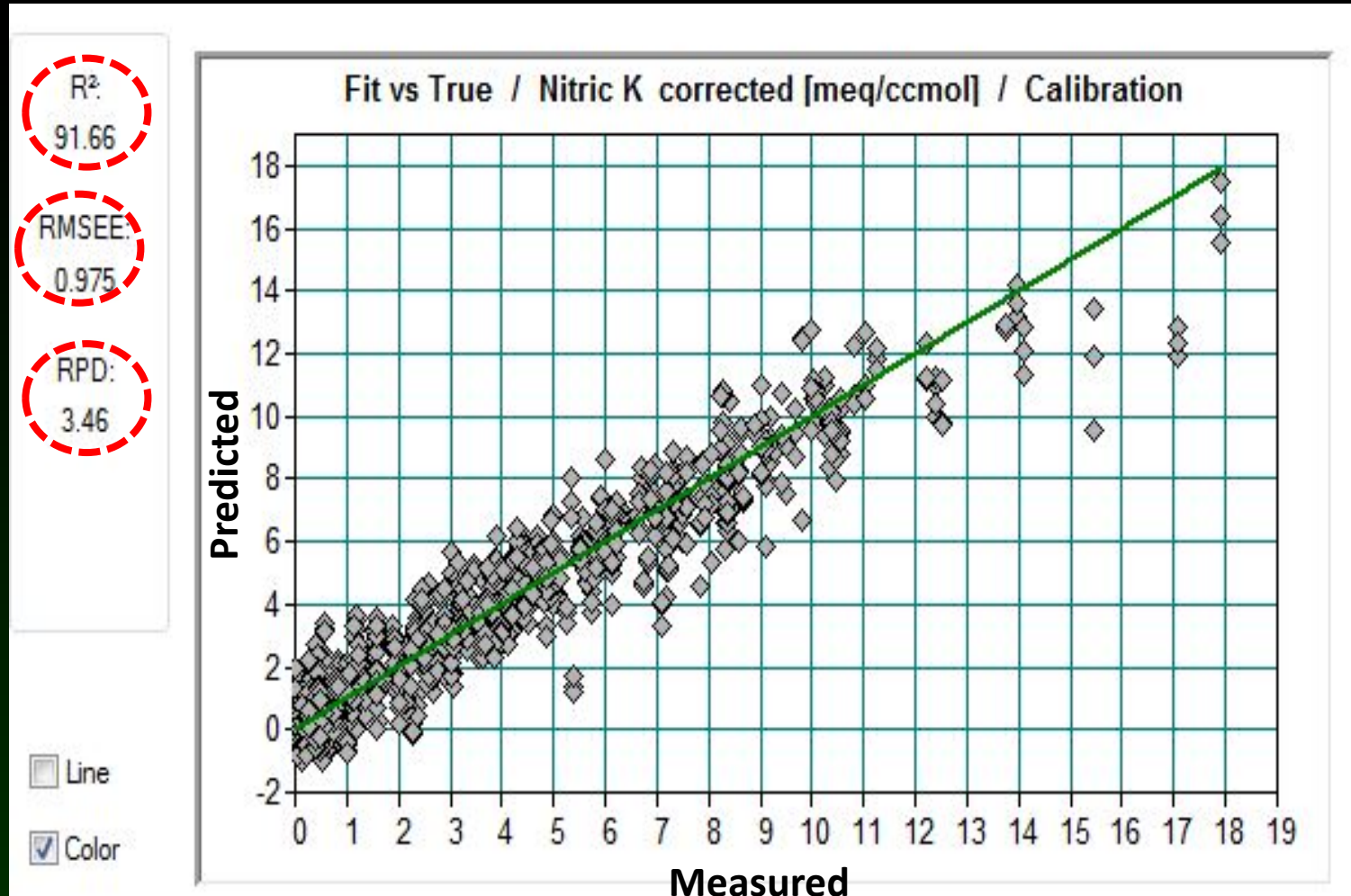
How nitric K determination not suited to use in routine soil-testing lab

- Multiple regression based on routinely-measured soil properties ($R^2 = 40.4$)
- Offer nitric K as an optional supplementary analysis at additional cost?
- Use MIR to routinely estimate nitric K on all samples?

Mid-infrared reflectance prediction of nitric K reserves in soil of the Southern African sugar industries



Mid-infrared reflectance prediction of nitric K reserves in soil of the Southern African sugar industries



Bad news for the fertiliser industry???

OPPORTUNITIES

- ✓ Improved efficiencies → enhanced sustainability.
- ✓ More effectively address other crop nutrient problems...N, S, micros.



Conclusions

- Field trial results point to the unnecessary use of K on many soils in Southern Africa
- Exploiting slowly-available K reserves → significant cost savings, without compromising production.
- MIR → possible solution to the problem of routine measurement of K reserves