IPNI Southeast Asia Program

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Nutrient Use Efficiency (NUE) of Oil Palm

T Oberthür, C Donough,
H Sugianto, YL Lim & MS Tan

Agriculture, Biotechnology and Sustainability (ABS) Conference
MPOB International Palm Oil Congress (PIPOC)
Kuala Lumpur, Malaysia
November 14-16, 2017

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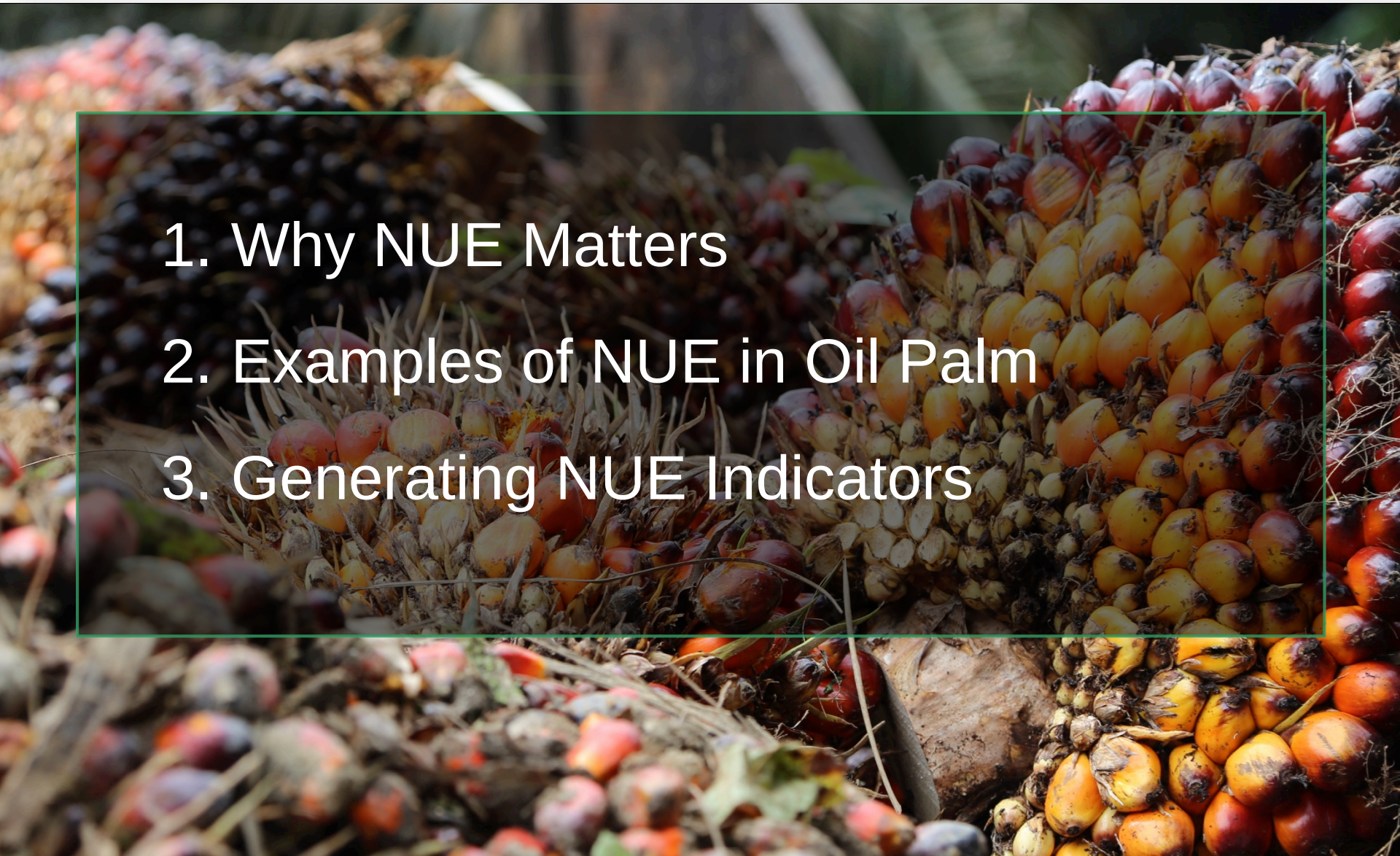
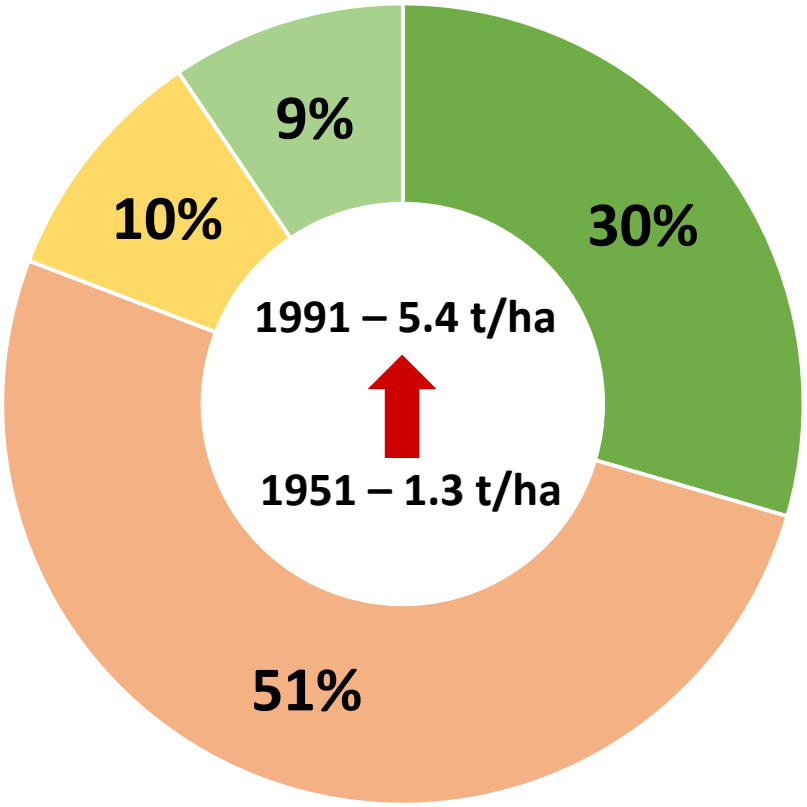


1. Why NUE Matters
2. Examples of NUE in Oil Palm
3. Generating NUE Indicators

1 Why NUE Matters

Contribution of Nutrition to Yield Formation

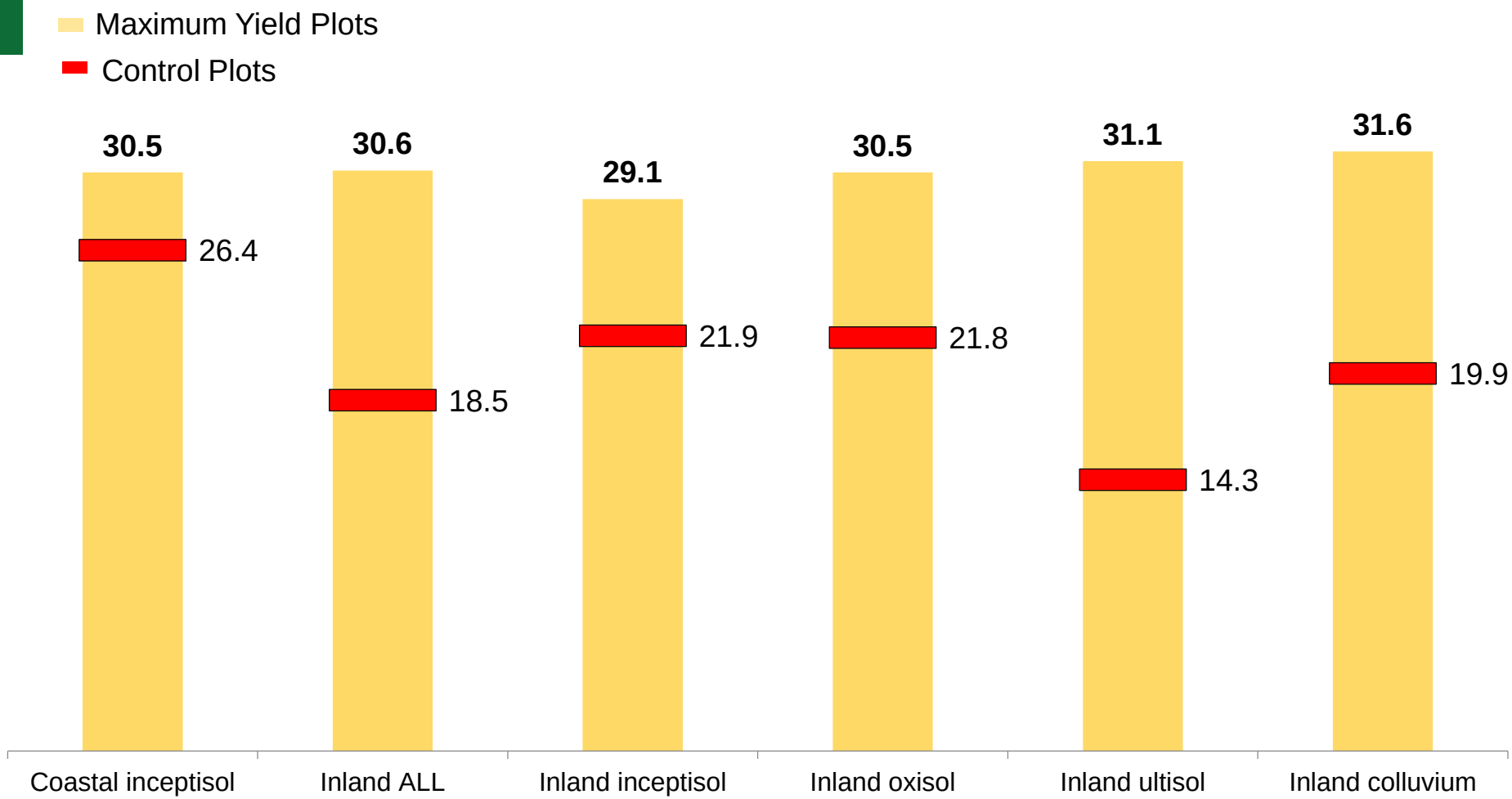


- improved nutrition
- improved genotype
- improved milling
- improved management

Source:

Analysis of Improvement in CPO yield (t/ha) 1951-1991 at Pamol Estate, Kluang (Davidson, 1993)

Contribution of Nutrition to Yield Formation



Source:
Tarmizi A M, Tayeb, M D & Zin Z Z (1992) Maximum yield of oil palm in Peninsular Malaysia: Yield response and efficiency of nutrient recovery. Proc 1990 ISOPB Int'l Workshop on Yield Potential in the Oil Palm, 29-30 Oct 1990, Phuket, Thailand. Palm Oil Research Institute of Malaysia, pp 145-153

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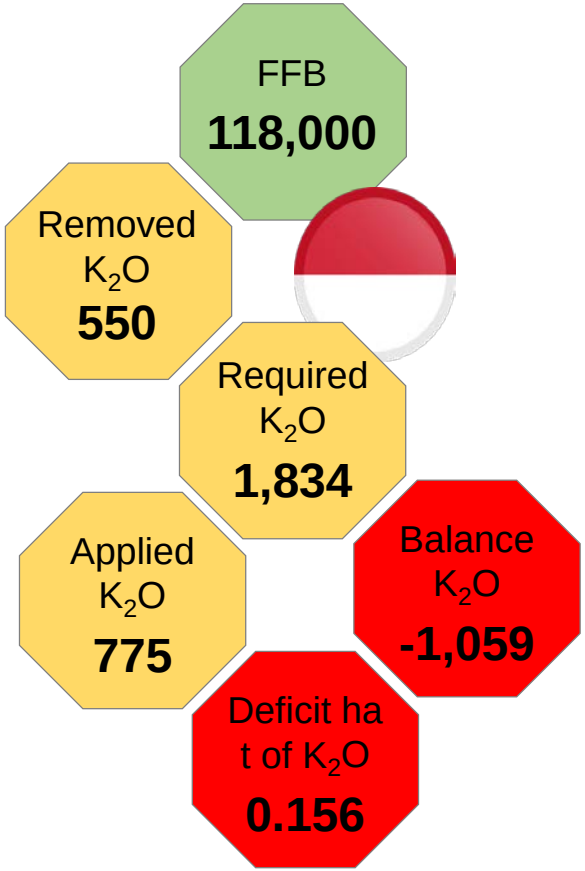
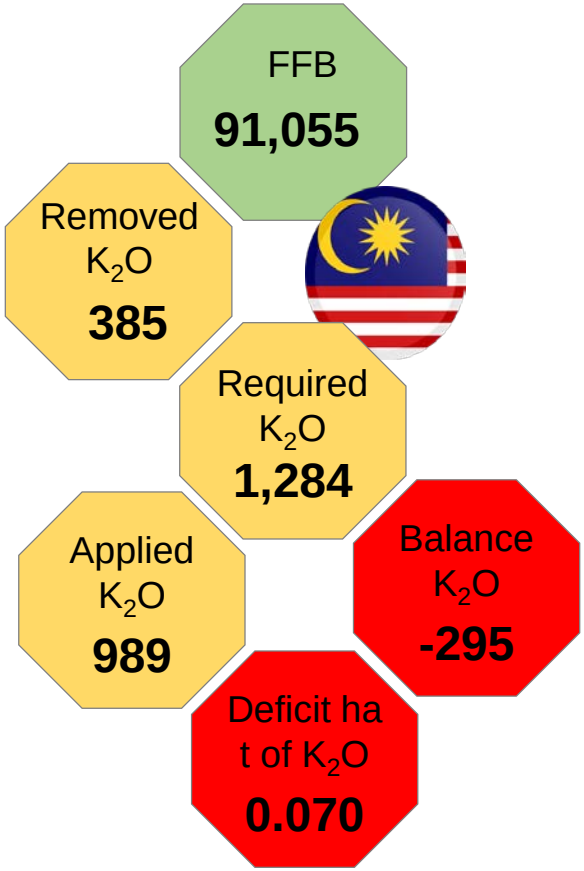
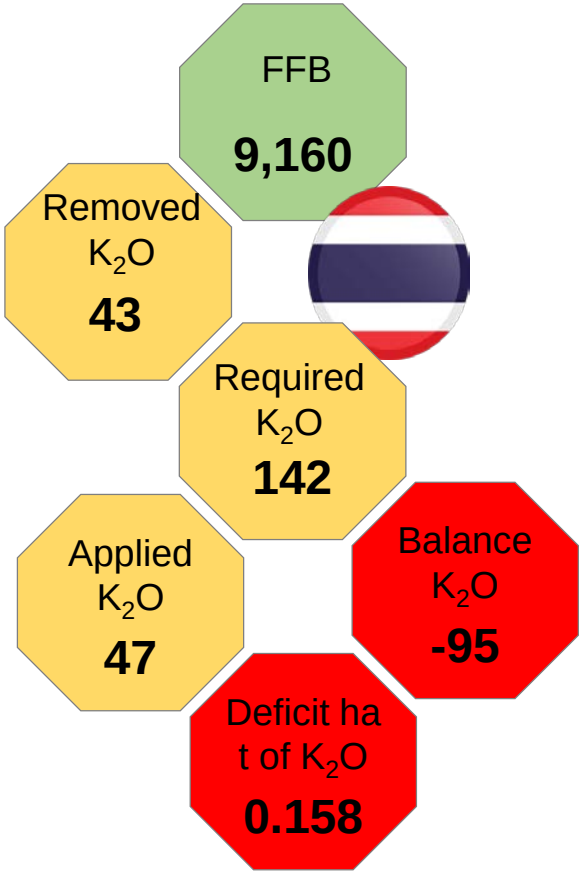
Sub-optimal Nutrition: The Example of K in FFB







'000 tons of FFB and K_2O
FFB: USDA (2010/11 CPO converted to FFB at 20% OER)
Applied K_2O: Heffer, IFA (2013)Q

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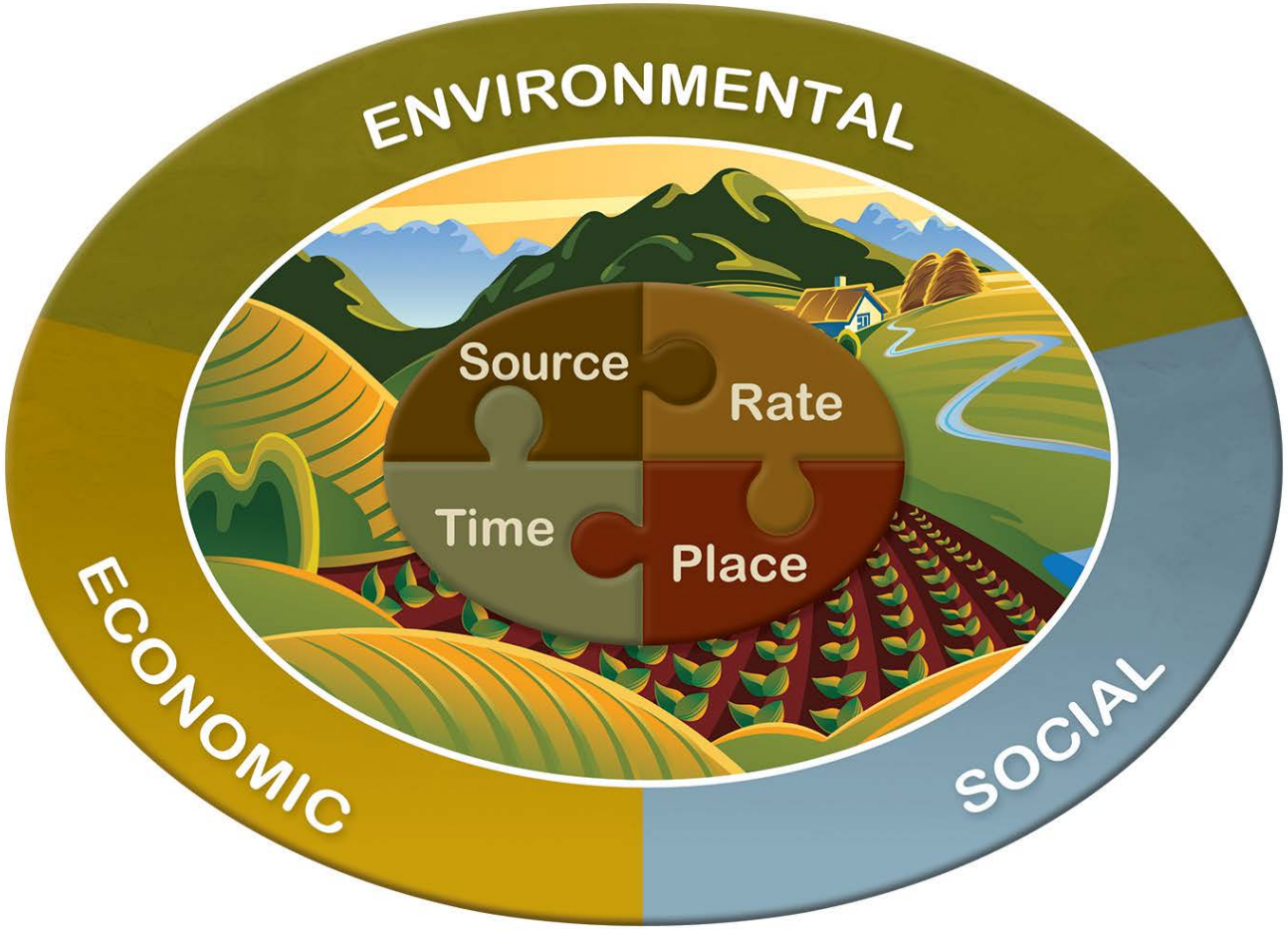
2 NUE Examples

Practical NUE Indicators to Guide Field Nutrition



Practical NUE Indicators to Guide Field Nutrition

PFP

Partial Factor Productivity
kg FFB per kg nutrient applied
PFP = Y/F

How productive is this cropping system in comparison to its nutrient input?

AGE

Agronomic Efficiency
kg yield increase per kg nutrient applied
AGE = $(Y-Y_0)/F$

How much productivity improvement was gained by use of nutrient input?

N P Mg K

PNB

Partial Nutrient Balance
kg nutrient removed per kg applied
PNB = U_H/F

How much nutrient is being taken out of the system in relation to how much is applied?

REF

Recovery Efficiency
kg nutrient uptake per kg nutrient applied
RE = $(U-U_0)/F$

How much of the nutrient applied did the plant take up?

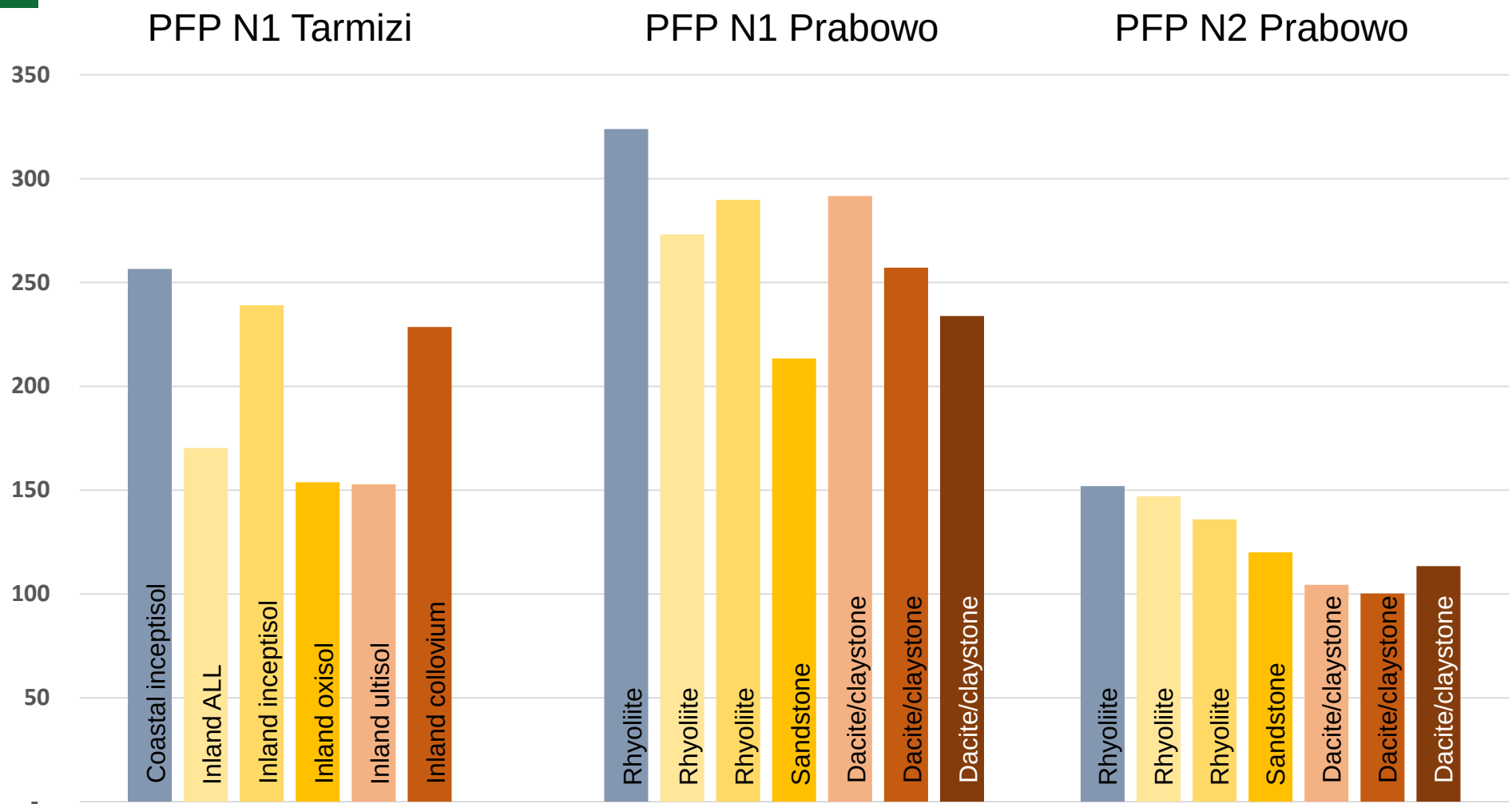
Practical NUE Indicators: Worked Examples

Prabowo NE, Foster HL, Nelson S, Sitepu B & Nelson PN (2012)
Practical use of oil palm nutrient physiological efficiency with regard to nutrient recovery and agronomic efficiency at different Sumatran sites.
XVII Conf. Int. sobre Palma de Aceite, Cartagena, Colombia

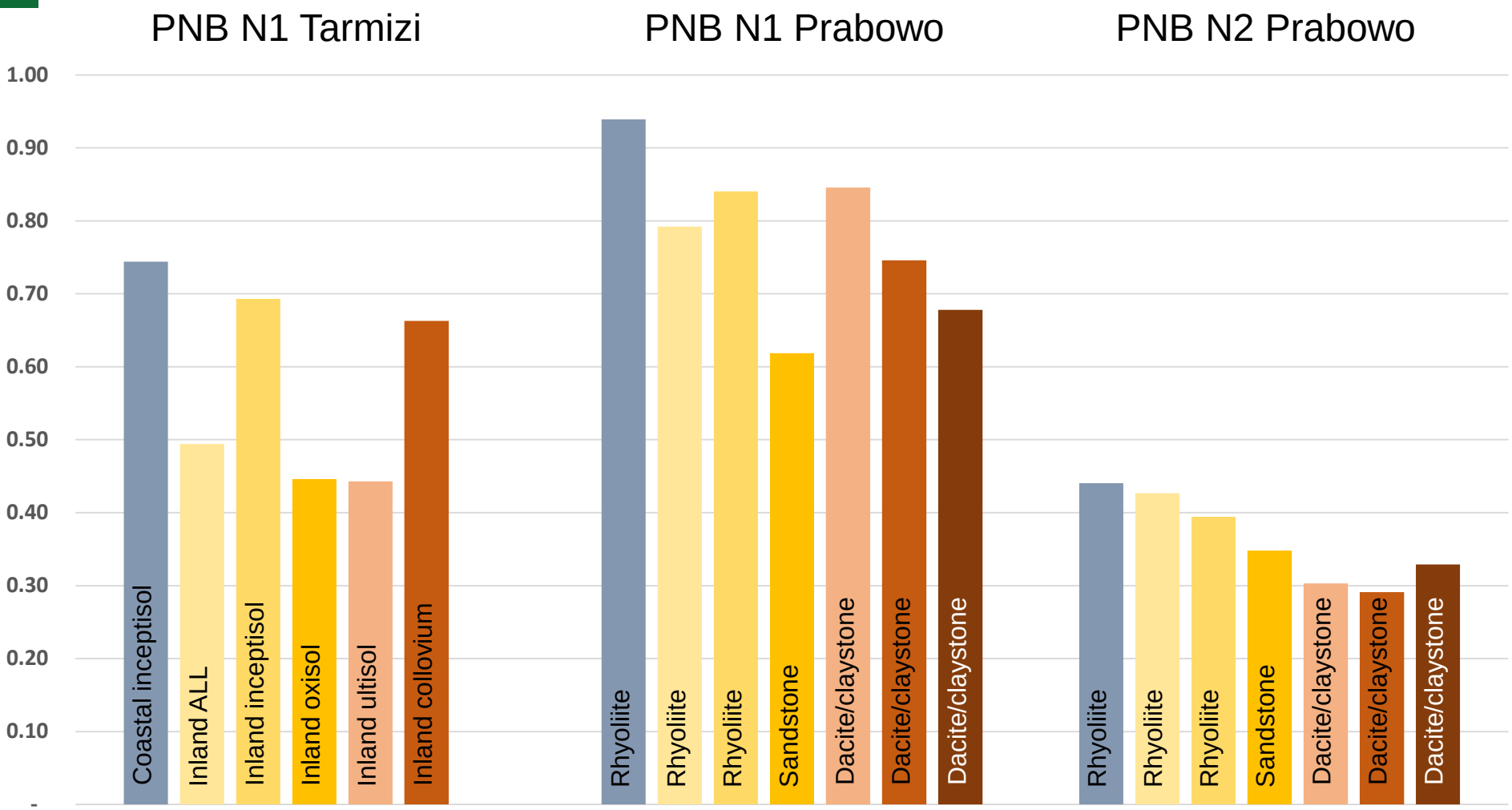
Tarmizi AM, Tayeb MD & Zin ZZ (1992)
Maximum yield of oil palm in Peninsular Malaysia: Yield response and efficiency of nutrient recovery.
1990 ISOPB Int'l Wkshp on Yield Potential in Oil Palm, Phuket, Thailand

IPNI & Plantation Partners
Ongoing and completed work in Malaysia and Indonesia

Practical NUE Indicators: PFP Nitrogen



Practical NUE Indicators: PNB Nitrogen



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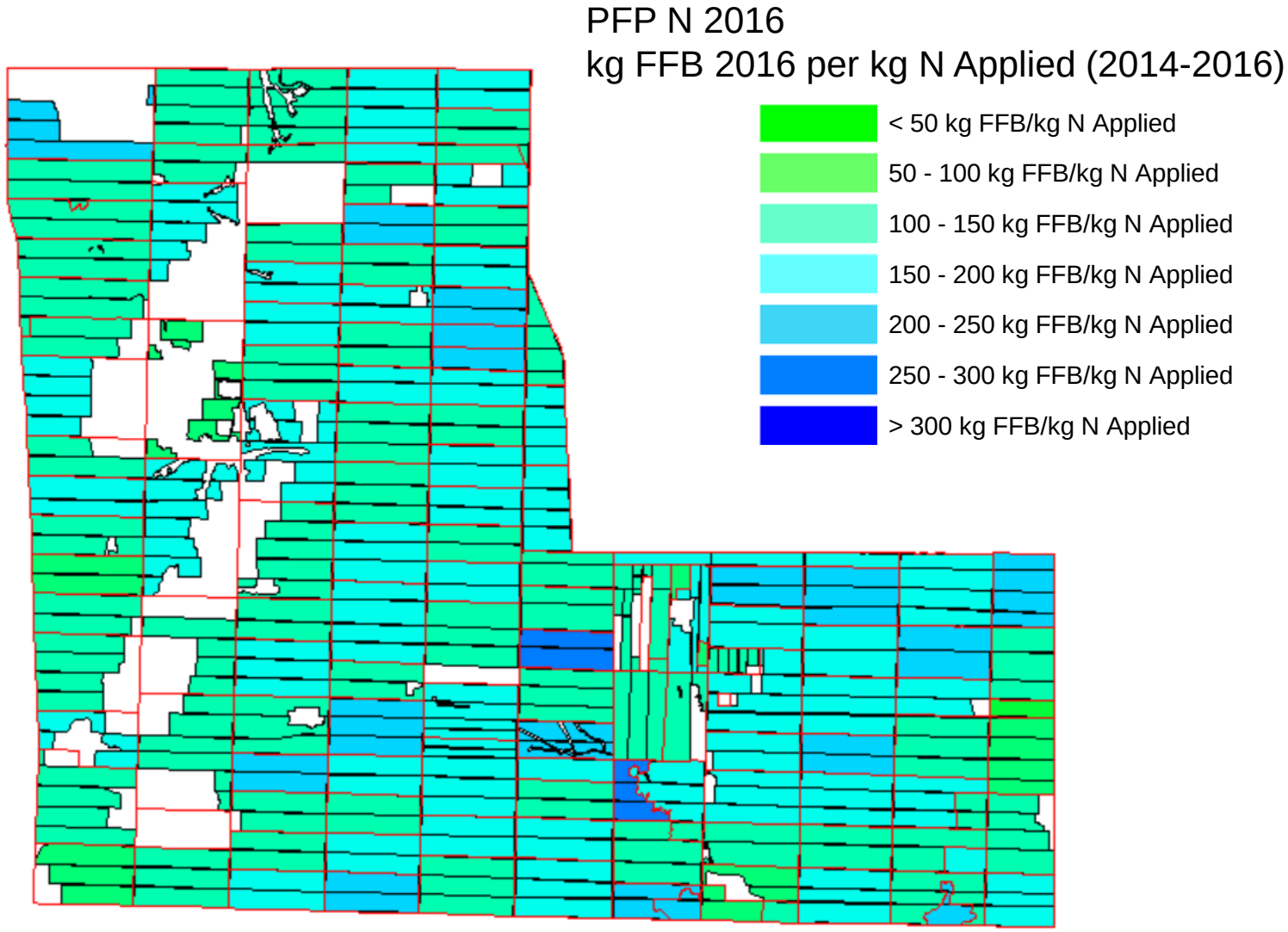
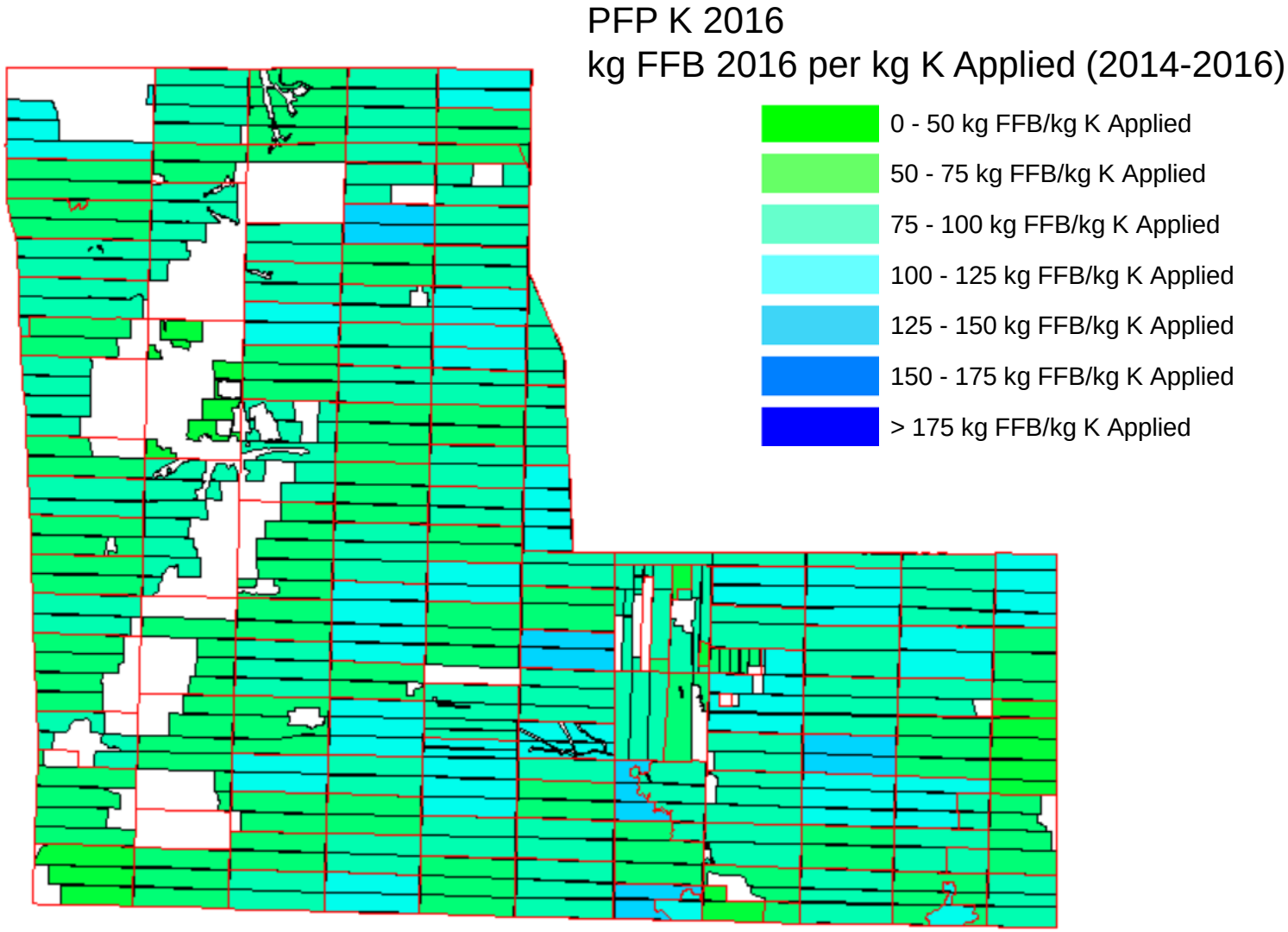


Practical NUE Indicators: PFP Potassium



Practical NUE Indicators: PNB Nitrogen 2014-16

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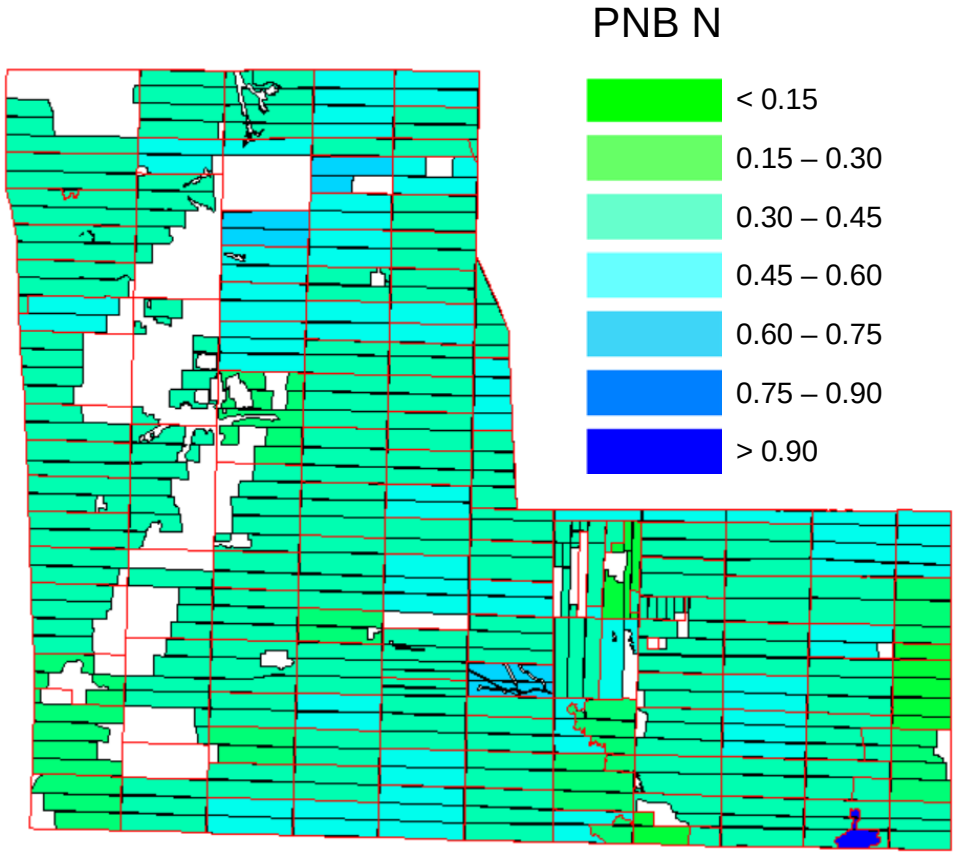

Practical NUE Indicators: PNB Nitrogen 2014-16

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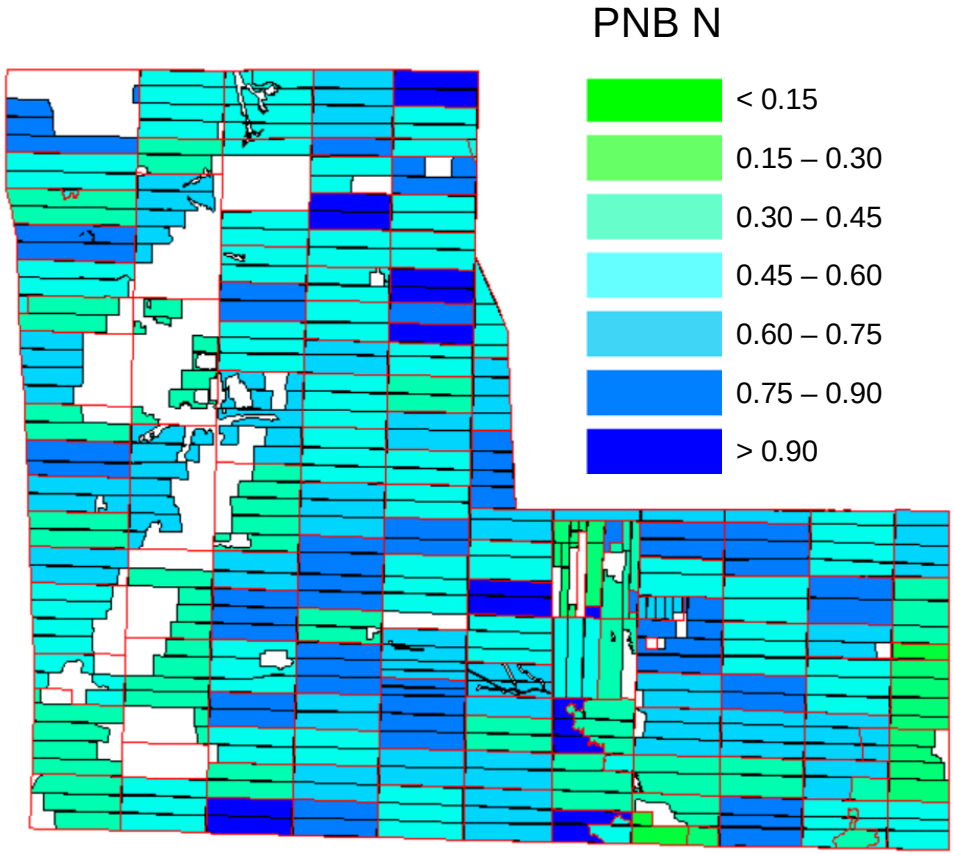

Practical NUE Indicators: PNB Nitrogen 2014-16

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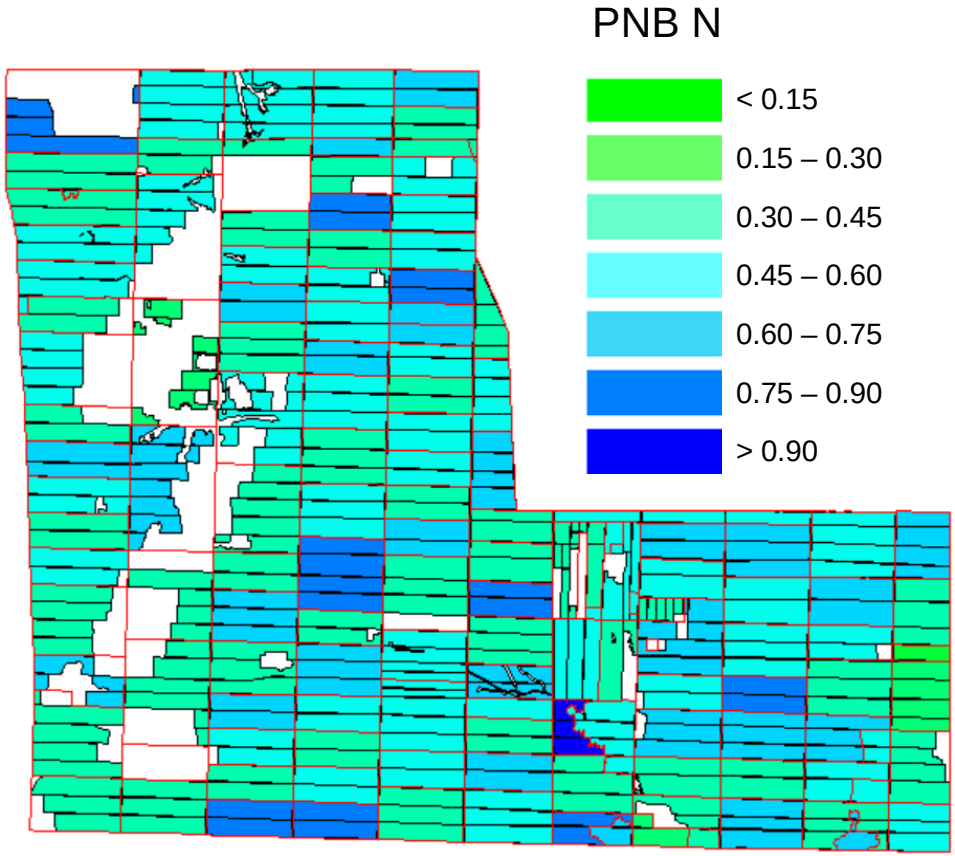

Practical NUE Indicators: PNB Potassium 2014-16

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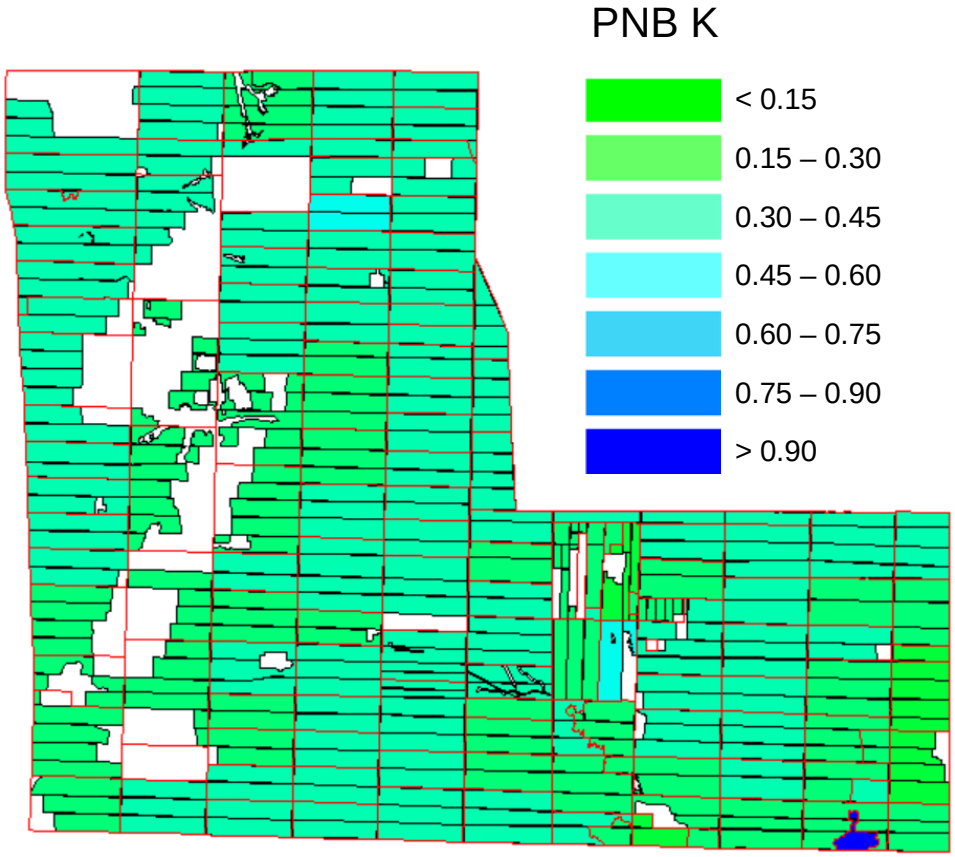

Practical NUE Indicators: PNB Potassium 2014-16

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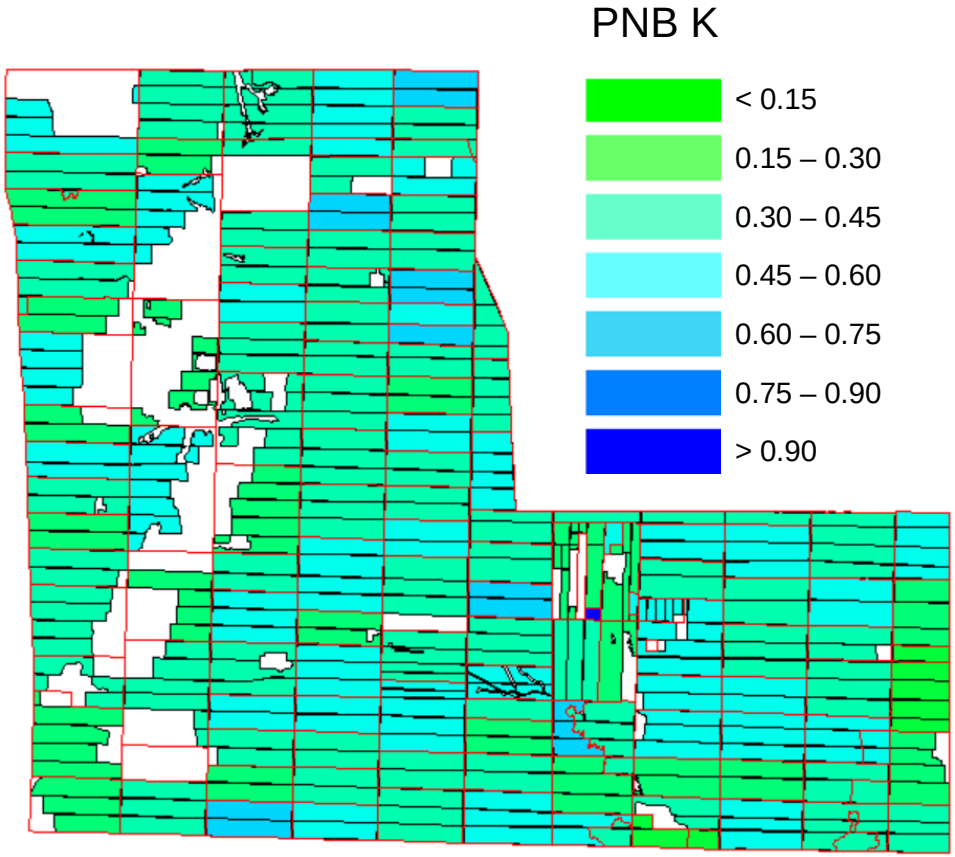

Practical NUE Indicators: PNB Potassium 2014-16

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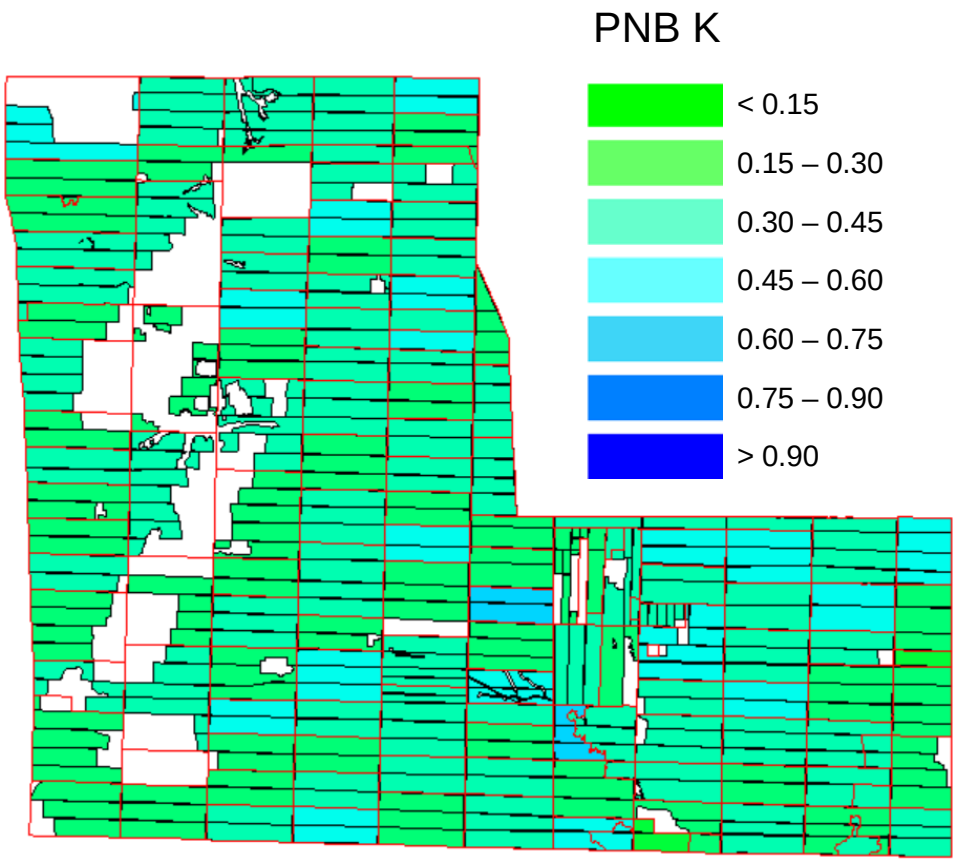
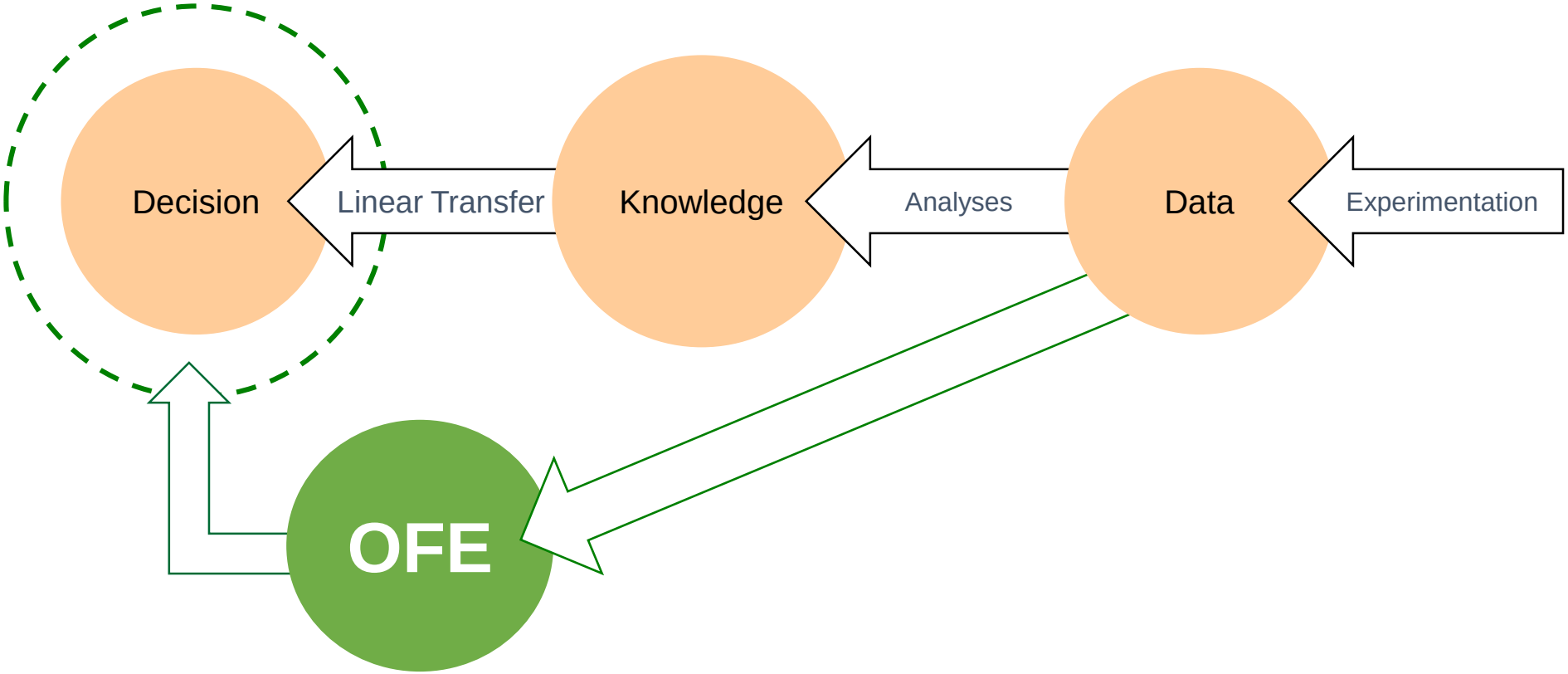


3 Developing NUE Indicators

Generating NUE in the Field



Generating NUE with Field Information

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$RE = (U-U_0)/F$

Generating NUE with Field Information

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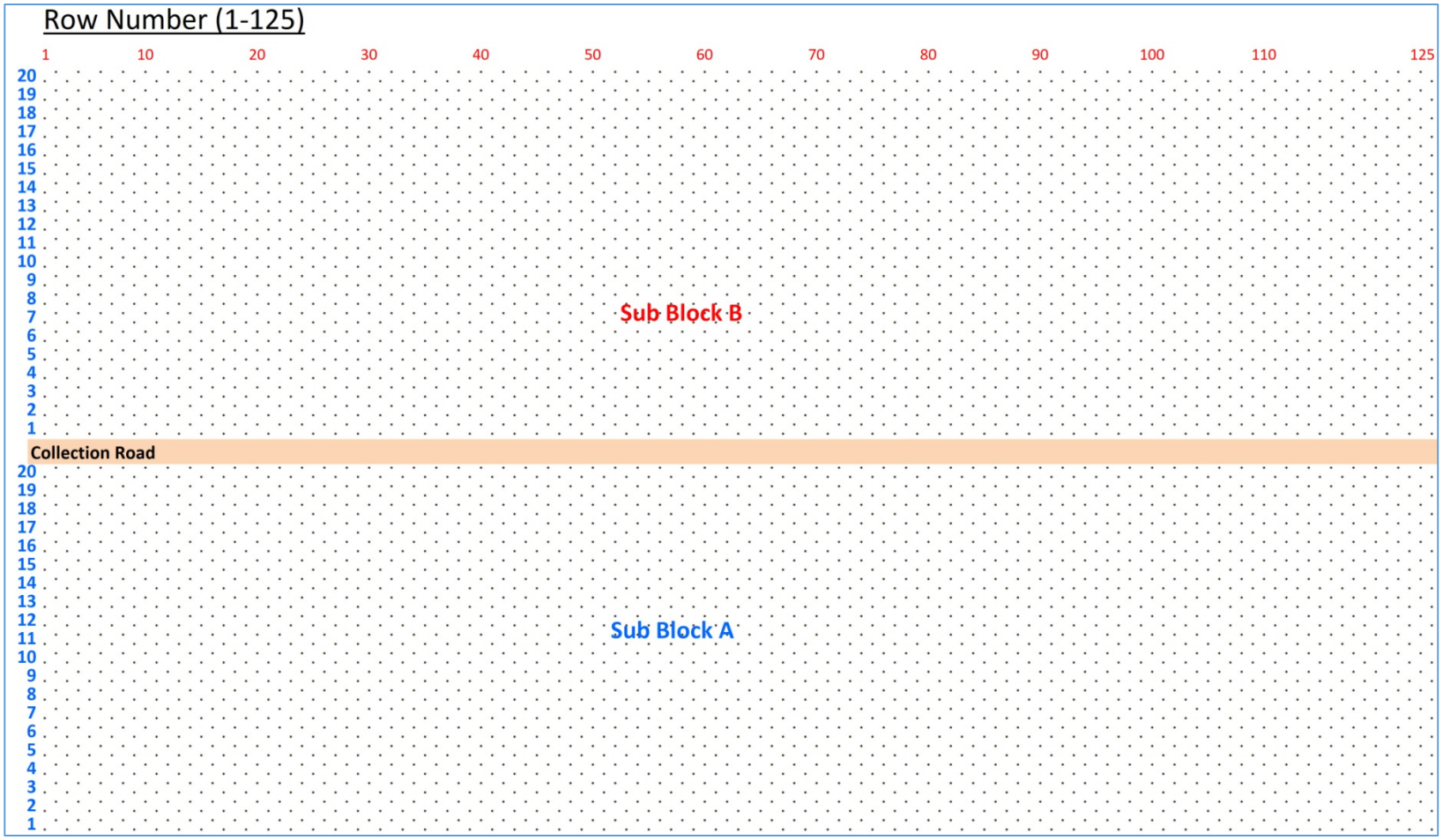
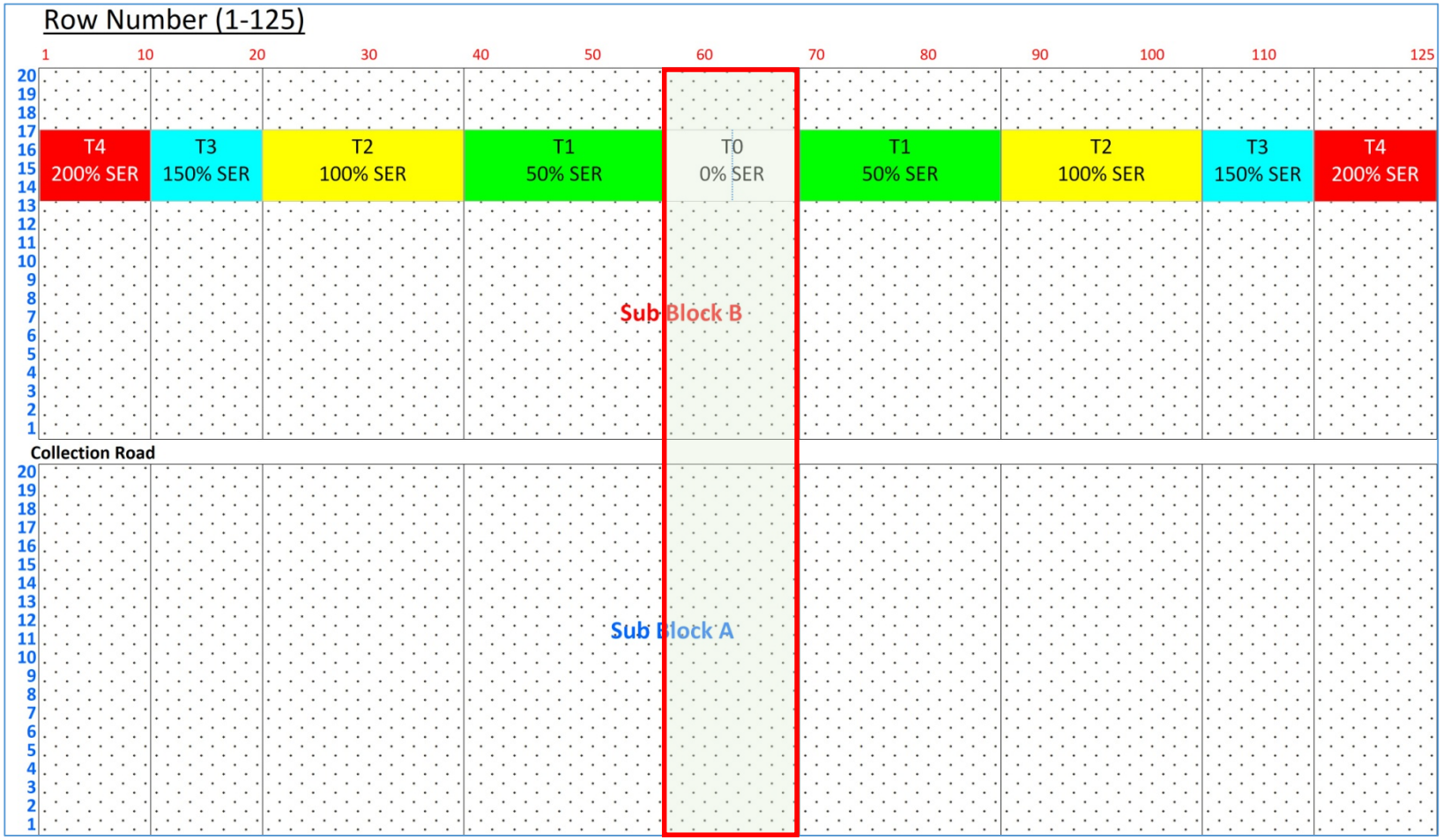
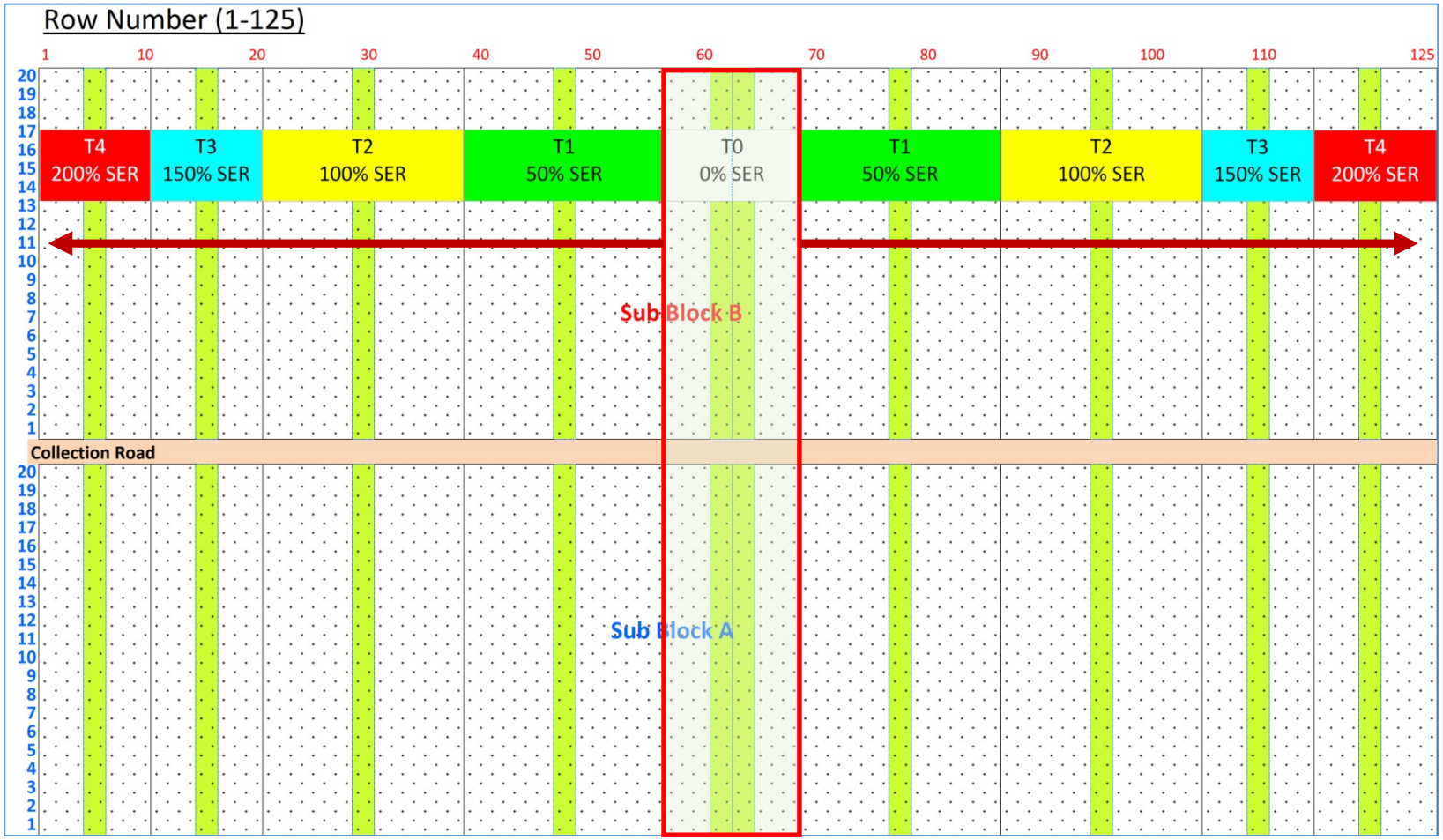


Generating NUE with Field Information



Generating NUE with Field Information



NUEs that Support Practical Management

Measure	Typical level in Annual Crops			Interpretation
	N	P	K	
Partial factor productivity (kg grain/kg nutrient)	40 - 90	100 – 250	75 – 200	Lower levels: less responsive soils or over application Higher levels: nutrient supply is likely limiting productivity.
Agronomic efficiency (kg grain/kg nutrient)	15 - 30	15 – 40	8 – 20	Lower levels: changes in management could increase crop response or reduce input costs
Recovery efficiency (%)	40 - 65	15 - 25	30 - 50	Lower levels: changes in management could improve efficiency or nutrients are accumulating in the soil
Partial nutrient balance (kg nutrient/kg nutrient)	0.7 – 0.9	0.7-0.9	0.7 – 0.9	Lower levels: changes in management improve efficiency or fertility is increasing Higher levels: soil fertility may be declining

Source:
Fixen et al. (2014) Nutrient/Fertilizer Use Efficiency: Measurement, Current Situation and Trends. In: Managing Water and Fertilizer for Sustainable Agricultural Intensification by IFA, IWMI, IPNI and IPI

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NUEs that Support Practical Management

Indicator	Source	N	P	K	Mg
PFP	IPNI trial 2	28 – 279	125 – 1587	16 – 145	423 – 7811
	IPNI trial 1	197 – 285	1509 - 3389	116 – 199	n.a.
	Tarmizi trials	153 - 257	953 - 1851	100 - 143	870 - 2082
	Prabowo trials	213 - 324	540 -1009	151 - 265	700 - 997
AGE	IPNI trial 2	n.a.	n.a.	n.a.	n.a.
	IPNI trial 1	47 - 89	531 – 994	27 - 51	254 - 456
	Tarmizi trials	34 - 84	210 - 1001	16 - 54	341 - 511
	Prabowo trials	21 - 88	88 - 262	21 - 54	37 - 193
PNB	IPNI trial 2	0.10 – 0.93	0.04 – 0.83	0.06 – 0.64	0.25 – 9.29
	IPNI trial 1	0.64 – 0.93	0.50 – 1.12	0.41 – 0.70	n.a.
	Tarmizi trials	0.44 - 0.74	0.44 - 0.85	0.37 - 0.53	0.71 - 1.71
	Prabowo trials	0.62 - 0.94	1.57 - 2.93	0.44 - 0.77	2.03 - 2.89
REF	IPNI trial 2	n.a.	n.a.	n.a.	n.a.
	IPNI trial 1	0.19 – 0.33	0.25 – 0.44	0.12 – 0.25	0.15 – 0.25
	Tarmizi trials	n.a.	n.a.	n.a.	n.a.
	Prabowo trials	0.20 – 0.88	0.39 – 0.74	0.14 – 1.47	0.21 – 0.66

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Thank you.