Soils and Global Food Security: An International Perspective

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International Plant Nutrition Institute

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IPNI

- IPNI is a not-for-profit, scientific organization
- We provide a scientific voice for the world's fertilizer industry; independent, and scientifically credible
- Established on the basis of defining appropriate use and management of plant nutrients

The mission of IPNI is to develop and promote scientific information about the responsible management of plant nutrition for the benefit of the human family

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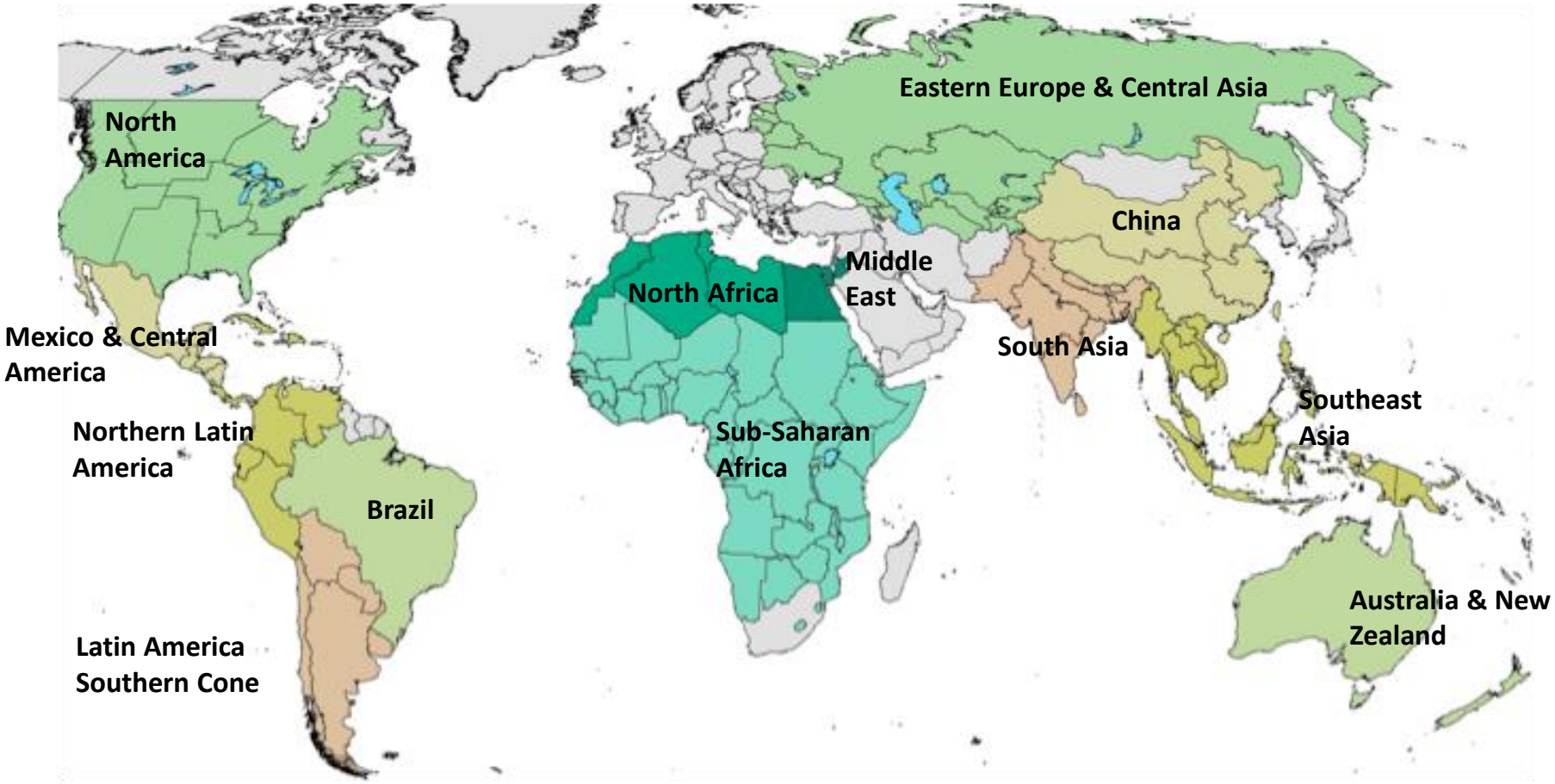
IPNI ... 33 scientists working in 13 Program Areas



Agronomic programs focus on research and education

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Adrian's Bias on Soil Quality / "Health"

- The productivity of a soil is a true measure of its quality, or "health".
- There are many soils we would consider to be of low productivity, but can be made productive with available management – improved genetics & fertilizer.
- There are soils which are degraded to the point that they do not respond to available management. These soils can be improved, but with major additions of organic amendments…years of manure.

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Challenges to Soil Quality in the Developing World

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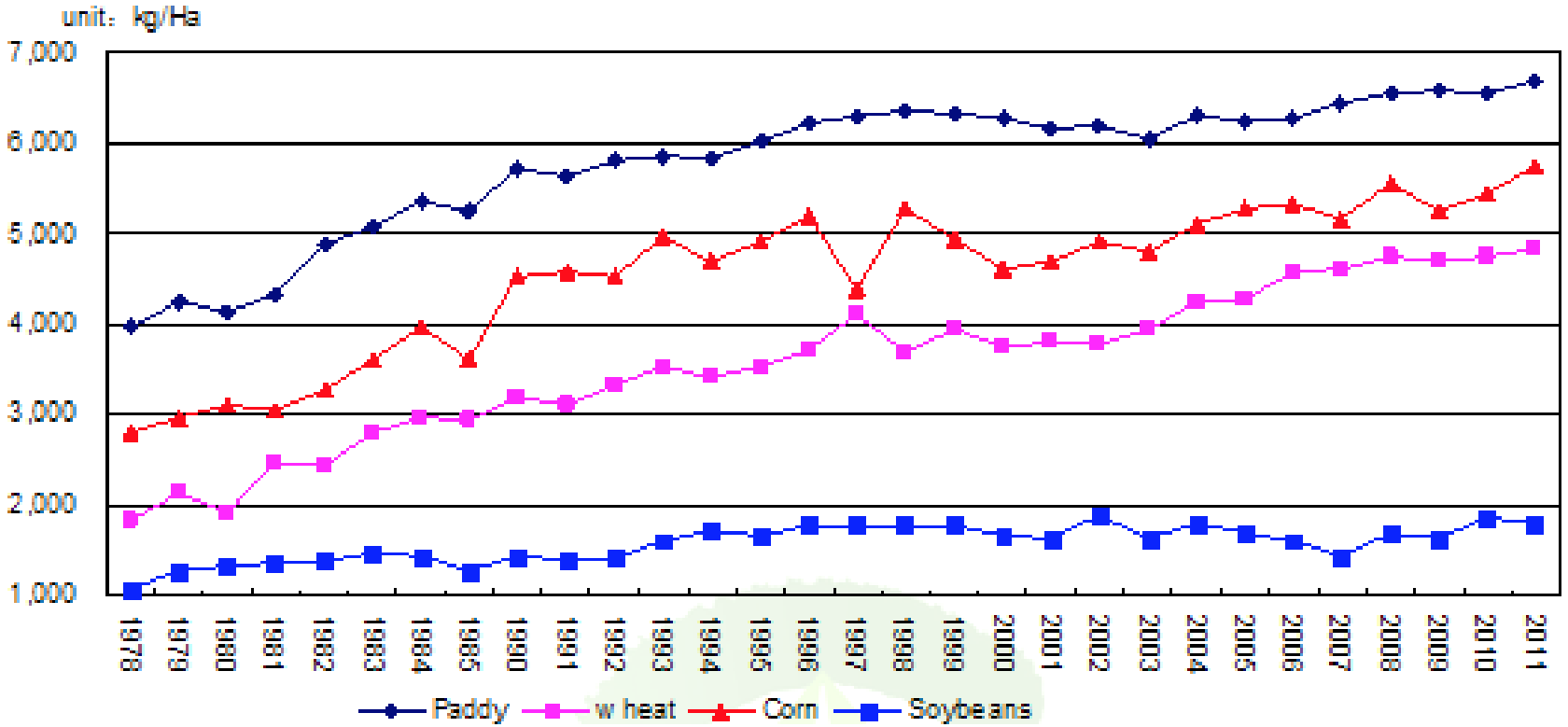
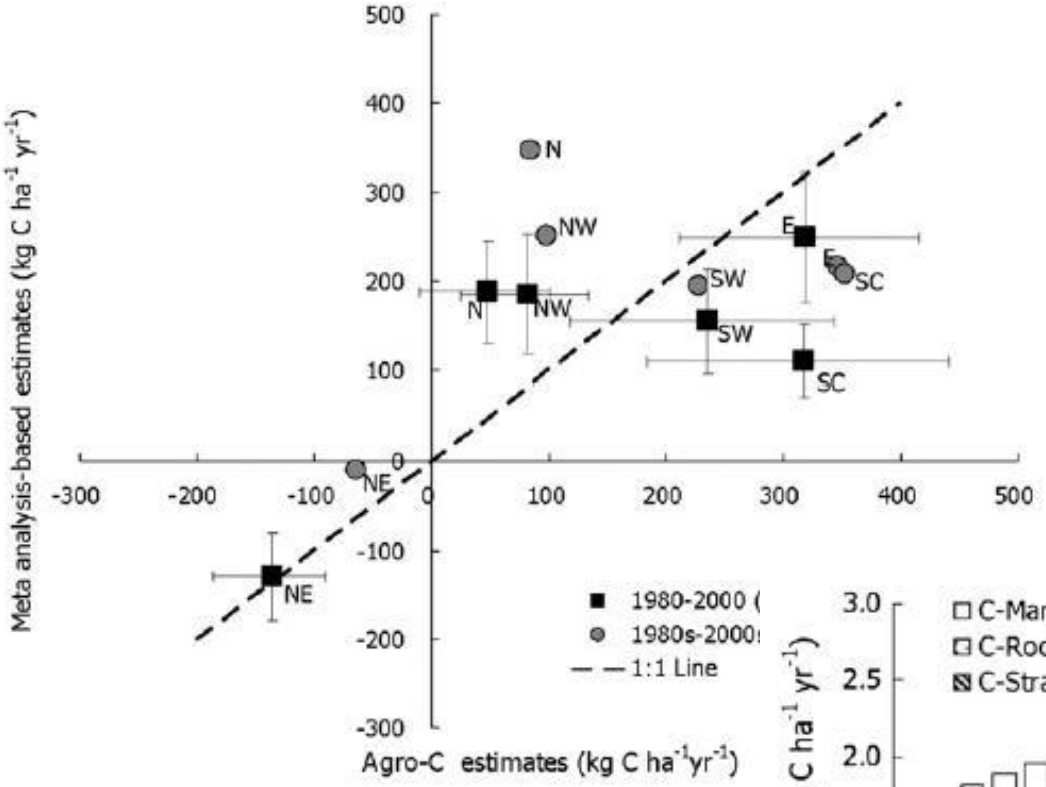
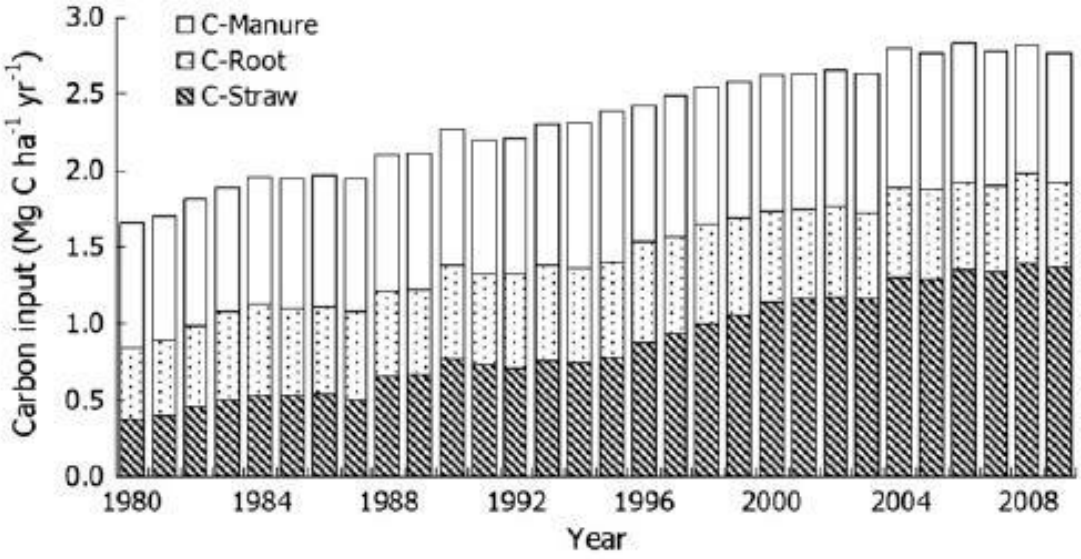
Three Examples of Soils and Food Security

China – Average Grain Crop Yields (1978-2011)



Changes to Soil Organic Carbon in China



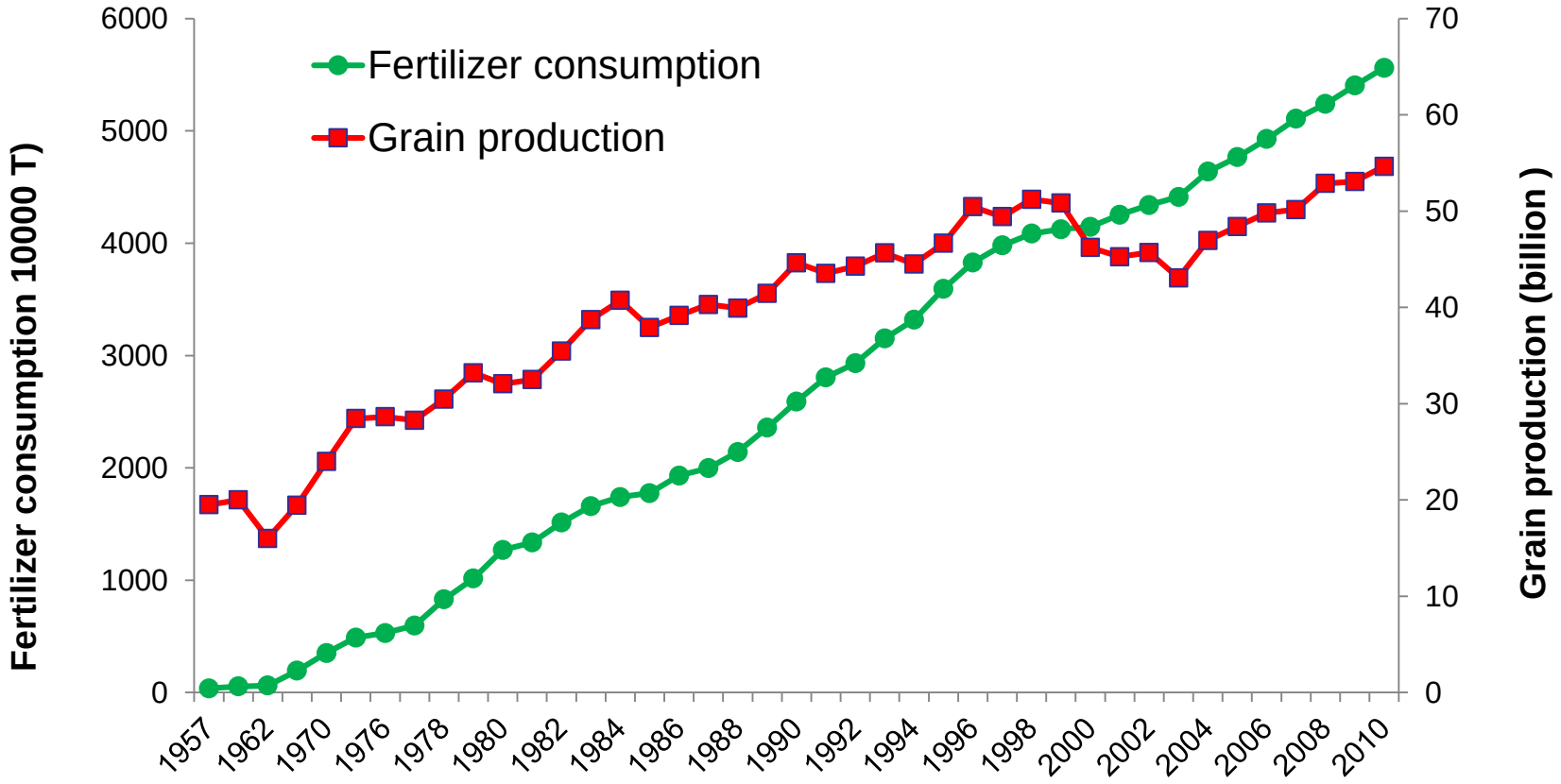


Ren et al., 2011
Yu et al., 2012

Crop Residue Management

From our own IPNI long-term (15 year plus) straw return projects we estimate that 50-60% of current crop K requirements can be replaced with straw return…not to mention secondary and micronutrients in many regions.

Fertilizer and Food Production in China



Overuse of N and P, while K remains short

Table 1. Nutrient input-output balance in agricultural land in China (in 1,000 tonnes).

		Year	1965	1975	1985	1995	2000
	Organic Manure	N	2,930	4,100	5,030	6,110	6,520
		P_2O_5	1,380	1,940	2,560	3,300	3,440
		K_2O	3,060	4,620	6,210	7,600	8,320
	Inorganic Fertilizer	N	1,210	3,640	12,590	22,240	25,140
		P_2O_5	550	1,610	4,190	10,350	9,730
		K_2O	3	130	980	3,360	6,590
Output		N	5,220	7,490	11,140	13,730	16,620
		P_2O_5	2,370	3,340	4,790	5,770	6,640
		K_2O	5,600	8,130	12,080	14,550	17,390
Balance		N	-1,690	-1,570	190	3,500	2,470
		P_2O_5	-600	-280	710	4,890	3,610
		K_2O	-2,540	-3,380	-4,890	-3,550	-2,480

Source: Li Jiakang et al. 2003.

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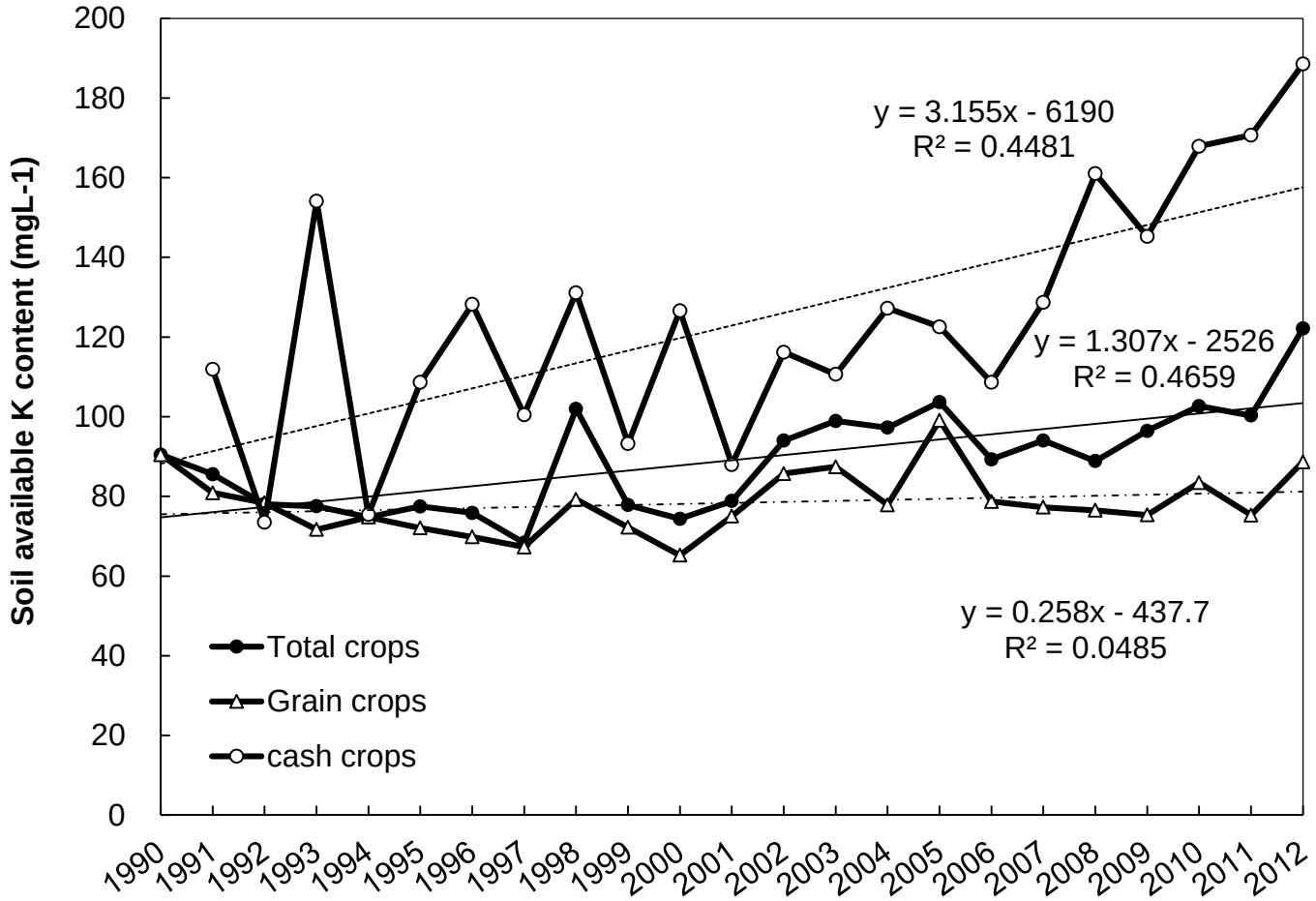
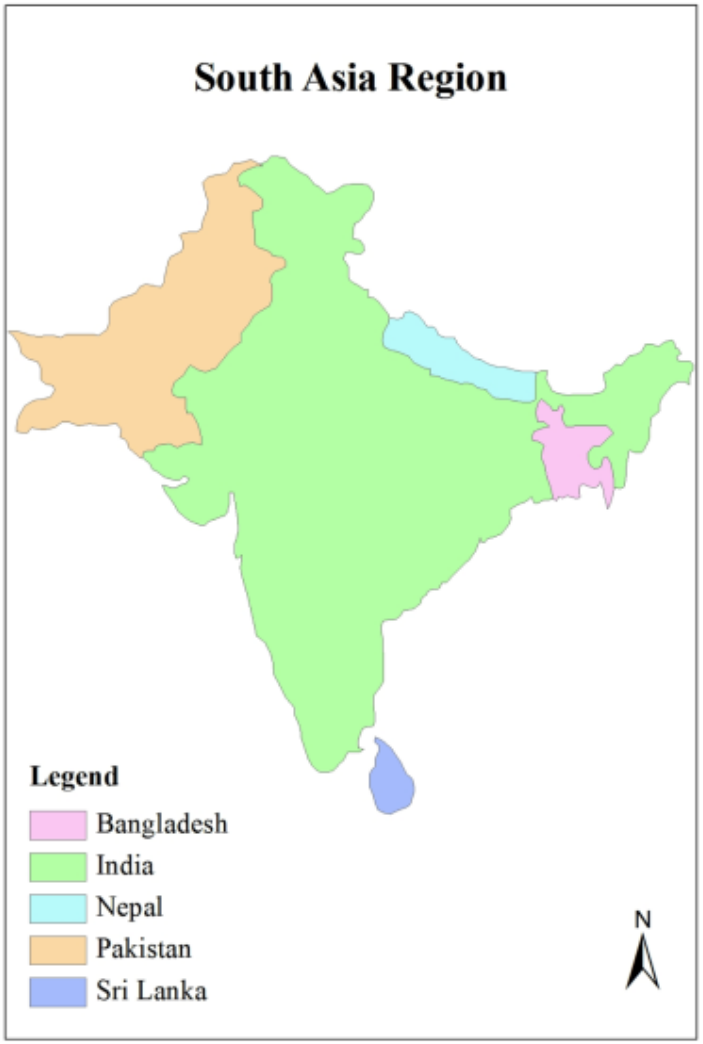
Soil Test K Increase: Grain vs Cash Crops

58,559 soil samples on-farm field trials 1990-2012 in China



He et al., 2015, Field Crops Research 173:49-56

South Asia – Nutrient Mining is the Issue



- Nutrient mining, by whole crop removal and limited nutrient return, poses the biggest threat to the region.
- Productivity has become “stagnant” in most countries in the region.
- Very small farms, partial subsidies, no credit, no insurance, no jobs, extreme poverty…big challenges.

Cereal Productivity(kg/ha) World Bank, 2012

Country	1998-02	2003-07	2008-12
Bangladesh	4102	4141	4144
India	2673	2572	2537
Nepal	2361	2374	2295
Pakistan	2654	2790	2592
Sri Lanka	3595	3664	3974

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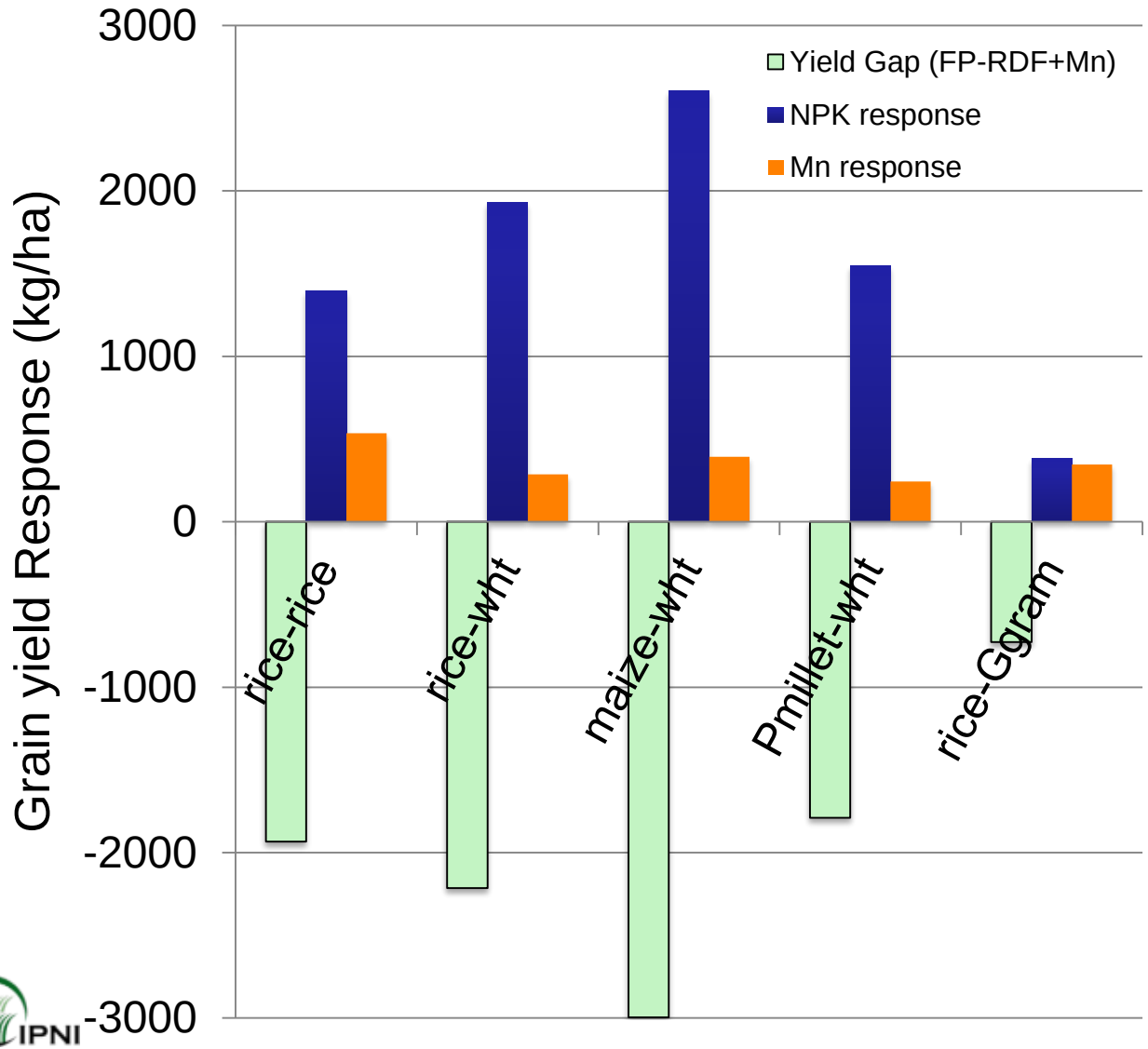
Yield Gap Analysis for Cropping Systems in India



Gangwar et al., 2013

South Asia's Multi-Nutrient Challenge

Significantly Deficient Nutrients in High Yield Rice-Wheat

IPNI-South Asia/PDCSR Trials (Tiwari et al., 2006)

Centers	Nutrient deficient							
	P	K	S	Zn	Fe	Mn	Cu	B
PDCSR, Modipuram	-	✓	✓	✓	-	✓	✓	✓
GBPUA&T, Pantnagar	✓	✓	-	✓	-	✓	-	✓
CSAUA&T, Kanpur	✓	✓	✓	✓	-	-	-	-
NDUA&T, Faizabad	✓	✓	✓	✓	-	✓	-	✓
BHU, Varanasi	✓	✓	✓	✓	-	✓	✓	✓
RAU, Sabour	✓	✓	✓	-	-	-	-	-
BAU, Ranchi	✓	✓	✓	✓	-	-	-	✓
HPKV, Palampur	✓	✓	✓	✓	-	-	-	✓
PAU, Ludhiana	✓	✓	✓	✓	✓	✓	✓	✓
R S Pura	✓	✓	✓	✓	-	✓	✓	-

P use efficiency due to omission of micronutrients (3 years average rice-rice)

Location	P use efficiency (kg grain kg^{-1} P_2O_5)			
	NPKS + Zn + B + Mn	- Zn	- B	- Mn
Maruteru	11.2	-	8.9	-
Jorhat	7.8	6.2	5.8	7.5
Navsari	5.5	5.2	5.4	5.2
Karjat	9.5	8.5	8.1	-
Coimbatore	12.6	9.6	-	-
Thanjavur	29.1	-	-	25.6
Mean	12.6	7.4	7.1	12.8
Reduction (%)		(41%)	(44%)	(+ 2%)

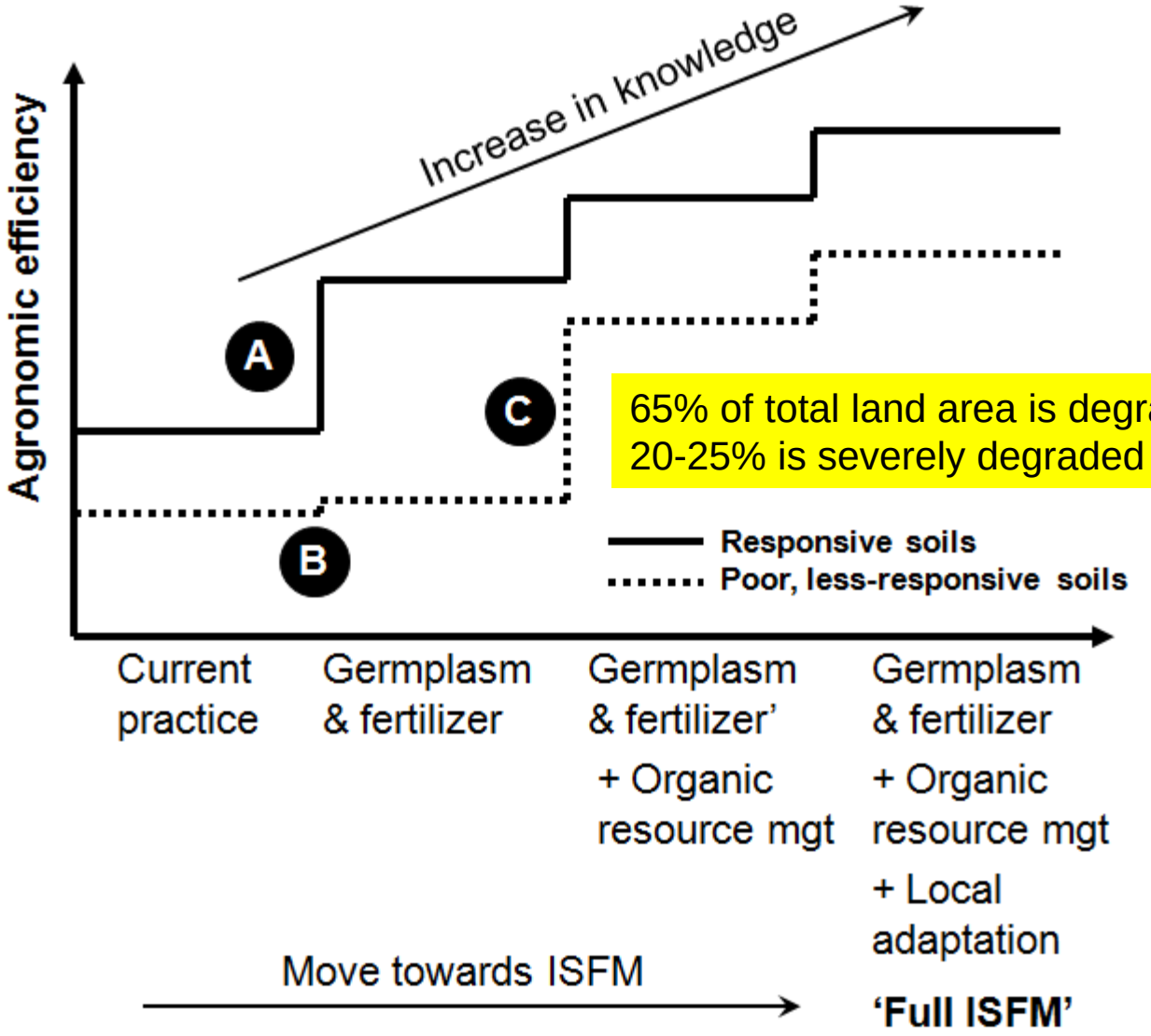
(IPNI Research with PDCSR, 2008)

AFRICA
Increasing Production

"*Improved seeds* have been described as the engine of any agricultural revolution, and *fertilizers* as the fuel. Access by farmers to these modern agricultural inputs is therefore the backbone of agricultural transformation in Africa and of ending hunger and poverty."

From interview with Akin Adesina, Nigerian Minister of Agriculture, featured in IFA's Fertilizers and Agriculture

Integrated Soil Fertility Management
An African Concept



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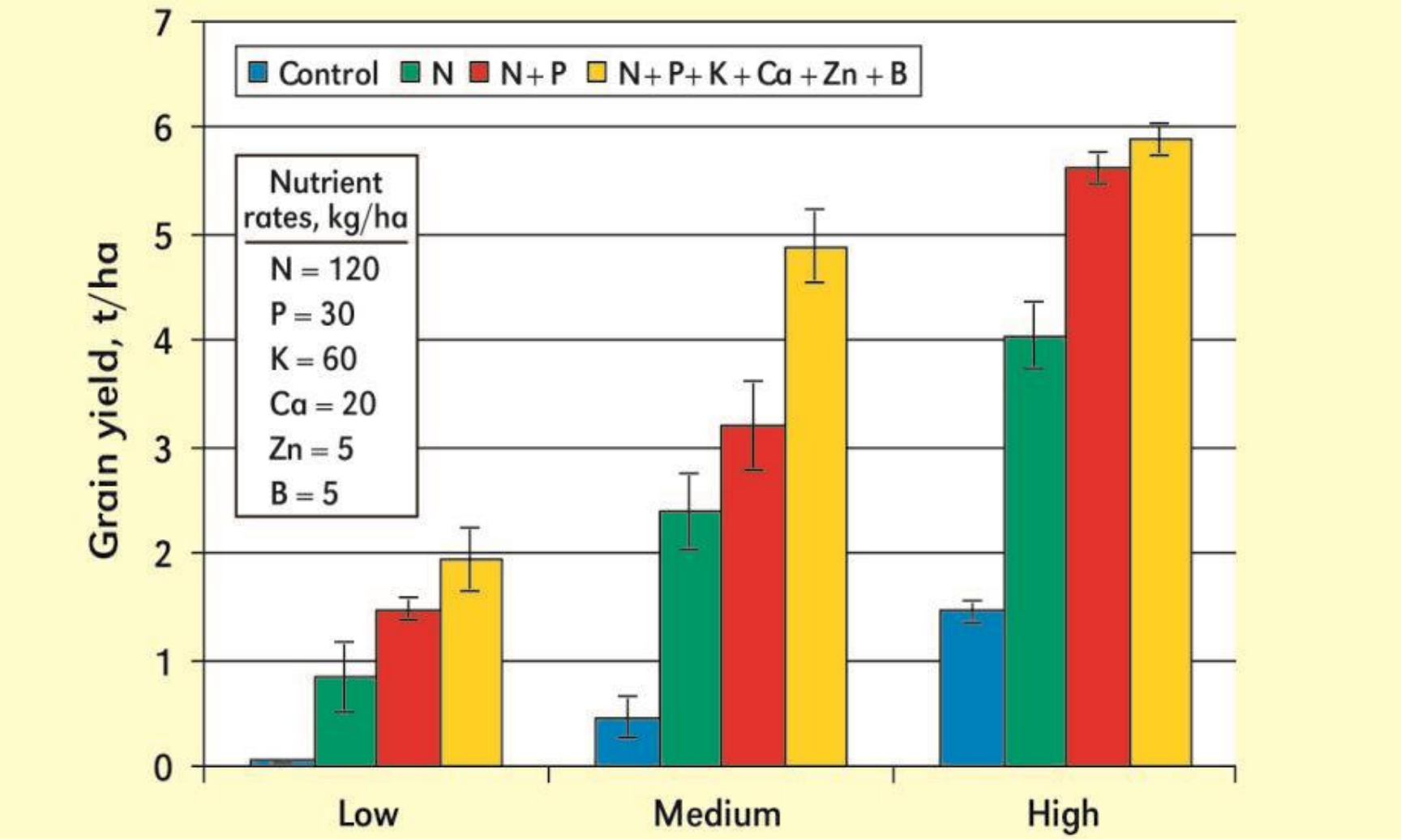
Vanlauwe et al. 2010

Small Holder Farm in Malawi
Note the productivity gradient

Soil Quality Impacts on Fertilizer Response

Malawi Soil Quality

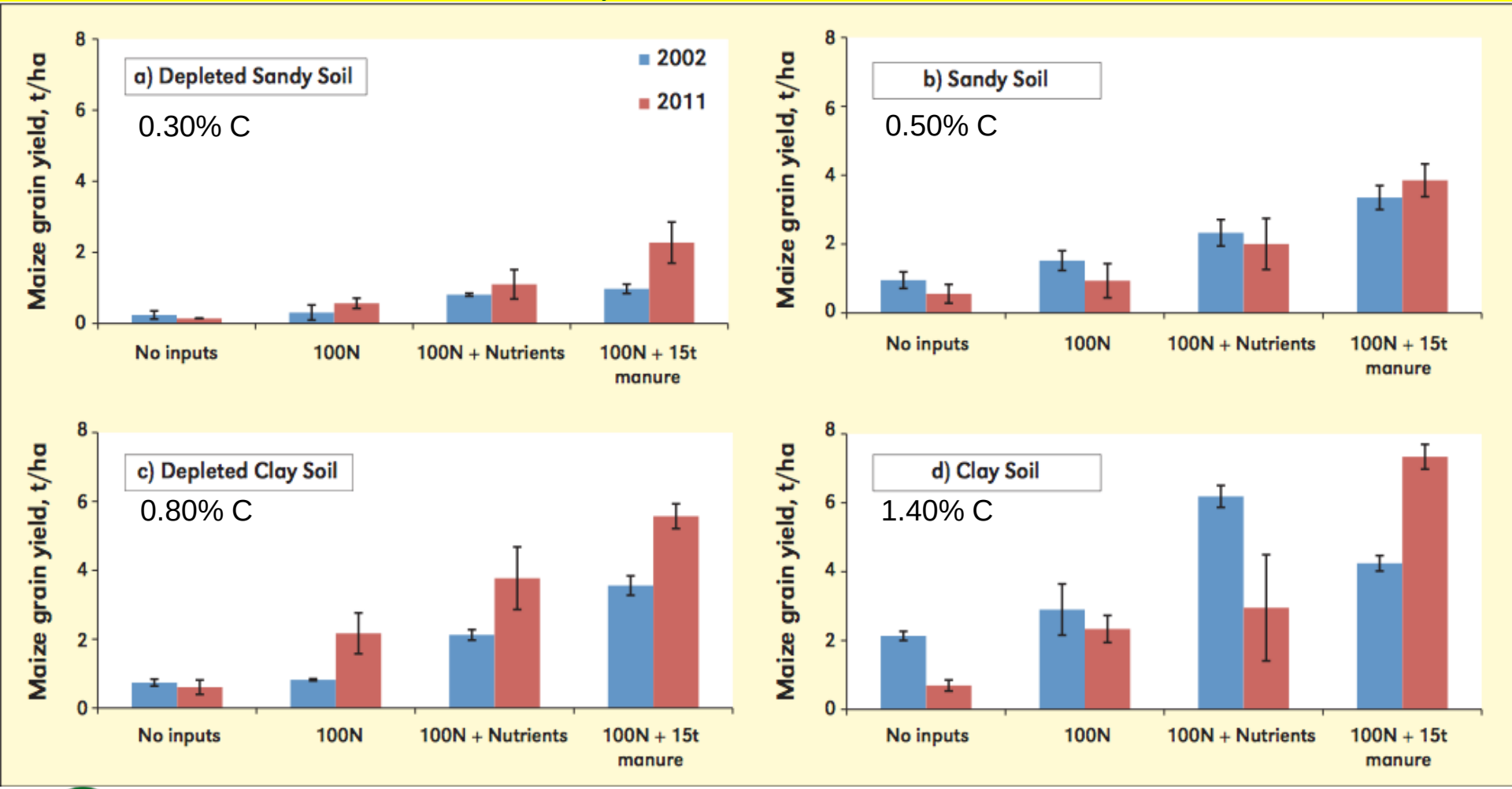


Zingore et al., 2011

Eastern Zimbabwe – Sandy soils less than 1 km apart;
Wide variability in SOC (<0.4 on left - >0.7 on right);
Large differences in productivity.

Initial and final maize yields and yield responses to long-term application of manure and mineral fertilizers under variable soil fertility conditions in Zimbabwe

Bars represent standard error of means



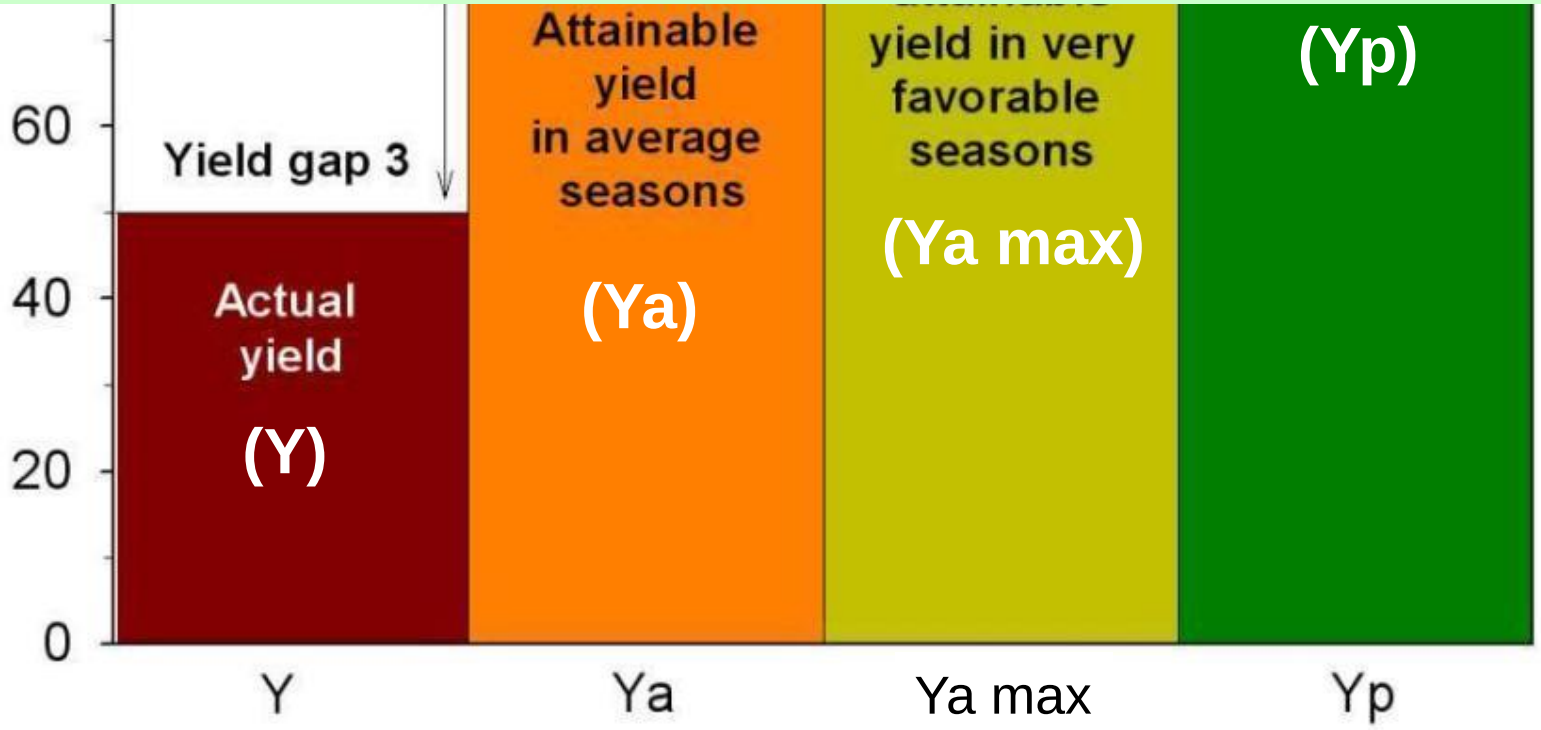
- Nutrients = 30P + 25S + 20Ca + 5Mn + 5Zn
- Manure providing about 30P

Better Crops 98:24-27, 2014

Analyzing farmers' practice: Closing Yield Gaps

"Yield gaps become serious poverty traps for smallholder farmers"

(Tittonell and Giller, 2012)



4R Nutrient Stewardship

Thank You

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