Soil Fertility Management in Sub Saharan Africa: Status, Challenges, and Future Prospects

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Soils and human health

There is a link between unhealthy soils and unhealthy people

PA Sanchez, MS Swaminathan. 2005. The Lancet 365: 442–44

The Poverty Trap:

- Poor soils result in low yields and low household capital.
- Low household capital prevents investments in soil nutrients, which is a primary constraint on soil productivity.

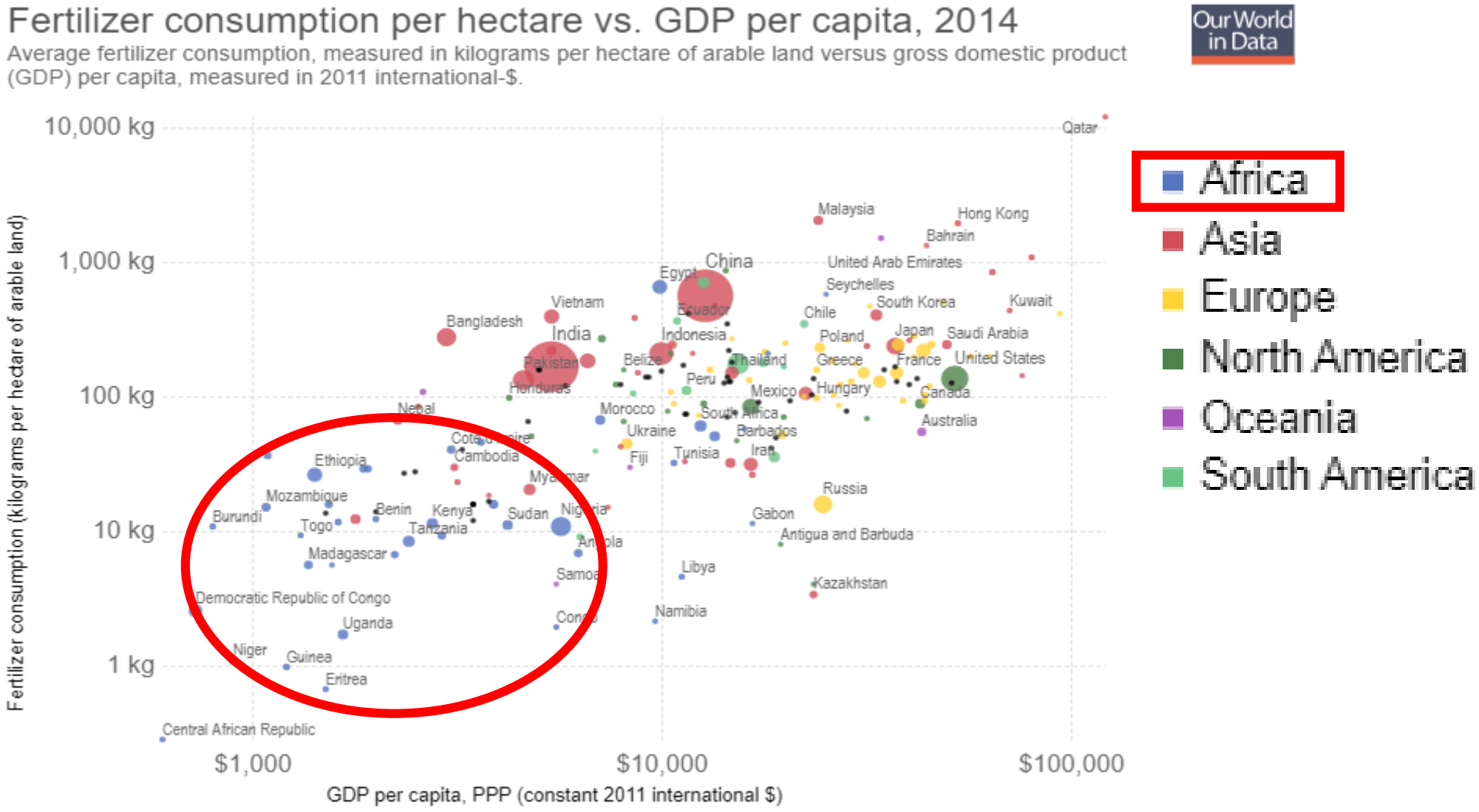
CB Barrett, LEM Bevis. 2015. Nature Geoscience 8: 907-912.

Cereal yields across subcontinents

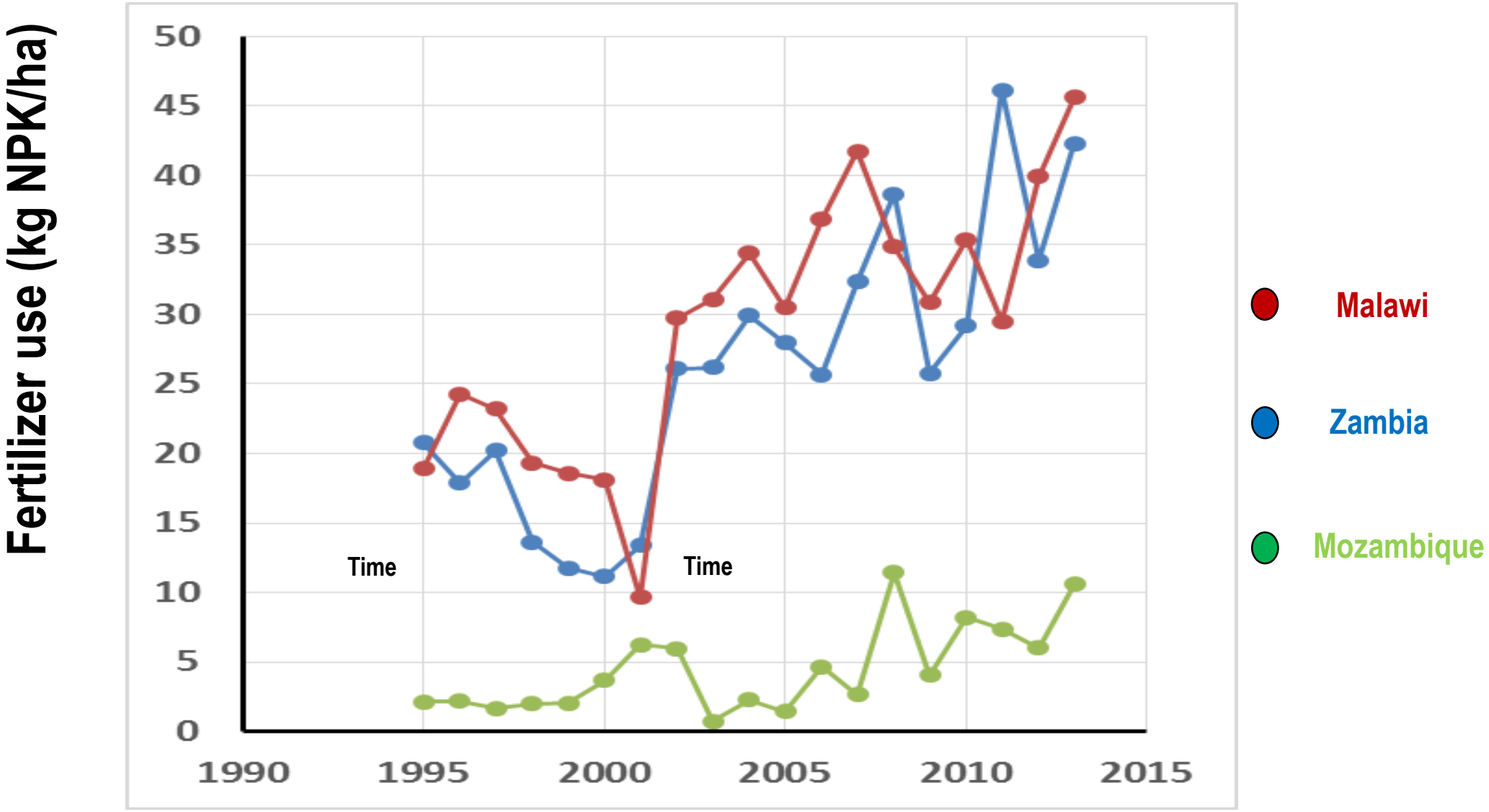
Cereal yields	2005 (tons/ha)	2014 (tons/ha)
SS Africa	1	1.6
Latin America	3	4.5
South & Southeast Asia	3	4.5
China	5	6.5
N. America, Europe, Japan	10	10+

Sanchez 2015. Nature Plants 1: 1-2. FAOSTAT 2016

Fertilizer use as a prerequisite to economic development

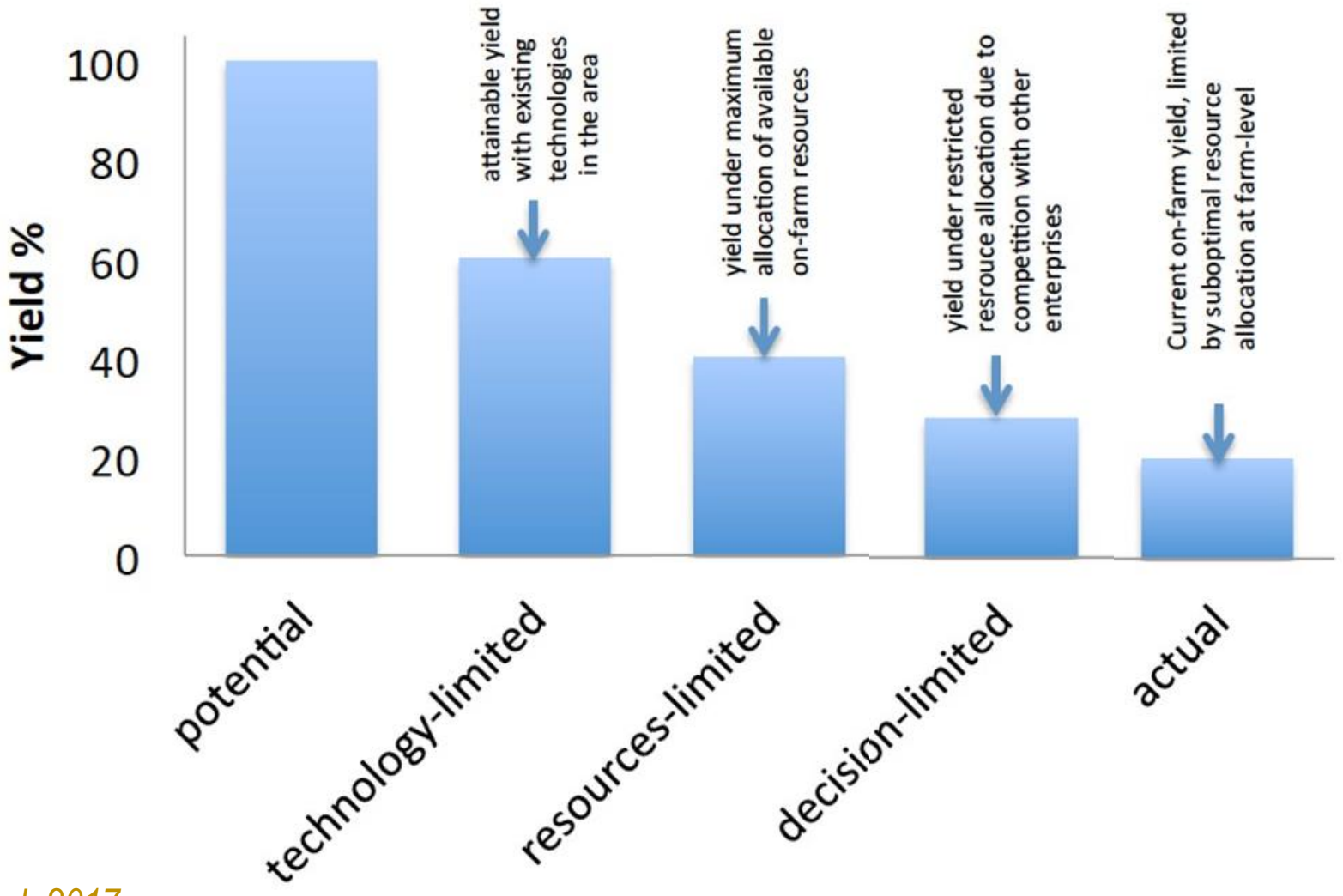


The situation has gotten better over the last decade



From Peter Crauford and Bernard Vanlauwe - www.fao.org; Nov 2016

A close look to addressing the “Yield gap”

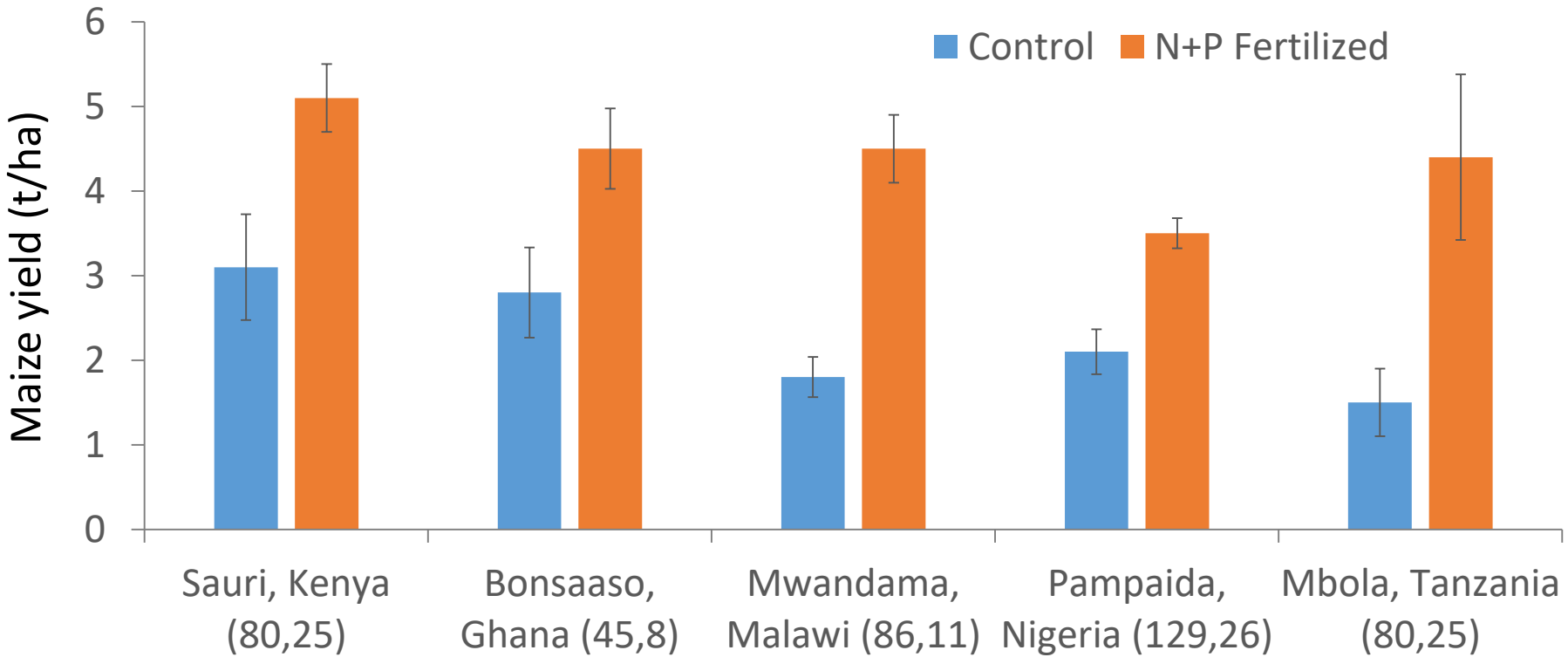


Source: Van Asten et al, 2017

Technologies

1. Fertilizers are a must

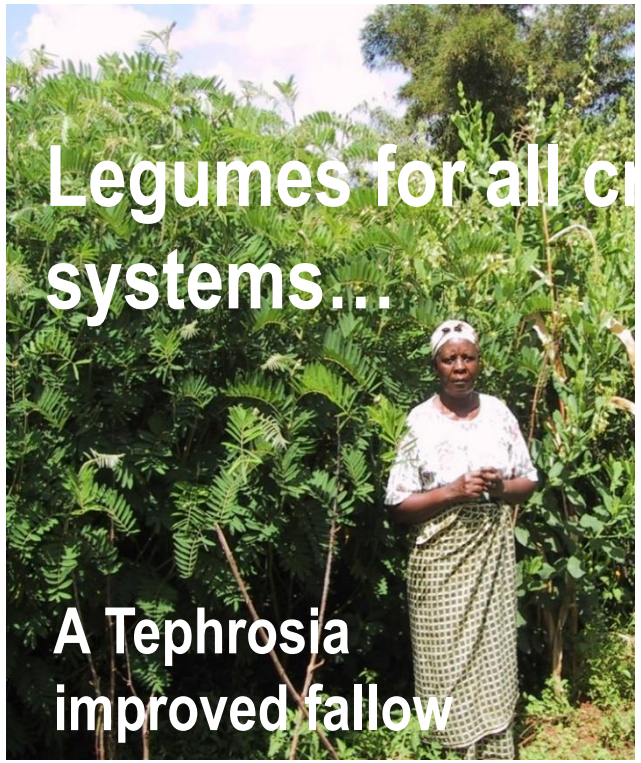
Effect of N+P fertilizers in 5 MVP sites (4-year averages)



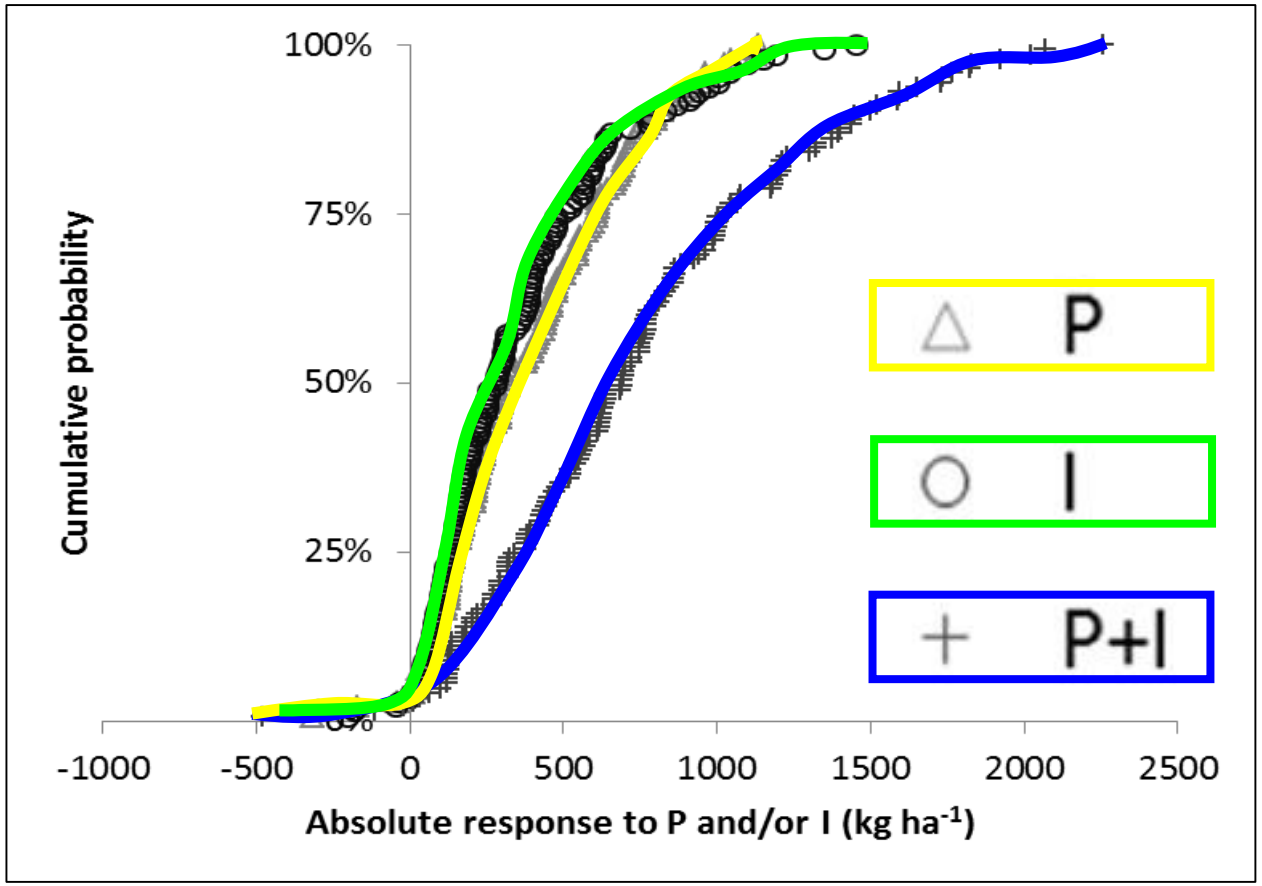
Source: Nziguheba et al, 2010

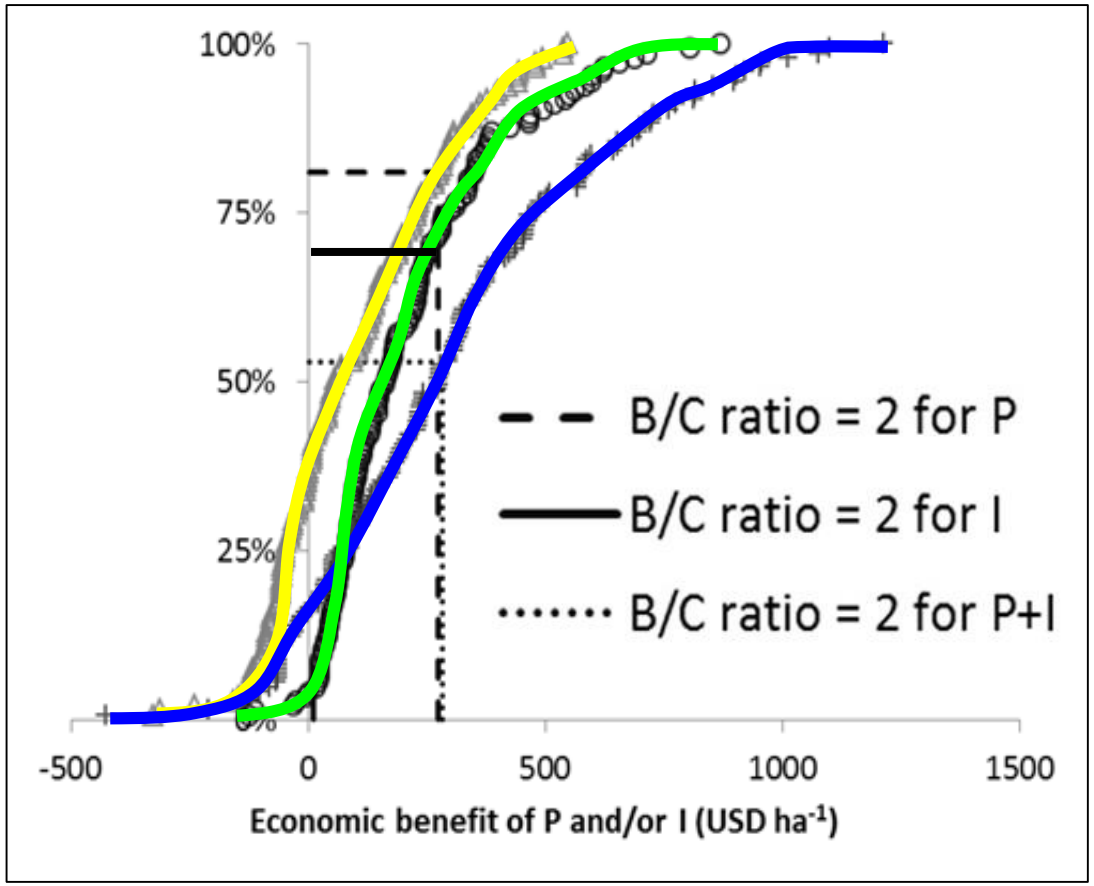
2. Incorporating legumes: organic nitrogen factories

- Captures 80-150 kg N/ha
- Worth $70-130
- Recycles K, micronutrients
- Adds organic carbon



3. Inoculants: effect on P fertilizer utilization by soybean in Nigeria

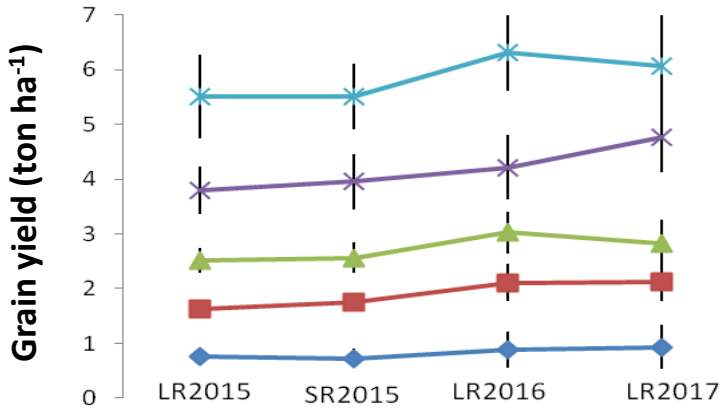




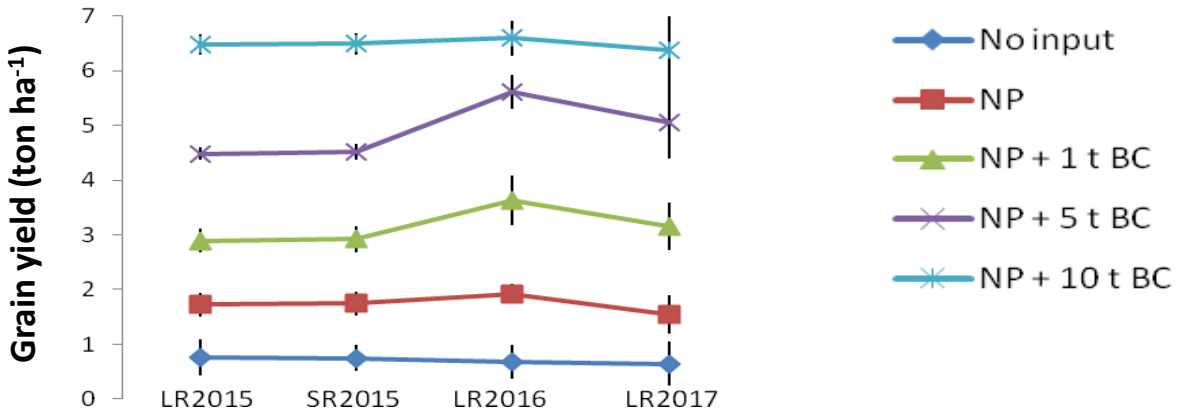
Source: Ronner et al, 2016

4. Biochar: recent work in Kenya is very encouraging

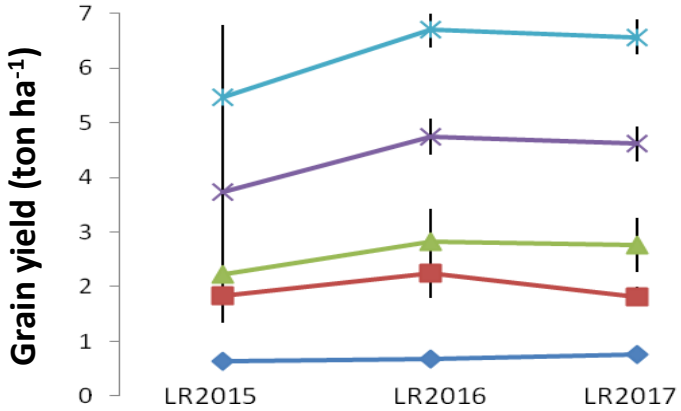
SIAYA



EMBU



KWALE



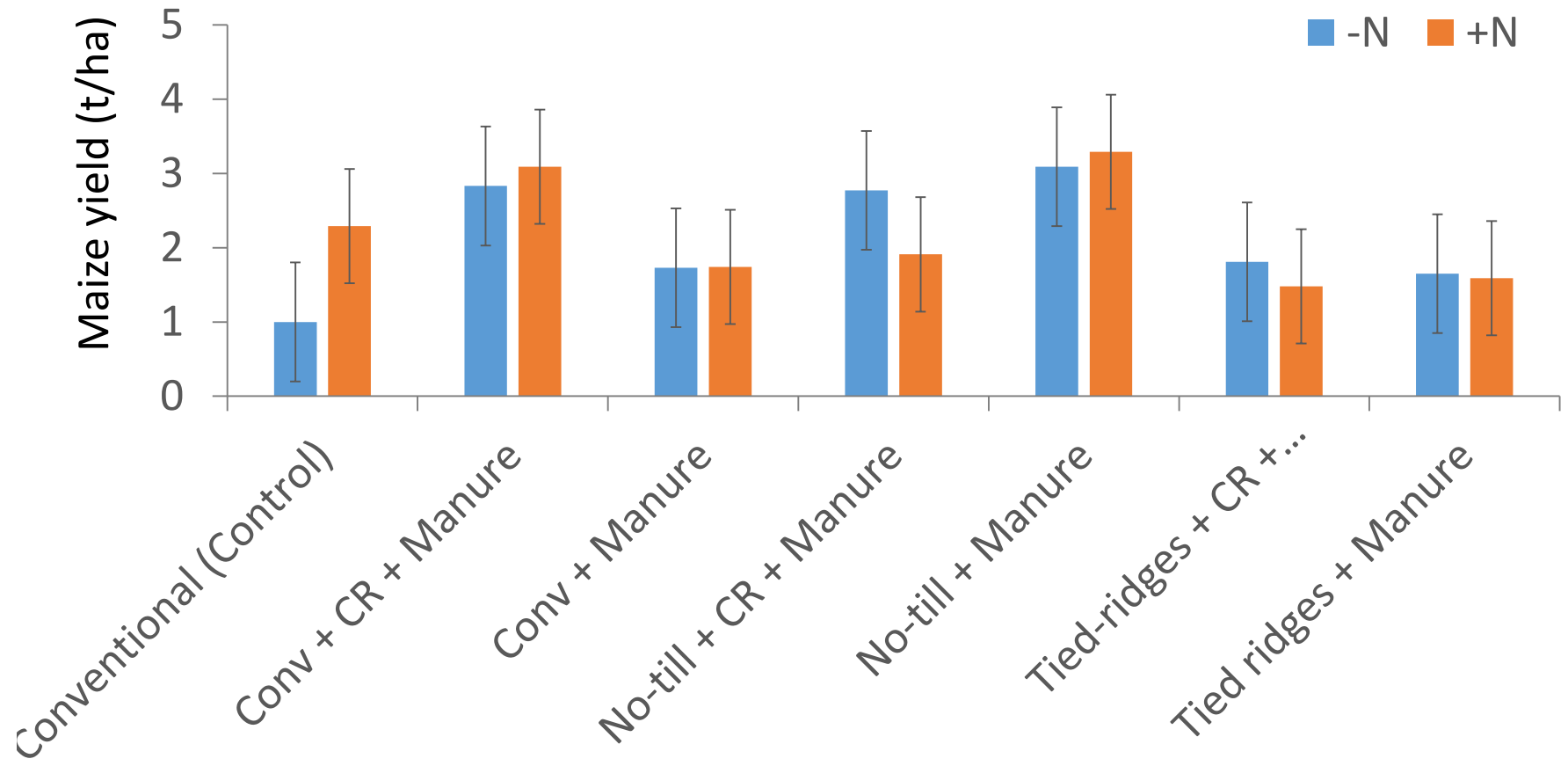
Responses to biochar input of 1 ton ha^{-1} are significantly varying between agro-ecosystems

Biochar input of 5 ton ha^{-1} is doubling maize productivity with NP fertilizer over 3 years

Biochar input of 10 ton ha^{-1} is tripling maize productivity with NP fertilizer over 3 years

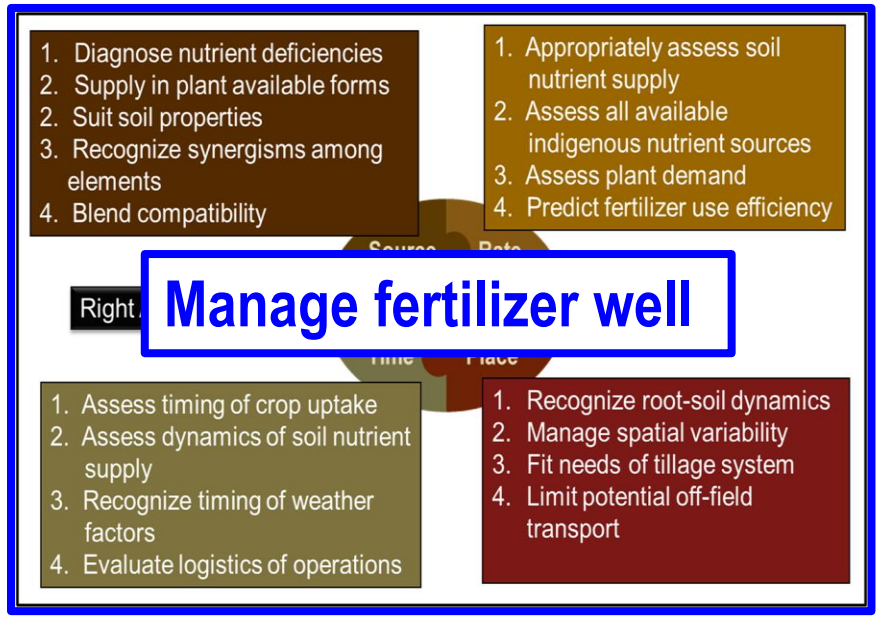
Source: Roobroeck et al 2019 (in prep)

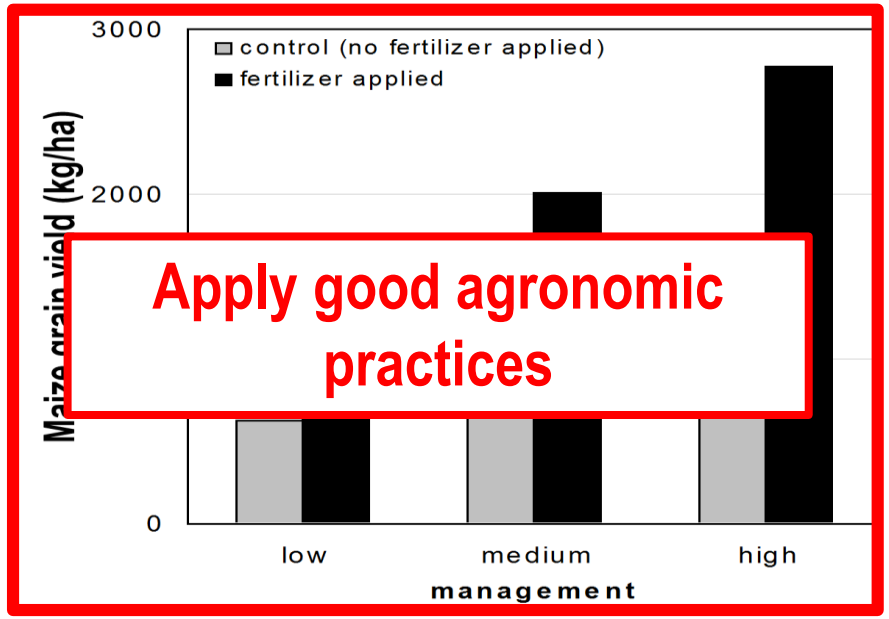
5. CA and organic inputs (after 4 seasons in Eastern Kenya)

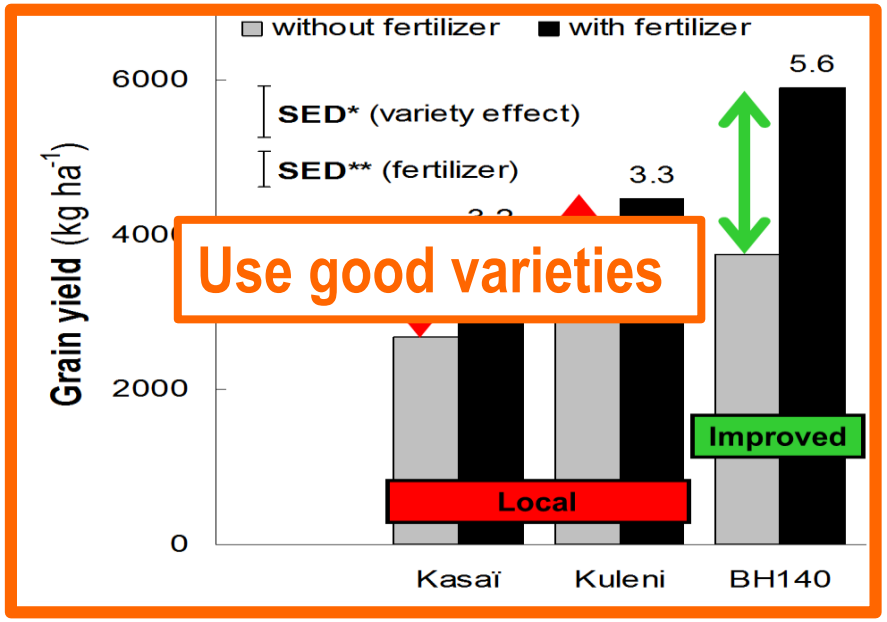


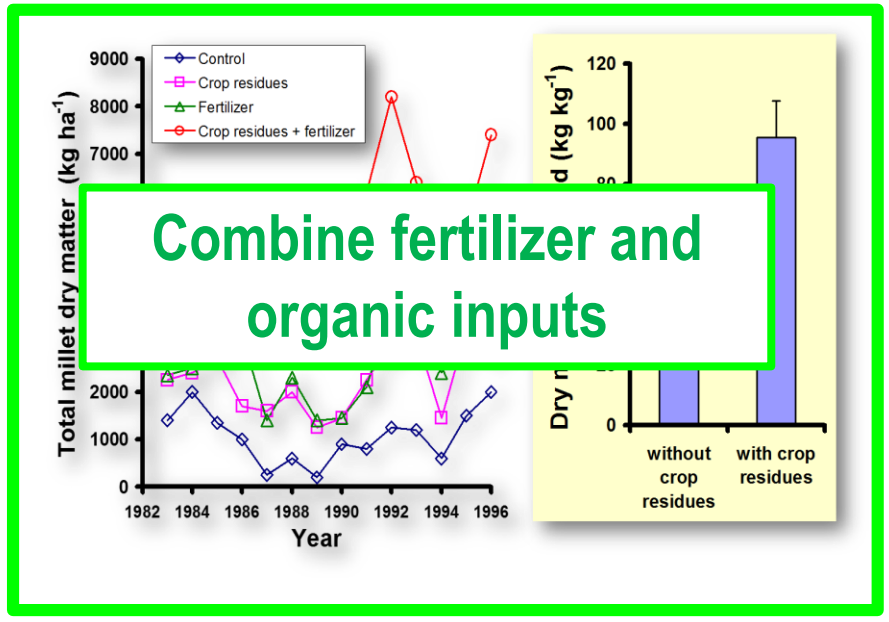
Source: Kihara et al, 2011

6. Integrated Soil Fertility Management

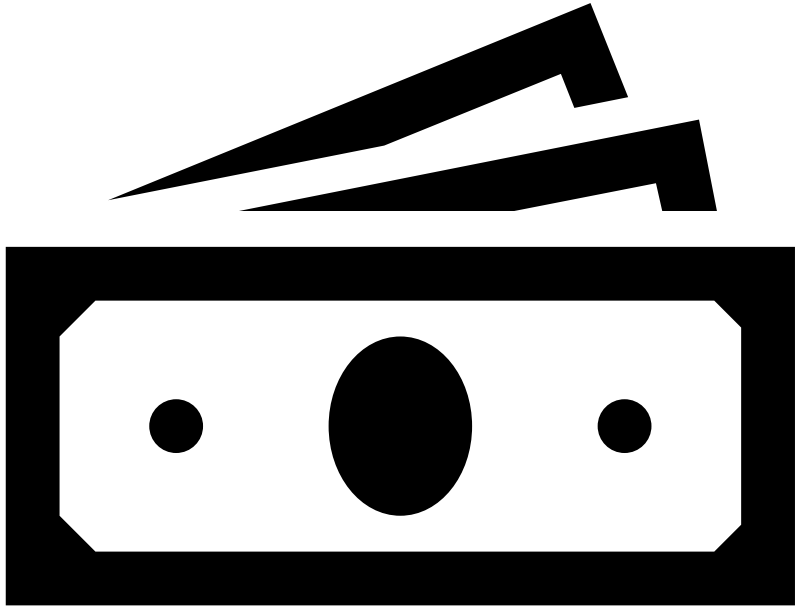




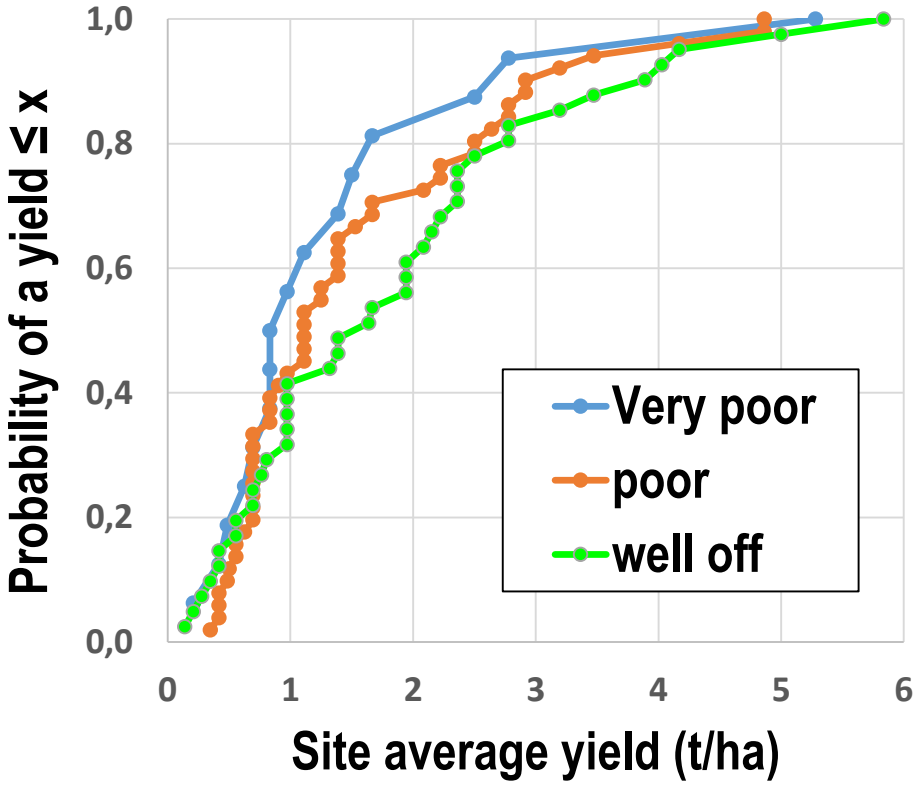


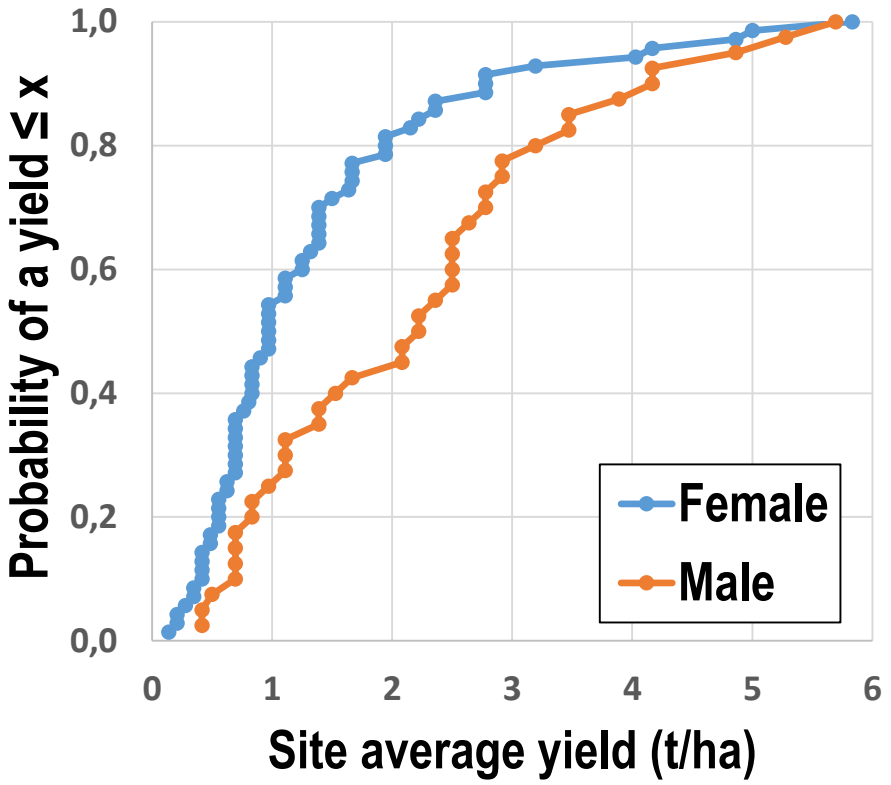


Resources



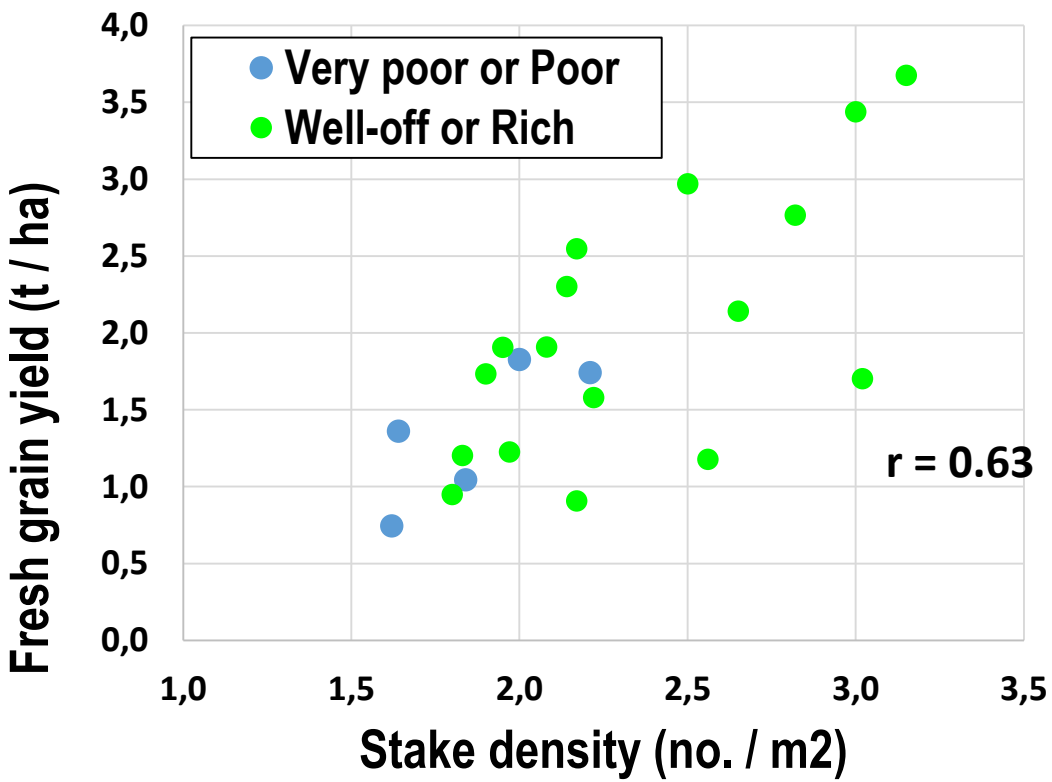
Household characteristics and climbing bean yields in NW Rwanda

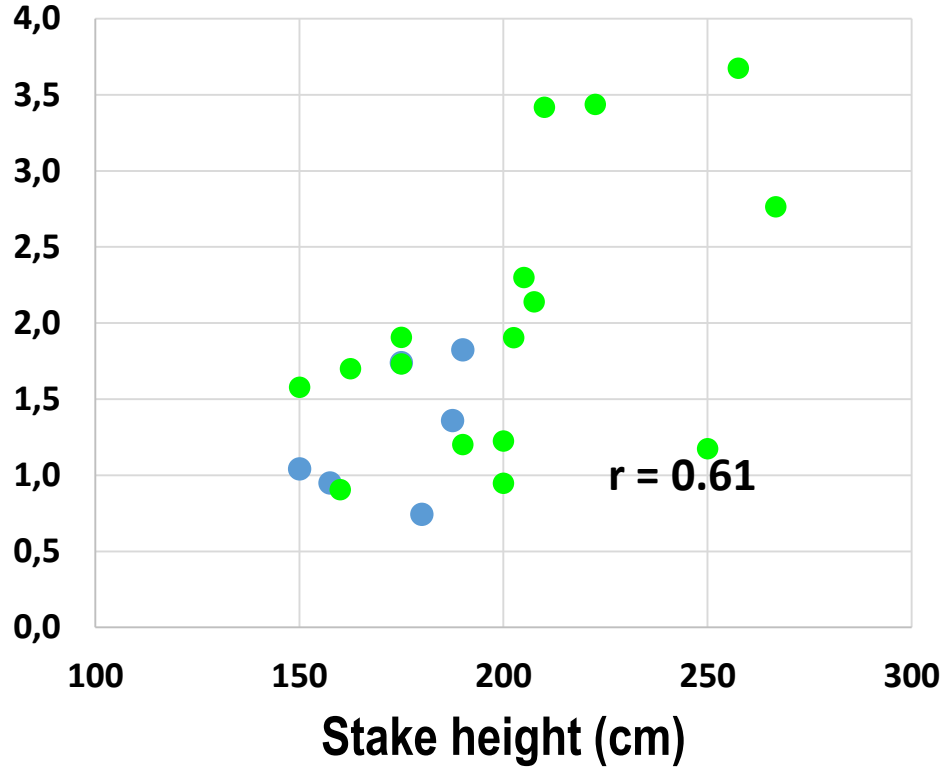




Source: Franke et al, 2016

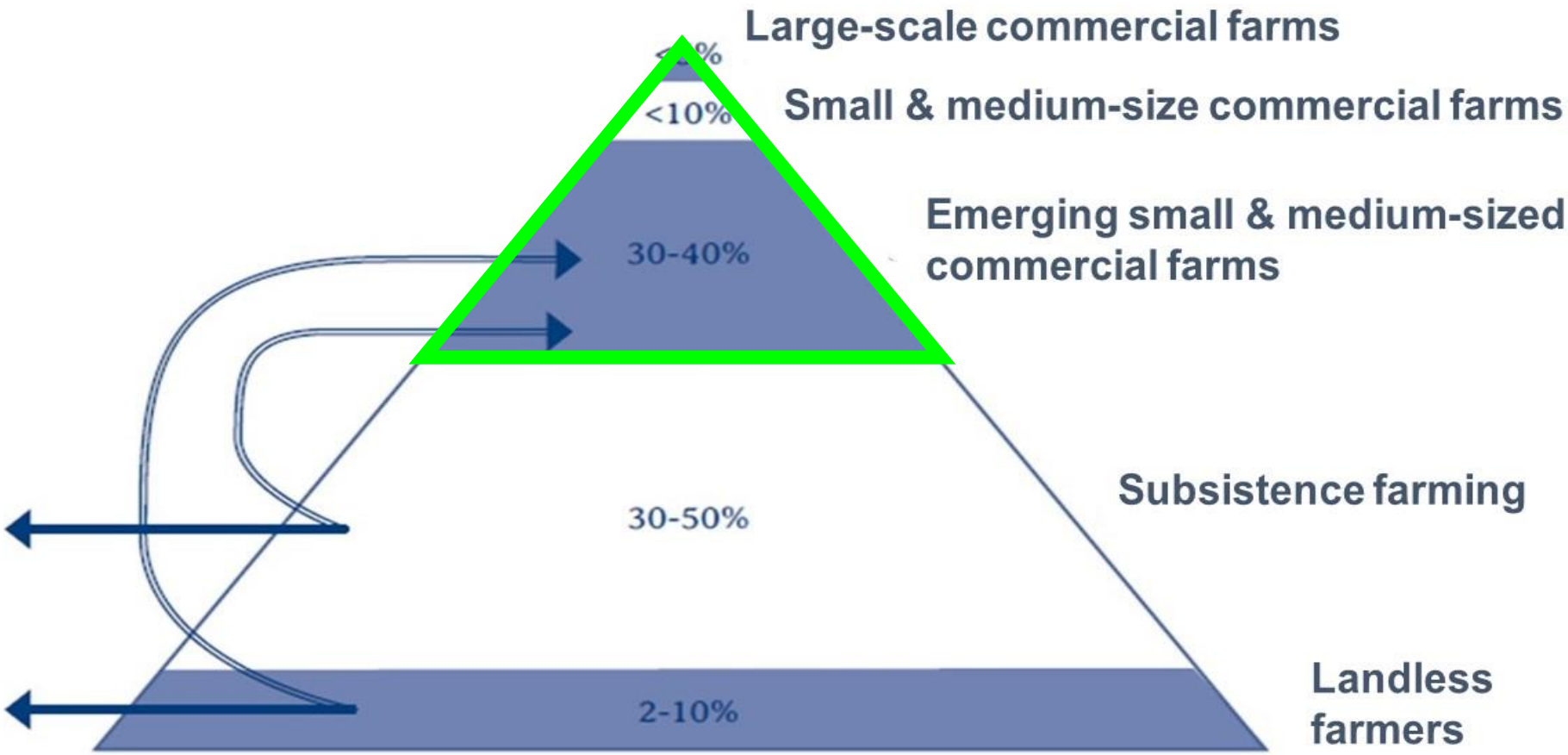
Resource allocation: effect of staking on climbing bean yields in NW Rwanda





Source: Franke et al, 2016

Not all households can adopt complete packages but partial uptake is also impact (in most cases)



Source: DFID, 2015

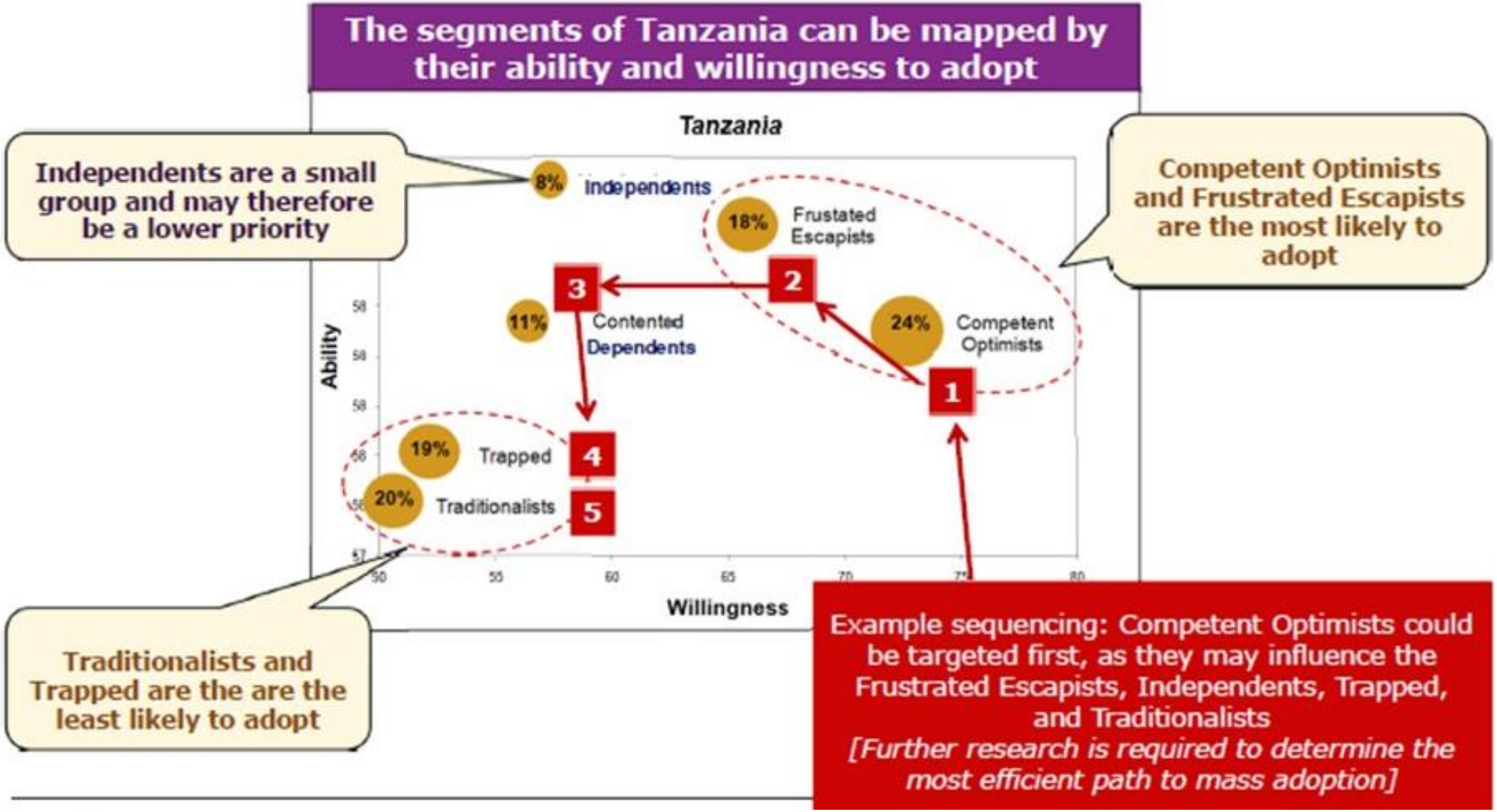
Decision making

Farmers' attitude towards farming

Segment		Proportions	Description
	Contented dependents	Tanzania = 11% Mali = 25%	• Has very positive attitude towards farming but feels he/she requires the assistance of others
	Competent optimists	Tanzania = 24% Mali = 13%	• Seeks information and networks with others; very independent and truly enjoys farming
	Independents	Tanzania = 8% Mali = 5%	• Generally savvy information user; but not very engaged or experienced in farming; no excitement from farming
	Frustrated escapists	Tanzania = 18% Mali = 3%	• Looking to make the best out of farming & improve, but if a better alternative came up, would easily stop farming.
	Traditionalists	Tanzania = 20% Mali = 28%	• Love the farming ethos, but is very low on information focus and doesn't look for change
	Trapped	Tanzania = 19% Mali = 25%	• Doesn't enjoy farming, sees no hope in farming; doesn't want his/her children to follow him/her

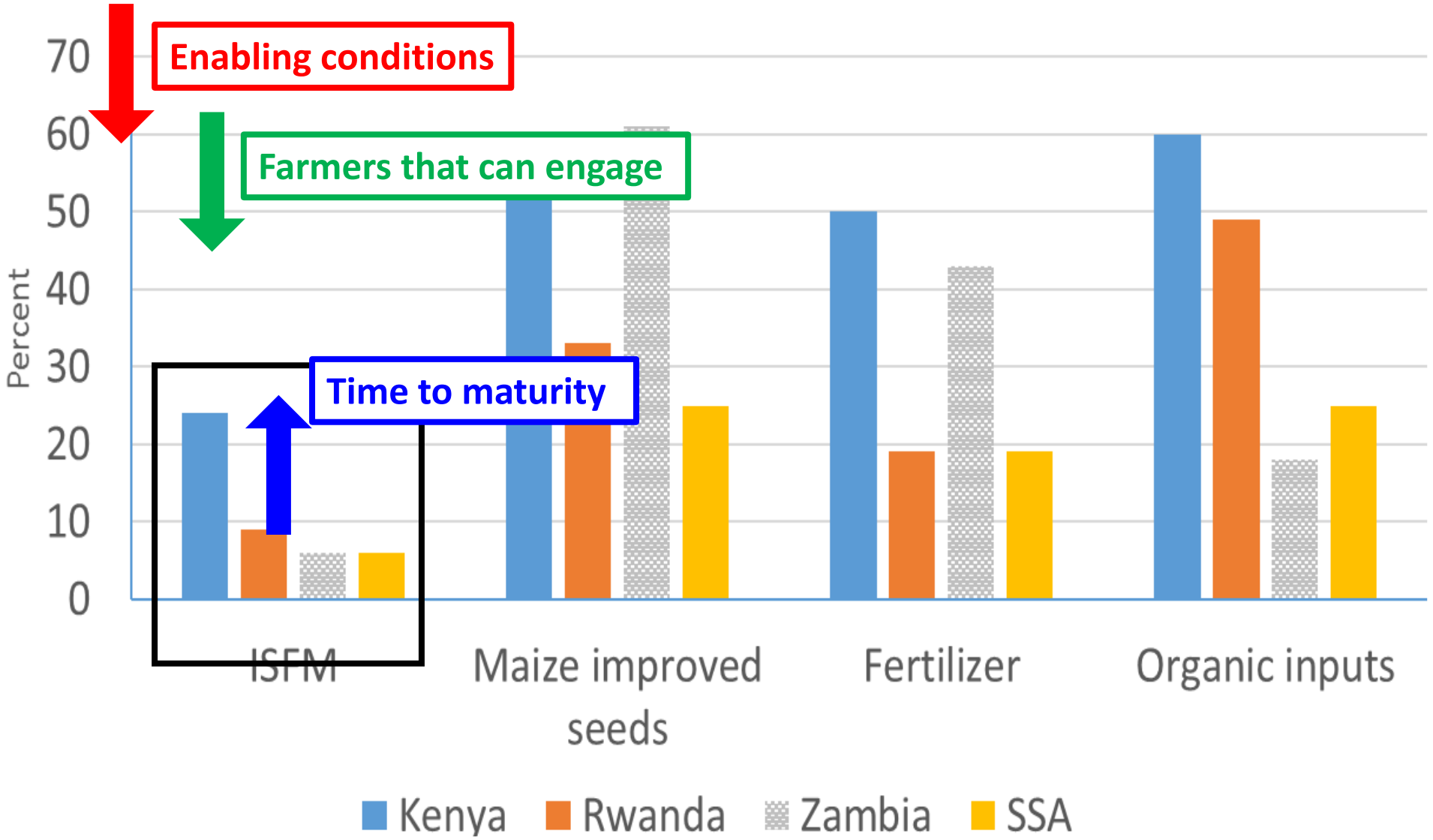
TNS, 2012

Farmers' attitude towards farming can vary substantially



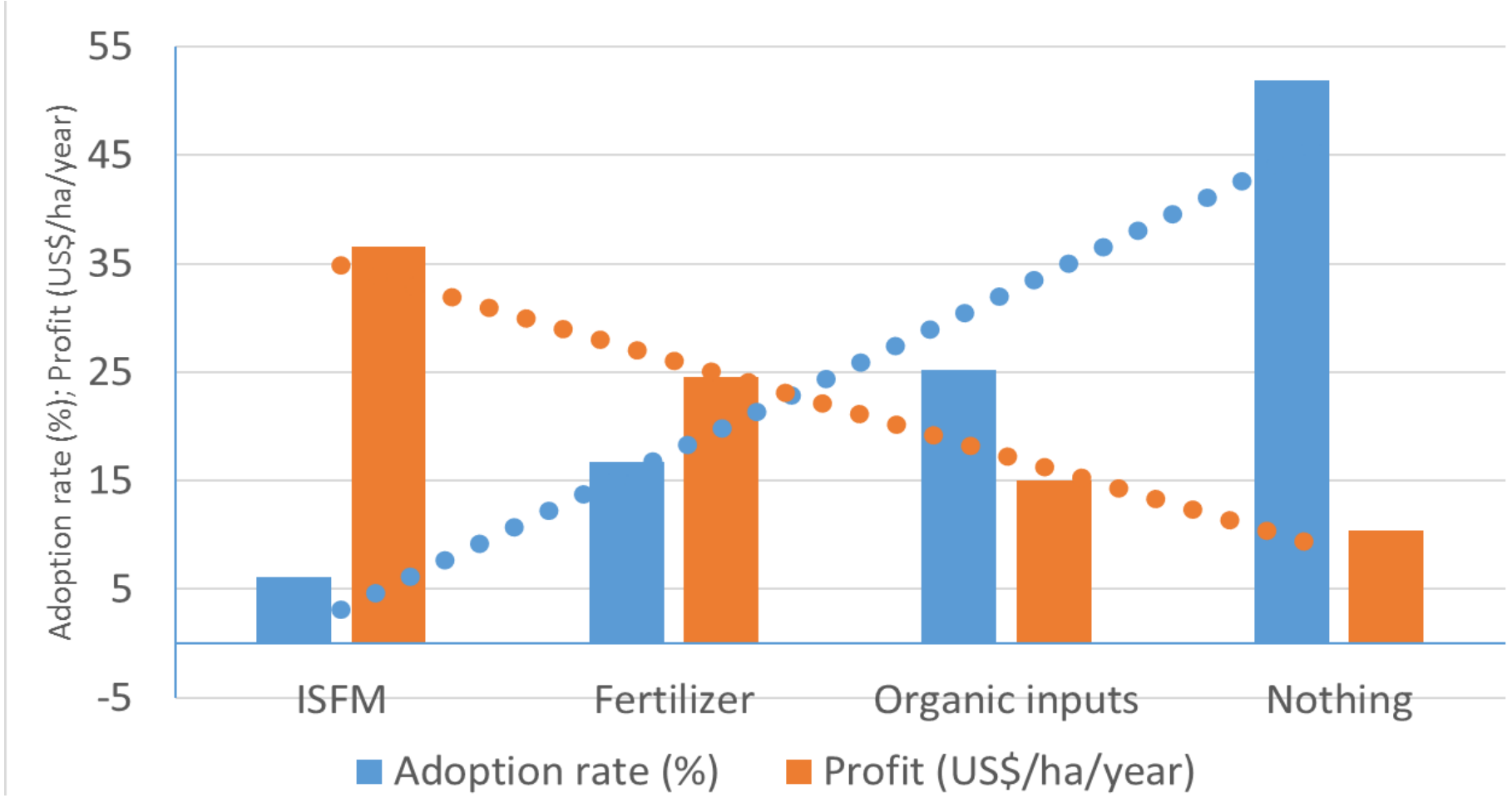
TNS, 2012

The low uptake of ISFM practices



Source: Nkonya et al, 2017

The inverse relationship between profitability and adoption rate (the unholy cross)



Source: Nkonya et al, 2017

Sustainable Intensification

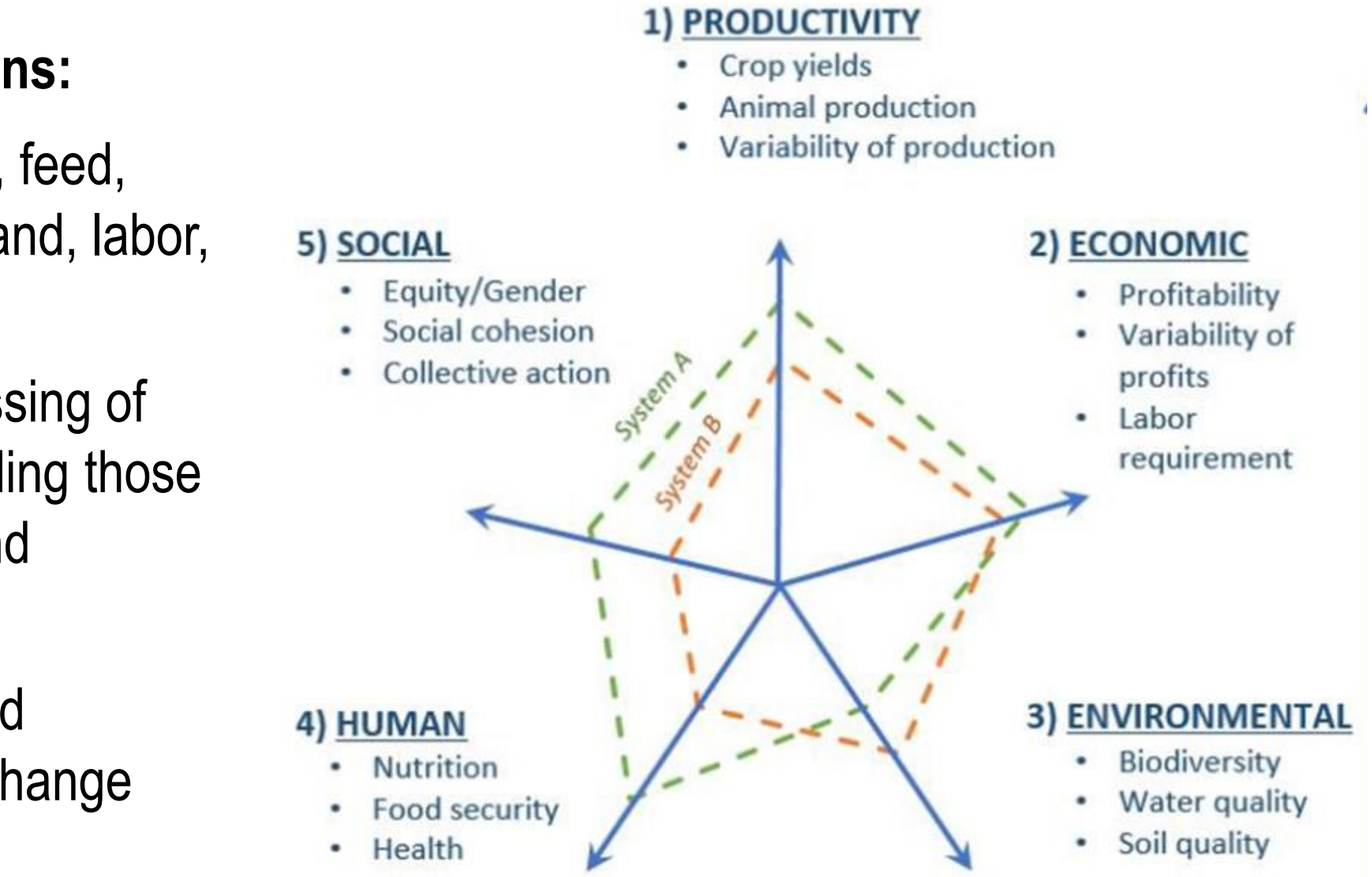
Sustainable Intensification

Has a number of dimensions:

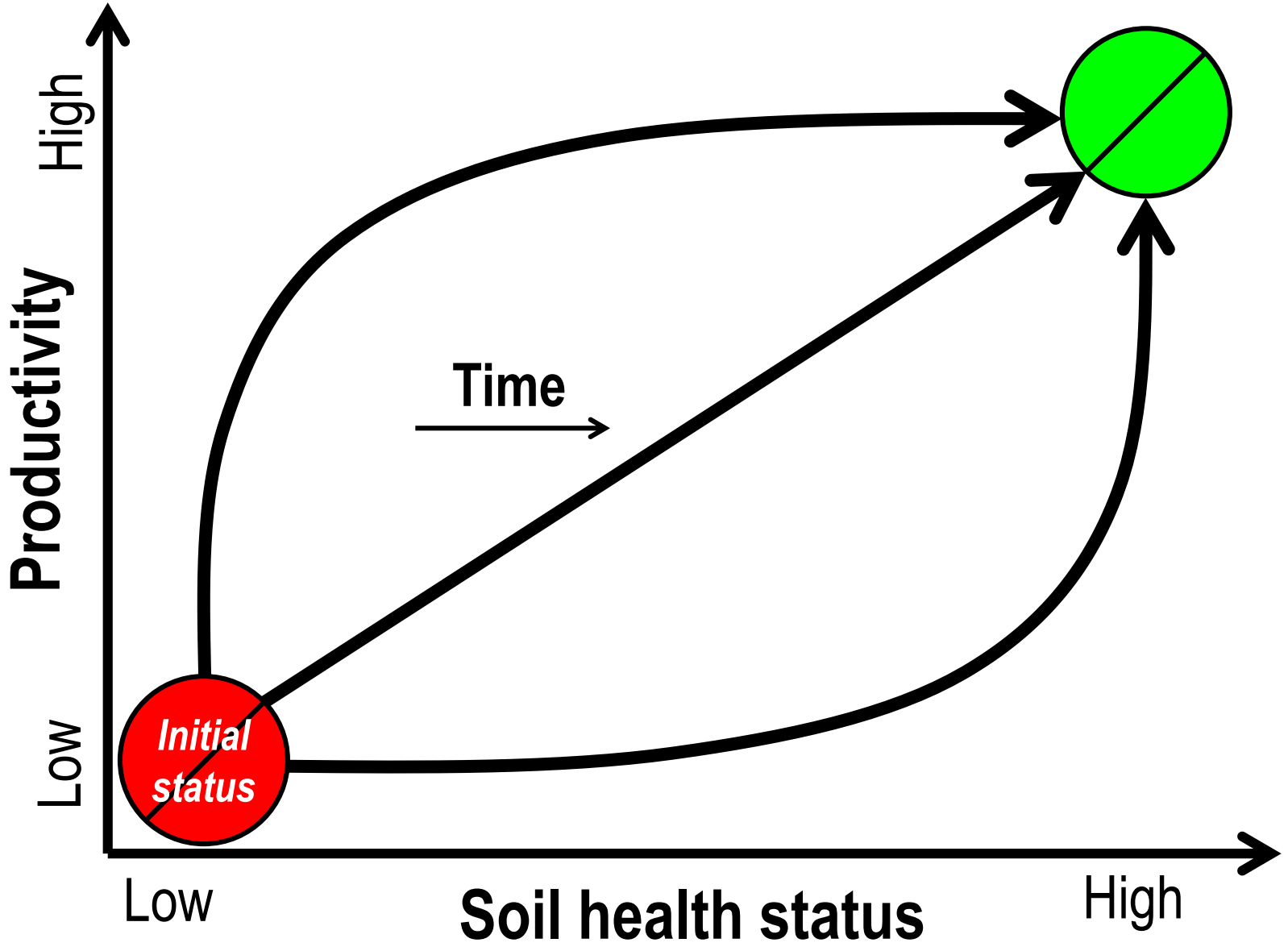
(i) **Production** of more food, feed, fuel and/or fiber per unit of land, labor, and/or capital used

(ii) Conservation and harnessing of **ecosystem services**, including those delivered by healthy soils and biodiversity

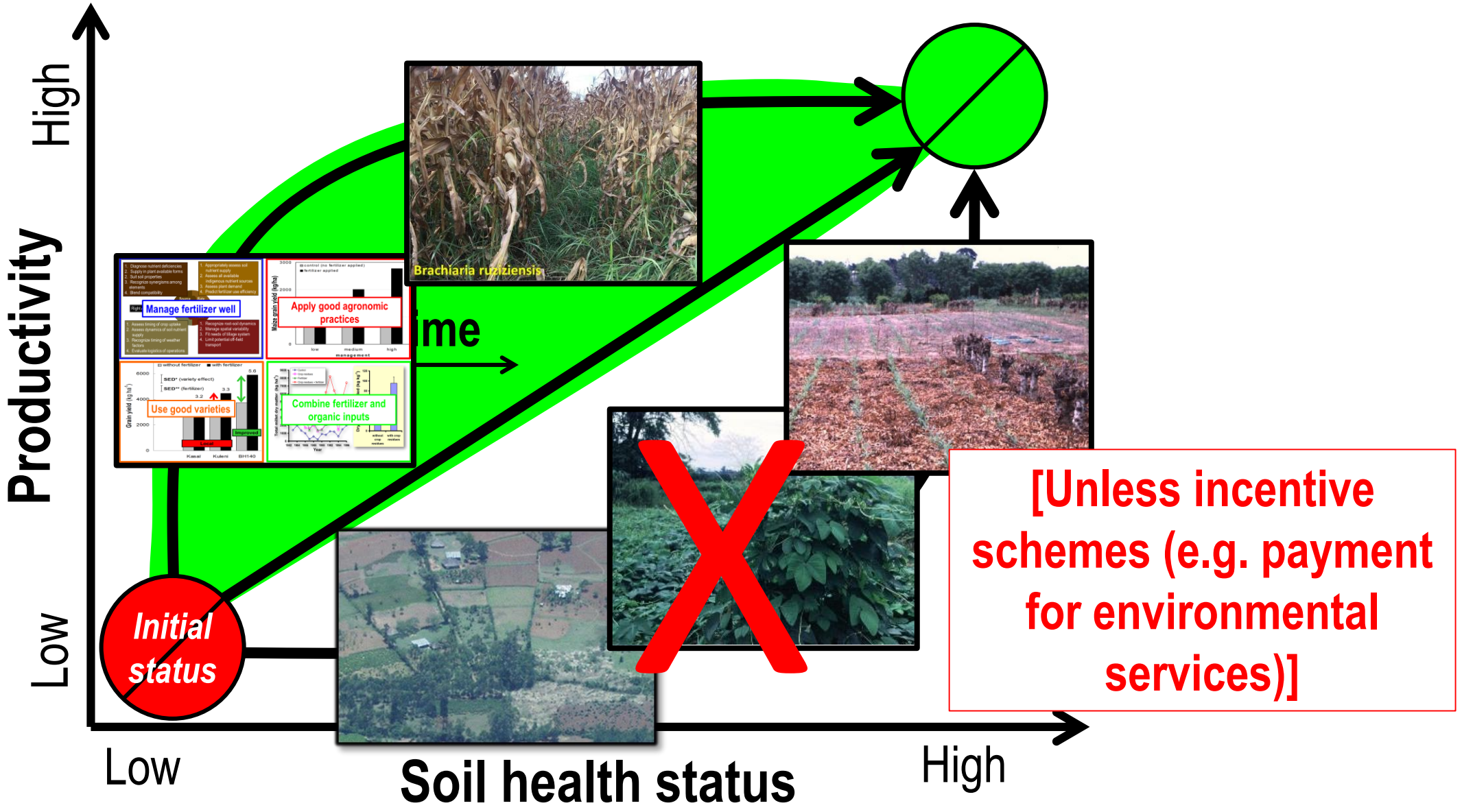
(iii) **Resilience** to shocks and stresses, including climate change



Pathways towards sustainable intensification



Pathways towards sustainable intensification



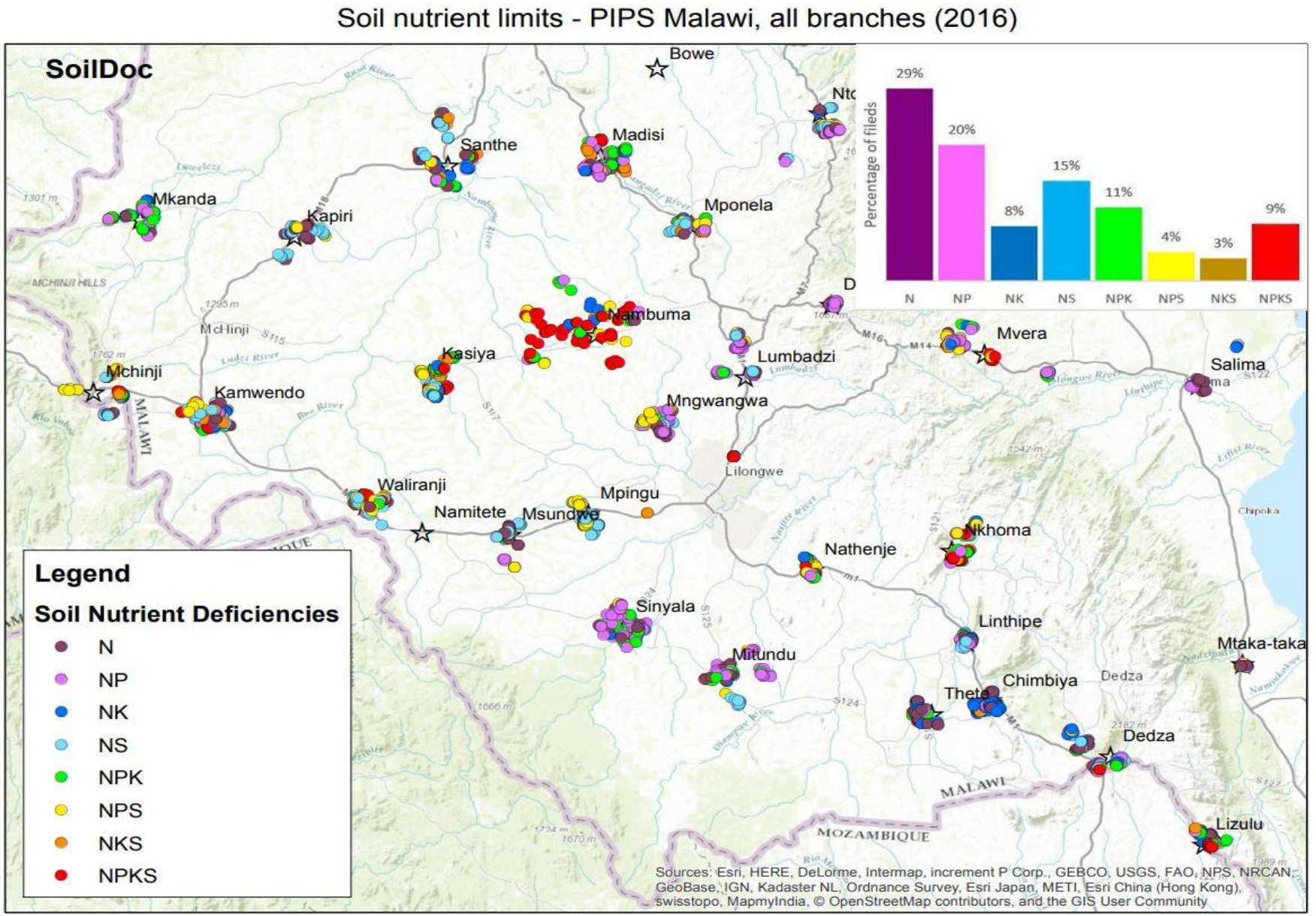
While we intensify, where do we apply what?

Test soils for:

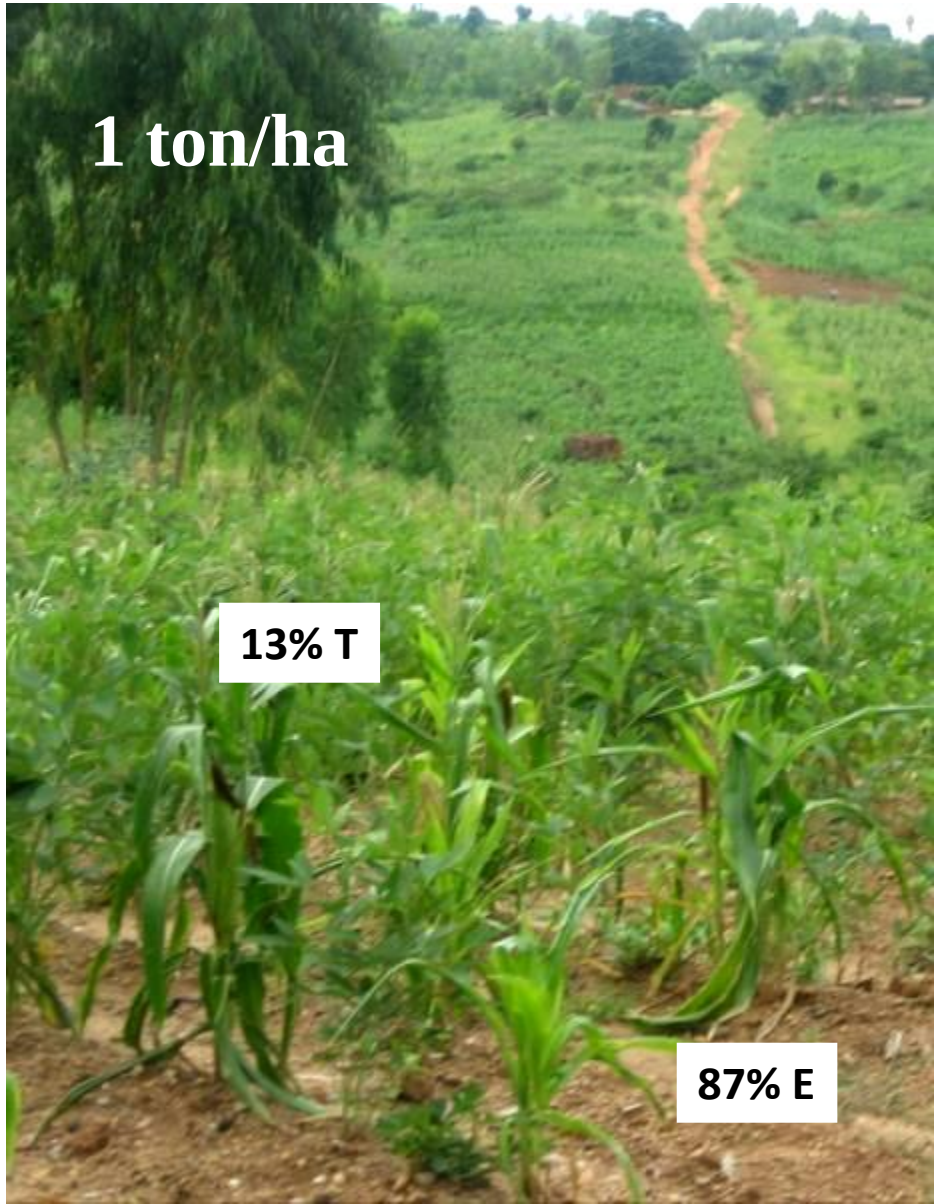
(i) Limiting nutrients

(ii) Liming requirements

(iii) Organic matter addition



Added benefit: Increasing yields in Africa can improve water use efficiency



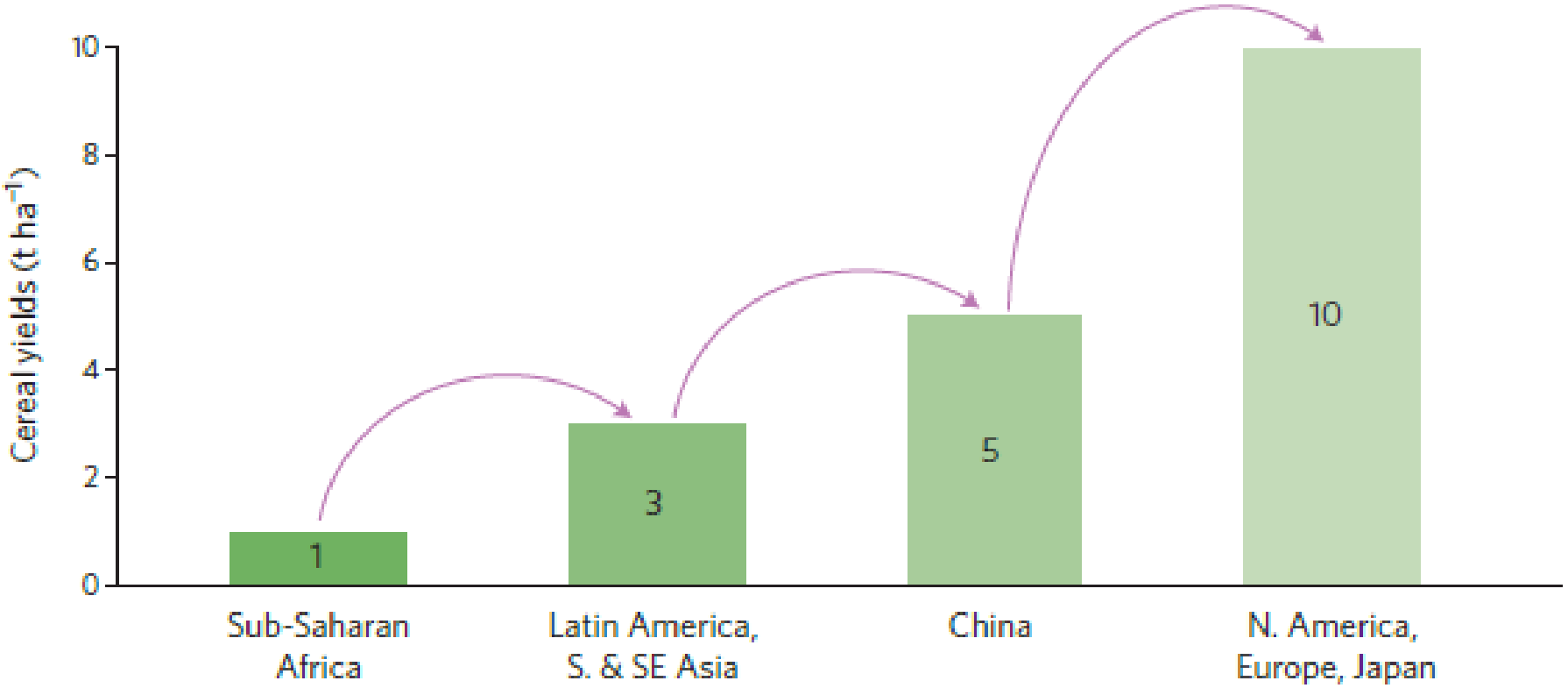
Fixing it together

Reaching 3 to 5 ton/ha

→ Sub-Saharan Africa can move from **1 to 3 t/ha** by increasing access to improved seeds and fertilizers

→ Going from **3 to 5 t/ha** will require interventions across the agricultural value chain; changes to production, processing and markets

→ Achieving **10 t/ha** is agronomically possible, but may require new technologies and beyond the scope of short-term interventions



Source: Sanchez et al, Nature Plants, 2015

Make inputs available and affordable: The ‘Coca-Cola’ paradox

$ 200-500 /ton urea world market 2011

$ 900-1,400 /ton urea in DR Congo

$ 1.5-2 in Europe

$ 0.5 in DR Congo

The overall picture: What it takes