State of the Art? Climate Smart!

What are climate smart agriculture practices and which smallholder farmers might want them?

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Outline

- Some background
- Promising technologies
- Reaching the poor?
- Can we learn from the past?

What defines climate-smart agriculture?

Climate-smart agriculture (CSA) aims to:

1. Sustainably **increase agricultural productivity**, to support equitable increases in farm incomes, food security and development;
2. **Adapt** and build resilience of agricultural and food security systems **to climate change** at multiple levels; and
3. **Reduce greenhouse gas emissions** from agriculture (including crops, livestock and fisheries).

Keywords: context specific, multiple goals and trade-offs, involves the poorest and most vulnerable.

Conservation Agriculture: The heretics' view

- Conservation agriculture (CA) promoted as a panacea
- Massive donor investment in Africa unjustified
- Univocal promotion by international organizations, governments, NGOs (and churches!) stifled debate

Two main arguments:

1. Scientific evidence to support the claims made for CA was unclear and inconsistent
2. CA did not 'fit' within the majority of smallholder farming systems in Africa

Giller, K.E., Witter, E., Corbeels, M., Tittonell, P., (2009) *Field Crops Research* 114, 23-34.

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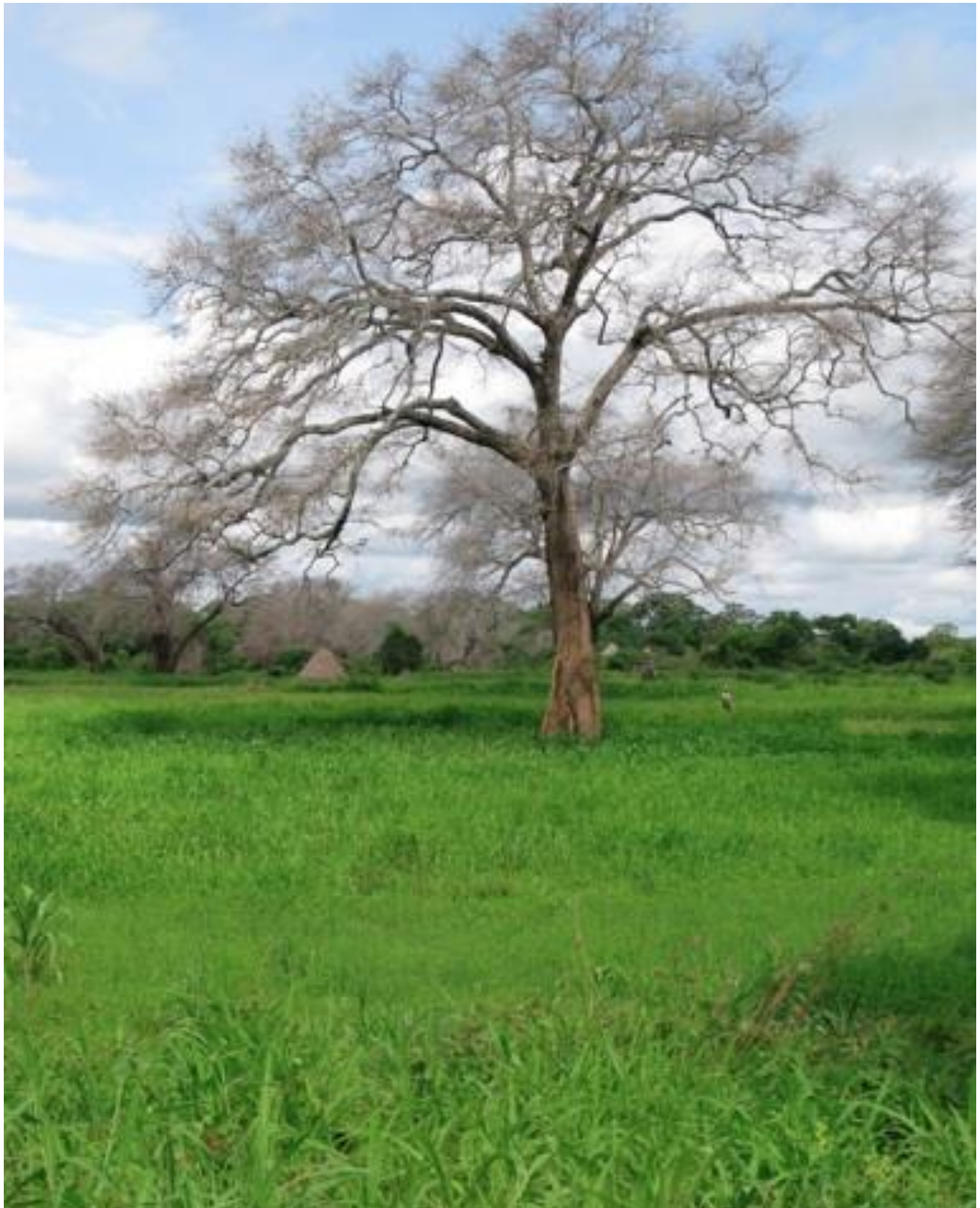
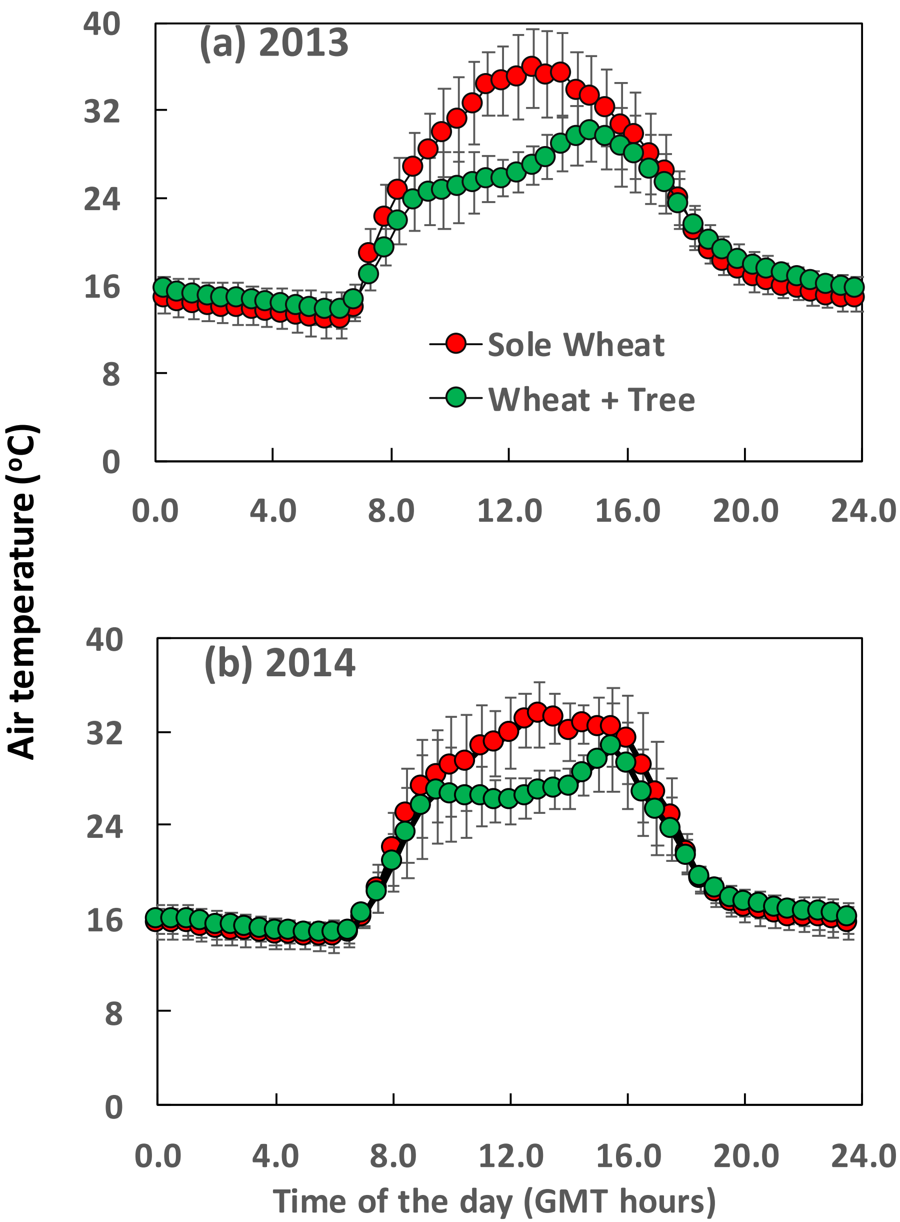
Faidherbia albida – islands of fertility



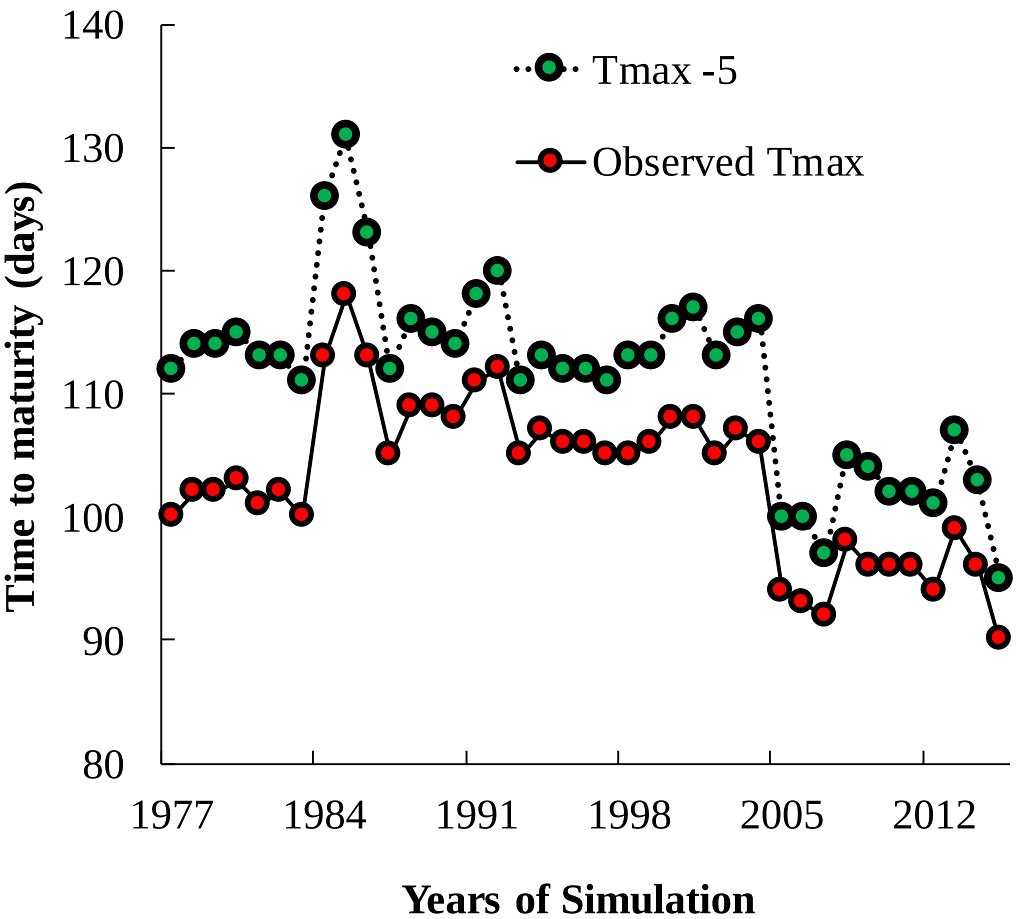
Greener wheat under *F. albida* canopy in farmers fields, potential for optimum tree density?

F. albida buffers wheat against heat stress



- Temperature lowered by up to 6°C at midday
- Temperature exceeded 28°C (optimum for wheat):
  - for about six hours day^{-1} in the open fields and
  - for less than two hours day^{-1} for under the canopy

Longer duration under trees in simulations



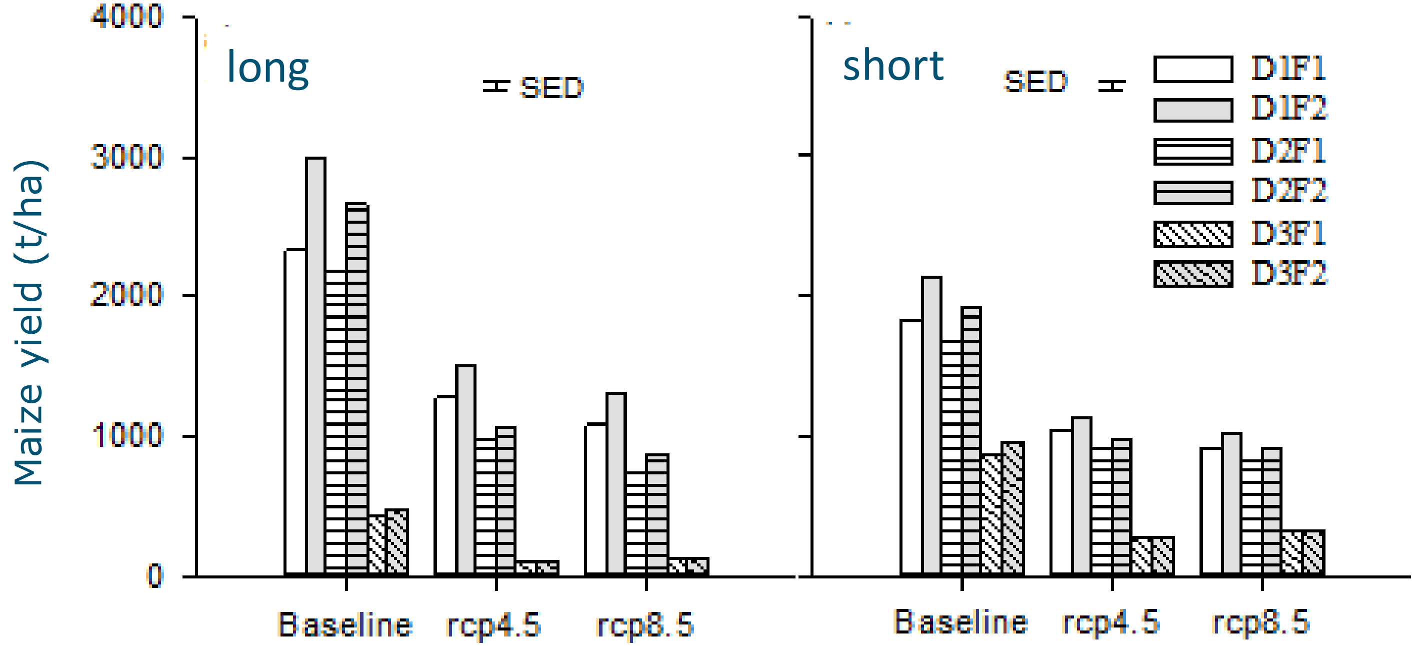
- 5^{o}C lower maximum temperatures under trees
- 10 days more grain filling
- Yields 25% larger

Sida, T., Baudron, F., Haekoo, K. & Giller, K.E. (Submitted) Climate Smart Agroforestry: *Faidherbia albida* trees buffer wheat against climatic extremes in the Central Rift Valley of Ethiopia. *Global Change Biology*.

Assessing impact of climate change adaptation in Mali

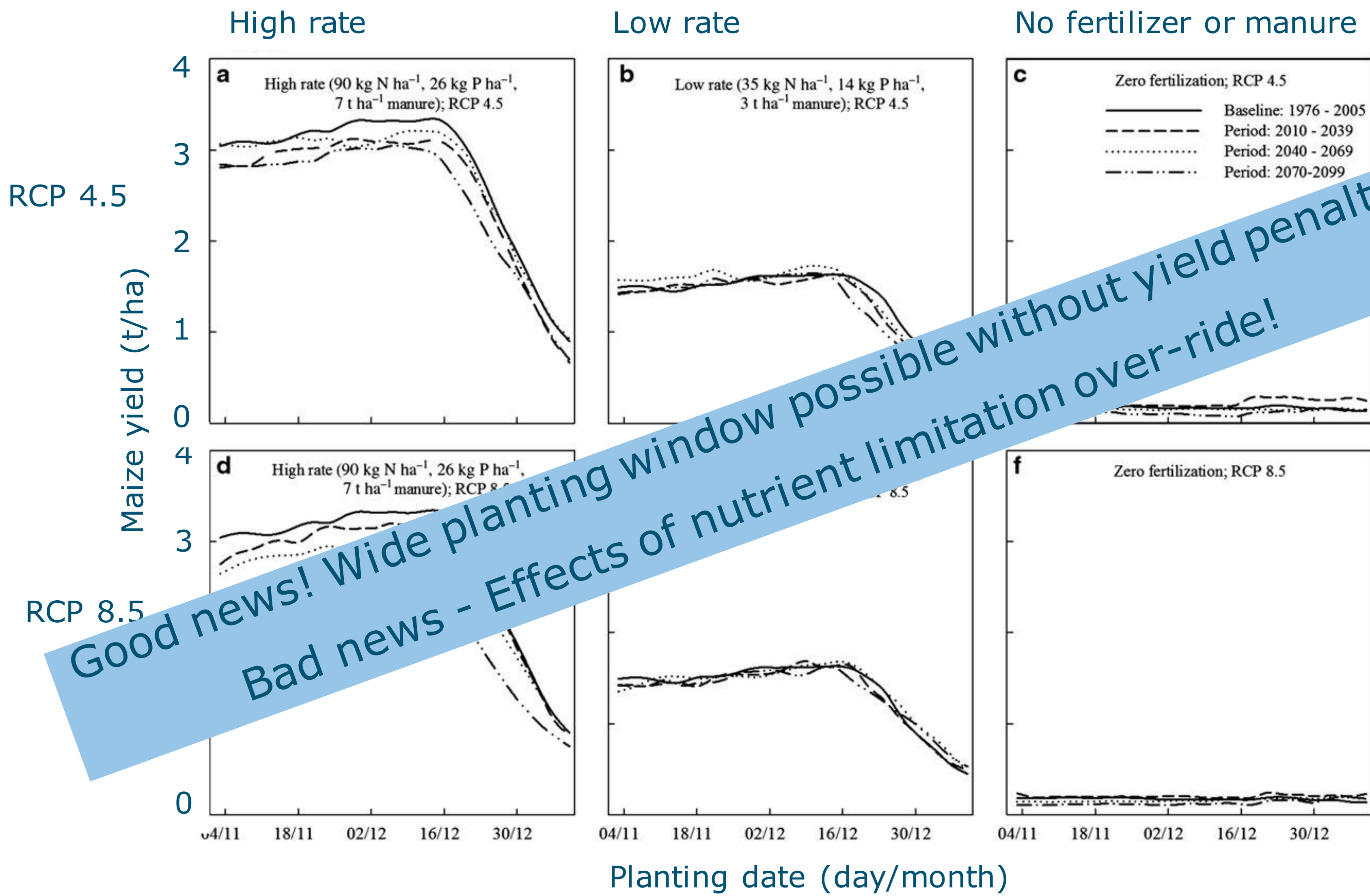
Short duration maize varieties

- Yield reduction in short duration varieties smaller under future climate change
- Negative effect of climate change smaller compared with long duration varieties
- Short duration varieties yield more when planted late



Traore, Descheemaeker, van Wijk, Corbeels, Supit, & Giller (2017) *Field Crops Research,* **201,** 133-145.

Assessing impact of climate change adaptation on maize



Good news! Wide planting window possible without yield penalty

Bad news - Effects of nutrient limitation over-ride!

Rurinda, van Wijk, Mapfumo, Descheemaeker, Supit & Giller (2015) *Global Change Biology*, **21,** 4588-4601.

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Maize-cowpea intercropping in semi-arid Zimbabwe

Total rainfall (mm) 354 594 190

12 on farm Replicates
Farmer managed
Nqindi Ward, Matobo District

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Masvaya, Nyamangara, Descheemaeker & Giller (2017) *Field Crops Research,* submitted.

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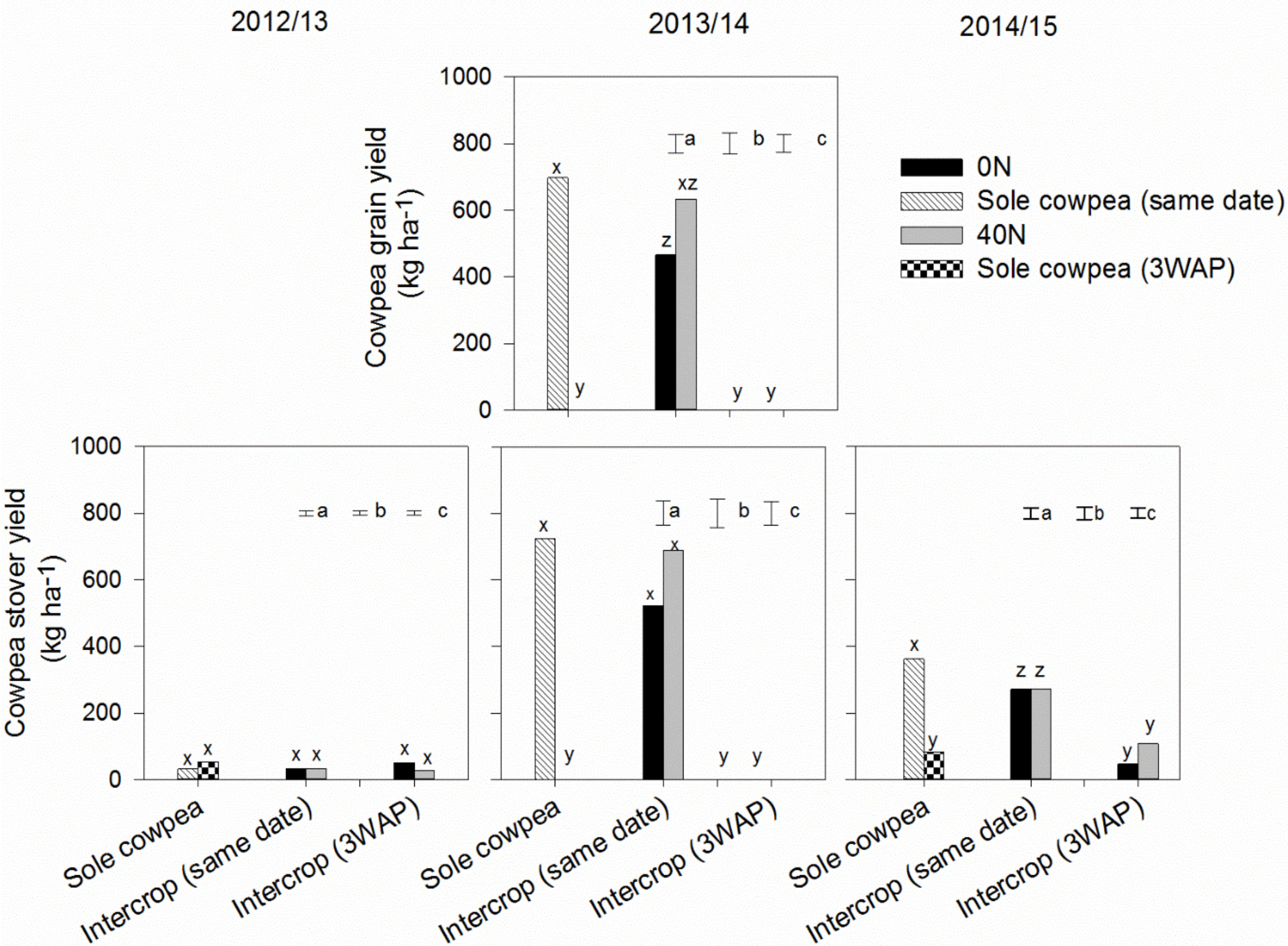


Masvaya, Nyamangara, Descheemaeker & Giller (2017) *Field Crops Research*, submitted.

Courting the rain

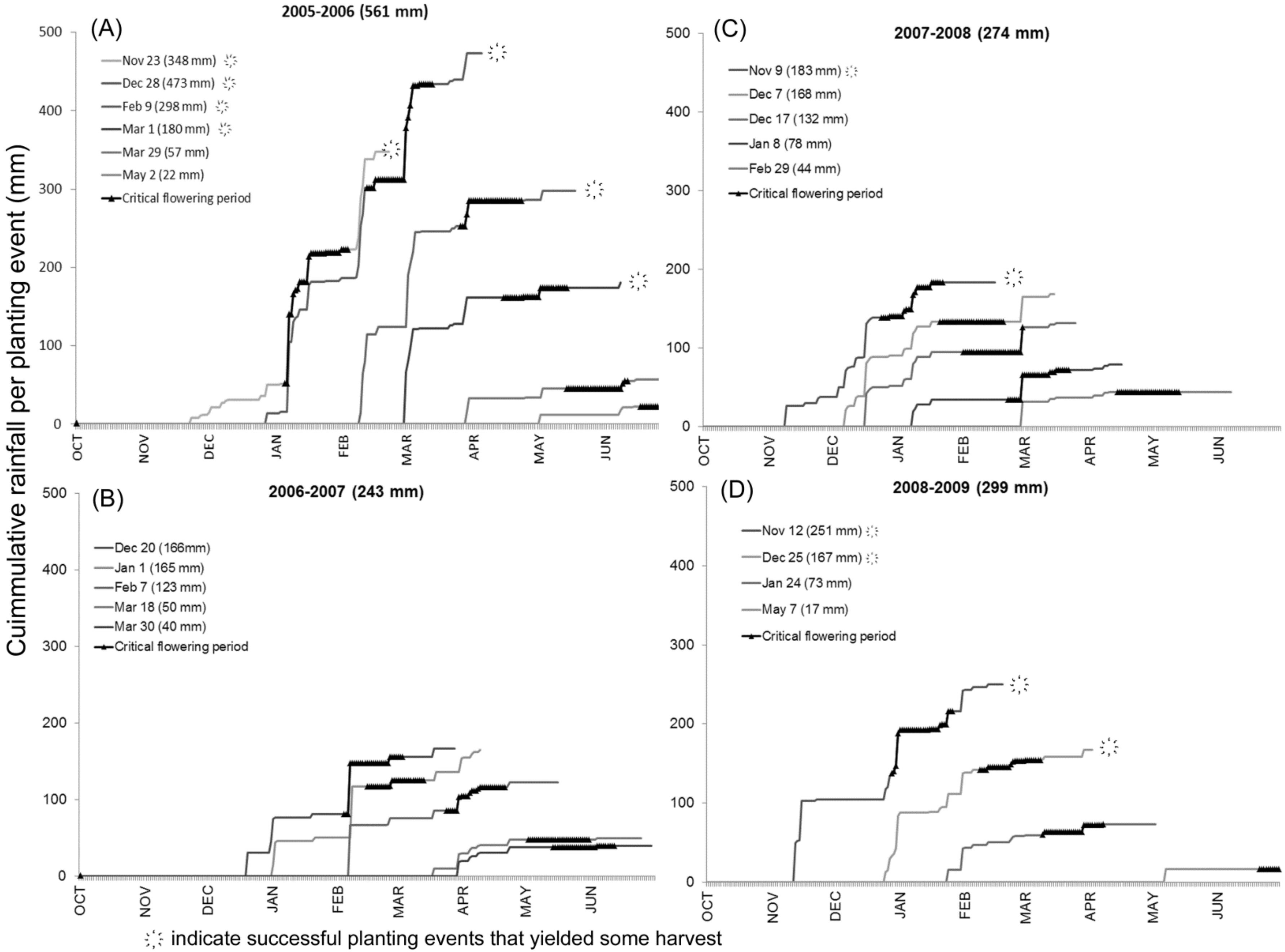
Rethinking seasonality and adaptation to recurrent drought in semi-arid southern Africa

Milgroom, J. & Giller, K.E. 2013 Agric Syst 118, 91-104

No fixed season

- Continuous planting
- Planting outside of the rai season
  - «Seasonal irregularities
  - «climate change
  - «topographical opportunities

May



Cuimmulative rainfall per planting event (mm)
(A)
2005-2006 (561 mm)
Nov 23 (348 mm)
Dec 28 (473 mm)
Feb 9 (298 mm)
Mar 1 (180 mm)
Mar 29 (57 mm)
May 2 (22 mm)
Critical flowering period
(B)
2006-2007 (243 mm)
Dec 20 (166mm)
Jan 1 (165 mm)
Feb 7 (123 mm)
Mar 18 (50 mm)
Mar 30 (40 mm)
Critical flowering period
(C)
2007-2008 (274 mm)
Nov 9 (183 mm)
Dec 7 (168 mm)
Dec 17 (132 mm)
Jan 8 (78 mm)
Feb 29 (44 mm)
Critical flowering period
(D)
2008-2009 (299 mm)
Nov 12 (251 mm)
Dec 25 (167 mm)
Jan 24 (73 mm)
May 7 (17 mm)
Critical flowering period
0
100
200
300
400
500
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
indicate successful planting events that yielded some harvest





Traditional
granaries
Modern
granaries

AgMIP The Agricultural Model Intercomparison and Improvement Project

RAP-2: transformative change

Indicators	SSP5, RAP-1: Conventional development		SSP1, RAP-2: Sustainable development	
Cultivated land area	-	Intensified production on less land	++	Expansion of cultivated land; labor saving techn., better market access
Herd size	+	Small increase due to improved feed and animal management	++	Large increase; more fodder production, market incentives
Systems change	+	Better crop-livestock integration	++	Further crop-livestock integration; crop diversification, intensification
Input use	+	Fertilizer and improved seed for maize	++	Fertilizer and improved seed for all crops
Legume cultivation	0	No change	+ +	Groundnut and legume forages
Off-farm income	-	Limited alternative options, people rely more on agriculture	+	Growth in other sectors attracts people, income diversification

SSP5, RAP-2 “Sustainable development”

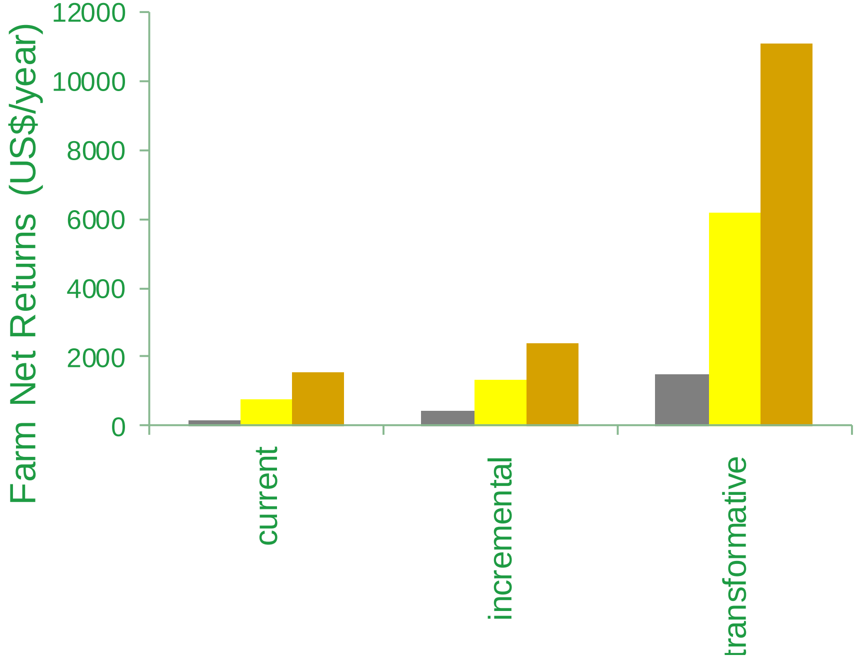
In Zimbabwe: conducive institutional environment for investment in sustainable solutions

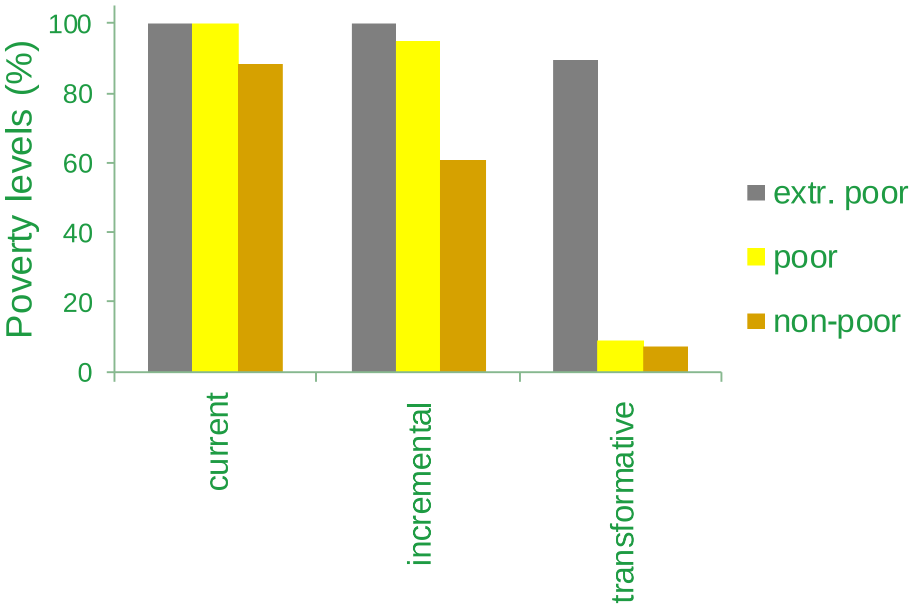
Adaptation package-2 “Transformative”

Shift to sorghum, crop rotation, drought tolerant and high-yielding varieties, fodder production, manure application

System comparison

Descheemaeker, Oosting, Tui, Masikati, Falconnier, & Giller (2016) *Regional Environmental Change,* **16,** 2331–2343.





0 cattle

1-8 cattle

>8 cattle

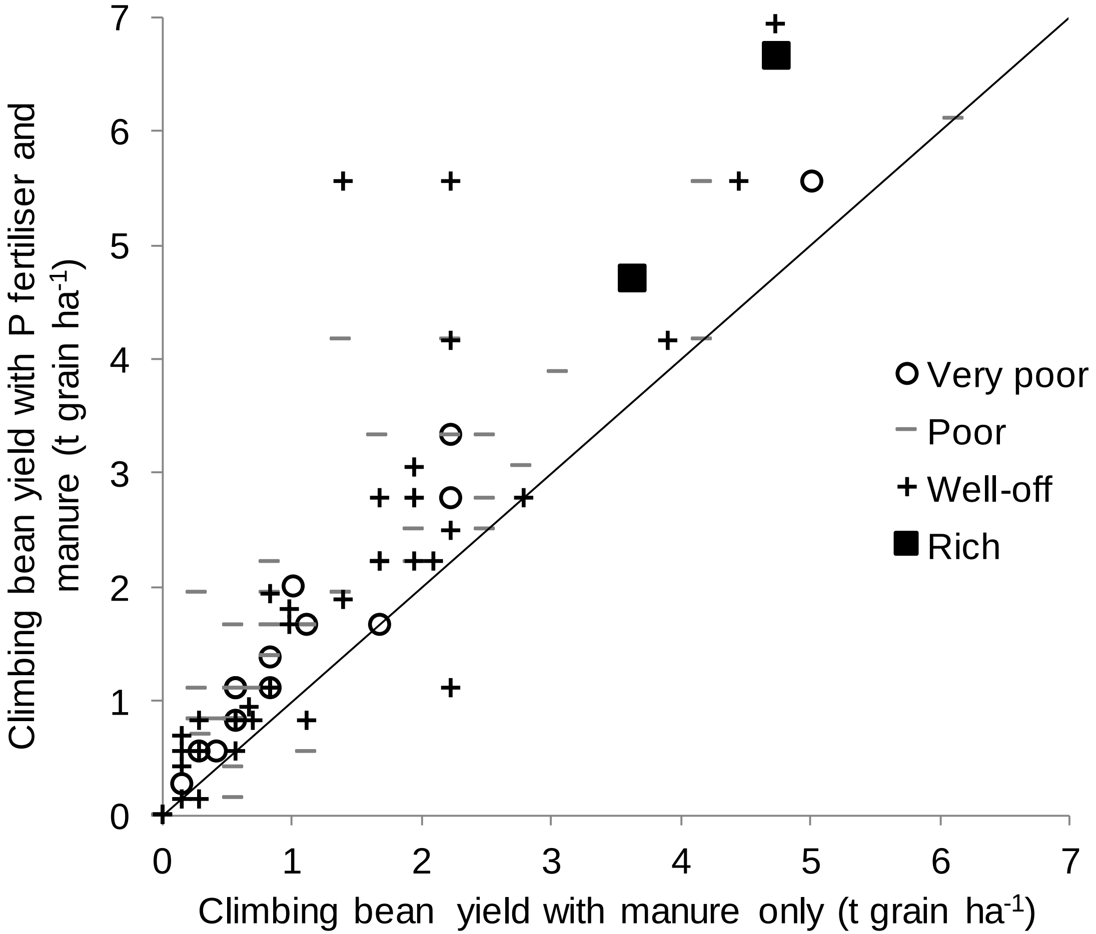
Climbing beans in Rwanda

No manure

With Manure and P

Putting nitrogen fixation to work for smallholder farmers in Africa

Response of climbing bean to P fertiliser, segregated by wealth category in N Rwanda



	Without P fertiliser (kg/ha)	With P fertiliser (kg/ha)
Very poor	**683**	**1061**
Poor	**1256**	**1891**
Well-off	**1356**	**2006**
Rich	**4167**	**5694**

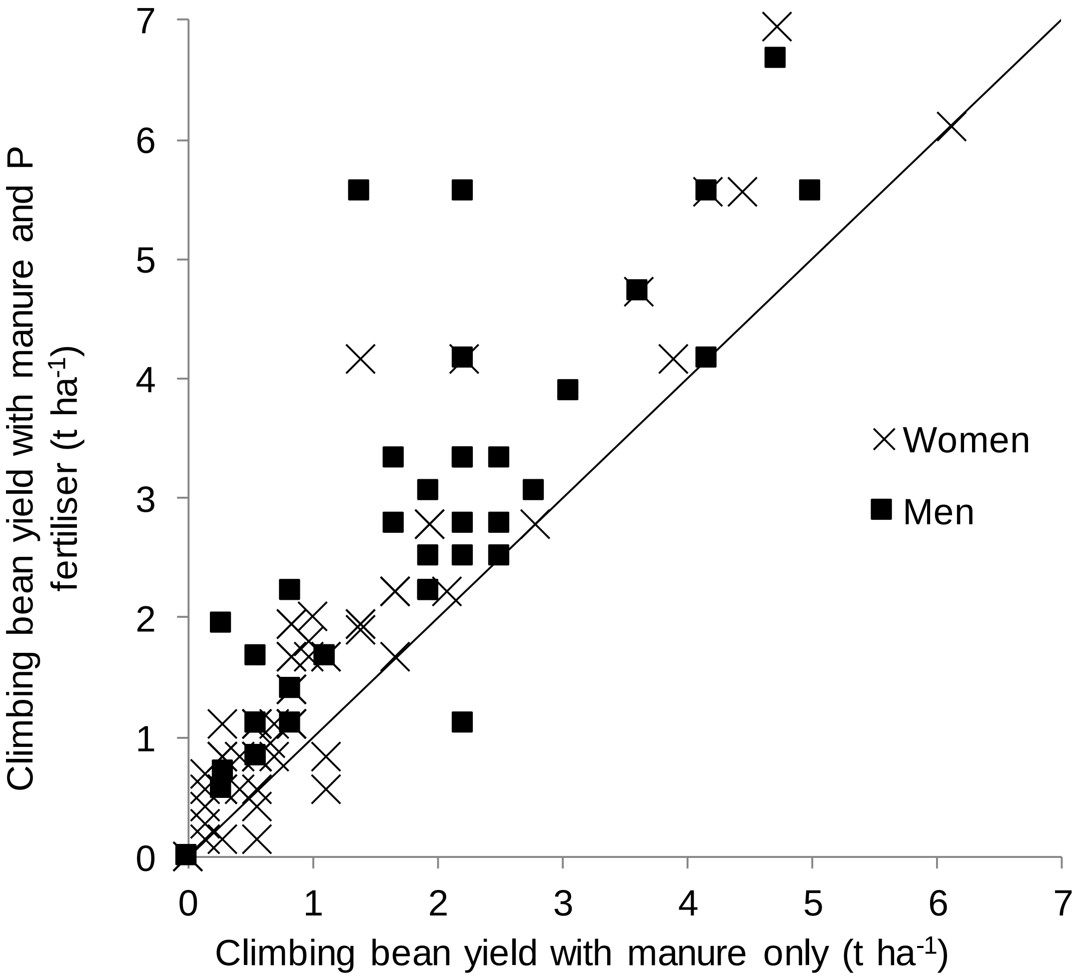
Franke, Baijukya, Kantengwa, Reckling, Vanlauwe, Giller (2016) *Exp. Agric.* online

Soil fertility in climbing bean trials affected by resource endowment

Variable	Very poor	Poor	Well-off	Rich	Significance
pH	5.4	5.7	5.5	6.0	*n.s.*
C (%)	**1.3**	**2.5**	**2.5**	**4.2**	*0.018*
N (%)	**0.12**	**0.25**	**0.24**	**0.43**	*0.020*
Avail. P (mg/kg)	**6.7**	**20.5**	**19.1**	**35.9**	*0.005*
Sand	**40.6**	**31.9**	**30.6**	**34.6**	*0.002*
Silt	**27.3**	**35.3**	**35.7**	**43.3**	*0.002*
Clay	32.1	32.8	33.7	22.2	*n.s.*

Franke *et al.* (2016)
Exp. Agric. online

Yields segregated by gender

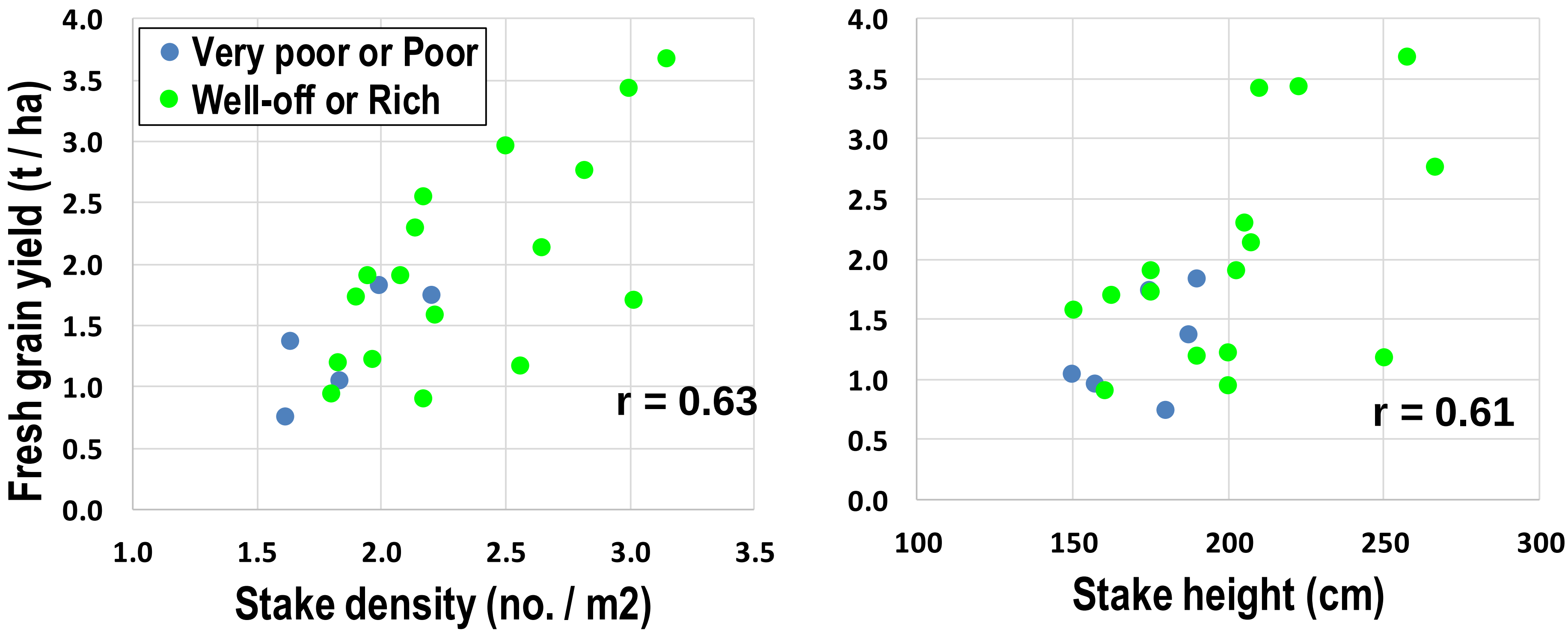


	Without DAP (kg/ha)	With DAP (kg/ha)
Women	**1107**	**1659**
Men	**1733**	**2517**

Franke *et al.* (2016)
Exp. Agric. online

Climbing bean yields depend on the length, number and quality of stakes

Poorer farmers have fewer, shorter stakes of inferior quality



Franke *et al.* (2016) *Exp. Agric.* online

Crop management factors that determine climbing bean productivity

- Planting time
- Timing of 1st weeding
- Staking density
- Stake length
- Organic input use
- P fertiliser use
- Labour input

Understanding constraints of different farmers allows research feedback to tailor technologies

Learning from history – The West Usambara Mountains, Tanzania

"***The mountains of what I have called the Fuga* [Vuga] *plateau, seem to be almost bare*.**"

"*Fuga is* [as a result of agrarian activities and the harvesting of building material and firewood] *nowadays the worst land in Usambara.*" Johnston, 1879

"***With the bad soil conditions, locals should use year long periods of fallow. But, this land is so densely occupied, that this is no longer possible*.**" von Schnee, 1912

Huijzendveld, F. (1997) *Die Ostafrikanische Schweiz: Plantages, Planters en Plattelandsontwikkeling in West-Usumbara, Oost Afrika, ca. 1870-1930,* Verloren, Hilversum. pp. 543.

Learning from history – The West Usambara Mountains, Tanzania

"*The hard facts are that the whole region* [West Usambara] *has reached* ***a very low level of fertility owing to over-cultivation, over-grazing and failure to manure the land…*** *these conditions can only be rectified by a vigorous soil-rehabilitation programme and a reshuffle of the human and cattle populations*." TARDA, 1945

"*…**the people are … living in the final stage before their overworked worn out land ceases to carry them. Every new baby is an added burden which cannot much longer be borne***." Provincial Commissioner of Tanga, 1946

"*In Tanzania, the West Usambara highlands are among* ***the most affected areas*** [by] ***soil erosion***." Wickama et al. 2014

"***Cultivation has a strong effect on reducing SOC across the Lushoto region. …implementing climate smart agriculture (CSA) practices may …help build resilience and adaptive capacity of the overall farming system***." Winowiecki et al. 2016

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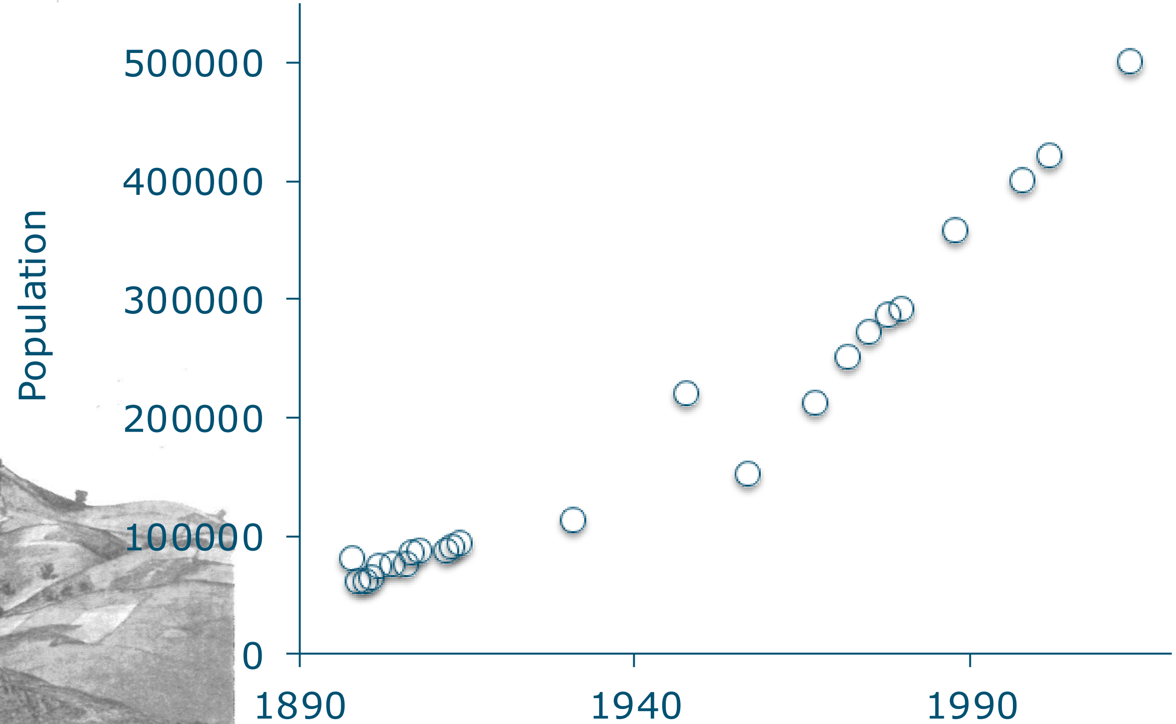
Huijzendveld, Baijukya and Giller, forthcoming

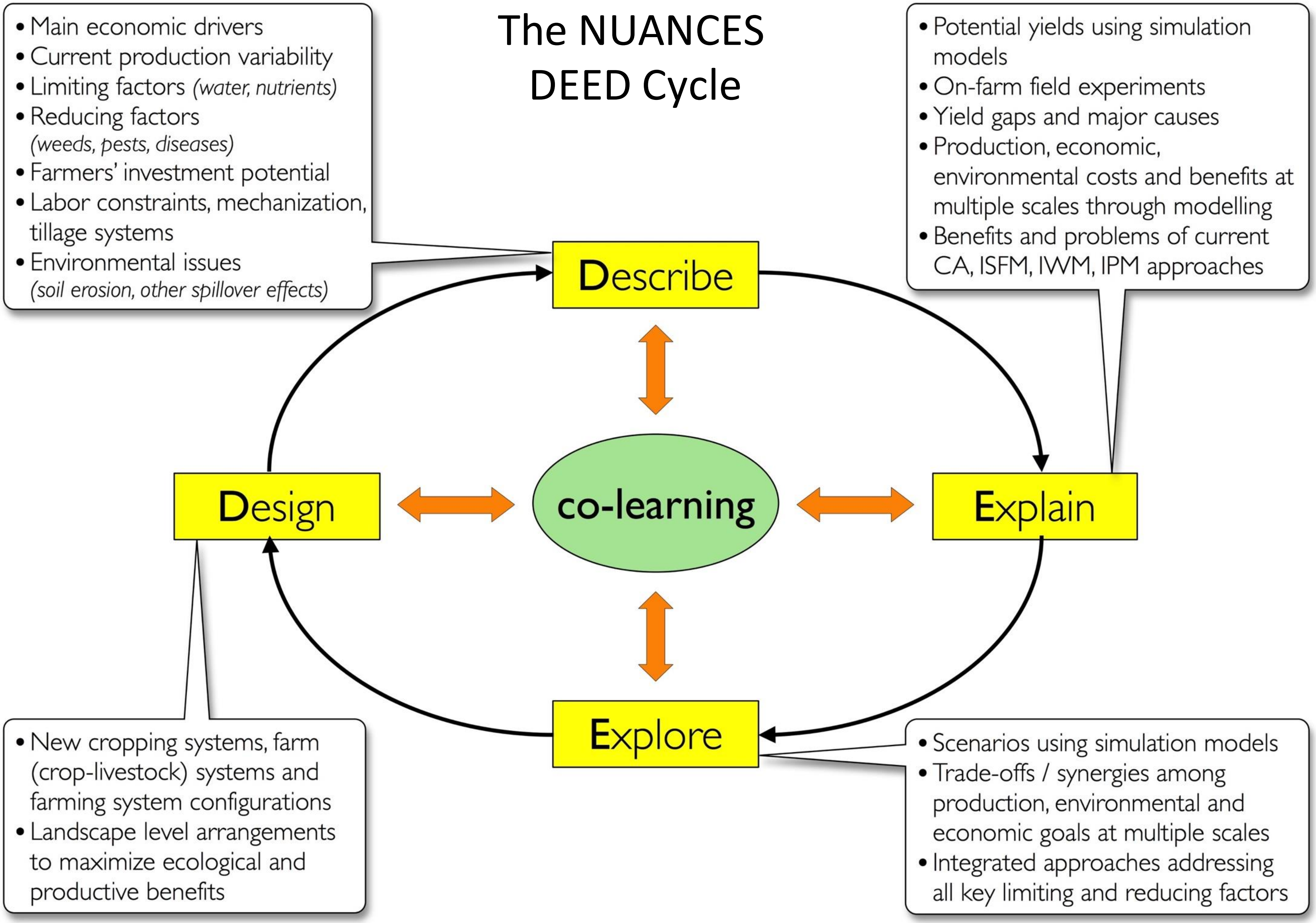
Population increased 10-fold yet no Malthusian disaster



Livelihood diversification

- Staple crops (maize and beans) on rainfed land important but lack investment
- Focus on vegetable production in valleys
- Reliance on remittances from Tanga and Dar es Salaam
- Yet the population will double within the next 20 years…

The NUANCES DEED Cycle



Conclusions

- Wide range of adaptive practices available to increase productivity
- Context matters!
- Hard to reach the poor
- Need participatory understanding
- Learn from history
- The jury is still out on mitigation