Conservation Agriculture in Africa – key lessons and development trajectories

Dr. Leonard Rusinamhodzi
CIMMYT - Nairobi, Kenya

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Outline of the talk

- **State of the art**
  - major crop production constraints in SSA
- **What is CA?**
  - The potential yield benefits
- **An expert's perspective**
  - Experiences of a long-time researcher
- **What is needed in future?**
  - How to coordinate efforts of CA promotion
- **Summary**

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True size of Africa

The continent is bigger than the USA, UK, Japan, China, India and the whole of Europe. All combined.

So much potential, but still cannot feed itself

What are the issues?

http://insideoutpaper.org/the-true-size-of-africa/

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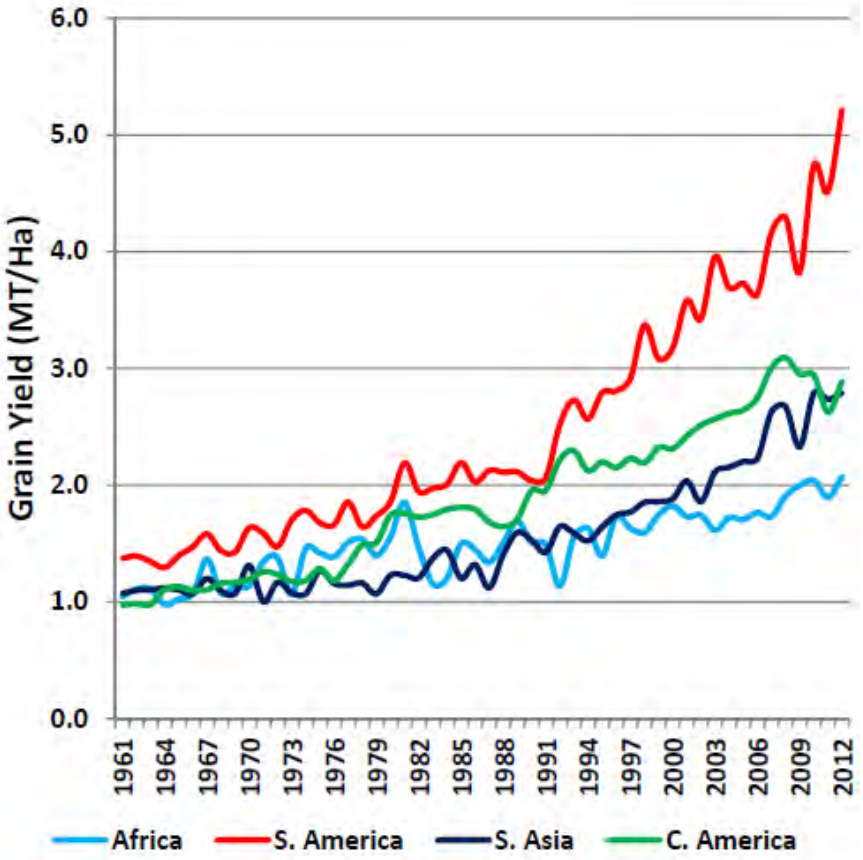
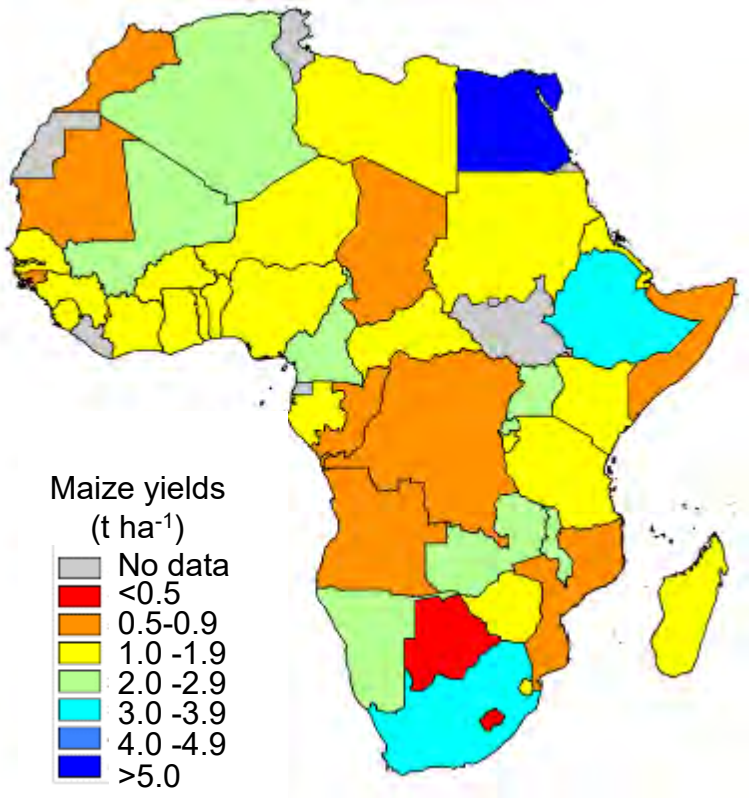
Maize yields in sub-Saharan Africa





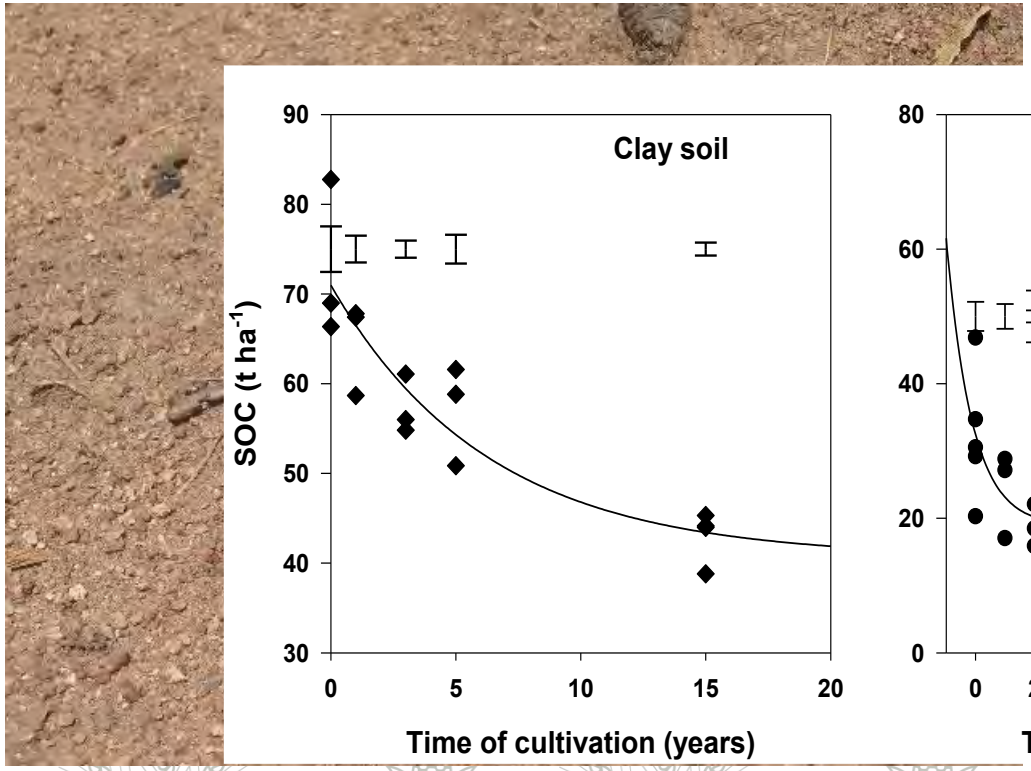
(world average = 4.92 t ha^{-1})

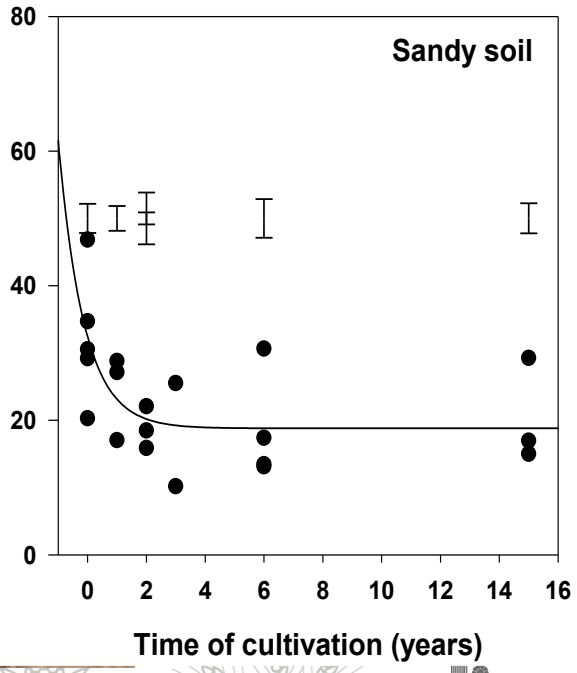
Data source: FAO, 2013

Soil fertility……..

- Predominantly sandy soils of poor soil fertility
  - Pockets of fertile red clays soils

Current crop production systems lead to accelerated loss of soil fertility





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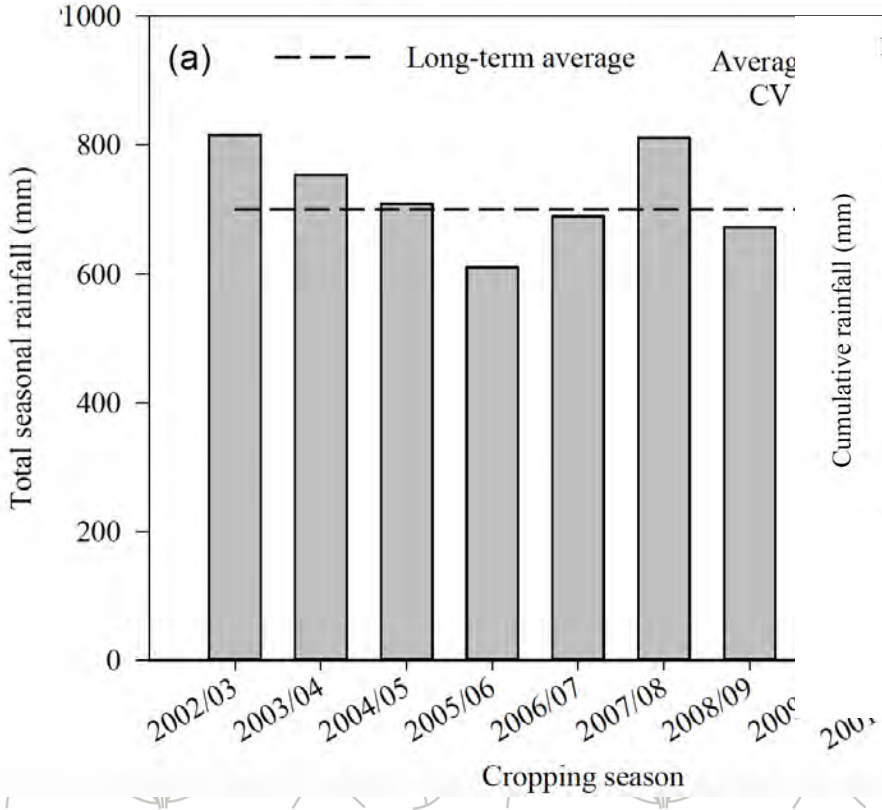
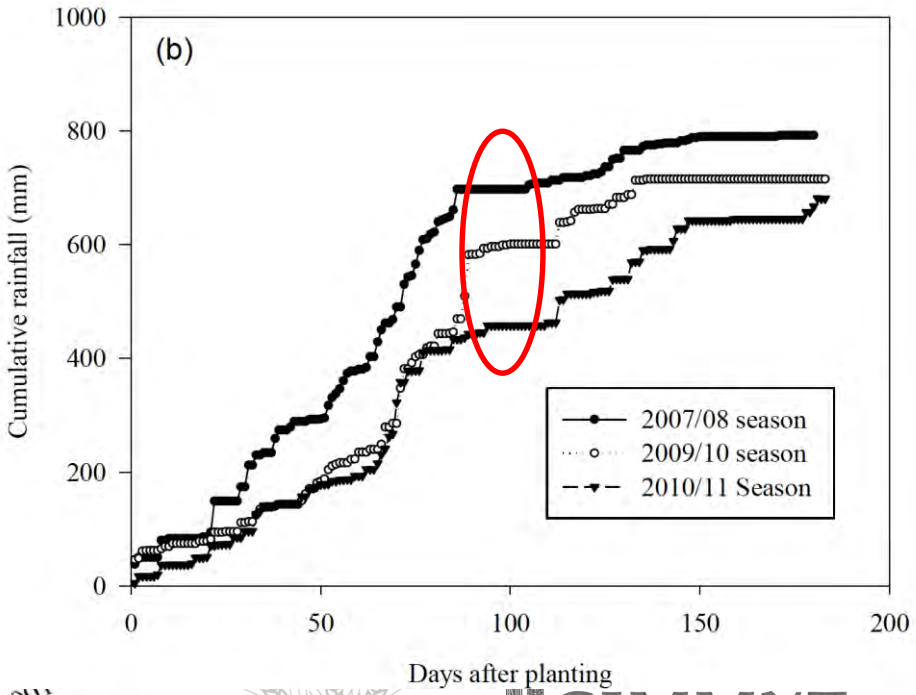
Poor rainfall distribution

- 90% of production occurs under rain-fed conditions
- Poor rainfall distribution with cropping seasons
- Severe mid-season dry spells





Rusinamhodzi *et al.* 2013

Farming systems of SAA

- **Maize based mixed crop-livestock systems are dominant**
  - **Crop residues are important for livestock feed**
  - **Manure is important for crop production**

Conflicts of resource use……

- **Degraded pastures intensify the conflicts for crop residue uses**
- **Limited options for alternative feeds**

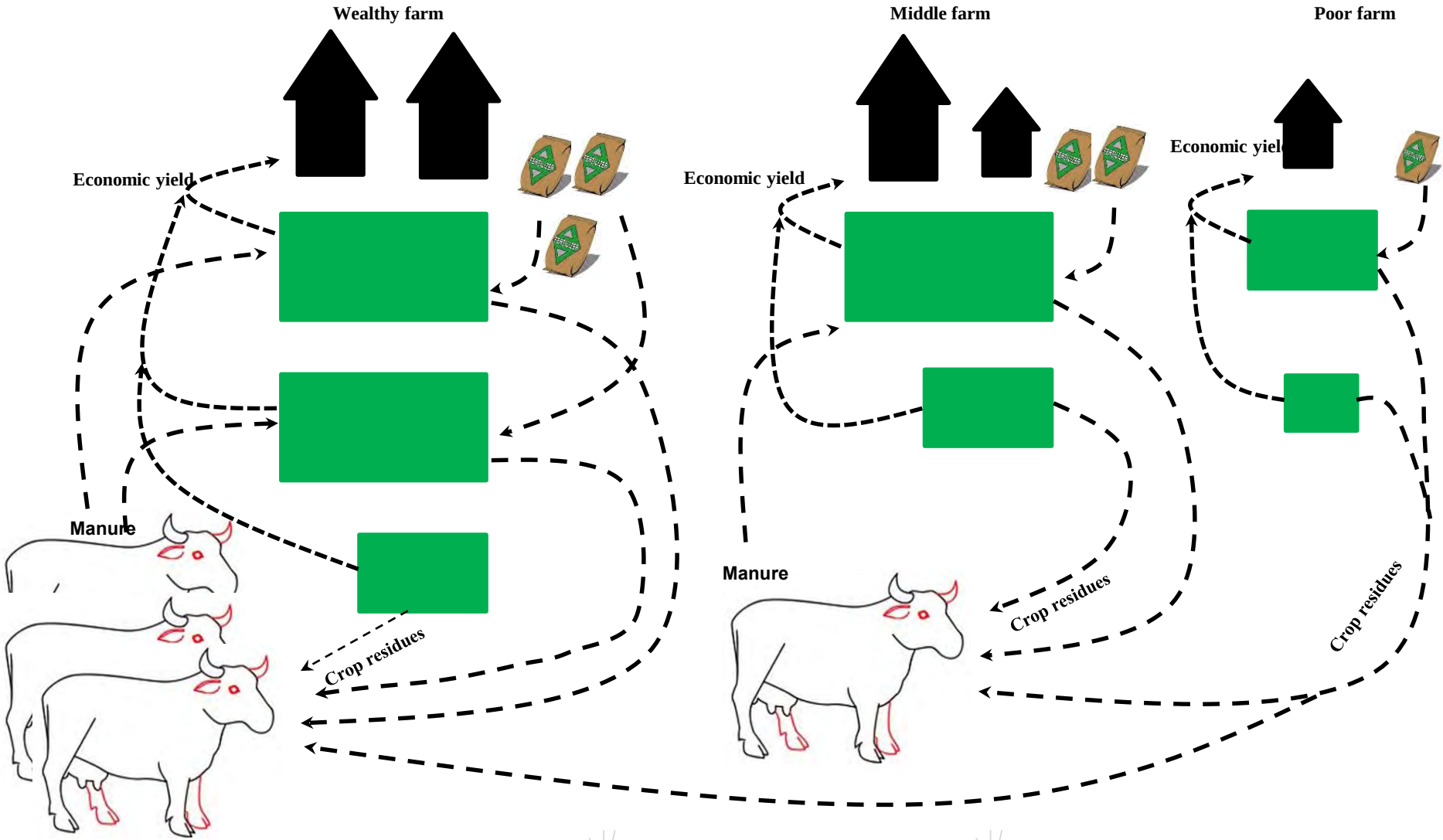
Other systems /conditions

- **Extensification systems (increase production by expanding area under crops)**
- Slash and burn
- Lack of inputs (manure, fertiliser, improved germplasm)

- **Extension support is severely indisposed**

Resource ownership - farm typologies

Farm diversity……..



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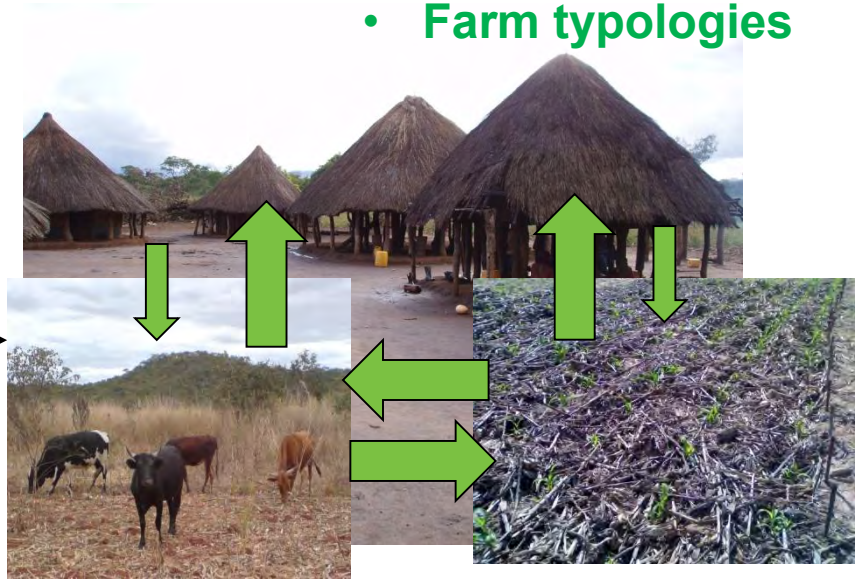
Where to target?

- Soil type
- Field type
- Rainfall (amount + distr)

- Farm level
- Farm typologies



Plot level

- Decision on what to grow and where
- Labour availability
- Cultural norms and community relations
- Access to markets (in and out)
- Goals and aspirations
- Investment decisions

Mind-set

- Conventional mouldboard plough
  - Baseline tillage system
  - Ploughing to a depth of 23 cm (ox-drawn)
  - Soon after harvest / just before sowing

Farm sizes are shrinking

Table 2
Land distribution among smallholder farms in selected African countries.

Country (year of survey)	(a) Sample size	(b) Mean farm size (ha)	(c) Farm size (hectares per capita)				
			Mean	Quartile			
				1	2	3	4
Kenya, 1997	1146	2.28	0.41	0.08	0.17	0.31	1.10
Kenya, 2010	1146	1.86	0.32	0.07	0.12	0.25	1.12
Ethiopia, 1996	2658	1.17	0.24	0.03	0.12	0.22	0.58
Rwanda, 1984	2018	1.20	0.28	0.07	0.15	0.26	0.62
Rwanda, 1990	1181	0.94	0.17	0.05	0.10	0.16	0.39
Rwanda, 2000	1584	0.71	0.16	0.02	0.06	0.13	0.43
Malawi. 1998	5657	0.99	0.22	0.08	0.15	0.25	0.60
Zambi, 2001	6618	2.76	0.56	0.12	0.26	0.48	1.36
Mozambique, 1996	385	2.10	0.48	0.1	0.23	0.4	1.16

Masters *et al*. (2013)

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In summary ….

- Given these constraints, where CA is **needed** is also where it is **most difficult to practice**
- A **multi-sectoral approach** is needed to overcome the challenges

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Previous approaches/ focus

- **The old strategy was to offer a basket of options – the so called best –bet strategy**

New focus

- In the last decade, new energy and renewed focus towards **Conservation Agriculture**

- **No-tillage**
- **Mulch cover**
- **Crop rotation**

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Good agronomic practices are part of CA

- Improved varieties
- Timely and correct weeding

- **Fertiliser application**
  - Combined chemical and organic fertiliser

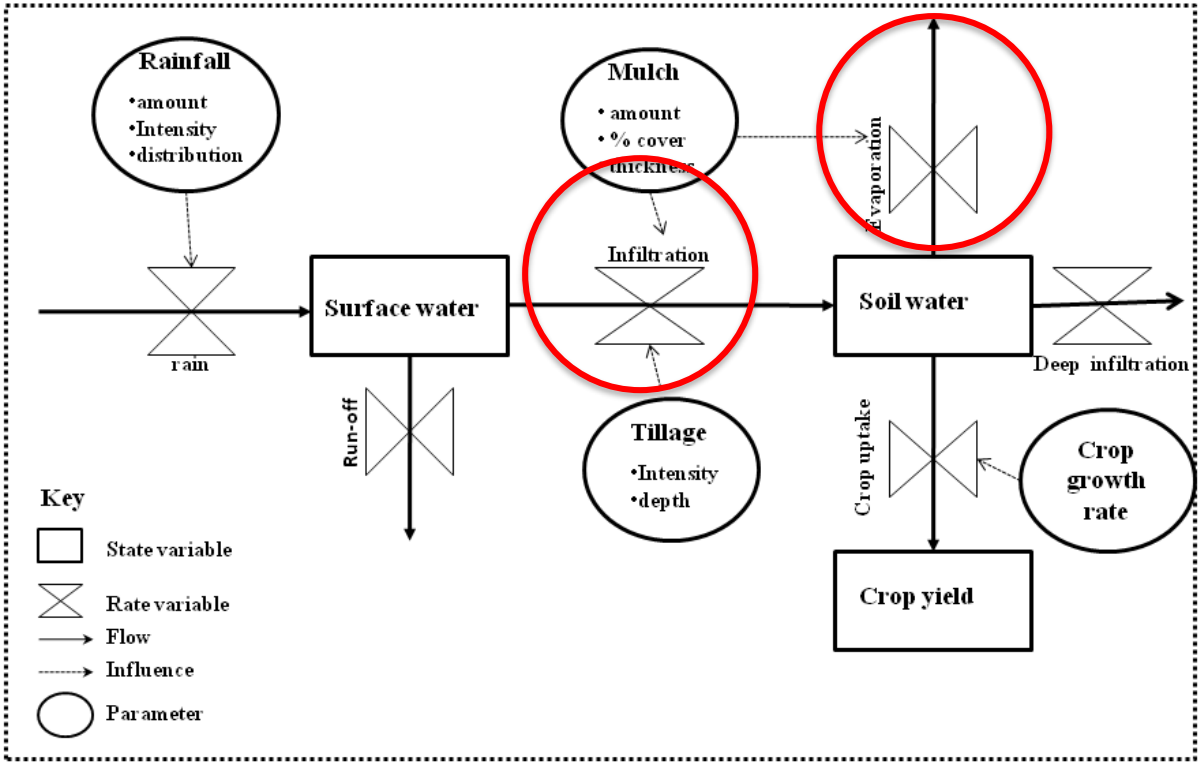
CA - climate smart agriculture?

- CA remains productive and profitable under variable weather circumstances, weather shock and projected climate conditions.

- High resource efficiency
  - Water
  - Nutrients

- CA reduces GHG emissions (CO_2) through CR retention and minimum tillage

Why Conservation agriculture?



Rusinamhodzi *et al.* (2011)

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Potential yield gains through combinations of technologies, ESA regional trials 2009-2014

	Maize grain yield (t ha^{-1})		Yield gain (%)
	Conventional agriculture	CA-Direct seeding	
Traditional variety no fertilizer	1.47	1.79	21
Traditional variety with fertilizer	2.50	2.95	18
Improved OPVs with fertilizer	3.42	4.01	17
Improved Hybrids with fertilizer	4.01	4.78	19

+225%

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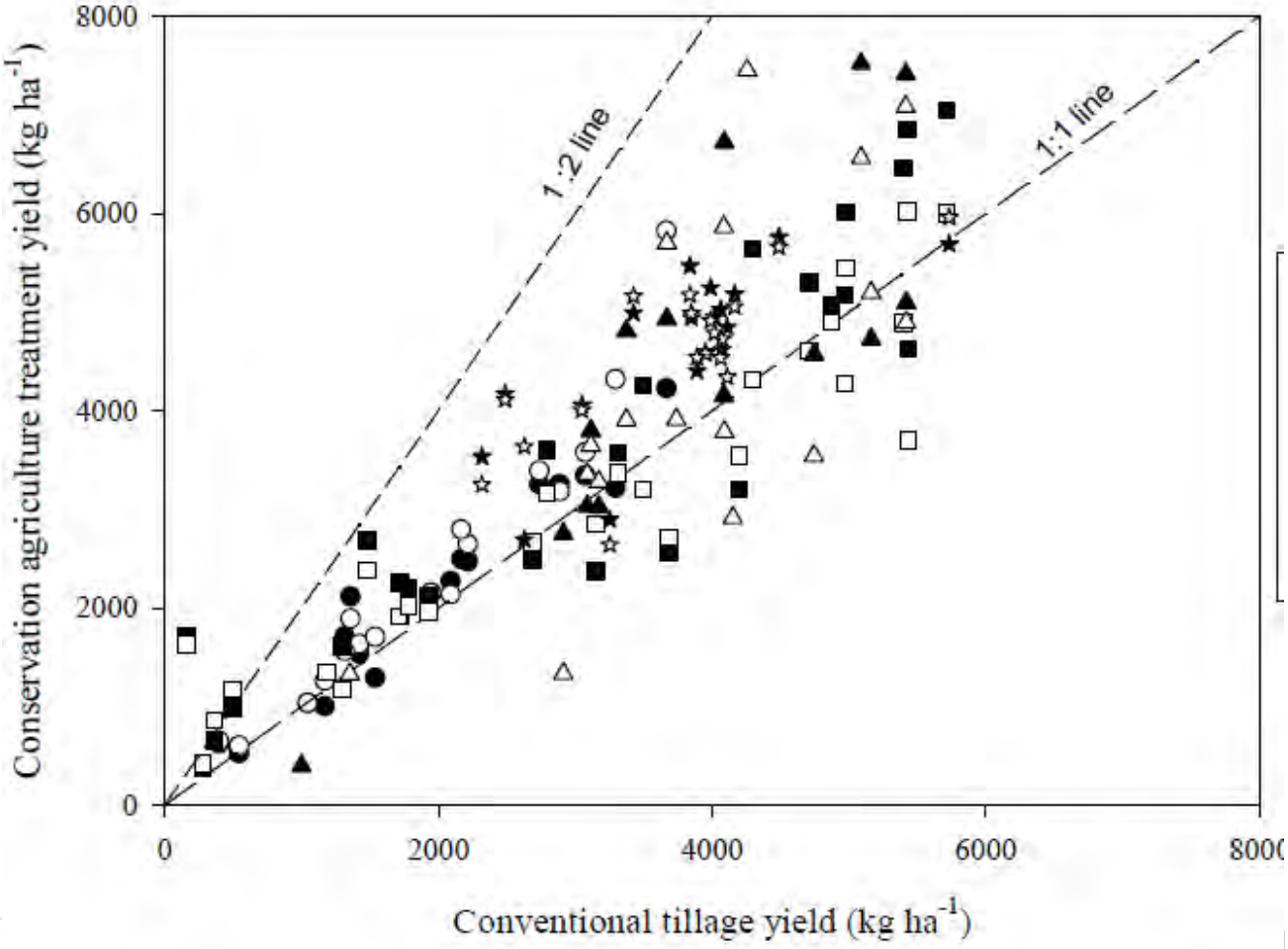
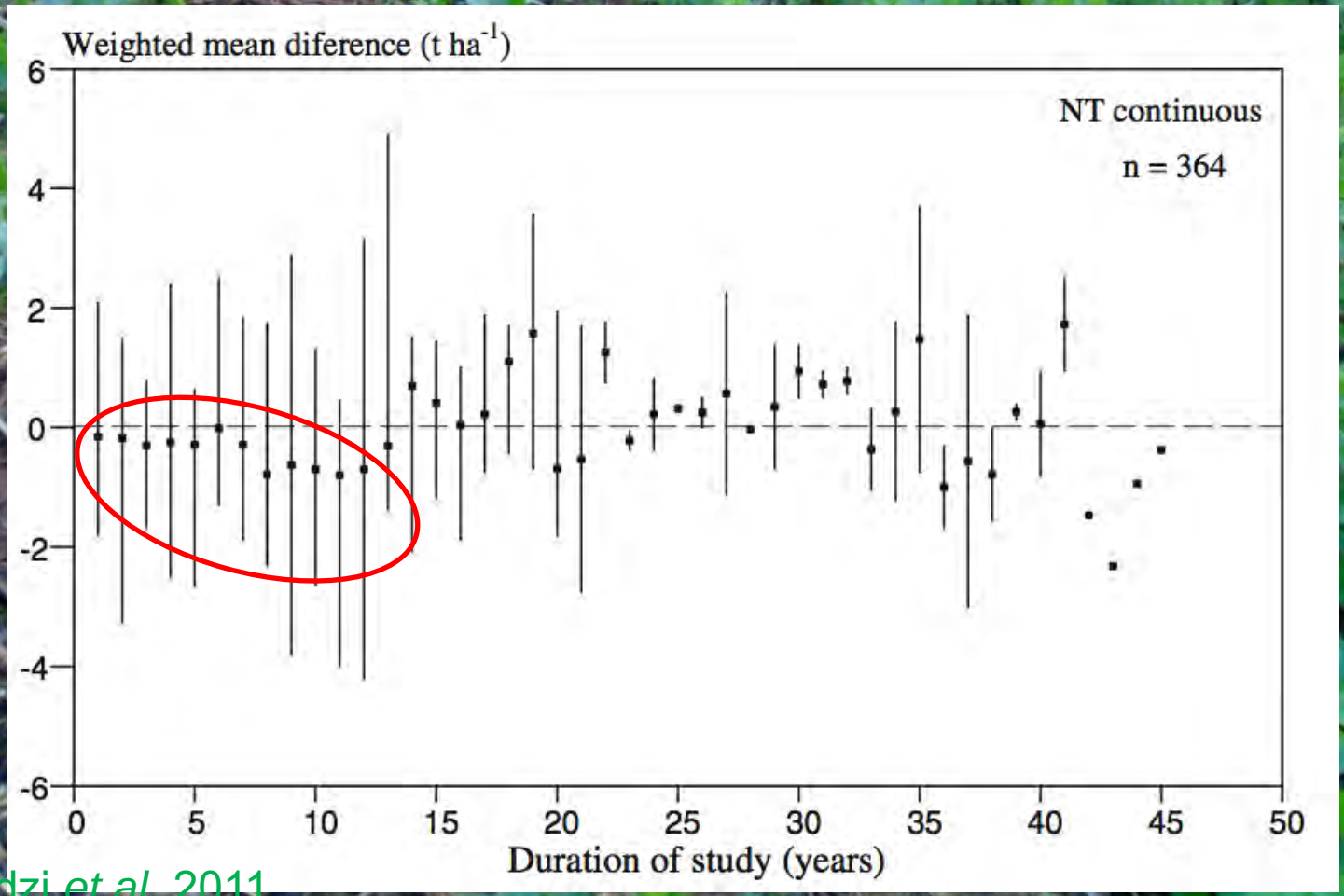
CA – yield benefits



Thierfelder and Rusinamhodzi 2014

Examples– what role for conservation agriculture?

- **CONTINUOUS MAIZE**
  - Early seasons lead to smaller yield
  - Overall, no yield advantage of CA

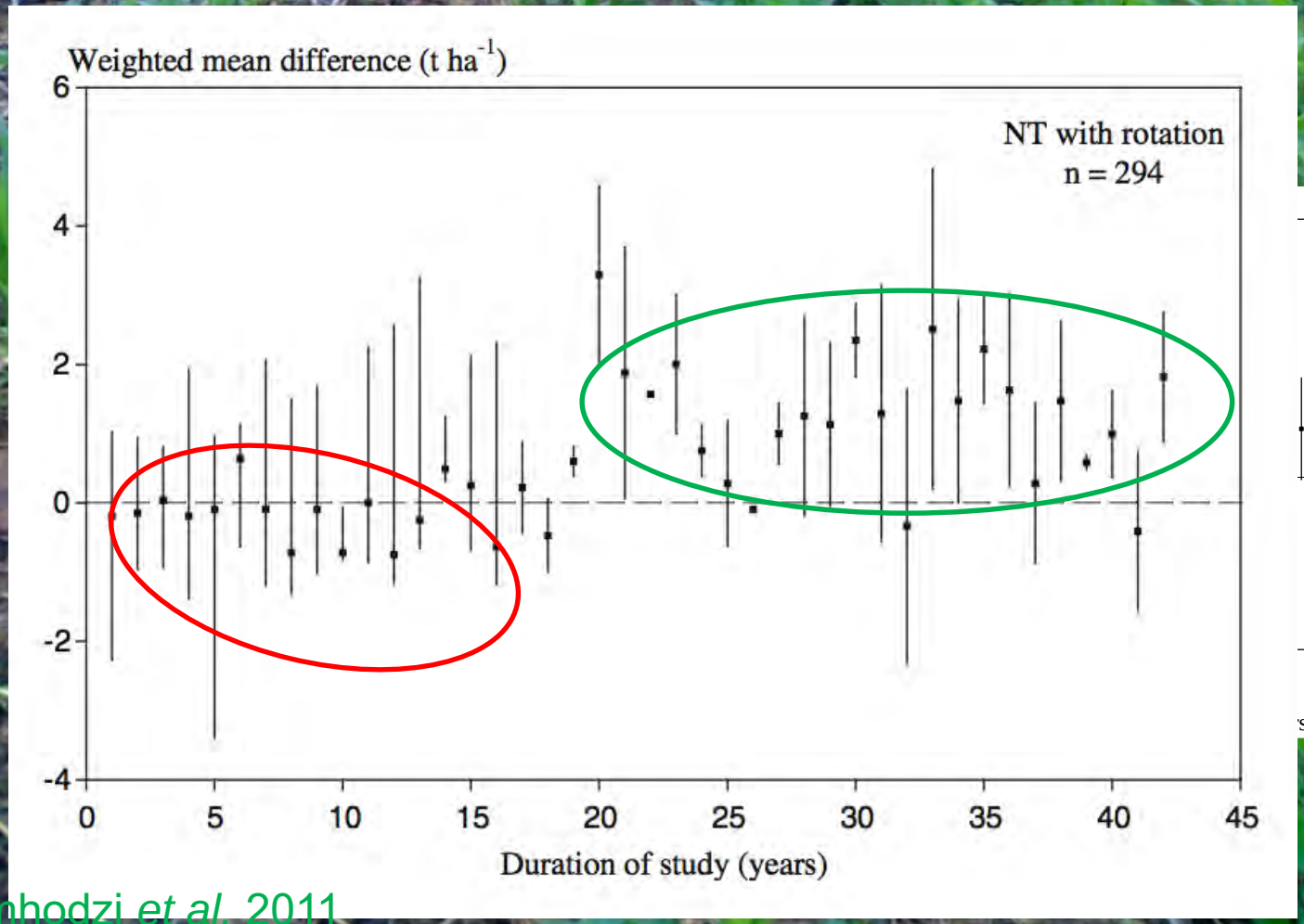


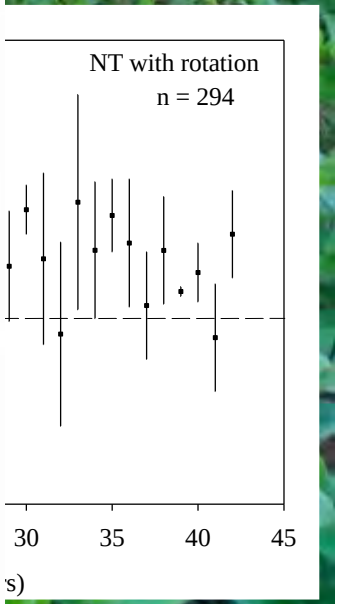
Rusinamhodzi *et al.* 2011

Examples– what role for conservation agriculture?

MAIZE-LEGUME ROTATION

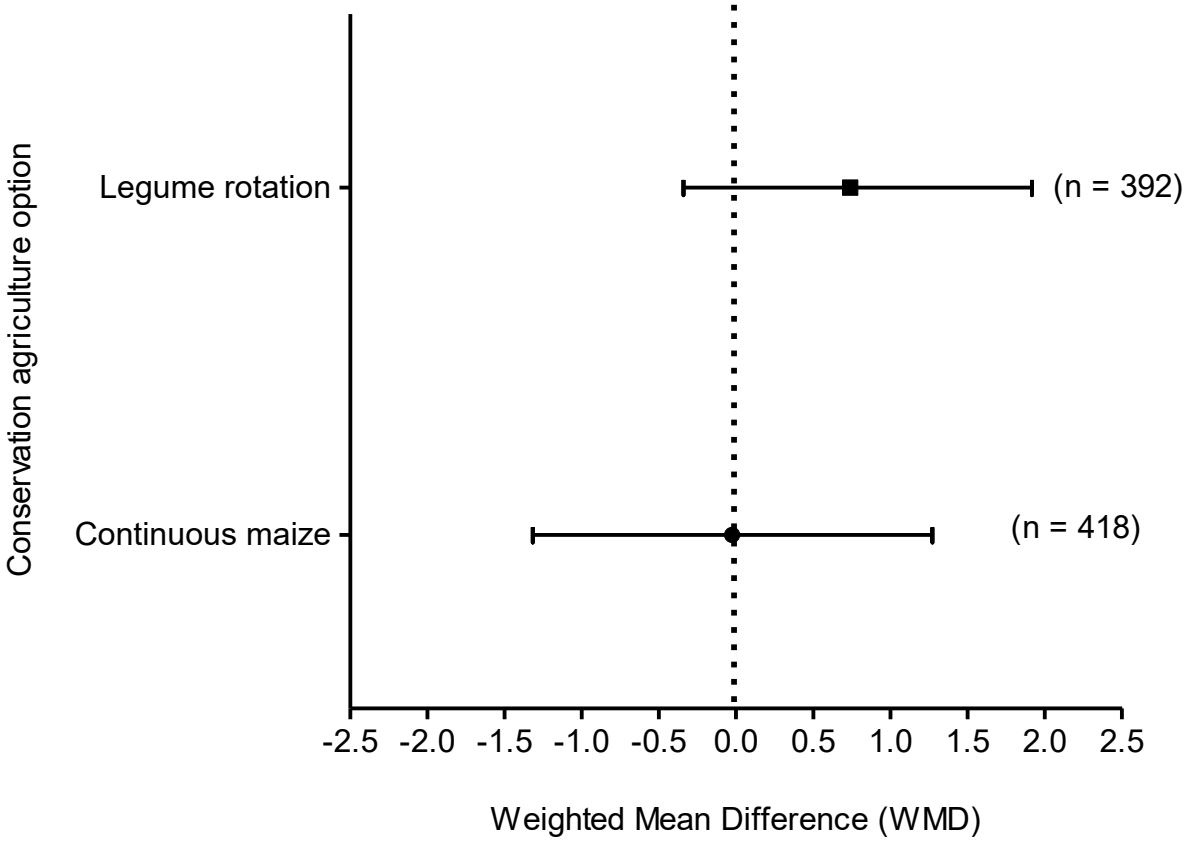
- **Yield advantage in the long-term**





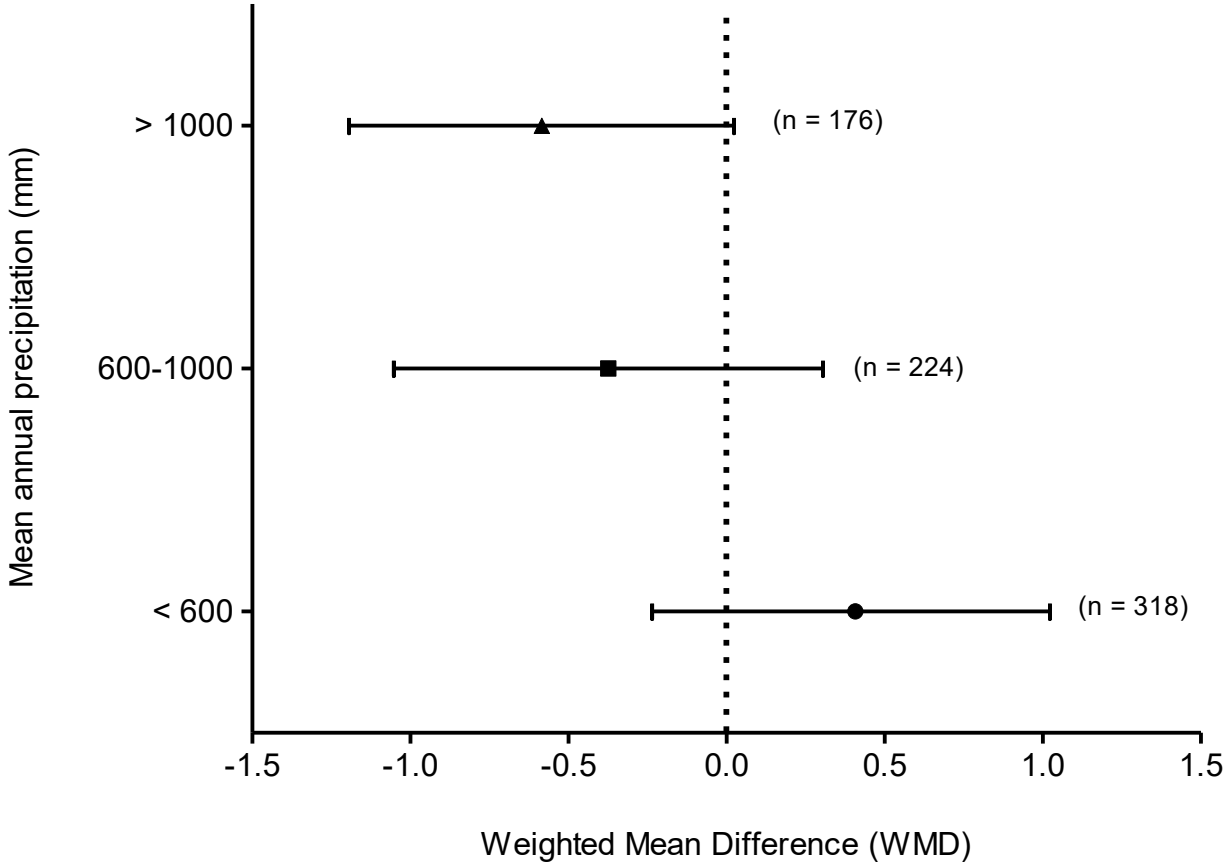
Rusinamhodzi *et al.* 2011

Importance of rotation in CA



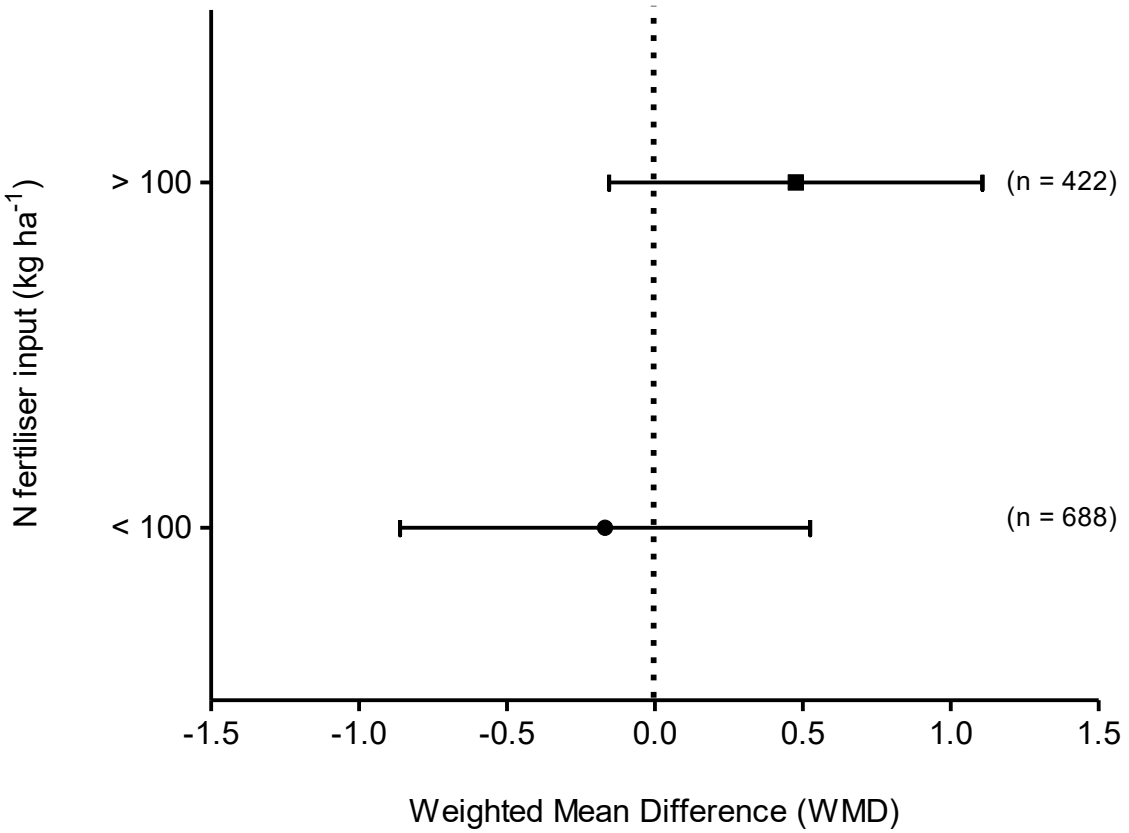
Rusinamhodzi 2015

Seasonal rainfall and CA



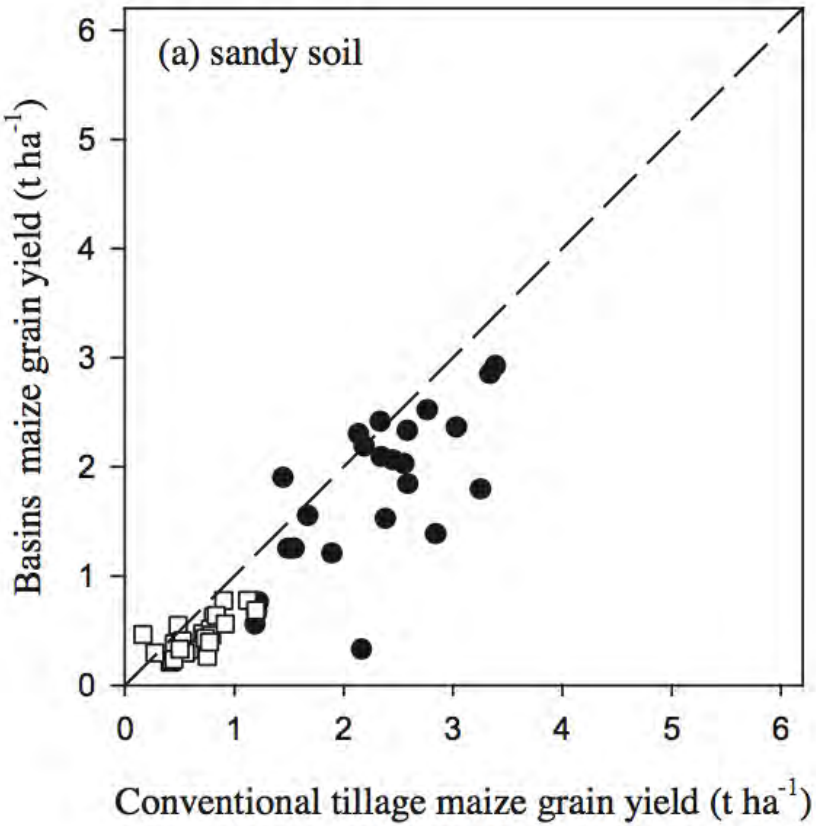
Rusinamhodzi 2015

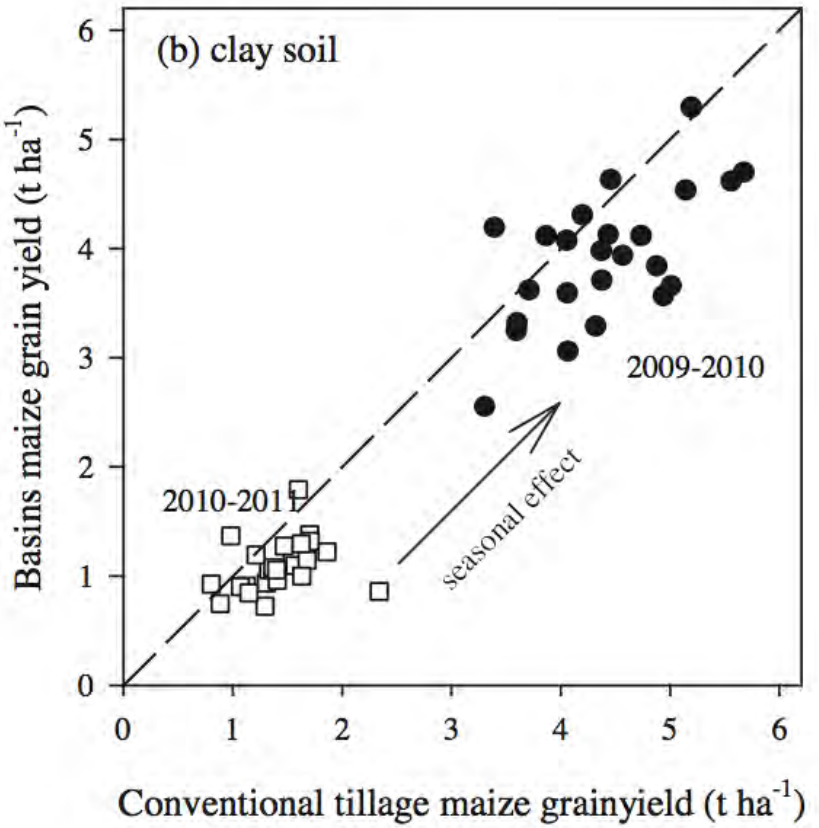
Management effects –N fertiliser



Rusinamhodzi 2015

Seasonal effect ✕ soil type





Rusinamhodzi *et al.* (2015)

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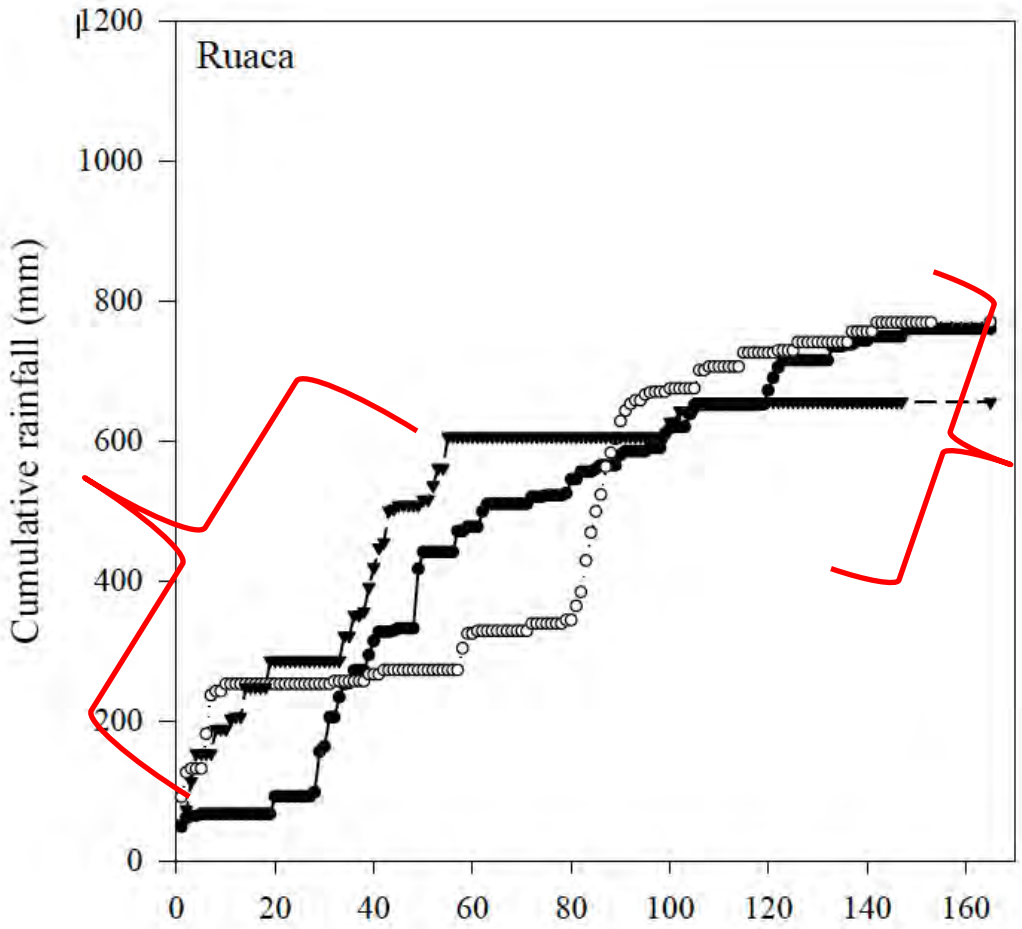
CA - legume intercropping

- **Relay intercropping reduces climatic risk of total crop failure**



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Ratoon pigeonpea in maize intercropping

- Productivity maintained
- Seed costs reduced across seasons
- No need for tillage

Rusinamhodzi *et al*. 2017

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Long-term large biomass production in combination with reduced tillage

- late maturity of pigeonpea delays free-grazing of cattle
- allows farmers to retain crop residues as mulch if they choose to

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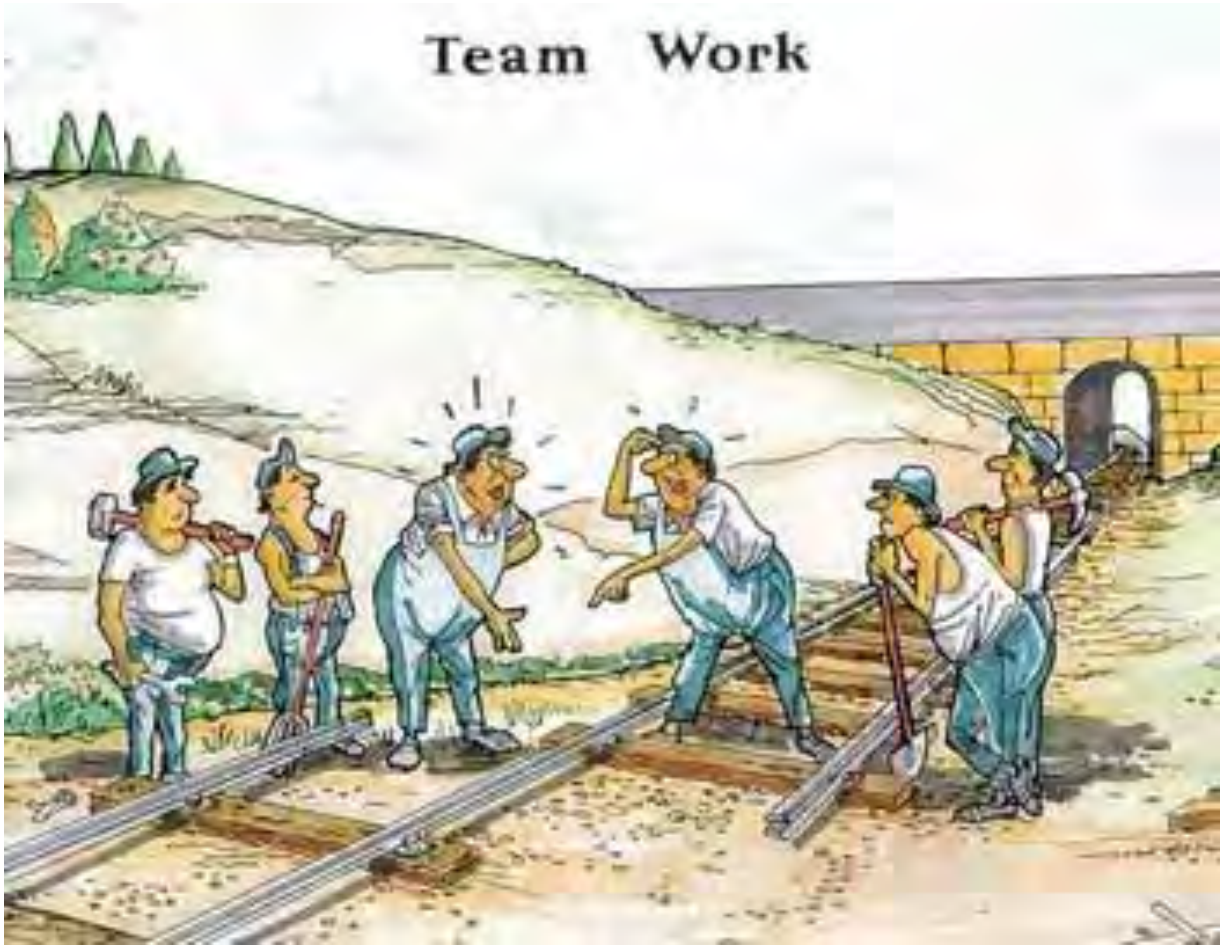
Expert experiences

- Dr. Christian Thierfelder – more than 10 years of working on CA

What is needed- how do we translate the potential benefits?



Need to Understand the needs, expectations and capabilities of resource-poor farmers.

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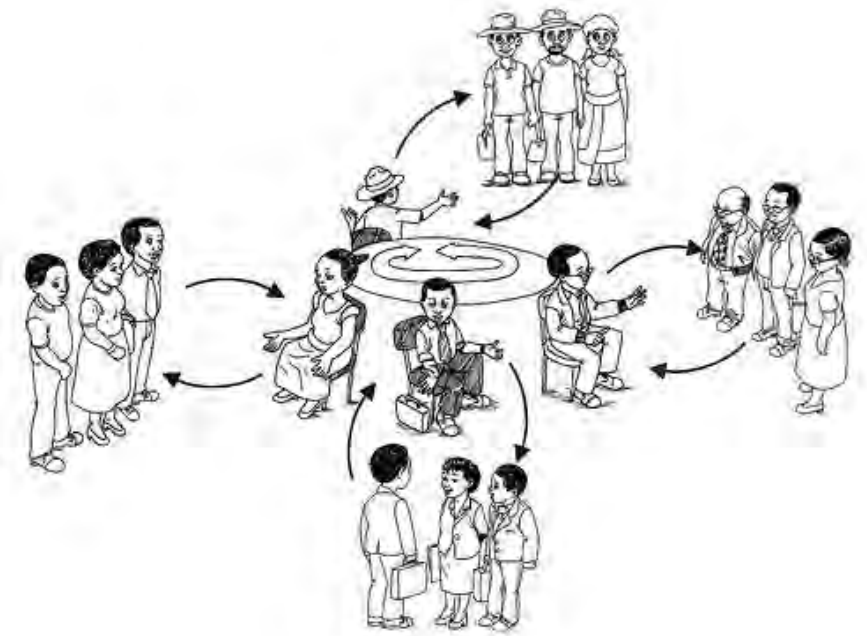
Innovation platforms (a space for learning and change)

- Future initiatives should provide different solutions to multi-stakeholders
- Bringing different actors farmers, traders, food processors, researchers, government officials etc. (**not based on *per diem***)
- diagnose challenges, identify opportunities and identify pathways to achieve their goals.
- They may design and implement activities as a platform, or coordinate activities by individual members.



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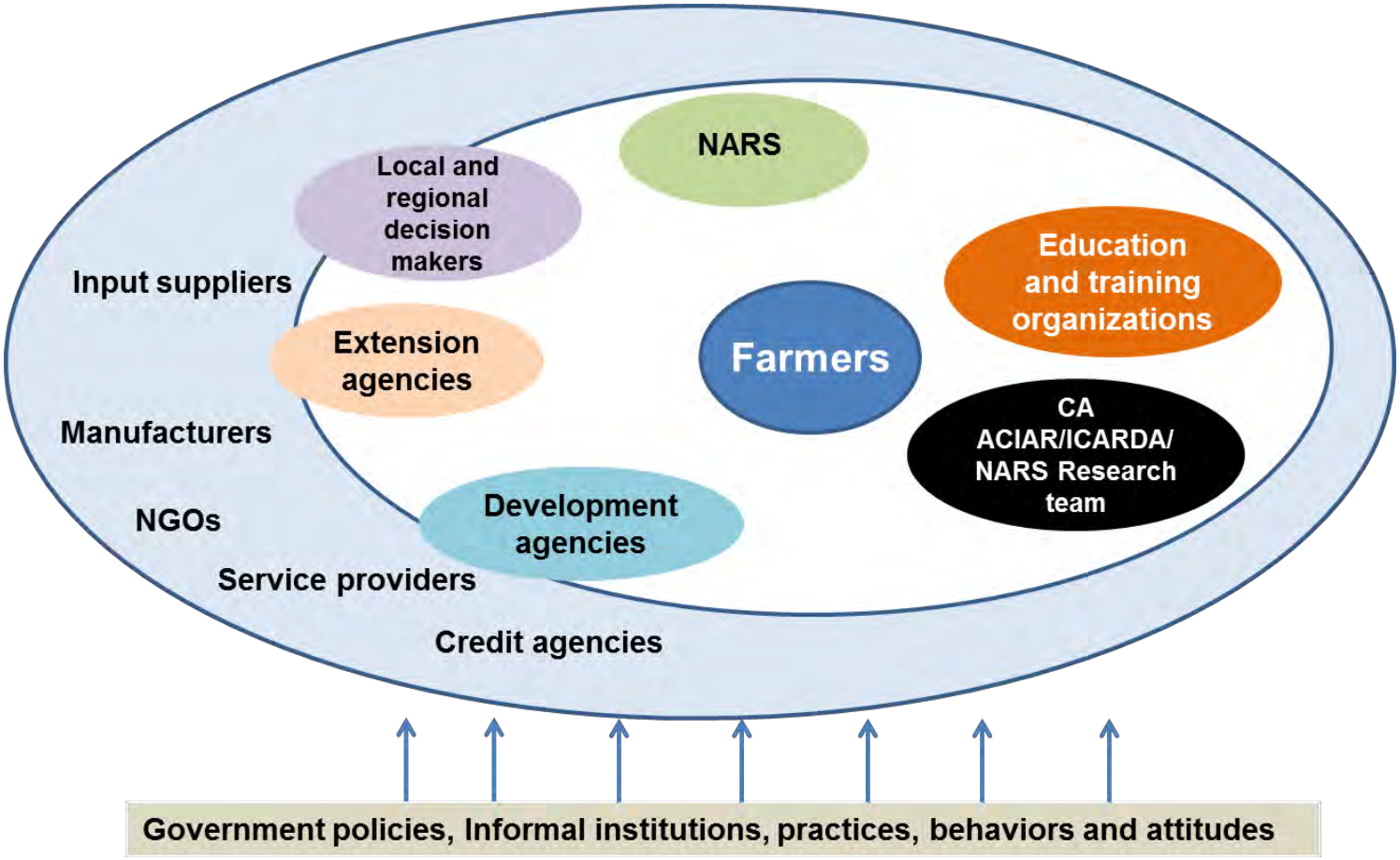
Conservation agriculture (CA) innovation system framework



Mourid (2013)

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Innovation Platforms

- Experiential learning
- Feedback mechanisms

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Approach - demonstrations

- Still important to provide evidence at all stages of the season


FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative
Promotion of
Drought-Tolerant **Maize Varieties** grown
under **Conservation Agriculture** and
Conventional Tillage
USAID
FROM THE AMERICAN PEOPLE
CIMMYT
International Maize and Wheat Improvement Center

Equipment needs –e.g Direct seeder

- Precise inputs and seed placement
- Need local manufacturers to adapt imported equipment to local conditions
- In Zimbabwe, partnered with Grownet a private company to modify the Brazilian equipment but demand by farmers remained low

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Equipment needs

Issues and challenges to the adoption of different forms of mechanization

Hand tools	DAP	Tractors
• labour availability • availability of manufacturers and suitable tools • socio-cultural traditions	• animal diseases • limited tradition of using DAP • security (likelihood of theft) Availability of: • suitable animals • animal husbandry skills • feed/pasture • veterinary services • implements and spare parts • artisans/blacksmiths • extension services for training • timber for yokes • harness makers • financial services • socio-cultural traditions	Availability of: • appropriate tractors, machines and implements • repair and maintenance services, spare parts • trained operators • supplies of fuel, lubricants etc. • implements for weeding and harvesting • financial services Other factors include: • suitable plot sizes • reasonable access to fields • shape of fields • reasonable distances between fields

*DAP is draught animal power

Sims and Kienze (2006)

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Weed control - herbicides

- Early years associated with high weed pressure which leads to high labour and or herbicide use
- Herbicides often not available at local level
- If available, often expensive for most farmers
- Their continued use not encouraged under sustainable agriculture
- **Preventing seed setting in weeds is a viable strategy to reduce weed pressure in the long term**

Adequate soil mulch needed

- 3 t ha^{-1} often considered the minimum requirement
- land size, cattle ownership and labor availability largely define the fate of crop residues
- Farmers prioritize the sustenance of livestock over soil cover
- Alternative livestock feed is needed or cover maybe be provided through intercropping

- Research is still needed to find solutions!

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Government policies

- The government policies around CA are still fragmented.
- overarching factor seems to be the level of activity of the NGO community, which has played an advocacy role as well as strategic lobbying for external funding for the technology.
- Zambia Ministry of Agriculture in 1998 formally embraced conservation farming as an official government policy
- A lot of work is needed to convince and assist governments to craft policies in support of CA

Better targeting and flexibility

- Success will largely depend on adapting CA to the different systems and scales
  - recognising the constraints,
  - strengths and opportunities of farmers

- Targeting is needed for
  - Ecological zones
  - Farm types – socio-economic status
  - Production orientation of farmers

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Proper targeting of CA means….

- **No-till option**
  - Jab planter?
  - Direct seeder?
  - Hand-hoe?
  - Ripper?
  - Dibble stick?
- **Rotation sequence?**
  - Which legumes

- **Mulch cover**
  - Which type?
  - how much?
- **Fertiliser application**
  - Source?
  - type?
  - rate?
  - Timing?

4Rs

- Crop varieties?
- Other management considerations?

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Conclusions

- The potential benefits of CA are apparent, but how to transform such to farm-level benefits given the different socio-economic and biophysical conditions of the African landscape remains a challenge.

- However, through innovation - many of the challenges can be transformed into opportunities for the successful transformation of smallholder agriculture through CA.
-
- The future requires combined efforts (using multiple disciplines) to upscale and out-scale the many success stories of CA implementation by increasing farmers' decision space, and linking them to key service providers at low cost.

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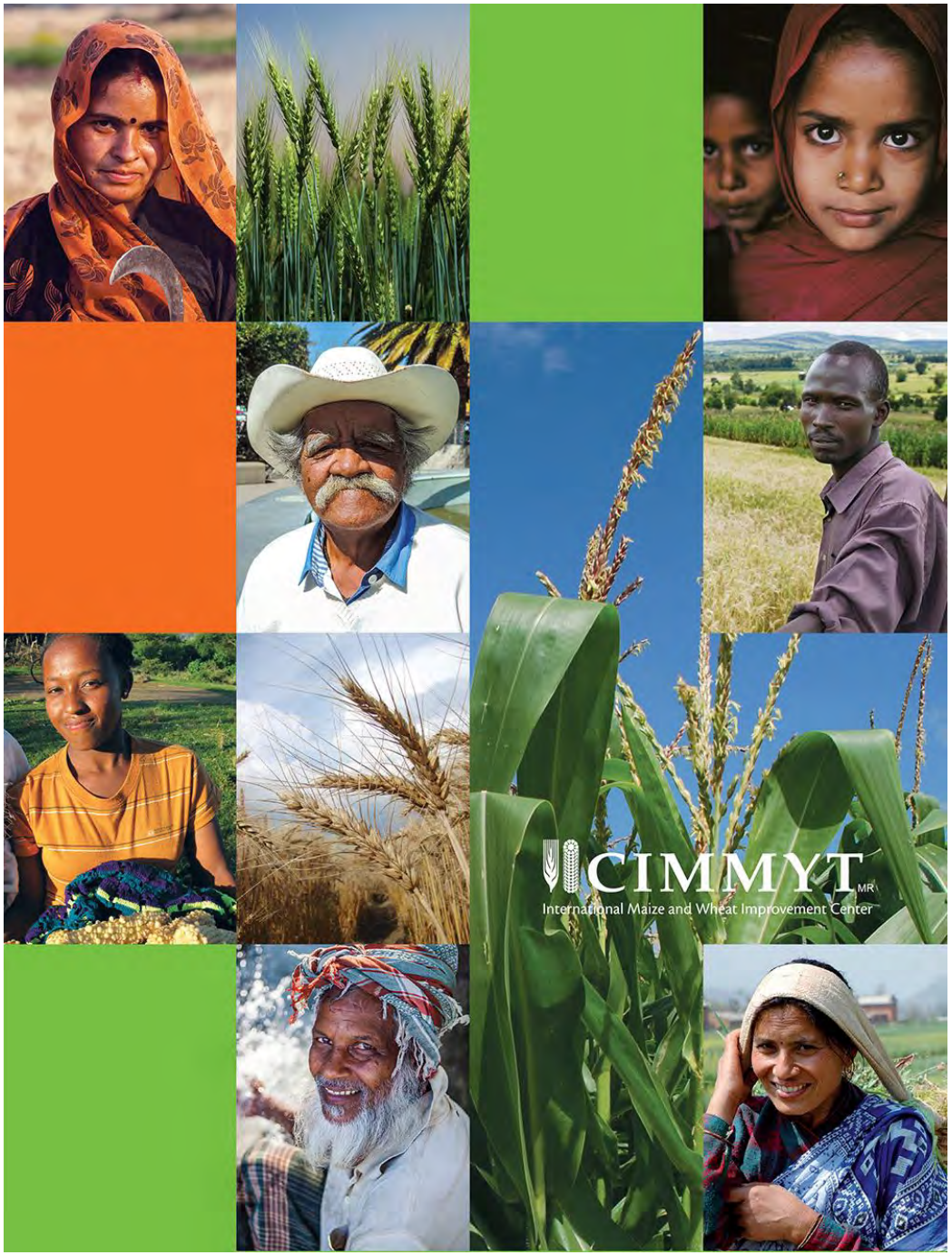

Thank you for your interest!