Transforming Maize-legume Value Chains –

A Business Case for Climate-Smart Agriculture in Southern Africa

By Christian Thierfelder, Geofrey Siulemba, Moses Mwale and colleagues from Malawi and Zimbabwe
Projected change in Agriculture Productivity, 2080

Projected changes in agricultural productivity 2080 due to climate change, incorporating the effects of carbon fertilization

Source: Hugo Ahlenius, UNEP/GRID-Arendal.
Traditional African smallholder farming systems

- Based on tillage (manual/animal traction)
- Residue removal
- Monocropping of maize
- Limited fertilizer use
- Based on traditional varieties
- Affected by variable climate
- Inherently poor soil fertility
The Challenges

Business as usual will not work

1. Increase in Temperatures by 2.1–2.7°C: UNFCC projections for Africa [ref: Girvetz et al., 2016]
2. 2 droughts every 5 years
3. Reduction in maize yield by 10% to 30% by 2030
4. and... 80% by 2050

Ref: UNEP/GRIDARENAL 2016
Landscapes with multiple CSA options

- Agroforestry
- Nutrition security
- Poverty alleviation
- Natural resource management
- Improved cook-stove
- Reduced degradation & erosion
- Conservation agriculture
- Increased yields
- Soil quality & carbon
- Dietary diversity
- Market access
- Increase income
- Participatory approach
- Intercropping
- Market access
- Increase income
- Dietary diversity
Out scaling climate-smart technologies to smallholder farmers in Malawi, Zambia & Zimbabwe

Adaptation to Climate Change for Smallholder Rural Areas (ACCRA) Project funded by GIZ/CCARDESA

- Undertake a climate change Vulnerability Assessment
- Piloting CSA technologies on-farm
- Prioritization of CSA technologies
- Feasibility study
- Development of out-scaling Proposals for CSA scaling
Vulnerability assessment - process

- Rural assessment
- Identification of climate hazards
- Definition of adaptation practices (Proactive/Reactive) to impacts
- Assessment of risks/impacts of climate hazards

Vulnerability status of communities
Piloting in CSA in on-farm communities of Southern Africa

19 farming communities in Zambia, Zimbabwe and Malawi

- 500mm to 1,800mm
- Low, mid and high altitude
- Sandy to clay soils
- Farming systems

across different agroecologies and farming systems

5 research stations
Cluster villages and "Mother and Baby" trials

Village of 100-200 households
Good extension officer
Vibrant and interested farmers
Accessible site

Distance 2-3 km

Cluster villages and "Mother and Baby" trials

Baby trials

Mother trials

Village of 100-200 households
Good extension officer
Vibrant and interested farmers
Accessible site

Distance 2-3 km
Maize-legume rotation under CA with Pigeonpea Alley Cropping
Prioritization of CSA technologies

Process:

- Local meetings with key stakeholder in target communities
- Regional meeting in Lusaka using the GIZ tool
- Ranking based on a ranking matrix

<table>
<thead>
<tr>
<th>Southern MAL Adaptation option</th>
<th>Effectiveness</th>
<th>Cost</th>
<th>Feasibility for Farmers</th>
<th>Political/social acceptance</th>
<th>Relative speed to benefit</th>
<th>No regret potential</th>
<th>Alignement to donor support</th>
<th>Alignement with Policy</th>
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A Feasibility Study on Climate-Smart Agriculture Systems

For an investment proposal we needed data on:

➢ Agronomic performance
➢ Economic viability
➢ Environmental impact
➢ Social impact (gender)
Conservation agriculture: A climate-smart agriculture system:

- Minimal soil movement
- Surface crop residue retention
- Diversification through crop rotations, intercropping and green manures
Maize-soybean rotation

Groundnuts under CA

Cowpeas under CA

Maize-groundnut rotation

Maize under CA

Maize-Gliricidia intercropping
Why focus on Conservation Agriculture?

➢ Combines all positive technologies prioritized above

➢ CA can help to adapt production to climate variability and change ....!

➢ CA is more water-, nutrient-, and energy-use-efficient

➢ CA improves the productivity of current farming systems

➢ Availability of long-term data to do the study
Productivity benefits – On-farm pilots in Malawi, 2019

Maize Grain yield (kg ha\(^{-1}\))

![Bar chart showing productivity benefits in Central and Southern Malawi with different tillage methods and legume rotations.](image-url)
Climate-smart agriculture in action!
Women empowerment!
Productivity benefits – long-term

Central Malawi (manual)
South Malawi (manual)
Eastern Zambia (manual)
Eastern Zambia (animal traction)
Southern Zimbabwe (animal traction)
Southern Zambia (animal traction)

Maize grain yield (kg ha\(^{-1}\))
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
Regional yield response to CA in southern Africa from 2005-2016

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Conventional tillage yield (kg ha$^{-1}$)

0 2000 4000 6000 8000 10000

Conservation agriculture treatment yield (kg ha$^{-1}$)

0 2000 4000 6000 8000 10000

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Planting basins, Mozambique

Ripline seeding, Zambia

Manual direct seeding, Mozambique

Direct seeding, Zambia

Manual direct seeding, intercrop., Malawi

Ripline seeding, Zimbabwe

Direct seeding, Zimbabwe

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Thierfelder et al. 2015a

Net benefits (in USD)

- Dibble stick-Maize -Cowpea rot
- Dibble stick-Maize/Cowpea intercrop
- Dibble stick Maize continuous
- Ridge & furrow Maize continuous

Mutenje et al. 2016
Labour reduction – a key benefit!

Thierfelder et al. 2015b
Environmental benefits – improved Water Infiltration

**Infiltration (mm h$^{-1}$)**

- **Conventional ploughing (CP)**
- **Rip-line seeded (RI)**
- **Direct seeding (DS)**
- **Rip-line seeded + leg intercrop (RI+ leg)**
- **Basin planting (BA)**

**Environmental benefits**

- Improved Water Infiltration
Environmental benefits – increased Soil Moisture
Environmental benefit – reduced Soil Erosion
Environmental benefit – gradual increase in soil carbon

- Conventional ploughing, maize
- CA- direct seeding, maize
- CA- direct seeding, cotton-maize

Year
2004 2005 2006 2007 2008 2009 2010 2011
Total carbon (Mg ha\(^{-1}\))
Planted same day, same fertilizer level, same variety – but different cropping system
Farmers practicing CA with TLC in Malawi – initiated with CIMMYT in 2005 but supported by many funders!

Source: Bunderson TLC, 2016
CA Adoption in Zambia and Malawi—with an increasing trend....!

<table>
<thead>
<tr>
<th>Country</th>
<th>Area under CA (ha) 2013</th>
<th>Area under CA (ha) 2018</th>
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</thead>
<tbody>
<tr>
<td>Malawi</td>
<td>65,000</td>
<td>210,000</td>
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<tr>
<td>Zambia</td>
<td>200,000</td>
<td>316,000</td>
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</table>

Source: Kassam et al. 2015; 2018
Some pertinent challenges ...

➢ Residues: How can we feed both livestock and crops?
➢ Weeds and their control – a major challenge if no herbicides are used
➢ Lack of fertilizer use – what are the alternatives?
➢ Limited crop diversification – too much focus on maize
➢ Lack of evidence and data taking – believe in myths
➢ **Targeting** the wrong systems to the wrong farmers

➢ Donor driven **adoption** - one-size fits-all approaches

➢ Low adoption – lack of **understanding** of underlying issues

➢ Ignoring farmers rationale and **decision making**

➢ The need for new **knowledge and co-development** of technologies
Scaling is more than the technology
Project results have been summarized in 4 project reports in contemporary design – This is our Business Case!
Several regional and country proposals have been developed for southern Africa

- **Work package 1**: Scaling out climate-smart agriculture with smallholders in a community-based approach
- **Work Package 2**: Incentivising the supply side to invest into climate-smart agriculture
- **Work Package 3**: Knowledge generation and dissemination
- **Work Package 4**: Creating an enabling policy environment
YES we CAN!

Participatory vulnerability assessment: what are the risks, exposure/sensitivity and existing coping mechanisms?

Prioritization: Identification of feasible CSA best-bet options to scale for better adaptation
- Stakeholder meetings (3) to select 2 best-bet CSA options to compare with conventional system in term of productivity, adaptation and mitigation potential.
- Regional decision-maker workshop in Zambia, 2018 with NARS research and extension directors; and other stakeholders using GIZ Climate proofing tool per agroecological zone

Long-term on-farm and station trials to understand benefits and trade-offs of CSA technologies/practices in variable climate (productivity, income, social, environment)

Quantity Soil Carbon?
- Pilot study to test adaptability of new CSA system (doubled legume rotation) & CSA mitigation potential