Christian Thierfelder is a Principal Cropping Systems Agronomist and Strategic Leader at the International Maize and Wheat Improvement Centre (CIMMYT). He studied soil science at the Christian-Albrechts-University of Kiel, Germany and did his PhD with the International Centre for Tropical Agriculture (CIAT) on soil conservation in Colombia. Christian specializes in Conservation Agriculture (CA) systems research. Since 2004, he has implemented on-farm and on-station CA-related projects in Malawi, Mozambique, Zambia, Zimbabwe and Namibia to adapt CA to the needs and environments of smallholder farmers. Christian writes "I was fortunate to begin my career in southern Africa in the early 2000s when the first push for conservation agriculture started. Our initial intentions were to reverse soil and land degradation and increase productivity and profitability of the traditional tillage-based farming systems while maintaining ecosystem services. Increasingly, we have also experienced unprecedented drought and flood years in Zambia, Malawi and Zimbabwe which has shifted our focus towards adaptation to extreme weather events and an increasingly variable climate."

CIMMYT
International Maize and Wheat Improvement Center

CEPHaS 6

Conservation Agriculture Perspectives

1. What are the main ways in which you have seen smallholder farmers adapting to climate change in southern and central Africa in recent years?

Many smallholders face delayed onset of the cropping season, more erratic and unpredictable rainfall, in-season dry-spells and droughts, and early tailing-off of the rains. In contrast, in years of abundant rainfall farmers must contend with floods, weed pressure and nutrient loss through leaching. Farmers have adapted to *droughts* by applying CA principles, and integrating complementary practices, in summary:

- Early planting and timely operations with the first effective rains
- Use of direct seeding and no-tillage
- Diversifying cereals-based cropping systems with legumes, including trees
- Retention of crop residues as surface mulch
- Selection of drought-resilient cultivars (e.g. drought-tolerant maize) and crops (e.g. cowpeas and millet)
- Timely weeding
- Targeted fertilizer and manure application

In years of *heavy rainfall* farmers resort to the following strategies:

- Timely planting with the first effective rains so crops are maturing before waterlogging occurs
- Construct ditches to drain excess water
- Target fertilizer application, including split-application to reduce leaching
- Grow late-season crops such as cowpeas on residual moisture

2. In what sets of circumstances (biophysical, socio-economic etc) are conservation agriculture practices most likely to be beneficial to rural communities, and in what circumstances are they least likely to be useful?

On-farm trials across southern Africa have shown that conservation agriculture systems perform better than conventional tillage practice under dry and hot climates, particularly on lighter soils (sands and sandy loams), with rainfall in the range 500–1600 mm, and at altitudes from sea level to 3000 m.a.s.l. In these conditions typical cropping systems are maize- and sorghum-based with different legumes such as beans and cowpeas. Dense very sandy soils which tend to waterlog are challenging for CA. In cool climates and where pest and disease pressure are high, CA systems tend to be outperformed by conventional practices. On very fertile soils the advantages of CA are reduced.

Other important factors are access to improved inputs (mineral fertilizer, herbicides and machinery) and to markets for crops. Baudron et al. (2015)[1] showed that CA systems are most advantageous in Africa where labour and farm power is limiting, where crops face moisture stress, and where degraded soils are susceptible to erosion.

3. What components of conservation agriculture systems are most problematic from the perspective of farmers?

Biophysical challenges:

- Where crops and livestock are closely integrated there is demand for crop residues as feed rather than mulch
- Improved weed control, maybe with herbicides, may be needed in the first years of conversion
- Lack of access to land means that farmers prioritize cereal production (to achieve food security) over rotational crops, which would generate more income and are more nutritious
- Some pests and diseases carry-over on crop residues or are encouraged by them (e.g. termites)

Socio-economic challenges:

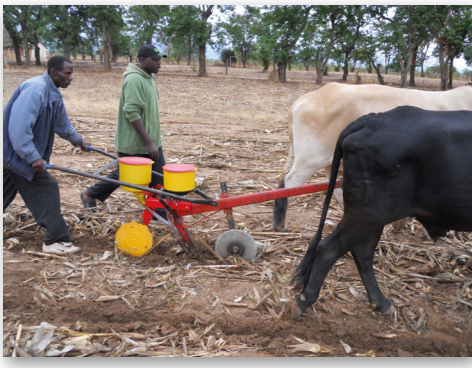
- Farmers may lack the knowledge and resources to invest in improved inputs and machinery, which may not be widely available
- Dysfunctional markets for legume crops discourage further diversification
- Uptake of CA systems at scale requires integrated extension with clearer messages
- Cultural factors and traditions may inhibit change from current tillage practices
- Better targeting of CA systems to environment and farmer conditions is needed

4. What are the main research questions that need to be addressed to support food security in sub-Saharan Africa under climate change?

Adaptation of CA systems to regional contexts under a changing climate entails fine-tuning of current cropping systems to the 'new normal'. This requires research on:

- Diversification strategies to increase the output per unit land area without affecting the environment
- Improved intercropping (double cropping, strip cropping, relay cropping) and more sophisticated rotations
- Mechanization to increase the efficiency of planting and reduce drudgery
- Farmer decision-making and overcome challenges of adoption
- Improved weed control strategies to reduce reliance on herbicides
- Crop/livestock interaction and how to turn trade-offs into synergies
- Water- and Nutrient-Use-Efficiency to optimize CA systems to contexts
- Better targeting of CA systems to specific farm typologies and environments

Crop residues, used as a mulch, help soil to retain water.



Mechanising direct seeding with animal power.

Termites may be encouraged by retention of crop residues.

1 Where to Target Conservation Agriculture for African Smallholders? How to Overcome Challenges Associated with its Implementation? Experience from Eastern and Southern Africa. Environments 2015, 2, 338–357.

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