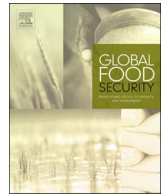


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Global learnings to inform the local adaptation of conservation agriculture in Eastern and Southern Africa

Brendan Brown^{a,b,*}, Rick Llewellyn^b, Ian Nuberg^a

^a School of Agriculture, Food and Wine, the University of Adelaide, Australia, Private Mail Bag 1, Glen Osmond, South Australia 5064, Australia

^b CSIRO Agriculture and Food, Adelaide, Australia, Private Mail Bag 2, Glen Osmond, South Australia 5064, Australia

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ABSTRACT

Conservation Agriculture (CA) has been widely promoted as a part of the process of sustainable agricultural intensification in several major grain producing regions but in many developing countries, such as those in sub-Saharan Africa, its uptake has been low. Through a broader view of the uptake of CA beyond binary adoption, this review addresses two research questions: (1) how has CA been modified in various regions around the world?; and (2) what processes occurred to enable CA uptake? We compare global learnings with the context in Sub-Saharan Africa to reassess expectations for uptake and leverage points to address limited practice change in African smallholder systems. Our findings indicate that there is limited evidence to suggest that continued use of a 'complete' three component version of CA has been widely implemented in any region and so should not be expected to readily occur in the African situation. Likewise, we find that there are multiple processes and developments required beyond acute erosion issues to enable CA uptake, namely: (1) strong perceptions of individual benefit; (2) economic stimulus to enable and motivate investment in CA systems; (3) functional market exchange mechanisms to supply the required resources to implement CA; (4) development of farmer driven organisations to drive local adaptation of CA; and (5) collaboration of farmer organisations with other institutions to create an enabling environment for further CA adaptation. The situation in many countries across eastern and southern Africa is without these required developments to enable CA utilisation. With this in mind, we identify three key learnings from a review of CA in the global context and the implications for Africa: (1) financial stimulation of households will be required to enable African smallholder farmers to transition to market orientation through utilisation of CA components; (2) farmer organisations require further development to enable context specific adaptation of CA which will require strong collaboration with various stakeholders and institutions; and (3) expectations on both the type of, and period for, CA utilisation must be lowered, noting the substantial institutional change required.

1. Background

Sustainable intensification of African agriculture is urgently required to feed a rapidly expanding population (Pretty et al., 2011) through sustainable productivity increases and without land expansion (Bank, 2007). Conservation agriculture (CA) has been promoted as one major pathway to achieve this (see Giller et al., 2009) through the simultaneous implementation of minimum soil disturbance, permanent soil cover and crop diversification practices (FAO, 2014). The various benefits accrued by farmers and the environment in implementing CA-based systems have led to substantial global uptake, with more than 157 million ha now estimated to be under CA-based production systems (Kassam et al., 2015).

The importance of CA in Africa is underwritten by the high potential

for increased agronomic and environmental outcomes (Mupangwa et al., 2016; Thierfelder et al., 2016), though such benefit may be nuanced (Pittelkow et al., 2015). Despite CA entering African regions at a similar time to other regions globally, Africa has shown the least uptake of CA, both in terms of cropland area (1.2 Mha) and percentage of cropland (0.9%; Kassam et al., 2015). As such, CA remains a potentially beneficial production system that is yet to impart substantial benefit to the livelihoods of African smallholder farmers. This review aims to contextualise this limited uptake and specifically address two research themes:

1] In regions where substantial CA uptake has occurred, what are the dominant types of CA being implemented and what implications will this have on the expected types of CA in eastern and southern

* Corresponding author at: School of Agriculture, Food and Wine, the University of Adelaide, Australia, Private Mail Bag 1, Glen Osmond, South Australia 5064, Australia.
E-mail addresses: Brendan.brown@outlook.com (B. Brown), Rick.Llewellyn@csiro.au (R. Llewellyn), ian.nuberg@adelaide.edu.au (I. Nuberg).

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Africa? To overcome the substantial ambiguity within the literature regarding the classification of CA (and CA components), we apply the proposed standardisation of CA (and CA components) definition as proposed in [Brown et al. \(2017c\)](#), whereby each CA component is assessed independently and then as part of a CA aggregation; and 2] In regions where substantial CA uptake has occurred, what processes enabled CA uptake to occur and what implications will this have for the expected uptake of CA in eastern and southern Africa? Whilst acknowledging the important benefits and costs of CA utilisation beyond the farm level, it is not within our scope to review the societal benefits and environmental services that CA provides. Instead, we focus on the changes in farmer perception and broader processes that enabled farmers to transition to CA based farming systems.

It should be noted that such a review is complicated, particularly in the African experience, by ambiguity in what constitutes ‘CA’ and ‘CA adoption’ (see [Brown et al., 2017c](#)), as well as the dominance of gray literature on the subject, mainly in the form of project documentation. This review draws on such literature due to the close relationship that these sources tend to have with farmers and the desire to review farmer perspectives and developments. Many studies also tend to be focused at the agronomic and/or plot level, with farm and socioeconomic factors often remaining under-researched ([Thierfelder et al., 2015](#)) and focus placed on the technology itself rather than the process of enabling change ([Baudron et al., 2015a, 2015b](#)). These are the gaps that this review aims to highlight and address, through the opportunity to learn from the experiences of regions with substantial CA uptake and apply these learnings to the African situation. In doing this, we provide a useful evaluation of the pathways and expectations for CA uptake in the African smallholder context and reveal new opportunities to leverage research and extension systems to enable wider CA uptake in eastern and southern Africa.

2. Types of CA implementation

CA is an aggregation of interrelated practices that has come to be defined by the [FAO \(2014\)](#) as the simultaneous implementation of:

- 1] Minimum soil disturbance (though a disturbed tillage area of less than 15 cm width or 24% of area); and
- 2] Crop residue cover of the soil (with a minimum of 30% soil cover at planting); and
- 3] Crop diversification (with greater than three crops in rotation).

Whilst this definition is often cited in the literature, there tends to be ambiguity around its practical application in the classification of CA adoption ([Andersson and D'Souza, 2014; Brown et al., 2017b](#)). Periodic global estimates of CA uptake are often cited as evidence of the far reaching success of CA (e.g. [Derpsch et al., 2010; Friedrich et al., 2012; Kassam et al., 2015](#)) yet are limited in addressing the adaptation of CA to local contexts, in part due to a focus on CA as a yes-or-no binary outcome ([Brown et al., 2017b](#)), the potentially biased methods used in data collection and often synonymous use of zero tillage, minimum tillage and CA (most likely due to the datasets available to make such estimates). Particularly in the North American and Australian contexts, the literature tends to specifically report on no-tillage, often without reference to the remaining two CA practices. Because of this definitional ambiguity, estimates of CA adoption within regions can vary greatly and make comparisons across regions difficult.

2.1. Types of CA implemented globally

In [Table 1](#), we provide a review of the limited literature that explores the types of CA that occur across 11 countries. The 11 countries presented account for 96% of global CA area according to [Kassam et al.](#)

(2015). While the definition of CA applied in studies such as [Kassam et al. \(2015\)](#) is often ambiguous and there are limitations in their collection of data, they provide a strong basis for understanding the proportional utilisation of CA and CA components globally which cannot be achieved through more geographically focused studies. These 11 countries are reviewed in terms of the types of CA and CA components implemented to understand what local modifications to the [FAO \(2014\)](#) definition have occurred globally.

2.2. Types of CA implemented in Africa

Whilst there have been some reports of substantial expansion of CA activities in Africa (e.g. [Kassam et al., 2015; Mloza-Banda and Nanthambwe, 2010](#)), multiple studies have shown that implementation of CA by African smallholder farmers tends to be in modified forms (e.g. [Giller et al., 2009; Gowing and Palmer, 2008; Pannell et al., 2014](#)). [Brown et al. \(2017c\)](#) studied CA utilisation across more than 6100 farmers in five countries (Ethiopia, Kenya, Tanzania, Malawi and Mozambique) in 2010 and found that 99% of CA implemented by smallholder farmers was in modified forms rather than ‘complete CA’ as defined by the FAO. [Brown et al. \(2017a\)](#) further extended those findings to understand the types of CA implemented by farmers, finding only 0.3% of farmer plots ($n = 27,545$) would meet the definition of CA specified by the [FAO \(2014\)](#) in the implementation of all three CA principles to adequate thresholds. Applying a wider definition of three CA components implemented together in any capacity, only 0.8% of plots were identified. Such findings are consistent with the growing body of analysis of CA utilisation identifying the substantial modification and limited total utilisation of CA that dominate across sub-Saharan Africa (e.g. [Baudron et al., 2007; Bunderson et al., 2017; Pannell et al., 2014](#)).

[Fig. 1](#) provides the breakdown of the types of CA found by [Brown et al. \(2017a\)](#), highlighting the limited application of multiple components of CA, and especially minimum tillage practices by the surveyed farmers.

2.3. Implications and expectations for the types of CA implemented in Africa

The continuous application of all three CA practices as part of a ‘complete CA’ appears to be rare and the modification of CA tends to be the most likely outcome (both in the global and African contexts), including where principles of low soil disturbance, residue retention and crop rotation are accepted as valued objectives. Whilst farmers may find ‘complete CA’ an attractive production system, they are likely to adapt beyond the strict definition of CA to a modified system that best suits their situation. As such, we contend that enabling CA uptake in eastern and southern Africa will involve greater flexibility in CA promotion, which should be reflected in a change in focus from increasing technological ‘adoption’ to a greater focus on the adaptation as part of a wider sustainable intensification process ([Brown et al., 2017c; Thierfelder et al., 2015](#)). This is consistent with the typical path farmers have taken elsewhere, particularly for tillage activities. The framing of CA will require a refocus towards promotion as part of a flexible and pragmatic framework to guide farmers in the sustainable intensification of their production systems and not as part of a strict classification of CA systems. This is in line with the recommendations of recent literature that highlight the need for greater localised adaption and process oriented (rather than outcome oriented) agricultural development activities ([Giller, 2012; Glover et al., 2016; Baudron et al., 2015a, 2015b](#)). Hence, we conclude that there is a need for more pragmatic promotion of CA in Africa that reflects transitional pathways based on modification (such as in other regions) whilst maintaining the longer term objective of ‘complete CA’. This will also involve a lessening of expectations for total CA utilisation as has occurred in other regions and contexts.

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