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Stepwise frameworks for understanding the utilisation of conservation agriculture in Africa

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ABSTRACT

Despite the large and ongoing investment in the promotion of Conservation Agriculture (CA) to African smallholder farmers, currently available estimates of adoption provide little insight into the realities of their use. Both the technologies and their adoption tend to be poorly defined, leading to large variation in estimates and validity issues. To address this void, we propose two independent but complementary frameworks: the Conservation Agriculture Appraisal Framework (CAAF) is used to quantify the intensity of implementation of CA; and the Process of Agricultural Utilisation Framework (PAUF) is used to classify various types of use and non-use by disaggregating the adoption process into ten stages. These frameworks are applied to household survey data across five eastern and southern African countries from 1,601 village and 6,559 households. Overall, we find a general overestimation of adoption of CA and CA components. By considering in more detail the intensity of implementation and the types of use and non-use, new meaning is found in the status and contributors to limited CA utilisation.

1. Introduction

Conservation Agriculture (CA) aims to make better use of agricultural resources through the simultaneous implementation of minimum soil disturbance, permanent soil cover and crop diversification (Thiombiano and Meshack, 2009). Over the past two decades, CA has been extensively promoted as the panacea for areas with low agricultural production in Africa (and more generally) and the dominant paradigm for both climate smart agriculture and sustainable agricultural intensification. The prominence of CA is underwritten by the high potential for increased agronomic and environmental outcomes (Mupangwa et al., 2016; Ndah et al., 2014; Thierfelder et al., 2015; Thierfelder et al., 2016).

Following strong promotion, the area under CA in Africa is claimed to have increased by 57% between 2008/9 and 2013 to more than 1.2 million ha (Kassam et al., 2015). The potential benefits and stated achievements have solidified the view that CA will be the primary solution for improving African smallholder agriculture (Hebblethwaite et al., 1996; Hobbs et al., 2008). In response to the claims of mass adoption of CA, questions have been asked of the validity of such estimates (Andersson and Giller, 2012; Andersson and D'Souza, 2014; Giller et al., 2015; Giller et al., 2009). The core argument made in such papers is that estimates of adoption are often more obscuring than revealing and adoption is substantially more limited than most estimates suggest. We use detailed data from farmers in five countries to test these arguments.

This article explores the limitations in CA adoption estimates, and subsequently proposes two interrelated frameworks to address the 'what' and 'how' of CA adoption. In doing so, we explore the hypothesis that adoption of CA (and CA components) has been more limited than other estimates in five eastern and southern African countries. By moving beyond binary classification, we create new meaning in the types of CA adoption and non-adoption to facilitate evidence based discussion on how to increase the use of CA practices.

1.1. Key limitations with CA adoption estimates

There is now a large body of literature that questions the validity of CA adoption estimates. The basis for such questions stems back to three key limitations: the use of weak methodologies to estimate adoption, definitional diversity of what constitutes CA, and the dominance of binary assessment frameworks.

1.1.1. Weak methodologies

Methodological weakness of prior adoption studies limits our understanding of smallholder CA adoption (Andersson and D'Souza, 2014). Many studies, such as those from the FAO based FAOstat (FAO, 2016) and further published periodic reviews (Friedrich et al., 2012; Kassam

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et al., 2015; Kassam et al., 2009) are based on estimates from ministries of agriculture, by farmer organizations, and/or well-informed individuals in research or development organizations. Likewise, many field studies are based on personal estimates and observations (e.g. Mloza-Banda and Nanthambwe, 2010; Nyagumbo et al., 2011). Whilst common, such methods are not easily repeatable and difficult to independently validate. Furthermore, such estimates are usually made in the context of development projects and thus have the potential to be biased.

1.1.2. Definitional diversity

There is large diversity in what constitutes CA throughout Africa. The formal definition as stated by the FAO (2016) is well established as the simultaneous implementation of three CA components:

- *Minimum tillage*: a soil disturbed area of less than 15cm (or 24%); and
- *Stover cover*: 30% ground cover at planting; and
- *Crop diversification*: Three crops in rotation.

Yet adoption studies tend to lack clarity on the definition of CA they implement and the thresholds they use. Many studies adopt a reductionist approach where one element may constitute CA adoption (e.g. Derpsch et al. (2010) where minimum tillage, conservation agriculture and zero tillage are said to be synonymous). Andersson and D'Souza (2014) summarise such issues in southern Africa with the development of different definitions of CA between Zambia, Zimbabwe and Malawi and the complications that arise.

1.1.3. Binary assessment frameworks

The literature body is mostly uniform in the application of binary classifications to understand adoption (i.e. a farmer can be either an 'adopter' or 'non-adopter'). Yet such a framework provides limited insight and can lead to misleading conclusions, noting the lack of understanding in reference to:

Modification and partial adoption

The realities of technology transfer in resource limited contexts, and where economic, social, political or institutional enabling environments may not exist, mean that partial CA adoption is the most likely outcome (Baudron et al., 2007; Giller et al., 2009; Gowing and Palmer, 2008; Pannell et al., 2014). Further, there is considerable literature indicating that partial adoption of CA (i.e. only one or two components of CA) may have poor outcomes, particularly if minimum tillage is done without stover cover (Erenstein et al., 2012; Guto et al., 2011). Despite this, partial adoption is rarely adequately recognised or quantified in the literature.

Intensity of Adoption

It is long-accepted that adoption of most agricultural technologies involves a non-binary process and tends to be partial and incremental (e.g. Baudron et al., 2007; Byerlee and De Polanco, 1986). In resource-limited environments, it is understandable that a farmer will reduce the intensity of a beneficial technology to match resource endowments and suit their socio-political circumstance. Currently, farmers who conduct small trials (usually of 10 m × 10 m in the East African context) are grouped together with farmers who may practice on a single plot or those who have fully embraced the technology across several fields. Using a binary classification may obscure our understanding of how a technology fits within the contextual constrains of community.

Incentivised adoption

In the African context, CA is strongly promoted via development projects which provide incentives to practice CA in the form of subsidised or free fertilisers, seeds, herbicides, or artificial market opportunities (Andersson and D'Souza, 2014; Mloza-Banda and Nanthambwe, 2010). This can lead to 'pseudo-adoption', where adoption claimed during the course of a development project is not a sustained change in practice but due to the temporary influence of the project (Haggblade and Tembo, 2003) and thus not indicative of longer term adoption (Andersson and Giller, 2012; Andersson and D'Souza, 2014). This has led to limited value in adoption statistics that do not disaggregate those with artificial short-term incentives and those who have truly invested in the innovation.

Determinants of non-adoption

Non-adoption is generally assumed to be a reflection of negative evaluation, be it due to low expected benefit (Kathage et al., 2015), resource availability (Baudron et al., 2014; Foster and Rosenzweig, 2010; Grabowski et al., 2016), institutional arrangements (Rockstrom et al., 2003) or personal preference (Lalani et al., 2016; Van Hulst and Posthumus, 2016). Such results may be partly due to use of data aggregation that tends to lessen the importance of issues such as exposure to the technology, which in the African context can be a leading contribution to non-adoption (Ngwira et al., 2014). Without disaggregating non adoption into its various stages, limited meaning can be gained from binary adoption estimates.

1.2. Implications of the limitations of CA adoption estimates

The limitations of CA adoption estimates often lead to ambiguity in what constitutes both CA as a technology and CA adoption. This has led to large variation in adoption estimates. For example, national estimates of the area under CA in Malawi vary nearly seven fold in 2009–10, from 5,407 farmers in Thiombiano and Meshack (2009) to 37,594 farmers in Mloza-Banda and Nanthambwe (2010). Such variation has been highlighted by several studies that suggest caution in the accuracy and validity of current estimates (Andersson and D'Souza, 2014; Giller et al., 2015; Giller et al., 2009; Glover et al., 2016). This lack of standardisation is acknowledged at national levels, for example by the National Conservation Agriculture Taskforce Secretariat (NCATFS) of Malawi which state that "…in the absence of standardised monitoring tools, critical statistics such as land area under CA are difficult to estimate" (Malawi Ministry of Agriculture, 2012). As such, there is little merit in comparison of CA adoption across studies without addressing the limitations of CA adoption estimates.

2. Theoretical Frameworks

Whilst there are claims that CA adoption is far less than current reports suggest (Andersson and D'Souza, 2014), there has been no framework to facilitate the quantification of such claims. To address this void, we propose two frameworks to estimate the 'what' and 'how' of CA adoption. The Conservation Agriculture Appraisal Framework (CAAF) is applied to quantify the intensity of use of CA and CA components, whilst the Process of Agricultural Utilisation Framework (PAUF) is applied to understand the types of adoption and non-adoption. These independent, but complementary, frameworks are proposed as a methodology to standardise CA adoption studies and provide increased depth to the reporting and analysis of agricultural adoption estimates.

2.1. Defining the 'what' of CA via the Conservation Agriculture Appraisal Framework (CAAF)

Whilst the FAO definition of CA is clear, it has limited applicability for understanding the intensity of use and partial use at farm level. As such, the practical and implemented definition of CA and the theoretical definition of CA have diverged. We propose a standardisation of CA definition to facilitate greater validity in comparisons of CA studies and to ensure 'like-for-like' comparisons (visualisation provided in Fig. 1).