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Early adoption of conservation agriculture practices: Understanding partial compliance in programs with multiple adoption decisions☆

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ABSTRACT

Land degradation and soil erosion have emerged as serious challenges to smallholder farmers throughout Southern Africa. To combat these challenges, conservation agriculture (CA) – a suite of agricultural practices consisting of zero tillage, mulching of crop residues, and intercropping with legumes – is widely promoted as a "sustainable" package of agricultural practices. Despite the many potential benefits of CA, however, adoption remains low. Yet relatively little is known about the decisionmaking process in choosing to adopt CA or any of its constituent practices. This article attempts to fill this important knowledge gap by studying CA adoption in southern Malawi. Unlike what is implicitly assumed when these packages of practices are introduced, farmers view adoption of CA as a series of separate decisions, rather than a single decision. But the adoption decisions need not be wholly independent. We find strong evidence of interrelated decisions, particularly among mulching crop residues and practicing zero tillage, suggesting that mulching residues and intercropping or rotating with legumes introduces a multiplier effect on the adoption of zero tillage.

1. Introduction

To preserve ecosystem services in agricultural landscapes, a range of "sustainable" agricultural packages are promoted across the world. These often find strong support within the agricultural development and donor communities, despite much evidence of context-specificity, evidence of limited adoption and subsequent dis-adoption, and contestations within the broader scientific community. Many of these contestations arise from the complexity of these approaches and the behavioral change that is required at the individual level to support transformative change at the landscape level, since such programs often involve bundled interventions comprised of several distinct technologies or practices exhibiting biophysical synergies. As a result, such interventions have met with limited success, despite ample short-term incentive programs to promote adoption and long-term private benefits for the farmer in terms of more resilient and sustainable yields.

Across Southern Africa, one of the most important areas where behavior change could prove most beneficial is in regards to soil management. Degradation and loss of soils is becoming more acute, not just through poor farming practice, but due to changing weather patterns with climate change (in particular more intense rainfall leading to more runoff and soil loss). To combat this, conservation agriculture (CA) – a package involving, typically, (a) the mulching of crop residues, (b) reduced or minimum tillage of soils, and (c) intercropping or rotation with legumes – is widely promoted by the development community as a major pillar of sustainable agriculture. For example, José Graziano da Silva, Director General of the FAO, commented, "Conservation Agriculture offers the prospect of a better future to both large-scale and smallholder farmers, and a means to raise productivity and secure economic and environmental benefits" (Jat et al., 2013, p. xiv).

Although CA was initially developed for large-scale commercial farms in the Americas (Thierfelder et al., 2013), much effort has gone into adapting CA systems for smallholder farmers in developing countries (Wall, 2007). In southern Africa in particular, CA offers many

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potential benefits to smallholder farmers, both in terms of increased crop productivity as well as reduced costs and, consequently, higher profits. For example, one of the immediate benefits of CA in rainfed agricultural systems is improved rainfall-use efficiency through increased water infiltration and decreased evaporation (Thierfelder and Wall, 2009). Furthermore, reducing the need for tillage means that farmers can shift planting dates in line with weather as well as reducing labor costs in some contexts (Baudron et al., 2007; Giller et al., 2011). At the same time, reduced tillage and mulching residues minimizes soil erosion and increases retention of soil moisture, while incorporating legumes as an intercrop or in a rotation helps with managing organic soil matter and nitrogen (Friedrich et al., 2009; FAO, 2011). A recently published long-term on-farm evaluation has shown CA systems to consistently yield more than conventional crop production systems in both Malawi and Zimbabwe (Thierfelder et al., 2015).

In the midst of this compelling narrative, however, there arises a paradox: while advocates describe CA is being unambiguously beneficial for farmers, adoption has remained surprisingly low in many developing countries, despite the persistent efforts at encouraging CA (Andersson and Giller, 2012). There has emerged a significant literature on the agronomic and economic impacts of CA for smallholder farmers as well as patterns of CA adoption (e.g., Haggblade and Tembo, 2003; Baudron et al., 2007; Giller et al., 2009; Kassam et al., 2009; Erenstein et al., 2012; Ngwira et al., 2012; Pannell et al., 2014; Corbeels et al., 2014). A common observation – among both critics and impartial proponents alike – is that the benefits of CA are very context-specific, depending upon, among other factors, location and seasonal variability (Erenstein et al., 2012).

Perhaps due to this context specificity, it has been observed that “there are few if any universal variables that regularly explain the adoption of conservation agriculture” (Knowler and Bradshwaw, 2007, p. 25). Giller et al. (2009), for example, refers to weeds as the “Achilles heel” of CA, since CA (particularly reduced tillage) increases weed pressure during the early years of CA adoption, and since controlling weeds manually is very labor intensive. Giller et al. (2009) also points to competing uses for crop residues, limited availability of labor, and access to physical inputs as important constraints to the adoption of CA, arguing that CA may not be suitable for the majority of farming systems in Africa south of the Sahara. As a result, full adoption of CA in much of the world is limited. Rather than full and complete adoption of CA, it is often observed that farmers may pick and choose which practices to follow, or may experiment with different practices, thus resulting in a more stepwise adoption or a more periodic adoption of CA (Baudron et al., 2007). In such cases, however, the result is not adoption of CA, per se, but rather a composite agricultural practice that potentially foregoes some of the benefits that would otherwise arise due to synergies between the different conservation practices.

This apparent paradox suggests the need for a deeper understanding of farmers’ decisionmaking process with respect to CA and its constituent practices. To date, however, there has been relatively little robust analysis regarding farmers’ perceptions about the benefits of CA practices – either in isolation or in tandem – that might shed light on these lingering puzzles.[1] While there is a vast literature that has addressed the adoption of new agricultural technologies and practices, many of the theoretical considerations and methodological tools that have been employed have changed relatively little over time.[2] For some agricultural practices or technologies, this may be easily justified. But particularly in the case of complex suites of practices – such as CA – many of the empirical methods that are frequently used in such analyses are often inappropriate.

This study aims to address this important knowledge gap by examining farmers’ adoption of the three constituent practices (zero tillage, mulching of crop residues, and intercropping of legumes) to better understand the structure of these decisions. This study contributes to the technology adoption literature by clearly demonstrating (a) that the decision to adopt a comprehensive CA package is complex rather than a unitary decision, and that (b) there is some intrinsic interrelatedness in farmers’ decisions regarding the various practices that comprise CA. Leveraging data from an early stage of an ongoing CA promotion project in the Shire River Basin in Southern Malawi, we demonstrate that compliance with the scheme's requirements is governed by the costs (simply perceived or otherwise) of each individual practice and requires separate decisions to undertake intercropping and mulching, with zero tillage being crowded-in by the adoption of residue mulching.

The remainder of the paper is organized as follows. In Section 2 we provide some background on the broader CA promotion project of which this study is an early part. In Section 3, we introduce the empirical strategy that we will use in attempting to unpack the various decisions related to farmers’ adoption of different CA practices. In Section 4 we introduce the data sources used in the empirical analysis. In Section 5 we report the results of the empirical analysis, first focusing on the decision to adopt the comprehensive CA package before proceeding to treat the decisions as separate but potentially interrelated. Finally, in Section 6, we offer some concluding remarks and areas for future research.

2. Background on CA promotion activities in southern Malawi

This study is part of a larger project related to the promotion of CA in the Shire River Basin in southern Malawi. Traditional farming practices in southern Malawi – characterized by annual tillage, the manual construction of planting ridges, and intensive cultivation – have resulted in progressive soil loss, deteriorating soil fertility, and consequential reductions in crop yields. In attempts to stem this tide, there have been numerous efforts aimed at promoting CA in Malawi in recent years. Unfortunately, because these efforts have been undertaken by many different independent stakeholders, the efforts have been uncoordinated and have met with limited success. Furthermore, because of the different tactics in promoting CA, there is a pervasive misunderstanding as to what constitutes CA, even among those actors actively engaged in promoting it (Chavula and Makizwa, 2012). In response, the Government of Malawi's Agriculture Sector Wide Approach (ASWAp) has attempted to integrate CA practices within its overall portfolio of agricultural interventions aimed at increasing the profitability of farming, particularly among smallholder farmers in Malawi.

Evidence from other contexts has demonstrated that various barriers to adoption lead farmers to dis-adopt CA practices or to not comply with CA program agreements before they can realize personal gains from CA, either in terms of increased productivity or increased profits (Giller et al., 2009; Robbins et al., 2006). In light of this evidence, it is sometimes argued that incentive mechanisms (e.g., subsidies) are critical for the success of institutions dispersing information regarding improved management practices such as CA (Lee, 2005). The larger project of which this study is a part aimed to introduce an innovative incentive mechanism to leverage network externalities in expediting the adoption of CA. The particular incentive mechanism under investigation in this larger study is the agglomeration payment incentive scheme (Parkhurst et al., 2002; Parkhurst and Shogren, 2007, 2008; Drechsler et al., 2010; Watzold and Drechsler, 2014). The agglomeration payment is a two-part incentive scheme. The first part is a flat subsidy that induces landowners to voluntarily participate in the CA program. The second part is a bonus payment distributed to farmers when their land enrolled in the CA program shares a common border with a neighboring parcel of land that is also enrolled in the CA program. The structure of the agglomeration payment creates a positive

[1] Ward et al. (2016) and Ortega et al. (2016) are two noteworthy examples of recent studies using discrete choice experiments to gain insight into farmer preferences and perceptions about CA practices, with the latter focusing explicitly on a maize/legume intercrop system.

[2] As an illustrative example, consider the persistent relevance of the seminal survey by Feder et al. (1985), despite being more than 30 years old.