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Heterogeneous preferences and the effects of incentives in promoting conservation agriculture in Malawi☆

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ABSTRACT

There is a great deal of interest in increasing food security through the sustainable intensification of food production in developing countries around the world. One such approach is through Conservation Agriculture (CA), which improves soil quality through a suite of farming practices that reduce soil disturbance, increase soil cover through retained crop residues, and increase crop diversification. We use discrete choice experiments to study farmers' preferences for these different CA practices, and assess willingness to adopt CA. Despite many long-term agronomic benefits, some farmers are not willing to adopt CA without incentives. Our results suggest that farmers perceive that CA practices interact with one another differently, sometimes complementing and sometimes degrading the benefits of the other practices. But our results also indicate that preferences are a function of experiences with CA, such that current farm level practices influence willingness to adopt the full CA package. Further, exposure to various risks such as flooding and insect infestations often constrains adoption. Providing subsidies can increase likely adoption of a full CA package, but may generate some perverse incentives that can result in subsequent disadoption.

1. Introduction

Conservation agriculture (CA) is often promoted as a means for sustainably increasing food production to address mounting challenges related to land degradation and food insecurity. As a package of "soil-crop-nutrient-water-landscape system management practices" CA "saves on production energy input and mineral nitrogen use in farming and thus reduces emissions" and "enhances biological activity in soil, resulting in long-term yield and factor productivity increases" (Friedrich et al., 2009). There are many practices and technologies that are promoted under CA, though they all adhere to three principles: minimum soil disturbance (including reduced or zero tillage, direct sowing or broadcasting), permanent organic soil cover (including the retention or mulching of crop residues), and diversification of crop species grown in rotation or through intercropping. While there has been success in promoting CA in certain parts of North and South America (with roughly 40 million hectares and 56 million hectares, respectively) and Oceania (roughly 17 million hectares), efforts to promote CA in other parts of the world have been markedly less successful, despite three decades of research and investment (Corbeels et al., 2014; Derpsch et al., 2010; Friedrich et al., 2012; Giller et al., 2009; Kassam et al., 2009). In Africa, it is estimated that only about 1 million hectares of land are under CA, despite the pressing problems of land degradation and food insecurity. Food insecurity has been estimated to impact close to 234 million people in sub-Saharan Africa (FAO, 2011), with these

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impacts likely to become worse as the global population grows and the impacts of global warming continue to be realized (Schmidhuber and Tubiello, 2007). Much of this can be attributed to low agricultural productivity, which itself is largely a result of low soil fertility. After decades of intensive crop production under poor land management and with little use of fertilizers, African soils are low on nutrients, despite soils being considered the “cornerstone of food security and agricultural development” (Agriculture for Impact, 2014).

In Malawi, current agricultural practices exacerbate the problem, as traditional technologies increase soil erosion leading some to opine, “the biggest export in Malawi is top soil” (Stoddard, 2005). Despite this, getting farmers to adopt CA in Malawi has proven difficult (Andersson and D’souza, 2014; Giller et al., 2009). While interest in CA in Malawi has increased steadily since the food price crisis of 2007/8, adoption still lags well behind that of other countries. To address some of these pressing challenges, Malawi’s Agriculture Sector Wide Approach (ASWAp) promotes CA through a range of conservation agriculture techniques that include maintaining soil cover, minimum tillage, and land-use diversification (MCC Malawi, 2011).

A wealth of studies have examined CA adoption in Malawi and elsewhere in sub-Saharan Africa, finding that the disappointing uptake may arguably be due to inappropriate adaptation of CA practices to fit within local farming systems or inadequately designed CA policies with insufficient economic incentives to overcome barriers to adoption for local farmers (Giller et al., 2009; Mwale and Gaussi, 2011; Orr, 2003; Pannell et al., 2014). Some of the impediments to adoption have been identified as a lack of information about CA management practices, uncertainty concerning full economic costs and benefits of CA practices (including important opportunity costs), sensitivity to increases in yield variability (e.g., due to farmers’ risk aversion), shorter planning horizons, land tenure status and high discount rates (e.g., Lee, 2005; Mwale and Gaussi, 2011; Pannell et al., 2014). The lack of information/technical knowledge on CA management practices is not only on the part of farmers but also on the part of field extension workers (mainly government field staff) who work directly with farmers (Andersson and D’souza, 2014). If extension agents lack detailed knowledge about CA, this would also impede the successful transmission of knowledge of CA and ultimately result in low levels of adoption (Mwale and Gaussi, 2011). There are further challenges to sustaining CA adoption, as resource constraints may lead farmers to dis-adopt CA practices or to be in noncompliance with CA agreements before they realize personal gains from CA techniques (Giller et al., 2009; Mwale and Gaussi, 2011; Robbins et al., 2006).

Part of the challenge in promoting CA across different contexts is that the various technologies and practices promoted under CA provide benefits – in terms of yields or farm profits – that accrue inconsistently over time and space, and these benefits often fail to outweigh the economic costs associated with adoption. This is perhaps particularly true for residue retention and mulching. In Malawi’s case for example, some farmers have adopted minimum tillage (Andersson and D’souza, 2014), as well as maize intercropping with legumes, but tend not to cover crops with mulched residues (Giller et al., 2009). In mixed crop-livestock systems, there are opportunity costs associated with retaining and mulching crop residues, as this reduces the amount of “free” fodder available for livestock (Baudron et al.., 2014; Giller et al., 2009). Even in regions where farmers do not own much livestock, residues are often burned as a way of expediting the clearing of agricultural lands to facilitate land preparation and planting (Giller et al., 2009). In addition, while residue retention has been shown to reduce soil erosion, increase soil moisture, and increase yields, especially in relatively dry areas, it has also been shown to negatively impact yields in areas with high-rainfall, as mulching in these areas tends to result in waterlogging (Mwale and Gaussi, 2011; Rusinamhodzi et al., 2011). Clearly, therefore, while the general principles of CA may have widespread applicability, one cannot simply take lessons learned in one area and expect results from similar CA programs elsewhere. Adoption of CA largely depends on farm-level economics, which are likely to be very context-specific and, therefore, very heterogeneous. Based on a review of 23 studies exploring CA adoption, Knowler and Bradshaw (2007) conclude that “there are few if any universal variables that regularly explain the adoption of conservation agriculture across past analyses” (p. 44), and that “efforts to promote conservation agriculture will have to be tailored to reflect the particular conditions of individual locales” (p. 25).

In this paper we study heterogeneity in farmers’ preferences for CA technologies in rural Malawi. We use a discrete choice experiment and estimation strategy that allows for preference heterogeneity at the individual level. With this approach, we are able to explore the individual-level determinants that affect farmers’ preferences toward the individual technologies included in the CA package as well as the overall package. Based on analyzing individual willingness-to-pay for CA practices and current behavior, we are able to explore potential subsidy-targeting mechanisms to incentivize widespread adoption of a complete CA package consisting of no tillage, intercropping, and residue mulching. Our results indicate current farm level practices largely influence willingness to adopt the full CA package. While many may argue that providing subsidies may encourage more widespread adoption of CA, doing so may introduce perverse incentives. Subsidies may increase the adoption of intercropping and residue mulching, but adoption of these practices may crowd-out adoption of zero tillage, leading to partial compliance. Further, exposure to various risks such as flooding and insect infestations often constrains adoption.

2. Empirical methods

The study relies upon the use of discrete choice experiments to estimate farmers’ valuation for different components of a package of CA practices. Discrete choice experiments are a form of stated choice experiment, where preferences are elicited based on responses to hypothetical scenarios rather than observed purchasing decisions. In a discrete choice experiment, individuals are presented a series of choice scenarios in which they must choose between bundles containing different traits (in this case, practices), each taking one of a number of pre-specified levels (such as a binary adoption indicator). Through statistical analysis of participants’ choices given the alternatives available in each choice scenario, the researcher is able to estimate marginal values (in either utility or monetary terms) for the various attributes embodied in the alternatives. Researchers control the experimental choice environment by providing necessary variation in attribute levels, which may not be present in historical data (i.e., in analysis of preferences revealed through real-world purchases). Furthermore, the methodology is particularly useful for eliciting valuation of products for which there is not a functioning market in which to observe such revealed preferences, which makes it a particularly useful methodology for analyzing preferences for hypothetical goods and services and for analyzing the welfare effects of multidimensional policy changes.

2.1. Choice experiment design

Our purpose in this study is to explore farmers’ preferences for a CA package promoted by several program implementers active in Malawi’s agricultural sector, including the Department of Land Resources and Conservation (DLRC), the National Smallholder Farmers’ Association of Malawi (NASFAM), Total LandCare (TLC),