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What Explains Minimal Usage of Minimum Tillage Practices in Zambia? Evidence from District-representative Data

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Highlights

- Despite having been actively promoted for several decades, minimum tillage use in Zambia remains quite low, with less than 5% of smallholder farmers using ripping or planting basins as their main tillage method.
- There has been a slight increase in use rates from 2008 to 2012, but the trend is highly variable in most districts.
- The main reasons for the stubbornly low use of conservation farming practices include high labor requirements for some practices especially in the first year of adoption, competing needs for farmers' resources, and the distribution of gifts by promoters of conservation farming as incentives for farmers to adopt conservation farming, which results in disadoption after the cessation of gift giving.
- Rainfall variability and landholding size are important determinants of both use and extent of use of minimum tillage practices. Farmers are more likely (less likely) to use minimum tillage following a drought season (flooding season). Farmers with more land are more likely to implement conservation farming on at least some part of that land.
- While use rates are very low, farmer use of ripping is slowly rising over time and can be further promoted by addressing cattle disease outbreaks and linking farmers to programs that promote use of tractor-drawn rippers and zero tillage planters.

INTRODUCTION: Conservation farming (CF) practices are widely considered to be important components of sustainable agricultural development in Sub-Saharan Africa because of their potential to raise farm productivity and incomes while maintaining or improving soil quality and reducing vulnerability to variable climatic conditions. CF in Zambia can be traced to the 1980s when government, private sector, and donor communities started promoting CF as an alternative set of agronomic practices for Zambian smallholders (Hagglblade and Tembo 2003). Initially, CF practices were promoted on the premise that they would improve crop yields given their potential to rejuvenate soils. However, more recently, CF practices are increasingly seen as potentially viable adaptations to climate change. In this regard,

CF technologies can potentially deliver double benefits of improved farm productivity and climate change adaptation.

Since the 1980s, CF has received massive investments aimed at promoting its adoption. Whether such investments have increased the adoption of CF remains contestable, mainly due to lack of reliable national evidence on adoption and/or use rate of CF practices amongst smallholder farmers. Available estimates of the numbers of farmers practicing particular CF technologies are typically based on case studies of areas where CF has been intensively promoted for longer periods compared to other places and usually rely on small samples. Moreover, most CF studies in Zambia are very old and may not be very useful for forward looking policies.

This study examines trends in the use of minimum tillage practices and their determinants. We specifically look at planting basins and ripping, which are two of the main elements of conservation farming. By understanding the trends and determinants of minimum tillage use, CF promoters and extensionists can better understand how farmers are responding to their promotion programs, and whether possible modifications in the programs or the technologies themselves should be considered.

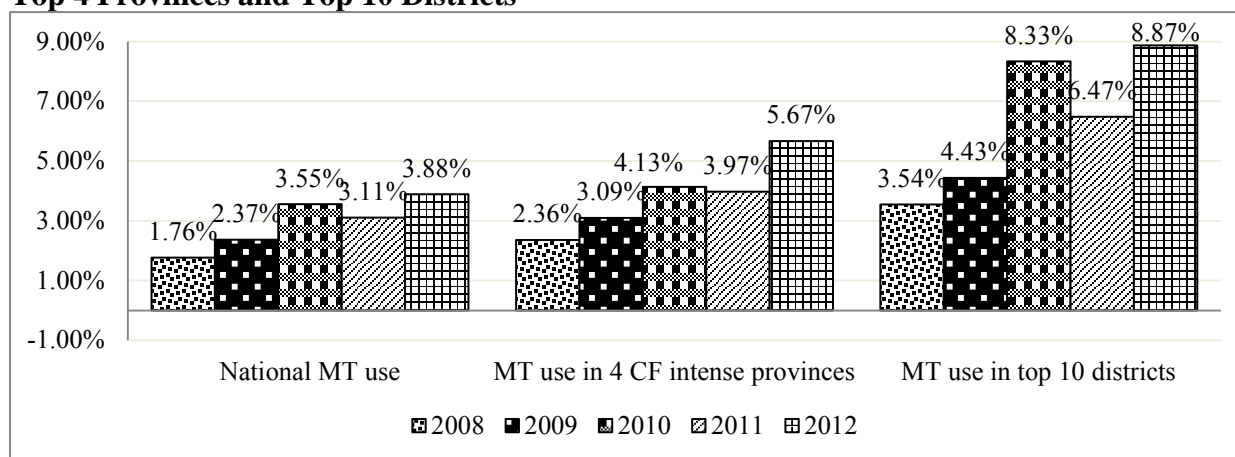
DATA AND METHODS: Data for this study were primarily drawn from data on roughly 63,000 households' farming practices as contained in the annual Crop Forecast Surveys (CFS) conducted by the Ministry of Agriculture and Livestock (MAL) and Central Statistical Office (CSO) for the period 2008 to 2012. The CFS surveys are considered statistically representative at the district-level. Other data used in the study are 10-day period rainfall from 1997/8 to 2010/2011 collected by the Zambia Meteorological Department. Focus group discussions were held in Chama, Choma and Petauke Districts to supplement these data. Additionally, key informants interviews were held with officials from MAL and the Conservation Farming Unit (CFU), the leading institution promoting CF in Zambia.

Two econometric models were used to determine household, climatic, and institutional

factors affecting use and extent of use of planting basins, ripping, and either planting basins and/or ripping. Double hurdle models with the use of the control function approach to control for endogeneity of CF program placement were used to determine factors affecting land sizes farmers cultivated using specific MT practices.

FINDINGS: Figure 1 shows MT use rate trends at national level, in the top 4 provinces and 10 districts where CF has mostly been promoted in Zambia, ranked according to the percentage of farmers using MT between 2008 and 2012. The most salient observation is that use rates for MT are very low, with less than 10% of farmers using either form of minimum tillage even in the provinces and districts where CF has been most actively promoted. Nationally, an estimated 3.9% of the smallholder farmers' population used MT in 2012, up from 1.8% in 2008. On a positive note, however, we find upward trends between 2008 and 2012 across all the three sub-samples shown in Figure 1. For example in 2012, results show that about 6.0% and 9.0% of the smallholder farmers in the top 4 provinces and the top 10 districts, respectively, used planting basins and/or ripping. These findings indicate that, at least in areas where CF is being promoted, use rates are rising over time, perhaps indicative of what could be expected if interventions are scaled up.

Figure 1. Trends in the Percentage of Farm Households Using MT at National Level, in the Top 4 Provinces and Top 10 Districts



Source: Authors' computations from CFS 2008-2012.

We also found highly variable use rates across time even in the top 10 districts. To better understand the drivers of this variability in use rates, we conducted focus group discussions in Chama, Choma, and Petauke Districts. From the FGDs, the most commonly articulated reasons for low use rates were: high labor requirements of some practices like basins and the timing of activities; and lack of access to finances required to purchase the requisite implements (Chaka hoes for basins and ox-drawn implements for ripping) and inputs including herbicides, hybrid seed, and mineral fertilizers. Focus group respondents stressed that the viability of CF depends largely on the use of appropriate implements and inputs, a recurrent conclusion of prior studies (see Haggblade and Tembo 2003; Haggblade, Kabwe, and Plerhoples 2011; Giller et al. 2009). If farmers cannot afford such purchased inputs and herbicides, they face problems of weed growth that can depress yields unless adequate peak season labor can be found, which can also be costly.

Our econometric analysis of determinants of use of minimum tillage and the area under minimum tillage cultivation yields produced three main findings. First, male-headed households were 39% more likely to use ripping than female-headed households. By contrast, male-headed households were 15% less likely to use planting basins. Similar results are reported in Nyanga, Johnsen, and Kalinda (2012) where it was found that men were less likely to adopt planting basins. These results have a somewhat intuitive explanation; ripping requires ox/tractor power, which is controlled mainly by men, while women are generally involved in field operations that use hand hoes, which are the implements used to prepare planting basins. Moreover, farmers with more land are more likely to use both types of minimum tillage on at least some of their fields. Each one hectare increase in landholding size raises the probability of using planting basins and ripping by 0.2 and 0.6 percentage points respectively. Hence, increasing smallholders' landholding size has potential to increase minimum tillage use rates.

Lastly, we find that if last year's rainfall was below average for that area, farmers were more than twice as likely to use ripping the following year. If last year's rainfall was above that area's average, farmers were less likely to use either ripping or planting basins. While all of these results were statistically significant and had large effects on the percentage change in the probability that a farmer would use minimum tillage practices, all of these effects were quite small in absolute terms because such a small proportion of farmers used either planting basins or ripping in any area of Zambia (below 10% in almost all districts).

Further, in districts where the Conservation Farming Unit (CFU) has been promoting minimum tillage practices through their extension programmes, households were 3.3 percentage points, on average, more likely to use ripping, which more than doubles the likelihood that a farmer would use that practice. By contrast, the CFU's presence had no significant influence on farmers' likelihood to use planting basins, mostly because for the period under consideration, the CFU has been actively promoting ripping, including mechanized ripping and facilitating provision of tractor ripping services. Persistent cattle disease outbreaks was found to hamper these efforts; farmers in districts recording major cattle diseases over the last 10 years were significantly less likely to use ripping than in districts not experiencing cattle disease, all else constant. However, ripping is used by so few farmers in almost all districts that in absolute terms, there is only a small difference in the use of ripping between districts experiencing cattle disease and those not experiencing such disease. Low access to draft animals and equipment may further explain this result, indicating that animal disease control, restocking programs, and programs for promoting farmers' access to draft equipment (e.g., rental markets) may all be necessary to appreciably increase the use of animal-drawn ripping.

We also estimated double hurdle models¹ to determine the factors influencing the amount of land that farmers cultivated using basins, ripping and/or MT in general. The variables that were significantly associated with the amount of land devoted to these minimum tillage practices were male-headed households, farmers' landholding size, drought in the prior crop season, and whether the CFU had been operating its minimum tillage promotion programmes in that district.

CONCLUSIONS AND POLICY IMPLICATIONS: Despite having been actively promoted for over two decades, less than 5% of Zambia's smallholder farmers used either ripping or planting basins as of 2012. Even in the top 10 districts ranked according to the percentage of minimum tillage users, only 8% of farmers used either form of minimum tillage. This indicates that minimum tillage practices as currently promoted are proving difficult for farmers given the resource constraints that they face. Research is needed to consider how the practices may need to be modified or complemented with other activities to achieve substantially greater and more consistent use by farmers. Focus group discussions suggest that low use rates are associated with farmers' labour constraints; difficulties in affording herbicide in managing weed growth (which appear to be more of a problem with planting basins than with conventional land preparation techniques); abundant crop-season rainfall, which may provide lower returns to usage of minimum tillage practices; and cattle disease (in the case of ripping). While some research indicates that farmers can benefit greatly from adopting these minimum tillage practices, the fact that such low use rates persist even after decades of active promotion suggests the need for sober stock-taking about how to make minimum tillage fit better within Zambian farmers' resource constraints and other types of programs and interventions that would support the profitable and consistent use of these practices.

¹ Full results are presented in a working paper available at <http://fsg.afre.msu.edu/zambia/wp82.pdf>

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