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Conservation Farming Adoption among Smallholder Cotton Farmers in Zambia, 2002 to 2011

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Key Points/Summary

- Adoption of conservation tillage systems appears to be increasing among Zambian cotton farmers, albeit slowly: the adoption rate went from 11% in 2002 to 13% in 2011.
- Ripping with oxen is the most common and fastest growing conservation tillage technique, increasing from 3% in 2002 to 8% in 2011. Conversely, hand hoe planting basins are becoming less popular: and its adoption rate during the same period reduced from 8% to about 4% over the same period.
- Adoption levels correlate with the number of years a technique has been promoted as well as with sales of herbicides and other complementary equipment.
- Adoption rates are higher where the lead farmers are using conservation farming techniques on their own land.

INTRODUCTION: Despite widespread enthusiasm about conservation agriculture (CA) in Africa, empirical evidence on adoption remains fragmentary. Available studies suggest that adoption of CA practices in Africa remains spotty and generally low (Rockström et al. 2009; Giller et al. 2009). In Zambia in 2002, after seven years of CA promotion, adoption rates ranged between 3% and 11%, depending on agro-ecological conditions and area-specific levels of past promotional support (Haggblade and Tembo 2003). Some international experts openly question the potential for widespread adoption of conservation farming in Africa (Giller et al. 2009). Because soil inversion under conventional tillage (by tractor, plow, or hand hoe) results in early season weed suppression, they note that minimum tillage CA systems lead to increased weed pressure, and hence CA performance (and, hence, adoption) may hinge on the availability and cost of herbicides. Other observers, however, consider prospects more promising, suggesting that regions such as Southern Africa have already reached an advanced stage of early CA adoption (Friedrich and Kassam 2011).

DATA AND METHODS: This study presents results from a survey of 1,452 cotton company lead farmers and buyers[1] detailing land preparation practices on their fields and among the 135,000 cotton farmers they supervise. Field investigations focused on Zambia's two largest cotton companies, NWK Agri-Services (formerly Dunavant) and Cargill, which together accounted for 78% of total cotton production in 2011. This study updates a 2002 census of NWK's cotton farmer distributors detailing the land preparation practices of the farmers they oversaw. During the 2002 survey, investigators interviewed 1,400 NWK distributors to learn about the use of conservation farming (CF) systems among distributors and the farmers they supervised. Therefore, use of a comparable survey instrument in 2011 enables estimates of changes over time of CF adoption. In order to statistically assess the determinants of CF adoption and non-adoption, a Tobit regression model has been applied to evaluate the impact of factors likely to influence the use of minimum tillage systems.

In 2011, 13% of Zambia's cotton farmers practiced some form of conservation tillage systems on their cotton plots. The ox-drawn ripper proved most popular, at 8% followed by hand hoe basins and the recently introduced tractor-drawn ripping services.

[1] Buyers are Cargill employees who are front runners in seed cotton production. They give inputs, provide extension services to the farmers and also buy seed cotton from them.

Table 1. Percent of Farmers Adopting CF Systems on Cotton Plots, 2002 and 2011

	2002	2011		
Land Preparation	NWK	NWK	Cargill	Total
	%			
Conservation farming				
Hand hoe basins	8	5	3	4
Ox ripping	3	9	6	8
Tractor ripping	0	2	1	1
Total using some CF	**11**	**16**	**10**	**13**
Conventional tillage				
Hand hoe	35	23	39	29
Plowing	54	62	51	58
Total using conventional methods	**89**	**85**	**90**	**87**
Total farmers				
Percent	100	100	100	100
Number in study	75,454	81,302	53,469	134,771

Source: Authors' Survey; Haggblade and Tembo 2003.

STUDY FINDINGS: Over the roughly one decade interval between 2002 and 2011, CF adoption levels appear to have increased in the aggregate. Among the most directly comparable population group – the NWK farmers, for whom we have information in both years – the overall adoption of CF practices increased by about one-third, from 11% to 16%. The biggest gain occurred in ox-ripping, which has tripled (from 3% to 9% of NWK farmers) over that interval. These gains in animal traction CF coincided with the period when major promotional efforts occurred in the form of both extension training and physical distribution and sale of rippers by the cotton companies and the Conservation Farming Unit (CFU). Tractor hire ripping services have also increased, from zero to about 2% of NWK farmers following the first wave of tractor distribution.

In contrast, the use of hand hoe CF basins, the centrepiece of early CF technology development and promotion activities in the 1990s, has declined. Among NWK farmers, CF basins usage has fallen from 8% to 5% of group cotton farmers. Conventional hand hoe tillage has likewise declined over the past decade, from 35% to 23% among NWK cotton farmers. This parallel decline in both forms of hand hoe tillage suggests that early preferences for CF basins may have stemmed at least in part from shortage of draft oxen. As cattle populations have recovered from diseases and drought (Lubungu and Mukuka 2013), both plowing and ox-drawn ripping have increased.

The lead farmers selected by NWK as cotton group distributors and the buyers employed by Cargill have adopted CF tillage practices at higher levels than their group members. Distributors and buyers plant 21% of their cotton area under CF tillage systems, compared to about 13% among the rank and file cotton farmers. In contrast, ordinary farmers devote more than three times as much cotton area to conventional hand hoe tillage than do their distributors and buyers. Because NWK selects its best performing cotton farmers as distributors, group members respect these lead farmers for their recognized superior performance. To the extent that distributors' behaviour influences that of their group members, the current adoption differential suggests that CF adoption among ordinary cotton farmers may continue to move higher in coming years.

Another key finding from this study is that CF practices introduced by the cotton farmers on their cotton fields appear to spill over into maize and other crops. For instance, they planted 17% of maize and 11% of legumes and other crops under CF cultivated area, though at lower rates than 21% of cotton under CF cultivated area. Given that cotton is a long-cycle crop, these tillage differentials suggest that lead farmers consider the dry season land preparation and early planting under CF useful for crops but most important for cotton.

Econometric analysis examines the influence of four sets of external factors on farmer adoption decisions. The first set of explanatory variables measures knowledge of CF practices. As proxies for farmer awareness of CF management practices, the Zambia data provide information on the number of CFU staff operating in each district as well as the number of years the CFU has operated in each district. Staffing in 2011 ranged from zero to 12 per district, while duration of CFU extension

presence ranged from zero to 15 years. The second set of influences concern the lead farmers that serve as distributors and buyers charged with transmitting extension messages, and providing management advice and inputs to their group members. The distributors' and buyers' experience with CF technologies ranged from zero to 17 years, while the percent of their cotton area under CF varied between zero and 100%.

The third set of factors influencing farmer uptake of CF practices concerns input availability. Herbicides sales defined as quantity of herbicides per litre sold to a farmer is critical for handling weed pressure under minimum tillage systems. The quantity of herbicides ranged from zero to 10 litres per farmer. Distribution of ox-rippers during the five-year period from 2006-2011 ranged from zero to 16 per hundred farmers. Finally, the availability of tractor ripper services, oxen, and human labour power shape opportunity sets available to smallholder farmers. Presence of tractor ripper, newly introduced technology, ranged from zero to 7 per depot[2]. The prevalence of draft animal utilization ranges from zero to 100% across Zambian's cotton farmer groups.

Because the organizational structures of Cargill and NWK field operations differ considerably, regressions for each company were done separately. Results from the NWK regressions suggest that all the four sets of environmental variables significantly influence CF adoption decision. Both the number of years of CFU presence in a district and distributor experience with CF significantly influences aggregate adoption levels. On average, cotton farmer groups, in which the distributor practices CF, experience 16% higher adoption among group members than do groups in which the lead farmers practice conventional tillage. When distributors use CF basins, their group members are more likely to use basins. When distributors use ox-drawn rippers and tractors, their group members are more likely to use these same forms of mechanization. This suggests a powerful demonstration effect, coupled no doubt with more active and informed CF promotion by distributors who practice CF in their own fields. These results underline the importance of early CFU extension efforts, which from the very first season in 1996 focused on running on-farm trials and demonstrations with lead cotton farmers. Over and above their influence via distributors, each additional year of CFU staff presence in a given district increases aggregate CF adoption by 0.5%.

Complementary inputs also make a significant difference in CF adoption. Recent moves to distribute herbicides through cotton company input depots perceptibly increase CF adoption rates. In the NWK depots, each additional liter of herbicide per farmer sold increases CF adoption by about 2%.

Distribution of ox-rippers through the company supply depots and the provision of tractor ripping services by lead farmers, likewise, increase adoption of animal traction CF. Increased availability of tractor ripping services reduces the use of CF basins. A similar pattern emerges with oxen. Where oxen are prevalent, the use of CF basins falls significantly. These findings suggest that cotton farmers prefer ox and tractor ripping over hand hoe CF basins. Given that they are by definition commercial farmers, cotton farmers opt for these non-human energy sources in locations where those options are available. This suggests that early CFU efforts to promote hand hoe CF basin packages served an important purpose during the 1990's in locations where cattle populations had been depleted by disease and drought. As livestock populations have recovered and as tractor ripping services have become available, CF cotton farmers have switched from basins to oxen or tractor-drawn ripping.

The Cargill results support these same general findings, though they are less robust because of large group sizes and, hence, smaller number of groups and smaller statistical sample size. The importance of the distributors' and buyers' example in promoting CF adoption emerges as highly significant and quantitatively similar in the Cargill regressions, at 16%, which is the same as in the NWK results. The importance of cattle availability for adoption of ox-drawn ripping and the associated decrease in CF basins, likewise, emerges as statistically significant.

CONCLUSION: Conservation farming adoption rates appear to be increasing among Zambian cotton farmers for the last decade, though at a slow rate from 11% in 2002 to 13% in 2011. The adoption rate of the ox-ripping technology increased by a factor of 2.7, while the adoption rate of hand hoe basins decreased by a factor of 2. And the CF practices among cash cropping cotton farmers have spilled over to food crops, though at lower levels than cotton. The adoption levels of conservation farming tillage systems correlate with

[2] Depot/Shed means the area which the distributors or buyer overseas.

years of promotion and herbicide and equipment sales. This is because herbicide use helps in solving the weed pressure which farmers face especially on conservation farming plots (Price and Kelton 2011). Furthermore, adoption rates are higher where the lead farmers are using conservation farming techniques on their own land.

From the policy standpoint, the following are the policy recommendations from this analysis: Firstly, the importance of lead farmers in the on-farm testing, demonstration and extension cannot be ignored. Zambia's lead cotton farmers adopt CF practices at a higher rate than average cotton farmers and prove to be highly influential in shaping the agronomic practices of their group members. Therefore, there is need to identify influential farmers as a conduit for promoting conservation farming practices as that would enhance the adoption of the same. Secondly, the results show that herbicides use has a positive and significant influence on CF adoption. Government and other stakeholders have to devise strategies of promoting the safe use of herbicides by farmers in order to enhance the adoption of CF. Finally, the use of ox-ripping and tractor ripping are on the increase and are likely to continue to grow as adoption of CF increases. Government could consider promoting CF adoption by reducing taxes on steel used in the production of Magoye rippers in order to encourage private companies to get engaged in the production of the same. During the time cattle populations declined, ox-ripping was less pronounced than in recent years. The increase in the use of ox-ripping could have been a result of increasing cattle populations in the country. Therefore, Government and other stakeholders should enhance existing disease prevention strategies such as investing in the development of dip tanks in all cattle rearing area, and promoting vaccination programs in order to reduce cattle deaths due to preventable disease.

REFERENCES

Friedrich, T. and A. Kassam. 2011. Conservation Agriculture: Global Perspectives and Development. Presented at the Conservation Agriculture Regional Symposium for Southern Africa, 8-10 February. Johannesburg, South Africa.

Giller, K.E., E. Witter, M. Corbeels, and P. Tittonell. 2009. Conservation Agriculture and Smallholder Farming in Africa: The Heretics' View. *Field Crops Research* 114: 23–34.

Grabowski Philip, Steven Haggblade, Stephen Kabwe, Gelson Tembo. Under Review. *Conservation Farming Adoption among Smallholder Cotton Farmers in Zambia, 2002 to 2011*. (This Policy Brief is derived from this paper.)

Haggblade Steven and Gelson Tembo. 2003. *Development, Diffusion, and Impact of Conservation Farming in Zambia*. FSRP Working Paper No. 8. Lusaka, Zambia: FSRP.

Lubungu Mary and Rhoda Mofya Mukuka. 2013. *The Status of the Smallholder Livestock Sector in Zambia*. IAPRI Technical Paper No. 1. Lusaka, Zambia: IAPRI.

Price, A.J. and J. Kelton. 2011. Weed Control in Conservation Agriculture. In *Herbicides, Theory and Applications*, ed. S. Soloneski and M. Larramendy. Rijeka, Croatia: Intech Press.

Rockström, J., P. Kaumbutho, J. Mwalley, A.W.M. Nzabi, M.L. Temesgen, L. Mawenya, J. Barron, J. Mutua, and S. Damgaard-Larsen. 2009. Conservation Farming Strategies in East and Southern Africa: Yields and Rainwater Productivity from On-farm Action Research. *Soil and Tillage Research* 103: 23-32.

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