POLICY SYNTHESIS

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PRODUCTIVITY IMPACT OF CONSERVATION FARMING ON SMALLHOLDER COTTON FARMERS IN ZAMBIA

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Key Points

• Conservation farming offers a package of improved agronomic practices – including early land preparation, early planting, early weeding, careful field measurement and precision input application – that enable resource-poor farmers to raise productivity through improved farm management.

• Zambia's cotton farmers own fewer cattle and earn only about 25% as much nonfarm income as non-cotton farmers, thus limiting their ability to hire labour and purchase cash inputs.

• This paper evaluates a series of conservation farming technology packages as possible vehicles for incrementally raising productivity and incomes among asset-poor farm households in Zambia's cotton zone, where a majority of farm families till with a hand hoe and where conservation farming is most well established and best suited agronomically.

• The results suggest that conservation farming can increase crop income by 140% among the poorest smallholder cotton farmers, with no access to cash inputs.

• A second category of farm households, using purchased input costing $60 per season, can increase crop income a further 40% under hand hoe conservation farming.

• Adding herbicides to the standard CF input package, at a cost of $130 per season, enables farm households to quadruple crop income compared to low-input conventional tillage.

• Area expansion made possible under conservation farming accounts for between one-third and one half of these income gains.

• Because this area expansion requires a large increase in dry season land preparation labor, seasonal employment competition with nonfarm activities strongly influences the magnitude of income gains attainable under conservation farming.

Figure 1. Typical Smallholder Cotton Farmer: Resources Include Family Labour and a Hand Hoe

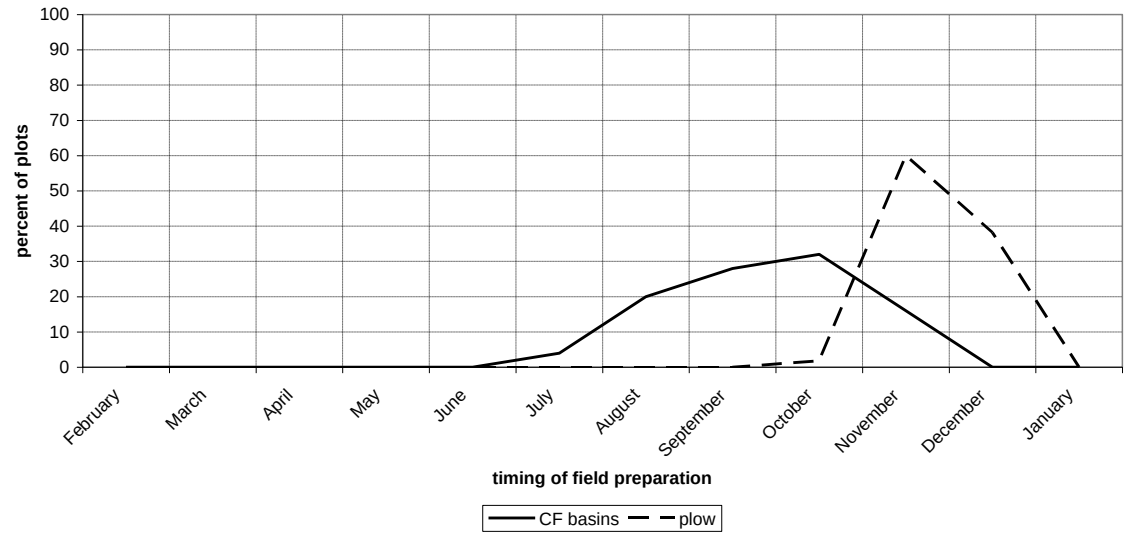
Introduction

Low agricultural productivity lies at the heart of continued widespread hunger and poverty in Africa. This policy synthesis examines conservation farming as a possible vehicle for incrementally raising the productivity and incomes of resource-poor farm households in Zambia's cotton zone, where a majority of farm families till with a hand hoe, where livestock disease and household financial constraints severely limit animal traction, and where family labor constraints limit cultivated area to roughly one hectare per household.

The paper aims to quantify two productivity-enhancing dimensions of conservation farming. The first involves increases in land productivity (yield) achieved through a variety of agronomic practices, including early planting, soil organic matter retention and leguminous crop rotations. The second but much-less-discussed benefit of conservation farming involves area expansion made possible by reducing peak season labor bottlenecks. Under rainfed agricultural production, common throughout most of Africa, labor bottlenecks at planting and weeding times often critically constrain farm output. During the four to six week period following the first rains, farmers must prepare their soil, plant crops and conduct the critical first weeding. Under conservation farming, reduced soil disturbance allows dry-season land preparation, thus enabling farmers to reallocate heavy land preparation to the slack agricultural season (Figure 1). Right after the first rains, during the peak agricultural season, they are able to concentrate household labor on early planting and early weeding of expanded areas. This increases peak season labor productivity by allowing farm households to cultivate greater areas with available household labor.

Using micro-economic evidence from Zambia's cotton belt, this synthesis reports results from a linear programming model developed to measure the magnitude of these yield and area gains as well as the consequent changes in income under different conventional and conservation farming packages (Haggblade, Kabwe and Plerhoples 2010). The analysis examines households with varying sets of resource constraints and evaluates prospects for moving them up the economic ladder towards higher productivity, more commercially oriented agriculture.

Figure 1. Timing of cotton farmers' land preparation, by tillage method, Zambia 2001



Source: Haggblade and Tembo (2003).

Agronomics of Conservation Farming

Conservation farming (CF), as practiced in Zambia, involves a package of several key practices: dry-season land preparation using minimum tillage methods; crop residue retention; seeding and input application in fixed planting stations; nitrogen-fixing crop rotations; and reduced but precise doses of mineral fertilizer. Given dry season land preparation, CF farmers prepare their fields two to three months earlier than farmers practicing conventional tillage (Figure 1).
As a result, CF farmers are able to manage larger areas than they could under conventional tillage by planting early and then concentrating available household labor on weeding their expanded plots.

Most studies of conservation farming document substantially higher yields on CF plots – often double those achieved under conventional tillage. Though gains vary across locations and over time, evidence from central Zambia suggests that about 25% of observed gains under conservation farming stem from higher input use, another 25% from early planting and about 50% of the yield difference stems the combination of other CF cultural practices –the build-up of soil organic material and concentration of nutrients in the basins, and the water harvesting effects of the basins during the sporadic rainfall common in semi-arid zones of Africa (Haggblade and Tembo, 2003).

Cotton and Conservation Farming

Cotton farmers constitute the single largest group of CF adopters in Zambia, adopting CF at roughly double the rate of non-cotton farmers (Haggblade and Tembo, 2003). Indeed, Zambia's Conservation Farming Unit (CFU) focused its first decade of field trials, demonstrations and extension efforts in the cotton belt of Central Province, attracted by the discipline of the cotton farmers and the Dunavant cotton company's willingness to financially support CF extension farmers.

The mutual attraction between cotton and conservation farming arises, in large part, because the CF practices of early land preparation, early planting, early weeding, precise field layout and careful input application coincide with best-practice management for cotton production. Because cotton is long-cycle crop, early planting is critical to achieving good yields.

The discipline required for successful cotton production likewise meshes well with the disciplined management required by conservation farming. Because cotton production demands careful attention to planting date, regular weeding, constant spraying and insect monitoring, as well as repeated careful hand harvesting, cotton farmers constitute a self-selected group of diligent, hard-working, professional small farmers.

Analytical Methods

To quantify the potential productivity gains available from the adoption of alternate technology packages, the following analysis applies standard linear programming methods. The basic model maximizes crop income, given fixed input-output coefficients and subject to a set of household asset constraints on farm labor, land and cash.

Table 1. Asset Holdings by Farm Size, Agro-Ecological Zone 2a

	Land (ha/hh)		Labor		Cattle (per hh)		Tractors	Net Income ($/hh)		
Farm Size	total*	cultivated	hh size	FTE**/hh	total	trained oxen	(per hh)	Nonfarm	Farm	Total
Farming households not growing any cotton										
Smallest 1.5 ha or less	0.9	0.8	5.3	1.6	2.6	0.4	0.1	209	161	370
Total All non-cotton farme	2.1	1.7	5.8	1.9	3.5	0.6	0.1	259	333	593
Cotton farming households in AEZ2a										
Smallest 1.5 ha or less	1.1	1.1	5.2	1.8	0.7	0.2	0.0	35	203	238
Total All cotton farmers	2.7	2.4	6.1	2.0	0.7	0.0	0.0	84	494	578

* total land = cultivated land plus fallow land.
** FTE = full-time adult male labor equivalent.

Source: Haggblade, Kabwe and Plerhoples (2010).

Table 2. Impact of Alternative Conservation Farming Technology Packages on Smallholder Farms

		Hectares Cultivated	Crop Income ($US)	Input cost ($US)	Labor inputs (days) peak	Labor inputs (days) total	Returns to Labor ($/day) peak	Returns to Labor ($/day) total
Cash-constrained households								
Hand hoe								
conventional	1a	1.02	173	0	43	111	$4.01	$1.56
CF basins	2a	1.43	421	0	43	204	$9.74	$2.06
Cash available for purchased inputs								
Conventional tillage								
hand hoe	1c	1.00	203	81	43	123	$4.69	$1.64
plow rental	1e	1.85	266	209	43	173	$6.17	$1.54
Conservation farming								
CF basins	2c	1.47	495	61	43	225	$11.46	$2.20
CF ripper rental	2e	1.47	458	98	43	182	$10.61	$2.51
CF basins + herbicides	2l	2.71	879	129	43	346	$20.35	$2.54

Source: Haggblade, Kabwe and Plerhoples (2010).

Impact of CF on Smallholder Incomes

The smallest 30% of cotton farmers cultivate a total of roughly 1 hectare each: 0.5 hectares of maize, 0.1 hectares of groundnuts and 0.4 of cotton hectares of cotton.

Cash constraints limit the choices available to many of them. Compared with non-cotton growing households in AEZ2a, the smallest cotton farmers earn only about 20% as much nonfarm income (Table 1). For these cash-constrained farm households, low-input conservation farming enables yield gains of about 40% on cotton and maize as well as area expansion from 1 to 1.4 hectares, using only household labor (Table 2, Simulations 1a and 2a). Under these conditions, total crop income more than doubles, from $170 to $420 per year.

A second category of farmers, with the capacity to finance cash inputs of about $60 per season, can access high-input CF maize and groundnut packages along with the standard company-financed cotton packs. Together, these CF packages more than double household crop income, from about $200 under conventional hand hoe production to $495 per season (Table 2, 1c and 2c).

Adding herbicides to the standard CF hand hoe packages enables smallholder farmers to increase cultivated area much further, to as much as 2.7 hectares, potentially quadrupling crop income. Farmer-financed herbicides, fertilizer and seeds costing $130 per season generate crop income of $880 per season (Table 2, Simulation 2l).

Policy Implications

Zambia's cotton farmers constitute a large group of cash-poor but disciplined smallholder households well positioned to benefit from conservation farming. They combine the management skills and motivation required to succeed under conservation farming. Given the prevalence of peak season labor bottlenecks in rainfed African agriculture, herbicides merit serious consideration as a means of raising smallholder income. Furthermore, given the paucity of off-season nonfarm income-earning opportunities available to them, smallholder cotton farmers are able to transfer land preparation labor to the dry season, as required under CF, without affecting dry season nonfarm earnings. As a result, conservation farming offers an array of technology packages with the potential to double or even quadruple crop income among this large group of disciplined but resource-poor small farms.

References

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