Agro-economic Performance of Mechanized Conservation Agriculture in Zambia

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Introduction

- Conservation agriculture (CA) is a climate-resilient and sustainable practice fit to enhance food security across sub-Saharan African (SSA)
- Despite the evidence of CA's positive benefits, adoption has been limited due to lack mechanization making it labour intensive
- This study investigated the potential differences between mechanized conventional and conservation tillage practices on operation time, fuel consumption, labour costs, soil moisture retention, soil temperature and crop yield
- This is the first large-scale on-farm mechanized experiment comparing CA and conventional tillage performance in Zambia

Methods

- The study was done in the Central Province of Zambia (annual rainfall 800-1000mm) and red-brown acrisols) for the 2019-2020 and 2020-2021 seasons

Table 1. Summary of experimental treatments and agronomic applications.

Crop	Maize	Soybean
Main plot (ha)	8	7
Experimental unit plot (ha)	0.6	0.5
Seed variety	SC 633	SC Safari
Plant spacing	75x25cm	75x5cm
Seed rate (kg/ha)	25	80
Expected plant population	53000	266000
Basal fertilizer rate (kg/ha)	300	225
Top-dressing rate (kg/ha)	200	100
Tillage treatments	Disc-harrowing, Ripping and No-Till, each four replicates based on RCBD	

- All farm operations were done using a 2WD 60hp tractor and specific implements; the crops were rotated in the subsequent season
- Statistical analysis: after testing normality, we used ANOVA based on RCBD and F and LSD tests using Minitab 18 software

Results

- No-till plots recorded higher soil moisture retention than the disc-harrowed plots (Fig. 1)
- Soil temperatures were higher in disc-harrowed plots across the soil profile

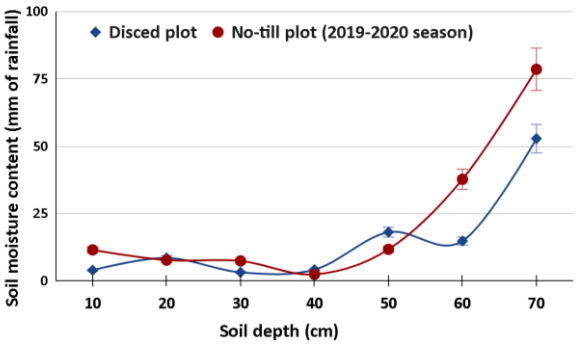

Figure 1. Volumetric soil moisture content (m^3/m^3) comparison between no-till and disc-harrowed plots across 10-60 cm soil profile.

Table 2. Maize and soya beans yield and rainfall-use efficiency for two seasons.

Crop	Tillage type	Crop yield (kg/ha)		Rainfall-use efficiency ($kgmm^{-1}$)	
		2019-2020	2020-2021	2019-2020	2020-2021
Maize	Disc-harrowed	7,792[a]	10,858[a]	11.07[a]	10.17[a]
	Ripped	7,873[a]	10,018[b]	11.18[a]	9.38[b]
	No-till	7,802[a]	9,751[b]	10.08[a]	9.13[b]
	p-value	0.969	0.003	0.967	0.003
Soyabean	Disc-harrowed	2,843[a]	2,678[a]	3.98[a]	2.51[a]
	Ripped	2,997[a]	2,669[a]	4.20[a]	2.50[a]
	No-till	3,120[a]	2,661[a]	4.37[a]	2.49[a]
	p-value	0.499	0.985	0.500	0.985

Note: Rainfall data per season: 2019/2020 – 714 mm; 2020/2021 – 1068.2 mm

- CA practices recorded relatively higher yields and rainfall-use efficiency in the dry season
- Maize yield under conventional disc-harrowing was significantly higher in the wet season

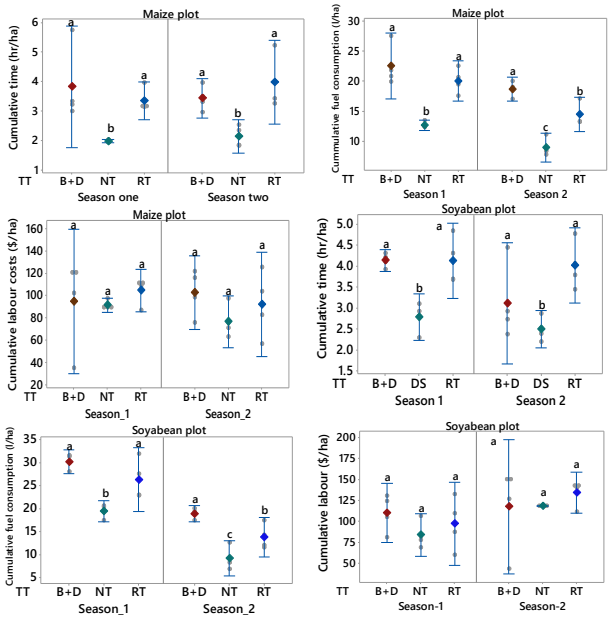

Figure 2. Mean individual plots of time, fuel and labour. 'a' are significantly different at p≤0.05, LSD-test. B+D-residue burning plus disc-harrowing, RT-ripping tillage & NT-No-till.

- Significant differences in operation time (hr/ha), fuel consumption (l/ha) and labour ($/ha) were recorded between no-till and ripped and disc-harrowed plots in the two seasons

Conclusion

- No-till and soil cover significantly enhances water infiltration and retention in dry season than the conventional disc-harrowing practice
- CA practices higher yields in dry season show their fit for rainfall deficient areas compared to conventional practices
- CA's time and labour constraints can be overcome by the use of mechanization thus saving fuel use and harnessing increased productivity (Mupangwa et al., 2017)
- Mechanized CA has positive short-term impacts on overall crop yield, soil and water conservation and profitability

References

- Mupangwa, W., Mutenje, M., Thierfelder, C., et al., 2017. Productivity and profitability of manual and mechanized conservation agriculture (CA) systems in Eastern Zambia. Renewable Agriculture and Food Systems, 1–15

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