Improving animal-powered reduced tillage systems in Zimbabwe

by

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Abstract

Low cattle numbers and poor cattle condition at the start of the rainy season increase the time taken for land preparation, resulting in delayed maize establishment. This has contributed to low yields, particularly for farmers who do not own cattle and therefore must wait for other farmers' cattle to become available. On-farm trials were undertaken to try to alleviate the problem. Using an animal-drawn ripper tine in combination with a herbicide increased maize yields in the Mangwende Communal Area of Zimbabwe. The system appeared economically appropriate, mainly due to a decrease in labour requirements at planting and weeding. Labour is a critical limiting factor during these periods.

Introduction

The Farming Systems Research Unit (FSRU) of the Department of Research and Specialist Services, Zimbabwe, was established in 1984 to study communal area farming systems.

According to a survey by FSRU in these areas, low cattle numbers and poor cattle condition at the start of the rainy season result in insufficient draft power (FSRU, 1985; Shumba, 1985). This has contributed to low maize yields particularly for non-cattle owners (GFA, 1987). The same survey also established that there were labour bottlenecks during planting and weeding periods. Some farmers were found to be "winter plowing" in March to May soon after harvesting and when moisture is still available.

Trials and methods

In order to capitalise on the existing "winter plowing" practices, a trial was initiated in the 1983/84 season using a ripper tine. In this trial a ripper tine was compared to the conventional use of plowing before planting. The use of a herbicide compared to hand weeding was superimposed on this trial. In the first season, 1983/84, the trial was conducted on eight sites that were divided into three groups according to rainfall pattern (Table 1).

Results

The results from this trial are shown in Table 2. The amount and distribution of rainfall received in January had a strong influence on overall crop performance. The January period coincided with the tasselling and silking period since the crop was planted in the second half of November at most sites. January rainfall also influenced the effects of individual treatments on yield.

The tine treatment significantly out-yielded the conventional tillage treatment in rainfall group 1. The yield increase was not significant in rainfall groups 2 and 3.

Since the ripper tine was associated with deeper penetration and basal fertiliser application at planting it might have resulted in deeper root penetration. This might have allowed the crop to cope better with the dry January period. Planting for both the tine and conventional plow was done on the same day at two sites in group 1, so that the increase in yield could not be attributed to differences in planting date.

Herbicide use significantly increased yield at the sites in rainfall groups 2 and 3. At one of the sites in group 1 it failed to work because it was applied

Table 1: Rainfall distribution in three grouped trial sites in Mangwende during the 1983/84 season

	Average rainfall (mm)						
Sites	*October*	*November*	*December*	*January*	*February*	*March*	***Total***
Group 1 (3 Sites)	28.3	55.0	126.6	40.0	123.3	100.8	**474.0**
Group 2 (2 Sites)	12.5	47.5	97.5	58.7	178.5	160.0	**554.7**
Group 3 (3 Sites)	18.5	52.5	119.5	109.2	156.2	98.5	**554.4**

Source: FSRU (1985)

under dry conditions (this explains the site by treatment interaction).

Economic implications

An economic analysis of the pooled data from this trial was carried out and the results are presented in Table 3. They show the highest net returns to labour for the treatment involving the ripper tine and herbicide. The lowest returns were for the treatment with ripper tine cultivation plus hand weeding.

Based on these results it might be appropriate for farmers to adopt the tine and herbicide technology. This will require less labour and draft power. Based on these results the trial was continued in the subsequent seasons, with farmers taking an active role in the management of the trial.

Follow-up trials and implications

After running the trial for six seasons, a survey was carried out in Mangwende in 1990 to see how the farmers were taking the ripper tine and herbicide technology (FSRU, 1991). It was established that farmers were very interested in the tine and saw no particular problems in using it.

Some farmers noted that they might have problems in using the herbicide. Cash problems for buying sprayers and the herbicide were associated with the technology. Some farmers expressed the wish to have credit to buy the sprayer and the herbicide.

To overcome the problems of herbicide use, farmers could profitably combine the tine with the use of an ox-drawn cultivator to control weeds. This would reduce the labour required for weeding and could enable more farmers to adopt the technology.

Table 2: Main effects of tillage and weed control methods on maize yield in Mangwende, 1983/84

	Mean yields (t/ha) and significance at each site		
	Group 1	*Group 2*	*Group 3*
Tillage			
Conventional plow	1.23	3.07	5.40
Ripper tine	1.73	3.25	5.76
Significance of treatment	P<0.01	NS	NS
Significance of site and treatment	NS	NS	P<0.01
Weed control			
Oxen/hand	1.51	2.82	5.25
Herbicide	1.45	3.50	5.92
Significance of treatment	NS	P<0.01	P<0.05
Significance of site and treatment	P<0.05	NS	NS

NS = not significant
Source: FSRU (1985)

In the 1990/91 season, a trial was run to compare the use of a herbicide with an animal-drawn cultivator. Two weeding regimes were employed:

- weeding at emergence, and emergence + 30 days
- weeding at emergence + 14 days and at emergence + 30 days.

The results of this trial are shown in Table 4. They show that there were no significant yield differences

Table 3: Economic analysis of maize tillage and weed control methods in Mangwende, 1983/84 season: pooled for all sites

	Conventional plowing		*Ripper tine*	
Criteria	*Hand weeding*	*Herbicide*	*Hand weeding*	*Herbicide*
Average yield of maize (t/ha)	4.65	4.78	4.03	5.20
Value of grain production (Z$)[1]	501.74	515.74	434.84	563.24
Treament cash cost (Z$)[2]	0.00	25.03	2.41	27.44
Non-treatment cash costs (Z$)[3]	192.50	192.50	192.50	192.50
Total labour cost (Z$)	85.77	57.72	98.31	50.98
(Total labour cost (hours))	(393)	(282)	(439)	(266)
Net benefit (Z$)	223.47	240.49	141.62	292.32
Net returns to labour (Z$/hour)[4]	0.57	0.85	0.32	1.10

[1] Yields were reduced by 10% to reflect the difference between experimental yields and farmers' expected yields
[2] Costs included Z$16 for herbicide, fixed costs of tine and sprayer and opportunity cost on capital
[3] Costs included Z$169 for 600 kg fertilizer, Z$7.5 for 5 kg Dipterex and Z$16 for 20 kg hybrid seed
[4] Returns calculated from (value of grain production – total costs)/labour hours
US$1 ≈ Z$3 (1984)
Source: FSRU (1985)

Table 4: Main effects of weed control methods on maize grain yield in Mangwende, 1990/91

	Yield at location (t/ha)			
Treatment	*Zihute*	*Musami*	*Muchinjike*	*Mean*
Herbicide (Atrazine)	4.40	5.06	3.23	4.23
Cultivator at emergence and 30 days later	5.55	3.80	3.27	4.20
Cultivator at 14 and 30 days after emergence	5.43	4.55	3.63	4.55
Significance (NS = not significant)	NS	NS	NS	
CV%	15.7	12.6	13.7	

between the treatments. This suggests farmers could use either method depending on the most important limiting factor for them. Thus cattle owners could easily use the tine and animal-drawn cultivator technology. Other farmers could use herbicides, and the least cost analysis suggested that farmers can benefit from using the tine and herbicide combination. The results of the economic analysis are shown in Table 5.

The 1990 survey identified that ripper tines were not available in the local shops, making it difficult for farmers to purchase them. To test the potential adoption rate of the technology, some tines were distributed to extension workers in Mangwende. The results will be assessed before encouraging the manufacturer to produce more tines.

References

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Table 5: Economic analysis of the three weeding methods after ripper tine cultivation

Criteria	*Herbicide*	*Ox weeding 0 and 30 days*	*Ox weeding 14 and 30 days*
Yield of maize grain (kg/ha)	4228	4202	4553
Variable costs (Z$)			
Cost of herbicide (2.5 litres/ha) (Z$)	49.13	–	–
Labour for applying herbicide (Z$)	2.25	–	–
Cost of hiring sprayer (Z$)	5.00	–	–
Cost of ox cultivating (Z$)	–	154.00	154.00
Cost of hand weeding (after cultivating) (Z$)	–	16.88	33.75
Total variable costs (Z$)	**56.38**	**170.88**	**187.75**

The prices used to compile the partial budget were as follows: Cost of Atrazine = Z$19.65/litre
Labour for applying the herbicide = Z$5/day; Time for herbicide application = half day/ha
Hiring sprayer = Z$5/day; Cost of cultivating = Z$77/ha; Weeding (after cultivating) = Z$16/ha
US$1 ≈ Z$5 (1991)