An economic evaluation of weed management options for cotton-based farming systems in Muzarabani

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Summary On-farm trials were carried out in Muzarabani to assess the costs of different weed management options. The treatments were grouped into two options, mechanical and non-mechanical. Some of the treatment combinations included pre-emergence herbicides, alachlor and cyanazine tank mixed, applied overall or in a 30 cm band application along the crop row in combination with ploughs, cultivators and hoes for inter-row weeding. Overall, herbicide and herbicide combined with ox cultivator were the lowest cost weed management options. The highest productivity was achieved with overall herbicide and hand hoe combined with ox-cultivator.

Keywords Cotton, weed management.

INTRODUCTION

Excessive weed growth is a critical factor limiting smallholder crop production in Zimbabwe (Chivinge 1984). Focus group discussions with farmers in the Muzarabani district, Zambezi Valley, where 95% of households produce cotton, identified weed control as a major problem limiting yield, the total area cultivated and therefore productivity of the farming system (Chatizwa *et al.* 2000). Weeds which were found to be common and problematic in Muzarabani, were button weed (*Boerria scabra* (Schumach & Thom) K.Schum), wild basil (*Ocimum canum* Sims), late weed (*Trichodemsa zeylanicum* (Burm f.) R.Br.), rough love grass (*Eragrostis aspera* Jacq. Nees), Jute (*Corchorus olitorius* L.), *Vernonia poeskana* Vatke & Hilder., *Beorhivia erecta* L., *Sphaeranthus fleoxuosus* L., Guinea grass (*Panicum maximum* Jacq.), *Ceratotheca sesamoides* Endl., Silver spinach (*Celosia trigyna* L.) and garden urochloa (*Urochloa panicoides* Beauv.).

Many farmers are unable to control these weeds efficiently during the critical period, despite weeding 3–4 times per season. On-farm studies in the area have demonstrated significant yield gaps in both cotton and maize crops attributable to weed competition under farmers current weed management practices (Mavudzi *et al.* 2001a).

The findings from farmer group discussions, the yield loss study and other household characterisation work were used to design a series of researcher-managed and farmer-managed field trials focusing on alternative weed management options. The objective of the study was therefore to evaluate different weed management options that integrate the use of pre-emergent herbicide mixtures (alachlor + cyanazine) with hand-hoeing and implements drawn with draft animal power (DAP), cultivator/ox plough.

MATERIALS AND METHODS

On farm experiments were conducted during 2000–2001 and 2001–2002 seasons in the northeast of Zimbabwe. Treatments were allocated to farmers according to their resources which affect weed management.

Treatments allocated to farmers:

Non mechanical

1. Overall hand-hoeing at 3, 6, and 9 weeks after crop emergence (WACE).
2. Hand-hoeing of crop rows at 2 WACE followed by post-emergence application of cyanazine (550 g a.i. ha^{-1}) in the crop inter-rows at 3 WACE**.**
3. Pre-emergence application of cyanazine (550 g a.i. ha^{-1}) plus alachlor (960 g a.i. ha^{-1}) in 30 cm wide bands along the crop row at cotton planting, followed by inter-row hand-hoeing at 3, 6 and 9 WACE.
4. Pre-emergence application of cyanazine (550 g a.i. ha^{-1}) plus alachlor (960 g a.i. ha^{-1}) in 30 cm over the whole plot.

Table 1. Characteristics of household resource categories.

Resource group	Arable land	Cattle	Implements	Labour utilisation
RG1	+ 5 ha	>20	Tractor and full range	Hires labour
RG2	5 ha	5–15	Full range	Hires labour
RG3	<5 ha	Nil	Hoe, sprayer	Hires out labour
RG4	<5 ha	Nil	Hoe only	Hires out labour

Mechanical

5. Hand-hoeing at 2 WACE along the row followed by inter-row cultivation with an ox-drawn cultivator at 4 WACE.
6. Inter-row cultivation using an ox-cultivator at 3 and 6 WACE accompanied by hand-hoeing in the cotton row.
7. Inter-row cultivation using an ox-cultivator with mouldboard for at 3 and 6 WACE accompanied by hand-hoeing in the cotton row.
8. Inter-row cultivation using an ox-cultivator without the mouldboard at 3 and 6 WACE accompanied by hand- hoeing in the cotton row.
9. Pre-emergence application of cyanazine (550 g a.i. ha^{-1}) plus alachlor (960 g a.i. ha^{-1}) in 30 cm wide bands along the crop row at cotton planting and inter-row cultivation using an ox-cultivator with mouldboard at 3 and 6 WACE accompanied by hand-hoeing in the cotton row.
10. Pre-emergence application of cyanazine (550 g a.i. ha^{-1}) plus alachlor (960 g a.i. ha^{-1}) in 30 cm wide bands along the crop row at cotton planting and inter-row cultivation using an ox-cultivator without the mouldboard at 3 and 6 WACE accompanied by hand-hoeing in the cotton row.
11. Pre-emergence application of cyanazine (550 g a.i. ha^{-1}) plus alachlor (960 g a.i. ha^{-1}) in 30 cm wide bands along the crop row at cotton planting and inter-row cultivation using an ox-cultivator at 3 and 6 WACE accompanied by hand-hoeing in the cotton row.

The trials consisted of single strips of treatments with farms as replicates. The plot size was 300 m^2. Cotton cultivar Albar SZ 8714 was planted at all sites at a plant population of 33,333 plants ha^{-1}. Compound L (5% N, 18% P, 10% K) fertiliser was applied at a rate of 150 kg ha^{-1} and ammonium nitrate (34.5% N) was applied at 6 WACE at a rate of 100 kg ha^{-1}. Partial budgets were calculated for each weed management option based on average yields. Input and output values for both seasons have been based on market prices for 2001–2002 season.

RESULTS

Partial budget analysis

The trials in the first season showed no significant differences between yields. Overall herbicide application and banded herbicide along crop row in combination with an ox-cultivator for weeding inter-row were the lowest cost weed management options giving the highest productivity for non-mechanical and mechanical weed management options respectively. Highest returns to labour were derived from overall herbicide and ox-cultivator with or without a mouldboard (Table 2 Parts A and B).

The second season 2001–2002 gave similar results with no significant effect on yields. As in the first season, overall herbicide and herbicide combined with ox-cultivator were the lowest cost weed management options with highest productivity being achieved with overall herbicide and hand-hoeing combined with ox-cultivator. Highest returns to labour were derived from overall herbicide and ox-cultivator with or without a mouldboard. Sensitivity analysis indicates that the price and hence the availability of labour is key. When this is easily available (or not valued) traditional farmer systems (hand-hoeing and ox-cultivator accompanied with hand-hoeing) are the most productive. As the labour price increases, due to unavailability or opportunity elsewhere, herbicide systems become more productive**.**

DISCUSSION

The study indicated that a farmer needs to choose the most appropriate method according to resources. Resource group one who are well resourced have got a wide range of choice they can choose any option depending on the DAP availability, labour availability and the money for purchasing herbicides. Resource group 2 with limited labour but with DAP available can choose hand hoe along the crop rows and ox-cultivator this is because less labour is required and it was observed to be the second cheapest option. Farmers with limited DAP in RG2 ad RG3 can consider the option of applying a pre-emergence herbicide in combination with ox-cultivation; this was second list option which required less labour hours. Resource group 4 with limited labour and DAP can consider the use of herbicide either overall herbicide spray which is the cheapest option and requires less time or hand hoe along the crop row and apply cyanazine between the crop row which requires less labour, or they can plant an area that will be equivalent to the labour available so that they do not end up abandoning their fields. These trials have demonstrated that weeds can be adequately suppressed in cotton by timely use of a number of herbicide and non-herbicide weed control methods. The choice will be influenced by the resources available to the farmer.

Table 2 Part A. Partial budget analysis for non mechanical weed management options in the 2000–2001 season.

Treatment	Benefits	Weeding costs ($Z)						
	Yield kg ha^{-1}	Value	Labour	DAP	Labour for herbicide	Herbicide	Knapsack	Total
Non-mechanical								
1	1,557	93,420	13,400	–	–	–	–	13,400
2	1,557	93,420	11,750	–	150	2,175	800	14,875
3	1,557	93,420	8,900	–	150	1,262	800	11,112
4	1,557	93,420	3,050	–	300	2,740	800	6,890
Mechanical								
5	1,931	115,834	6,750	1,750	–	–	–	8,500
6	1,931	115,834	7,400	1,750	–	–	–	9,150
7	1,931	115,834	6,600	3,500	–	–	–	10,100
8	1,931	115,834	6,950	3,500	–	–	–	10,450
9	1,931	115,834	150	3,500	150	2,175	800	10,775
10	1,931	115,834	4,150	3,500	300	2,175	800	10,925
11	1,931	115,834	5,400	1,750	150	2,175	800	10,275

Table 2 Part B.

Treatment	Benefits less costs ($Z)			Returns ($Z h^{-1})
	Margin	Margin over farmer method	%	
Non-mechanical				
1	80,020	–	–	299
2	78,545	−1,475	2	334
3	82,308	2,288	3	462
4	86,530	6,510	8	1,419
Mechanical				
5	107,334	650	1	795
6	106,668	–	–	721
7	105,734	−950	1	801
8	105,384	−1,300	1	758
9	105,059	−1,625	2	1,266
10	104,909	−1,775	2	1,264
11	105,559	−1,125	1	977

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