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Weed growth and labor demand under hand-hoe based reduced tillage in smallholder farmers' fields in Zimbabwe

Justice Nyamangara*, Nester Mashingaidze[1,3], Esther Nyaradzo Masvaya[3], Kudzai Nyengerai[3], Machiweyi Kunzekweguta[3], Ronald Tirivavi[3], Kizito Mazvimavi[2,3]

International Crop Research Institute for the Semi-Arid Tropics, Matopos Research Station, P.O. Box 776, Bulawayo, Zimbabwe

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ABSTRACT

Conservation agriculture based on hand hoe dug planting basins has been widely promoted for the last decade or two in the smallholder farming sector of southern Africa targeting resource constrained households without access to draft power. In Zimbabwe planting basins are used by about one hundred thousand households but on small plots (<0.5 ha) although most are unable to adopt soil surface mulching and crop rotation due to competing uses for crop residues as livestock feed and poorly developed markets for other crops, respectively. We report on the effects of reduced tillage based on hand-hoe dug planting basins (PB) on weed growth (20 farms), and labor demand and returns to investment (50 farms) compared with animal-drawn mouldboard plough based conventional tillage (CONV) in maize (*Zea mays* L.) fields, across selected districts located in contrasting agro-ecological zones in Zimbabwe. Weed growth was assessed through a survey conducted at the end of the 2009/10 and 2010/11 cropping seasons. Labor demand and returns to investment were measured on 50 farms across five districts using direct observations during the 2011/12 cropping season. The survey showed that farmers on average weeded their PB plots 2.7 times per season compared to 1.7–1.9 times in CONV plots ($P < 0.001$), and timing was often delayed in the former. Reduced tillage plots had 17% ($P < 0.001$) more weed ground cover and 9% ($P < 0.05$) more weed dry matter compared with CONV plots in the 2009/10 season, and differences in 2010/11 were not significant. Weed growth was highest in semi-arid areas (natural regions III and IV) compared with wetter sub-humid areas (natural region II) and arid areas (natural region V). Farmers planted their PB plots 12–23 days earlier, weeding frequency was 42.1–58.9% higher in PB plots, compared with CONV. Labor demand was more than double under PB (84.7 man days ha^{-1}, weeding 48.1 man days ha^{-1}) compared to CONV (38.6 man days ha^{-1}). However, returns to investment were 42.7% higher under PB (U$1.77) compared with CONV (U$1.24). Weed growth and labor demand remained high under PB tillage even after several years, interventions such as the use of alternative weed control methods need to be introduced to farmers to reduce labor demand and consequently increase its adoption both in terms of number of farmers and cultivated area in southern Africa.

1. Introduction

The lack of effective weed management strategies by resource-poor smallholder farmers in southern Africa may be one of the main constraints to increasing crop productivity through conservation agriculture (CA). The CA package currently being promoted in southern Africa comprises continuous minimum tillage, at least 30% permanent or semi-permanent organic soil cover and the cultivation of a wide range of crops in a spatial or temporal crop association/sequence/rotation (Kassam and Friedrich, 2011; Nyamangara et al., 2013). Manual minimum tillage systems, such as hand hoe dug planting basins (PB), that are currently being promoted in southern Africa as part of CA have been reported to increase crop yields by 30–120% on farmers' fields in Zambia (Haggblade and Tembo, 2003) and in Zimbabwe (Mazvimavi and Twomlow, 2009). However, farmers still have a larger proportion of their planted fields under conventional mouldboard tillage (CONV) (Baudron et al., 2007; Mazvimavi and Twomlow, 2009) and purportedly under CA; only the reduced tillage principle is followed by most farmers (Mazvimavi et al., 2008).

Labor limitations, especially for weeding, and low levels of mechanization for both land preparation and weeding have been

* Corresponding author. Tel.: +263 383 311 5.
E-mail addresses: jnyamangara@gmail.com, j.nyamangara@cgiar.org (J. Nyamangara).
[1] Address: Department of Agronomy, Midlands State University, P. Bag 9055, Gweru, Zimbabwe.
[2] Address: ICRISAT Patancheru, 502324 Andhra Pradesh, India.
[3] Tel.: +263 383 311 5.

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