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An assessment of smallholder soil and water conservation practices and perceptions in contrasting agro-ecological regions in Zimbabwe

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ABSTRACT

Improved soil and water management practices can reduce moisture stress and crop failures associated with rain-fed cropping systems. Little information exists on soil and water management technologies requirements for male and female farmers in different agro-ecological regions. The objective of current study was to investigate farmers' sources of information and perceptions on soil and water management technologies. Four sites selected from different agro-ecological regions (AERs), sub-humid (Mazowe/Goromonzi, and Kadoma) and semi-arid (Matobo and Chiredzi). Data on sources of information on soil and water management, types of technologies preferred by farmers and constraints to adoption of technologies were collected through household interviews and focus group discussions. Results showed that government extension agents, farmer-to farmer extension and non-governmental organizations were the main sources of information on soil and water management technologies at all the sites. NGOs mainly provide information on reduced tillage methods. Main technologies were mulching (61%), reduced tillage methods (53%), and contour ridges (33%) in Mazowe/Goromonzi district, reduced tillage method (83) and mulching (64%) in Kadoma, and reduced tillage methods (54%) and contour ridges (47%) in Matobo. More farmers used soil and water management technologies at the sub-humid sites than at the semi-arid sites. Soil and water conservation technologies used were similar between male-headed (MHH) and female-headed households (FHH). Soil and water conservation technologies used by farmers matched their preferences in two of the four study sites. The findings are important for targeting soil and water management practices in the various agro-ecological zones.

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1. Introduction

Smallholder rain-fed agriculture in sub-Saharan Africa is inherently risky due to frequent droughts and mid-season dry spells associated with climate change and variability. Moreover, land degradation in the form of nutrient and soil loss due to erosion is also prevalent. Coupled to low rainfall, smallholder farmers practice low-input agriculture characterized by low yields averaging about 1 ton ha^{-1} for most grain crops (Rockström et al., 2009). On the other hand, high costs associated with development of irrigation systems in SSA (circa US$6000/ha; Brown et al., 2012), imply that the majority of smallholder farmers will continue to rely on rain-fed agriculture for livelihoods and food security. To overcome the hydro-climatic risks and soil-related constraints to crop production, farmers employ a variety of soil and water management technologies. In the context of the current study, soil and water management technologies is a broad term referring to various management practices aimed at manipulating the water balance to minimize runoff and soil erosion, while enhancing land and crop water productivity (Rockström et al., 2009; Nyamudeza, 1993; Nyakatawa et al., 1996). These technologies include in-situ or in-field water harvesting systems, and those entailing harvesting runoff for storage and subsequent use at a local scale. Such practices may also include improvement of soil fertility to optimize plant water uptake and increase productivity (Rockström et al., 2009). Examples include; ridges, a variety of reduced tillage methods, conservation agriculture, pot-holing and runoff harvesting and storage for supplementary irrigation at a local scale.

Literature drawn mainly from semi-arid Zimbabwe show that soil and water management technologies improve soil moisture retention, reduce runoff and soil erosion and crop productivity (e.g., Motsi et al., 2004). Soil and water management technologies considered effective in semi-arid regions include tied ridges/furrows (Motsi et al., 2004; Unganai and Murwira, 2010), reduced tillage methods (Mupangwa et al., 2008; Rockström et al., 2009) and infiltration pits (Mupangwa et al., 2008). In semi-arid southern Zimbabwe, dead level contours with or without infiltration pits have also been reported to increase soil moisture retention and crop yields (Mugabe, 2004; Mupangwa et al., 2012; Mhizha and Ndiritu, 2013). Meanwhile, in three semi-arid communal lands of Zimbabwe namely, Mudzi in agro-ecological region (AER V), Gutu (AER IV) and Chivi (AER V) farmers who practiced tied ridges realized yields of about 3t/ha compared to conventional tillage treatments whose yields were about 1.5 t/ha (Motsi et al., 2004). In semi-arid Gwanda and Insiza, planting basin had greater potential for improving available plant water than mulch ripping and conventional tillage practices across different soil types (Mupangwa et al., 2008). These studies show the potential of various soil and water management technologies to boost yields in rain-fed agriculture, in both sub-humid and semi-arid smallholder areas. In contrast, Nyakudya et al. (2014) noted that combining infiltration and planting pits did not improve soil moisture and/or maize yield in Rushinga, a semi-arid area in landscapes with homogenous soils. However, most results show positive effects of using various soil and water management technologies.

Adopting soil and water management technologies is considered a key adaptation strategy to the impacts and risks associated with climate change and variability (Nyamadzawo et al., 2013). Several models/approaches including participatory approaches were developed to enhance t adoption of soil and water management technologies in smallholder areas (Hagmann and Murwira, 1996). Despite these efforts, technology adoption remains relatively low due to constraints such as lack of labour and resources (e.g. Motsi et al., 2004; Amsalu and de Graaff, 2007; Munamati and Nyagumbo, 2010) and farmers' perceptions of needs, investment options and risks (Giller et al., 2009). Low adoption due to lack of resources is particularly critical for female farmers, who often have lower capital assets than their male counterparts (Mazvimavi and Twomlow, 2009. Therefore, understanding the role socio-economic, cultural, and agro-ecological factors is critical technology development and transfer, targeting and adoption among different farmers practicing rain-fed cropping systems. However, limited information exists on use of various soil and water management technologies, preferences and selection criteria among male and female farmers in contrasting agro-ecological regions of SSA including Zimbabwe.

The current study investigated three research questions: (1) which organizations disseminate information on soil and water management technologies in different agro-ecological regions?; (2) which soil and water management technologies are used and preferred by male-headed and female-headed households?; and, (3) what are the major constraints to adoption of soil and water management technologies in different agro-ecological regions.

2. Materials and methods

2.1. Description of study sites

Zimbabwe is classified into five natural regions (NR) 1 to V also commonly referred to as agro-ecological zones (AER) based on annual rainfall and agricultural potential (Vincent and Thomas, 1960). Rainfall patterns and crop production progressively decrease from AER I to V. Sites were therefore selected based on rainfall and temperature characteristics, based on at least 25 years meteorological data. The study was conducted out in four of the five agro-ecological regions (AER) of Zimbabwe. The four sites selected consisted of two from wetter AERs that comprised Mazowe/Goromonzi districts (AER II), and Kadoma district (AER III) and two from drier regions that comprised of Matobo district (AER IV and V) and Chiredzi district (AER V) (Fig. 1).

Average annual rainfall for Mazowe/Goromonzi was 842.9 mm and mean annual temperature 18.2 °C, and 721.7 mm and 21.8 °C, respectively for Kadoma. Matobo mean annual rainfall was 567.1 mm while that of Chiredzi was 541.2 mm. Matobo mean annual temperature was 18.4 °C and that of Chiredzi 21.3 °C. At the drier sites (Matobo and Chiredzi) rainfall distribution is very poor, mid-season droughts and short seasons are common (Unganai and Murwira, 2010). In particular, Chiredzi is