Assessing management options for Zimbabwean small-holder farmers to enhance yield reliability in face of climate change

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Abstract

The already low productivity of rain-fed crops in Zimbabwe is pressurized by climate changed provoked modifications in temperature and rainfall, such as the increased occurrence of intra-seasonal dry spells. This study assessed different tillage, fertilizer and mulching practices for their capability to reduce production risks for maize growing smallholder farmers. Farmers' benefits from different combinations of these management options were analyzed in a field experiment with maize and a simulation study. Management effects on long-term crop production under climate change were simulated with the APSIM model for the period 2020-2050. The tillage methods were reduced tillage through ripping and conventional tillage. Two different fertiliser rates, a low and a high rate, reflected rates used by resource-constrained farmers and resource-endowed farmers, respectively. Four different mulching treatments were compared. In general, approximately 2 Mg/ha of common thatching grass (Hyparrhenia hirta) plant residue was used per mulched plot. The application times were either at emergence, tasseling or at both stages (two times 2 Mg/ha). The control had no mulch. The study was conducted as an on-farm experiment in Wedza district (Eastern part of Zimbabwe) during the 2015/16 cropping season. The treatments of the maize experiment were arranged in a split-split plot design with tillage (reduced and conventional) as the main plot, fertiliser treatments (high and low rate) being the subplot and mulching (at emergence, at tasseling, continuously and bare soil) as the sub-sub plot. Plant development, soil water content at different points in times and maize grain yield were measured. In the experiment, mulching increased soil water content significantly. The time for mulch application had an effect. A long intra-seasonal dry spell occurred after emergence, while at tasseling there was more rainfall. As a consequence, plots under emergence mulch yielded 0.2 Mg/ha more than mulching at tasseling. The highest yields were achieved under continuously mulching. This indicates that with mulching twice at the two important growing stages smallholder farmers can lower the risk of missing the best time for mulch application and get an additional yield advantage in dry years. The mulching effect on yields was more profound under reduced tillage but the benefits of conventional tillage lead to overall higher yields. The combination of conventional x high x continuously yielded 525% more than the combination of reduced x low x bare (1.915 Mg/ha compared to 0.365 Mg/ha). In the long-term simulation study, high fertiliser rate had the greatest influence on crop yields by doubling the potential yield from approximately 1 to 2 Mg/ha. Mulching could only slow down but not prevent SOC decline. It is concluded that mulching has the potential to buffer the effects of intra-seasonal dry spells and can, in combination with an adequate fertilisation, lead to more resilience for smallholder farmers when facing climate change. In the future, improved crop models combined with the experience and knowledge of farmers as well as results from science and research might be a useful instrument for farmers to evaluate different suitable management options based on the agro-ecological conditions and predicted weather situations.

Keywords: intra seasonal dry spells, long term simulation, mulch, tillage, fertiliser rate, resilience of smallholder farmers