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Research Application Summary

Effects of integrated water and nutrient management technologies on crop and labour productivity in Zimbabwe

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Abstract

Poor soils, erratic rainfall, frequent dry spells have been cited as the major threats to the development agricultural in Southern Africa. This experiment was designed to evaluate the benefits derived from post planting tied ridging, conservation farming basins and rip and potholing treated with cattle manure and compound D on maize and soya bean yield, soil profile moisture storage, plant nitrogen uptake and biomass. Nine farmers from the semi-arid region of Kadoma are hosing the experiment with a parallel study being conducted in Domboshawa which receives annual rainfall of between 450 – 650 mm and 750-1000 mm, respectively. Labour productivity for each innovation will also be assessed.

Key words: Erratic rainfall pattern, inherent soil infertility, soil water and nutrient management

Résumé

Les sols pauvres, les précipitations irrégulières et les périodes fréquentes de sécheresse ont été citées comme les principales menaces pour le développement agricole en Afrique australe. Cette expérience a été conçue pour évaluer les avantages découlant du buttage lié à la post-semence, des bassins d'agriculture de conservation et de ripage et de la spéléologie traitée avec du fumier de bovins et le composé D sur le maïs et le rendement du soja, le stockage d'humidité du profil du sol, l'absorption de l'azote des plantes et la biomasse. Neuf agriculteurs de la région semi-aride de Kadoma realisent l'expérience avec une étude parallèle menée à Domboshawa qui reçoit des précipitations annuelles comprises entre 450 et 650 mm et entre 750 et 1000 mm, respectivement. La productivité du travail pour chaque innovation sera également évaluée.

Mots clés: Pluviométrie irrégulière, l'infertilité inhérente des sols, la gestion de l'eau du sol et des éléments nutritifs.

Background

Poor soils, erratic rainfall, frequent dry spells and lack of irrigation infrastructure, among others, have been cited as the major threat to the development of a sustainable agricultural system in Southern Africa (Kahinda, 2007). Most cropping seasons in sub Saharan Africa are characterized by mid-season dry spells which seriously reduce yield potential, making water the greatest limitation to crop productivity. The static growth of crop productivity despite efforts to conserve soil water necessitated further tillage research and concepts of better land husbandry such as no-till to tackle problems of soil water deficits and soil degradation (Nyagumbo, 2008). In addition to low rainfall, soil nutrient deficiencies account for continued decline in smallholder maize production (Woomer and Swift, 1994) and correcting this using inorganic fertilizers is severely limited by prohibitive costs and general lack of availability (Scoones *et al.,* 1996). The scarcity of mineral fertilisers, and poor quality and low quantity of the organic fertilisers (Mugwira, 1995) have left the smallholder farming sector with limited options to sustain agricultural productivity (Mapfumo and Giller, 2001). In additon, despite breakthroughs in technology development, gaps still remain in exploring the synergy derived from integrated use of water and nutrient management technologies.

Literature Summary

Traditional farming practices like convention tillage have been blamed for the deteriorating soil fertility in Southern Africa with estimated annual cost through sheet erosion being as high as 536 kg ha^{-1} organic matter, 50 kg ha^{-1} of nitrogen and 8 kg ha^{-1} phosphorus (Elwell *et al.*, 1988). Studies have shown conservation agriculture (CA) to increase moisture retention, improving natural resource use through integrated management of available resources. The practice could be used to achieve sustainable agricultural productivity. No till, minimum tillage, conservation farming basins, reduced tillage and mulch tillage are terms synonymous with conservation tillage (FAO, 1991). Yield increases (Twomlow and Hove, 2006) and reduction in soil erosion levels (Nyagumbo, 2002), have been recorded on conservation farming practices compared to conventional till in 8 districts of Zimbabwe and at Domboshawa Training Centre. Complimenting conservation agriculture (CA) involving water harvesting techniques like ripping and tied ridging have showed 20-60% yield increases in research trials carried out in Zimbabwe (Morse, 1987). Tied ridging involve constructing ridges on the crop rows and tying them at 1-2m interval depending on the slope with the aim of creating small ponds between the rows that traps water and retain it for future use

by the plants. Although several soil fertility management options like the use of mineral and organic fertilisers are available, to small-scale farmers are failing to utilise them due to scarcity of resources. This research seeks to find suitable combination of water and nutrient technologies that enhances crop productivity.

Study Description

The study is being conducted under rainfed agriculture for two seasons on two sites which have different ecological rainfall patterns. Eight experimental plots were established in Kadoma (NR-III) and one similar trial was established at Domboshawa Training Centre (NR-II) which receives between 500-650mm and 750-1000mm annual rainfall, respectively. Maize and soybean are the test crops. The trial plot at Domboshawa was established in order to assess the effects of the treatments under different climatic conditions and for close monitoring of some parameters since Domboshawa is closer to University of Zimbabwe facilities. These trial plots were set to investigate how soil moisture storage, grain yield, and total biomass are affected by tied ridging, conservation farming basins, rip and pot holing and conventional (control) where fertility amendments, i.e., 200 kg ha^{-1} compound D, 200 kg ha^{-1} compound D + 5 tonnes ha^{-1} manure, 5t ha^{-1} manure and 0 kg ha^{-1} (control) were superimposed as sub-treatments. Yield, biomass, plant and nitrogen content data were obtained from the experimental plot.

Research Application

The preliminary results indicated that tied ridging resulted in significantly higher ($p < 0.05$) soil profile moisture storage and maize and soya bean grain yield compared to conventional mouldboard plough. Post planting resulted in 85.69%, 65.80% and 43.47% yield increases as compared to conventional mouldboard plough, conservational farming basins, and rip and potholing, respectively. Additional of fertility amendments on post-planting tied ridging resulted in further yield increases by 5.37%, 10.32% in compound D and compound D + cattle manure treated sub-plots.

Post planting tied ridging could go a long way in minimizing effects of erratic rainfall patterns and frequent dry spells being caused by climate change, as the practice resulted in significantly higher soil profile moisture storage and maize and soya bean yield as compared to other forms of tillage. Combing post planting tied ridging with cattle manure + inorganic compound D fertiliser had an additional yield increase and such integration

is friendly to the resource constrained farmers with limited financial base to rely fully on recommended inorganic fertiliser application rates.

Recommendation

Recommendation will based on the findings from the study.

Acknowledgement

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