

Impacts of traditional tillage practices on field characteristics and crop yields: the case of semi-arid, Central Tanzania

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The present study started by assessing impacts of traditional tillage practices on field characteristics (i.e. weed species diversity and distribution, soil fertility, moisture retention) and crop yield in semi-arid areas of central Tanzania. Furthermore, impacts of manure application and mulching practices on crop yields in the area were also assessed.

Smallholder farmers in the case study area were shown to be applying three different tillage practices i.e. Traditional No-Till (TNT), Shallow Tillage (ST) and Ridging Tillage (RT). These practices are differently cited by farmers to reduce weed species effects, improve soil fertility, conserve soil moisture and hence improve crop yield.

Findings reported in chapter three show that farmers applying TNT do so due to unreliability of seasonal rainfall periods and the erratic nature of rains during the rainy season in this area. Further, some farmers spend much of their time doing casual labour out of their farms which hinders them in preparing their own farms. Hence they apply TNT as most convenient practice. Results from the farmers' perception study in the case study area indicate crop harvests for farms under TNT to be lower than for those under ST and RT. The main reason stated for lower crop yield under TNT is that crops compete with weeds for both soil nutrients and moisture right from the beginning of their life cycle. In the case study area, ST was mentioned to be the most common tillage practice used by farmers. Reasons given by farmers who are in favour of this type of tillage practice are that farms become free of weeds during planting which reduces early weed-crop competition and improves soil fertility through soil mixing. Additionally, ST was mentioned as a means to form rough surface which was perceived by most farmers to be useful in retaining soil water and thus to favour soil water availability to plants. Farmers applying RT mentioned to do so as the practice is perceived to support high soil moisture retention ability as well as to promote suppression of weeds in the area; subsequently a higher crop yield is obtained.

Findings from field surveys assessing impacts of continuous application of traditional tillage practices on weed species diversity and distribution indicate TNT to encourage more weed species to grow at the early stages of the planting season compared to other practices studied (chapter four). Higher weed incidence at these early stages results in high weed-crop competition thus affecting the health of plants, which as a result negatively impacts crop yield. These findings support farmers' perceptions on the effects of these practices on weed infestation.

Soil samples for soil fertility assessment collected in different fields in the case study area as detailed in chapter five indicate that farms under TNT are richer in nutrients in the top soil layer than other studied tillage practices. This is in contradiction to farmers' perceptions. Although TNT leads in soil conditions that are rich in top soil nutrients, availability of these nutrients to plants is limited as they are highly competed for by both crops and weeds which reduce their availability to crops. As a result, this reduces crop health and hence leads to lower crop yields under TNT compared to those obtained with the other practices studied.

As indicated in chapter six, on-farm field experimentation with farmers showed higher soil moisture retention and higher aboveground biomass for *Sorghum bicolor* in RT and ST practices when manure and mulching were not applied, compared to TNT. Improving these practices by the application of manure (i.e. to both ST and RT) and mulching to ST at rates that farmers mentioned to afford in the area (i.e. 5 Mg/ha for manure and 3 Mg/ha for mulching materials) revealed a higher crop yield compared to the application of these practices without any improvement.

It is concluded and recommended in chapter seven that, application of locally available materials such as cow dung manure and mulching to ST can result in doubling crop yields in comparison to TNT practice in the area. As a means to improve crop yield at farm level, smallholder farmers should be encouraged to apply shallow tillage practice with manure and mulching materials at the rate they can afford. Moreover, farmers should not burn crop residues as the latter can be used as mulching materials in subsequent cropping seasons for improving soil moisture retention capability, soil fertility and hence improved crop production. At village level, demonstration plots for different practices tested in this study should continue to be carried out in village farms to showcase best practices that can be adopted by farmers. At district level, the agricultural extension department should be equipped to carry out awareness raising campaigns with farmers on the potential for the application of manure and mulching as locally available materials on ST for sustaining improved crop yield in these dryland areas. Cost/benefit analysis for different tillage practices and other soil management practices studied should be carried out in the area in order to inform farmers on the positive and negative aspects of applying certain soil tillage and management practices. At national level, the government should put more emphasis on funding agricultural research mainly for those aspects that deal with soil and water management as well as topics related to new crop development and production.



Figure 1. Traditional no till (Sesa)



Figure 2. Shallow tillage (Kutifua)



Figure 3. Ridging tillage (Matuta)



Figure 4. Sorghem bicolor under shallow tillage + mulching treatment in Kisokwe Village Farm