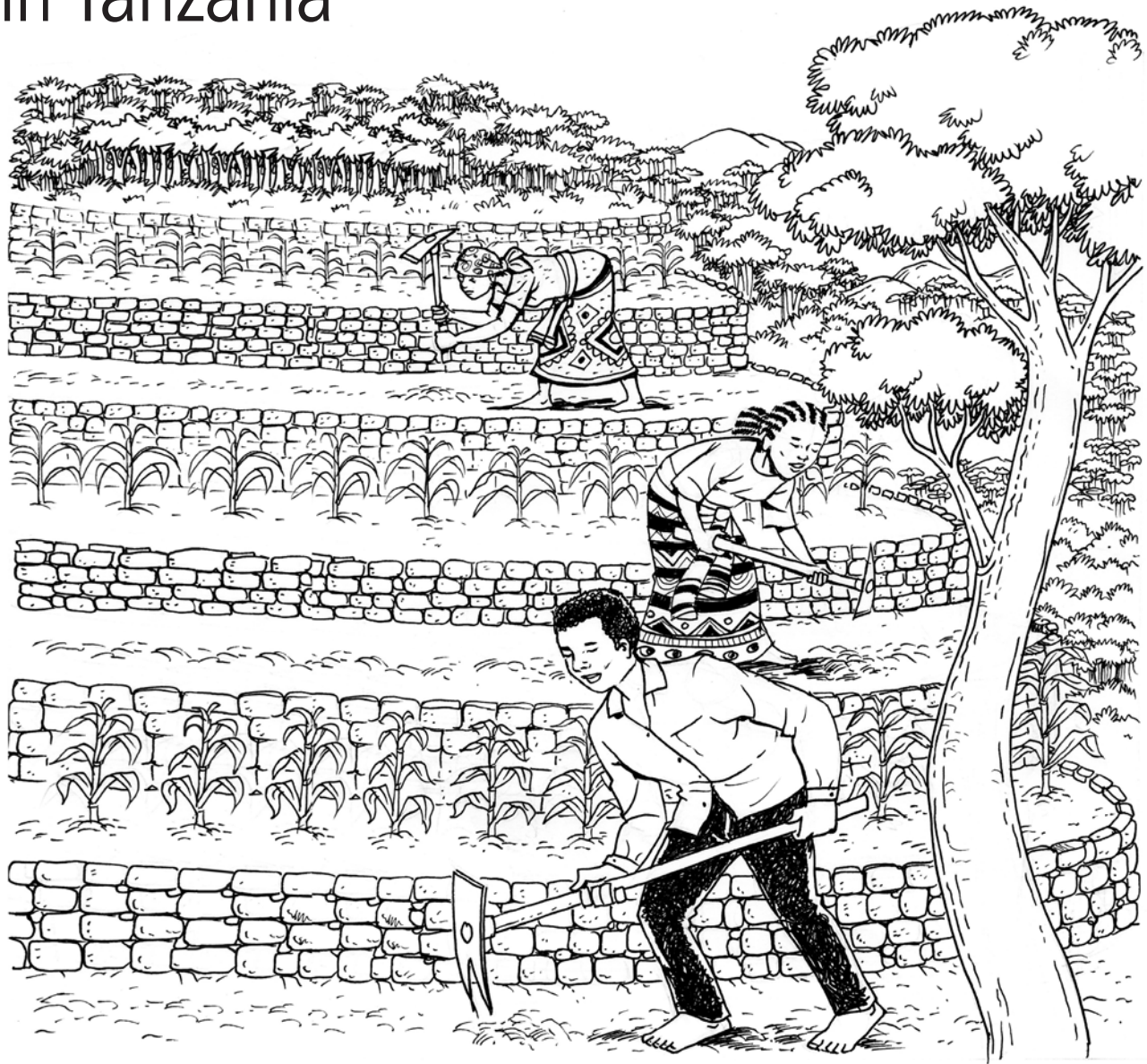


Hillside Conservation Agriculture for Improving Land and Water Productivity in Tanzania



Tanzania has a total area of 945,000 km² (MARI, 2006). Its inland lakes cover 59,000 km² (6% of total area) and the remaining land covers 886,000 km² (94% of total area). Despite its complex climatic and topographic setting, the country has sufficient land to allow substantial growth in agricultural production. However, land degradation due to soil erosion and decline in soil fertility caused by continuous cropping with no attempt to

replenish the soil with mineral and organic manure are the major setbacks to agricultural production in the country. Any attempt to improve and expand agriculture in the country should invest in the betterment of land and crop husbandry practices.

On the other hand, there is shortage of water for agricultural production in the country due to inadequate rainfall in various parts of the country

(Mutabazi *et al.* no date). In general, nearly two-thirds of Tanzania, which covers a total area of 939,701 km², can be described as semi-arid on the basis of having a less than 25% probability of receiving 750 mm of rainfall per year (Mascarenhas, 1995; Bourn and Blench, 1999). Such areas, including Same District, are known to be less productive in agriculture. As Mutabazi *et al.* (no date) indicate, this is the reason why semiarid areas of sub-Saharan Africa (SSA), including Tanzania, where water is the most critical constraint to development, manifestations of poverty such as food and income insecurity are apparent. The question is: 'How can agriculture continue under such situations of soil degradation and insufficient water for agricultural production?' Answering this question becomes even more difficult, given the fact that some attempts by smallholder farmers in various places are strictly constrained by lack of efficient technology and capital. This, therefore, calls for a new, inexpensive approach that smallholder farmers can easily use. Conservation agriculture (CA) is thus considered for improving land and water productivity in Tanzania.

Conservation agriculture is any system or practice that aims to conserve soil and water by using minimum soil disturbance (conservation tillage) and crop rotation/association to minimize soil evaporation, which reduces runoff and erosion and improves conditions for plant establishment and growth. It involves planting crops and pastures directly into land, which is protected by mulch using minimum or no-tillage techniques. It is also used to increase organic matter content by improving soil structure and fertility, reduce reliance on cultivation, and achieve viable and sustainable productivity (Fig. 1a).



Fig. 1a. Conservation agriculture is an option to improve land and water productivity in Tanzania.

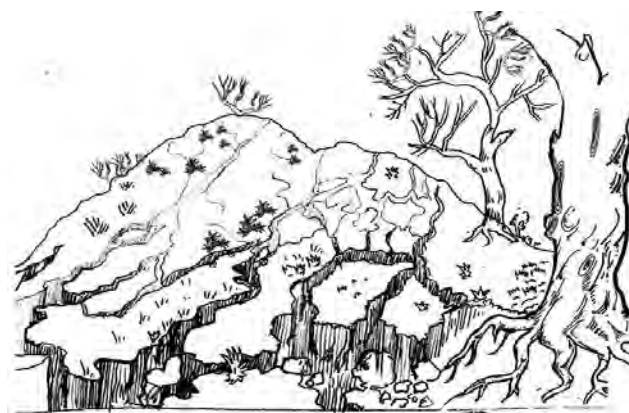


Fig. 1b. A degraded hillside landscape results from poor land and crop husbandry.

Other components and practices of CA comprise agroforestry, trap cropping, cover and green manure cropping, alley cropping, contour farming and strip cropping, organic and biodynamic farming, stubble mulching, integrated pest management, and crop and pasture rotation.

Conventional tillage, on the other hand, which is most commonly practiced in the country, involves the use of hand hoes, ox-drawn moldboard plow, tractor-drawn disc plow and harrows, combined with straw collection and burning during land preparation (Fig. 1b). During the operation, the soils are cut, inverted, and pulverized while most of the residues are buried underneath. The practice frequently causes soil compaction, affects soil physical properties, provokes biological degradation, and results in lower crop yields. With fine dust on the surface and compaction below, a lot of soil is washed away by the first rains. Soil losses of up to 30 tons/ha have been reported in Kilimanjaro region in conventional flat cultivated fields at a slope of 5% (Kaihura *et al.*, 1998).

Why conservation agriculture?

Land degradation has been a growing problem in Tanzania because of increased human activity and the growing demand for land as the population grows. Deforestation, overgrazing, and inappropriate tillage practices are contributing heavily to land degradation. It has been observed that the rate of soil losses in some parts of the country have increased from 1.4 tons/ha/year in 1960 to 224 tons/ha/year in 1980 (MTNRE, 1994). With the

increased population pressure, the fallow periods, which were commonly used, have become shorter for the soils to recover, perpetuating the “soil mining” of nutrients. The replenishment of nutrients is low because of inadequate application of manure and inorganic fertilizers. This has led to a further decline in soil fertility, which is manifested in lower crop yields.

Therefore, CA can help improve, conserve, and use natural resources in a more efficient way through integrated management of available soil, water, and biological resources, in combination with external inputs (FAO, 2005). This, in turn, can help improve the productivity of agricultural land and water. The impacts of CA have been marked positive in agricultural, environmental, economic and social terms (Garcia-Torres *et al.*, 2003; Bishop-Sambrook *et al.*, 2004).

While millions of hectares of farmland are already under zero tillage in Latin America, conservation tillage in Africa, which is one of the practices of CA, was restricted mainly to larger estates. There are, however, enough examples demonstrating that conservation tillage can be practiced successfully by smallholder farmers, too, as it has been done in northern and northeastern parts of Tanzania (Babati, Same, and Lushoto districts) and central and eastern parts (Chamwino, Morogoro, Kilosa, and Mvomero districts). This paper reviews the CA practices in various case study sites in the country, which have also shown positive impacts of land and water management as a strategy toward water-smart agriculture.

Approach followed

The CA practices in Tanzania generally started with the sensitization of district authorities and farmers to create awareness on the CA initiative. Inception workshops were also conducted for all participating district authorities, technicians, manufacturers, researchers, and other stakeholders.

A total of 30 participatory farmer groups each consisting of 25 individuals, 10 in each district, were organized on the basis of common interests and similar constraints and were encouraged to work together. Each participating farmer was asked to set aside an area equivalent to 0.4 ha as a management training plot. The area was divided into two equal parts. One part was to be used for CA practices,

where the farmer use inputs provided by the project. These included high-yielding varieties of maize crop as recommended by the District Agriculture Office for that particular area, and basal and topdressing fertilizer as a soil fertility improvement measure prior to the establishment of cover crops and cover crop seeds.

Farmers were trained on the use of better tools such as hand jab planters and direct seeders to reduce labor requirements for various agricultural operations. Training of farmers was conducted by trained village extension officers. Under their guidance, farmers also kept records of timing of activities, the costs involved, and outputs to facilitate the analysis of cost/benefit derived from the adoption or adaptation of CA practices. In this way, the farmers were able to see the differences between their practices and the proposed CA interventions.

Various methods were used to impart CA knowledge to farmers. Examples are farmers’ field schools (FFS), exchange visits, farmers’ field discussions, open day exhibitions, farmer-to-farmer contacts, and use of para-professionals/contact farmers just to mention a few. The Ministry of Agriculture training institutes and agricultural research institutes have played a big role in showcasing the importance of CA and many other agricultural techniques that made a difference through training farmers.

Key results

Conservation agriculture has created a huge positive impact in improving soil properties and structures, soil fertility, and soil and water conservation. It has also reduced soil erosion, increased infiltration of rain and surface water, enhanced retention of soil moisture, and shown resilience to the effects of drought. Regularly flowing streams have increased crop yields at lower production costs, mainly due to reduced labor inputs. This time-saving practice often allows diversification into other agricultural production or rural income-generating activities.

The impact of CA on livelihood is significant as it has brought positive changes on all areas where it has been practiced. The improved production of agricultural produce in various parts of the country is evidence of positive impact on the communities concerned. This is also reflected in the amount of harvest from the CA plots for the main crop (maize)

and cover crop seed production. In Mvomero District, for example, maize harvests for all groups from the CA plots were 4870 kg/ha, compared with 3216 kg/ha realized from the farmer practice plots. In villages where the rains were better, the harvest from the CA plots was also higher.

The CA practices in all the selected districts and villages in Tanzania have been remarkably successful in those areas. Success stories include reduced erosion and improved soil structure; improved infiltration and moisture efficiency; improved soil health and nutrient retention; lower soil temperatures and better establishment; increased planting opportunities and flexibility; lower machinery, labor, and maintenance costs; and more reliable yields. All these increased the interests of the local manufacturers to produce direct seeding equipment and sell them to the farmers. They also increased the willingness of district/local government authorities to introduce CA as an important approach to reverse land degradation. This requires a change in mindset on the part of the farmers, who have used conventional tillage as the correct approach in crop production for many years. Also, links have been strengthened with local research institutions on suitable cover crops and proper crop rotation recommendations for adoption by the farmers.

Challenges and limitations of conservation agriculture

No single farming system or technique is perfect for all applications, and conservation farming is no exception. Conservation farming involves more planning, management, and a commitment to sustainability. Trade-offs are necessary and extra costs may be incurred in the initial years.

Conservation farming will not always result in higher yields, especially in seasons where rainfall is ample and well-distributed. The effectiveness of some herbicides is reduced by mulch on the surface as high rates of organic matter 'tie up' many chemicals. Fertilizers such as nitrates and herbicides may leach more readily through the soil due to higher infiltration rates under conservation tillage; however, runoff losses will be reduced. These aspects are being addressed through improvements in fertilizer and herbicide formulation, application technology, and better management practices.

Conservation farming systems are dynamic and call for innovation and continual improvement. Grazing, weed, insect, and fertilizer management are required for successful conservation farming, and it takes time and experience to develop these skills. A good understanding of the interaction between plants, animals, the soil, and the environment is necessary. Conservation farming systems are intended to be flexible and responsive and to work within the constraints of the environment.

Some of the challenges that have not been resolved yet include the lack of adequate funding to reach more farmers, shortage of locally available direct seeding implements, inadequate awareness-creation campaigns among all stakeholders, and poor integration of crop and livestock farming systems whereby several conflicts between pastoralists and farmers have been experienced.

Conclusions

Conservation agriculture consists of easily and readily available practices that can be used in every part of the world. It is a scalable, effective, cheap, and manageable practice that can be transferred from one place to another.

It has helped improve land and water productivity, thereby changing the livelihood of the smallholder farmers in various areas in Tanzania as it

- ◆ increases farm production and/or stabilizes it,
- ◆ has no adverse environmental effects,
- ◆ prevents erosion and improves soil fertility,
- ◆ is easy for farmers to adopt, and
- ◆ makes it easy to provide institutional support and outreach and technology transfer from one area to another.

More efforts are needed to ensure that the concept of CA and, hence, water-smart agriculture, is taken up by the government and adopted by the majority of smallholder farmers in Tanzania. This will help increase income at the household level and thereby improve livelihood.

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