Conservation agriculture for smallholder farmers in dryland areas, Kenya

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Summary

The Laikipia district, in the Rift Valley of Kenya, is located on the plateau north west of Mount Kenya. Due to its leeward position, the district is significantly dry, with aridity increasing from the slopes of the mountain to the dry lowlands. Inadequate rainfall and periods of drought have caused land degradation and soil erosion, affecting the productivity of agriculture and the livelihoods of smallholder farmers in these arid and semi-arid areas.

Two Farmer Field Schools (FFS) established in the district introduced Conservation Agriculture (CA)principles and techniques which mitigated the impact of drought on farm production and on the environment. The goal of conservation agriculture is to maintain and improve crop yields and resilience against drought and other hazards, while at the same time protecting and stimulating the biological function of the soil.

Description

The Laikipia district is situated in the rain shadow of Mount Kenya, which creates a generally unreliable, inadequate and unevenly distributed rainfall pattern. Seventy-five per cent of total land area is devoted to livestock production and game parks/reserves, leading to overstocking which in turn results in a high rate of soil and environmental degradation. Due to several factors, the yield of most crops has declined by 40 percent over the years, with continued tillage identified as one of the principal causes. Frequent tillage operations expose and destroy soil micro-organisms, release carbon into the atmosphere and put the ozone layer at danger of depletion.

A project funded by the German Trust Fund and implemented by FAO and the Ministry of Agriculture led to establishment of a two FFS in the district, involving 55 individuals, with a 50:50 gender balance. Village-based facilitators were trained on the farmer field school approach and conservation agriculture farming practices.

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rotation, minimum disturbance of soil and maintenance of a permanent soil cover.

In particular, the use of cover crops ensured cost effective weed management as well as improving soil fertility. The introduction of specific soil rotations and associations, on the other hand, promoted biological sub soiling which facilitated plant root growth and water infiltration, besides breaking cycles of crop pest and disease.

1. Implementation of the technology

Conservation agriculture is a farming practice based on integrated management of soil, water and agricultural resources.

There are three essential interrelated features of conservation agriculture.

1. Minimizing tillage

Ploughing, harrowing, and any kind of mechanical soil disturbance operations by farmers are reduced to a minimum or, where possible, abolished altogether. Mechanical tillage hinders "biological tillage". This is the process of soil biological activity that relies on soil life to produce very stable soil aggregates and various sizes of pores, allowing air and water infiltration. Furthermore, among the farming operations, soil tillage is the single most energy consuming and thus air polluting operation. Farmers may therefore save between 30 and 40 percent of time, labour, and in mechanized agriculture, fossil fuels by not tilling the soil.

2. Maintenance of a cover of (live or dead) vegetal material on the soil surface

This cover protects the soil from the physical impact of rain and wind and stabilizes soil moisture and temperature in the surface layers. Soil cover turns this zone into a habitat for soil life (plant roots, insects, worms, fungi and bacteria). Soil life uses soil cover and organic matter, recycles them into humus and nutrients and contributes to the stabilization of the soil structure. The aim of maintaining a permanent soil cover is incompatible with the widespread farming practices of burning plant residues and of incorporating organic matter or plant residues into the soil. These practices disrupt soil life and structure, remove the soil cover and destroy humus by enhancing organic matter mineralization. Uncontrolled grazing, which may completely destroy soil cover and induce soil compaction, should be avoided too. The soil cover also inhibits the germination of many weed seeds, minimizing weed competition with the crop. *Mucuna spp.* for example contains Dihydroxyphenylalanine, which causes suppression of weeds such as Striga hermonthica and Cynadon dactylon among many others. Some species, such as the leguminous, have the added value of improving soil fertility. In the first few years herbicides may have to be applied, so knowledge of specific locations where weeds grow is very important. However, in the long term the approach aims to manage weeds through agronomic means (soil cover, cover crops) or minimal mechanical means (superficial weeding with hoe or cutlass).

3. Diversified crop rotation (annual crops) or plant associations (perennial crops)

This enhances the soil's rooting environment, its structure, nutrients and moisture retention capacity, while avoiding build-up of pests and diseases and controlling weeds. Crop rotations are designed to make full use of the physical and chemical interactions between different plant species and to achieve multiple purposes: crop production for food and energy, cattle feeding, biological tillage and

decompaction through different kinds of rooting systems, nutrient cycling and weed control.

Another essential element of conservation agriculture is to plan crop sequences over several seasons, to minimize the build-up of pests or diseases and to optimize plant nutrient use through synergy between different crop types and by alternating shallow-rooting crops with deep-rooting ones. Smallholder farmers in the Laikipia district have been able to increase their yield by 30 to 40 percent by adopting in situ water harvesting methods and technologies which are part of conservation agriculture approach. Before the introduction of conversation agriculture techniques, intensive cultivation resulted in development of hard pan/plough pans which hindered plant root growth and water infiltration into the soil. Subsequent introduction of specific crop rotation/association under conservation agriculture promoted biological sub soiling, saving the cost of hiring or using mechanical means. Such rotation/association of crops also helped breaking crop pest and disease cycles.

The water harvesting methods and technologies that are part of conversation agriculture, crop rotation/associations, and maintenance of a permanent cover crop have drastically reduced soil and environmental degradation and increased resistance to drought and climatic variability. conversation agriculture is an approach that enhances livelihoods´ resilience against the impact of natural hazards, in the case draught in the Lajkipia district.

2. Institutions fostering the practice

2.1 Intergovernmental organizations

- The Food and Agriculture Organization of the United Nations (FAO).

2.2 Government institutions

- Ministry of Agriculture (Kenya).
- Kenya Agricultural Research Institute (KARI).

2.3 Non-governmental organisations

- African Conservation Tillage network (ACT).
- Kenya Draught Animal Technology (KENDAT).

2.4 Research institutions

- Regional Land Management Unit based at International Centre for Research in Agro-Forestry (RELMA/ICRAF).

3. Beneficiaries of the practice

The practice is adopted by smallholder farmers and their households, especially HIV/AIDS affected households. The hydropower generating companies downstream indirectly benefit from decreased sedimentation in the dams thanks to zero tillage.
Spillovers from adoption of conversation agriculture benefit equipment hirers, tractor and draught animal hirers, seed-fertilizer-chemical-equipment companies.

4. Impacts on natural resource base

4.1 Actual impacts

- Reduction of soil runoff by 60 percent, enhancement of water infiltration into the soil by 70 percent.
- Reduction of soil water evaporation by 30 percent.
- Increased soil fertility. For example maize stover cover added to the crop field the following elements: 0.7 N, 0.14 P, 1.43 K, 0.36 Ca (percent of dry weight).

4.2 Expected impacts

- Increased ground water quality and level.
- Reduced sedimentation downstream.
- Reduced greenhouse gases as a result of carbon sequestration.

- Increased soil micro-organism activities leading to improved soil fertility.
- Reduced weed seed bank.

5. Impacts on livelihood of the practice users

5.1 Actual impacts

- Improved food security as a result of increased crop yield by 30 to 40 percent.
- Better household nutrition as a result of sufficient household food reserve.
- Improved household income as a result of the sale of surplus crop production.
- Reduced household labour requirement by over 40 percent thanks to zero till.
- Reduced mechanical weeding.

5.2 Expected impacts

- Reduced food deficit and over reliance on relief food (especially important for HIV/ Aids infected).
- Increased household purchasing power.
- Improved overall economic growth in the region.
- Increased hydro power generation due to better water quality.

6. Other impacts

Better watershed management leading to environmental resilience.

7. General success factors

- The two Farmer Field Schools (FFS) established in the district have strengthened group cohesion and understanding among smallholder farmers.
- The project provided the FFS with a grant of USD 500 to acquire input for the trial plots and to pay the facilitator a small allowance.
- Dolichos lablab (hyacinth bean), used in conservation agriculture as a source of soil cover had a high adoption rate among small scale farmers in the district. This was due to the fact that besides fixing Nitrogen in the soil, its seeds are considered a delicacy by the Kikuyu and Meru inhabitants of the district.
- The use of jab planters reduced the household's workload during planting.
- The equipment used for direct seeding also spreads fertilizer and seeds simultaneously, reducing the overall workload. A single person can now perform the work initially undertaken by three persons.
- Farmer field days and farmer to farmer exchange visits facilitated by the project attracted the participation of small-scale farmers within the district and other stakeholders such as equipment manufacturers and hires, chemical companies, seed companies, fertilizer companies among others.
- Farmer field schools were backstopped by subject matter specialists, including local and international consultants that gave training on key subjects such as weed and cover crop management, gender and group dynamics, equipment access and utilization, efficient use of chemicals and fertilizers, among others.

8. Problems remaining to be resolved

- Weed management for those farmers who are reluctant to use herbicides needs further research. Some mechanical shallow weeding should be considered acceptable within the conservation agriculture approach.
- Cover crop management, especially hyacinth bean, is a challenge to most farmers, due to the fact that it can easily outgrow a main crop such as maize and suffocates it if not planted at the correct time. Other challenges include the fact that this species is site specific, hence will do better under certain AEZ. It is also easily

affected by diseases such as *Fusarium oxysporum, Anthracnose* (*Colletotrichum lindemuthianum*), Leaf spot (*Cercospora dolichi*), Powdery mildew (*Leveillula taurica var. macrospore*) while common insects include Pod-borer (*Adisura atkinsoni*), Gram caterpillar (*Helicoverpa armigera*), Plume moth (*Exelastis atomosa*), Spotted podborer (*Maruca vitrata*), Bruchid beetles (*Callosobruchus spp.*), Root-knot nematodes (*Meloidogyne spp.*), Reniform nematode (*Rotylenchus reniformis*), Lession nematode (*Pratylenchus penetrans*).

- Access to conservation agriculture equipment by farmers is a challenge since they are not available at the local equipment distributor outlets; increased private sector involvement in field days and project activities is therefore recommended for the follow up phase.
- Dissemination of information on conservation agriculture for awareness creation among small scale farmers needs to be reinforced for greater impact.

9. Further reading

9.1 e-Resources

- Africa Conservation Tillage Network
- FAO-Conservation Agriculture

9.2 Contact details

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10. Agro-ecological zones

- Tropics, warm

11. Related/associated technologies

- Conservation tillage management for marginal small farm systems, Zimbabwe: 4465.
- Strategies for improved soil and water conservation practices in hillside production systems: 4469.
- Introduction to conservation agriculture (its principles & benefits): 7413.

12. Objectives fulfilled by the project

12.1 Resource use efficiency

Conservation agriculture maintains and improves crop yields and resilience against hazards. It protects and stimulates the biological function of the soil.

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