African Conservation Tillage Network
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Conservation Tillage – Gateway to Food Security and Sustainable Rural Development

Producing in Harmony with Nature through Conservation Tillage

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Introduction

African governments and regional organisations like SADC[1] increasingly undertake efforts to address challenges such as poverty, food insecurity, destruction of natural resources, and HIV/AIDS, and the general stagnation of economic development. It has become obvious that agricultural development has been neglected over the past decades, despite clear evidence, that broad-based agricultural development provides an effective means for both reducing poverty and accelerating economic growth. (FAO and World Bank, 2001). While per capita food production has risen in Asia and Latin America over the last decades, it is still declining in Sub-Saharan Africa (IFAD, 2001). There are many reasons for this development. The farming systems in most parts of Africa are not sustainable. They are no longer adapted to a changing natural and socio-economic environment. They are characterised by extremely low yields, exploitation of natural resources ("soil mining") and an increasing labour input. Only a drastic change of farming systems, a turn towards a more sustainable management of soils and an increased labour productivity can improve the situation. Conservation tillage (CT), which has revolutionised the farming systems in Latin America within the last decade, may offer a solution to Sub-Saharan Africa, too.

Conventional farming practices, especially the burning of crop residues and fallow vegetation, intensive hoeing or ploughing, and lacking restitution of organic matter and plant nutrients, results in soil degradation. Declining soil fertility linked to lower water infiltration and storage results in declining yields, increased vulnerability of crops to droughts, hence food insecurity and increasing poverty.

This threatening development calls for a radical change in the way farming is done. What is required are farming systems which imitate tropical ecosystems, i.e. protect soils from rapid degradation, are more productive, and at the same time reduce drudgery especially that of women and children.

CT responds to these requirements. This production system provides the means that can prevent further destruction of precious soils, ensures higher and more stable yields while it reduces production costs (especially the energy input for tillage) and increases labour productivity.

The burning of crop residues destroys the accumulated organic matter desperately required for the protection of the soil surface and the maintenance of soil fertility, causes significant losses of plant nutrients (especially nitrogen) and contributes to the global climate change by emitting CO_2.

(Photo: CGIAR - Systemwide Programme on Integrated Pest Management)

[1] Southern African Development Community

Principles of Conservation Tillage

CT is distinguished from other forms of agricultural practices by the following three principles. In order to gain the full benefit of CT, all three principles have to be applied and build into the system.

They are:

1. ***Minimum disturbance of soil***
2. ***Maintenance of soil cover***
3. ***Rotation of crops***

- ***Minimum disturbance of soil:***

Soil is a living organism and therefore has to be treated as such. Soil organisms are destroyed by exposure to solar radiation and rapid drying of the soil. Soil inversion enhances the decomposition of organic matter in the soil and leads to soil compaction, reduced water infiltration and reduced aeration. With most soils – especially the tropical ones - organic matter assures overriding importance in the storage of nutrients and water in the soil. Therefore, without sufficient quantities of organic matter in the soil, the efficiency and effectiveness of mineral fertilizers is greatly reduced.

Practical solutions include direct planting through mulch, using special implements or minimum tillage where just a planting line (furrow) is opened with a tine implement or a planting station with a hand hoe.

- ***Maintenance of a soil cover:***

Soils need to be protected against the impact of raindrops, the speed of wind and the heat of solar radiation by a cover of crop residues or cover crops. Soil cover effectively reduces soil erosion by water and wind. It impedes the loss of precious rainwater by water run-off, allowing increased water infiltration and reduced evaporation. Soil cover leads to a low and stable soil temperature - overheating during daytime is prevented, as is rapid cooling-off after sunset. Soil cover ultimately results in a more favourable environment, which is also beneficial to soil organisms. Practices such as burning of crop residues are juxtaposed to this principle.

- ***Crop rotation:***

A suitable crop rotation, that combines cereals and legumes helps in the management and maintenance of rich soil nutrient regime and contributes towards the prevention of outbreaks of pests and diseases.

A good mulch cover forms a central element of CT. It protects the soil from the impact of rain, wind and solar radiation, water infiltration is increased and losses by evaporation are reduced. The ground cover creates a favourable environment for soil life. It suppresses weed growth, thus reducing labour requirements and costs of weeding.

Related terms

- ***No-Tillage/Zero-Tillage or Direct Planting:***

This method means planting through a mulch layer, directly into the soil without any seedbed preparation. The soil remains undisturbed. Herbicides (pre-planting application) applied before planting and/or knife rollers may be used to kill weeds and desiccate green manures/covercrops as to prepare the field for planting with special direct planting implements (manual or animal/tractor-powered).

- ***Minimum Tillage:***

This method means non-turning, superficial tillage respectively opening of planting rows with a ripper tine or planting stations with a hand hoe. Ripping, planting and fertilizer application can be combined in one single operation. It is an option for situations where no full ground cover can be obtained (e.g. semi-arid regions). A minimum ground cover of 30% should be respected, however, to prevent run-off and erosion by wind and water. Weed

control is more demanding and can be done mechanically or with herbicides.

- ***Conservation Agriculture or Conservation Farming:***

These are general terms for all practices that
- conserve soil and water
- maintain soil fertility
- reduce soil disturbance
- improve water infiltration
- build up soil organic matter (SOM)

While the term conservation tillage stresses the non-inversion and minimum disturbance of soils, these terms intend to stress the fact that a systems approach is required to stop soil degradation and maintain soil fertility. The terms are often applied alternatingly.

CT is not linked to a specific source of power. Implements are available for manual labour, draft animal power and tractor power.

Direct Planting through mulch without any soil tillage, is the optimal way of plant production. Soil quality is maintained or even improved, while production costs are reduced. This technique allows for timely planting, as no time is lost for soil preparation.

World wide Application of Conservation Tillage Practices

The agricultural land under CT is increasing from year to year. The most rapid spread is observed with no-tillage in Latin America, especially in Brazil, Argentina and Paraguay, where over 60% of cropped land is under no-till based farming systems. In Africa the rate of adoption of these farming systems has accelerated significantly over the last decade; especially among commercial farmers. In smallholder-communal farming systems, adoption is low.

But there is, however, an increased awareness and desire to find solutions to farming problems, especially that of an increasing soil infertility.

Area under no-tillage in different countries

Country	Area under No- tillage in ha 2000/ 2001
USA	21.120.000
Brazil	15.046.000
Argentina	11.660.000
Australia	8.640.000
Canada	4.080.000
Paraguay	1.100.000
México	650.000
Bolivia	350.000
Venezuela	150.000
Chile	100.000
Colombia	70.000
Uruguay	50.000
Others	1.000.000
Total	**64.016.000**

Source: DERPSCH, R. (2002): www.rolf-derpsch.com

Direct planting through mulch provides the optimal conditions for growing food crops. While this system is applied by a growing number of farmers in the sub-humid tropics and sub-tropics, the adaptation to the semi-arid tropics constitutes a real challenge.

Principal Effects of Conservation Tillage

The application of CT provokes a number of positive environmental, economic and social effects.

- ***Environmental effects:***

The principal effects of CT are:

- Building up and maintenance of soil fertility
- Significant reduction of soil erosion, which means cleaner surface water; less off-site damage by siltation of lakes and roads
- Increased water infiltration rates make rivers and springs flow over a prolonged period of time
- An increased biodiversity provides a better habitat for small animals like arthropods or birds
- Emissions of green house gases like $Co2$, $N2O$ or $NH4$ are reduced due to a slower decomposition of organic matter. Under optimal conditions even a build up of organic matter takes place (carbon sequestration)

- Economical effects:

More immediate and crucial to a farmer are the economical benefits. A reduction in production costs, savings in energy (fuel, labour) and capital (wear and tear), all goes to translate farming into a more profitable enterprise. The reduction of production costs already becomes effective in the first year, while all other practices of soil management usually have an impact on farm revenues with a time lag. Reduction of production costs also means a reduced risk of investment.

The time formerly spent on tilling, harrowing and weeding can be used for other income-generating activities like the transformation of products or growing of vegetables and fruit trees.

Lower siltation of dams prolongs the life span of the dams. This is why the management of the world largest dam, the Itaipu Dam on the border between Brazil and Paraguay is funding R&D activities in the watershed area of the dam.

- ***Social effects:***

The experiences in Brazil show that the introduction of CT has contributed to social and economic empowerment of farming communities. Farmers are organised in "earthworm clubs", "friends of the earth clubs" and farmer cooperatives. Farmers organise themselves to learn from each other, to buy advice and farm inputs.

The successful change of the production system and the increased income has raised the self-confidence of entire farming communities. The communities claim bigger participation in development planning and a decentralisation of decision-making processes.

Global Effects of Conservation Tillage

- ***Carbon sequestration:***

Significant amounts of carbon are stored in the soil. The quantity stored in productive tropical soils can equal that of forests (6-13 kg C/m^2 at 0-20 cm depth). This carbon is released rapidly under intensive cultivation, especially in the tropics. Soils are turned into a carbon source. CT can reverse this trend and turn soils into a carbon sink.

- Poverty reduction:

Agriculture is the most important industry in most developing countries. The livelihood of over 90% of Africa's rural population depends directly on agriculture. Land and labour productivity is in general extremely low. Experiences from Latin America have highlighted that CT can drastically increase labour productivity and income. Reduced labour requirements for tilling and weeding allow farmers to spend their time on other income-generating activities.

- ***Food security:***

CT enables an efficient use of rainwater. This considerably reduces the risk of crop failure due to drought. CT thus contributes to food security, especially in arid and semi-arid regions.

CT contributes to food security by making the use of precious rain (or irrigation) water more efficient and thus reducing the risk of crop failure due to drought. Reduced labour requirements relieve women of their daily work-load.

Promotion of Conservation Tillage – Learning from Successes and Failures

CT practices can be applied everywhere. However, under certain ecological and socio-economic conditions the benefits of CT are more pronounced and the likelihood of a wide adoption by farmers is greater. Before starting with CT in a given region it is therefore opportune to first assess the potential of CT, and select situations with a good potential or greater probability of success (see also STEINER 1998).

- Conducive Factors for CT:

The following conditions were identified as conducive factors, especially for no-tillage

- *ecological factors:*
  - high precipitation in conjunction with a long growing period (> 1,000 mm)
  - soils with > 20% clay content

- *socio-economic factors:*
  - growing cash crops (income generation for purchasing inputs)
  - demand for various agricultural products
  - well developed rural infrastructure (access to markets, extension services, credit)
  - shortage of labour, high wages

These conditions prevail only in parts of the forest and humid savannah areas of West Africa and parts of the East African highlands. In most parts of Africa, however, semi-arid savannahs dominate. Here the potential of no-tillage is rather limited.

- ***The main constraining factors, especially for no-tillage, are***

- *ecological factors:*
  - low (unreliable) precipitation = low biomass production
  - short growing season (< 6 months)
  - sandy soils with a tendency to compaction
  - soils at risk of water logging

- *socio-economic factors:*
  - strong demand for crop residues as forage for livestock
  - communal land tenure systems - limiting the right of land use to the growing season
  - poorly developed infrastructure with different problems of access to land
  - distinct market preference for one crop only (e.g. maize)
  - limited farm management capabilities

As a result of this situation - especially the lack of a sufficient ground cover - the only appropriate solution for semi-arid areas is minimum tillage.

Planting pits, called *Za* . in the Sahel, are traditional ways of harvesting precious rain water and conserving soils. In situations where mulch material is available the pits are covered with mulch, which increases their efficiency. This old practice is revived and promoted by development projects.

Some Lessons learned

Adaptation rates are actually low in most parts of Africa. This situation will change only when solutions to some of the main constraints are found:

Problems	Possible Solutions
Alternative use of crop residues	Installation of feed lots, agro-forestry systems (fuel, forage)
Uncontrolled grazing after harvest	Local binding agreements on grazing; life fences
Insufficient residual moisture for cover crops	Inter- or relay cropping of green manure crops or cover crops; intercropping of green legumes
Lack of credit for purchase of implements	Foundation of farmer organisation, hire services
Weed control becomes difficult - no access to herbicides and money for them	Use of animal drawn weeders, intercropping of legumes, pumpkins, sweet potatoes; where possible

Preconditions for adoption of Conservation Tillage

A Significant increase in the rate of adoption can only be achieved through participatory extension approaches. Essential features of this approach are:

- Explanation of guiding principles of minimum tillage
- Encouragement of farmer innovations
- Making use of indigenous knowledge
- Taking advantages of specific local opportunities
- Supporting the formation of farmer groups
- Building up of professional capacity of farmers
- Building up of communal capacity
- Encouragement of mutual learning and training – farmers and extensionists
- Integration of gender-sensitive approaches

Farmers are increasingly interested in CT practices. They have observed that cover crops suppress weed growth and help to reduce the time required for weeding the crops.

Success factors and lessons learned

Case study - Brazil

An analysis of the development in Brazil shows, that quite a range of factors was responsible for the break through of the new production system

- Extreme pressure for the farmers due to serious soil degradation and decreasing product prices
- The development of new production systems was initiated by esp. the medium and large scale farmers; only later agricultural research and extension stepped in
- Farmer organisations and cooperatives played an important role in the adaptation, further development and implementation of the system to local conditions
- Small farmers were supported by the World Bank and State government programmes; they obtained farm implements, fertiliser and seeds for green manures
- No-tillage systems made the cultivation of formerly marginal lands - the so called *campo gerais* or the *cerrados* - profitable

- ***Main lessons***

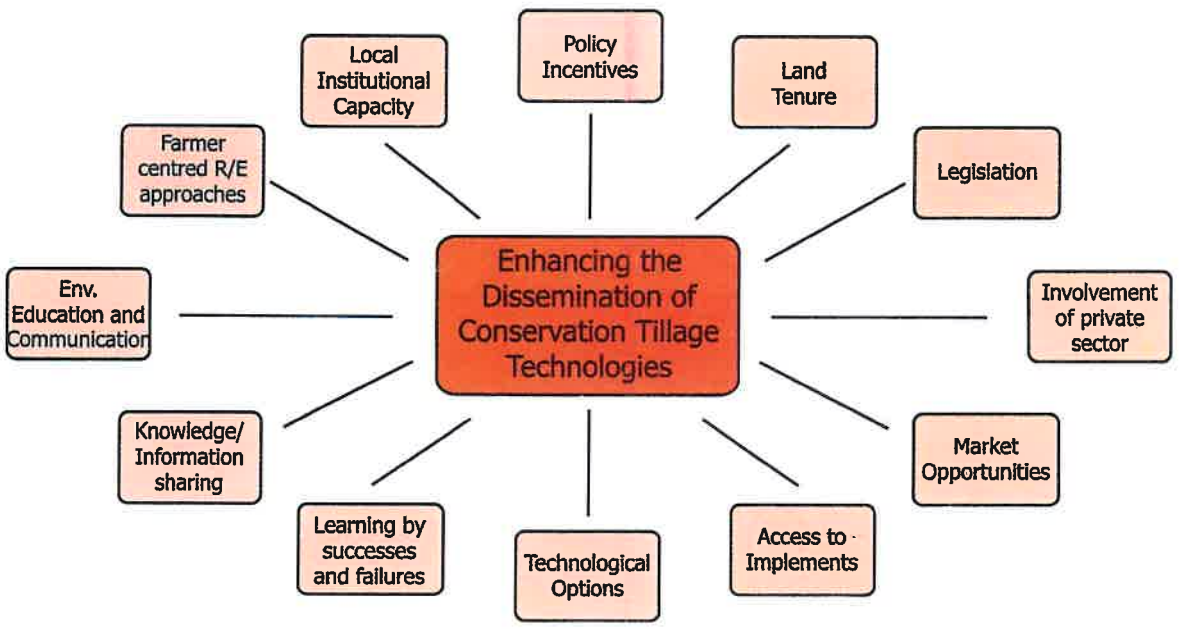
can be learned from the Brazilian case. The fundamental lessons, which are also valid for a sustainable rural development in African countries, are:

- Increases in farm income are the gateway for overcoming environmental problems
- The increase of labour productivity provides chances for other income generating activities
- To be sustainable the development of new farming systems needs to be carried by a social movement, such as decentralisation of decision making from provincial or district governments to communities, the participation of the population in development planning, and organisation of farmers in the producer cooperatives.

Smallholder farmers without access to draft power use a jab planter, called "matraca" in Latin America. Experienced farmers plant up to 1 – 2.5 ha maize per day by hand. While a farmer has to walk 30 – 40 km when ploughing 1 ha in conventional systems plus 10 km when seeding, he has to walk only 10 km when planting maize directly.

Conceptual Framework for the Dissemination of Conservation Tillage Technologies

For a successful dissemination of conservation tillage practices it is not enough to offer farmers appropriate techniques and apply participative extension approaches. Efforts have to be undertaken to create conducive frame conditions. The following graph illustrates which factors influence the dissemination of conservation tillage practices.



Overcoming the challenge in the adoption of CT will be difficult, but not impossible. There are no magic solutions. Changes in tradition, priorities and policies will be cardinal. This will require joint efforts and strengthened partnerships involving all stakeholders – individuals, households, farmers, local communities and civic societies, local and national government authorities and the international community.

It is in this regard, that the African Conservation Tillage Network aims to facilitate such linkages. For further information, contact the ACT Secretariat.

Contacts and Websites

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FAO, AGL (Conservation Agriculture)
http://www.fao.org/waicent/FaoInfo/Agricult/AGL/agll/prtcons.htm

FAO, AGSE (Agricultural Engineering Branch)
http://www.fao.org/waicent/faoinfo/agricult/ags/AGSE/Agse.htm

Rolf Derpsch
www.rolf-derpsch.com

No-Till on the Plains:
http://www.notill.org

CTIC (Conservation Tillage Information Centre)
http://www.ctic.purdue.edu

ECAF (European Conservation Agriculture Federation)
http://www.ecaf.org

ACT (African Conservation Tillage Network)
http://www.welcome.to/ACT-Network

No-Till Farmer
http://www.no-tillfarmer.com

Message to policy makers

Even though conservation farming is a production method, its implications reach far beyond the farm gate. When lobbying for conservation farming the following effects need to be stressed:

- CT is an alternative to slash and burn
- CT sustainably maintains and even improves soil fertility
- CT increases food security
- CT contributes to an improved rural livelihood
- CT can be an answer to HIV/AIDS induced labour shortage
- CT reduces the labour burden of women
- CT is an essential part of natural resource conservation
- CT contributes to cleaner water
- CT favours carbon sequestration
- CT combats desertification

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