# Part 2

Women carrying manure to terraces in Nepal for rice and potato cultivation: maintaining fertility and investing in the future. (Hanspeter Liniger)

# Case studies

# where the land is greener


**Case studies of soil and water conservation initiatives worldwide**

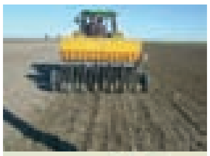
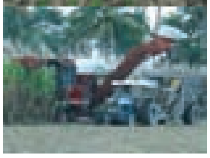
42 technologies and 28 approaches
documented under the WOCAT methodology
by local contributors


Restoration of degraded rangeland

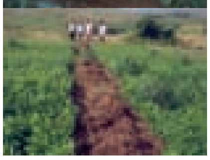

Conversion of grazing land/
Farmer innovation
Orchard agroforestry/
Transition to local initiative
Poplar trees
for bio-drainage
Orchard terraces
with bahia grass cover
Stone wall bench
terraces
Runoff harvesting/
Participatory techno-
logy development
Traditional irrigated rice
terraces
Shelterbelts for
farmland in sandy
areas
Landslip stabilisation/
Integrated watershed
management
Zhuanglang loess
terraces/
Terrace approach
Kyrgyzstan
Tajikistan
Syria
P. R. China
Area closure/
Local level participatory
planning
Nepal
Rainfed paddy rice
terraces
Thailand
India
Niger
Philippines
Ethiopia
Improved grazing land/
Local level participatory
planning
Forest catchment
treatment/
Joint forest manag.
Multi-storey cropping
Kenya
Uganda
Grevillea agroforestry/
Spontaneous spread
Sunken streambed
structure/
Watershed development
*Pepsee* system/
Market support and
branding
Small level bench
terraces
Natural vegetative
strips/
Landcare
South
Africa
Australia
Traditional stone wall
terraces/
Community tradition
*Fanya juu* terraces/
Catchment approach
Vetiver grass lines/
Self-teaching
Small scale conser-
vation tillage/
Self-help groups
Green cane trash
blanket/
The 'triple bottom line'
Ecograze/
Development and pro-
motion of Ecograze
No-till with controlled
traffic
WOCAT

## Case studies – titles and short descriptions (1)

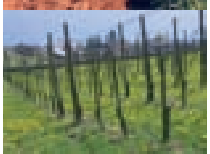
### Conservation agriculture

| | | Technology | Approach |
|---|---|---|---|
|  | Morocco | **No-till technology**<br>A no-till system with crop residue management for medium-scale wheat and barley farming.<br>➜ p 69 | **Applied research and knowledge transfer**<br>Innovative, cross-disciplinary community-based approach for development and transfer of no-till technology at the farm level.<br>➜ p 73 |
|  | UK | **Conservation agriculture**<br>Improved soil management based on non-inversion tillage for cost-effective and timely crop establishment.<br>➜ p 77 | **Soil management initiative**<br>An independent organisation that promotes the adoption of appropriate soil management practices, especially conservation agriculture, within England.<br>➜ p 81 |
|  | Kenya | **Small-scale conservation tillage**<br>Ripping of soil using oxen-drawn implements, to improve water storage capacity and cropland productivity on small-scale farms.<br>➜ p 85 | **Self-help groups**<br>Small-scale farmers forming self-help groups to provide mutual support for adopting and promoting conservation agriculture.<br>➜ p 89 |
|  | Australia | **No-till with controlled traffic**<br>Large-scale no-till grain production with permanent wheel tracks common to all on-farm equipment.<br>➜ p 93 | no approach described |
|  | Australia | **Green cane trash blanket**<br>Elimination of burning as a pre-harvest treatment of sugar cane, and managing the resultant trash as a protective blanket to give multiple on and off-site benefits.<br>➜ p 97 | **The 'triple bottom line'**<br>A new expression used by agriculturalists in Australia to explain why farmers change practices: the 'triple bottom line' implies economic, environmental and social concerns.<br>➜ p 101 |

### Manuring/ composting

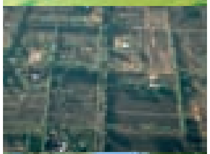
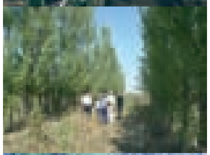
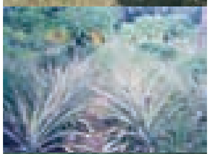
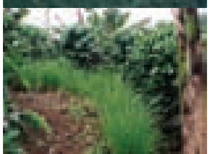
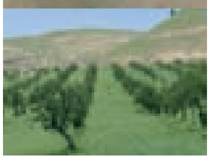
| | | Technology | Approach |
|---|---|---|---|
|  | Nicaragua | **Vermiculture**<br>Continuous breeding of earthworms in boxes for production of high quality organic compost.<br>➜ p 105 | **Productive development and food security programme**<br>An integrated programme-based approach promoting participatory testing and extension of various SWC technologies, as well as providing institutional support.<br>➜ p 109 |
|  | Burkina Faso | **Composting associated with planting pits**<br>Compost production, and its application in planting pits *(zai)* by farmers on fields near their homes.<br>➜ p 113 | **Zabré women's agroecological programme**<br>A demand-driven initiative, by women's association, aimed at the promotion of composting through training and extension, using project staff and local facilitators.<br>➜ p 117 |
|  | Uganda | **Improved trash lines**<br>Weeds and crop residues, laid in bands across the slope of annual crop fields, to conserve soil and water, and to incorporate organic matter into the soil after decomposition.<br>➜ p 121 | **Promoting farmer innovation**<br>Identification of 'farmer innovators' in SWC and water harvesting, and using them as focal points for visits from other farmers to spread the practices and stimulate the process of innovation.<br>➜ p 125 |

### Vegetative strips/ cover

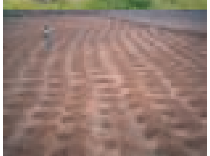
| | | Technology | Approach |
|---|---|---|---|
|  | Philippines | **Natural vegetative strips**<br>Within individual cropland plots, strips of land marked out on the contour and left unploughed in order to form permanent, cross- slope barriers of naturally established grasses and herbs.<br>➜ p 129 | **Landcare**<br>Associations that help diffuse, at low cost, soil and water conservation technologies among upland farmers to generate income while conserving natural resources.<br>➜ p 133 |
|  | Switzerland | **Green cover in vineyards**<br>Naturally growing or sown perennial grasses/herbs providing cover between rows in sloping vineyards, where the vines are usually oriented up and down slope.<br>➜ p 137 | **Farmer initiative within enabling environment**<br>Initiative and innovation of land users, stimulated by government's technical and financial support.<br>➜ p 141 |
|  | South Africa | **Vetiver grass lines**<br>Contour lines of vetiver grass planted within fields of sugar cane, on stream banks and roadsides, to act as 'hedges against erosion'.<br>➜ p 145 | **Self-teaching**<br>Learning how to use vetiver grass as a vegetative conservation barrier through instructions from a booklet and hands-on, practical experience.<br>➜ p 149 |

## Case studies – titles and short descriptions (2)

### Agroforestry

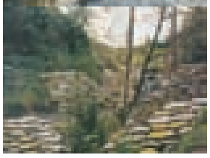
| | | Technology | Approach |
|---|---|---|---|
|  | P. R. China | **Shelterbelts for farmland in sandy areas**<br>Belts of trees, planted in a rectangular grid pattern within areas of farmland, to act as windbreaks.<br>➜ p 153 | no approach described |
|  | Kenya | **Grevillea agroforestry system**<br>Multipurpose *Grevillea robusta* trees planted along farm boundaries, on terrace risers and occasionally scattered in cropland.<br>➜ p 157 | **Spontaneous spread**<br>Spontaneous land users' initiative to meet household needs – especially firewood and timber – through planting *Grevillea robusta* trees as part of an agroforestry system.<br>➜ p 161 |
|  | Kyrgyzstan | **Poplar trees for bio-drainage**<br>Poplars planted to lower the ground water table and reduce salinity where irrigation drainage systems have broken down; lucerne cultivated between the tree lines.<br>➜ p 165 | no approach described |
|  | Philippines | **Multi-storey cropping**<br>Cultivating a mixture of crops with different heights (multi-storey) and growth characteristics which together optimise the use of soil, moisture and space.<br>➜ p 169 | no approach described |
|  | Colombia | **Intensive agroforestry system**<br>A protective and productive high-input agroforestry system comprising multi-purpose ditches with bunds, grass barriers, contour ridges, annual crops and fruit trees.<br>➜ p 173 | **Integrated rural community development**<br>Development of an impoverished indigenous reserve – incorporating alternative land use systems – through intensive training provided by a small NGO.<br>➜ p 177 |
|  | Costa Rica | **Shade-grown coffee**<br>An agroforestry system which combines coffee with shade trees – including fruit, timber and leguminous species – in a systematic fashion.<br>➜ p 181 | **Agroforestry extension**<br>Participatory extension of agroforestry systems, especially of shade-grown coffee, to promote sustainable and productive use of natural resources among small and medium scale farmers.<br>➜ p 185 |
|  | Tajikistan | **Conversion of grazing land to fruit and fodder plots**<br>Fencing-off part of an overgrazed hillside, combined with terracing, manuring and supplementary irrigation for grape, fruit and grass production.<br>➜ p 189 | **Farmer innovation and self-help group**<br>Overcoming administrative and technical problems, an innovative land user, assisted by a self-help group, has established a fruit garden within degraded communal grazing land.<br>➜ p 193 |
|  | Tajikistan | **Orchard-based agroforestry**<br>An agroforestry system where legumes and cereals are planted in fruit orchards, giving simultaneous production and conservation benefits.<br>➜ p 197 | **Transition from centralised regime to local initiative**<br>A land use system established during the authoritarian regime of the Soviet Union is being adapted to farmers' needs through their own initiative.<br>➜ p 201 |

### Water harvesting

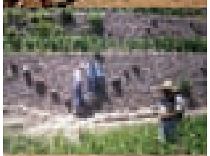
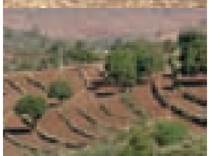
| | | Technology | Approach |
|---|---|---|---|
|  | India | **Sunken streambed structure**<br>Excavations in streambeds to provide temporary storage of runoff, increasing water yields from shallow wells for supplementary irrigation.<br>➜ p 205 | **Comprehensive watershed development**<br>Participatory approach that includes a package of measures leading to empowerment of communities to implement and sustain watershed development.<br>➜ p 209 |
|  | Niger | **Planting pits and stone lines**<br>Rehabilitation of degraded land on gentle slopes through manured planting pits, in combination with contour stone lines.<br>➜ p 213 | **Participatory land rehabilitation**<br>Planning and management of individual and village land, based on land users' participation, with simultaneous promotion of women's activities.<br>➜ p 217 |
|  | Syria | **Furrow-enhanced runoff harvesting for olives**<br>Runoff harvesting through annually constructed V-shaped microcatchments, enhanced by downslope ploughing.<br>➜ p 221 | **Participatory technology development**<br>Participatory technology development, through close researcher-farmer interaction, for sustainable land management of olive orchards in dry marginal areas.<br>➜ p 225 |

# Case studies – titles and short descriptions (3)

## Gully rehabilitation

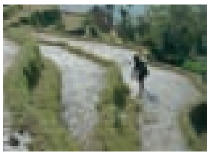
| | | Technology | Approach |
|---|---|---|---|
|  | Nicaragua | **Check dams from stem cuttings**<br>Gully rehabilitation by check dams constructed from stem cuttings of trees which retard concentrated runoff and fill up the gullies gradually with sediment.<br>➜ p 229 | no approach described |
|  | Bolivia | **Gully control and catchment protection**<br>Integrated gully treatment consisting of several simple practices including stone and wooden check dams, cut-off drains and reforestation in sediment traps *(biotrampas)*.<br>➜ p 233 | **Incentive-based catchment treatment**<br>A project supported, incentive-based approach. Farmers are sensitised about erosion, and involved in gully control and other measures to protect catchments.<br>➜ p 237 |
|  | Nepal | **Landslip and stream bank stabilisation**<br>Integration of vegetative and structural measures for landslip, stream bank and gully stabilisation on hillsides.<br>➜ p 241 | **Integrated watershed management**<br>Integrated watershed management based on fostering a partnership between community institutions, line agencies, district authorities and consultants.<br>➜ p 245 |

## Terraces

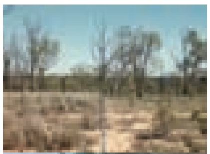
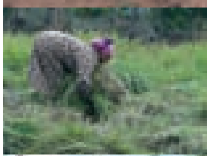
| | | Technology | Approach |
|---|---|---|---|
|  | Syria | **Stone wall bench terraces**<br>Ancient level bench terraces with stone walls, built to stabilise slopes, retain moisture, and create a suitable environment for horticulture.<br>➜ p 249 | no approach described |
|  | Peru | **Rehabilitation of ancient terraces**<br>Repair of ancient stone wall bench terraces with stone walls, and of an associated irrigation and drainage system.<br>➜ p 253 | **Participatory catchment rehabilitation**<br>Promoting the rehabilitation of ancient terrace systems based on a systematic watershed management approach.<br>➜ p 257 |
|  | South Africa | **Traditional stone wall terraces**<br>Stone walls built on sloping fields to create terraces for cultivation and conservation: both ancient and contemporary.<br>➜ p 261 | **Community tradition**<br>Inherited, and still current, tradition of stone terracing – passed down from generation to generation.<br>➜ p 265 |
|  | Kenya | **Fanya juu terraces**<br>Terrace bund in association with a ditch along the contour, or on a gentle lateral gradient. Soil is thrown on the upper side of the ditch to form the bund, which is often stabilised by planting a fodder grass.<br>➜ p 269 | **Catchment approach**<br>A focused approach to integrated land and water management, including soil and water conservation, where the active participation of the villagers – often organised through common interest groups – is central.<br>➜ p 273 |
|  | Thailand | **Small level bench terraces**<br>Terraces with narrow beds, used for growing tea, coffee, and horticultural crops on hillsides cleared from forests.<br>➜ p 277 | no approach described |
|  | P. R. China | **Orchard terraces with bahia grass cover**<br>Rehabilitation of degraded hillsides through the establishment of fruit trees on slope-separated orchard terraces, with bahia grass planted as protective groundcover.<br>➜ p 281 | no approach described |
|  | P. R. China | **Zhuanglang loess terraces**<br>Level bench terraces on the Loess Plateau, converting erodible, sloping land into a series of steps suitable for cultivation.<br>➜ p 285 | **Terrace approach**<br>Highly organised campaign to assist land users in creating terraces: support and planning from national down to local level.<br>➜ p 289 |
|  | Philippines | **Rainfed paddy rice terraces**<br>Terraces supporting rainfed paddy rice on steep mountain slopes: these have been in existence for more than a thousand years.<br>➜ p 293 | no approach described |

## Case studies – titles and short descriptions (4)

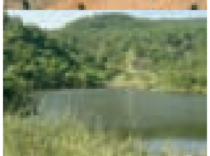
### Terraces (continued)

| | | Technology | Approach |
|---|---|---|---|
|  | Nepal | **Traditional irrigated rice terraces** Level bench terraces with risers protected by fodder grasses, used for irrigated production of rice, potatoes and wheat. ➜ p 297 | no approach described |

### Grazing land management

| | | Technology | Approach |
|---|---|---|---|
|  | Australia | **Ecograze** An ecologically sound and practical grazing management system, based on rotation and wet season resting. ➜ p 301 | **Development and promotion of Ecograze** Research-based development and promotion of Ecograze principles and practices through on-farm testing and demonstration. ➜ p 305 |
|  | South Africa | **Restoration of degraded rangeland** Eradication of invasive species and revegetation of degraded rangelands by different treatments, including oversowing with grass seed mixture, supplementing with lime, cattle dung, and 'brush packing'. ➜ p 309 | no approach described |
|  | Ethiopia | **Improved grazing land management** Rehabilitation of communal grazing lands, through planting of improved grass and fodder trees and land subdivision, to improve fodder and consequently livestock production. ➜ p 313 | **Local level participatory planning approach** An approach used by field staff to implement conservation activities, involving farmers in all stages of planning, implementation and evaluation. ➜ p 321 |
|  | Ethiopia | **Area closure for rehabilitation** Enclosing and protecting an area of degraded land from human use and animal interference, to permit natural rehabilitation, enhanced by additional vegetative and structural conservation measures. ➜ p 317 | **Local level participatory planning approach** An approach used by field staff to implement conservation activities, involving farmers in all stages of planning, implementation and evaluation. ➜ p 321 |

### Other technologies

| | | Technology | Approach |
|---|---|---|---|
|  | India | **Pepsee micro-irrigation system** A grassroots innovation that offers most of the advantages of conventional micro-irrigation at a much lower establishment cost. ➜ p 325 | **Market support and branding for input quality** Market development and support through use of a brand name – *Krishak Bandhu* ('the farmer's friend') – to help ensure quality amongst manufacturers and suppliers of drip irrigation equipment. ➜ p 329 |
|  | Niger | **Sand dune stabilisation** A combination of three measures: area closure, mechanical stabilisation through palisades, and vegetative fixation through natural regeneration as well as planting. ➜ p 333 | **Participatory land rehabilitation** Planning and management of individual and village land, based on land users' participation, with simultaneous promotion of women's activities. ➜ p 217 |
|  | India | **Forest catchment treatment** Catchment treatment of degraded forest land including social fencing, infiltration trenches and enrichment planting with trees and grasses for production and dam protection. ➜ p 337 | **Joint forest management** Government and NGO supported community protection of forested catchments, through village-based Hill Resource Management Societies. ➜ p 341 |
|  | South Africa | **Strip mine rehabilitation** Rehabilitation of areas degraded by strip mining, through returning stockpiled topsoil and transplanting of indigenous species, to promote revegetation. ➜ p 345 | no approach described |

**left:** No-till barley seeding using the special drill, supervised by an extension agent; the photo was taken in the first year of NTT, thus the residue cover is still poor. (Ait Lhaj A.)
**right:** Lentil crops on NTT extension plots. (Ait Lhaj A.)

# No-till technology

Morocco – الزراعة بدون فلاحات

### A no-till system with crop residue management for medium-scale wheat and barley farming.

This no-till technology (NTT) system, with direct seeding and crop residue management, was designed by the National Institute of Agricultural Research (INRA) in Settat, Morocco. A special no-till drill was developed to simultaneously seed and fertilize annual crops: the drill cuts through residue, opens a 20 cm wide slot which, after seed and N/P-fertilizers are dropped into it, is closed firmly to encourage contact between seed and soil. Seeding is earlier than in the case of conventional tillage – which requires seedbed preparation. Spacing between rows is adjusted according to crop type: 20 cm for wheat or barley, and 40 cm for lentils and chickpeas. Tillage depth is between 5–12 cm depending on soil workability and moisture content.

Crops, planted in rotation with a fallow period, are barley, wheat, legumes (lentils and chickpea) and also fodder species. Application of special herbicides replaces tillage for weed control, and enables the farmer to have an 18-month fallow period (a 'chemical fallow') after two crops have been taken over a 6-month period. Fallowing is essential for water conservation in this semi-arid area. NTT reduces passes with heavy machines to three times per year. Residue management involves maintaining the soil partially covered with stubble and straw. Overall, yields are higher and costs are lower than under conventional tillage. NTT reduces soil erosion and soil compaction while conserving water in the soil. Optimum use of scarce and low rainfall to stabilise/increase crop yields is essential in this area.

The use of the special no-till drill ensures both minimal working of the soils, and precise incorporation of phosphate fertilizer beneath seeds. Depending on the specific site, residue management is adjusted from low residue maintenance (stubble/controlled grazing) to medium surface cover (stubble/straw maintenance, forage crops and exclusion of grazing). Erosion and evaporation suppression/control are the main impacts of the system: runoff and concentrated flow in watersheds are reduced. Chemicals are applied for weed control, but this takes into account the environment, and can be reduced over time. Maintaining crop residues in the fields increases soil organic matter and thus the amount of carbon sequestered, as well as nutrient levels. Hence application of inorganic fertilizers can be reduced.



**Location:** Settat, Khourigba and Benslimane Provinces, Chaouia Ouardigha Region, Morocco
**Technology area:** 20 $km^2$
**SWC measure:** agronomic and management
**Land use:** cropland
**Climate:** semi-arid, subhumid
**WOCAT database reference:** QT MOR10
**Related approach:** Applied research and knowledge transfer, QA MOR10
**Compiled by:** Rachid Mrabet, INRA, Settat, Morocco
**Date:** April 2003, updated June 2004

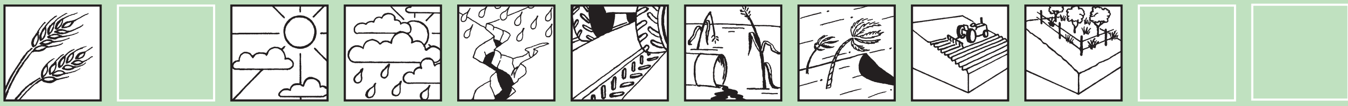
**Editors' comments:** No-till technology (NTT) is a promising system, still at an early adoption stage, but spreading gradually in Morocco as well as in Tunisia. Worldwide, conservation agriculture is expanding rapidly: by 2002, there were up to 60 million hectares under these systems. While it is well documented in Latin America, this case is an example from Northern Africa where it is not common.

## Classification

### Land use problems

Conventional tillage practices are often inappropriate, leading to various problems: disk plough operations make soils more vulnerable to erosion, evaporation, loss of organic matter and nutrients (due to inversion of soil) and thus reduce soil fertility. Furthermore, land preparation often takes place when soils are too dry or too wet. The soils in this area have a weak structure, due to low organic matter content, and are thus susceptible to compaction. Energy input in conventional tillage is much higher than in NTT.

**Land use** | **Climate** | **Degradation** | **SWC measures**



annual crops: wheat, barley, lentils, chickpea | semi-arid | subhumid | water erosion: loss of topsoil | physical: soil compaction | chemical: fertility/organic matter decline | wind erosion: loss of topsoil | agronomic: zero tillage | management change: rotation/fallow

**Technical function/impact**

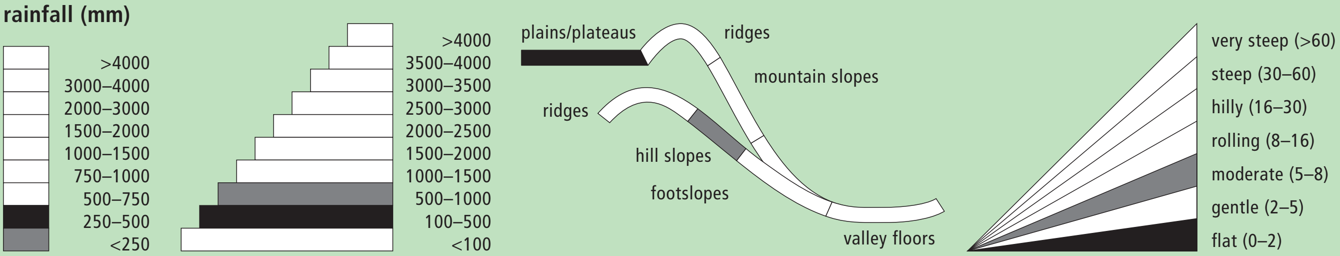
**main:**
- increase/maintain water stored in soil
- increase in organic matter
- control of raindrop splash

**secondary:**
- retain/impede dispersed runoff
- retain/impede concentrated runoff
- increase in soil fertility
- reduction in wind speed
- improvement of soil structure

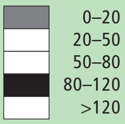
## Environment

### Natural environment*

**Average annual rainfall (mm)** | **Altitude (m a.s.l.)** | **Landform** | **Slope (%)**




**Soil depth (cm)**



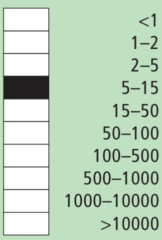

NB: soil properties before SWC

**Growing period:** 180 days (November to April)
**Soil fertility:** low
**Soil texture:** mostly fine (clay), partly medium (loam)
**Surface stoniness:** mostly no loose stone, partly abundant loose stone
**Topsoil organic matter:** mostly low (<1%), partly medium (1–3%)
**Soil drainage:** mostly poor, partly good
**Soil erodibility:** mostly high, partly medium

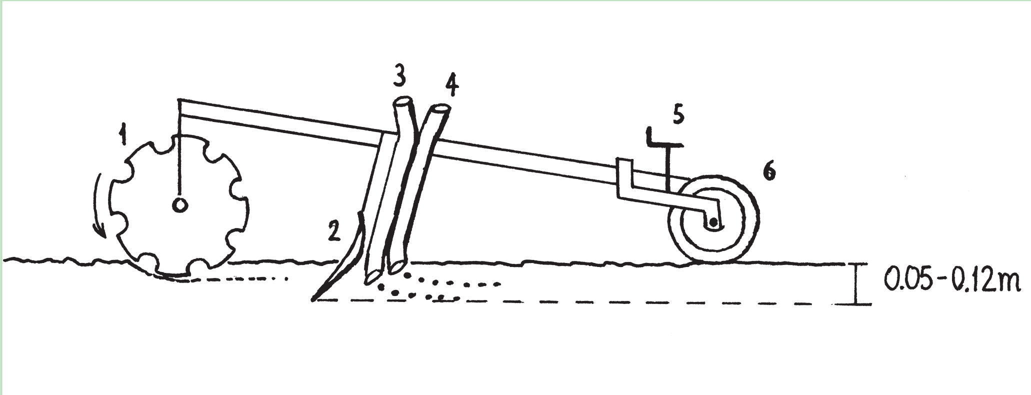
* The data given in this chapter are related to two regions with different agro-climatic conditions. The dominant category (1) refers to the flat plains whereas the second data set (2) refers to the hilly region.

### Human environment

**Cropland per household (ha)**




**Land use rights:** individual
**Land ownership:** individual titled
**Market orientation:** mixed (subsistence and commercial)
**Level of technical knowledge required:** field staff/extension worker: moderate, land user: high
**Importance of off-farm income:** 10–50% of all income: the younger generation work either in cities or overseas (in Europe), others in manufacturing or industry




**Technical drawing**
Schematic view of the specially designed no-till drill that simultaneously plants and applies fertilizer.
Note the key components of the drill:
1 disc/opener
2 hoe
3 fertilizer tube
4 seed tube
5 seeding depth control
6 wheel packer

## Implementation activities, inputs and costs

### Establishment activities

Usually agronomic measures do not have initial establishment costs, but in this case a major investment is needed to buy the special drill. An explanation of the cost calculation is given below (see remarks).
Duration of establishment: not applicable

### Establishment inputs and costs per ha

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Equipment | | |
| - No-till drill | 600 | 0% |
| **TOTAL** | **600** | **0%** |

### Maintenance/recurrent activities

1. Stubble maintenance (no grazing, only partial straw removal after harvest).
2 Direct seeding/fertilizer (N/P) banding using no-till drill (early November).
3. Chemical weed control (December/January).
4. Nitrogen fertilization (March).
5. Harvest (May: after 6 months crop period).
6. Leave fields to fallow for 18 months; apply herbicides if needed.

Time of seeding is earlier than in the case of conventional tillage systems that need seedbed preparation. Depending on rainfall pattern and efficiency of first herbicide application, a second application may be needed. Activities are carried out by fuel driven machines (no-till seed drill, sprayer, tractor and combine/harvester) except nitrogen application, some weeding and other minor activities by hand.

### Maintenance/recurrent inputs and costs per ha per year

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (16 person days) | 160 | 100% |
| Equipment | | |
| - Machines (11 hours) | 110 | 0% |
| Agricultural | | |
| - Seeds (140 kg) | 60 | 0% |
| - Fertilizers (130 kg) | 30 | 0% |
| - Biocides | 40 | 0% |
| **TOTAL** | **400** | **40%** |

**Remarks:** Annual recurrent costs are calculated on a two years basis, including a 6-month cropping and 18-month fallow period, divided by two. The initial cost for the no-till drill is calculated – on a per hectare basis – for an average farm size of 10 ha. In this case a 'pilot' farmer's case is taken, where the drill is supplied free. As with conventional drills, a new no-till drill costs US$ 6,000 but it is subsidised by up to 50% by the Government. Thus farmers can buy it for US$ 3,000 (though 'pilot' farmers receive it free of charge – as noted above). They have no extra costs (compared to conventional tillage) and they can share the price of the drill between them if they wish. The price of certified seeds and fertilizers, energy and equipment are the main factors affecting the costs of no-till, when subsidies are cut after the pilot phase. However, the costs of NTT are lower than for conventional farming, even when the cost of the drill is included.

## Assessment

### Acceptance/adoption

- All the 14 pilot farmers accepted the technology with incentives, receiving all inputs (machinery, seeds, fertilizers and biocides) in the first 3 years.
- These pilot farmers are still in the phase of adoption. Out of the 14 farmers, there are two or three that still resist the change. Farmers' attitudes alter slowly and complete acceptance is only reached after several years.

## Benefits/costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | not applicable* | not applicable* |
| maintenance/recurrent | slightly positive | very positive |

* Pilot farmers receive the no-till drill fully financed by the project (thus no benefits under 'investment costs' above). Farmers who purchase the drill on their own (with a 50% subsidy) will recover its cost in less than two years.

## Impacts of the technology

**Production and socio-economic benefits**

+ + + crop yield increase of 1.0 t/ha (wheat)
+ + + fodder production/quality increase
+ + + farm income increase
+ + reduced labour and energy inputs

**Production and socio-economic disadvantages**

− − initial investment for special drill/tractor
− increased input constraints
− increased economic inequity

**Socio-cultural benefits**

+ + national institution strengthening
+ + improved knowledge SWC/erosion

**Socio-cultural disadvantages**

− − stubble grazing by neighbours can cause socio-cultural conflicts (it is no longer allowed)

**Ecological benefits**

+ + + soil cover improvement (residues, early seeding)
+ + + increase in soil moisture
+ + + increase in soil fertility
+ + + soil loss reduction
+ + + increase in soil organic matter
+ + biodiversity enhancement

**Ecological disadvantages**

− herbicide use: herbicide persistence/carry over

**Other benefits**

+ + + flexible labour inputs: seeding is independent of rain onset
+ + + timeliness
+ + costs: fewer tractor passes in field

**Other disadvantages**

− − increased skills and technical knowledge (expertise) needed: new system of managing crops/soils, new equipment/herbicides

**Off-site benefits**

+ + + reduced downstream siltation
+ + + reduced transported sediments
+ + + reduction of wind erosion: improved air quality
+ + + extra carbon sequestration
+ + reduced downstream flooding
+ + increased stream flow in dry season

**Off-site disadvantages**

none

## Concluding statements

**Strengths and ➜ how to sustain/improve**

Erosion control ➜ Maintaining sufficient soil cover.

Soil quality improvement ➜ Controlled biomass exportation and grazing; on-time seeding.

Efficient use of soil water: increased infiltration, water loss reduced, increased water availability for plants ➜ Fallowing, maintaining sufficient soil cover.

Increased crop production and yield stability ➜ Promote productive and pest-resistant crop varieties and early seeding in order to cover soils and protect them from rainfall impact.

Improved land use and diversified cropping systems with higher yields than in conventional system ➜ Refine the integrated crop management and pest control system.

More flexibility in planting, early land access and easier management of soils ➜ Continue to cover soils with residues at planting/seeding to ensure sufficient soil moisture.

Reduced energy, labour and cost: in NTT the tillage and seedbed preparation operations are eliminated; the no-till drill applies P and N fertilizers with the seed ➜ Stress the use of appropriate equipment and inputs.

**Weaknesses and ➜ how to overcome**

High level of management is required ➜ Training of land users.

Sensitive to nitrogen level management ➜ Soil tests/apply N according to needs of crops under NTT.

High disease and pest prevalence if crop residues are not well managed ➜ Resistant varieties and early seeding of diverse crops.

Reduced availability of straw (fodder) ➜ Optimise crop/livestock integration: straw production under NTT is higher but farmers have to be convinced to remove only part it; use fodder crops in rotation.

Unforeseen environmental risks: eg soil or ground water contamination with herbicides/phosphate ➜ Training, video presentations etc.

Costly machinery (drills, tractor, sprayer) required ➜ Subsidies, purchase of equipment by groups of farmers.

Weed control in NTT is critical: weed infestation if not well managed; high cost of herbicides ➜ Apply environment-friendly herbicides, crop diversification; hand weeding.

Socio-economic constraints of Moroccan farmers ➜ Technology needs a long-term approach for full acceptance and implementation.

**Key reference(s):** Mrabet R, Ibno-Namr K, Bessam F and Saber N (2001) Soil chemical quality changes and implications for fertilizer management after 11 years of no-tillage wheat production systems in semi-arid Morocco. *Land Degradation & Development* 12: 505-517 ▪ Mrabet R (2002) Wheat yield and water use efficiency under contrasting residue and tillage management systems in a semi-arid area of Morocco. *Experimental Agriculture* 38: 237–248

**Contact person(s):** Rachid Mrabet, *INRA Institut National de la Recherche Agronomique, Centre Aridoculture,* 26000 Settat, PO Box 589, Morocco; phone ++212 23 729300/01/02/03, fax ++212 23 720927; rachidmrabet@yahoo.co.uk


**left:** No-till field day in Benahmed region. The sign says: 'trial with barley, direct seeding'. (Ait Lhaj A.)
**right:** Barley samples from on-farm plots at Khourigba, showing improved growth under no-till technology compared with conventional farming. (Ait Lhaj A.)

# Applied research and knowledge transfer

Morocco – البحوث التطبيقية ونقل المعرفة

**Innovative, cross-disciplinary community-based approach for development and transfer of no-till technology at the farm level.**

After 15 years of on-station research at the National Institute of Agricultural Research (INRA), testing and evaluation of no-till technology (NTT) at farm level started in 1997 with three pilot farmers. Recently two new projects were established to promote the introduction and adoption of NTT, in collaboration with the regional council and extension service of the Ministry of Agriculture (MoA). Fourteen pilot farmers are now involved in NTT.

The overall purpose is to promote no-till technology to restore soils, improve production, mitigate drought, increase wealth and strengthen farmers' organisations. NTT has been shown to be socially, economically and ecologically adapted to the local conditions. The approach has three stages: (1) Initiation: this includes basic research, strategic research and applied research; (2) Consolidation: planning is followed by detailed evaluation of technology adoption on farmers' fields; (3) Maturity: this involves the acceptance/spread of NTT with an increased number of farmers in the future.

INRA carries out research, information dissemination, gives training to technicians and farmers, and provides both technical assistance and monitoring. The regional council was convinced by the technology and now financially supports research activities, drill manufacture and extension of NTT. It also facilitates contacts with decision makers and farmers, and carries out evaluations. MoA development and extension services provide financial support, advice, technical assistance, and logistical support to farmers: they help to make the drills available. NGOs are engaged in the development of local/regional networks and farmers' associations, as well as in funding and providing incentives. Farmers themselves are involved in the implementation, evaluation and dissemination of NTT.

Participation, cross-discipline and bottom-up planning are key elements of the approach. Methods for implementation include long-term community on-farm trials, on-site training and information exchange, participation of stakeholders, information dissemination tools, and multi-directional knowledge flow. These are supplemented by intensive measurement/monitoring schemes, establishment of local/regional networks and farmers' association creation. On-the-job training is also provided.



**Location:** Settat, Khourigba and Benslimane Provinces Chaouia/Ouardigha, Morocco
**Approach area:** 16,760 km$^2$
**Land use:** cropland
**Climate:** semi-arid, subhumid
**WOCAT database reference:** QA MOR10
**Related technology:** No-till technology, QT MOR10
**Compiled by:** Rachid Mrabet, INRA, Settat, Morocco
**Date:** April 2003, updated June 2004

**Editors' comments:** This is a unique approach within Morocco, developed by INRA (National Institute of Agricultural Research) in that it integrates several institutions and stakeholders (research institute, government extension service, manufacturers, NGOs, community and farmers) at different levels. It is specifically designed for the promotion of no-till farming.

## Problem, objectives and constraints

### Problem
- previous absence of an integrated research and extension programme
- lack of technical options in a harsh and risky environment
- underlying problems of land degradation and drought periods

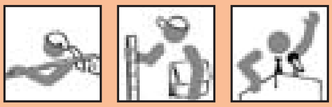
### Objectives
- spread the no-till technology: thereby enhancing soil productivity and reducing susceptibility to land degradation
- develop the production of no-till drill machinery
- generally: to ameliorate the living conditions of rural people through enhancing expertise, capacities and knowledge of farmers in managing their soils and crops

### Constraints addressed

| Major | Specification | Treatment |
|---|---|---|
| Technical | Lack of adapted machinery. | Promotion of no-till drill industry in Morocco. |
| Institutional | Extension services are not well incorporated in the approach due to lack of knowledge/information on no-till. | Special training programme, changing institutional thinking regarding no-till systems. |
| Financial | Lack of specific funds, credit, loans for investment in new machinery. | Prioritise funds for no-till development. |
| Social/cultural/religious | Over-reliance on traditions in soil management; attitudes of farmers towards conventional tillage need challenging through information about alternatives. | Training, video conferences, travelling workshops etc. |
| **Minor** | **Specification** | **Treatment** |
| Legal | Lack of SWC-related laws. | Recommendations on laws to cover SWC technologies. |
| Legal | Small field sizes. | Encouragement of collaboration between farmers to establish 'economies of scale' (per unit input of labour/machinery a larger area can be treated than in conventional farming). |

## Participation and decision making

### Target groups



Land users; SWC specialists/ extensionists; Politicians/ decision makers

### Approach costs met by:

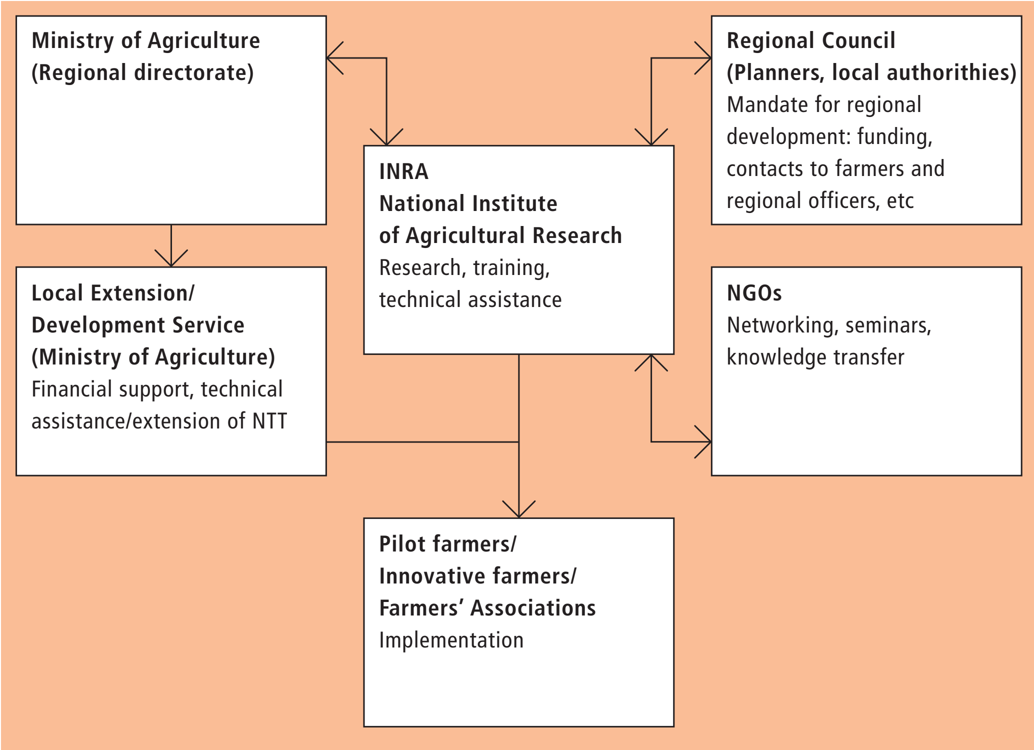
| | |
|---|---|
| National government: INRA/Ministry of Agriculture | 80% |
| Community/local: regional council | 20% |
| | 100% |

**Decisions on choice of the technology:** Mainly made by SWC specialists, supported by politicians, with the consultation of land users. Recognition of no-till as an appropriate technology by decision-makers at local, regional and national level is due to research results as well as to the international call to promote this technology.
**Decisions on method of implementing the technology:** Mainly made by SWC specialists with consultation of land users; no-till technology was under research and on-farm trials (3 farmers) and showed very marked benefits, particularly during drought years.
**Approach designed by:** National specialists.

### Community involvement

| Phase | Involvement | Activities |
|---|---|---|
| Initiation | passive | open days (public meetings, workshops) |
| Planning | payments/incentives | public meetings, workshops |
| Implementation | payments/incentives | responsibility for minor steps, also casual labour |
| Monitoring/evaluation | payments/incentives | field observations, interviews, measurements, public meetings, workshops |
| Research | interactive | on-farm demonstration plots |

**Differences in participation of men and women:** There are no differences. Both men and women participate.




**Institutional framework**
Stakeholders and their roles: cross-disciplinary linkages between INRA, collaborating institutions and farmers.

## Extension and promotion

**Training:** Training is provided in the no-till system, including weed control, machinery use, cropping systems, and crop varieties. The following methods are used: on-the-job training, demonstration areas, and also public meetings. The effectiveness of training on land users, planners and politicians has been 'good', on trainers/extensionists it is 'excellent'.
**Extension:** The two key elements are as follows: (1) participation of extension agents and farmers (observations on the crop, weeds, disease, seeding condition, yield components); (2) training/open days (field days) to allow farmers and extension staff to discuss no-till technology. Extension and awareness raising have had a good impact on land users, but extension continuation through government is inadequate as yet. Extension agents need to be further trained.
**Research:** Research on technology, ecological and agronomic aspects were carried out by INRA in collaboration with pilot farmers. Topics were as follows: crop performance, soil analysis, no-till drill design and evaluation, and socio-economic analysis of NTT. Research is an essential part of the project, and its impact has been, and continues to be, great.
**Importance of land use rights:** Small field size requires collaboration between farmers for the use of the no-till drill and other equipment. It is important to share the costs of drills.

## Incentives

**Labour:** Labour inputs by the farmers are not reimbursed.
**Inputs:** Drills, seeds, fertilizers and biocides have been provided and fully financed by the project. The Government (MoA) has purchased drills for pilot farmers in order to encourage implementation of NTT. This is to help farmers to understand the benefits of no-till systems, but also to encourage them to purchase their own no-till drills in the future.
**Credit:** To promote the acceptance of the technology, farmers receive a 50% subsidy on the purchase price of the no-till drill (as is the general case for all types of drills).
**Support to local institutions:** Moderate support: both financial and in terms of training.
**Long-term impact of incentives:** Once no-till is adopted by the farmers the ecological effects of NTT (increase in crop production and soil quality changes) will last and incentives can be reduced. However with direct incentives there is some risk that when these are phased out, some farmers may abandon NTT.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Bio-physical | regular measurements of soil properties, soil water content, weeds, disease, insects, production (straw and grain yield) |
| Technical | regular measurements of drill performance (seeding depth, plant vigour, fertilizer banding depth, roughness, residue management), energy (fuel consumption, traction needs, speed of seeding), inputs, herbicide application (rate, distribution, amount of water needed, efficacy on weeds, toxicity on crops), harvest (straw and grain yields, stubble, yield components, seed quality, seed health) |
| Socio-cultural | ad hoc evaluation of farmers' observations and constraints, labour (household/off-farm) and traditional farming (type, tools, crop management skills, soil management knowledge, level of education and technical knowledge) |
| Economic/production | regular measurements of use of agricultural inputs , energy consumption, yield, labour |
| Area treated | ad hoc measurements |
| No. of land users involved | regular assessment |
| Management of approach | ad hoc observations: during field days and seminars the remarks, comments and suggestions of farmers regarding the no-till system are discussed |

## Impacts of the approach

**Changes as result of monitoring and evaluation:** The evaluation is still in process: thus too early to state what changes are likely.
**Improved soil and water management:** Better use of the rainwater stored in the soil by crops leads to improvement of soil and water management: increase in soil organic matter has multiple benefits.
**Adoption of the approach by other projects/land users:** This no-till system can now be considered for several different agroecological situations where a similar approach can be applied.
**Sustainability:** Progress can continue to be made, assuming that training, subsidised drills, and the creation of farmers' organisations all persist.

## Concluding statements

| **Strengths** and ➜ how to sustain/improve |
|---|
| The NTT project has integrated several institutions -which is unique in Morocco. Now research, extension, community and farmers are working together towards the same objective ➜ Further develop, refine and spread NTT. |
| Progressive implementation of a 'bottom-up' approach; integration of farmers' decisions, opinions and criticisms ➜ Further involve farmers and farmers' associations in all stages of the process. |
| Cross-discipline: involving land users, research and extension agents has helped in building up an approach suitable for the local conditions. |
| NGO development: the association of NTT farmers and environmental clubs are important for spreading NTT and for re-enforcing the importance of NTT amongst government officers and decision makers ➜ Encourage special NGOs to respect soils, nature, and the environment. |
| Incentives make it possible for land users to experiment with a new cultivation system ➜ Diversification of incentives: eg reduction in seed prices and herbicides for NTT farmers; award 'NTT best producers'; reduction in interest rates for NTT farmers (for credits or loans); special NTT training courses. |
| Adaptability to farmers' needs and constraints ➜ Improve integration of livestock and crops. |

| **Weaknesses** and ➜ how to overcome |
|---|
| The programme's duration is currently too short to overcome resistance (to new technology adoption) and to address economic constraints of farmers ➜ A long term programme is needed to increase acceptance among farmers. |
| Direct incentives: there is always a risk that when eliminating these incentives, farmers will abandon NTT ➜ Eliminate incentives gradually and replace with loans and credits. |
| Information availability: up to now information and communication on NTT is scarce ➜ Intensify training. |
| In some situations (farmers with very low incomes), the need for external inputs such as herbicides, seeds, fertilizers and drills may retard implementation of NTT ➜ Incentives should be maintained for a short period and supplemented by credit systems. |

**Key reference(s):** Segry L, Bousinac S and Pieri C (1991) *An approach to the development of sustainable farming systems.* World Technical Paper N-2. IBSRAM Proceedings 1991 ▪ Wall et al (2002) *Institutional aspects of conservation agriculture.* International Workshop on Conservation Agriculture for Sustainable Wheat Production, 14-18, October 2002, Tashkent, Uzbekistan
**Contact person(s):** Rachid Mrabet, *INRA Institut National de la Recherche Agronomique, Centre Aridoculture,* 26000 Settat, PO Box 589, Morocco; phone ++212 23 729300/01/02/03, fax ++212 23 720927; rachidmrabet@yahoo.co.uk

**left:** A tractor with the 'Väderstad Rapid Cultivation Drill' in action: a light surface tillage followed by direct seeding. (Soil and Water Protection, SOWAP)
**right:** The grain crop emerging through a light mulch of straw. (SOWAP)

# Conservation agriculture

England, UK

**Improved soil management based on non-inversion tillage for cost-effective and timely crop establishment.**

Conservation agriculture (CA), involving superficial non-inversion tillage, began to be widely taken up in England following advances in seed drill technology, non-selective herbicides and straw-chopping combine harvesters in the late 1980s. This case focuses on the Game Conservancy Trust's Allerton Project at Loddington, which in 2000 pooled resources with its neighbour to purchase a single set of cultivation equipment, and replaced conventional mouldboard ploughing (with its multiple cultivations) by state-of-the-art CA. Contract services offered by the joint venture means that 1,000 ha are now covered each year. The main winter crops are wheat, oats, and oilseed rape. Beans are sown in the spring. The heavy clay loam is vulnerable to excessive surface moisture, restricting crop establishment 'windows'.

Immediately after harvest the soil is loosened and straw incorporated, and then soil is consolidated (using a 'cultivation train' combining two machines: the 'Simba Solo' and the 'Cultipress'). This encourages up to 60% of the weeds to emerge in a 'stale seedbed'. Spraying then removes all the weeds and volunteer plants of previous crops. This is followed by a light surface tillage, using the 'Väderstad Rapid Cultivator Drill', before sowing into the seedbed created. Equipment comprises implements with tines and/or discs which create a tilth to around 10 cm without inverting the soil. Cambridge rollers are then used to consolidate the sown land. After crop maturity, combine harvesting takes place – with simultaneous chopping of straw/crop residues. A trash rake is used to disperse the chopped straw. This way excessive trash is incorporated rapidly into the soil. Compaction may arise in the transition phase, because of the lack of soil loosening through ploughing: minimising traffic, keeping to tramlines and headlands can all help. In time, increases in soil organic matter content and earthworm biomass make compaction less of a problem. The problem of slugs can be reduced by improving seed-to-soil contact, and by drilling deeper.

The main purpose of conservation agriculture is cost effective, timely and rapid crop establishment, under good soil conditions. High-speed operations are the key. Compared with conventional ploughing, labour is saved and fuel costs lowered. However, an additional application of herbicides represents an extra expenditure. Yields per hectare haven't risen but the key difference is that about four times as many hectares can be prepared in time for autumn planting under conservation tillage, thus improving overall production. Incorporation of crop residues improves soil structure and leads to a more friable, less erodible topsoil.



**Location:** Leicestershire, England
**Technology area:** 10 $km^2$
**SWC measure:** agronomic
**Land use:** cropland
**Climate:** subhumid
**WOCAT database reference:** QT UNK01
**Related approach:** Soil management initiative, QA UNK01
**Compiled by:** Alastair Leake, The Allerton Trust, Loddington, Leicestershire, UK
**Date:** October 2004, updated March 2005

**Editors' comments:** Conservation agriculture is rapidly catching on throughout the world. While most attention has been focussed on the Americas, a revolution is taking place in Europe also. In England, for example, around 40% of the large scale arable area is now under CA – a rise from just 10% a decade ago. CA helps to minimise costs and reduce local, and global, environmental impacts. This is a case from a leading proponent of CA in England. Comparative case studies are documented from Morocco, Australia and Kenya.

## Classification

### Land use problems

Traditional inversion tillage is slow and costly. By moving to high speed non-inversion conservation tillage farmers can spread costs over a larger area and maximise the area under winter crops. The speed at which ground can be worked in the autumn is critical: one month earlier planting can mean an extra ton in cereal yield.

**Land use**

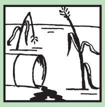
annual crops: wheat, oats, oilseed rape

**Climate**

subhumid (temperate)

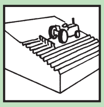
**Degradation**

water erosion: loss of topsoil, gully erosion



chemical: decline in organic matter and fertility

**SWC measures**



agronomic: non-inversion tillage

**Technical function/impact**

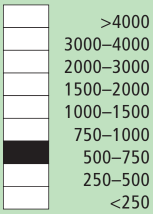
**main:**
- improvement of ground cover
- improvement of soil structure
- increase in organic matter
- increase in soil fertility
- increase in infiltration

**secondary:** - none

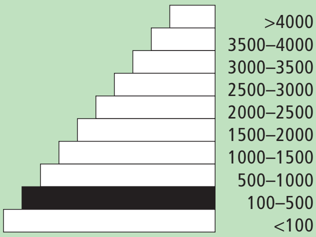
## Environment

### Natural environment

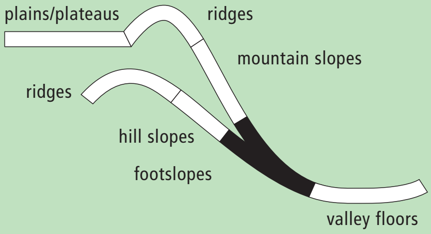
**Average annual rainfall (mm)**



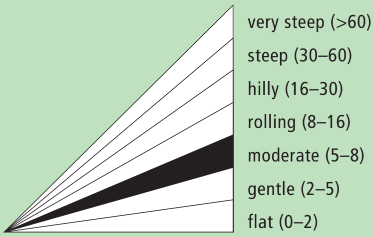

**Altitude (m a.s.l.)**



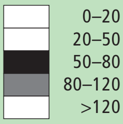

**Landform**




**Slope (%)**




**Soil depth (cm)**

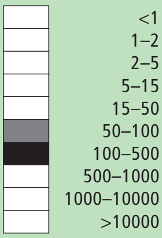



NB: soil properties before SWC

**Growing season:** 300 days (March to December)
**Soil fertility:** medium
**Soil texture:** medium (loam) and fine (clay)
**Surface stoniness:** some loose stone
**Topsoil organic matter:** low (<1%)
**Soil drainage:** medium
**Soil erodibility:** medium

### Human environment

**Cropland per household (ha)**




**Land use rights:** individual and leased
**Land ownership:** company and individual titled
**Market orientation:** commercial (market)
**Level of technical knowledge required:** field staff: high; land user: moderate
**Importance of off-farm income:** contract work on other farms is an important source of additional revenue for the 'joint venture' of the two neighbouring farms


Detailed view of the 'Väderstad Rapid Cultivation Drill' with tines and discs. (Alastair Leake)

## Implementation activities, inputs and costs

**Establishment activities**

not applicable

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| not applicable | | |

**Maintenance/recurrent activities**

1. Loosen the soil and incorporate the straw using the 'Simba Solo'; soil consolidation, using the 'Cultipress' (immediately post-harvest).
2. Spray the stale seedbed to remove all the weeds/volunteer plants of previous crops (mid September).
3. Light surface tillage and sowing into the seedbed; using the 'Väderstad Rapid Cultivator Drill' (usually end September, just after spraying).
4. Consolidation of the sown land (using Cambridge rollers).
5. After crop maturity, combine harvesting – with simultaneous chopping of straw.
6. Disperse the chopped straw, using a trash rake.

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Equipment | | |
| - various machines | 180 | 100% |
| **TOTAL** | **180** | **100%** |

**Remarks:** No establishment costs for purchase of special conservation tillage equipment are included here – though this investment is considerable. Tractors of sufficient horsepower and a couple of special machines (see above) are needed. The investment in this case was shared by two neighbouring farms, who implemented conservation agriculture on a joint venture basis. The only costs presented in the table above are total recurrent annual costs for tillage operations. This total, US$ 180, compares with US$ 260 for conventional tillage operations. While drilling is not included in the above conventional tillage calculation, subsequent application of additional herbicides represents an extra cost of conservation tillage of about US$ 80/ha. In balance the costs per hectare are broadly similar. Labour inputs however are reduced considerably as a proportion: the Allerton farm with its 260 ha of arable land is operated by a farm manager and just one farm worker.

## Assessment

**Acceptance/adoption**

- From just 10% in 1995, approximately 40% of arable land in England is currently (2004) under conservation agriculture/ cultivation tillage. The farmers involved have adopted the system without incentives other than those of timeliness, lower cost, speedier crop establishment, reduced soil erosion and benefits to wildlife.
- There is significant growing spontaneous adoption: the extent of adoption depends on farm size, enterprise, and soil type.
- There are government subsidies to farmers for following sound land management practices (see associated approach 'Soil Management Initiative', under 'Inputs').

## Benefits/costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment* | negative | positive |
| maintenance/recurrent | positive | very positive |

* change of machinery

## Impacts of the technology

**Production and socio-economic benefits**

| | |
|---|---|
| + | overall farm income increase |

**Production and socio-economic disadvantages**

| | |
|---|---|
| − | reduced yields in the early years (due to initial compaction) until the soil restructures |

**Socio-cultural benefits**

| | |
|---|---|
| ++ | community institution strengthening |
| ++ | improved knowledge SWC/erosion |
| + | national institution strengthening |

**Socio-cultural disadvantages**

| | |
|---|---|
| − | socio-cultural conflicts |

**Ecological benefits**

| | |
|---|---|
| +++ | runoff and soil loss reduced |
| +++ | loss of nutrients (through leaching) reduced |
| ++ | soil cover improvement |
| ++ | increase in soil moisture |
| ++ | biodiversity enhancement (above and below ground) |
| ++ | improved soil structure |
| ++ | increase in soil organic matter |
| ++ | carbon sequestration increased |
| + | efficiency of excess water drainage |
| + | increase in soil fertility |

**Ecological disadvantages**

| | |
|---|---|
| − | organic matter depletion (in certain sandy soils) |
| − | increased reliance on herbicides |

**Off-site benefits**

| | |
|---|---|
| ++ | reduced downstream flooding |
| ++ | reduced downstream siltation |
| ++ | reduced river pollution |
| ++ | reduced transported sediments |

**Off-site disadvantages**

none

## Concluding statements

**Strengths and ➜ how to sustain/improve**

Lowers recurrent soil tillage costs – mainly due to reduction in fuel use (down by about one third) and labour (saving around one person day per hectare) ➜ Spread over greater area to maximise cost reduction.

Increases overall farm yield (and income) by speeding up land preparation in autumn, allowing a larger area to be planted as winter crops ➜ Ditto.

Improves soil structure and physical properties in various ways ➜ Maintain system over time to maximise these benefits.

Reduces runoff (by a half), soil erosion (by two thirds), and leaching of nutrients (by three quarters) thus decreasing movement of phosphates and nitrates to streams and rivers ➜ To improve further, combine with other measures such as adding organic matter or growing green manures and cover crops.

Increases soil buffering capacity against climatic extremes (especially rainfall) through maintaining surface cover and building up soil organic matter ➜ Maintain system over time to maximise these benefits.

Increases soil biota (more than doubling earthworm mass) and biodiversity generally (nearly doubling the number of different organisms) ➜ Maintain system over time to maximise these benefits.

**Weaknesses and ➜ how to overcome**

Increased growth of grass weeds and thus greater cost of herbicides ➜ Use 'stale seedbeds' – surface tillage immediately post-harvest to induce weed germination – followed by spraying. Crop rotation, spring cropping, occasional ploughing (every few years as necessary).

Not suitable for all soil types (not appropriate on some sandy soils) ➜ Don't introduce/promote CA indiscriminately.

Excessive surface trash/crop residues ➜ Good chopping, then spreading and incorporation.

Problems with slugs ➜ Drill seed deeper, ensure good seed-to-soil contact.

Surface compaction in the early stages of conversion to conservation agriculture ➜ Appropriate loosening of soil, using tined implement.

**Key reference(s):** Soil Management Initiative/Department for Environment, Food and Rural Affairs (DEFRA) (undated) *A guide to managing crop establishment.* SMI, UK (www.smi.org.uk) ▪ Soil Management Initiative (undated) *Improved soil management for agronomic and environmental gain.* SMI, UK ▪ Soil Management Initiative/Väderstad (undated) *Target on establishment: innovation for the future of farming.* SMI, UK
**Contact person(s):** Dr A R Leake, Chairman UK Soil Management Initiative, Loddington House, Main Street, Loddington, LEICESTERSHIRE LE7 9XE, UK; phone ++44 1572 717220; aleake@gct.org.uk; www.gct.org.uk; www.allertontrust.org.uk

**left:** Extension methods include practical and theoretical elements: farmers attending a field day organised by SMI. (Soil and Water Protection – SOWAP)
**right:** Classroom training sessions on conservation agriculture with presentations from experts (SOWAP).

# Soil management initiative

England, UK

**An independent organisation that promotes the adoption of appropriate soil management practices, especially conservation agriculture, within England.**

The zero tillage systems promoted in the UK during the 1970s were radical. Pioneering farmers moved from ploughing to zero tillage using special direct drilling machines and non-selective contact herbicides. However, they encountered serious problems with slugs, persistent grass weeds and straw, and zero tillage was largely abandoned. Pressures to reduce crop establishment costs then led to the intermediate method of 'conservation agriculture' (CA).

The Soil Management Initiative (SMI) has been central to the development and promotion of CA. SMI is an independent non-profit organisation that was established by a small, committed group in 1999. Its aim is to promote the adoption of cultivation systems which improve soil quality, minimise soil erosion and water pollution, and simultaneously maintain or enhance farm economic returns.

SMI brings together organisations with varied expertise and technical abilities, and provides both research results and advice to the large numbers of farmers who are progressively adopting CA. Furthermore, SMI was a founder member of the European Conservation Agriculture Federation (ECAF), under which there are 14 national organisations. Competence within SMI is drawn from research institutes, educational establishments, farmers and landowners, machinery manufacturers, crop protection companies, charitable trusts, and from independent agronomists and advisers.

The EU Life fund provided an initial three-year allocation to support SMI. This ended in 2002. SMI now raises finance from the UK and EU governments, commercial sponsorship (international agrochemical and machinery companies) and fees paid by farmers. In the current climate of privatisation of advisory services, there is no targeted governmental advisory body to carry out such a function. DEFRA (The UK Government's Department for Environment, Food and Rural Affairs) does however provide some support to SMI with both funds and expertise, and is an associate member.

Amongst SMI's methods for spreading the message of improved soil management are field days – where farmers pay to attend – an interactive web-based help-line on 'lo-till' and farmers' magazines. SMI also undertakes extension 'roadshows', visiting specific farms for question and answer sessions. A formal session with presentations from experts precedes a practical outdoor demonstration. SMI gains knowledge and practical experience from the 'joint venture' at Loddington (see associated technology).



**Location:** England, UK (based at: Loddington, Leicestershire)
**Approach area:** England
**Land use:** cropland
**Climate:** subhumid
**WOCAT database reference:** QA UNK01
**Related technology:** Conservation agriculture, QT UNK01
**Compiled by:** Alastair Leake, The Allerton Trust, Loddington, Leicestershire, UK
**Date:** October 2004, updated March 2005

**Editors' comments:** SMI is an example of an independent organisation set up to advise farmers in appropriate cultivation and conservation practices. As government-based advisory services within Europe are reducing in size and scope, farmers are turning to specialised organisations for help.

## Problem, objectives and constraints

### Problem
- Attempts to apply conservation agriculture by arable farmers in the 1980s and 90s were not matched by an understanding of the whole system. There was a thirst for more knowledge.
- Privatisation of government advisory services has left a gap to be filled – in this case an advisory body in sustainable soil management.

### Objectives
- improve technology transfer through extension to farmers
- promote agricultural and environmental policies to support sustainable soil management
- improve information exchange in and amongst the research, policy and practitioner communities and private companies (machinery and agrochemical etc)
- research, develop, evaluate and promote soil management systems to improve crop production and protection of the environment

**Constraints addressed**

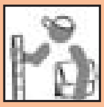
| Major | Specification | Treatment |
|---|---|---|
| Technical | Farmers lacked adequate knowledge regarding use of new CA implements, and emerging weed and pest control methods. | SMI provides demand-driven technical support services. |
| Financial | SMI has needed to operate within a tight budget, and this was reduced further in 2002 when the 3-year allocation from the EU Life fund ended. | The remedy has been to depend more on support from private companies (agrochemical and machinery) and payment by farmers for advice/attendance at field days. |

## Participation and decision making

**Target groups**

Land users/ landowners/ contractors

Politicians (govt. agencies)



Environmentalists/ researchers

**Approach costs met by*:**

| | |
|---|---|
| International (European Union: EU Life Fund) | 40% |
| Commercial companies (including Monsanto, Syngenta and Väderstad) | 30% |
| National government (DEFRA) | 10% |
| National NGO | 10% |
| Community/local: regional council | 10% |
| | 100% |

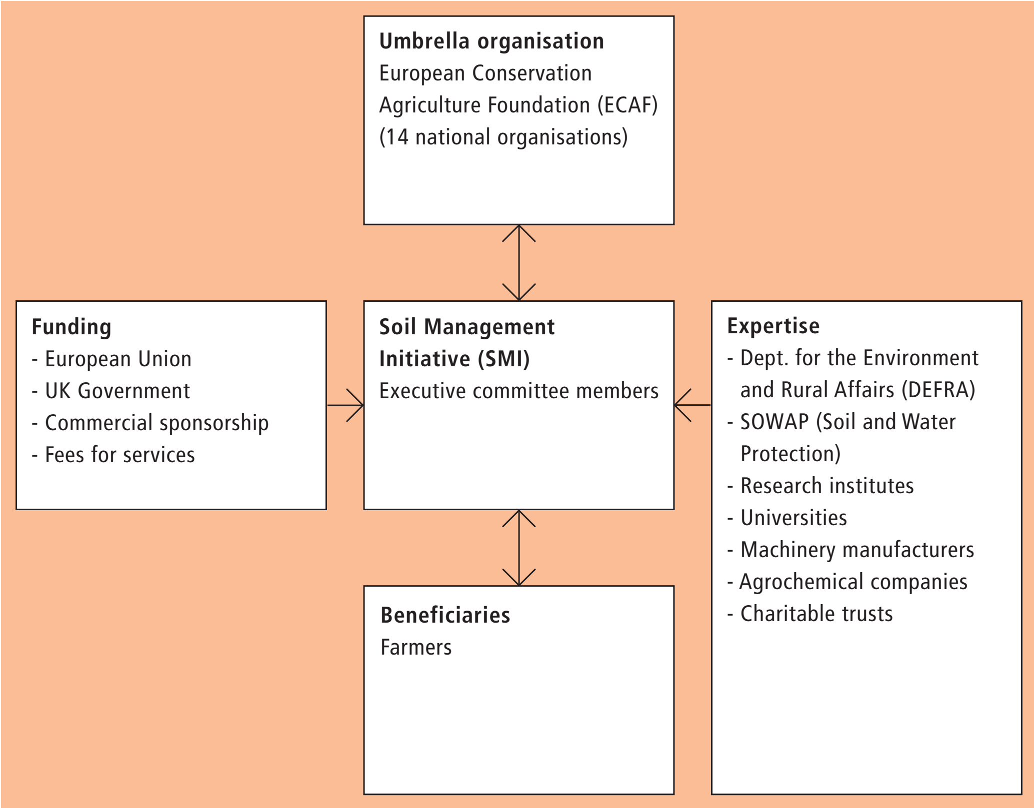
* until 2002

**Decisions on choice of the technology:** Made by land users alone.
**Decisions on method of implementing the technology:** Made by land users alone (farmers).
**Approach designed by:** National specialists (SMI's specialists, and especially the executive committee).

**Community involvement**

| Phase | Involvement | Activities |
|---|---|---|
| Initiation | passive | setting up SMI |
| Planning | passive | setting up SMI |
| Implementation | interactive | advisory services/demand-driven field events |
| Monitoring/evaluation | passive | M&E of SMI's activities |
| Research | interactive | on-farm research on conservation agriculture |

**Differences in participation between men and women:** None in principle, though *de facto* most farmers are male, and they constitute the majority at field days.




**Institutional framework**
Linkages between the Soil Management Institute, the European Conservation Agriculture Foundation, funding agencies, research institutions, land users and producers of machinery and agrochemicals.

## Extension and promotion

**Training:** Technical demonstrations in the field are the primary means of knowledge transfer. A formal session with presentations from experts precedes a practical outdoor demonstration. Although conservation agriculture is the 'umbrella topic', specific issues – such as herbicide application – are treated on demand.
**Extension:** SMI undertakes extension 'roadshows', visiting specific farms for question and answer sessions. It also hosts an e-mail/website based 'lo-till' helpline – through the Farmers' Weekly magazine (www.fwi.co.uk). SMI furthermore contributes to frequent press articles as well as producing publications (see key references). These methods have proved to be very effective: this is evidenced by the number of farmers willing to pay for advice, and by the number of hits on the helpline.
**Research:** Conservation agriculture was initially supported by public funded research. Current research – through SMI but also some research institutes and farmers themselves - is focused on specific issues, including slug control, grass weeds, trash management and soil compaction. Recently, environmental, economic and social concerns arising from the practice of conventional agriculture have been taken up by SOWAP (Soil and Water Protection), a collaborative initiative, supported by the EU Life scheme, between commercial companies, NGOs, academic institutions and farmers.
**Importance of land use rights:** Ownership and the attitude of the owner towards CA can affect uptake significantly. For example, some landlords do not like tenants to practice conservation agriculture because 'it looks messy' with trash lying on the surface rather than neatly ploughed fields.

## Incentives

**Labour:** Farmers themselves provide labour – though the adoption of conservation agriculture involves a considerable saving on labour inputs compared with conventional agriculture.
**Inputs:** There are no subsidies specifically connected to CA or sustainable soil management. However, the CA principles fall within UK's new 'cross-compliance' conditions for the Single Farm Payment scheme which effectively constitutes a subsidy to farmers for following sound land management practices. There is also a recently introduced 'Environmental Stewardship Scheme', which embraces environmental concerns. Under this scheme, it is likely that much of the area under conservation agriculture will qualify for, at least, the entry-level category of subsidy, currently set at approx. US$ 60/ha/year: note – this is on top of the single farm payment, which will be considerably greater (for more details see www.defra.gov.uk). Manufacturers of non-inversion tillage equipment provide machines for demonstration. Manufacturers of biocides provided finance and support to specific farmers in the early stages of progressive development.
**Credit:** None provided.
**Support to local institutions:** None specifically, though the promotion of conservation agriculture tends to encourage collaborative ventures and sharing between farmers.
**Long-term impact of incentives:** Not applicable.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Bio-physical | regular observations/measurements by SMI |
| Technical | regular observations/measurements by SMI |
| Socio-cultural | ad hoc observations by SMI |
| Economic/production | regular observations/measurements by SMI |
| Area treated | ad hoc measurements (survey) by SMI |
| Management of approach | ad hoc observations by SMI |

## Impacts of the approach

**Changes as result of monitoring and evaluation:** SMI is constantly refining its advice on the basis of results monitored from the field.
**Improved soil and water management:** Considerable: erosion reduced, organic matter built up, nitrate losses reduced etc
**Adoption of the approach by other projects/land users:** There are other similar service providers in different aspects of farming, though not in soil management.
**Sustainability:** SMI can continue to support land users with advice as long as they are prepared to continue paying for the services, and sponsorship continues from agencies and commercial companies. Land users can continue to practice CA without external support – but services such as those provided by SMI are extremely valuable.

## Concluding statements

| **Strengths** and ➜ how to sustain/improve | **Weaknesses** and ➜ how to overcome |
|---|---|
| Has successfully stimulated conservation agriculture, which should in turn ultimately lead to environmentally sound and sustainable land management in England ➜ Continue operations for as long as possible. | SMI has an on-going problem with adequacy of funding ➜ Through top-class services, continue to attract funds and voluntary contributions from a wide range of actors. |
| SMI has acted effectively as a channel for making results from research, and a wide body of experience, readily available to farmers ➜ Continue to focus on farmers as the main target group and link them with research and private companies. | |
| SMI has managed to combine the efforts and expertise of a wide range of actors towards a common goal: to provide a unique advisory service in conservation agriculture ➜ Continue to serve as a centre of excellence. | |
| Improvements in soil management techniques have been documented in an accessible way ➜ Continue to publish simply and clearly as new messages develop. | |
| Ad hoc advice available via a web-based helpline ➜ Continue. | |

**Key reference(s):** Soil Management Initiative/Department for Environment, Food and Rural Affairs (DEFRA) (undated) *A guide to managing crop establishment.* SMI, UK (www.smi.org.uk) ■ Soil Management Initiative (undated) *Improved soil management for agronomic and environmental gain.* SMI, UK ■ Soil Management Initiative/Väderstad (undated) *Target on establishment: innovation for the future of farming.* SMI, UK
**Contact person(s):** Dr A R Leake, Chairman UK Soil Management Initiative, Loddington House, Main Street, Loddington, LEICESTERSHIRE LE7 9XE, UK; phone ++44 1572 717220; aleake@gct.org.uk; www.gct.org.uk; www.allertontrust.org.uk

**left:** Demonstration of conservation tillage through shallow ripping of soil using draught animals: Lines are spaced at 30 cm, reaching a depth between 10 cm and 30 cm, depending on the purpose. (Hanspeter Liniger)
**right:** 'Victory' plough toolbar with extension to provide extra penetration: deep ripping is practiced every 3–5 years if soil compaction requires this. (Fredrick Kihara)

# Small-scale conservation tillage

Kenya – *ConTill / Kupiga tindo*

**Ripping of soil using oxen-drawn implements, to improve water storage capacity and cropland productivity on small-scale farms.**

Laikipia District in Kenya is characterised by a semi-arid climate, high altitude and rolling terrain. Most of the soil and water loss occurs during a few heavy storms at the beginning of each growing season. More than 90% of families have under two hectares of land, and few have alternative sources of income.

The form of conservation agriculture described in this case study involves the use of ox-drawn ploughs, modified to rip the soil. Ripping is performed in one pass, to a depth of 10 cm, after harvest. Spacing between the rip lines is 30 cm – in the case of wheat. Deep ripping (subsoiling) with the same implement is done, when necessary, to break a plough pan and reaches depths of up to 30 cm. An adaptation to the ordinary plough beam (the common mouldboard 'Victory' plough) makes adjustment to different depths possible and turns it into a ripper for surface and deeper ripping.

The aim of ripping is to increase water infiltration and reduce runoff. In contrast to conventional tillage, the soil is not inverted, thus leaving a certain amount of crop residue on the surface. As a result, the soil is less exposed and not so vulnerable to the impact of splash and sheet erosion, and water loss through evaporation and runoff. In addition, there are savings in terms of energy used for cultivation. In well-ripped fields, rainfall from storms at the onset of the growing season is stored within the rooting zone, and is therefore available to the crop during subsequent drought spells. Ripping the soil during the dry season combined with a mulch cover reduces germination of weeds, leaving fields ready for planting. In case of stubborn weeds, pre-emergence herbicides are used for control. Yields from small-scale conservation tillage can be more than 60% higher than under conventional ploughing. An additional important benefit is that crops mature sooner in conservation agriculture, because they can be planted earlier: under inversion tillage the farmer has to wait for the soil to become moist before ploughing. Earlier crop maturity means access to markets when prices are still high.

There are various supportive technologies in use which can improve the effectiveness of the ripping. These include: (1) use of compost/manure to improve soil structure for better water storage; (2) use of a cover crop (eg *Mucuna pruriens)* planted at the end of the season to prevent erosion, control weeds and improve soil quality; (3) agroforestry: principally *Grevillea robusta* planted on the field boundaries (see also 'Grevillea agroforestry system').



**Location:** Umande, Daiga, Laikipia District, Kenya
**Technology area:** 4 $km^2$
**SWC measure:** agronomic
**Land use:** cropland
**Climate:** semi-arid
**WOCAT database reference:** QT KEN30
**Related approach:** Self help groups, QA KEN13
**Compiled by:** Frederick Kihara, Nanyuki, Kenya
**Date:** June 2003, updated August 2004

**Editors' comments:** Optimum use of the limited water is crucial for crop production in semi-arid environments. Over the last decade conservation agriculture (including minimum and zero tillage) has spread worldwide. While it was originally adopted by large-scale farmers in the case study area, conservation farming has recently begun to be taken up by small-scale farmers. Other examples of conservation agriculture are presented from Morocco, UK and Australia.

## Classification

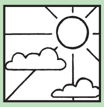
### Land use problems

- loss of rainwater through runoff and direct evaporation from soil surface
- runoff causing surface erosion
- fertility decline due to erosion and nutrient mining

**Land use**

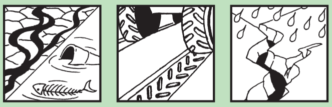
annual crops: wheat

**Climate**



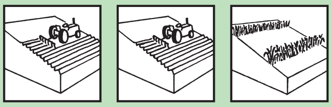
semi-arid (lower highland zone IV)

**Degradation**



water degradation: soil moisture problem; physical: soil compaction; water erosion: loss of topsoil

**SWC measures**



agronomic: conserv. tillage (ripping); agronomic: manure, cover crop (supp.); vegetative: *Grevillea robusta* (supp.)

**Technical function/impact**

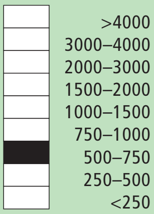
**main:**
- increase of infiltration
- control of raindrop splash
- promote germination due to reduced soil disturbance and reduced evaporation
- increase/maintain water stored in soil
- improve soil structure
- improvement of ground cover

**secondary:** - none

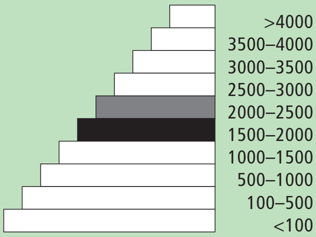
## Environment

### Natural environment

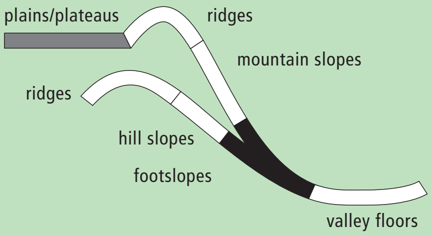
**Average annual rainfall (mm)**



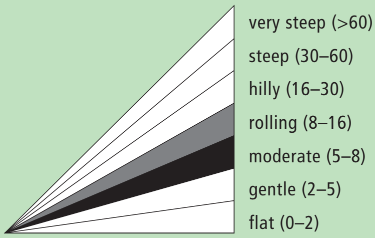

**Altitude (m a.s.l.)**



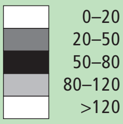

**Landform**




**Slope (%)**




**Soil depth (cm)**

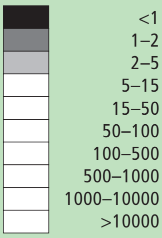



NB: soil properties before SWC

**Growing season:** 120 days (March to June) and 100 days (October to January)
**Soil fertility:** mostly medium, partly low
**Soil texture:** mostly medium (loam), in isolated lower areas fine (clay)
**Surface stoniness:** some loose stone
**Topsoil organic matter:** mostly medium (1–3%), partly low (<1%)
**Soil drainage:** medium
**Soil erodibility:** medium

### Human environment

**Cropland per household (ha)**




**Land use rights:** mostly individual, partly leased
**Land ownership:** individual titled
**Market orientation:** mostly subsistence, partly mixed (subsistence and commercial): surplus wheat is sold locally for income
**Level of technical knowledge required:** field staff/extension worker: moderate, land user: moderate
**Importance of off-farm income:** 10–50% of all income: many small-scale farmers work part time as casual labourers on large-scale horticultural farms


**left:** The ox-drawn ripper used for small-scale conservation tillage. (Hanspeter Liniger)
**right:** Conservation tillage using a ripper with seeder attached for direct planting. (Hanspeter Liniger)

## Implementation activities, inputs and costs

**Establishment activities**

not applicable

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| not applicable | | |

**Maintenance/recurrent activities**

1. Spreading of crop residue as mulch: up to 3 t/ha (before planting, dry season).
2. Application of compost/household waste: up to 4 t/ha.
3. Ripping of soil with modified plough (dry season).
4. Subsoiling: every 3 years; or as required to break a plough pan.
5. Seeding and application of mineral fertilizer (nitrogen, phosphorus) at the rate of 20 kg/ha, close to seed.
6. Legume interplanting *(Dolichos lablab)* into the cereal crop (supplementary measure): *Dolichos* needs replanting every 3 years.

All activities are carried out using animal traction, mulching done manually.
Equipment/tools: pair of oxen, modified 'Victory' plough beam, plough unit, ripper/chisel (tindo) used for ripping/deep ripping.

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (3–5 person days) | 25 | 100% |
| Equipment | | |
| - Animal traction (included in Labour) | 0 | |
| - Tools (modified plough) | 0 | |
| Agricultural | | |
| - Seeds for wheat (50 kg) | 25 | 100% |
| - Fertilizers (20 kg) | 8 | 100% |
| - Compost/manure (4,000 kg) | 35 | 100% |
| **TOTAL** | **93** | **100%** |

**Remarks:** Cost calculated charges for hiring equipment, draught animals and operator: these are all rolled up into the 'cost of labour' at US$ 25/ha. Conventional tillage costs US$ 37.5/ha compared with US$ 25/ha for conservation tillage operations: other costs remain more or less the same.

## Assessment

**Acceptance/adoption**

- All the 200 families who accepted the technology did so without incentives.
- Some innovative farmers noticed the practice on large scale farms and decided to test it for themselves. Furthermore, enterprising individuals saw an opportunity to contract their services (oxen, equipment) to neighbouring farms.
- Women did not adopt the practice as technological operations and animal ownership are typically male preserves. But women and youth are being trained and are attending demonstrations to the extent that they are now beginning to participate in field operations.
- There is some growing spontaneous adoption through self-help groups (see corresponding approach 'self-help group').

## Benefits/costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | not applicable | not applicable |
| maintenance/recurrent | very positive* | positive* |

* large increases in yields and reduction in costs after introduction

## Impacts of the technology

**Production and socio-economic benefits**

- +++ crop yield increase (>60%)
- ++ fodder production/quality increase
- ++ farm income increase
- ++ earlier crop maturity

**Production and socio-economic disadvantages**

none

**Socio-cultural benefits**

- ++ community institution strengthening (farmers' associations formed)
- ++ improved knowledge SWC/erosion

**Socio-cultural disadvantages**

- − male-oriented activity (heavy equipment/animals) compared to using the hoe

**Ecological benefits**

- ++ increase in soil moisture; better rainwater harvesting
- ++ soil loss reduction
- ++ reduction of evaporation
- \+ soil cover improvement (crop residue)
- \+ reduced energy consumption

**Ecological disadvantages**

- − waterlogging (contingency plans needed for draining excess water in very wet years – only 1 in 10 – but still important)
- − more prone to weeds; may require annual use of pre-emergence herbicides

**Other benefits**

- ++ time-saving
- \+ timely weeding reduces yield loss

**Other disadvantages**

none

**Off-site benefits**

- ++ reduced downstream siltation
- ++ improved streamflow characteristics (more gradual discharge of groundwater to streams over the season)
- \+ reduced downstream flooding
- \+ reduced river pollution (chemical contamination)

**Off-site disadvantages**

none

## Concluding statements

**Strengths and ➜ how to sustain/improve**

Better soil and water management resulting in (1) reduction of runoff (heavy storm runoff reduced from 75% to 50% and medium storm runoff from 50% to 25%; no runoff from small storms); (2) reduction of evaporation loss (without crop residues 40–60% of the rainwater is lost through direct evaporation from the exposed soil surface)[1]; (3) improved soil moisture (25-60% with better results for high rainfall and heavy storms)[2]; (4) reduced amount of soil inverted: impact is energy saving and organic matter conservation; (5) earlier crop maturity (16% reduction in crop maturity period for wheat: reduced risk of suffering from drought and able to get crops to market early); (6) improved crop production and yield (from 1.5 to 2.7 t/ha/year of wheat)[3] ➜ Access to more appropriate varieties, diversify cropping, better weather predictions to enable farmer to better spread risk.

Large potential for increased income (yield surplus sold) ➜ Continuous encouragement of entrepreneurial skills in farmers; maintain equipment in good order.

Sustainable and stable crop production ➜ Opportunity for expanding marketing capacity for the equipment and technology to raise more income and collective bargaining power for the farmers.

Intensification of production with reduced inputs (a 'win-win' situation): mitigates the problem of declining plot sizes.

**Weaknesses and ➜ how to overcome**

No clear advantage in extreme climatic conditions ➜ Make farmers aware about this so they do not become discouraged.

As crop residues are often used for feeding animals, there is a conflict between using residues as mulch and as livestock fodder ➜ Greater yields mean a higher income, and savings can be put aside to buy fodder; through water conservation there is more residue production also.

Equipment and animal maintenance cost ➜ Possible loan scheme (micro-finance option); build farmer self-help-groups to share costs.

In areas with stubborn weeds pre-emergence herbicides application is necessary ➜ Mulch application reduces negative effects of weeds.

1 Mutunga, 1995; 2 Liniger & Thomas, 1998; 3 Ngigi, 2003

**Key reference(s):** Kihara FI (1999) *An investigation into the soil loss problem in the Upper Ewaso Ng'iro basin, Kenya.* MSc. Thesis. University of Nairobi, Kenya ▪ Mutunga CN (1995) *The influence of vegetation cover on runoff and soil loss – a study in Mukogodo, Laikipia district Kenya.* MSc Thesis, University of Nairobi, Kenya ▪ Ngigi SN (2003) *Rainwater Harvesting for improved land productivity in the Greater Horn of Africa.* Kenya Rainwater Association, Nairobi ▪ Liniger HP and Thomas DB (1998) GRASS – Ground Cover for Restoration of Arid and Semi-arid Soils. *Advances in GeoEcology* 31, 1167–1178. Catena Verlag, Reiskirchen

**Contact person(s):** Frederick Kihara, Boniface Kiteme, CETRAD – Centre for Training and Integrated Research in ASAL Development, PO Box 144, Nanyuki, Kenya; phone ++254-62 31328; b.kiteme@africaonline.co.ke

**left:** Farmer explaining the difference between conventional tillage (left of picture) and conservation tillage (right of picture). (Hanspeter Liniger)
**right:** Contractor demonstrating the plough extension for deep ripping to members of the self-help group. (Hanspeter Liniger)

# Self-help groups

Kenya

**Small-scale farmers forming self-help groups to provide mutual support for adopting and promoting conservation agriculture.**

The self-help group approach described here is an initiative which grew from the local land users themselves. Farmers with common interests and goals came together, formed and registered groups and developed constitutions. Conservation agriculture groups started forming in 1997: within two years, five groups had been set up in the study area with over 150 members

The Ministry of Social Services facilitated the registration process. Groups have liased with technology promoters from the Ministry of Agriculture, KENDAT (Kenya Network for Draught Animal Technology), and research and development projects, to gain access to technical knowledge. These organisations have set up research and monitoring projects to assess the impact of conservation agriculture in this area. The groups receive more attention from local development partners than individuals would.

The overall purpose behind the formation of the groups is to improve household food security and raise income. More specific objectives include: (1) mutual adoption of the technology, enabling group members to improve their farm operations and yields, and thereby; (2) creation of opportunities for additional income to help and support each other; (3) sharing knowledge, and conservation tillage equipment.

Groups involve themselves in farmer-to-farmer training. They develop training modules which cover all aspects of conservation agriculture as well as practical training of the animals. Meetings are held once a month to plan group activities. The groups also solicit loans from local development partners for equipment, and they access training on technology from national institutions. Further collaboration with national institutes is planned to facilitate availability of drought-tolerant crop varieties. The members of the self-help groups make various contributions including time, money, animals and some equipment – for joint group activities. Farmers with equipment contract their services to those without, but this is provided at a 20% discount to members.

High adoption levels of conservation agriculture have been achieved through the self-help groups, due to the sharing of resources for technology development and mutual support. The interest in conservation agriculture and demand for equipment is high and growing. Group members are also diversifying their activities into, for example, agroforestry, water harvesting and bee-keeping.



**Location:** Umande, Daiga, Laikipia District, Kenya
**Approach area:** 60 km$^2$
**Land use:** cropland
**Climate:** semi-arid
**WOCAT database reference:** QA KEN13
**Related technology:** Small-scale conservation tillage, QT KEN30
**Compiled by:** Frederick Kihara, Nanyuki, Kenya
**Date:** June 2003, updated August 2004

**Editors' comments:** Self-help groups are common in Kenya, and in parts of the country have been instrumental in the success of SWC campaigns. The formation of such groups, to share knowledge and to give each other practical assistance in conservation agriculture, is a promising approach to promote this new technology, and other SWC measures, amongst smallholders.

## Problem, objectives and constraints

**Problem**
- insufficient individual resources to invest in/or learn about new technology
- underlying problems of (1) food security and (2) insecure water supply for rainfed crop production due to insufficient and poorly distributed rainfall

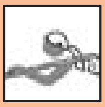
**Objectives**
- increase household food security and raise income within the group
- provide mutual support and thereby develop collective bargaining power – an example is the ability to attract technology training from national organisations
- seek possible ways of acquiring equipment for all members of the group, through securing donor support or sponsorship
- all cropland to be under conservation tillage, with all members being fully trained in the technology and having the necessary equipment

**Constraints addressed**

| Major | Specification | Treatment |
|---|---|---|
| Technical | Technology was new and initially not well understood. | As organised groups, the members were able to attract technical training from experts (eg KENDAT and Kenya Conservation Tillage Initiative) which was paid by local development partners. |
| Financial | Equipment is costly and generally cannot be afforded by many. | Ability to hire services from farmers in the group who have equipment. |
| **Minor** | **Specification** | **Treatment** |
| Organisational | Group formation and group dynamics. | Two to three enthusiastic, visionary individuals ensure success. |
| Social/cultural/religious | Use of draught animals seen as backward, non-progressive and gender-biased. | The number of practising farmers providing mutual support neutralises such thinking and the group approach has created an avenue for women to participate. |

## Participation and decision making

**Target groups**



Land users

**Approach costs met by*:**

| | |
|---|---|
| Community/local | % N/A |
| National NGO (KENDAT) | % N/A |
| International NGO (SNV, Netherlands) | % N/A |

* The community contributed a considerable percentage (through labour and time). KENDAT mainly provided training and extension, whereas SNV gave credits. Details of the breakdown are not available (N/A).

**Decisions on choice of the technology:** Mainly made by land users supported by SWC specialists supported by the National Soil and Water Conservation programme under the Ministry of Agriculture (MoA). SWC specialists created awareness of the technology in the local community, with land users independently deciding to adopt.
**Decisions on method of implementing the technology:** Made by land users alone (bottom-up). Farmers adopted the technology with modifications so that they could use their animals for draught power. However, there was a degree of follow-up by SWC specialists.
**Approach designed by:** Land users.

**Community involvement**

| Phase | Involvement | Activities |
|---|---|---|
| Initiation | interactive | farmers received information about an innovation that could be beneficial to them; they then mobilised themselves into self-help groups, elected leaders and sought formal registration |
| Planning | self-mobilisation | the group plans its own agenda in meetings |
| Implementation | interactive | the group is responsible for procuring equipment and inputs; they train their animals, while training on technology is provided by specialists |
| Monitoring/evaluation | self-mobilisation | group members keep yield records which are reported and discussed at meetings (without participation of specialists) |
| Research | interactive | farmers themselves compare cultivation methods; in addition, some research plots by KENDAT, the extension services (MoA) and students have also been set up in farmers' fields |

**Differences in participation between men and women:** Men traditionally own animals and have easier access to investment capital to purchase equipment than women. However, this is changing. In addition, in one group, the treasurer is a woman. The group also trains women how to use the technology. Within the first year, one woman had obtained the whole set of equipment plus a pair of oxen.

**left:** Farmer-led discussion on conservation tillage equipment with facilitation by extension staff. (Frederick Kihara)
**right:** Demonstration of improved draught animal technology. (Frederick Kihara)

## Extension and promotion

**Training:** The main element is farmer-to-farmer training within the group on use of appropriate equipment, equipment maintenance, animal health and care. Members attend training courses organised by extension staff and NGOs including KENDAT and Operation Comfort (from Central Kenya). Apart from courses, there are demonstration areas on research sites and group plots, as well as farm visits amongst and between farmers. The overall impact of training on land users is considered to be good.
**Extension:** Extension is carried out through governmental and non-governmental specialists, equipment sales person and well-informed group members. This is facilitated by the way groups formed and tapped into the extension advice, and also shared information amongst themselves. The impact of extension on land users is good.
**Research:** On-farm research is carried out by KENDAT, who conduct field trials to investigate the best technological practices. The data is collected in collaboration with participating farmers. Research has been quite effective: results from on-farm trials and NRM3 (Natural Resource Monitoring, Modelling & Management) Research Station at Kalalu have been quickly assimilated and acted upon by farmers. The field research activities have included long-term experiments, demonstration sites and field days.
**Importance of land use rights:** Small land size can hinder adoption of the technology: the group approach can help to overcome this limitation. Those with small land parcels can access and afford the technology without having to keep animals.

## Incentives

**Labour:** All labour is voluntary.
**Inputs:** No free inputs are provided except for technical training and back up.
**Credit:** Two year loans are available from international development partners (SNV). Generally 50% is repaid in the 1st year, 50% in the 2nd year. These loans are used to purchase equipment, with group members acting as guarantors for each other.
**Support to local institutions:** Local self-help groups were supported by national and local development agencies in group formation and management; loans were given for the purchase of implements; training was provided on the use of implements.
**Long-term impact of incentives:** No incentives provided, thus the question of impact – negative or positive- does not arise.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Bio-physical | ad hoc observations (informal) |
| Technical | ad hoc observations of work undertaken |
| Socio-cultural | regular observations of rate of adoption, attitudinal changes |
| Economic/production | ad hoc measurements of yield/area with the data from research station being occasionally analysed and results shared out |
| Area treated | ad hoc measurements of acreage |
| No. of land users involved | ad hoc observations (members of the group being followed up season after season by extension staff) |
| Management of approach | regular observations as membership feedback at meetings |

## Impacts of the approach

**Changes as result of monitoring and evaluation:** There have been a few changes to the approach itself: the success of the technology – conservation agriculture – has strengthened group collective bargaining power to attract further extension input support, regular visitation and advice on best agronomic practices. There has also been a move to encourage women's uptake of the technology.
**Improved soil and water management:** Great improvements have been achieved: these include in situ moisture conservation (reduced evaporation and runoff), water harvesting, increased soil fertility and reduced soil loss.
**Adoption of the approach by other projects/land users:** Many self-help groups have arisen and are addressing their particular problems related to conservation agriculture.
**Sustainability:** Land users can continue group formation and the associated activities without external support because they can seek technical support for the specific activities.

## Concluding statements

| **Strengths** and ➜ how to sustain/improve | **Weaknesses** and ➜ how to overcome |
|---|---|
| Easier for extension services to target a group of like-minded farmers than individuals ➜ Encourage further self-help group formation. | Self-help groups are not optimal where some individuals are relatively poor and cannot afford contributions ➜ Modify arrangements to permit higher contributions by more financially able members who then get a greater share of the profits. |
| Self-help groups are self-sustaining ➜ Ensure continual success by providing refresher courses on technology by extensionists, introduce innovations to keep group interest alive. | Greater time and energy input from the innovative farmers, because they pass on their knowledge without direct reward ➜ Farmers gain confidence and status in the group or area as leaders. |
| Collective bargaining power is achieved through good accounting and positive group financial status. This tends to attract donor support for further collective activities. | |
| Sharing of technological knowledge, as well as equipment, within the groups and exchange between groups. | |

**Key reference(s):** Kihara FI (1999) *An investigation into the soil loss problem in the Upper Ewaso Ng'iro basin, Kenya.* MSc. Thesis. University of Nairobi, Kenya ▪ Mutunga CN (1995) *The influence of vegetation cover on runoff and soil loss – a study in Mukogodo, Laikipia district Kenya.* MSc Thesis, University of Nairobi, Kenya ▪ Ngigi SN (2003) *Rainwater Harvesting for improved land productivity in the Greater Horn of Africa.* Kenya Rainwater Association, Nairobi ▪ Liniger HP and Thomas DB (1998) GRASS – Ground Cover for Restoration of Arid and Semi-arid Soils. *Advances in GeoEcology* 31, 1167–1178. Catena Verlag, Reiskirchen
**Contact person(s):** Frederick Kihara, Boniface Kiteme, CETRAD – Centre for Training and Integrated Research in ASAL Development, PO Box 144, Nanyuki, Kenya; phone ++254-62 31328; b.kiteme@africaonline.co.ke

**left:** A view of a set of tramlines in the previous winter's wheat stubble. Spacing is 2 m between the two permanent wheel tracks and 10 m between two sets of tramlines (visible to the left and right). (Hanspeter Liniger)
**right:** Two soil profiles (0–30 cm depth): from the sorghum 'bed' with excellent, crumb and small blocky structure, with abundant root growth (top) and – only 50 cm apart – from the wheel track with massive and platy structure (bottom). (Des McGarry)

# No-till with controlled traffic

Australia

**Large-scale no-till grain production with permanent wheel tracks common to all on-farm equipment.**

This controlled traffic, no-till farming system (CT/NT) is practiced on a 1,900 ha farm on the broad, almost flat Jandowae Plains in semi-arid Queensland, Australia. Principal soil types are vertisols, with some poorer areas where the sand content is greater, and these have a tendency to hard-set and crust.

Over the past five years, the farm owner has changed the farming system completely from conventional farming to no-till with controlled traffic. Controlled traffic means permanent uncropped wheel tracks or 'tramlines': all equipment has 2 metre axles. The total farm machinery comprises a tractor, a spray rig and two 11 meter zero-till planter/fertilizer units; one each for wheat and sorghum sowing. The tramlines were laid out two years ago by a contractor using Geographical Positioning System (GPS).

The main technical objective was to eliminate soil compaction. The CT/NT combination ensures the land – between the tramlines – remains in excellent condition. There has been no ploughing or tillage at all in those 5 years. He practices a three year rotation between winter wheat, summer sorghum and fallow, but the system is not fixed: it depends very much on soil moisture status and thus on the rainfall (opportunity cropping). Generally in summer about one third is in summer sorghum and in winter about one third in winter wheat, the rest of the land is under fallow. The one-year fallow is maintained through the use of herbicides sprayed onto the undisturbed residue from the previous crop. The system is designed for rain capture – to build up soil moisture stores in the fallow periods for subsequent crops – and for disease control (to 'spell' the land). During the cropping cycle, the key to his effective weed control system is 'to get in early' and 'actively chase weeds' through judicious spraying. The farm is now free of the locally common persistent weed *Erigeron annuus.* In the five years his sorghum yields have risen from 3 to 7 tons per hectares. Over the last three years the soil has improved, becoming soft, friable and moist between his plant lines. Infiltration has improved a lot and soil structure is now excellent.

Tractor use and overall fuel consumption has decreased to less than one quarter of that under conventional tillage. Correspondingly the workload is hugely reduced: from four men required under the conventional system for an equivalent area, the farmer is the sole operator, very occasionally assisted by his son, and a paid contractor for harvesting. He is so satisfied with the CT/NT system that he is attempting to purchase a nearby property to extend the area that he can farm using his current machinery.



**Location:** Jimbour (north of Dalby), Queensland, Australia
**Technology area:** 19 $km^2$
**SWC measure:** agronomic
**Land use:** cropland
**Climate:** semi-arid
**WOCAT database reference:** QT AUS02
**Related approach:** not documented
**Compiled by:** Des McGarry, Natural Resource Sciences, Queensland, Australia
**Date:** February 2004; updated May 2005

**Editors' comments:** No-till with controlled traffic is a specific form of conservation agriculture (CA) – of which there are also examples in this book from Kenya, Morocco and the UK. In Australia, where CA is practiced, random in-field traffic remains the norm, though there is now an estimated one million hectares of arable land (2–3% of the total) under combined no-till and controlled traffic. The controlled traffic system is the special feature of this conservation agriculture case study.

## Classification

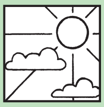
### Land use problems

The farmer's main reason for starting the combination of CT and NT was to rid himself of soil compaction, in order to achieve better utilisation of locally low and unpredictable rainfall amounts while minimising costs and reducing labour and machinery requirements.

**Land use**

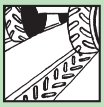
annual crops: sorghum, wheat

**Climate**



semi-arid to arid

**Degradation**

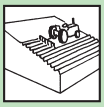


physical: soil compaction

water erosion: loss of topsoil, gully

wind erosion

**SWC measures**



agronomic: conservation tillage with controlled traffic

**Technical function/impact**

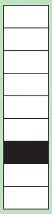
**main:**
- improvement of ground cover
- control of raindrop splash
- control of dispersed runoff (retain and trap)
- improvement of soil structure
- increase of infiltration
- increase and maintain water stored in the soil
- increase of organic matter
- reduction of compaction by traffic
- increase of soil fertility

**secondary:** - none

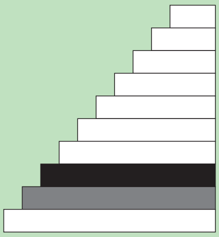
## Environment

### Natural environment

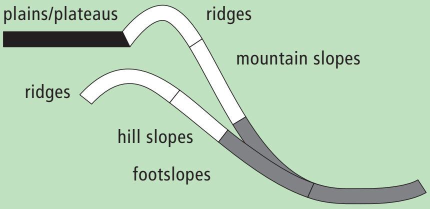
**Average annual rainfall (mm)**



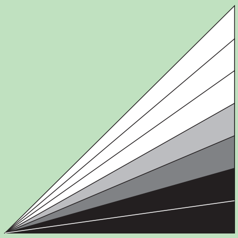

**Altitude (m a.s.l.)**




**Landform**




**Slope (%)**




**Soil depth (cm)**


NB: soil properties before SWC

**Growing season:** 180 days (either summer: October to April – or winter: April to September)
**Soil fertility:** mostly medium, partly high
**Soil texture:** fine (clays and loams)
**Surface stoniness:** no loose stone
**Topsoil organic matter:** mostly low (<1%), partly medium (1–3%)
**Soil drainage:** poor
**Soil erodibility:** mostly medium, partly high

### Human environment

**Cropland per household (ha)**


**Land use rights:** individual
**Land ownership:** individual titled
**Market orientation:** commercial (market)
**Level of technical knowledge required:** field staff/extension worker: moderate, land user: moderate
**Importance of off-farm income:** <10% of all income

**left:** All equipment has wheels on 2 meter axles to fit the tramlines. The no-till air-seeder (with disk openers and press wheels) is used mainly for sowing wheat: as large rates are applied (40 kg/ha), precision seed placement is not vital; the seed/fertilizer tank is installed in front of the tractor and connected with tubes. For sorghum a seeder with seed boxes mounted on the bar is used: rates of seed applied are very low (1 kg/ha), so precision placement is essential. Both seeders are 11 m wide. The tractor is small size (for a grain producing farm in this area). (Hanspeter Liniger)
**right:** The Spray-Coupe (rear view) is used for weed control; it is 22 m wide with booms extended, ie double the width of the 'planting footprint', so it travels in every 2nd set of tramlines. (Des McGarry)

## Implementation activities, inputs and costs

### Establishment activities

1. Layout of the controlled traffic lines (tramlines) using GPS mounted in a 4x4 vehicle. Two days were adequate for the whole farm.

Duration of the establishment: within 1 year

### Establishment inputs and costs per ha

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (contracted) and machines | 5 | 100% |
| **TOTAL** | **5** | **100%** |

### Maintenance/recurrent activities

**Summer sorghum** (650 ha, during 1 season or half a year)
1. Weed control (spray-coupe) with roundup, using 1.25 l Glyphosate/ha
2. Fertilizing, using 200 kg Urea/ha.
3. Sowing: 2 kg seed/ha and simultaneous application of starter fertilizer 25–30 kg/ha (mid-October)
4. Spraying pre-emergent herbicide (3.8 l/ha) to kill summer grasses;
5. Harvest by contractors (early March)

**Winter wheat** (650 ha, during 1 season or half a year)

6. Weed control (details see above)
7. Fertilizing (Urea, details see above)
8. Sowing: 42 kg seed/ha and simultaneous application of starter fertilizer 25–30 kg/ha (mid-May)
9. In-crop weed spray (5 g broadleaf herbicide/ha)
10. Harvest by contractors (October)

**Fallow** (1,250 ha, during 2 seasons or totally 1 year)

11. Weed control: 5–6 times per fallow period (combination of roundup mixed with broadleaf herbicide, see above)

To determine soil moisture he uses an iron rod; if he can push it into the heavy clay soil, then the soil is moist. Additionally, he measures rainfall.

### Maintenance/recurrent inputs and costs per ha per year

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour: 0.02 person days | 5 | 100% |
| Equipment | | |
| - Machines: 0.2 hours | 6 | 100% |
| Agricultural | | |
| - Seeds | 8 | 100% |
| - Fertilizers | 53 | 100% |
| - Biocides | 22 | 100% |
| Other | | |
| - Harvesting by contractors | 17 | 100% |
| **TOTAL** | **111** | **100%** |

**Remarks:** In average one third of the farm area is in crop and two thirds are fallow. This means that overall farming costs per ha are reduced, since during fallow period activities are limited to spraying herbicides. Labour costs approximately US$ 160 per day. Machinery costs average out at US$ 20 per hour (diesel costs US$ 0.9 per litre). All the data comes from this single farmer. Purchase of equipment is not included in the table above.

Comparison of costs between conventional tillage and no-till farming (CT/NT): (1) Labour costs are 4x less in CT/NT: 4 men used to work on the farm (conventional), now the farmer is alone – (plus contractors for harvesting). (2) Average annual diesel consumption: reduced from 108,333 litres (conventional) to 13,636 litres (no-till) which is 8 times less. (3) Costs of equipment to set up a CT/NT system (US$ 240,000) are 3 times less than that for conventional tillage equipment (US$ 700,000). (4) For biocides he has to invest 5 times more in CT/NT. The conventional values are estimates.

## Assessment

### Acceptance/adoption

- Approximately 200 farmers have adopted CT/NT in the Queensland grain growing area, and none of them received any subsidies or incentives. Adoption stemmed from farmer observations at field days on adjoining farms – where they saw the potential/real benefits and carried them over to their own farms.
- The farmer of this case study only received a small bank loan to buy the land and equipment, and he as been given a little assistance with fertilizer and spraying strategies from a local agronomist.
- There isn't a strong trend now towards growing spontaneous adoption: uptake has slowed dramatically as many conservative farmers prefer to continue their traditional tillage practices.

### Benefits/costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | very positive | very positive |
| maintenance/recurrent | very positive | very positive |

### Impacts of the technology

**Production and socio-economic benefits**

| | |
|---|---|
| +++ | crop yield increase |
| +++ | farm income increase |

**Production and socio-economic disadvantages**

none

**Socio-cultural benefits**

| | |
|---|---|
| +++ | improved knowledge SWC/erosion |

**Socio-cultural disadvantages**

none

**Ecological benefits**

| | |
|---|---|
| +++ | soil cover improvement |
| +++ | increase in soil moisture |
| +++ | efficiency of excess water drainage |
| +++ | increase in soil organic matter |
| +++ | increase in soil fertility |
| +++ | soil loss reduction |
| +++ | biodiversity enhancement |
| +++ | reduced soil compaction |

**Ecological disadvantages**

none

**Off-site benefits**

| | |
|---|---|
| ++ | reduced transported sediments |
| + | increased stream flow in dry season |
| + | reduced downstream siltation |
| + | reduced river pollution |
| + | reduced downstream flooding |

**Off-site disadvantages**

none

## Concluding statements

### Strengths and ➜ how to sustain/improve

Land that previously was un-farmable is now under crops. Site inspection shows initially poor land to be now in good condition (after only 5 years). The value of the land has increased ➜ Farmers practising CT/NT can and are buying/leasing more land, which will improve the overall state of the land in Queensland.

Farmers can manage much larger growing areas with less personnel and equipment. A single operator is well able to run a large arable farm on his own ➜ Ditto.

Cereal farming is now less prone to yield losses (and crop failure) in drought years – as there is better rainwater infiltration and water use efficiency with CT/NT ➜ Continue with the system.

He has all weeds under control (without need for tillage).

### Weaknesses and ➜ how to overcome

The contract harvester runs on 3 m wide axles, so the wheels run on the beds. However, there has only been one wet harvest in 5 years so the incidence of soil compaction from harvesting is negligible ➜ This is not really seen as a problem. One solution would be to build a dedicated harvester (too expensive) or find a contractor with equipment that fitted the system.

A conservative mentality towards conservation agriculture is constraining the adoption of the system by other farmers ➜ Continue demonstrating and disseminating knowledge about benefits.

**Key reference(s):** Blackwell P (1998) Customised controlled traffic farming systems, instead of standard recommendations or 'tramlines ain't tramlines'. *In Second national controlled farming conference,* pp. 23–26. Eds JN Tullberg and DF Yule. Gatton College: University of Queensland ■ Hulme PJ, McKenzie DC, MacLeod DA and Anthony DTW (1996) An evaluation of controlled traffic with reduced tillage for irrigated cotton on a Vertisol. *Soil and Tillage Research* 38:217–237 ■ McGarry D, Bridge BJ and Radford BJ (2000). Contrasting soil physical properties after zero and traditional tillage of an alluvial soil in the semi-arid tropics. *Soil and Tillage Research* 53:105–115

**Contact person(s):** Noel Griffith, Jimbour (north of Dalby), Queensland, Australia ➜ *through:* Dr Des McGarry, Natural Resource Sciences, Queensland Government, Block 'B', 80 Meiers Road, Indooroopilly, Queensland, Australia; mcgarrd@nrm.qld.gov.au

**left:** Harvesting of green sugar cane and simultaneous spreading of the separated residues, leaving a dense mulch cover, the so called green cane trash blanket. (Hanspeter Liniger)
**right:** A 'ratoon': a re-growing sugar cane sprouts through the trash blanket after harvest. (Hanspeter Liniger)

# Green cane trash blanket

Australia

**Elimination of burning as a pre-harvest treatment of sugar cane, and managing the resultant trash as a protective blanket to give multiple on and off-site benefits.**

Under conventional production systems, sugar cane is burnt before being harvested. This reduces the volume of trash – comprising green leaves, dead leaves and top growth – making harvesting of the cane simpler, and subsequent cultivation of the soil easier. In the humid tropics of Far North Queensland, harvesting of cane used to be carried out by hand – as it still is in many parts of the developing tropics. Burning was necessary to make harvesting possible in a dense stand (and to reduce the danger of snakes). However, with the advent of mechanical harvesters in the 1960s, burning continued to be practiced through habit.

A new system then brought fundamental changes in soil management: The 'green cane trash blanket' (GCTB) technology refers to the practice of harvesting non-burnt cane, and trash blown out behind in rows by the sugar cane harvester. This trash forms a more or less complete blanket over the field. The harvested lines of cane re-grow ('ratoon') through this surface cover, and the next year the cycle is repeated: the cane is once again harvested and more trash accumulates in the inter-rows. Generally the basic cropping cycle is the same, whether cane is burnt or not. This involves planting of new cane stock (cuttings or 'billets') in the first year, harvesting this 'plant crop' in the second year, and then in years three, four, five and six taking successive 'ratoon' harvests. In year six, after harvest, it is still common, even under the GCTB system, to burn the residual trash so that the old cane stools can be more easily ploughed out, and the ground 'worked up' (cultivated) ready for replanting. A minority of planters, however, are doing away with burning altogether, and ploughing in the residual trash before replanting. A further variation is not to plough out and replant after the harvest in year six, but to spray the old cane stock with glysophate (a broad spectrum non-selective systemic herbicide) to kill it, then to plant a legume (typically soy bean) as a green manure crop, and only replant the subsequent year after ploughing-in the legume. Under this latter system, one year of harvest is lost, but there are added benefits to the structure and nutrient content of the soil.

Whatever variation of GCTB is used, there are advantages in terms of increased organic matter, improved soil structure, more biodiversity (especially below ground) and a marked reduction in surface erosion – from over 50 t/ha to around 5 t/ha on average. Less erosion is good for the growers – but is also of crucial importance off-site, as sediment lost from the coastal sugar cane strip is washed out to sea, and damages the growing coral of the Great Barrier Reef.



**Location:** Far North Queensland, Australia
**Technology area:** 800 km$^2$
**SWC measure:** agronomic
**Land use:** cropland
**Climate:** humid
**WOCAT database reference:** QT AUS03
**Related approach:** The 'triple bottom line', QA AUS03
**Compiled by:** Anthony Webster, CSIRO, Mossman, Queensland, Australia
**Date:** September 2005

**Editors' comments:** Burning of crop residues on large scale farms causes air pollution, and has negative impacts on biodiversity and soil organic matter. In the tropics of far north Queensland burning of sugar cane before harvest has been eliminated, and the increase in trash forms a beneficial 'blanket' giving multiple on-site benefits, as well as reducing pollution, from eroded sediment, of the adjacent Great Barrier Reef.

## Classification

### Land use problems

Conventional burning of sugar cane before harvest can lead to compaction of top soil and reduced organic matter. There is also, despite the low slopes, a serious problem of sheet/rill erosion that has a negative impact both on the fields, and also off-site on the coral reef.

**Land use**

perennial crops: sugar cane

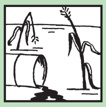
**Climate**

humid (tropical)

**Degradation**

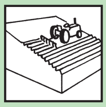
water erosion: loss of topsoil

off-site: pollution of water bodies with sediments



chemical: decline in organic matter and fertility

**SWC measures**



agronomic: mulching ('trash blanketing')

**Technical function/impact**

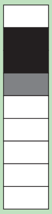
**main:**
- improvement of ground cover
- control of raindrop splash
- control of dispersed runoff
- improvement of soil structure

**secondary:**
- increase in organic matter
- increase in soil fertility
- increase in surface roughness
- increase in infiltration

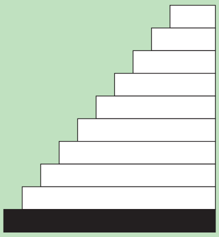
## Environment

### Natural environment

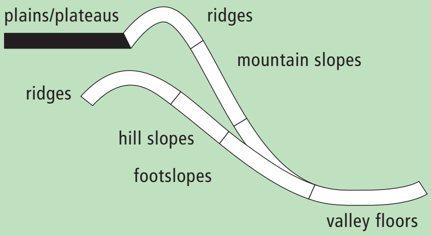
**Average annual rainfall (mm)**



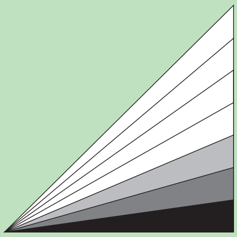

**Altitude (m a.s.l.)**



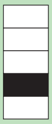

**Landform**




**Slope (%)**




**Soil depth (cm)**

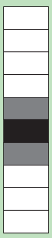



NB: soil properties before SWC

**Growing season:** 300 days (August to May)
**Soil fertility:** high and medium
**Soil texture:** medium (loam) and some fine (clay)
**Surface stoniness:** no loose stone
**Topsoil organic matter:** low (<1%)
**Soil drainage:** good
**Soil erodibility:** medium

### Human environment

**Cropland per household (ha)**




**Land use rights:** individual
**Land ownership:** individual titled
**Market orientation:** commercial (market)
**Level of technical knowledge required:** field staff: low; land user: low
**Importance of off-farm income:** 10–50%: various off-farm enterprises undertaken to supplement income during years of poor sugar prices

Comparison of conventional sugar cane production (above left) and green cane trash blanket technology (above right): the soil under the trash cover is moist and has a good structure (below right) while the unprotected soil is hard and sealed (below left). (William Critchley)

## Implementation activities, inputs and costs

**Establishment activities**

not applicable

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| not applicable | | |

**Maintenance/recurrent activities**

1. August: harvest green cane through contractor and simultaneous mulching of inter-rows with trash
   [previously: burn cane with associated trash and then harvest]
2. September: no field work
   [previously: cultivate land]
3. October: fertilize cane
   [previously: cultivate and fertilize]
4. November: spray with Amicide (very efficient herbicide, systemic and non-selective)
   [previously: cultivate land]
5. December: no field work
   [previously: cultivate and spray with Diuron, a non-selective contact herbicide]
6. January: Spray with Amicide
   [previously: no field work]

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Contract harvesting | 390 | 100% |
| Agricultural | | |
| - Fertilizer | 120 | 100% |
| - Herbicide | 33 | 100% |
| **TOTAL** | **543** | **100%** |

**Remarks:** The year budgeted above is a non-planting year – the costs therefore refer to an established crop which grows throughout the year and is harvested in August. The assumption is a cane yield of 80 t/ha. Each of the three categories of costing groups machinery, labour (at US$12 per hour) and inputs together. The comparative costs for a burnt cane crop system with the same yield are (a) contract harvesting = US$ 378 (b) fertilizer = US$ 120 (c) herbicide = US$ 56, plus (d) cultivation = US$ 30. Note that under the burnt cane system, soil cultivation/tillage is required, but the cost of harvesting is a little cheaper. The total for the burnt crop system is US$ 584 compared with US$ 543 for the GCTB crop, representing a saving of approx. US$ 40 (around 7%) per hectare per year.

## Assessment

### Acceptance/adoption

- Adoption has spread from a handful of growers in the mid 1970s, to 95% of the (approximately) 1,000 growers today. The growers have adopted the GCTB without any incentives other than those of lower costs, reduced soil erosion and benefits to biodiversity etc.
- It is possible that the few growers who persist in burning will eventually adopt the GCTB system through social and environmental pressure.

### Benefits/costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | not applicable | not applicable |
| maintenance/recurrent | slightly positive | positive |

### Impacts of the technology

**Production and socio-economic benefits**

| | |
|---|---|
| + | overall farm income increase |

**Production and socio-economic disadvantages**

none

**Socio-cultural benefits**

| | |
|---|---|
| + + | improved knowledge SWC/erosion |
| + + | enhanced reputation of sugar cane growers as 'environmentally friendly' |

**Socio-cultural disadvantages**

none

**Ecological benefits**

| | |
|---|---|
| + + + | runoff and soil loss reduced (from >50 t/ha to 5 t/ha; although the location is relatively flat, soil erosion can be high due to high rainfall) |
| + + + | soil cover improvement |
| + + | loss of nutrients reduced |
| + + | increase in soil organic matter |
| + + | biodiversity enhancement (above and below ground) |
| + + | improved soil structure |
| + | increase in soil moisture |
| + | carbon sequestration increased |
| + | efficiency of excess water drainage |
| + | increase in soil fertility |

**Ecological disadvantages**

none

**Off-site benefits**

| | |
|---|---|
| + + | reduced transported sediments |
| + + | reduced downstream siltation |
| + | reduced river pollution |
| + | reduced downstream flooding |

**Off-site disadvantages**

none

## Concluding statements

**Strengths and ➜ how to sustain/improve**

GCTB systems offer multiple on-farm environmental benefits ➜ Continue to refine the system, by encouraging (a) non burning of trash in the planting year and (b) planting a one-year green manure fallow when/if necessary.

Increases overall farm income by maintaining yields of sugar cane while reducing costs by 5–10% ➜ Continue to refine the system.

GCTB systems provide protection to the coral reef, through substantially reducing the sediment yield that reaches the lagoon and thence the Great Barrier Reef ➜ Give recognition to the growers for their overall environmental contribution.

**Weaknesses and ➜ how to overcome**

Some burning still continues through (a) the few farmers who have not yet adopted GCTB and (b) the common practice of burning trash before replanting ➜ Continue to encourage non-burning for multiple reasons.

**Key reference(s):** Mullins JA, Truong PN and Prove BG (1984) Options for controlling soil loss in canelands – some interim values. *Proc. Aust. Soc. Sugar Cane Technol.*, 6: 95–100 ■ Vallis I, Parton WJ, Keating BA and Wood AW (1996) Simulation of the effects of trash and N fertilizer management on soil organic matter levels and yields of sugarcane. *Soil and Tillage Research.* 38: 115–132 ■ Wood AW (1991) Management of crop residues following green harvesting of sugarcane in north Queensland. *Soil Till.* Res. 20: 69–85

**Contact person(s):** Anthony Webster, Research Agronomist, CSIRO, Mossman, Queensland, Australia; tony.webster@csiro.au; www.csiro.au

**left:** Moist soil beneath mulched (trash blanketed) cane. (William Critchley)
**right:** Automatic monitoring station measuring climatic parameters, runoff and nutrient flows to assess infield effects and downstream impacts on the Great Barrier Reef. (Hanspeter Liniger)

# The 'triple bottom line'

Australia

**A new expression used by agriculturalists in Australia to explain why farmers change practices: the 'triple bottom line' implies economic, environmental and social concerns.**

A fundamental change has occurred in farming practice amongst sugar cane growers in the tropics of far north Queensland. Where it was once standard practice to burn cane before harvest (defoliating green canes for easier harvest), tradition has been turned on its head and now almost no-one burns. Instead a 'green cane trash blanket' system has developed, with multiple benefits and few or no drawbacks.

There has been no official campaign or punitive sanctions imposed, no enticing financial incentives offered or charismatic environmental leadership – just a quiet technological revolution, based on the principles of the 'triple bottom line' (TBL). TBL has recently emerged into common usage amongst agriculturalists in Australia. Rather than attributing farmers' actions as simple responses to economic stimuli ('the bottom line') TBL is a framework that helps explain the complexity of factors that influence farmers to modify their practices. TBL suggests that farmers do indeed respond to money, but also to environmental concerns, and furthermore to social considerations as well. This gives credit to farmers for being responsible stewards of the land.

In this particular case, the transition in technology started in 1974, when sugar cane growers in the far north of Queensland were simply unable to burn their cane prior to harvest because of the exceptionally heavy rains. Instead, they had to harvest wet – and green. The technical implications were first, a slower harvest speed because machinery had to cope with a greater load of biomass, and second, a thick residual blanket of trash that covered the soil. The multiple benefits of mulching were recognised by a few growers, who then continued to harvest green cane. Non-burning spread – a technology now described as the 'green cane trash blanket' – until almost every grower adopted it within one generation. While the extension service has supported the transition, growers themselves took the initiative to change. There are indeed small financial benefits, chiefly in terms of reduced overall input costs, but growers have simultaneously been motivated by social and environmental considerations. Burning has come to be considered anti-social: a dirty practice, carrying the danger of fire spreading outside the targeted fields. Neither is it a pleasant task, requiring help of family and friends, often at inconvenient times. From an environmental perspective, the benefits of trash mulch are tangible in terms of improved soil quality, and reduced erosion rates. And, equally important, the end result is reduced damage to the close-by Great Barrier Reef with its sediment-sensitive living coral.



**Location:** Far North Queensland, Australia
**Approach area:** 800 km$^2$
**Land use:** cropland
**Climate:** humid
**WOCAT database reference:** QA AUS03
**Related technology:** Green cane trash blanket, QT AUS03
**Compiled by:** Anthony Webster, CSIRO, Mossman, Queensland, Australia
**Date:** September 2005

**Editors' comments:** The 'triple bottom line' (TBL) is an expression which has evolved in Australia to help explain why farmers act as they do. Its three components of economics, the environment and social aspects cover the considerations that cause farmers to modify technologies. TBL implicitly gives credit to farmer for being sensitive to multiple external signals. In this case the change in practice is from burning sugar cane to harvesting it green in Far North Queensland. This is a case where emerging conservation-friendly farmer practice and the goals of the environmental lobby have neatly coincided.

## Problem, objectives and constraints

### Problem

- anti-social farming practice of burning sugar cane which also has negative environmental impacts, both in situ, and off-site in the coral reef
- resistance to change in traditional farming practice

### Objectives

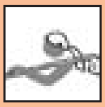
- the spread of non-burning practices, specifically the 'green cane trash blanket' technology to promote sustainable and environmentally friendly sugar cane production
- indirectly: to satisfy social concerns associated with burning of sugar cane

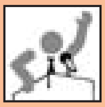
### Constraints addressed

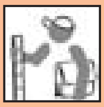
| Major | Specification | Treatment |
|---|---|---|
| Technical | Harvesting machines at first were not so well able to cope with the greater biomass to be harvested. | Manufacturers developed higher capacity harvesters. |
| Financial | Higher costs of harvesting (a small premium charged by contractors per tonne of green cane harvested). | These costs are offset by lower tillage input, no costs associated with burning, and lower inputs of agrochemicals also. |

## Participation and decision making

### Target groups


Growers


Politicians (govt. agencies)


Environmentalists

### Approach costs met by*:

| | |
|---|---|
| State Government (Bureau of Sugar Experiment Stations) | 20% |
| Growers themselves | 80% |
| | 100% |

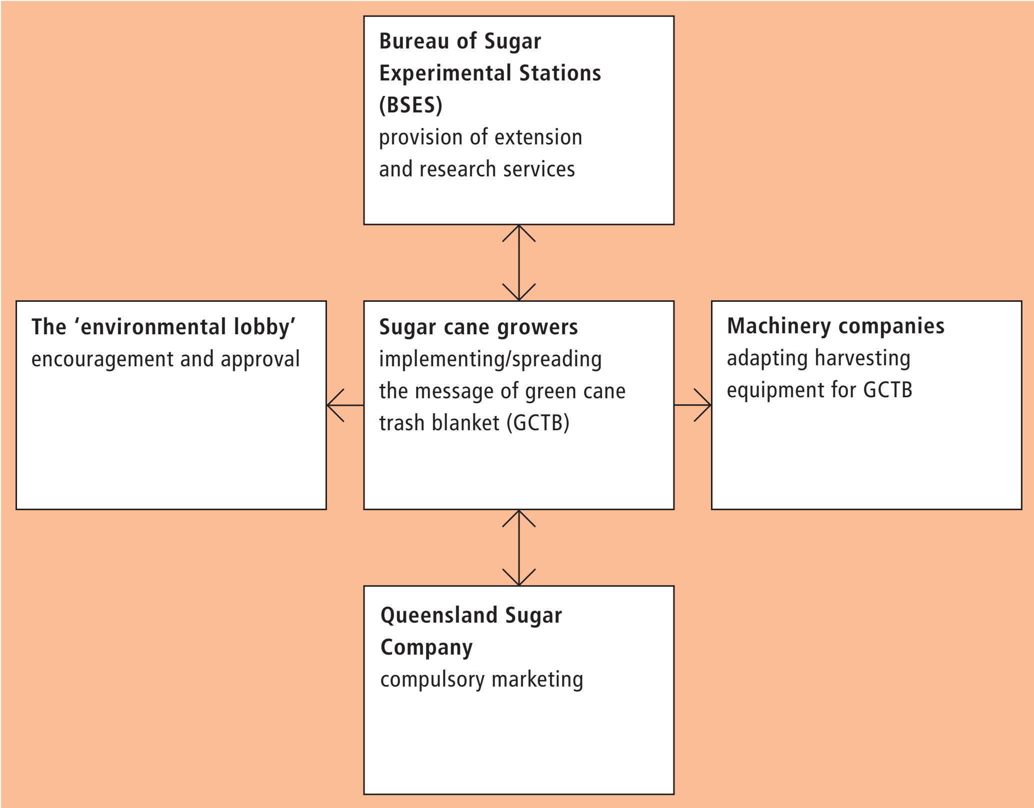
* rough estimate

**Decisions on choice of the technology:** Made by land users alone (sugar cane growers).
**Decisions on method of implementing the technology:** Made by land users alone.
**Approach designed by:** Farmers (with limited support from extension and research).

### Community involvement

| Phase | Involvement | Activities |
|---|---|---|
| Initiation | self-mobilisation | starting up the practice of green cane trash blanket (GCTB) |
| Planning | not applicable | no specific planning involved |
| Implementation | interactive | growers spreading the word, support by extension services |
| Monitoring/evaluation | interactive | growers joining hands with research |
| Research | interactive | ditto |

**Differences in participation between men and women:** None in principle, though *de facto* most growers are male.




**Institutional framework**
Inter-relationships between sugar cane growers and other stakeholders.

## Extension and promotion

**Training:** There was no specific training involved.
**Extension:** The Bureau of Sugar Experimental Stations (BSES) provides an extension service to Queensland's growers. The green cane trash blanket (GCTB) system was supported through this extension service, as one component of the general extension message, and a variety of methods were used (visits, field days, publications) to help get the message across. Nevertheless the main form of extension was informal farmer-to-farmer spread.
**Research:** There has been some ad hoc research carried out on technical parameters by both the BSES as well as CSIRO.
**Importance of land use rights:** The ownership of the land makes no difference to the uptake of GCTB.

## Incentives

**Labour:** Farmers themselves provide labour – though it should be noted that the adoption of GCTB involves a saving on labour inputs compared with conventional cane burning systems.
**Inputs:** There are no subsidies connected to GCTB. Australia does not subsidise its sugar cane growers and sugar is sold at the world price.
**Credit:** None provided.
**Support to local institutions:** None.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Bio-physical | ad hoc observations/measurements of nutrients/ sediment by BSES & CSIRO |
| Technical | ad hoc observations/measurements of yield by BSES |
| Socio-cultural | ad hoc observations by growers |
| Economic/production | regular measurements by BSES |
| Area treated | ad hoc observations/calculations by millers |
| No. of land users involved | ad hoc calculations |
| Management of approach | not applicable |

## Impacts of the approach

**Changes as result of monitoring and evaluation:** Not applicable.
**Improved soil and water management:** Considerable: nutrient losses reduced, erosion reduced, organic matter built up, etc.
**Adoption of the approach by other projects/land users:** The 'triple bottom line' is probably active throughout Australia in influencing farmers' decisions.
**Sustainability:** By definition this is sustainable: it is an internal mechanism amongst farmers.

## Concluding statements

| **Strengths** and ➜ how to sustain/improve | **Weaknesses** and ➜ how to overcome |
|---|---|
| Has successfully stimulated the spread of the green cane trash blanket system ➜ Outsiders should continue to support farmers' multiple concerns. | The fact that farmers are responsive to environmental and social as well as economic stimuli is covered up by conventional thinking that 'only money matters to them' ➜ Investigation and documentation of the 'triple bottom line' is required. |
| Farmers take the responsibility of choosing a land management practice that has a positive 'triple bottom line': environmental, economic and social benefits ➜ Support awareness raising and give appreciation to the on-site and off-site benefits; acknowledge sugar produced under this system an environmentally friendly and economic product. | |
| Sugar cane growing has previously had a bad environmental and social reputation, especially here, close to the Great Barrier Reef, which is a World Heritage Site. This change in practice, resulting from the 'triple bottom line' has changed the reputation of sugar cane growers ➜ Make this public. | |

**Key reference(s):** none
**Contact person(s):** Anthony Webster, Research Agronomist, CSIRO, Mossman, Queensland, Australia; tony.webster@csiro.au; www.csiro.au


**left:** Boxes for earthworm culture, mounted on poles and covered with dark, thick plastic sheeting (or corrugated iron, see right) to provide shade, maintain an ideal microclimate and give protection from birds. (Mats Gurtner)
**right:** Every three days a new layer of cattle manure is added to feed the worms.
(Mats Gurtner).

# Vermiculture

Nicaragua – *Lombricultura*

**Continuous breeding of earthworms in boxes for production of high quality organic compost.**

Vermiculture is a simple and cheap way to produce a continuous supply of organic compost of high quality. *Eisenia foetida,* the Red Californian earthworm (also called 'the red wiggler') is ideal for vermiculture since it is adapted to a wide range of environmental conditions. Under culture, the worms are kept under shade, in long wooden boxes filled with earth, cattle manure and an absorbent material (eg straw). The box is covered by sheet metal (or wood, thick plastic sheeting, or banana leaves) to protect the worms against UV radiation and birds/chickens, and also to maintain a favourably humid microclimate. Fresh cattle manure is a perfect food for the worms, but rotten coffee pulp can also be fed. Chopped crop residues (eg cowpeas, leucaena leaves or other legumes) may be added.

The compost produced by the earthworms has a dark colour, no smell and a loose and spongy structure. It is a high value, high quality product which is very rich in nutrients, and in a form that makes them readily available to vegetation. The content of a full box can be harvested every 3–4 months, and is used for crops -mainly coffee and vegetables, but also maize and beans. It is very effective in increasing soil fertility and thus crop production. It also improves soil structure, infiltration and water storage capacity.

The compost can either be applied directly to coffee, mixing it with an equal amount of earth and applying 1 kg to each plant. Alternatively it can be sprayed: for preparation of liquid fertilizer 50 kg compost are mixed with 50 litres of water and left to soak for 5 days. The concentrated solution produced is mixed with water at a ratio of 1 to10 and applied to the crop using a knapsack sprayer. The earthworms reach their reproductive age after three months and live for many years. In perfect conditions an earthworm produces up to 1,500 offspring per year. Thanks to their rapid reproduction, new cultures can easily be established, or earthworm stocks can be sold according to the farmer's needs. A certain amount of earthworm compost is kept back and being used instead of fresh earth to reinitiate the whole process, or to start new cultures.

The area is characterised by humid climate, steep slopes and low soil fertility. Farmers are mainly smallholders with individual properties. Earthworm culture does not depend closely on the external environment, but it is essential to maintain favourable conditions inside the box – namely continuous feeding and wetting. That's why it is usually recommended to keep cultures near the house and the home-garden. Ants, the main enemy of earthworms, can be controlled standing the boxes on poles in cans filled with water.



**Location:** Pancasán, Matiguas, Matagalpa, Nicaragua
**Technology area:** approx. 5 $km^2$
**SWC measure:** agronomic
**Land use:** cropland
**Climate:** humid, subhumid
**WOCAT database reference:** QT NIC01
**Related approach:** Productive development and food security programme, QA NIC03
**Compiled by:** Julio Gómez, Ramón Caceres, ADDAC, Matagalpa, Nicaragua
**Date:** April 2000, updated February 2004

**Editors' comments:** Earthworms produce compost ('casts') of high quality: however vermiculture for compost production is new in Nicaragua, where it shows promise but is not yet widespread. This case study demonstrates that it can work efficiently. *Lombricultura* has been copied from Cuba where it has been used successfully for over 10 years.

## Classification

### Land use problems
- low crop yields due to soil fertility decline
- water and wind erosion
- small landholdings

**Land use**

annual crops: maize/beans, vegetables

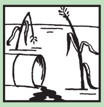
perennial crops: coffee

**Climate**

humid

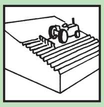
subhumid

**Degradation**



chemical: fertility decline/ reduced organic matter

**SWC measures**



agronomic: applying compost

**Technical function/impact**

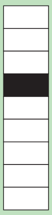
**main:**
- increase in soil fertility
- improvement of soil structure
- increase in organic matter

**secondary:**
- increase of surface roughness
- increase in infiltration

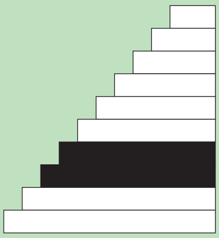
## Environment

### Natural environment

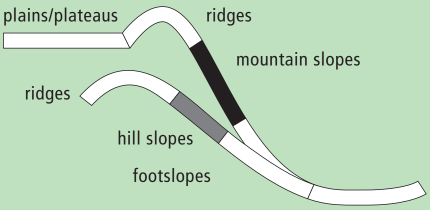
**Average annual rainfall (mm)**



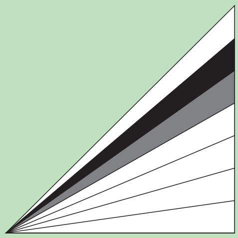

**Altitude (m a.s.l.)**




**Landform**




**Slope (%)**




**Soil depth (cm)**

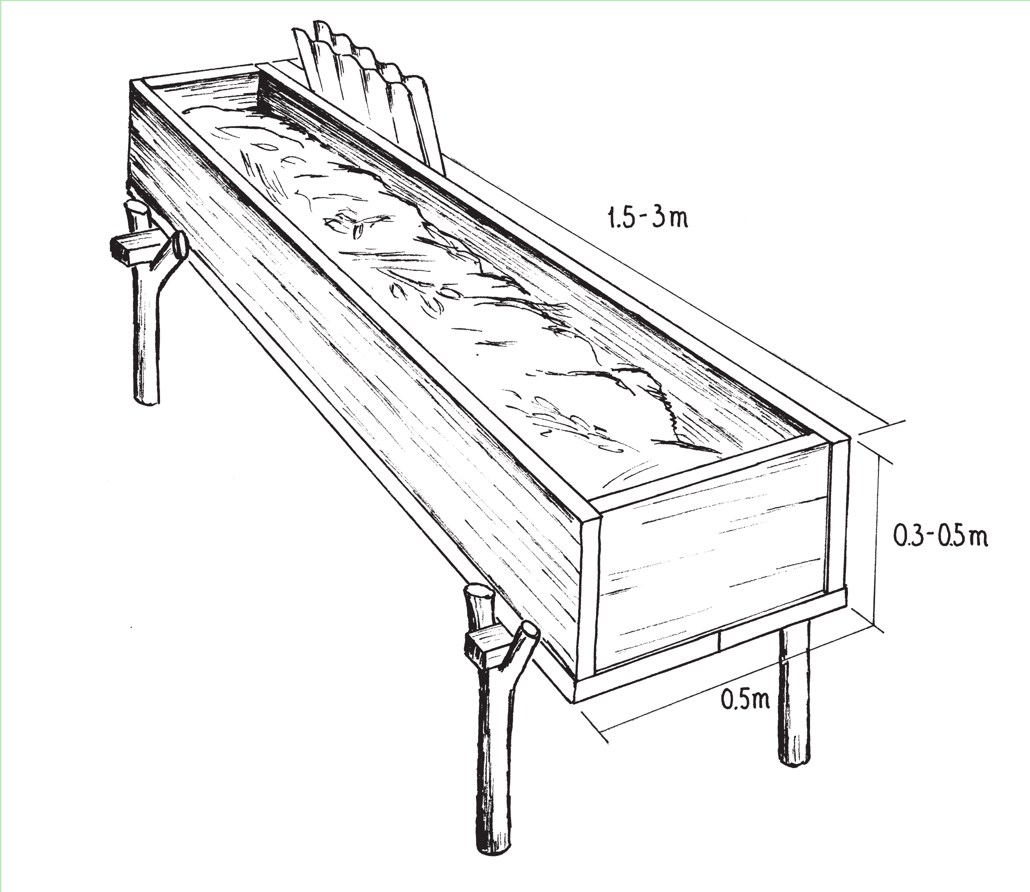

NB: soil properties before SWC

**Growing season:** 240–300 days (May/June to February/March)
**Soil fertility:** low
**Soil texture:** fine (clay)
**Surface stoniness:** mostly no loose stone, partly some loose stone
**Topsoil organic matter:** low (<1%)
**Soil drainage:** medium
**Soil erodibility:** medium

### Human environment

**Cropland per household (ha)**


**Land use rights:** mainly individual (95%), some leased (note: holding size is highly polarised: many with small plots, a few with large farms)
**Land ownership:** mainly individual not titled, some individual titled
**Market orientation:** subsistence (self-supply) and mixed (subsistence and commercial)
**Level of technical knowledge required:** field staff/extension worker: moderate, land user: moderate
**Importance of off-farm income:** <10% of all income: nearly all land users are fully occupied with agricultural activities, very few are involved in commerce or are employed




**Technical drawing**
Detailed view of wooden box for compost production by earthworms. Cover (corrugated iron or alternative) is important to protect worms from light, from birds and other natural enemies, and to maintain moisture in the box.

## Implementation activities, inputs and costs

### Establishment activities

1. Construct 3 wooden boxes (for design see technical drawing); another possibility is to dig pits in the soil, same measurements, with cut-off drain above pit to protect from flooding.
2. Fill with earth and cattle manure (2 kg each per box, not too wet/not too dry).
3. Put in stock of earthworms (1–2 kg per box).
4. Protect from natural enemies (ants, birds, certain snails): roof, set the poles in cans filled with water.

No specific timing (implementation possible at any time).
Tools: hammer, nails, buckets/wheelbarrow, shovel, possibly water hose.
Duration of establishment: 2 days

### Establishment inputs and costs per ha

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (3 person days) | 6 | 100% |
| Materials total | | |
| - Wood (6–10 m$^3$) | 50 | 100% |
| - Earth (6 kg) | 0 | |
| - Sheet metal, plastic | 6 | 100% |
| Agricultural | | |
| - Cattle manure (6 kg) | 0 | |
| - Residues | 0 | |
| Others | | |
| - Earthworms (3 kg) | 60 | 0% |
| **TOTAL** | **122** | **51%** |

### Maintenance/recurrent activities

1. Feeding: every 3–5 days add another layer of cattle manure (1 kg earthworms eat 1 kg manure per day).
2. Maintain humidity at 80%, water frequently in dry season, maintain temperature between 15–30°C: do not exceed 42°C.
3. Gather compost every 3–4 months: discontinue feeding and irrigation for 5 days, then put a sieve with fresh manure on top of the compost. The worms migrate into the fresh manure. After 2–3 days take out the sieve and gather the ready, worm free compost.
4. Apply compost to the crops (1 kg/coffee plant, see description).
5. Continue the process.
6. Possible improvement: add lime to raise pH to a optimum level of 7.0.

Tools: buckets/wheelbarrow, shovel, possibly water hose.

### Maintenance/recurrent inputs and costs per ha per year

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (30 person days) | 60 | 100% |
| Agricultural | | |
| - Fresh cattle manure (3,000 kg) | 0 | |
| - Residues | 0 | |
| **TOTAL** | **60** | **100%** |

**Remarks:** 60% of the land users have their own cattle, others get manure free from their neighbours. The cattle manure has no commercial price in the region – there is no market for it. The inputs and costs are estimated for the production of approx. 4,000 kg of worm compost, which is enough for one hectare of coffee per year (note figures from India for vermiculture suggest higher input-output ratios: in other words less output for the same amount of input).

## Assessment

### Acceptance/adoption

By the year 2000, 88 land users had implemented the system supported by incentives; the trend is towards further adoption. The programme provides an initial stock of earthworms as an incentive to the participating farmers. Maintenance is usually good. As ADDAC (the Association for Agricultural Community Development and Diversification) has a permanent and long-term presence in the approach area, most interested farmers are directly involved in the programme activities: this explains the fact that only 5% of the technology users (6 people) took up earthworm culture without incentives (see approach).

### Benefits/costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | positive | very positive |
| maintenance/recurrent | very positive | very positive |

### Impacts of the technology

**Production and socio-economic benefits**

| | |
|---|---|
| +++ | crop yield increase |
| ++ | fodder production/quality increase |
| ++ | farm income increase |

**Production and socio-economic disadvantages**

none

**Socio-cultural benefits**

| | |
|---|---|
| ++ | improved knowledge SWC/erosion |

**Socio-cultural disadvantages**

none

**Ecological benefits**

| | |
|---|---|
| +++ | increase in soil fertility |
| +++ | stimulation of soil fauna |
| ++ | increase in soil moisture (through improvement of soil water storage capacity) |
| ++ | improvement of soil structure |

**Ecological disadvantages**

| | |
|---|---|
| – | pests: the compost attracts pests like ants, chickens, moles |

**On-site benefits**

| | |
|---|---|
| ++ | reduced river pollution (lower inputs of chemical fertilizers) |

**Off-site disadvantages**

none

## Concluding statements

**Strengths and ➜ how to sustain/improve**

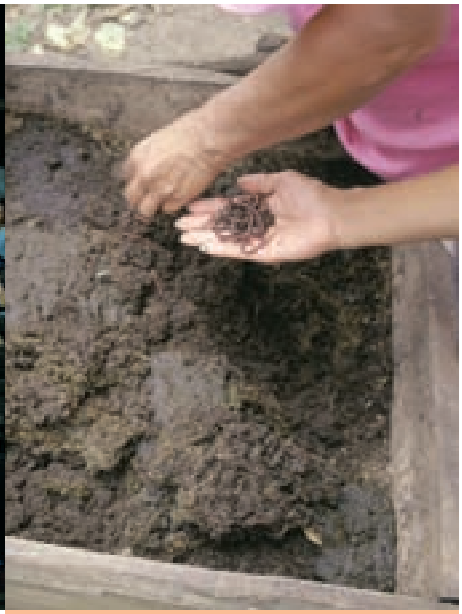
- Continuous and increasing production of organic and very effective compost with high nutrient content (replacing chemical fertilizers) ➜ Expand the use of worm culture.
- Appropriate for different crops (though in different forms – direct application or spraying).
- Simple and cheap technology; low labour input ➜ Keep boxes close to the house.
- Increased crop yields ➜ Expand the use of worm culture.
- Earthworm culture is becoming an integrated part of the production system, especially for land users who have cows.
- Additional economic income through commercialisation of earthworm stocks ➜ Continuous maintenance of technology.
- Health: clean products without chemical treatment.

**Weaknesses and ➜ how to overcome**

- Requires permanent access to water ➜ A close fitting and secure box cover, as well as placement of the box in the shade reduces loss of humidity. Roof-top rainwater collection helps to get over dry periods.
- Requires continuous availability of manure to feed worms.
- Attracts natural enemies like ants, chickens, moles, flies; needs protection ➜ Improve the construction of the boxes (close holes and cover the box tightly).

**Key reference(s):** PASOLAC (2000) *Guía Técnica de Conservación de Suelos y Agua.* PASOLAC, Managua ■ Ferruzzi C (1986) *Manual de Lombricultura.* Ediciones Mundi-Prensa. Madrid, Spain ■ Castillo H (1994) *La lombricultura.* in *Altertec. Alternativas de Mejoramiento de Suelos. Proceso de Capacitación para Profesionales. Modulo II.* Altertec, Ciudad de Guatemala

**Contact person(s):** Julio César Gómez Martínez, De ENITEL 3c al Norte y 75 varas al Este. Calle Santa Ana, Apartado Postal 161, Matagalpa, Nicaragua; addacentral@addac.org; www.addac.org; phone: (505) 0772-7108; fax: (505) 0772-5245



left: Training based on the methodology of popular education: two ADDAC specialists presenting and explaining a simple water pump which can be constructed by the land users themselves. (Mathias Gurtner)
**right:** A farmer proudly showing her vermiculture compost box with the earthworms. The compost is ready to be applied to her coffee plants. (Mats Gurtner)

# Productive development and food security programme

Nicaragua – *Programa de desarrollo productivo y seguridad alimentaria*

**An integrated programme-based approach promoting participatory testing and extension of various SWC technologies, as well as providing institutional support.**

The Association for Agricultural Community Development and Diversification (ADDAC) is a non-profit NGO, founded in 1989, whose mission is to improve the living standard of poor rural families engaged in small/medium scale farming in marginal areas to the north of Nicaragua. The main purpose of ADDAC's approach is to develop and strengthen local capacity to analyse problems and find solutions for rural sustainable development. There are five main components: (1) food security and productive development, including technological improvement and diversification within traditional crop cultivation, and extension of alternative agricultural land use practices; (2) support to farmers' organisations; (3) promotion of gender equality; (4) identification of alternatives in marketing; and (5) provision of an alternative credit system for farming. These fields of activities are based on the principles of organic agriculture and a powerful training process – using the methodology of 'popular education', which involves participatory training and extension activities.

ADDAC initiates its work in communities through PRA (Participatory Rural Appraisal) – evaluating problems and potential solutions. These serve as a base for the formulation of project proposals which are then submitted to interested financing organisations. Further steps include participatory planning, and later, evaluation, in collaboration with the land users. For execution of activities ADDAC contracts an interdisciplinary crew of specialists, which stays in the area. Twice a year a participatory reunion is organised to evaluate, and accordingly improve, the activities. Key to the approach is the formation of a grassroots organisation in each community to guarantee local management, build up alternative enterprises and promote community development. These organisations consist of representatives of local support groups, and farmers with a leading role in SWC application and extension. The organisations have various functions during the lifetime of a project: they are the counterparts of the extensionists for project execution, and later they ensure sustainability of activities. Farmers' associations are formed to improve storage and marketing of crops. Networks of local promoters exchange experience between communities and consolidate extension of alternative technologies. Demonstration farms serve as a tool for technology extension, innovation and validation.



**Location:** Matagalpa, Nicaragua
**Approach area:** approx. 7,500 km$^2$
**Land use:** cropland
**Climate:** humid, subhumid
**WOCAT database reference:** QA NIC03
**Related technology:** Vermiculture, QT NIC01
**Compiled by:** Julio Gómez, Eneida Ulloa Mercado, ADDAC, Managua, Nicaragua
**Date:** April 2000, updated February 2004

**Editors' comments:** Integrated approaches to development – which include soil and water conservation – based on 'popular education' are becoming increasingly important in Central America. This is an example from northern Nicaragua where it is spreading strongly.

## Problems, objectives and constraints

**Problem**

Lack of organisation and skills to analyse and overcome underlying problems of:

- poverty; lack of financial resources for investments (eg in SWC)
- insufficient food/poor nutrition
- soil degradation/indiscriminate burning of vegetation
- lack of appropriate technologies
- lack of access to public services and markets

**Objectives**

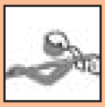
- support the economical sustainability and food security of land users in the project area through increased production, diversification, soil conservation and environmental protection
- develop feasible production models, aimed at self-sufficiency and the integration of land users into an alternative internal and external market; build up alternative forms of marketing and credit systems
- community development and capacity building: build-up local farmers' organisation

**Constraints addressed**

| Major | Specification | Treatment |
|---|---|---|
| Institutional | Lack of collaboration between land users. | Strengthen farmers' organisation. |
| Social/cultural/religious | Resistance to implement SWC technologies by some land users. | Awareness raising, demonstration plots, convince with facts. |
| Financial | Poverty, lack of resources for investments into SWC. | Support in the form of credit, basically in kind but also in cash (see credit section). |
| **Minor** | **Specification** | **Treatment** |
| Legal | Lack of land use rights. | Problem cannot be resolved under the project. |

## Participation and decision making

**Target groups**



Land users

**Approach costs met by:**

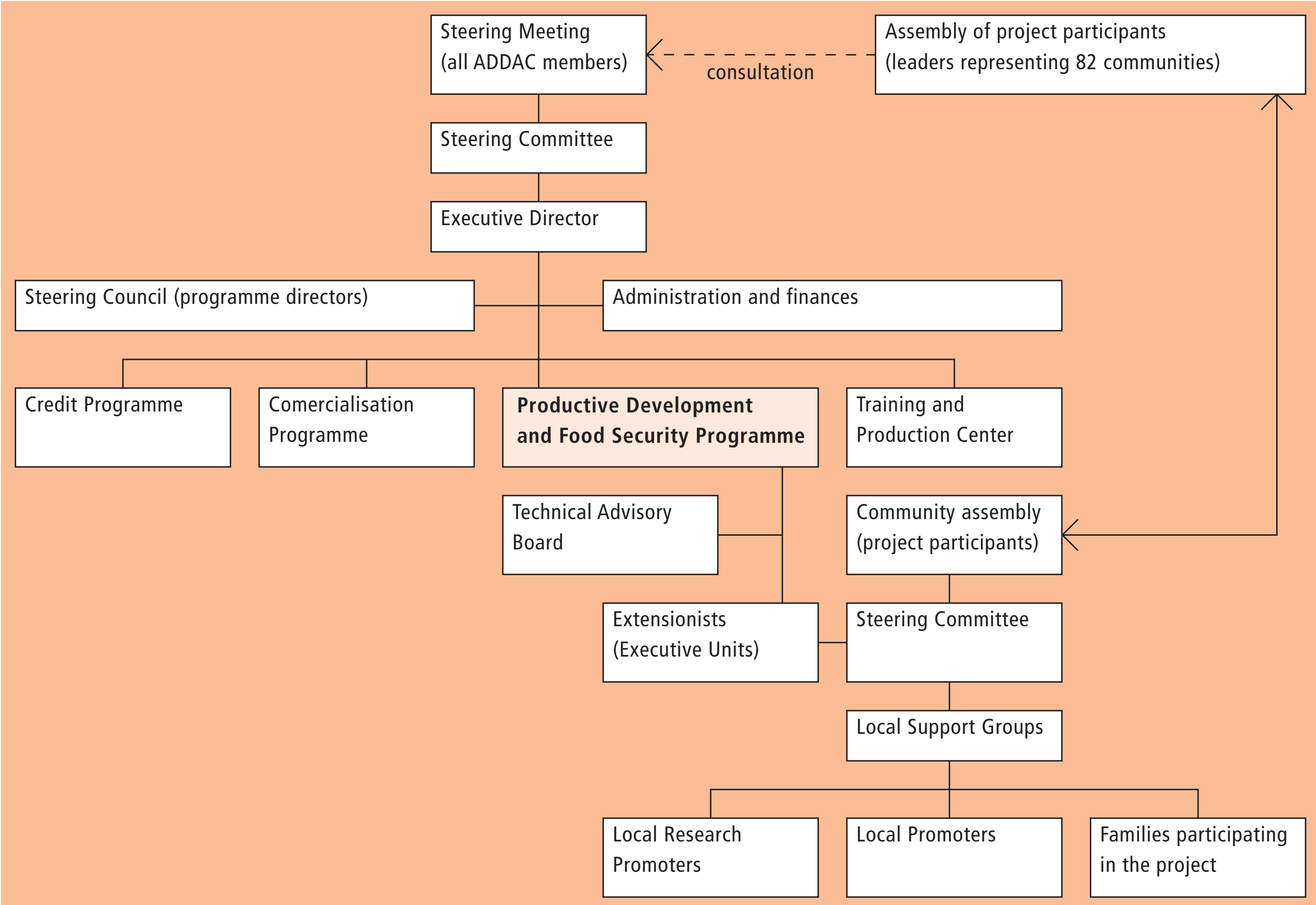
| | |
|---|---|
| International NGO | 90% |
| National NGO | 10% |
| | 100% |

**Decisions on choice of the technology:** Mainly made by land users supported by SWC specialists.
**Decisions on method of implementing the technology:** Mainly made by land users supported by SWC specialists.
**Approach designed by:** National specialists.

**Community involvement**

| | | |
|---|---|---|
| Initiation | interactive | participatory rural appraisal (PRA), participatory planning in public meetings |
| Planning | interactive | public meetings, workshops/seminars: assemblies for municipal planning (elaboration of community action plan) |
| Implementation | interactive | responsibility for major steps: execution of the action plans where each community decides |
| Monitoring/evaluation | interactive | particularly public meetings, also measurements/observations and workshops/seminars: a specialist is in charge of the continuation of activities and of the planning process with each community; annual assembly of delegates representing all communities assisted by ADDAC |
| Research | interactive | on-farm experimentation with interested land users: assessment of different technologies (variety tests, evaluation of ecological effects, etc) |

**Differences in participation of men and women:** The integration of women is a key element of the approach. Nevertheless, there are moderate differences due to cultural factors: men are mainly in charge of agricultural activities, whereas women work in the household.




**Organogram**
'Productive Development and Food Security Programme' – one of the focal development activities of the Association for Agricultural Community Development and Diversification (ADDAC).

## Extension and promotion

**Training:** The form of training promoted by ADDAC is called 'popular education'. It is a continuous and participatory process of mutual learning between farmers and technicians, based on a course of 'action – reassessment – action', with the aim of re-establishing indigenous knowledge, improving local self-esteem and the ability to analyse innovations, and, in the long term, to build up the capacity within the community to independently manage development activities according to their needs. Popular education involves a whole range of different methods of participatory training for poor land users: workshops, field days/trips, farm visits, demonstration areas, public meetings, formation of local support groups, and farmer-to-farmer experience exchange. Main subjects treated include: SWC practices, gender issues, land users' organisation, marketing and accounting. The impact on land users is excellent.
**Extension:** Key elements are demonstration areas, technical assistance through farm visits, farmer-to-farmer extension, local promoters organised into 'Local Support Groups', and an associated network. The impact is considered to be good.
**Research:** Research is carried out on demonstration farms through local promoters. Topics include on-farm testing of technologies, and adaptive trials with maize and pea varieties. The impact has been excellent, especially in terms of introduction of new crops and SWC technologies.
**Importance of land use rights:** Most of the land users have individual properties which facilitates the implementation of the SWC approach activities.

## Incentives

**Labour:** Voluntary: land users works on their own farms at their own cost.
**Inputs:** Tools were partly financed under the project. For production of manure from earthworms, fresh cattle manure is given as a gift from neighbours to farmers who don't have their own cattle. Earthworms are initially provided by the project, then further stocks are produced by the farmers themselves. Community infrastructure has been fully financed – for example the training and meeting centre.
**Credit:** Credit was provided through the programme of alternative financing by ADDAC. The 1.5% interest rate (lower than the market rate) is accessible to individuals and organised groups.
**Support to local institutions:** Institutional capacity building: 3 local farmers' organisations have been built up: Association of Organic Coffee Farmers, Breeders' Association, Association *Banco de granos buena esperanza* (Organisation for Storing and Commercialisation of Grain) and Farmer Support Groups (local promoters) for technology extension.
**Long-term impact of incentives:** Moderate positive long-term impacts are expected: the incentives have direct effects on the adoption. Soil conservation – stimulated by incentives – often has positive impacts in the long term on production.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Socio-cultural | land users' needs |
| Economic/production | % of land users achieving nutritional security, cost-benefit ratio, diversification, organic products, certified production; % of land users producing for market |
| No. of land users | regular measurements |
| Management of approach | the strategic plan is revised annually; the progress made by the projects is evaluated and reported twice a year |
| Training | % of land users trained as local promoters (SWC extension) |

## Impacts of the approach

**Changes as result of monitoring and evaluation:** There were several changes: at the beginning the approach consisted only of two components: training and research. Then it was broadened to involve extension of SWC technologies and promotion of crop diversification. Later the credit programme and the organisational component became part of the approach. The approach activities are supposed to be a continuously expanded based on the needs of the land users. Evaluation is carried out twice a year. This is part of a constant process of adjustment of policies, methods and concepts of the approach. However there is always emphasis on promotion of organic agriculture, agricultural diversification and organisational development based on participation.
**Improved soil and water management:** Moderate improvement through the implementation of SWC practices.
**Adoption of the approach by other projects/land users:** There are 6 more projects assisted by ADDAC, which use the same approach in the north of Nicaragua.
**Sustainability:** Land users can continue activities without further support

## Concluding statements

| **Strengths** and ➜ how to sustain/improve | **Weaknesses** and ➜ how to overcome |
|---|---|
| Evaluation of land users' needs and involvement of new approach components according to their needs; continuous mutual learning process between land users and between land users and extensionists/specialists ➜ Continue the present 6-monthly evaluation procedures; implement a system of information, communication, evaluation and monitoring to analyse the impact of the approach activities. | Process takes long and requires high inputs of human resources and materials ➜ In an integrated approach with strong participation of land users this problem is unavoidable; formulation of good project proposals help in finding donors to finance long-term programmes. |
| Efficient extension method: 86% of involved land users apply more than 3 different SWC technologies promoted by the approach which contributes to sustainable development of the region ➜ Maintain and extend present farmer-to-farmer extension system: continue training of local promoters, network of promoters, local support group. | |
| Growing active integration of women (25% more contribution to farm income and >25% more participation in decision making in comparison with non-participants) ➜ Keep the gender programme as a component of the approach. | |
| Farmers' organisations: build up capacity for autonomous management of alternative development activities ➜ Integrate more farmers in the baseline organisations. | |
| Increasing self-esteem of the people. | |

**Key reference(s):** Rolando Bunch (1990) *Dos Mazorcas de Maíz* ▪ Anon (1990) *El pequeño agricultor en Honduras* ▪ ADDAC (2002) *Plan estratégico Institucional 2003–2005*
**Contact person(s):** Julio César Gómez Martínez, De ENITEL 3c al Norte y 75 varas al Este. Calle Santa Ana, Apartado Postal 161, Matagalpa, Nicaragua; addacentral@addac.org; www.addac.org; phone: (505) 0772-7108; fax: (505) 0772-5245

**left:** Compost pits in Bam province with low containing walls: Pit compost requires little or no additional water and is preferable in dry zones. (William Critchley)
**right:** After her training, this young farmer succeeded in compost making. She is seen holding composted material ready for use: next to her is a heap still decomposing, under its straw cover. (Reynold Chatelain)

# Composting associated with planting pits

Burkina Faso – *Zai avec apport de compost*

**Compost production, and its application in planting pits *(zai)* by farmers on fields near their homes.**

Compost is produced in shallow pits, approximately 20 cm deep and 1.5 m by 3 m wide. During November and December layers of chopped crop residues, animal dung and ash are heaped, as they become available, up to 1.5 m high and watered. The pile is covered with straw and left to heat up and decompose. After around 15–20 days the compost is turned over into a second pile and watered again. This is repeated up to three times – as long as water is available. Compost heaps are usually located close to the homestead. Alternatively, compost can be produced in pits which are up to one metre deep. Organic material is filled to ground level. The pit captures rain water, which makes this method of composting a valuable option in dry areas.

The compost is either applied immediately to irrigated gardens, or kept in a dry shaded place for the next sorghum seeding. In the latter case one handful of compost is mixed with loose soil in each planting pit *(zai).* These pits are dug 60 cm by 60 cm apart. Three to four grains of sorghum are planted in each pit. Compost in the pits both conserves water and supplies nutrients. This enables the sorghum plants to establish better, grow faster and reach maturity before the rains finish. As compost is applied locally to the crop, not only is the positive effect maximised, but also the weeds between the pits do not benefit. The water retaining capacity of the compost (absorbing several times its own weight) makes the difference. This is much more important than the additional nutrients, which only become available in subsequent years, and do not anyway completely replace all the nutrients extracted by the crops.

The planting pits also help by harvesting runoff water from the microcatchments between them. Boulgou experiences erratic and variable rainfall with frequent droughts. The poor soils are often crusted and have a low water-retention capacity. Due to a high and increasing population, the land has become exhausted, and fallow periods are no longer sufficient as a consequence. Fertility and yields have declined. Sorghum without compost is more vulnerable to drought and crop failure.

During the dry season, after harvest, fields are grazed by cattle of the nomadic pastoral *Peuhl,* who also herd the agriculturalists' livestock. Interestingly, the *Peuhl* have started to systematically collect the manure for sale, since the increased demand (for composting) has led to doubling of the price. Composting has been applied in Boulgou Province of Burkina Faso since 1988.



**Location:** Boulgou Province, Burkina Faso
**Technology area:** 200 $km^2$
**SWC measure:** agronomic
**Land use:** mixed: agro-pastoral
**Climate:** semi-arid
**WOCAT database reference:** QT BRK10
**Related approach:** Zabré women's agro-ecological programme, QA BRK10
**Compiled by:** Jean Pascal Etienne de Pury, CEAS Neuchâtel, Switzerland
**Date:** August 2002, updated July 2004

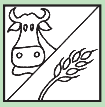
**Editors' comments:** Soil fertility decline is a major problem for much of Africa, and composting provides an opportunity for local mitigation of this. There are many ways of making compost, and this case is a good example of 'aerobic heap compost' from Burkina Faso. Here, the compost is concentrated in planting pits, which additionally harvest water.

## Classification

### Land use problems

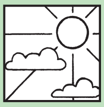
Population increase has led to cultivation of all the available arable land, thus shortening or eliminating fallow periods. Organic matter in the soil is reduced, the water holding capacity of the soil has diminished and consequently yields have fallen. This has been compounded by the droughts of the 1970s and 1980s. Thirty years ago farmers harvested 800 kg/ha each year, but by the 1980s yields had fallen to merely 400 kg/ha on average.

**Land use**



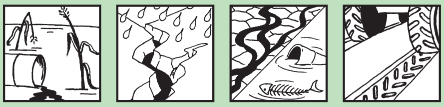
agro-pastoral: sorghum and zebu cattle (after harvest)

**Climate**



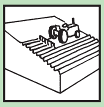
semi-arid

**Degradation**



chemical: fertility decline; water erosion: surface (sheet/rill erosion); water degradation: soil moisture problem; physical: compaction, crusting

**SWC measures**



agronomic: organic matter/soil fertility

**Technical function/impact**

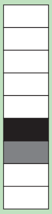
**main:** - increase/maintain water stored in soil

**secondary:**
- improvement of soil structure
- increase in organic matter
- increase in soil fertility
- increase in infiltration

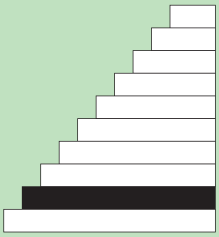
## Environment

### Natural environment

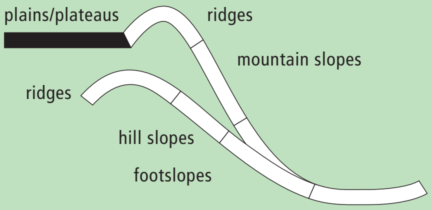
**Average annual rainfall (mm)**



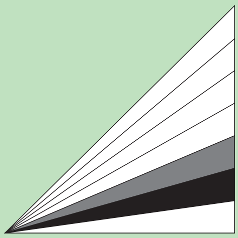

**Altitude (m a.s.l.)**



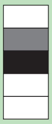

**Landform**




**Slope (%)**




**Soil depth (cm)**



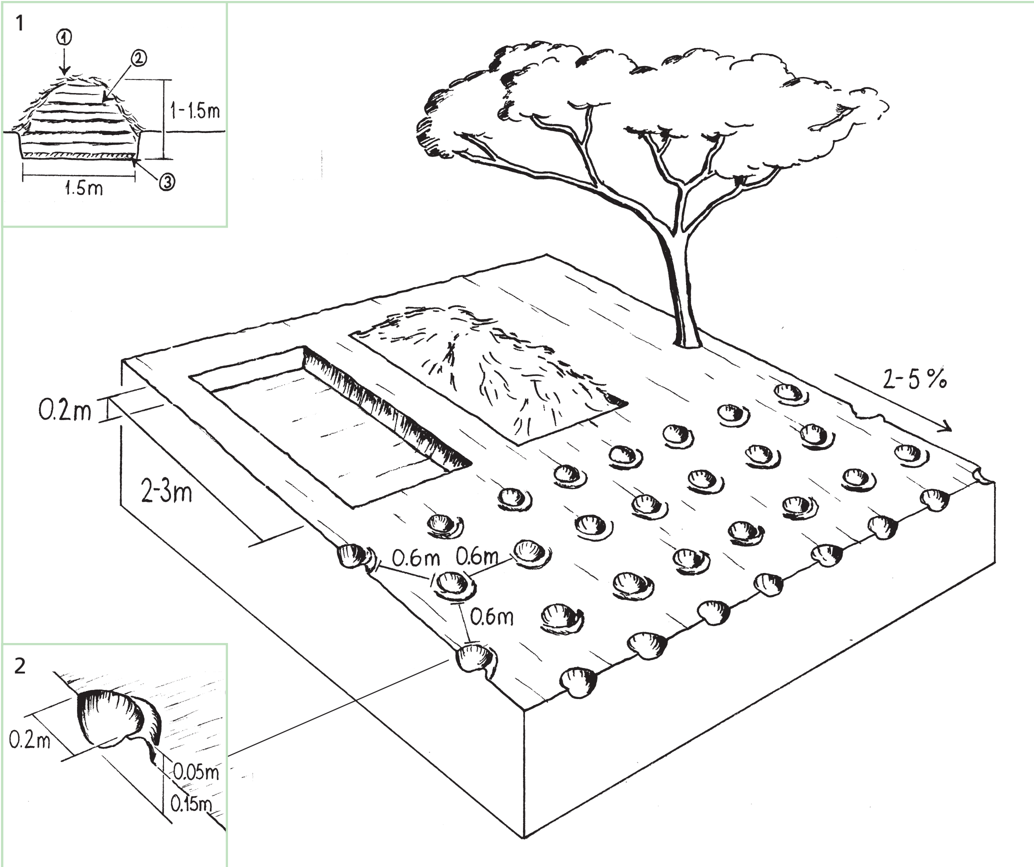

NB: soil properties before SWC

**Growing season:** 180 days (May to October)
**Soil fertility:** mainly low, partly medium
**Soil texture:** mainly fine (clay) (elevations), partly coarse (sandy) (depressions)
**Surface stoniness:** mainly no stone, partly stony
**Topsoil organic matter:** low (<1%), and decreasing further
**Soil drainage:** mainly poor, partly medium
**Soil erodibility:** mainly medium, partly high

### Human environment

**Mixed land per household (ha)**


**Land use rights:** communal (organised)
**Land ownership:** communal/village
**Market orientation:** mainly subsistence (self-supply), in good years mixed (subsistence and commercial)
**Level of technical knowledge required:** field staff/extension worker: moderate, land user: low
**Importance of off-farm income:** <10% of all income




**Technical drawing**
Overview of compost making and *zai* planting pits within a field. Tree shade helps to conserve moisture in the compost pits.
Insert 1: Cross section of compost pit: protective straw (1); successive layers of compost (2), clay layer at the bottom (3).
Insert 2: Detailed view of *zai* planting pit.

## Implementation activities, inputs and costs

### Establishment activities

1. Dig two compost pits (3 m by 1.5 m and 20 cm deep) at beginning of the dry season (November).
2. Cover the bottom of each pit with 3 cm clay layer.

Duration of establishment: 1 week

### Establishment inputs and costs per ha

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (2 person days) | 2 | 100% |
| Equipment | | |
| - Tools: hoe, knife, digging stick bucket | 10 | 100% |
| Materials | | |
| - Clay (0.5 m$^3$) | 0 | |
| **TOTAL** | **12** | **100%** |

### Maintenance/recurrent activities

1. Put 20 cm layer of chopped crop residues (cereal straw) into the compost pit (water with one bucket) in November.
2. Add 5 cm layer of animal manure.
3. Add 1 cm layer of ash.
4. Repeat steps 1–3 until the compost pile is 1.0–1.5 m high.
5. Cover pile with straw to reduce evaporation, and leave to decompose. Check heating process within the heap by inserting a stick.
6. Turn compost after 15 days into the 2nd pit, then after another 15 days back into the 1st pit. Turning over is done up to 3 times (as long as water is available).
7. Water the pile after each turning with 3 buckets of water.
8. Store ready compost in dry shady place (January).
9. Transport compost to the fields by wheelbarrow or donkey-cart (April).
10. Deepen planting pits *(zai)* with a hoe (to original dimensions of 15 cm deep, 20 cm diameter, and 60 cm apart) and apply a handful of compost mixed with earth, just before planting sorghum (after the first rains).

### Maintenance/recurrent inputs and costs per ha per year

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (20 person days) | 20 | 100% |
| Equipment | | |
| - Wheelbarrow renting | 6 | 100% |
| Materials | | |
| - Ash | 0 | |
| - Wet straw | 0 | |
| Agricultural | | |
| - Manure (100 kg) | 2 | 100% |
| Others | | |
| - Compost transportation | 2 | 100% |
| **TOTAL** | **30** | **100%** |

**Remarks:** Costs relate to production and application of one ton of compost per hectare – which a farmer can make in one year and is the product of one full compost pit. The compost is directly applied to each planting pit: since the pits all in all constitute only around 10–15% of the field surface, compost is effectively applied at a concentration of 7–10 t/ha. This rate is equal to actual rates applied in small irrigated gardens (<0.1 ha). If compost is produced in deep pits, production is cheaper because there is less work involved.

## Assessment

### Acceptance/adoption

All the land users (5,000 families) who accepted the technology have done so without external incentives. Even some pastoralists use it in their gardens. There is a strong trend towards growing spontaneous adoption. Almost everybody, man or woman, rich or poor, wants to imitate his or her trained neighbours – but not everyone had received adequate training by 1997. Demand grew because of the expanded membership of the association.

### Benefits/costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | very positive | very positive |
| maintenance/recurrent | very positive | very positive |

### Impacts of the technology

**Production and socio-economic benefits**

- +++ crop yield increase
- +++ farm income increase (by several times in dry years, compared to no compost use)
- ++ fodder production/quality increase

**Production and socio-economic disadvantages**

- − increased labour constraints
- − increased input constraints (water for compost making)

**Socio-cultural benefits**

- +++ community institution strengthening
- ++ improved knowledge SWC/erosion
- ++ integration of agriculturalists and pastoralists

**Socio-cultural disadvantages**

none

**Ecological benefits**

- +++ increase in soil moisture
- ++ increase in soil fertility
- ++ soil cover improvement
- ++ efficiency of excess water drainage
- + soil loss reduction

**Ecological disadvantages**

none

**Off-site benefits**

none

**Off-site disadvantages**

none

## Concluding statements

**Strengths and ➜ how to sustain/improve**

All land users, even the poorest, can learn to make and apply compost. No jealousy amongst land users, which is a prerequisite for its spread/acceptance ➜ Keep going with training and extension.

Possibility of doubling cereal yields in normal years: any surplus production can be sold ➜ Produce enough good compost/manure.

Ensures yields in dry years, giving security against drought and hunger.

Gives high income in dry years due to production increase and double prices on the market for the surplus ➜ However the government is attempting to stabilise prices, so this benefit might not endure.

Requires only locally available resources, and knowledge about compost application is 'owned' by the farmers: nobody can take it away from them.

**Weaknesses and ➜ how to overcome**

The modest quantity of compost applied is not enough to replace the nutrients extracted by the crops in the long term ➜ Small amounts of nitrogen and phosphorous fertiliser need to be added and crop rotation practiced.

The short/medium term local benefits are not associated with a positive overall, long-term ecological impact because there is a net transfer of organic matter (manure) to the fields from the surroundings ➜ Improve management of the vegetation outside the cropland, avoiding overgrazing etc to increase manure production.

Needs considerable water and thus also extra labour ➜ Pit composting helps to reduce water requirement in drier areas and at the same time reduces labour input.

**Key reference(s):** Ouedraogo E (1992) *Influence d'un amendement de compost sur sol ferrugineux tropicaux en milieu paysan. Impact sur la production de sorgho à Zabré en 1992.* Mémoire de diplôme. CEAS Neuchâtel, Switzerland ■ Zougmore R, Bonzi M, et Zida Z (2000) *Etalonnage des unités locales de mesures pour le compostage en fosse de type unique étanche durable.* Fiche technique de quantification des matériaux de compostage, 4pp

**Contact person(s):** Ouedraogo Elisée, Ingénieur agronome, c/o CEAS, 2 rue de la Côte, 2000 Neuchâtel, Switzerland; oelisee@hotmail.com; www.ceas.ch ■ Moussa Bonzi, INERA, B.P. 8645, Ouagadougou 04, Burkina Faso

**left:** Result of the technology: sorghum yield (25 heads) grown with compost (left) and 25 heads without compost. On-farm trials are used to compare yields between plots with, and without, compost: this helps convince the land users to adopt the technology. (Reynold Chatelain)
**right:** Heaps of compost in the field prior to planting. (Moussa Bonzi)

# Zabré women's agroecological programme

Burkina Faso – *Programme agroecologique de l'association des femmes Pag-La-Yiri de Zabré (AFZ)*

**A demand-driven initiative, by a women's association, aimed at the promotion of composting through training and extension, using project staff and local facilitators.**

Leaders of the women's association of Zabré *(Association des Femme de Zabré,* AFZ) initiated a training programme for their members on compost making, and its application in planting pits *(zai)* after they visited a seminar on the topic in 1987. AFZ actively sought technical and financial help, and found this through the *Centre Ecologique Albert Schweitzer* (CEAS, based in Switzerland). Support began with the establishment of a first demonstration site where five local facilitators (one from each zone), learned about and developed the technology together over a whole year – comparing the results with sorghum fields without compost. In the following year, those five facilitators each trained 20 women in their zones, using the same training methods as they themselves had experienced.

AFZ set up demonstration and training sites in each of the five zones. These demonstration areas were protected by a wire netting fence, contained a well, a cement water tank, and some shade trees for the compost heaps and training sessions. Machines for the wells, hand tools and manure were fully financed, whereas community infrastructure was only partly funded. Each demonstration site had one hectare of cultivated land, with irrigated vegetables in the dry season and sorghum in the rainy season. The facilitators used this land to demonstrate the effect of the compost, and thus to visually convince the trainees. Each of the trainees carried 20 kg of compost home and applied it to their own sorghum fields. During the first 18 months, a CEAS technician visited the zones regularly.

In the following years, the neighbouring villages each sent groups of 20 women to the established demonstration and training sites, each group for one day a week. They carried out the successive phases of composting in the demonstration plots, while simultaneously implementing the practice at home – where they were supervised by the facilitators as far as possible. In this way, 500 women were trained within one year. Although it took a while, men gradually began to take part and assist their wives when they lost their fear of being ridiculed by others. Many more women then put themselves forward for training. While waiting, they tried to imitate their neighbours, but with mixed results. The support of the CEAS project decreased over the years until 1997, after which it was phased out, being no longer necessary. Training has since continued through the five zonal facilitators and the local agriculture extension service.



**Location:** Boulgou Province, Burkina Faso
**Approach area:** 2,000 km$^2$
**Land use:** mixed: agro-pastoral
**Climate:** semi-arid
**WOCAT database reference:** QA BRK10
**Related technology:** Composting and planting pits, QT BRK10
**Compiled by:** Jean Pascal Etienne de Pury, CEAS Neuchâtel, Switzerland
**Date:** August 2002, updated July 2004

**Editors' comments:** Support for women's groups in rural areas of the developing world became an explicit feature of development aid and investment from the 1970s onwards. This is an example of empowerment of women at political, financial and socio-cultural levels. The approach described takes an example from Burkina Faso, in relation to a simple but effective technology composting, which has found wide acceptance.

## Problems, objectives and constraints

### Problem

Since the drought and famine periods of 1970–74 and 1981–84, the main concern of the women in Zabré was how to feed their families. This meant trying to raise crop production again to the pre-1970s average of 800 kg/ha from the level of 400 kg/ha to which it had fallen. The soils were deteriorating because of declining organic matter as increased population led to continuous cultivation without fallow periods. The status of women was low, and they found it hard to generate income through other activities.

### Objectives

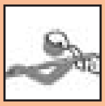
- train 6,000 women members of AFZ (in 1987) in making compost, and applying it to planting pits (*zai)* in order to double yields of sorghum or maize – the eventual target is for all farmers of the two departments to make, and apply compost on their fields
- improve the status of women and their livelihoods
- encourage women's participation in development
- promote training and cooperative action

### Constraints addressed

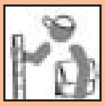
| Major | Specification | Treatment |
|---|---|---|
| Social/cultural/ religious | Men were afraid of being ridiculed in case of failures. | Contrastingly, women don't fear being laughed at. The expectation of increasing the yields encourages them to take risks: eventually men also followed for the same reasons. |
| Institutional | The existing institution of the women's association of Zabré (AFZ), which has functioned well for 12 years, needed to adapt to the new agroecological programme promoted by CEAS. | The management of the AFZ was motivated to adopt and integrate the technology offered by CEAS. |
| **Minor** | **Specification** | **Treatment** |
| Financial | Training of farmers is relatively expensive. | The donors (Fondation pour le Progrès de l'Homme) and CEAS took care of the approach costs. |
| Technical | One key question was: how best to teach composting to 6,000 women? | AFZ already had an extension structure and the five facilitators served as 'multipliers'. |

## Participation and decision making

### Target groups



Land users



SWC specialists/ extensionists

### Approach costs met by:

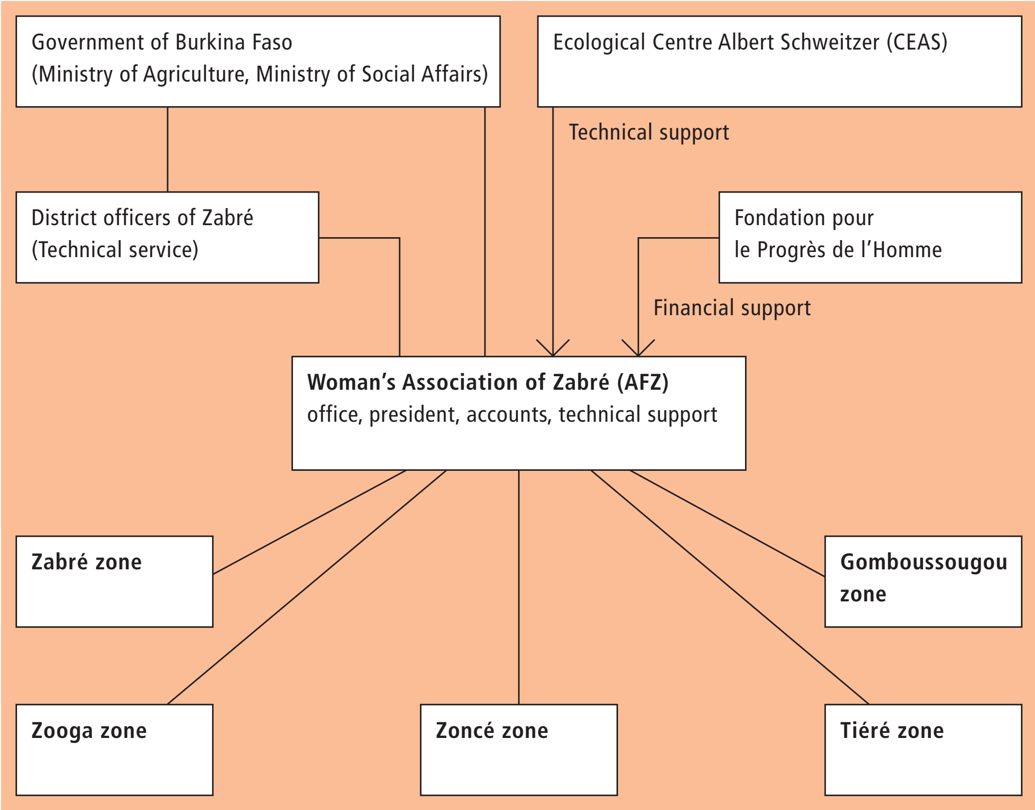
| | |
|---|---|
| International NGO | 80% |
| Community/local | 20% |
| | 100% |

**Decisions on choice of the technology:** Made by the leaders of the women's association of Zabré (AFZ).
**Decisions on method of implementing the technology:** Made by the leaders of AFZ in consultation with experts from the *Centre Ecologique Albert Schweitzer* (CEAS).
**Approach designed by:** National and international specialists. CEAS, their engineers at Zabré and the facilitators designed the approach, which fitted well into the existing structure of AFZ.

### Community involvement

| Phase | Involvement | Activities |
|---|---|---|
| Initiation | interactive | discussion of problems in public meetings |
| Planning | interactive | meetings with those in charge of the groups of women farmers |
| Implementation | interactive | in exchange for the training received, some land users volunteered themselves as temporary/part-time facilitators |
| Monitoring/evaluation | interactive | the land users learned to control the quality and the efficiency of their work and voluntarily contributed to monitoring/evaluation which involved measurements/ observations, interviews, public meetings – the facilitators were responsible for progress reports |
| Research | passive | visit of international researchers to the farms |

**Differences in participation between men and women:** There were great differences – in the beginning at least – when AFZ merely asked the men to 'allow' their wives to learn about composting. After two years, men started to participate in the training and eventually as many of them as women began to make and use compost. Another difference was in discussions, when men tended to dominate.




**Organogram**
The agroecological programme of the Zabré Women's Association (AFZ). There are five facilitator's zones each with:
- 1 president, 1 vice-president
- 1 facilitator
- 1 pharmacy
- 1 cereal bank
- 1 meeting room
- 1 shop
- 1 demonstration/training site

## Extension and promotion

**Training:** Training, as the central focus of the approach, was provided on two levels: project staff trained local facilitators, who then further spread the gained SWC knowledge among the land users. Subjects treated included compost making and application, reforestation, soil protection and anti-erosion measures. This was a mixture of on-farm and demonstration station training. Farm visits, public meetings and courses were also included. The training of facilitators and extension agents was viewed as being excellent, and the further training of land users was good. Not all land users gained the same value from the training provided, however, but all put it into practice.
**Extension:** Extension basically comprised demonstrations and practical training of of AFZ's members in the five demonstration areas in the respective AFZ zones. As the technology is now practiced by all farmers, women and men, the facilitators only intervene if there is a request. This method has proved to be effective.
**Research:** Applied research was not part of this approach. However CEAS used previous recommendations from an applied research station in Gorom (Burkina Faso) and thereby adapted the technology to the local situation.
**Importance of land use rights:** Ownership rights did not affect the implementation of the approach. Even though the land users do not own the land they cultivate (the state officially owns the land, though land use rights are traditional and secure) they receive immediate and full benefits through improved crop yields.

## Incentives

**Labour:** Labour was provided voluntarily by the land users: the hope of increasing yields served as an effective incentive.
**Inputs:** Beside the free training, there were no inputs provided directly to the land users. However for the five demonstration areas of one hectare each, machines (for the wells), hand tools and manure were fully financed and community infrastructure (see list above) were partly financed by the approach.
**Credit:** No credit was provided. AFZ does have its own credit scheme, but no credit was needed by the members for composting.
**Support to local institutions:** There was a great level of support to the Women's Association of Zabré (AFZ): financial, training and equipment.
**Long-term impact of incentives:** There may be moderate negative long-term impacts of the 'extra yield incentive'. While compost application in planting pits assures increased yields in the short term, continuous application over many years can contribute to soil mining, because it does not replace the nutrients extracted and additional fertilizer and crop rotation will be needed.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Bio-physical | regular observations and measurements of colour, texture and temperature of compost |
| Technical | regular observations of learning progress and production |
| Socio-cultural | ad hoc observations of effects on input and product prices |
| Economic/production | regular measurements of agricultural output |
| Area treated | regular observations and measurements of fields with compost |
| No. of land users involved | regular observations and measurements of trained land users and implementers of technology |
| Management of approach | regular measurements of CEAS' accounting expertise (in 1992, Fondation pour le Progrès de l'Homme funded a general evaluation of the AFZ agroecological programme and of CEAS' technical support) |

## Impacts of the approach

**Changes as result of monitoring and evaluation:** There were no major changes to the approach.
**Improved soil and water management:** The compost making and its application has helped to improve soil and water management, as the compost returns humus to the soil and increases its water retention capacity and thus improves ground cover.
**Adoption of the approach by other projects/land users:** Many women's groups from other regions throughout the country invite delegations from AFZ to teach them compost making. The AFZ delegates are provided with food, accommodation, travel costs and presents in exchange for training. This is much cheaper than the 'official' compost training provided by the Association for Agroecological Technology Development (ADTAE).
**Sustainability:** The land users are continuing activities and can do so in future, assuming no new problems arise.

## Concluding statements

| **Strengths** and ➜ how to sustain/improve | **Weaknesses** and ➜ how to overcome |
|---|---|
| Training of local trainers/facilitators ➜ Positive feedback from the farmers will stimulate the facilitators to continue their work. | Internal conflicts within the association may cause problems and there is a danger of CEAS specialists becoming involved in these AFZ rivalries ➜ CEAS should be aware of AFZ power struggles and not get involved. CEAS must stick to its technical role – which is related to knowledge only and not to power. |
| AFZ represents female land users, it is local and not 'created' by CEAS and is thus an ideal structure ➜ CEAS has the knowledge, but AFZ has the power. AFZ needs to learn to use its power to access CEAS' knowledge bank. | |
| AFZ was convinced about the necessity of compost before they knew about CEAS. They searched for a technical collaborator for training and financial support ➜ This preliminary motivation is an asset and the technical partner has to fulfil neither less, nor more, than what AFZ expects. | |
| Land users have confidence in their organisation (AFZ) and learn while working in the fields and discussing with the facilitators ➜ The facilitators know to nurture this confidence until the land users get profit from the compost (which in turn reinforces that confidence). | |

**Key reference(s):** UNEP (2002) Enriching soils naturally. In: *Success stories in the struggle against desertification* pp 5–8
**Contact person(s):** Jean Pascal Etienne de Pury, ancien directeur du Centre Ecologique Albert Schweitzer, 2 rue de la Côte, CH-2000 Neuchâtel, Switzerland; ceas.ne@bluewin.ch, ceas-rb@fasonet.bf; www.ceas-ong.net/burkina1.html, www.ceas.ch ■ Maria Lougue, Association des femmes Pag-La-Yiri de Zabré (AFZ), O9 B.P. 335 Ouagadougou 09, Burkina Faso; http: www.ccaeburkina.org/afz.html

**left:** Extension agent with trash lines – newly formed from cereal residues. (William Critchley)
**right:** An improved trash line, laid out along the contour, in a field of beans. (William Critchley)

# Improved trash lines

Uganda – *Emikikizo*

**Weeds and crop residues laid in bands across the slope of annual crop fields to conserve soil and water, and to incorporate organic matter into the soil after decomposition.**

Trash lines of organic material across the slope constitute a traditional land husbandry practice in south-west Uganda. These traditional, 'unimproved', trash lines are beneficial, but even better is an improved version designed through Participatory Technology Development (PTD). Improved trash lines are smaller, closer spaced, and of longer duration than the traditional type. They are more effective in controlling runoff and maintaining soil fertility.

All trash lines (improved and traditional) are composed of cereal stover (straw) and weeds that are collected during primary cultivation (hand hoeing), and heaped in strips along the approximate contour. Creeping grasses should not be used in trash lines: they can alternatively be decomposed in bundles, and then used as mulch in nearby banana plantations. Trash lines are used in hillside fields where annual crops, including sorghum, finger millet, beans and peas, are grown. The recommended spacing between the improved trash lines is 5–10 m, depending on the slope: the steeper the closer. The amount of material available determines the cross section of each trash line (typically ±0.5 m wide and ±0.3 m high). Improved trash lines are left in place for four seasons (there are two seasons a year in Kabale) before they are dug into the soil. Much of the material used has, by this time, decomposed or been eaten by termites. Through incorporation into the topsoil, they improve soil fertility acting effectively as 'mobile compost strips'. New trash lines are then established between the sites of the former lines. Upkeep comprises removal of weeds that sprout within the lines – before they set seed – and the addition of more trash during each new cultivation and weeding cycle.

Improved trash lines are multipurpose in retarding dispersed runoff while, as discussed, maintaining soil fertility. They are a low-cost option for soil and water conservation. However, they need to be complemented by other measures on the steeper slopes. The climate in this part of Uganda is subhumid, with a bimodal rainfall regime, and average annual rainfall of around 800 mm. Hill tops are used for grazing, the lower slopes are cultivated with annual crops (where the trash lines are found) and the valleys are dedicated to bananas and other cash crops. Families are large: 8–10 persons, and the population density is high, at nearly 200 persons/km$^2$.



**Location:** Kamwezi, Kabale District, Uganda
**Technology area:** 0.25 km$^2$
**SWC measure:** agronomic
**Land use:** cropland
**Climate:** subhumid
**WOCAT database reference:** QT UGA04
**Related approach:** Promoting farmer innovation, QA UGA04*
**Compiled by:** Henry Dan Miiro, Entebbe, Uganda
**Date:** 1998, updated June 2004

**Editors' comments:** Cross-slope trash lines of weeds and crop residues are a well-known practice in East Africa and elsewhere in the tropics. In some situations these are the basis of permanent structures. In this case study of improved trash lines – developed through a participatory process – they are temporary, acting effectively as 'mobile compost strips'.

* note: not the precise approach used in this area, but many common elements

## Classification

### Land use problems

Continuous cultivation of annual crops on slopes prone to erosion, with little or no restitution of fertility through manures or fertilizers.

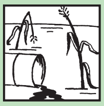
**Land use**

annual crops: sorghum, finger millet, beans and peas

**Climate**

subhumid

**Degradation**

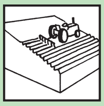


chemical: fertility decline

water erosion: loss of topsoil

water degradation: soil moisture deficit

**SWC measures**



agronomic: trash lines

**Technical function/impact**

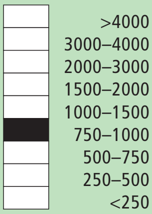
**main:**
- increase in soil fertility
- retard dispersed runoff
- increase of infiltration

**secondary:** - none

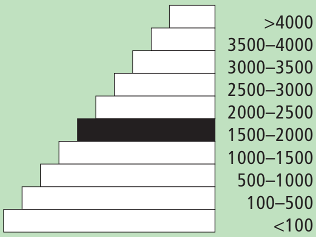
## Environment

### Natural environment

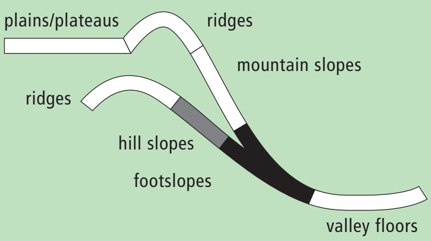
**Average annual rainfall (mm)**



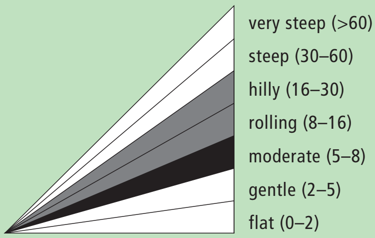

**Altitude (m a.s.l.)**



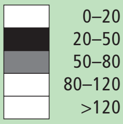

**Landform**




**Slope (%)**




**Soil depth (cm)**

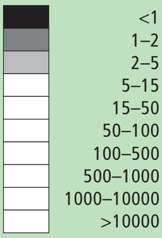



NB: soil properties before SWC

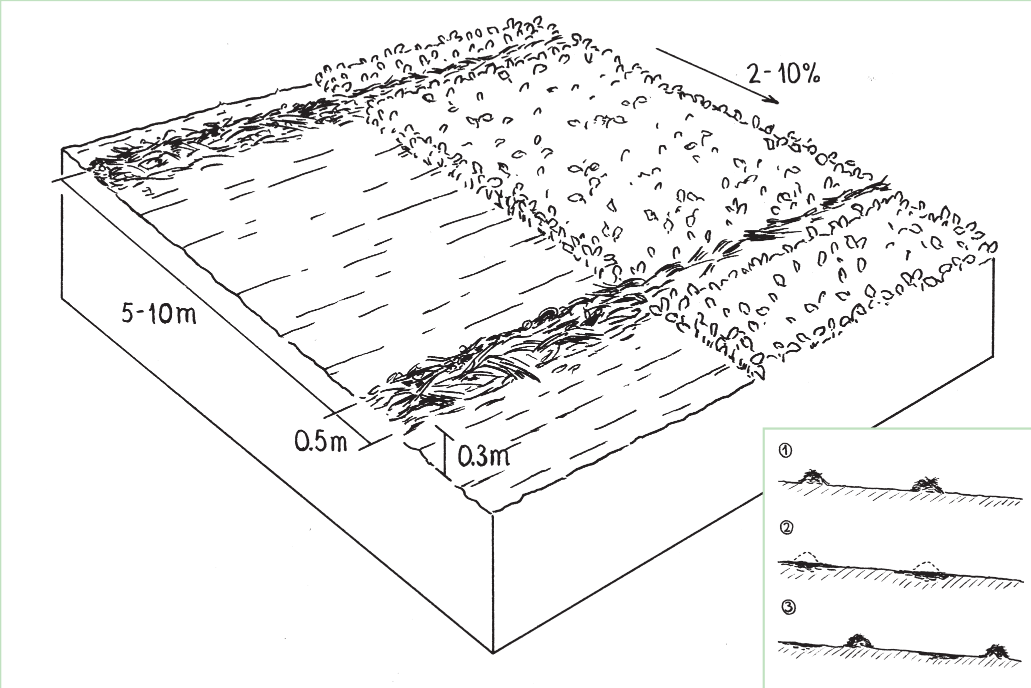
**Growing season:** 150–180 days (February to July) and 120 days (September to January)
**Soil fertility:** mostly medium, partly low
**Soil texture:** medium (loam)
**Surface stoniness:** some loose stone
**Topsoil organic matter:** mostly low (<1%), partly medium (1–3%)
**Soil drainage:** mostly medium
**Soil erodibility:** medium

### Human environment

**Cropland per household (ha)**




**Land use rights:** individual
**Land ownership:** individual not titled
**Market orientation:** mixed (subsistence and commercial)
**Level of technical knowledge required:** field staff/extension worker: low, land user: low
**Importance of off-farm income:** 10–50% of all income: some farmers are involved in trade with nearby Rwanda and there are also a number of families who receive remittances from family members who work in Kabale or as far away as Kampala




**Technical drawing**
Trash lines without crops (left) and with crops (beans; right).
The insert shows the stages of the technology: regularly spaced trash lines are kept place for four seasons (1); then decompose over time and are incorporated into the soil (2); and finally new trash lines are placed between the previous strips (3).

## Implementation activities, inputs and costs

**Establishment activities**
not applicable

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| not applicable | | |

**Maintenance/recurrent activities**
First season:
1. During land cultivation by hand hoe, existing (old) trash lines are dug into the soil.
2. New trash lines are then created exactly between the (cross-slope) locations of the old lines using weeds and crop residues.
3. The size of the trash lines depends on the amount of trash available, but typically they are ±0.5 m wide and ±0.3 m high. Spacing between lines depends on slope (and amount of trash) but is between 5 and 10 metres – the steeper, the closer.

Second season:

4. Weeds are added to the trash lines, and, in preparation for the second season, trash lines are built up again during land cultivation by hand hoe.

Third and fourth seasons:

5. Trash lines are kept free of growing weeds and built up with more trash.

Full cycle for improved trash lines: 4 seasons (2 years)

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (25 person days) | 25 | 100% |
| Equipment | | |
| - Tools (hand hoes) | 5 | 100% |
| Materials | | |
| - Organic material/weeds | 0 | |
| **TOTAL** | **30** | **100%** |

**Remarks:** These figures are approximate, representing a typical situation with 1,500 running metres of improved trash lines, per hectare, at a spacing of 7 m apart on a 10% slope. The 1st year (first and second seasons) involves more work than the 2nd year (third and fourth seasons): the figure given is an annual average of all work associated with trash lines. The costs of the traditional, larger and wider spaced trash lines are about 50% more than these given above – because trash has to be carried further.

## Assessment

### Acceptance/adoption
- All families (around 30 families in the locality) who took up the improved trash line technology did so without incentives: they saw the benefits on the farms where the system was developed.
- There is some evidence of growing spontaneous adoption.

**Benefits/costs according to land user**

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | not applicable | not applicable |
| maintenance/recurrent | positive | very positive |

**Impacts of the technology**

**Production and socio-economic benefits**
- ++ crop yield increase
- + farm income increase

**Production and socio-economic disadvantages**
- −− less material for mulching bananas in valleys

**Socio-cultural benefits**
none

**Socio-cultural disadvantages**
none

**Ecological benefits**
- ++ increase in soil fertility
- ++ increase in soil moisture
- ++ soil loss reduction

**Ecological disadvantages**
none

**Off-site benefits**
none

**Off-site disadvantages**
none

## Concluding statements

**Strengths and ➜ how to sustain/improve**

The technology is very simple and uses locally available material.
It is easy to understand, being a modification of an existing tradition ➜ Continue with farmer-to-farmer visits for first hand learning.

Multiple ecological and SWC benefits: improves soil fertility, reduces erosion, increases infiltration etc ➜ Continue to encourage adoption of (and further farmer experimentation with) the improved trash lines.

Improved trash lines have small but significant advantages over the traditional trash lines (which are beneficial themselves) in terms of (a) less labour (b) improved crop performance ➜ Continue with farmer-to-farmer visits for this to be explained.

**Weaknesses and ➜ how to overcome**

The trash lines are not enough on their own to control erosion on the steeper slopes ➜ Introduce/promote supplementary structural remedies such as earth bunds.

Competition for crop residues which have an alternative use as livestock fodder and, especially, mulch in banana plantations ➜ Grow hedgerows of shrubs/grasses to increase availability of material for fodder, trash lines and mulching.

Source of weeds ➜ Pull out weeds before they set seed and don't use stoloniferous or rhizome-forming (creeping) grasses in trash lines (see picture).

**Key reference(s):** Briggs SR et al (1998) *Livelihoods in Kamwezi, Kabale District, Uganda.* Silsoe Research Institute, UK ■ Mutunga K and Critchley W (2001) *Farmer's initiatives in land husbandry* Technical Report No 27, Regional Land Management Unit, Nairobi, Kenya ■ Critchley W and Mutunga K (2003) Local innovation in a global context: documenting farmer initiatives in land husbandry through WOCAT *Land Degradation and Development* (14) pp 143–162
**Contact person(s):** Henry Dan Miiro, Ministry of Agriculture, Animal Industry and Fisheries, Entebbe, Uganda; entebbe@ulamp.co.ug

**left:** A cluster of innovators in Kabale District, Uganda, with the national coordinator, Alex Lwakuba (far left). (William Critchley)
**right:** Farmer-to-farmer extension: a female innovator shares her skills. (William Critchley)

# Promoting farmer innovation

Uganda

**Identification of 'farmer innovators' in SWC and water harvesting, and using them as focal points for visits from other farmers to spread the practices and stimulate the process of innovation.**

The 'Promoting Farmer Innovation' (PFI) approach seeks to build on technical initiatives – 'innovations' in the local context - developed by farmers themselves in dry/marginal areas where the conventional approach of 'transfer of technology' from research to extension agents, and then on to farmers, has so often failed.

The approach basically comprises identifying, validating and documenting local innovations/initiatives. Simple monitoring and evaluation systems are set up amongst those innovative farmers who are willing to co-operate. Through contact with researchers, extra value is added to these techniques where possible. Farmer innovators are brought together to share ideas. Finally, 'best-bet' technologies, in other words those that are considered to be good enough to be shared, are disseminated through farmer-to-farmer extension. This takes two forms. First, farmers are brought to visit the innovators in their farms. Secondly farmer innovators are used as teachers/trainers to visit groups of farmers – including FAO's 'farmer field schools' in some cases. Only in this second form of extension is an allowance payable to the innovator. A ten-step field activity methodology has been developed.

At programme level, there is capacity building of in-line extension and research staff, who are the main outside actors in the programme. In each of the countries the project has been implemented through a government ministry, which partners various NGOs in the field. The principle, and practice, is not to create separate project enclaves, but to work through existing personnel, sharing buildings and vehicles that are already operational in the area. A 'programme development process' methodological framework shows how the ultimate goal of institutionalisation can be achieved. PFI's first phase, completed in 2000, was financed by the Government of The Netherlands, through UNDP, and was active in Kenya, Tanzania and Uganda.



**Location:** East Africa (parts of Kenya, Tanzania and Uganda)
**Approach area:** 15,000 km$^2$
**Land use:** cropland
**Climate:** semi-arid, subhumid
**WOCAT database reference:** QA UGA02
**Related technology:** Improved trash lines, QT UGA04
**Compiled by:** Kithinji Mutunga & William Critchley (Ministry of Agriculture, Kenya & Vrije Universiteit Amsterdam, Netherlands)
**Date:** 2000, updated July 2004

**Editors' comments:** 'Promoting Farmer Innovation' is one amongst several new, related approaches to participatory research and development. The starting point is acknowledging the skills and creativity of land users to develop appropriate technologies, and their capacity to spread their ideas to others. Farmers, researchers and extensionists work together in this new methodology.

## Problem, objectives and constraints

**Problem**

- poor supply of relevant recommendations from research for small scale farmers in marginal areas
- poor delivery of SWC technologies (where they exist) to farmers
- lack of motivation of research and extension staff
- isolation of promising 'innovative' SWC/water harvesting ideas which address low crop yields, land degradation and poverty
- lack of exchange of this knowledge

**Objectives**

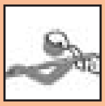
Improve rural livelihoods through an increase in the rate of diffusion of appropriate SWC/water harvesting technologies based on farmer innovation, and through farmer-to-farmer exchange visits. At a higher level: to demonstrate the effectiveness of such an approach so that it can be institutionalised.

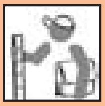
**Constraints addressed**

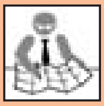
| Major | Specification | Treatment |
|---|---|---|
| Social | 'Favoured farmer syndrome' – where too much attention is given to particular innovative farmers and jealousy is aroused in others. | 1. Avoid working with innovators who are so exceptional that they are 'outside society' and others cannot relate to them. 2.'Rotate' the farmers who are used as learning points: in other words once another farmer has adopted the technology, use him or her as the focal point. |
| Financial | Danger of identifying innovations that are good technically but too expensive for ordinary farmers to implement. | Linked to point (1) above: beware of farmers who are too exceptional/too rich. |
| Cultural | Gender imbalance in identification of innovators: women overlooked. | Gender sensitisation and training: bring together the 'identifiers' (usually extension staff) with the farmers – male and female. |
| **Minor** | **Specification** | **Treatment** |
| Legal | Who gets the credit for the particular innovation? | Important to make sure that an innovation is traced back – within the locality – to its roots, identifying the 'owner'. Especially important when a name is attached to an innovation. |

## Participation and decision making

**Target groups**


Land users


SWC specialists/ extensionists


Planners


Politicians/ decision makers

**Approach costs met by:**

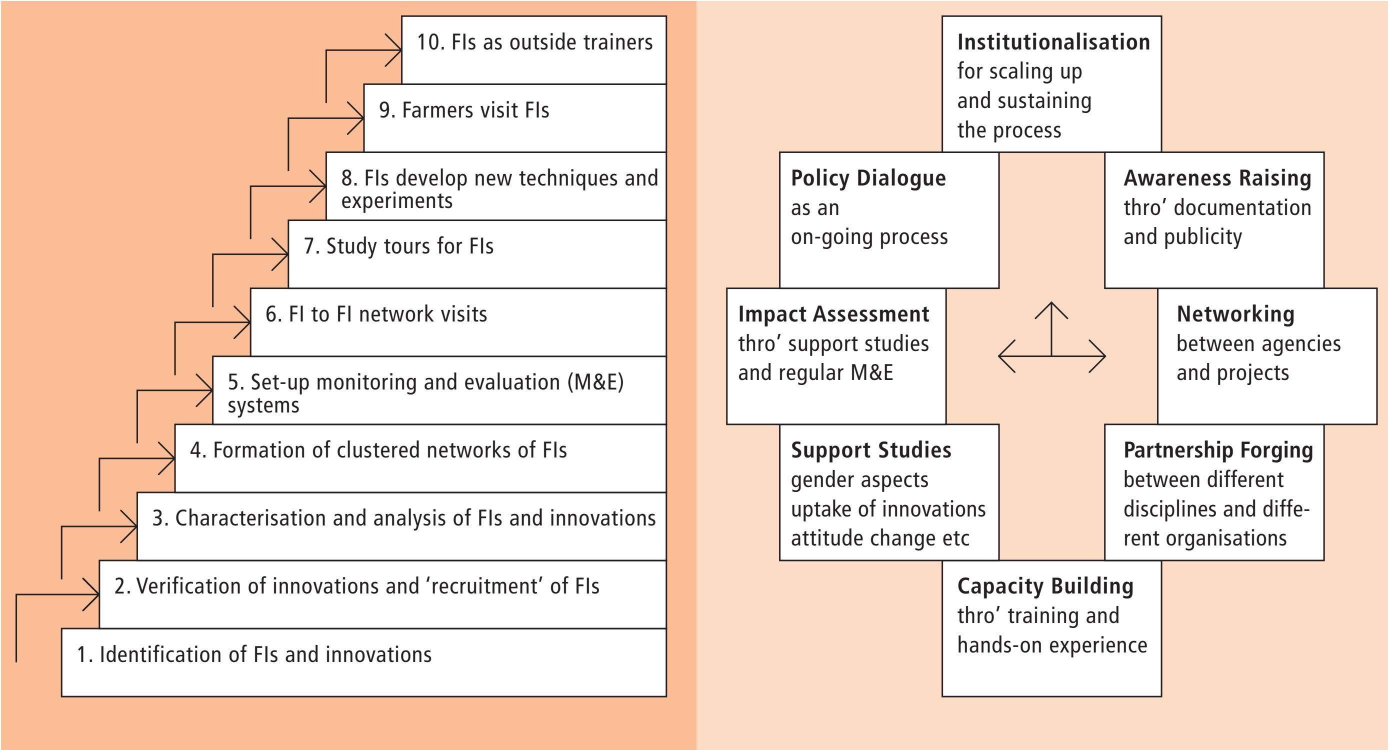
| | |
|---|---|
| International agency | 60% |
| National government | 20% |
| Community/local | 20% |
| | 100% |

**Decisions on choice of the technology:** 'Best –bet' technologies chosen by extension agents/researchers based on the selection of innovative farmers' technologies identified in the field – but the farmers choose (develop) which technology to implement.
**Decisions on method of implementing the technology:** Made by land users alone.
**Approach designed by:** International specialists interacting with national specialists.

**Community involvement**

| Phase | Involvement | Activities |
|---|---|---|
| Initiation | passive/interactive | interviews/Participatory Rural Appraisals etc |
| Planning | passive/interactive | interviews/Participatory Rural Appraisals etc |
| Implementation | interactive | farmer-to-farmer exchange |
| Monitoring/evaluation | interactive | monitoring, using forms designed mainly by specialists |
| Research | interactive | on-farm |

**Differences in participation between men and women:** Moderate difference: men have tended to 'volunteer' themselves as innovators and to ignore their wives. This led to (1) gender studies within the project in each country and (2) gender sensitisation and training workshops for extension staff and farmers alike which helped to overcome the problem (see 'constraints addressed' section).




**Farmer innovation methodology**
**left:** Field activities: the ten steps– from identification through to using innovators as trainers. (Critchley, 2000)
**right:** Programme development processes: the framework of a farmer innovation programme. (Critchley, 2000)
FI: Farmer Innovator, M&E: Monitoring and Evaluation

## Extension and promotion

**Training:** Staff seconded from Ministries of Agriculture/NGOs provide: (1) methodology training for participating staff (2) presentational skill training for farmer innovators and (3) training in gender aspects. Training has proved very effective – partially because it was provided on a 'response to need' basis and not predetermined.
**Extension:** There are new roles for government/NGO extension staff under this methodology - as trainers and facilitators. Substantive extension work is carried out by the innovators themselves, through (a) other farmers visiting their plots/homes (b) the innovators going outside to act as trainers themselves, either to individual farmers or to train groups as happens under PFI Kenya, through FAO supported 'farmer field schools'. Farmer-to-farmer extension has been a main strength of the programme.
**Research:** Theoretically, researchers should respond to the farmers' research agenda, though this has proved difficult to achieve in practice. Apart from process monitoring of the methodology, which has led to improvements, technical research into the innovations has been relatively weak.
**Importance of land user rights:** Farmers will only invest time and effort in innovation when they have secure land use rights (though not necessarily ownership), which is the case in all the areas where PFI has been operational.

## Incentives

**Labour:** All labour involved in the implementation of innovations is voluntary – done by the farmers themselves.
**Inputs:** Meals are provided during field days/exchange visits, and farmers often are given or collecting themselves planting materials from the locations they visit.
**Credit:** None is provided under this approach.
**Support to local institutions:** Support to institutions has been moderate: it has mainly taken the form of transporting existing groups (for example women's groups/church groups) to learn from farmer innovators.
**Long-term impact of incentives:** There are expected to be none because no incentives have been used, apart from small allowances given when farmers are on outside study tours.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Bio-physical | regular observations by farmers and some measurements by researchers (soils, moisture etc) |
| Technical | regular observations by farmers and some measurements by researchers (inputs etc) |
| Socio-cultural | ad hoc measurements (eg number of men/women participating) |
| Economic/production | regular observations by farmers and some measurements by researchers (yields) |
| Area treated | ad hoc estimations |
| No. of land users involved | ad hoc impact assessment exercises |
| Management of approach | none |

**Changes as result of monitoring and evaluation:** Some changes, for example (a) increased numbers of women identified as innovators in response to gender sensitisation/training and (b) 'rotation' of farmer innovators used for training – that is not using the same farmers all the time, as this can create envy.
**Improved soil and water management:** Considerable local adoption of innovative SWC/land husbandry measures, all of which lead to improved production and conservation.
**Adoption of the approach by other projects/land users:** There are examples in each of the three countries of Government and NGOs adopting at least certain elements of the approach: for example it is cited in the project document for Kenya's National Agricultural and Livestock Extension Programme (NALEP). UNDP has joined hands with FAO in Kenya to set up a joint 'PFI-Farmer Field School' project.
**Sustainability:** There are examples of spontaneous voluntary continuation of farmer innovator groups in all three countries – but on a reduced level after initial project support ended.

## Concluding statements

| Strengths and ➜ how to sustain/improve | Weaknesses and ➜ how to overcome |
|---|---|
| Builds on local ideas ➜ Continue the approach and institutionalise. | Dependent on individual commitment and flexibility ➜ Training in skills and methodologies. |
| Revitalises the extension service ➜ Train and make use of existing Government extension agents. | Does not follow the conventional institutional chain of command ➜ Considerable training in skills and methodologies required. |
| Is attractive to stakeholders at all levels ➜ Involve and inform stakeholders at all levels of plans and progress. | Sometime confers too much prestige on a particular group of 'favoured farmers' ➜ 'Rotate' farmers who are the focus of attention. |
| Gives land users more confidence in their own abilities ➜ Continue to prioritise farmers and keep them at centre of activities. | Researchers reluctant to respond to farmers' agenda ➜ Effort needed to convince research staff of the need for, and potential benefits from, joint research with farmers. |
| Offers new locally tested ideas/technologies which work ➜ Keep the focus on the farmers' initiatives and use participatory technology development processes to improve these technologies. | |

**Key reference(s):** Critchley WRS (2000) Inquiry, Initiatives and Inventiveness: Farmer Innovators in East Africa. *Phs Chem Earth (B),* Vol 25, no 3, pp 285–288 ▪ Mutunga K and Critchley W (2001) *Farmers' initiatives in land husbandry.* Regional Land Management Unit, Nairobi, Kenya ▪ Critchley W and Mutunga K (2003) Local innovation in a global context: documenting farmer initiatives in land husbandry through WOCAT. *Land Degradation and Development* (14) pp 143–162
**Contact person(s):** Kithinji Mutunga, Ministry of Agriculture, Nairobi, Kenya; Kithinji.Mutunga@fao.org

**left:** A two-year old, well established NVS on a 35% slope: the NVS here have developed into forward sloping terraces. Note that contour ploughing is practiced between the strips. (Agustin Mercado, Jr)
**right:** These recently established NVS are clearly laid out along the contour. (Bony de la Cruz)

# Natural vegetative strips

Philippines

**Within individual cropland plots, strips of land are marked out on the contour and left unploughed in order to form permanent, cross-slope barriers of naturally established grasses and herbs.**

Natural vegetative strips (NVS) are narrow live barriers comprising naturally occurring grasses and herbs. Contour lines are laid out with an A-frame or through the 'cow's back method' (a cow is used to walk across the slope: it tends to follow the contour and this is confirmed when its back is seen to be level). The contours are then pegged to serve as an initial guide to ploughing. The 0.3–0.5 m wide strips are left unploughed to allow vegetation to establish. Runoff flowing down the slope during intense rain is slowed, and infiltrates when it reaches the vegetative strips. Eroded soil collects on and above the strips and natural terraces form over time. This levelling is assisted by ploughing along the contour between the NVS – through 'tillage erosion' – which also moves soil downslope.

The vegetation on the established NVS needs to be cut back to a height of 5–10 cm: once before planting a crop, and once or twice during the cropping period. The cut material can be incorporated during land preparation, applied to the cropping area as mulch, or used as fodder. This depends on whether the farmer has livestock or not, on personal preference, and on the time of cutting. If the grass is applied as mulch or incorporated, the technology can be considered to be an agronomic, as well as a vegetative, measure.

NVS constitutes a low-cost technique because no planting material is required and only minimal labour is necessary for establishment and maintenance. Some farmers had already practiced the technology for several years before the intervention of the ICRAF (The World Agroforestry Centre) in 1993. ICRAF came to realise that farmers here preferred NVS to the recommended 'contour barrier hedgerows' of multipurpose trees – which land users viewed as being too labour intensive. When farmers became organised into 'Landcare' groups, NVS began to gain wide acceptance.

Land users appreciate the technique because it effectively controls soil erosion and prevents loss (through surface runoff) of fertilizers applied to the crop. As an option, some farmers plant fruit and timber trees, bananas or pineapples on or above the NVS. This may be during establishment of the contour lines, or later. The trees and other cash perennials provide an additional source of income, at the cost of some shading of the adjacent annual crops.



**Location:** Misamis Oriental and Bukidnon, Philippines
**Technology area:** 110 km$^2$
**SWC measure:** vegetative
**Land use:** cropland
**Climate:** humid
**WOCAT database reference:** QT PHI03
**Related approach:** Landcare, QA PHI04
**Compiled by:** Jose Rondal, Quezon City, Philippines & Agustin Mercado, Jr, Claveria, Misamis Oriental, Philippines
**Date:** October 1999, updated June 2004

**Editors' comments:** Contour grass strips within cropland can be found worldwide: the difference in this example is that the grass/herb mixture isn't planted – hence the name. Natural vegetative strips are also preferred here to 'contour barrier hedgerows' of densely planted multipurpose trees – a research recommendation that farmers view as too labour demanding.

## Classification

### Land use problems

Loss of topsoil through sheet erosion and rills, leading to rapid soil fertility decline. In turn soil fertility decline results in the need for increasing levels of fertilizer inputs to maintain crop yield. However, these fertilizers are often washed away by surface runoff – a vicious circle.

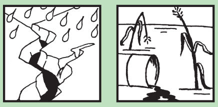
**Land use**

annual crops: maize, vegetables

**Climate**

humid

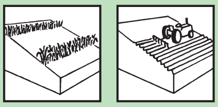
**Degradation**



water erosion: loss of topsoil, gully

chemical: fertility decline

**SWC measures**



vegetative: narrow grass barriers

agronomic: contour plough, mulching (supp.)

**Technical function/impact**

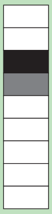
**main:**
- control of dispersed runoff
- reduction of slope angle
- reduction of slope length

**secondary:**
- increase of infiltration
- increase in soil fertility
- improvement of ground cover

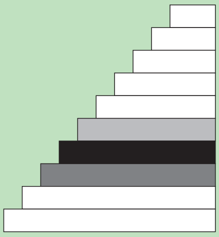
## Environment

### Natural environment

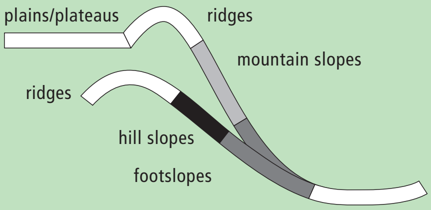
**Average annual rainfall (mm)**



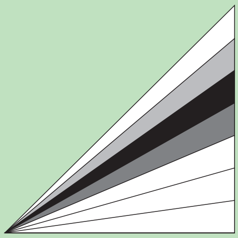

**Altitude (m a.s.l.)**



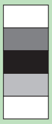

**Landform**




**Slope (%)**




**Soil depth (cm)**



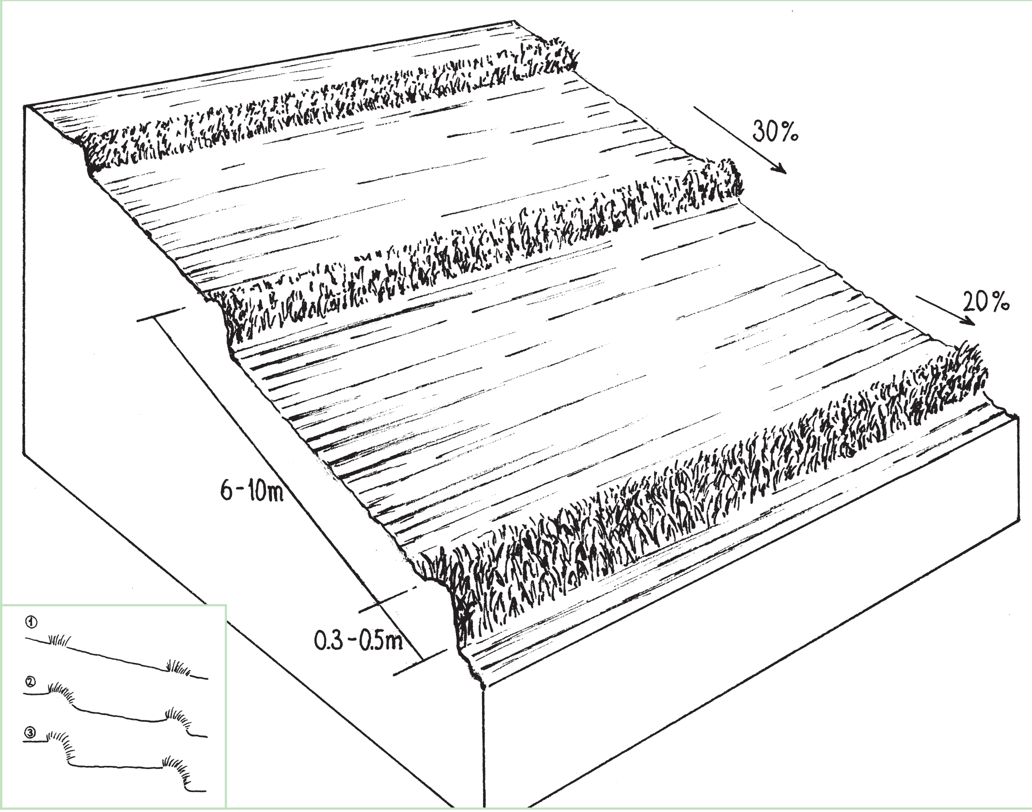

NB: soil properties before SWC

**Growing season:** 240 days, (May to December)
**Soil fertility:** mostly low, strongly acid and with high P fixing capacity
**Soil texture:** mostly medium (loam), some fine (clay)
**Surface stoniness:** mostly no stone, partly stony
**Topsoil organic matter:** mostly low (<1%), partly medium (1–3%), rapid organic matter mineralisation due to high temperature
**Soil drainage:** generally good except in depressions
**Soil erodibility:** medium to high

### Human environment

**Cropland per household (ha)**


**Land use rights:** mainly individual, partly leased
**Land ownership:** mainly individual titled, partly individual not titled
**Market orientation:** mixed (subsistence and commercial)
**Level of technical knowledge required:** field staff/extension worker: moderate, land user: moderate
**Importance of off-farm income:** 10–50% of all income: carpentry, trade, business, labour for neighbouring farms with intensive agricultural activities (eg vegetable production)




**Technical drawing**
Spacing of natural vegetative strips depends on the slope. The insert shows the evolution of terraces over time through tillage and soil erosion, leading to accumulation of sediment behind the strips (steps 1–3).

## Implementation activities, inputs and costs

### Establishment activities

1. Layout of contours with the use of an A-frame (or cow's back method: see description) during the dry season before land preparation, placing wooden pegs along the contours.
2. Initial ploughing along the contour: leaving unploughed strips.

Duration of establishment: 1 year

### Establishment inputs and costs per ha

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (5 person days) | 15 | 100% |
| Equipment | | |
| - Animal traction (32 hours) | 40 | 100% |
| - Tools (2): Plough and harrow | 25 | 100% |
| - Stakes (pegs) | 4 | 100% |
| **TOTAL** | **84** | **100%** |

### Maintenance/recurrent activities

1. Slashing grass by manual labour using machete (twice per cropping season; two cropping seasons per year).
2. Spreading the cut materials evenly in the alleys (between strips) as mulch and/or use as fodder for livestock.
3. Ploughing mulch into the soil during normal land cultivation.

### Maintenance/recurrent inputs and costs per ha per year

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (12 person days) | 36 | 100% |
| **TOTAL** | **36** | **100%** |

**Remarks:** Costs of establishing contours and maintenance by slashing are calculated by total length of NVS. This example is from a typical field with an 18% slope: at an NVS spacing of 5 m, the approximate total linear distance for one hectare is 2,000 m. In this example, the farmer has paid for everything him/herself (see section on acceptance/adoption). Note that the establishment cost is more or less equivalent to the cost of standard land preparation by ploughing. When 'enrichment planting' of the strips is carried out, extra cost for seedlings (of fruit trees for example) and associated labour for planting are incurred.

## Assessment

**Acceptance/adoption:**
50% of the land users (2,000 families out of 4,000) who implemented the technology did so without incentives. The other 50% (a further 2,000) received free crop seeds, breeding animals (eg heifers or just simply technical assistance (eg laying out of contours). All are marginal farmers, who adopted NVS because of its cheapness, ease of maintenance and for environmental protection. A factor that helped was the formation of Landcare associations which have benefited their members in various ways. Non-landowners have not implemented the technology due to insecurity of tenure. There is a strong trend towards spontaneous adoption, especially where Landcare associations are in operation.

**Benefits/costs according to land user**

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | positive | very positive |
| maintenance/recurrent | positive | very positive |

**Impacts of the technology**

**Production and socio-economic benefits**

| | |
|---|---|
| +++ | fodder production/quality increase (or biomass as mulch) |
| +++ | very low inputs required |
| ++ | farm income increase |
| + | crop yield increase |

**Production and socio-economic disadvantages**

| | |
|---|---|
| – | pest sanctuary |
| – | crop area loss, before NVS can evolve to fodder grasses |
| – | hinders some farm operations |

**Socio-cultural benefits**

| | |
|---|---|
| +++ | improved knowledge SWC/erosion |
| ++ | community institution strengthening |
| ++ | national institution strengthening (government line agencies and educational institutions) |

**Socio-cultural disadvantages**

none

**Ecological benefits**

| | |
|---|---|
| +++ | soil cover improvement |
| +++ | soil loss reduction |
| +++ | soil structure improvement |
| + | increase in soil moisture |
| + | increase in soil fertility |
| + | biodiversity enhancement |

**Ecological disadvantages**

| | |
|---|---|
| ––– | weed infestation due to seed dispersion and grass roots spreading from the NVS to nearby areas (especially with *cogon* grass: *Imperata cylindrica)* |

**Off-site benefits**

| | |
|---|---|
| ++ | reduced river pollution |
| + | reduced downstream flooding |
| + | increased stream flow in dry season |

**Off-site disadvantages**

none

## Concluding statements

**Strengths and ➜ how to sustain/improve**

Easy to establish and maintain ➜ Strengthen farmers associations. Intensify information and education campaign.

Little competition with crops for space, sunlight, moisture and nutrient ➜ Ensure continued regular trimming of vegetative strips and use of these as fodder or mulch.

Low requirement of labour and external inputs ➜ Use only naturally growing grass species.

Effective in reducing soil erosion (by up to 90%) ➜ Adopt other supportive technologies like mulching, zero tillage/minimum tillage, etc.

**Weaknesses and ➜ how to overcome**

Effect on yield and income is not readily felt, since reduced erosion is not easily translated into increased income or yield ➜ Farmers should have supplementary sources of income (eg livestock). Education about what long-term sustainability means.

Reduction of productive area by approx 10% ➜ Optimum fertilization to offset production loss. Nutrients are conserved under NVS and this will result in the reduction of fertilizer requirement after some years.

Creation of a fertility gradient within the alley (soil is lost from the top of the alley and accumulates above the NVS where fertility then concentrates) ➜ Increased application of fertilizer on the upper part of alley.

Overall increase of production value is low ➜ Land users could ask for subsidy/assistance from Government: eg for fertilizers, establishment of nurseries, free seedlings (for higher value fruit trees).

**Key reference(s):** Garrity DP, Stark M and Mercado Jr A (2004) Natural Vegetative Strips: a bioengineering innovation to help transform smallholder conservation. pp 263–270 in Barker DH, Watson AJ, Sombatpanit S, Northcutt B and Maglinao AR *Ground and Water Bioengineering for Erosion Control and Slope Stabilisation.* Science Publishers inc. Enfield, USA ■ Stark M, Itumay J and Nulla S (2003) *Assessment of Natural Vegetative Contour Strips for Soil Conservation on Shallow Calcareous Soil in the Central Philippines.* World Agroforestry Centre (ICRAF), Nairobi, Kenya
**Contact person(s):** Jose Rondal, Bureau of Soils and Water Management, Diliman, Quezon City, Philippines, joserondal@yahoo.com ■ Agustin Mercado, Jr, ICRAF – Claveria Research Site, MOSCAT Campus 9004, Claveria, Misamis Oriental, Philippines, agustin9146@yahoo.com, ICRAF-Philippines@cgiar.org

**left:** Farmer sharing the technology with his fellow land users. (Agustin Mercado, Jr)
**right:** Cutting the natural vegetative strips during maintenance. The cut material may be spread as mulch before being ploughed under to enhance soil organic matter. (Agustin Mercado, Jr)

# Landcare

Philippines – *Claveria Landcare Association (CLCA)*

**Associations that help diffuse, at low cost, soil and water conservation technologies among upland farmers to generate income while conserving natural resources.**

In parts of the Philippines, farmers who are interested in learning and sharing knowledge about sustainable land management and new SWC measures organise themselves into the so-called 'Landcare' associations. These self-help groups are a vehicle for knowledge exchange, training and dissemination of SWC technologies. A main objective is the empowerment of farmers' groups in their efforts to improve their livelihoods as well as the environment.

Landcare has three components and aims at strengthening collaboration between those: (1) grassroot farmers' organisations (Landcare organisations); (2) technical facilitators, for example the World Agroforestry Centre (formerly the International Centre for Research in Agroforestry: ICRAF) and government and academic agencies and (3) Local Government Units (LGUs).

The Landcare associations are structured as municipal groups, village groups *(barangay* level or affiliate peoples' organisations), and village sub-groups *(sitio* or *purok level).* This ensures effective dissemination of technologies from the municipal level down to the smallest village. To give the associations a legal status, they are registered with the Securities and Exchange Commission (SEC). Landcare associations conduct regular monthly meetings to promote exchange of information, ideas, and experience, thus promoting spread of SWC technologies. Extension service is carried out through the Local Government Units, which allocate 20% of their development funds for Landcare related activities such as meetings, training and visits, and nursery establishment. Farmers organised in Landcare groups have better access to technical and financial support for SWC activities from LGUs and other technical facilitators.

LGUs also enact local laws to encourage adoption of SWC technologies, such as giving tax incentives, and Landcare members are given priority access to programmes and financial assistance. Landcare acts as a guarantor against loans. The facilitating agencies provide technical assistance, and also help create an environment of dynamism among Landcare groups. A link is created between Landcare associations and these service providers.

Landcare enhances sharing of labour, builds camaraderie, and encourages group decisions on matters relating to SWC. The approach is spreading rapidly: from the original one association with 25 members in 1996, this increased to 45 groups with over 4,000 members by 1999.



**Location:** Misamis Oriental and Bukidnon, Philippines
**Approach area:** 140 km$^2$
**Land use:** cropland
**Climate:** humid
**WOCAT database reference:** QA PHI04
**Related technology:** Natural vegetative strips (NVS), QT PHI03
**Compiled by:** Agustin Mercado, Jr, Claveria, Misamis Oriental, Philippines
**Date:** October.1999, updated June 2004

**Editors' comments:** The 'Landcare' concept originates from Australia where groups of farmers came together in the 1980s to jointly conserve land for their mutual benefit. Landcare has been modified to the Philippines, and elsewhere, with the same basic principles. This is a case study of how land users within a watershed can organise themselves into self-help groups.

## Problem, objectives and constraints

**Problem**
- lack of appropriate local organisations and institutions
- low adoption of SWC technologies
- financial problems
- food/nutritional insecurity

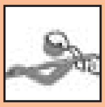
**Objectives**
- organise farmers with common concerns, problems, needs and aspirations into self help groups
- establish farmers' groups as conduits for financial and other support for SWC technologies
- empower farmers' groups in their efforts to improve their livelihoods as well as the environment
- strengthen working linkages between farmers and the LGU, NGOs and technical facilitators
- promote sharing of new technologies, information, ideas and experiences about sustainable agriculture and natural resources management among Landcare groups and members
- facilitate collective efforts in activities – which cannot be carried out at household level (eg communal nurseries)
- assist in the marketing of agroforestry-derived products of the members, and to develop links to studies on agroforestry-based farming

**Constraints addressed**

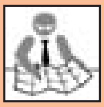
| Major | Specification | Treatment |
|---|---|---|
| Legal | Insecurity of land tenure – since some land is classified as forest land and belongs to the government. | Speed up the land reclassification and land registration program of the Department of Environment and Natural Resources (DENR). |
| Financial | Insufficient capital. | Members of Landcare are recommended to lending institutions for production loans. |
| **Minor** | **Specification** | **Treatment** |
| Technical | Insufficient knowledge by farmers about land and animal husbandry. | Farmer training and cross visits to nearby farmers. |

## Participation and decision making

**Target groups**


Land users


SWC specialists/ extensionists


Planners

**Approach costs met by:**

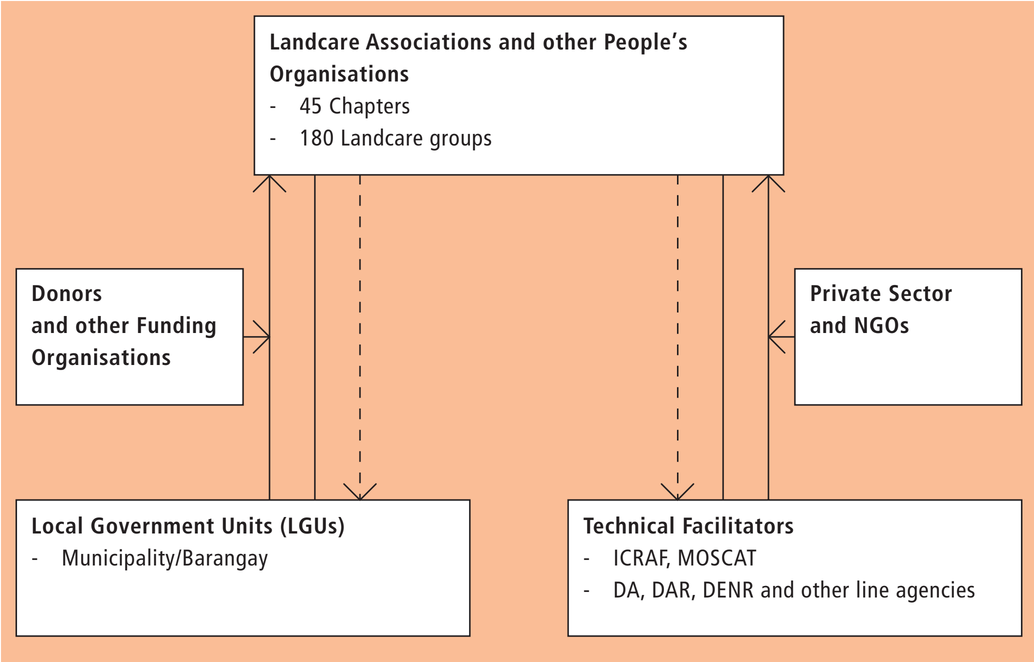
| | |
|---|---|
| International NGOs | 20% |
| Community/local | 80% |
| | 100% |

**Decisions on choice of the technology:** Made by land users supported by SWC specialists.
**Decisions on method of implementing the technology:** Made by land users supported by SWC specialists through the Landcare associations.
**Approach designed by:** National specialists, international specialists and land users. ICRAF facilitated the organisation of farmers. Specialists established the linkage between Landcare and LGUs/NGOs.

**Community involvement**

| | | |
|---|---|---|
| Initiation | self-mobilisation, interactive | public meetings, rapid/participatory rural appraisal, workshops/seminars |
| Planning | interactive | public meetings, rapid/participatory rural appraisal, workshops/seminars |
| Implementation | self-mobilisation | organisation of major and minor activities: coordination of casual labour |
| Monitoring/evaluation | interactive | measurements/observations, public meetings, interviews/questionnaires |
| Research | interactive | on-farm research (supported by LGU, academics, ICRAF) |

**Differences in participation between men and women:** Men attend public meetings and make the major decisions regarding field activities. Women carry out home-related/domestic tasks.




**Organogram**
The diagram demonstrates the collaboration, complementarity, interdependence and synergism between the actors.
Explanations:
→ Support (technical, financial, policy)
- -> Demands, requests, feedback
ICRAF: International Centre for Research in Agroforestry
MOSCAT: Misamis Oriental State College of Agriculture and Technology.
DA: Dept. of Agriculture
DAR: Dept. of Agrarian Reform
DENR: Department of Environment and Natural Resources
(Jose Rondal)

## Extension and promotion

**Training:** Training (by LGU, ICRAF, academics) is given to land users, extension workers/trainers, and SWC specialists (at different levels) in tree nursery establishment and seeding, soil sampling and soil fertility assessment, layout of contours for natural vegetative strips, and pest and disease control in the farm. This has been through on-the-job training, while also using farm visits and specific demonstration areas. The training has generally been effective; in the case of SWC specialists it has been 'excellent'.
**Extension:** The key elements of extension are 'training and visit', formation of Landcare groups and technical backstopping to these groups. Some farmers are trained and used as extension agents, especially for layout of contour lines. The extension service of the government is now carried out through the LGUs. Its functioning is adequate, but most of the staff tend to be poorly motivated and are lacking in direction. Planning is still 'top-down' from national/regional level. Activities and projects are target driven and set by the national/regional office. The effectiveness of extension on farm management, however, is good.
**Research:** On-farm research on sociology and technology is an important part of the overall approach. ICRAF has been conducting research in the area on SWC for more than ten years. This includes understanding the biophysical and socio-economic factors that influence adoption or non-adoption of SWC technologies. The effectiveness of the applied research is considerable. Research results are fed back to the Landcare groups to meet their needs. Farmers accept or reject technologies on the basis of joint evaluation.
**Importance of land use rights:** Ownership rights have helped implementation of the approach. Land tenure is still an important factor in adoption of SWC technology.

## Incentives

**Labour:** There has been no payment for the labour involved in SWC activities under the approach. Voluntary labour by land users includes that for land preparation, laying out contours and maintenance of contour strips.
**Inputs:** Coffee and tree seedlings, seeds and fertilizers and breeding animals have been provided to some farmers.
**Credit:** There has been no credit provided directly for SWC activities (some land users may have obtained credit but not directly for SWC activities, although SWC practitioners were given preference for loans for fertilizers, seeds – see comment below).
**Support to local institutions:** Landcare is very supportive to local institutions, and to SWC activities in general. The local government enacts laws to support SWC implementation. Among the incentives are endorsement to lending institutions for production loans, tax credit and, in some cases, the provision of seeds, fertilizer and breeding animals to the land users.
**Long-term impact of incentives:** The impact of incentives has still to be reviewed and evaluated. Although incentives certainly hasten the adoption of SWC technologies, in some cases interest is not sustained once these incentives are discontinued. There should perhaps be some system of preferential assistance to those who adopt technologies without incentives.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Bio-physical | regular observations of improvement in crop yield |
| No. of land users involved | regular measurements of numbers of groups and farmers under Landcare |

## Impacts of the approach

**Changes as result of monitoring and evaluation:** There have been no significant changes in the approach itself due to monitoring and evaluation.

**Improved soil and water management:** The approach has greatly helped land users in the implementation of soil and water management technologies. Farmers now adopt 'natural vegetative strips' (NVS). Large farms (> 3 ha) have generally evolved into commercial production of tree crops (coffee) and trees (timber).

**Adoption of the approach by other projects/land users:** Many other NGOs, local government units (LGUs) and line agencies have adopted – and further adapted – the Landcare approach in their respective areas. The approach has been proven effective and it is now being looked upon as a model for the implementation of SWC and other related activities, particularly in Mindanao.

**Sustainability:** Landcare has become an integral part of civil organisation. It is characterised by a triangular relationship between grass-roots organisations (farmers), local government units (LGUs), and technical facilitators. The financial resources required for this approach are embedded in the regular budget of the municipality or *barangay.* The LGUs (politicians) consider Landcare groups as political voting blocks: if they are to stay in politics, they are obliged to sustain Landcare. The Landcare groups have learnt to demand technical backstopping, financial support and policy support from line agencies such as the Department of Agriculture, Department of Environment and Natural Resources – and LGUs.

## Concluding statements

| Strengths and ➜ how to sustain/improve |
|---|
| Promotes rapid adoption of SWC technologies. Provides easy and fast access/implementation of SWC technologies ➜ Encourage meetings and cross-visits between Landcare groups to share knowledge, ideas and experience. Encourage Landcare members to participate in information and education campaigns. |
| Encourages farmers to gain access to services and financial support from LGU, technical facilitators and service providers ➜ Promote strong leadership among Landcare groups. Encourage Landcare groups to be very open in requesting financial and technical assistance. |
| Provides a vehicle for participatory research and technical interventions and ensures that newly-developed technologies are appropriate ➜ Encourage expression of needs by different Landcare groups. |
| Makes extension activities cost-effective ➜ Encourage farmer-to-farmer transfer of technology. LGUs to share the cost of technology transfer. |
| Ensures sustainability of actions ➜ Continue to strengthen Landcare groups. Develop leadership skills. |
| Promotes social integration and addresses other social issues which are beyond individual household capacity to solve (burials, weddings, etc) ➜ Encourage regular meeting and conduct activities to enhance social integration. |
| Makes farm work easier ➜ Encourage workgroups. |

| Weaknesses and ➜ how to overcome |
|---|
| Over-emphasis of political patronage by some LGUs alienates people of different orientation/background ➜ Encourage more transparent government at LGU and particularly at barangay level. |
| Some farmers join Landcare expecting handouts or grants ➜ Project objectives and strategies should be explicitly explained to farmers. |
| Lack of leadership and organisation skills of some Landcare leaders, who are unable to guide groups into cohesive, dynamic organisation. It takes time to get consensus and to make them work together ➜ Landcare group leaders need to be better trained in leadership skills group facilitation and participation. |
| Over-reliance on ICRAF for technical innovation ➜ Encourage farmers to conduct farmer level experimentation. |
| Participation entails time away from farm work ➜ Meetings and discussions should be scheduled during evenings or holidays. |
| Individual problems not easily addressed, as few members are frank and open ➜ Encourage everybody to share their problems and concerns. |

**Key reference(s):** Mercado Jr A, Patindol M and Garrity DP (2001) The Landcare experience in the Philippines: technical and institutional innovations for conservation farming. *Development in Practice,* Vol. 11, No. 4

**Contact person(s):** Agustin Mercado, Jr, ICRAF – Claveria Research Site, MOSCAT Campus 9004, Claveria, Misamis Oriental, Philippines, agustin9146@yahoo.com, ICRAF-Philippines@cgiar.org

**left:** Green cover in a vineyard with rows oriented up and down the slope, Twann, Lake Biel, Switzerland. (Nicole Güdel)
**right:** Details of a vineyard: every second row freshly ripped, leaving rich plant diversity in the rows between – which supplies pollen for beneficial insects. May, Twann, Lake Biel, Switzerland. (Nicole Güdel)

# Green cover in vineyards

Switzerland – *Begrünung auf Rebflächen*

**Naturally growing or sown perennial grasses/herbs providing cover between rows in sloping vineyards, where the vines are usually oriented up and down slope.**

The area around Lake Biel has a strong wine growing tradition dating back several centuries. The vineyards are, for micro-climatic reasons, sited on the south-west facing slope close to the lake. Annual rainfall is about 1,000 mm, with at least one erosive storm per year, and the soils are highly erodible. In conventional viniculture all weeds are controlled chemically. The 'green cover technology' comprises sown, or naturally occurring, perennial grasses and herbs which form a biodiverse green cover – a 'living mulch' – over the soil surface between vine rows. In this region, rows are generally oriented up and down the slope for ease of machine operation. Green cover may also be applied where vines are grown on narrow bench terraces. The purpose is the prevention of soil degradation, especially soil erosion by water. Secondary purposes include protection of the soil surface from compaction when using mechanised equipment, and promotion of biodiversity.

Green cover is generally established naturally – except on contour-planted terraced vineyards, where cover is planted for immediate stabilisation of the terraces. To avoid competition, a 10–40 cm diameter zone around the freshly planted vines is kept free from vegetation: during the three year establishment period it is removed by hoe, later it is controlled with herbicides (either as a strip along vine rows or around individual vines). The topsoil between the vine rows is ripped every few years with an implement pulled by a small caterpillar tractor. The green cover vegetation is cut, chopped and left as mulch several times using special mulching machines. These operations are not carried out over the whole field at once: alternate rows are left untouched to ensure that some vegetation remains to maintain biodiversity. When these rows redevelop their green cover, the others are then treated. This is effectively a minimum tillage system, building up organic matter in the soil. Cutting and mulching, in addition to ripping, serves to circulate nutrients. Mineral fertilizer and herbicides are applied once a year around the vines. Experiments with the technology started in the 1970s, but green cover has now become standard practice.

Supportive measures include not removing crop residues (from vineyards) which are chopped later – simultaneously with the cover crop (grass) – to protect the soil surface, and irrigation in dry years.



**Location:** Region around Lake Biel, Canton of Berne, Switzerland
**Technology area:** 2 km$^2$
**SWC measure:** vegetative and agronomic
**Land use:** cropland
**Climate:** subhumid
**WOCAT database reference:** QT SWI01
**Related approach:** Farmer initiative within enabling environment, QA SWI01
**Compiled by:** Nicole Güdel, Berne, Switzerland
**Date:** October 2003, updated September 2004

**Editors' comments:** Green cover is very widespread in Swiss vineyards, covering approximately 60% of the total 15,000 ha. Such green cover of grasses and herbs is common also in Germany, France and Italy – except in dry regions. Biodiversity is enhanced, amongst other environmental benefits. This is a case study from a single village, where it started in the 1970s and is now the accepted practice.

## Classification

### Land use problems

The main problem was decreasing soil fertility, especially through soil erosion by water, caused by lack of soil cover and intensive cultivation. There were associated negative offsite effects including sand/sediment deposition and contamination of groundwater by nutrients. This became a serious problem from the 1960s when the traditional labour-intensive methods were superseded by a mechanised-industrial agricultural system.

**Land use**

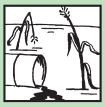
perennial crops: grapevines (vineyards)

**Climate**

subhumid

**Degradation**

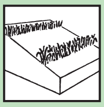
water erosion: loss of topsoil,



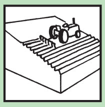
chemical: declined fertility/ organic matter, soil pollution

off-site degradation effects

**SWC measures**



vegetative: cover cropping (natural occur. grasses/herbs)



agronomic: minimum tillage: cutting & mulching, ripping

**Technical function/impact**

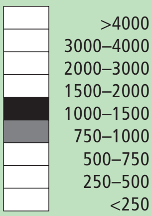
**main:**
- improvement of ground cover
- control of raindrop splash
- improvement of soil structure
- control of dispersed runoff

**secondary:**
- increase of surface roughness
- increase of infiltration
- increase/maintain water stored in soil
- increase in organic matter
- increase in soil fertility

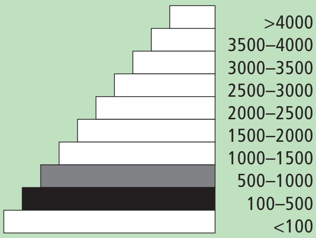
## Environment

### Natural environment

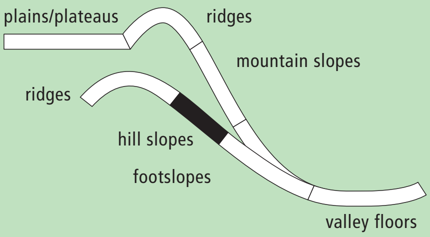
**Average annual rainfall (mm)**



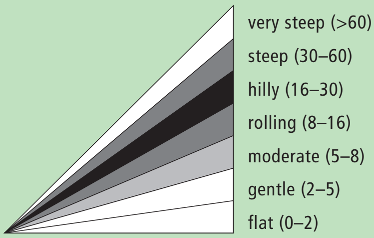

**Altitude (m a.s.l.)**



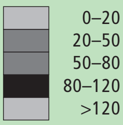

**Landform**




**Slope (%)**




**Soil depth (cm)**

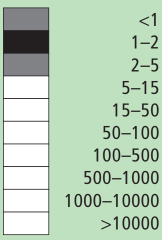



NB: soil properties before SWC

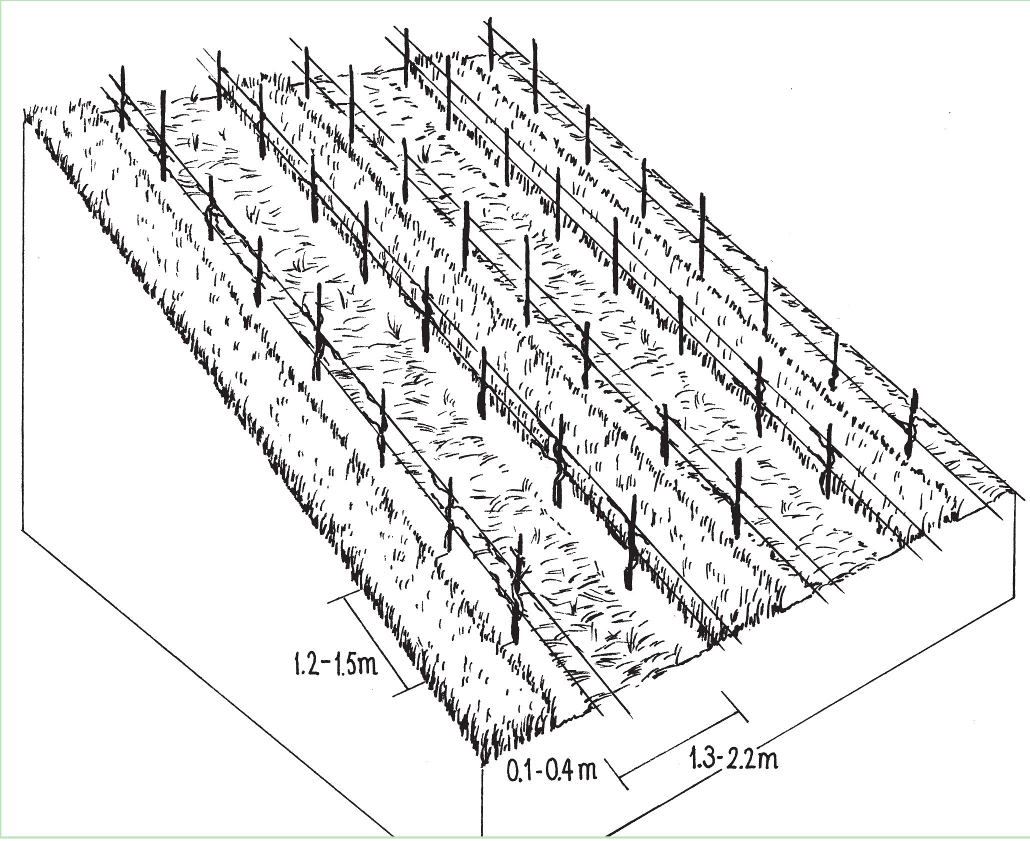
**Growing season:** 210 days (April to October)
**Soil fertility:** medium
**Soil texture:** medium (loam)
**Surface stoniness:** some loose stone
**Topsoil organic matter:** medium (1–3%)
**Soil drainage:** mostly good, partly medium
**Soil erodibility:** high

### Human environment

**Cropland per household (ha)**




**Land use rights:** mostly individual, partly leased
**Land ownership:** individual titled
**Market orientation:** commercial (market)
**Level of technical knowledge required:** field staff/extension worker: moderate, land user: moderate
**Importance of off-farm income:** mostly <10%, partly 10–50% of all income: some of the farmers grow vines alongside a salaried off-farm job




**Technical drawing**
Vineyard planted up-and-down the slope: ground protection is provided by the alternate strips of green cover and mulch.

## Implementation activities, inputs and costs

### Establishment activities

1. Allow natural cover to establish.
2. Weeding around base of vines to reduce competition, 2–4 times during growing season. Done manually, using a hoe, since young grapes are sensitive to chemicals.
3. Apply mineral fertilizer to the vines (particularly K, N, P, Mg) by hand at the beginning of the growing season (April, May).
4. Cut cover vegetation with a portable motor scythe or mower with tracked vehicle and leave in situ as mulch during growing season: 2–4 times.

Duration of establishment: 3 years (steps 2 to 4 are repeated each year; the total establishment costs thus represent the sum of the average annual costs in the first 3 years)

### Establishment inputs and costs per ha

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour | 13,800 | 100% |
| Equipment | | |
| - Machine hours | 1000 | 100% |
| - Tools | n/a | 100% |
| Agricultural | | |
| - Fertilizers | 200 | 100% |
| - Biocides | 0 | |
| - Naturally occuring seeds of cover vegetation | 0 | |
| **TOTAL** | **15,000** | **100%** |

### Maintenance/recurrent activities

1. Minimum tillage (rip topsoil) of alternating inter-rows with machine in May/early June. Each inter-row is treated every few years.
2. Cut/mulch cover vegetation with machine during season 2–4 times. Cut/chop vine leaves and wood for mulching.
3. Apply mineral fertilizer to the vines (particularly K, N, P, Mg) by hand in April/May: once a year.
4. Apply herbicides (Glyphosate) around vines. Either done manually (knapsack sprayer) or by machine (biocide tank transported by tracked vehicle). Applied once beginning of season (May), and if necessary a second time in August/September.

### Maintenance/recurrent inputs and costs per ha per year

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (8.5 person days) | 1,500 | 100% |
| Equipment | | |
| - Machine hours | 650 | 100% |
| Agricultural | | |
| - Fertilizers (70–120 kg) | 60 | 100% |
| - Biocides | 90 | 100% |
| **TOTAL** | **2,300** | **100%** |

**Remarks:** Costs are calculated on the basis of vine rows being oriented up and down the slope, a distance between rows of 1.3–2.2 m and 6,500 vines per ha on a slope of <60%. Establishment costs have been estimated and are representative of the situation when green cover is encouraged to establish at the same time as new vines are planted (normal practice). This means that the estimated costs include all the annual agronomic and vegetative inputs within the first 3 years during the establishment phase. If green cover is implemented more than 3 years after planting new vines, establishment costs are much reduced, because the vines are bigger, competition with the green cover is less, and the vines are not so sensitive to herbicides, which permits the replacement of labour intensive manual weeding by application of herbicides. Maintenance costs are based on one typical winegrower in the region. Initial investments in machinery and costs directly attributable to 'plant capital' (the vines) are not included. Labour is the major cost component, since wage levels are very high in Switzerland.

## Assessment

### Acceptance/adoption

Nearly all of the land users have adopted green cover independently of the direct incentives received for growing vines. The spontaneous spread of green cover occurred before these incentives were tied to 'ecological production'. Note: Swiss agriculture in general is highly subsidised (see approach).

### Benefits/costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | negative | positive |
| maintenance/recurrent | positive | positive |

### Impacts of the technology

**Production and socio-economic benefits**

- ++ farm income increase (indirectly due to less erosion damage in the long-term – also due to subsidies related to green cover, marketing under the label of 'ecological agricultural production', and other criteria)

**Socio-cultural benefits**

- ++ green cover/sustainable viniculture as personal satisfaction
- \+ improved knowledge on SWC/erosion
- \+ community institution strengthening
- \+ national institution strengthening (research stations)
- \+ healthier due to less application of biocides

**Ecological benefits**

- +++ soil cover improvement
- +++ soil loss reduction
- +++ increase in soil fertility
- +++ biodiversity enhancement
- +++ improved biological pest control through beneficial animals
- \+ less compaction of soil
- \+ increase in soil moisture
- \+ reduced wind erosion

**Off-site benefits**

- +++ reduced downstream siltation
- +++ reduced transported sediments
- \+ reduced river pollution (and groundwater)
- \+ reduced downstream flooding

**Production and socio-economic disadvantages**

- −− increased input constraints: (special machines required).
- − reduced maximum production capacity (10–20% due to competition for water/nutrients)
- − increased labour constraints (weeding, cutting, ripping)

**Socio-cultural disadvantages**

- − socio-cultural conflicts between generations or between farmers applying green cover and others; traditionally every 'plant-out-of-place' was seen as a weed and fought with a hoe
- − change of landscape and appearance of vineyard – again, different norms of 'how a vineyard should look'

**Ecological disadvantages**

- − competition for water and nutrients (in drier regions and years)
- − undesirable plant species
- − undesirable animal species, especially mice
- − higher susceptibility to fungal decay
- − danger of frost in spring due to transpiration of green cover, especially in plains and depressions

**Off-site disadvantages**

- − transport of seeds (grasses, weeds, etc) to neighbouring areas where it might not be desired)

## Concluding statements

**Strengths and ➜ how to sustain/improve**

Prevention of erosion ➜ Maintain green cover.

Improvement of soil quality (fertility, organic matter, moisture retention, soil structure) ➜ Ensure that cover vegetation doesn't compete with the vines; improve soil properties by applying mentioned agronomic measures.

Contribution to a better balanced and more stable ecosystem (with living space for a wider range of organisms) ➜ Specific management of cover crops (alternating treatment of inter-rows; find solutions to replace application of herbicide).

In the long-term economically beneficial because of cutting costs of restoration of soils and fertility loss after heavy erosion events.

Possibilities of farm income increase through marketing wine under the 'vinatura' label, certifying ecologically produced wine.

Personal satisfaction/challenge for ecologically and economically sustainable viniculture ➜ Promote ecologically sustainable agriculture.

Increased exchange of knowledge and contacts in winegrowers' associations ➜ Sustain/strengthen farmers' institutions.

Improved knowledge/awareness regarding SWC/erosion: among wine-growers, but perhaps also to some extent among consumers (through ecological marketing) or walkers passing by.

**Weaknesses and ➜ how to overcome**

General competition of water and nutrients depending on climate, soil depth and species of cover vegetation ➜ Eliminate/reduce competitive effect of cover vegetation by cutting/mulching vegetation or ripping/ploughing soil.

Application of herbicides around vines because of undesirable vegetation in proximity of vine ➜ Find alternative solutions, or minimise application of herbicides.

**Key reference(s):** Güdel N (2003) *Boden- und Wasserkonservierung in Schweizer Rebbergen. Ein Beispiel im Rahmen von WOCAT.* Unpublished diploma thesis. Centre for Development and Environment (CDE), University of Berne

**Contact person(s)/institution(s):** Nicole Güdel, CDE, University of Berne, 3008 Berne, Switzerland, nguedel@gmx.ch ■ FAW (Federal Research Station for fruit-growing, viniculture and horticulture) www.faw.ch ■ RAC (Federal Research Station for fruit-growing, viniculture and horticulture) www.agroscope.admin.ch/inde.html

**left:** Typical vineyards around Lake Biel: traditional small-scale plots with terraces (upper right) and 'improved' plots, with terraces removed for ease of mechanisation (bottom and left). (Nicole Güdel)
**right:** Winegrower cutting green cover with a portable motor scythe, Ligerz, Lake Biel, Switzerland. (Laila Teutsch)

# Farmer initiative within enabling environment

Switzerland

**Initiative and innovation of land users, stimulated by government's technical and financial support.**

The application of green cover (a 'living mulch' between vine rows) in viniculture within the case study area has been developed and spread, primarily, by experimentation and exchange of knowledge between winegrowers. Individual initiatives and personal contacts have been the most important elements. Other channels are: (1) higher education and specific training courses (the majority of winegrowers have undergone at least 3 years of agricultural college, including both applied and theoretical training); (2) participation in conferences and meetings; (3) self-teaching using the internet and national and international journals or books; and (4) extension services. Disseminated results from national research institutions also play an important role – over and above individual knowledge and experimentation.

The approach is thus characterised by responsiveness of winegrowers to the various information sources listed above. This should be seen in the context of national agricultural policy which provides an 'enabling environment' including payments to farmers: the production quotas of the 1950s were replaced in 2001 by direct grants (subsidies) based on area grown and/or other specific criteria, eg ecological services such as green cover. However, the technology of green cover spread spontaneously before direct incentives were tied to 'ecological production'. Government policy supports agriculture as a weak sector of the national economy, and guarantees, through subsidies, a high percentage of the overall national production. Subsidies in Swiss agriculture are amongst the highest in the world. These subsidies effectively keep wine production going. Vineyards are seen as an important part of the rural cultural heritage and as a characteristic feature of the landscape.

Recently, with this type of production system, there has emerged a further opportunity – to market wine under a label of controlled ecological production ('vinatura'). A step further is the label of 'organic production' which, in addition to green cover, requires a range of other criteria to be strictly fulfilled (eg no use of chemical fertilizers/biocides). Customers are increasingly willing to pay a premium for such products. This is an example of a win-win situation: the environment is protected and simultaneously farmers are rewarded with a higher value for their output.

Within the framework of subsidies to farmers and information availability, the 'approach' to improved viniculture can therefore be viewed as an enabling environment for land users to take initiatives themselves. The diffusion of innovative technologies is also largely left to the land users.



**Location:** Swiss viniculture area, Switzerland
**Approach area:** 150 km$^2$
**Land use:** cropland
**Climate:** subhumid
**WOCAT database reference:** QA SWI01
**Related technology:** Green cover in vineyards, QT SWI01
**Compiled by:** Nicole Güdel, Berne, Switzerland
**Date:** October 2003, updated September 2004

**Editors' comments:** Many developments in Swiss agriculture, ancient and modern, have originated from the initiative and innovation of farmers themselves - and have been spread by them also. This has been facilitated by an 'enabling environment' put in place by national policies. Subsidies are employed deliberately to maintain the aesthetic quality of the countryside.

## Constraints and objectives

**Problem**

- initial technical problem of soil degradation within vineyards: no 'off the shelf' solutions
- slow spread of technical solutions (such as 'green cover' which requires fundamental changes in land users' attitudes)

**Objectives**

The overall objective of national policy is, within a framework of subsidies, to allow farmers to develop and spread solutions themselves through access to sources of knowledge and information. The objectives of the farmers themselves are to improve their production systems through ecologically sound conservation.

**Constraints addressed**

| Major | Specification | Treatment |
|---|---|---|
| Technical | The optimal implementation of green cover strongly depends on specific farm or field situations (infrastructure/equipment/age of vines, planting system etc). | Individual consultation with extension service where specific advice required. |
| Natural environment | Climatic (drought, frost) and pedological (soil depth) factors can hamper the effectiveness of green cover. | Information provided by the various sources mentioned above: many technical variations of the green cover treatment possible. |
| **Minor** | **Specification** | **Treatment** |
| Socio-cultural | In a community of winegrowers who are used to either clean tillage (the traditional method) or chemical weeding, green cover implies a change of values and priorities. This can cause conflicts especially between neighbours and within families. | First, raising awareness of advantages and possible disadvantages of green cover by (further) education, literature, meetings/conferences and internet by research institutions and extension services. The second step is conflict resolution on a one-to-one basis. |

## Participation and decision making

**Target groups**

Land users; SWC specialists/extensionists; Politicians/decision makers; Teachers/school children/students

**Approach costs met by:**

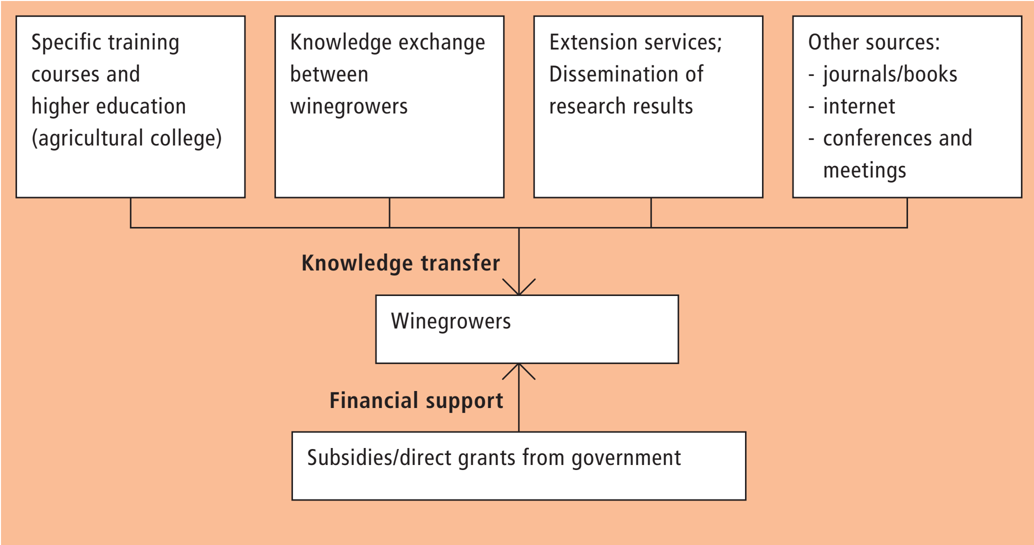
| | |
|---|---|
| National government | 70% |
| Community/local | 30% |
| | 100% |

**Decisions on choice of the technology:** Made by land users alone (land user driven, bottom-up).
**Decisions on method of implementing the technology:** Made by land users alone (land user driven, bottom-up).
**Approach designed by:** Arose spontaneously through land users' initiatives within the national 'enabling environment'.

**Community involvement**

| | | |
|---|---|---|
| Initiation | self-mobilisation | spread of ideas between innovative winegrowers who probably had seen green cover (or other technical developments) elsewhere – or had heard/read about it |
| Planning | interactive | the basic idea was further enhanced by planning based on available information from various sources |
| Implementation | self-mobilisation | responsibility of winegrowers for all steps of technology implementation |
| Monitoring/evaluation | mostly self-mobilisation, partly interactive | observation by land users; some indicators are monitored and evaluated by extension services or research institutions |
| Research | interactive | both on-farm and on-station |

**Differences in participation of men and women:** The integration of women is a key element of the approach. Nevertheless, there are moderate differences due to cultural factors: men are mainly in charge of agricultural activities, whereas women work in the household.




**Enabling environment**
Factors facilitating winegrowers to implement green cover.

## Extension and promotion

**Training:** There are various possibilities which include green cover as one of several topics: (1) agricultural college (three years, including both practical and theoretical knowledge); (2) further education (full time or short courses) at agricultural universities; (3) attendance at regional, national or international meetings/conferences, organised by research institutions, extension services, or regional associations; (4) workshops or farm visits.
**Extension:** Extension of ideas including green cover in vineyards was/is essentially a function of the winegrowers themselves. It comprises informal contact, discussions and observations of different systems under personal trials. In the region of Lake Biel winegrowers often own many small plots scattered over the hills: travelling between them gives the growers the opportunity to get an impression of different winegrowing practices and discuss techniques with neighbours. There is also a government extension service which can be consulted if necessary.
**Research:** Research is an important part of this approach. The topics related to green cover are primarily focused on the management of the vegetative cover. These include aspects such as competition between the cover and the vines, and providing living conditions for animals (especially insects) beneficial to grape production – for example promoting predators for biological pest control.
**Importance of land use rights:** On the one hand it could be said that fragmentation of holdings (owning several small plots) enhances the possibility of learning through observations and discussions while travelling between the holdings (see 'extension' above). On the other hand, the presence of some large parcels allows various trial options such as using different mechanised equipment.

## Incentives

**Labour:** Labour is a substantial input and exclusively carried out voluntarily by land users – though the overall agricultural system is subsidised (see below).
**Inputs:** There are no specific inputs – apart from general financial subsidies to Swiss winegrowers. Since 1992 these incentives in agriculture have been tied to a certain standard of ecological management in the vineyards, including green cover. But in the area of the case study, green cover was established mainly before this date, and can therefore hardly be attributed directly to these financial incentives. The list below shows the different financial incentives in Swiss viniculture, all of them requiring green cover as one component.

| Type of direct payment | Specification | US$/ha/year |
|---|---|---|
| Direct payments independent of slope | | 1,200 |
| Additional direct payments for sloping vineyards (one option of the three) | slopes 30–50% | 1,125 |
| | slopes >50% | 2,250 |
| | vineyards on stone terraces | 3,750 |
| Special additional direct payments for certified organic production | | 900 |

**Credit:** None specifically provided.
**Support to local institutions:** Negligible.
**Long-term impact of incentives:** It should be noted that even though the financial incentives are linked to green cover, in most cases, it would be applied anyway. The adoption should therefore be seen as spontaneous. A positive long-term impact of the general incentives to winegrowers is that, in the long term, green cover is not more expensive – and may be even cheaper – than conventional system or other alternatives. Therefore from an ecological perspective the general incentives lead to a more sustainable use of natural resources (in particular a significant reduction of soil erosion, and improvement in soil fertility). It is clear that Swiss viniculture (as is the case for Swiss agriculture as a whole) would be threatened without subsidies – at least under marginal environmental and economic conditions. Also, the national winegrowing training, extension and research system supports the principle of green cover.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Bio-physical | ad hoc observations (by land users and research stations) and measurements (by research stations); indicators: rate of erosion, organic matter content, soil moisture, water potential in vine leaves (to measure water competition), compaction, soil structure, soil temperature, biodiversity, chemical analysis of wine, nutrient elements (especially nitrogen) in soil and vines |
| Technical | ad hoc observations (by land users and research stations) |
| Socio-cultural | ad hoc observations (by land users and research stations); indicators: change of attitude towards green cover, knowledge about SWC and awareness of natural environment, change of appearance of man-made landscape |
| Economic/production | ad hoc and regular observations (by land users) and measurements (by extension service with data from land users); indicators: costs (per ha), production (kg/ha; l/m$^3$), quality, manual labour, machine hours etc – often data are not specifically gathered for green cover; but total establishment and annual recurrent costs for different winegrowing systems (of which green cover is part) can give some insight into the economic status of green cover |
| Area treated | ad hoc observations; indicators: diffusion of green cover (visual impression of the current status, time-series photos, descriptions from past) |
| No. of land users involved | ad hoc observations and measurements (by Swiss Agency for Statistics); indicators: number of households involved (with a questionnaire, personal estimations, visual impressions): number of farmers receiving direct payments |

## Impacts of the approach

**Changes as result of monitoring and evaluation:** Few changes to the technology or the approach have resulted directly from formal monitoring and evaluation.
**Improved soil and water management:** The approach (with all its elements) has led to greatly improved soil and water management.
**Adoption of the approach by other projects/land users:** As described before the 'enabling environment' for land user innovation and dissemination is typical of Swiss agriculture as a whole.
**Sustainability:** Within the framework of the existing national policies the approach is sustainable.

## Concluding statements

| **Strengths** and ➜ how to sustain/improve | **Weaknesses** and ➜ how to overcome |
|---|---|
| Very bottom-up oriented. The interest, the own initiative and the generation of own experience and knowledge is the dominant motor ➜ Maintain the enabling environment put in place by the government which is the framework for this approach. | Winegrowing as a whole is highly dependent on financial incentives. Without direct payments, continuation of Swiss winegrowing and therefore green cover would be threatened – at least under marginal conditions ➜ Continue the incentive policy (though this may conflict with international efforts to reduce farm subsidies worldwide). |
| Many information sources and ways of receiving information are available and used frequently. | |

**Key reference(s):** Güdel N (2003) *Boden- und Wasserkonservierung in Schweizer Rebbergen. Ein Beispiel im Rahmen von WOCAT.* Unpublished diploma thesis. Centre for Development and Environment, University of Berne
**Contact person(s)/institution(s):** Nicole Güdel, Centre for Development and Environment (CDE), University of Berne, Steigerhubelstrasse 3, 3008 Berne, Switzerland, nguedel@gmx.ch ■ SVBL (Swiss Association for Agricultural Extension): www.lbl.ch/svbl/wer.htm ■ FAW (Federal Research Station for fruit-growing, viniculture and horticulture in Wädenswil) www.faw.ch ■ RAC (Federal Research Station for fruit-growing, viniculture and horticulture in Changins) www.sar.admin.ch/scripts/get.pl?rac+index_e.html+0+90010

**left:** Mature vetiver barriers protect fields of sugar cane, forming 'hedges against erosion'. Terraces develop over time. (Hanspeter Liniger)
**right:** The effectiveness of vetiver depends on maintaining a gap-free barrier: here a space that should have been filled. (William Critchley)

# Vetiver grass lines

South Africa

**Contour lines of vetiver grass planted within fields of sugar cane, on stream banks and roadsides, to act as 'hedges against erosion'.**

This example of vetiver grass barriers comes from a commercial farm in Kwa-Zulu Natal, South Africa, where sugar cane is grown on a large scale under a rainfall regime of around 1,000 mm per year. Vetiver grass *(Vetiveria zizanioides),* which had been growing naturally on the farm for years in isolated clumps, began to be used in 1989 to form vegetative hedges along the contour.

The purpose of these hedges is to protect the land from surface erosion by creating semi-permeable barriers, allowing excess runoff to filter through but holding back sediment. Infiltration is thus increased and moisture conserved in-situ. Although sugar cane in itself protects the soil quite well when the canopy is closed, after harvest on the moderate to steep slopes (10% to >30%) and erodible soils of the north coast of Kwa-Zulu Natal, extra protection is required. The vetiver system is supplemented by other soil conservation measures such as strip cropping, terraces, mulching and minimum tillage – all of which are used to some extent on this farm. Vetiver also helps by permanently marking the contour line, which then guides land preparation. In common with other vegetative barriers, vetiver lines lead to the formation of terraces over time, through the effect of tillage and water erosion between the strips.

Vetiver clumps are dug up and separated into slips (tillers), cut to a length of 10 cm and then planted 10–15 cm apart along the contour, also by stream banks, and by roadsides, just before the rains. This ensures good establishment. Single lines are used in this farm, though double lines are more effective at creating a hedge, and are the normal recommendation. Work starts at the top of the slope, and continues downwards. The cross-slope grass hedges are sited at 5 m vertical intervals on slopes of more than 10%, in lines about 200 m long. The cost of vetiver grass planting depends very much on slope (and thus the number of lines to be planted), availability of materials and labour.

Maintenance is very important, as vetiver often requires 'gapping-up' to keep the barrier dense, and it needs also to be cut back before the dry season to prevent it burning. The cut material can be used for mulching. Vetiver is poorly palatable, and therefore not useful as fodder. The maximum height of a vetiver hedge is kept down to approximately 50 cm. This minimises shading and competition, keeps the fire risk low, increases tillering (for production of vegetative splits) and ensures adequate density.



**Location:** Lower Tugela District, Kwa-Zulu Natal Province, South Africa
**Technology area:** 8 km$^2$
**SWC measure:** vegetative
**Land use:** cropland
**Climate:** subhumid
**WOCAT database reference:** QT RSA04
**Related approach:** Self-teaching, QA RSA04
**Compiled by:** Robert Maxime, Vallonia Estate, KZN, South Africa
**Date:** September 1999, updated February 2004

**Editors' comments:** Vetiver grass has been strongly promoted worldwide by the World Bank as a vegetative hedge against erosion – but it has often proved unpopular with small-scale farmers, mainly because it does not simultaneously provide fodder for livestock, in contrast to other grass barriers. However it has found an appropriate niche in certain places, as in this case study.

## Classification

### Land use problems

- erodible soils on slopes under sugar cane
- need for cheap supplementary SWC options to support other technologies, including mulching, terracing, minimum tillage and strip cropping

**Land use**

perennial crops: sugar cane

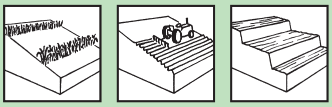
**Climate**

subhumid

**Degradation**

water erosion: loss of topsoil, gully — water degradation: soil moisture problem — wind erosion: loss of topsoil

**SWC measures**



vegetative: grass strip as hedges — agronomic: strip cropping, minimum tillage, mulching (supp.) — structural: terrasses (opt.)

**Technical function/impact**

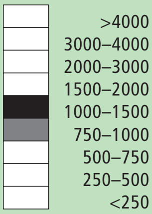
**main:** - control dispersed runoff

**secondary:** - control concentrated runoff
- increase/maintain water stored in the soil

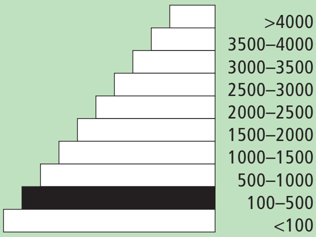
## Environment

### Natural environment

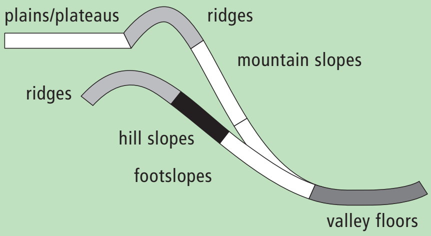
**Average annual rainfall (mm)**



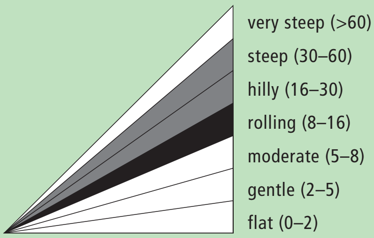

**Altitude (m a.s.l.)**



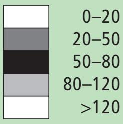

**Landform**




**Slope (%)**




**Soil depth (cm)**

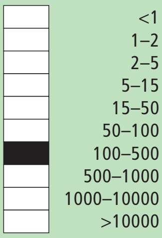



NB: soil properties before SWC

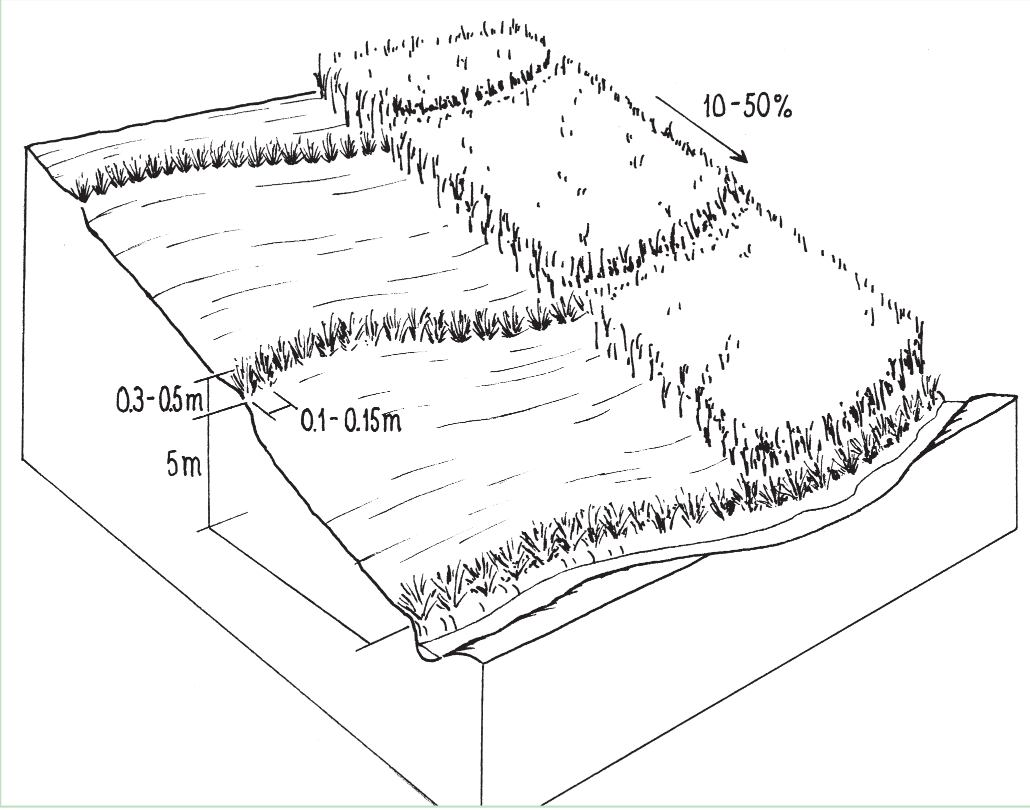
**Growing season:** not specified
**Soil fertility:** medium
**Soil texture:** mainly medium (loam), partly coarse (sand)
**Surface stoniness:** no loose stone
**Topsoil organic matter:** mainly medium (1–3%), some high (>3%)
**Soil drainage:** mainly good, some medium, less poor
**Soil erodibility:** mainly medium, some high

### Human environment

**Cropland per household (ha)**




**Land use rights:** individual
**Land ownership:** individual titled
**Market orientation:** commercial (market)
**Level of technical knowledge required:** field staff/extension worker: low, land user: low
**Importance of off-farm income:** <10% of all income: large scale commercial farms in South Africa usually provide the main source of income for the family owners




**Technical drawing**
Contour lines of vetiver grass help protect sugar cane fields (right) from erosion: note the lowest line acts as a field-end boundary above a stream.

## Implementation activities, inputs and costs

### Establishment activities

1. Mature vetiver clumps growing on the farm are dug up and split to provide planting material before the rains.
2. These slips are trimmed, and planted using hand tools, with fertilizer, and watered for improved establishment (during summer rains: December/January).
4. The lines are weeded and gaps filled with new young splits during the summer growing season.
5. The plants are cut back (after the growing season) to promote tillering and prevent burning.

Duration of establishment: approx. one year to plant 2.5 hectares – though it takes three years for the hedge to reach a width of approx 50 cm and full effectiveness

### Establishment inputs and costs per ha

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (15 person days) | 30 | 100% |
| Equipment | | |
| - Tools (hoe) | 4 | 100% |
| Agricultural | | |
| - Slips (approx. 5,000) | 66 | 100% |
| - Fertilizers (200 kg) | 40 | 100% |
| **TOTAL** | **140** | **100%** |

### Maintenance/recurrent activities

1. Repairs to the fence are carried out every year.
2. Vines and trees that fail are replaced.
3. Irrigation of new seedlings.
4. Grapes and trees pruned every year.
5. Harvesting of fruits and fodder: transport of the yield to the house by donkey.
6. Manuring, when replacing grapes or trees that had died: manure is transported from summer pastures to the village by cars and to the plot by donkeys (every year).

### Maintenance/recurrent inputs and costs per ha per year

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour (5 person days) | 10 | 100% |
| Equipment | | |
| - Tools (hoe) | 4 | 100% |
| Agricultural | | |
| - Slips (small amount) | 6 | 100% |
| - Biocides | 5 | 100% |
| **TOTAL** | **25** | **100%** |

**Remarks:** In this single case study, taking the large vertical interval (VI) of 5 m (the normal recommendation is a VI of 2 m), and thus a wide spacing between lines – of 25 metres on a 20% slope – and single lines of vetiver slips rather than double (which is normally recommended), costs are relatively cheap. Costs differ very much from situation to situation depending on conditions including: (1) price of labour; (2) slope of land; (3) availability of planting material; (4) single or double lines.

## Assessment

### Acceptance/adoption

- three local land users (commercial farmers) in the neighbourhood have taken up vetiver barriers (without incentives) because they perceive soil moisture, and other, benefits
- there is evidence that other farmers are adopting/likely to adopt spontaneously

**Benefits/costs according to land user**

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| establishment | nautral/balanced | positive |
| maintenance/recurrent | positive | very positive |

**Impacts of the technology**

| Production and socio-economic benefits | | Production and socio-economic disadvantages | |
|---|---|---|---|
| + | crop yield increase | – | loss of land |
| **Socio-cultural benefits** | | **Socio-cultural disadvantages** | |
| none | | none | |
| **Ecological benefits** | | **Ecological disadvantages** | |
| +++ | efficiency of excess water drainage (slowing flows) because of their semi-permeability | – – – | fire hazard |
| +++ | soil loss reduction | | |
| ++ | reduction of wind velocity | | |
| **Other benefits** | | **Other disadvantages** | |
| +++ | demarcates the contour | none | |
| **Off-site benefits** | | **Off-site disadvantages** | |
| +++ | reduced downstream siltation | none | |

## Concluding statements

| Strengths and ➜ how to sustain/improve | Weaknesses and ➜ how to overcome |
|---|---|
| When planted correctly, vetiver forms a dense, permanent hedge which retains soil and water so increases crop yield ➜ Make sure there are no gaps between slips in order to maintain a dense vegetative barrier. | Burns easily when mature ➜ Strategic/controlled burning at end of growing season or trimming back. |
| It has a strong fibrous root system that penetrates and binds the soil to a depth of up to 3 meters and can withstand the effects of tunnelling and cracking. | Susceptible to certain chemicals used in sugar cane ➜ Keep chemicals off vetiver. |
| Vetiver grass seed is sterile so it doesn't spread. | Planting material expensive to buy: therefore costs increase considerably unless farmer has own nursery ➜ Establish own nursery. |
| Not very competitive to crops growing alongside. | Takes time to plant a large area (in this case 2.5 ha per year). |
| The cut material can be used for mulching and has multiple secondary uses (thatching, basket making, etc). | |
| Once established it can withstand periods of drought and waterlogging. It is also resistant to grazing and to most pests and diseases. | |
| Adaptability: can be planted in various environments and grows well in most soil types. | |
| Depending on the availability of planting materials and the spacing adopted, can be relatively cheap and easy to establish and – once well established – vetiver requires minimal maintenance. | |

**Key reference(s):** World Bank (1990) *Vetiver Grass: The Hedge against Erosion.* World Bank, Washington DC, USA ■ South Africa Vetiver Network (undated: c 2001) *Utshani I-Vetiver: Vetiver Grass.* Institute of Natural Resources, Scottsville, South Africa
**Contact person(s):** Rinda van der Merwe, Institute for Soil, Climate and Water, P/Bag x79, 0001 Pretoria, South Africa; rinda@arc.agric.za ■ Dick Grimshaw; dickgrimshaw@vetiver.org

**left:** Slips of vetiver grass are planted according to instructions in the booklet. (William Critchley)
**right:** Spacing between slips is 10–15 cm apart at the time of planting. This should form a dense barrier but 'gapping-up' may be necessary in subsequent seasons. (William Critchley)

# Self-teaching

South Africa

**Learning how to use vetiver grass as a vegetative conservation barrier through instructions from a booklet and hands-on, practical experience.**

The manager of the farm from which this case study is taken was given a booklet on vetiver grass produced by the World Bank. His objective was to teach himself to improve his conservation system. Already he had a number of conservation strategies, including terracing, minimum tillage, mulching and strip cropping, but he felt there was a need to better his system. Through self-teaching he gave himself an opportunity to do so.

There had been some vetiver plants on the farm for 40 years, and the vetiver visibly held the soil in place where it grew. These plants had grown into huge clumps comprising multiple tillers or 'slips'. The practical handbook, disseminated very widely throughout erosion-prone countries by the World Bank, demonstrated how vetiver could be dug up, split and planted to form a continuous barrier hedge for soil and water conservation (World Bank, 1990: see references). In other words, in this situation, the booklet offered the possibility of improving what was already there.

The 'approach' therefore comprised taking ideas from a book, testing those ideas and seeing how they worked in practice. The approach has developed further by the farmer spreading his message to neighbours, some of whom have copied the system after visiting his farm and seeing the results for themselves. While the original handbook had been aimed especially at Indian farmers, subsequent to the successful experience of this particular farmer, a locally focussed handbook has been recently prepared in English and Zulu by the South African Vetiver Network (see references).



**Location:** Lower Tugela District, Kwa-Zulu Natal South Africa
**Approach area:** 8 km$^2$
**Land use:** cropland
**Climate:** subhumid
**WOCAT database reference:** QA RSA04
**Related technology:** Vetiver grass lines, QT RSA04
**Compiled by:** Robert Maxime, Vallonia Estate, Lower Tugela District, KZN, South Africa
**Date:** June 1999, updated February 2004

**Editors' comments:** Using documents (or the internet, or the media in general) is not a common way to learn about and initiate a soil and water conservation system, but is an approach that should be encouraged. It fits perfectly with the WOCAT philosophy of learning from other people's experience through information exchange.

## Problems, objectives and constraints

**Problem**

- lack of knowledge about alternative conservation technologies
- need for a new and cheap supplement to existing forms of soil and water conservation within sugar cane, that could be tested and tried by the farmer himself without need for outside advice

**Objectives**

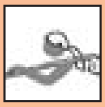
- 'test and try' a new method by self-teaching and gaining hands-on experience

**Constraints addressed**

| | Specification | Treatment |
|---|---|---|
| Financial | Need to find a cheap supplement to existing SWC in sugar cane. | Discovery of vetiver grass barrier hedge technology described in a booklet. |

## Participation and decision making

**Target groups**



Land users (large scale individual farmers)

**Approach costs met by*:**

| | |
|---|---|
| Individual farmers | 100% |
| | 100% |

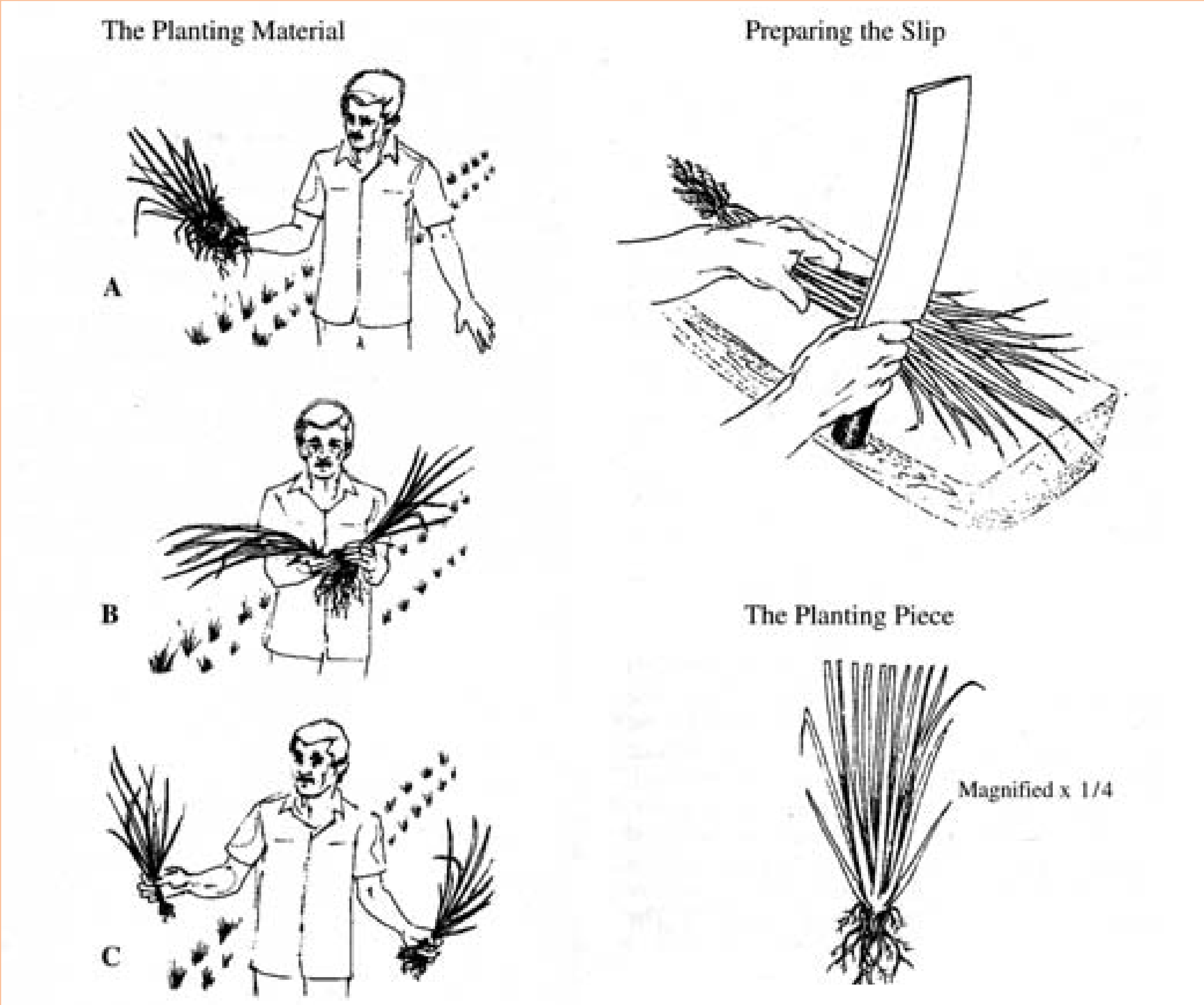
*does not include the costs of developing/distributing the booklet

**Decisions on choice of the technology:** Made by land user.
**Decisions on method of implementing the technology:** Made by land user.
**Approach designed by:** The land user (by using the handbook).

**Community involvement**

| Phase | Involvement | Activities |
|---|---|---|
| Initiation | self mobilisation | looking for ideas |
| Planning | self mobilisation | reading and thinking through the possibilities |
| Implementation | self mobilisation | paying farm labourers to plant the grass |
| Monitoring/evaluation | self mobilisation | observations |
| Research | not applicable | not applicable |

**Differences in participation between men and women:** No difference in theory: but mainly men participating in practice.



Establishing vetiver hedges: instructions on preparation for planting in the vetiver handbook. (World Bank, 1990)

## Extension and promotion

**Training:** Self-taught through use of World Bank's vetiver handbook (see references); hands-on experience.
**Extension:** Nothing formalised: merely informal farmer-to-farmer visits (by the farmer's neighbours to learn from his experience).
**Research:** No formal research: the farmer relies on observation and comparison with neighbours.
**Importance of land use rights:** Owning the land was a great help because the farmer-owner can do as he pleases in terms of conservation.

## Incentives

**Labour:** Implemented at own cost.
**Inputs:** Conservation material bought/grown by the farmer himself – though the promotional material (booklet) was provided free of charge.
**Credit:** None.
**Support to local institutions:** None.
**Long-term impact of incentives:** Not relevant as no incentives are provided.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| Bio-physical | regular observations of vetiver performance by the farmer |
| Technical | ad hoc observations by the farmer |
| Economic/production | ad hoc observations by the farmer |
| Area treated | measurements carried out each year by the farmer |
| No. of land users involved | ad hoc observations by the farmer |

## Impacts of the approach

**Changes as result of monitoring and evaluation:** No information given.
**Improved soil and water management:** There was a great improvement noted by the farmer.
**Adoption of the approach by other projects/land users:** Three neighbouring farmers have adopted the technology through their observations (not necessarily directly influenced by the publication, but by visiting/talking to the innovative farmer).
**Sustainability:** Land users can continue without support and at least a modest spontaneous expansion of adoption is expected.

## Concluding statements

| **Strengths** and ➜ how to sustain/improve | **Weaknesses** and ➜ how to overcome |
|---|---|
| A technical system devised from a handbook and experience rather than needing a project or intensive visits from extension agents ➜ Make sure such handbooks are spread and available in local languages. | Not everyone has access to such teaching material – or is literate ➜ Spread literature and information more widely and in local languages – both in written form and on the radio. |
| Neighbours can easily see and copy ➜ Farmer-to-farmer visits could be promoted through self-help groups and associations. | |
| A very cheap method of extension/ knowledge transfer ➜ Produce and disseminate booklets (and information on the internet) more widely. | |

**Key reference(s):** World Bank (1990) *Vetiver Grass: The Hedge against Erosion.* World Bank, Washington DC ■ South Africa Vetiver Network (undated) *Utshani I-Vetiver: Vetiver Grass.* Institute of Natural Resources, Scottsville, South Africa
**Contact person(s):** Rinda van der Merwe, Institute for Soil, Climate and Water, P/Bag x79, 0001 Pretoria, South Africa; rinda@arc.agric.za ■ Dick Grimshaw; dickgrimshaw@vetiver.org