Sustainable Land Management in Sub-Saharan Africa

Information Cards

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No. 01 STONE LINES

Summary

Stone lines (or stone bunds) slow down runoff, increase water infiltration and form the basis for improved production in semi-arid areas. At the same time, sediment is captured behind these semi-permeable barriers. Stone lines were originally a traditional water harvesting technique in the Sahel, but have been improved through careful construction, and by aligning on the contour. A perennial grass (*Andropogon gayanus*) is sometimes planted to supplement the lines where stone is scarce. Stone lines are suited to low slopes, high runoff and hand labour. This technique is readily adopted by resource-poor farmers and can lead to a harvest even in years with low and erratic rainfall: thus an excellent climate change adaptation practice. Wide and deep planting pits (*zaï* in Burkina Faso; *tassa* in Niger: No 06) are often used in combination, acting as microcatchments within the field.

Principal Purposes

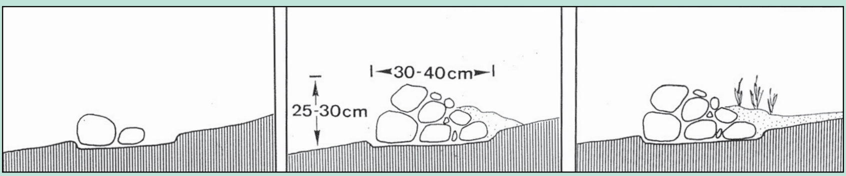
- Stone lines rehabilitate degraded land and improve plant production while slowing down and filtering rainfall runoff.
- They help to increase soil fertility – when manure/ compost is added and sediment is captured.
- The lines form the basis for cultivation of annual crops and in the establishment of trees/ shrubs in semi-arid areas.

Effectiveness and Upscaling

- The system works best on land under individual user rights.
- Participation and acceptance/ adoption of the technology may be greater when minor direct incentives (eg hand tools) are provided.
- Upscaling occurs where farmers experience improved and stabilised yields, and are thus stimulated to exchange knowledge about stone lines, *zaï/tassa*, and soil fertility management.

Technical Specifications

- Stone lines vary from 25-30 cm in height with a spacing (dependent on slope and availability of stone) of 15-30 metres apart.
- They are sited along the contour, which is marked out using a “water-tube level” (a water-filled pipe suspended between poles).
- A foundation trench is dug: 5 cm deep and approx. 30-40 cm wide.
- Large stones are placed in the rear of the trench and the line built up with smaller stones and pebbles.
- Maintenance is important: smaller stones may be displaced by livestock, and lines can become quickly silted up.
- *Andropogon gayanus* can be planted alongside stone lines where stone is limiting: this grass acts as a living, semi-permeable barrier.



Development of stone lines over time (Critchley, 1991)

Implementation Requirements/ Suitability

- Plenty of hand labour is required – from 70 person-days per hectare when abundant surface stone is available; to double that amount when stone has to be transported by wheelbarrow.
- A proven approach is through “farmer-to-farmer learning” with an emphasis on cross-visits to areas where the system is in place.
- Stone lines are most appropriate where:
  - rainfall limits cultivation (400–800 mm/ annum), slopes are low and rain fall runoff occurs
  - a cropping system based on hand cultivation is in place
  - manure/ compost is available in adequate quantities

Sources/ Further Details

Critchley W (1991) *Looking after our Land*. Oxfam, Oxford
Reij C (1991) *Indigenous Soil and Water in Africa*. IIED
Rochette R (1989) *Le Sahel en Lutte Contre la Désertification. Leçons d’expériences*. CILSS/PAC/GTZ, Margraf
WOCAT (2007) *Where the Land is Greener*. CDE, FAO, UNEP

No. 02 FANYA JUU TERRACES

Summary

Fanya juu ("throw the soil up" in Kiswahili) terraces are the most popular and successful cross-slope barrier measures used in Kenya's small-scale farming sector. Contour earth bunds are constructed by throwing soil upwards from trenches immediately below them. This design leads to the gradual formation of terraces with a level or slightly forward-sloping bed (diagram over page). This is a very versatile technology – ideally suited to smallholder farms, especially in sub-humid areas where land is sloping and erosion a threat. Fodder grasses may be planted on the bunds and cut for livestock. In dry areas, water harvesting from roads into the trenches allows production of bananas and fruits (No 04). This is a proven and effective technology in the highlands of East Africa and beyond.

Principal Purposes

- Terraces prevent soil (and water) loss, leading to improved fertility when combined with manure/ fertilizer – thus providing increased and more stable crop yields.
- Cultivation is made easier (by machine, draft animals or hand) after the terrace beds become more level.
- *Fanya juu* conserve rainfall within the field in marginal areas; in humid zones they are designed to discharge excess water.

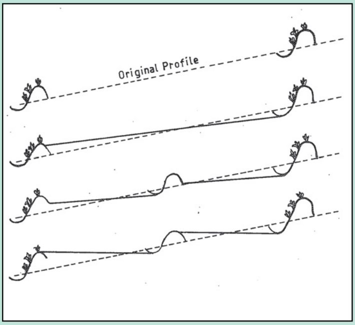
Effectiveness and Upscaling

- Security of land tenure is a prerequisite for investment in terracing.
- Maintenance is extremely important: it is essential to keep the terraces built up to the correct height because if terraces overtop with runoff there can be a "domino effect" of collapsing bunds.
- Spread of knowledge between farmers stimulates interest.
- Availability of hand tools may be a limiting factor in poor areas.

Technical Specifications

Fanya juu terraces are well-documented in terms of technical specifications; key aspects include:

- Spacing between structures (eg 12 metres apart on a 15% slope).
- Height of the bunds (40-50 cm) and depth of the trench (60 cm).
- The grade of the bunds (on the contour or slightly sloping).
- The need in certain situations for a cut-off drain above the field for protection from external runoff.
- Planting grasses on the bunds (eg napier or “elephant” grass - *Pennisetum purpureum*) to stabilise structures, and provide fodder; in drier areas, *makarikari* grass (*Panicum coloratum*) is preferred.



Levelling of fanya juu terraces after several seasons (Hudson, 1987)

Implementation Requirements/ Suitability

- *Fanya juu* terraces typically require between 90 and 150 person-days per hectare of hand labour to construct, dependent on slope.
- It is common practice in Machakos and Kitui Districts of Eastern Kenya, for work groups (of women) called *mwethya* to work on each others’ farms.
- Simple surveying equipment is needed to lay-out the contour (or slight gradient) for structures: “line-levels” (spirit-levels on a string between poles) are effective and their use is easily learnt.

Sources/ Further Details

Critchley W (2010) *More People, More Trees*. PA Publications

Hudson N (1987) *Soil and Water Conservation in Semi-Arid Areas*. Soils Bulletin no 57, FAO, Rome

Thomas D (1997) *Soil and Water Conservation Manual for Kenya*. Ministry of Agriculture, Government of Kenya

WOCAT (2007) *Where the Land is Greener*. CDE, FAO, UNEP

No. 03 GREVILLEA AGROFORESTRY

Summary

Although Grevillea robusta ("silky oak"; an Australian native) was originally introduced to East Africa as a shade tree in tea and coffee estates, it is now more commonly associated with small-scale farming. Farmers value the tree for its multiple uses. Grevillea supplies fuelwood and building materials, as well as providing shade. It controls raindrop splash, increases organic matter, and provides mulching materials to improve ground cover in the farm. Grevillea reduces wind speed, and encourages nutrient recycling due to its deep rooting system. It is ideally suited to intensive areas of small-scale mixed farming.Because the tree competes little with crops it has become the on-farm tree of choice for an increasing number of smallholder farmers in East Africa. It has largely spread through farmer-to-farmer exchange of experience, rather than through project campaigns.

Principal Purposes

- *Grevillea* is a true multipurpose tree: it provides timber, fuelwood, leaf mulch, shade, and it serves as a windbreak.
- *Grevillea* interferes minimally with crop growth, because of its deep root system, and its canopy which is not very dense.
- It is tolerant of pruning (both coppicing and pollarding), thus it can be readily managed to meet its desired purposes.

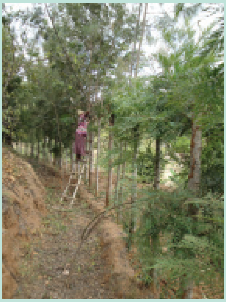
Effectiveness and Upscaling

- The proof of its effectiveness and impact is in its increasing spontaneous adoption.
- Because planting requires few resources other than tools, even poor land users can readily adopt the technology.
- Seedlings can be bought, but it is possible to collect "wildings" (naturally generated seedlings) and plant these at minimal cost.

Technical Specifications

- *Grevillea* is normally planted from seedlings along farm boundaries, on conservation barriers, or mixed with crops.
- Spacing varies, but when planted in a row, trees are normally located one metre apart.
- Planting of seedlings is carried out in holes of approx. 30 cm deep. Compost is added to encourage establishment and growth.
- Trees are carefully pruned: pollarded (side branches removed) and coppiced (main stem cut) and occasionally root-pruned. This reduces competition with crops, and provides wood and mulch.

Selling seedlings



Coppicing

Mulching with prunings

Implementation Requirements/ Suitability

- *Grevillea* is not a demanding tree in terms of planting requirements; one person can plant at least 50 seedlings in a day.
- Weeding and pruning are the major maintenance requirements.
- The success of the spontaneous spread, through farmer-to-farmer exchange demonstrates that tree planting is not something that has always to be "pushed" by outside agencies.

Sources/ Further Details

Critchley W (2010) *More People, More Trees*. PA Publications
Liniger H et al (2011) *Sustainable Land Management in Practice.* FAO, TerrAfrica
WOCAT (2007) *Where the Land is Greener.* CDE, FAO, UNEP

No. 04 ROAD RUNOFF HARVESTING

Summary

Road runoff harvesting is practiced in many parts of the world – wherever there is a combination of dry conditions and farmland alongside a road. The advantages are obvious: roads provide a hard surface with a high runoff coefficient (whether tarmac or "dirt"), and drainage is integral to road design. Thus, runoff is *de facto* available and land users can "tap into" this supply of water. Technically, this is a specific form of external water harvesting catchment system. Despite being very widespread, it rarely features in water harvesting manuals, and it is certainly underestimated in extent and contribution to small-scale farming in dry areas. However Ngigi (2003) estimates that some 4,000 hectares of land within one dry area in Kenya (Kitui District) benefit from this additional supply of water.

Principal Purposes

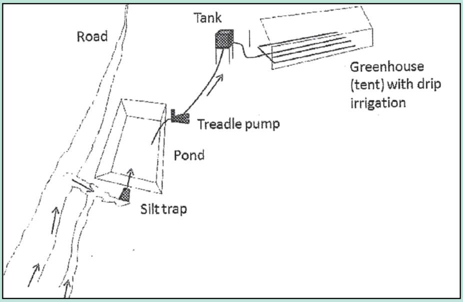
- Runoff from roads provides a supplementary source of water for crops during the rainy season.
- Water may be spread immediately (eg for cereals), or ponded and then used for supplementary irrigation (for horticultural crops – both vegetables and fruit trees).

Effectiveness and Upscaling

- Little quantified information is available about the important production, environmental and economic benefits.
- There is a positive downstream impact of reducing otherwise erosive drainage water, especially when culverts are the source.
- But there can be competition between up- and down-road farmers.
- Efforts to upscale include "business models" where runoff is ponded, then vegetables irrigated in greenhouses for the market.

Technical Specifications

- Details are few but there are two basic sources of road runoff:
  - The first is drainage from the near side of the road through a “mitre drain”– the width of the catchment comprises half of the road, and the catchment length is the road crest.
  - The second form is runoff that drains under the road through a culvert. This water originates from the land on the far side of the road, as well as the road itself. The catchment area is less simple to calculate and the flow often less easy to predict or manage.
- Runoff may be led into the farm and reticulated around the planted area; it may be captured in an infiltration ditch; or it may be ponded and extracted for supplementary irrigation.



Combining a pond with a greenhouse in Kenya (Kubbinga, 2012)

Implementation Requirements/ Suitability

- The proximity to a suitable road or path catchment determines whether such a system is feasible or not for a given farm.
- Another limitation is where the flow of water from the road (especially when delivered through a culvert) is potentially erosive.

Sources/ Further Details

Kubbinga B (2012) *Road Runoff Harvesting in the drylands of Sub-Saharan Africa.* MSc Thesis, VU University Amsterdam

Ngigi S (2003) *Rainwater Harvesting for Improved Food Security*. Greater Horn of Africa Rainwater Partnership

Nissen-Petersen E (2000) *Water from Roads*. DANIDA, Nairobi

Oduor A et al (2012) *From drought relief to business model.* Chapter 4 in Critchley W and Gowing J Water Harvesting in Sub-Saharan Africa. Earthscan

No. 05 ZERO-GRAZING AND BIOGAS

Summary

Zero-grazing is a form of dairy production where fodder is cut and carried to cows kept in stalls. This is a labour-intensive method of production that maximizes milk output per unit area: thus it is ideally suited to urban/ peri-urban agriculture where land is scarce yet there is often plenty of family labour. Fodder may be grown in the backyard, or brought in from close-by areas. Market wastes can also be fed after careful sorting. Zero-grazing can be conveniently combined with the production of biogas; the manure, mixed with water, provides input to the biogas plant. Anaerobic bacteria break down the material and release biogas – a mixture of mainly methane with some carbon dioxide. The biogas can be burned as a fuel for cooking or used for lighting. Methane burns with a clean, blue flame, without producing smoke or soot: it is an environmentally friendly cooking system. The semi-solid residue produced by the biogas plant not only makes good fertilizer but is also odour-free.

Principal Purposes

Zero-grazing

- Profitable production of milk under a labour-intensive system.
- Resource optimization: space limited but labour plentiful.
- Recycling of local wastes (eg greens from markets and brewer's grains) into milk and fertile slurry.

Biogas

- Production of clean renewable energy close to home.
- Turning animal manure into energy and fertilizer.
- Reducing reliance on external sources of energy.

Effectiveness and Upscaling

- Very effective under situations of good management and technical skills: dependent on initial and on-going support.
- Becoming increasingly popular as population density rises and demand for milk and alternative energy increases.

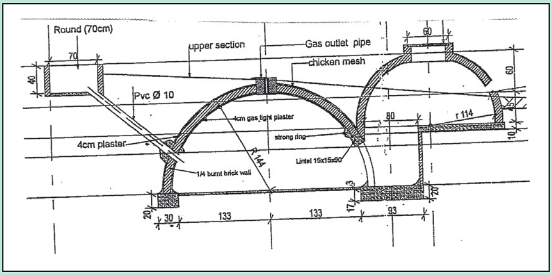
Technical Specifications

Zero-grazing

- Zero-grazed cattle can produce as much milk as those grazed on pasture if fed well in terms of quantity and quality.
- Reliable water supply: each cow needs up to 50 litres per day.
- Each dairy cow requires 50-100 kg of fresh fodder grass per day equivalent to production from around 0.25 hectares, plus concentrates (eg brewer's grain) and mineral licks.
- Backyard/ homestead area with good drainage needed.

Biogas

- Biogas plants are available in various designs including relatively cheap prefabricated plastic models.
- Three to four cows are needed to provide gas for a stove that burns for four hours a day.
- A good water supply necessary to mix with the cow dung.



Cross-section design detail (Uganda Biogas Programme, 2011)

Implementation Requirements/ Sustainability

- Dependent on relatively high initial investment.
- An advanced level of technical and management skills required.
- Usually needs both initial and on-going support from specialized extension agencies.
- Most appropriate in area with high population densities - including urban zones.

Sources/ Further Details

Lukuyu M. et al (2007) *Feeding dairy cattle: a manual for smallholder dairy farmers and extension workers in East Africa*. ILRI. Kenya

Uganda Domestic Biogas Programme (2011) Brochure

www.heifer.org.za/faq/what_is_zero_grazing

No. 06 *ZAÏ* PLANTING PITS

Summary

Zaï (in Burkina Faso, or *tassa* in Niger) are wide and deep planting pits, used in semi-arid areas as a water harvesting technique. *Zaï* act as microcatchments within the field. Farmers often apply *zaï* in order to rehabilitate barren, crusted soils. They are commonly combined with contour stone lines (No 01) which slow down runoff, increase infiltration and protect the pits from sedimentation. *Zaï* planting pits are dug by hand: they are approx 25 cm in diameter, 20 cm deep and spaced 90 cm apart. The pits are generally manured to improve soil fertility. Crops planted are sorghum and bulrush (pearl) millet. *Zaï* - usually in combination with contour stone lines - are easily adopted by resource-poor farmers and provide a harvest in years with low and erratic rainfall. They are the biggest single "success story" of water harvesting in West Africa over the last 25 years.

Principal Purposes

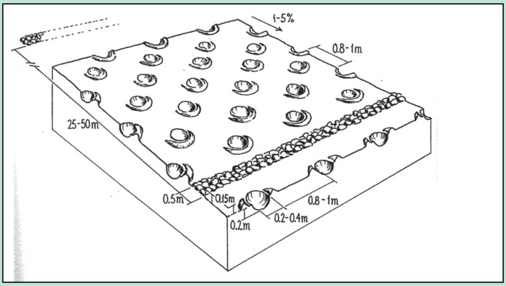
- *Zaï* improve plant production by concentrating rainfall runoff.
- They help to increase, and concentrate, soil fertility when manure/ compost is added, or microdosing with inorganic fertilizer is used; and also through capturing sediment in overland flow.
- *Zaï* can also form the basis for establishment of trees/ shrubs.

Effectiveness and Upscaling

- *Zaï* have been widely adopted in West Africa as a simple, effective technique based on a tradition which has been improved by farmers, field agents and researchers.
- Acceptance/ adoption of the technology has been encouraged through provision of direct incentives (eg hand tools).
- Upscaling has occurred rapidly where farmers have been stimulated to exchange knowledge and experience.

Technical Specifications

- *Zaï* pits are approx 20-30 cm diameter and 15-25 cm depth, spaced about 80-100 cm apart in each direction; land between remains uncultivated, acting as a catchment for runoff.
- Excavated earth is formed into a ridge downslope of the hole.
- Before planting, compost or manure is added to the pits to improve the fertility and structure of the soil.
- At the beginning of the rainy season, several seeds of millet or sorghum are sown in the pits, and typically three or more establish.
- Digging and maintenance of *zaï* pits is relatively easy but labour-intensive; an advantage of *zaï* is that rehabilitation of degraded land can be carried out incrementally during dry seasons.



Zaï pits: artist's impression (WOCAT 2007)

Implementation Requirements/ Suitability

- *Zaï* are appropriate where rainfall limits cultivation (400–800 mm/ annum), slopes are low and rainfall runoff occurs.
- The system is suited to a cropping system based on hand cultivation by hoe, though can be semi-mechanized where draft animals first rip lines in the earth.
- Manure/ compost should be available in adequate quantities to address soil fertility problems: inorganic fertilizer is also required when microdosing is practiced.

Sources/ Further Details

Critchley W (1991) *Looking after our Land.* Oxfam, Oxford

Rochette R (1989) *Le Sahel en Lutte Contre la Désertification. Leçons d'expériences.* CILSS/PAC/GTZ, Margraf

Scheierling S et al (2012) *Improving Water Management in Rainfed Agriculture.* Water Paper. Water Anchor, World Bank

WOCAT (2007) *Where the Land is Greener*. CDE, FAO, UNEP

No. 07 DEMI-LUNES

Summary

Demi-lunes (half-moons) are earth embankments in the shape of a semi-circle with the tips of the bunds on the contour. *Demi-lunes* can be constructed in a variety of sizes, with a range of both radius and bund dimensions. Construction is almost always by hand. The principle of the most common design of *demi-lunes* is to capture water from within the field. The radius for these smaller structures is generally 3 to 6 metres, with bunds of about 25 cm in height, and they are built in sequence over a whole plot. In this case they function as microcatchment system. A modified, larger design of a semi-circular bund, with a diameter of 20 or more metres can act as a single planting plot and accommodate runoff from outside. As such it functions as an external catchment system.

Principal Purposes

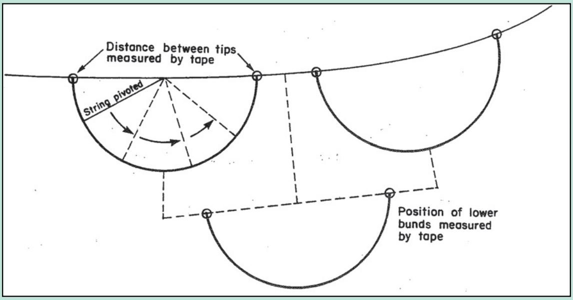
- *Demi-lunes* comprise a water harvesting technique for crop production in semi-arid areas, capturing runoff for improved yields.
- They may also be employed for rangeland rehabilitation, fodder production or for tree establishment.
- The technique helps to increase soil fertility by concentrating nutrients within the field when manure/ compost is added and sediment captured from overland flow.

Effectiveness and Upscaling

- *Demi-lunes* have resulted in improved crop/ vegetation growth, notably in Burkina Faso and Niger, but data are scarce.
- Construction is simple but demanding: bunds are not easy to make by machine, nor can cultivation under *demi-lunes* be mechanised.
- Cross-visits are effective for upscaling, and both provision of hand tools and training in layout help encourage adoption.

Technical Specifications

- *Demi-lunes* are generally made of earth, but stone can be used.
- Structures are staggered: the second and subsequent lines catch runoff flowing between structures in the lines above.
- Catchment to cultivated area ratio is determined by the proximity of the *demi-lunes* to each other: as low as 1:1 but often greater.
- The tips of the *demi-lunes* are laid out on the contour, often using a line-level (a spirit-level on a string between poles): the outline is drawn by a peg at the end of a string which is swung around.
- In the larger designs, excess runoff is designed to spill around the wing tips, sited on the contour and fortified with stone.



Layout technique (Critchley and Siegert, 1991)

Implementation Requirements/Suitability

- *Demi-lunes* are best on slopes of 2% or less. Otherwise earthwork volumes rise considerably (the bund will be higher at the lower part) and water is distributed less evenly.
- Construction cannot be easily mechanised: *demi-lunes* are most readily and efficiently made and maintained by hand, thus hand tools (including line-levels for layout) are prerequisites.
- Training in design, layout, construction and maintenance is most readily carried out *in situ* during cross-visits.

Sources/ Further Details

Critchley W and Siegert K (1991) *Water Harvesting.* FAO

Oweis T et al (2012) *Rainwater harvesting for Agriculture in the Dry Areas.* Taylor and Francis Group. Leiden, The Netherlands

www.rainwaterharvesting.org/international/dryland.htm

No. 08 PARKLAND AGROFORESTRY

Summary

Parkland agroforestry is a multipurpose system where dispersed indigenous trees are mixed in fields with crops. Livestock are an integral part too. There are no precise technical specifications for parklands: the wide range of local traditions defies such description. Local tree species are consciously and deliberately managed by the farmers due to their specific (eg fruit or nuts) or multiple (soil amelioration; timber; fodder, etc) benefits. Farmer managed natural regeneration (No 10) is a common means to establish parklands. Tree species are specific to particular areas: in the Sahel, *Faidherbia albida, Parkia biglobosa*, *Vitellaria paradoxa* and *Adansonia digitata* are particularly common. However, the trees merely form the framework - or the "parasol" of the parklands: underneath are crops and livestock and the land management techniques are vital to the overall system.

Principal Purposes

- Trees within the parkland system produce timber and firewood; but also fruits, pods, leaves and medicines - for people and livestock.
- These trees provide other benefits: N-fixing species improve soil fertility; roots draw nutrients from deep and add these to the surface as leaf litter; they reduce wind speed and local temperature.
- The system as a whole supports agricultural production, crops and livestock, while sustaining a specific agroforestry-based ecosystem.

Effectiveness and Upscaling

- There exist very few data on overall benefits and impacts: but the fact that many farmers protect and manage trees on their land indicates that they perceive real benefits of parkland agroforestry.
- Key is security of land rights – and rights to the trees themselves.
- Naturally regenerated trees are low-cost; parkland agroforestry systems demand only time and skill to establish and maintain.

Technical Specifications

- There are no strict rules or technical specifications to parkland agroforestry: farmers manage their own fields as they choose.
- Parklands constitute a flexible system in which the farmer makes the final decision about species, population, and canopy cover of trees, and the production sub-systems associated with the trees.
- Trees may be allowed to regenerate naturally (eg indigenous species - No 10), or are planted (eg fruits such as mangoes).

Baobab

Vitellaria paradoxa (Shea nut)

Implementation Requirements/ Suitability

- On-farm trees are commonplace worldwide, but parklands are especially renowned in the Sahel, where the soils, and (often) relatively high water table suit these systems.
- Good rainfall conditions favour emergence of tree seedlings, and are crucial for their survival and establishment.
- Water harvesting technologies – such as *zaï* (No 06) and *demi-lunes* (No 07) can help establish trees in dry conditions.
- Other implementation requirements depend on the associated production and land management sub-systems.

Sources/ Further Details

Critchley W (2010) *More People, More Trees*. PA Publications

Liniger H et al (2011) *Sustainable Land Management in Practice*. TerrAfrica

Rochette R (1989) *Le Sahel en Lutte Contre la Désertification. Leçons d'expériences.* CILSS/PAC/GTZ, Margraf

Von Maydell H (2005) *Trees and Shrubs of the Sahel.* GTZ, Eschborn

No. 09 INTEGRATED SOIL FERTILITY MANAGEMENT

Summary

Soil fertility limits plant production in most of Africa; and there is a growing problem with plant nutrients being exported from rural to urban areas in a process known as "nutrient mining". Organic sources of fertilizer are inadequate. Integrated soil fertility management (ISFM) is based on three interlinked principles:

i. maximizing the use of organic fertilizers
ii. minimizing the loss of nutrients
iii. optimizing the use of inorganic fertilizer

Practices include: composting and manuring; microdosing with inorganic fertilizer, and application of rock phosphate. Composting is the natural process of decomposition of organic matter such as crop residues. Microdosing is the precision application of small quantities inorganic fertilizer. Additional practices of fertility management include fallowing, crop rotation, planting of legumes, and mulching.

Principal Purposes

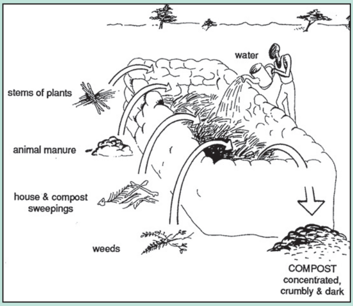
- ISFM combines various methods to maximise the impact of limited resources to improve soil fertility and health.
- Composting utilises farm by-products and household wastes to improve fertility, and to increase soil organic matter.
- Microdosing increases production through judicious and efficient use of inorganic fertilizer: a vital supplement to organic methods.
- Mulching, and inclusion of nitrogen-fixing legumes (including agroforestry trees) give soil fertility, and other, benefits.

Effectiveness and Upscaling

- Adoption of ISFM is determined by the availability of organic materials sources, and access to affordable inorganic fertilizers.
- Composting by farmers has taken off in the Sahel (and elsewhere); spontaneous adoption of microdosing is beginning to happen; conservation agriculture is growing in popularity; agroforestry is enjoying a resurgence of interest, and an expansion of area.

Technical Specifications

- Compost can be produced in pits (dry areas) or heaps (humid zones). There are many documented methods. For example:
  - After harvest layers of chopped crop residues, animal dung and ash are heaped and watered as required.
  - The pile is covered with straw and left to decompose, during which the aerobic bacteria give off heat.
  - After 15-20 days the compost is turned over into a second pile. This is repeated up to three times.
- In microdosing, small amounts of mineral fertilizer, usually around 4g per planting station, are applied to the planting hole at the time of sowing, and/or after emergence as a top dressing.



Compost Pit in West Africa (Critchley, 1991)

Implementation Requirements/ Suitability

- ISFM is recommended in all areas of SSA, especially those with low and rapidly declining soil fertility.
- Composting requires certain skills which can be readily taught, and are easily learnt from farmer-to-farmer also.
- Composting is demanding in terms of labour; and water in dry areas.
- Microdosing with inorganic fertilizer requires both financial inputs, availability of fertilizer, and knowledge regarding application.

Sources/ Further Details

Critchley W (1991) *Looking After Our Land*. Oxfam, Oxford
Hilhorst T and Muchena F (2000) *Nutrients on the Move*. IIED, London
Liniger H et al (2011) *Sustainable Land Management in Practice*. TerrAfrica
ICRISAT (2006) *Fertilizer Microdosing*. Report No. 23. Niamey, Niger

No. 10 FARMER MANAGED NATURAL REGENERATION

Summary

Farmer managed natural regeneration (FMNR) involves farmers selecting and pruning growth from (a) stumps of previously felled but living trees, and/or (b) seedlings that emerge naturally. It is a particular sub-set of agroforestry and constitutes one way of stimulating the recreation of parkland agroforestry systems where these have been degraded (No 08). In Niger there was a progressive destruction of trees and shrubs between the 1950s and 1980s. However, an "underground forest" remained and this is the secret behind FMNR in that country: the result has been an estimated five million hectares of land "regreened". The usual response to increase trees on-farm is to create nurseries and raise seedlings for transplanting. But these have a much poorer survival rate. On the other hand, FMNR can be a quick, simple and secure method, through protecting and nurturing naturally occurring seedlings, or shoots from living stumps.

Principal Purposes

- FMNR ensures rapid propagation of (usually) indigenous trees from rootstocks or seedlings through nurture by farmers: in the Sahel it is the basis of recently renewed parkland systems (No 08).
- On-farm trees produce timber and firewood; also fruits, pods and leaves for human nutrition and fodder for livestock.

Effectiveness and Upscaling

- Key to adoption is secure rights to land, and rights to the trees also.
- Naturally regenerated trees are low-cost; these systems demand only time and skill: certain basic competencies (selection, spacing, pruning, utilisation, etc) need to be taught.
- Promotion is largely based on farmer-to-farmer exchange.

Technical Specifications

- There are no strict rules or technical specifications to FMNR/ parklands: farmers manage their trees and fields as they choose.
- FMNR–generated parkland agroforestry is a flexible system in which the farmer decides about species, population, and canopy.
- It is often supported by planting seeds in on-farm mini-nurseries, and transplanting seedlings of naturally regenerating trees.
- Because it involves naturally growing species it is based on indigenous trees, and often there is one dominant type found in the system eg *Faidherbia albida* in Burkina Faso and Ethiopia, and *Vitellaria paradoxa* (Shea nut) in northern Ghana.

Faidherbia albida naturally regenerated in Ethiopia: and seedpod

Implementation Requirements/ Suitability

- On-farm trees are commonplace worldwide, but FMNR is especially renowned in the Sahel, where the soils, and (often) relatively high water table suit parkland agroforestry systems.
- Good rainfall conditions favour emergence of tree seedlings, and are crucial for their survival and establishment.
- Water harvesting technologies – such as *zaï* (No 06) and *demi-lunes* (No 07) can help establish trees in dry conditions.
- There are no high investment costs involved.

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No. 11 FARMER AND PASTORALIST INTERACTIONS

Background

Farmers and pastoralists in Africa have lived in proximity since agriculture emerged, and their relationship with each other is complex. While co-existence has never been without tension, because of rivalries for resources, there is a long history of mutual dependence. At the most basic level there has been trade: pastoralists selling animals and livestock products to agriculturalists in exchange for grain and other foodstuffs. But there are other interactions too, based on resource exchange. Two examples are based on cattle manure. There are arrangements, in Niger for example, where pastoralists are encouraged to graze on stubble, and browse trees and shrubs after harvest, and the dung is then used by the host farming community to fertilize their fields. And in Mali there are examples of settled communities digging wells to supply water for pastoralists' livestock – again in exchange for a supply of manure. It is not uncommon to find that these are based on contractual arrangements. As the academic pendulum swings towards understanding and appreciation of pastoralists' traditional opportunistic "tracking" strategies, so we also need to acknowledge the value of farmer-pastoralist interaction. However simultaneously there is a need for support and dispute mediation.

Case Study: The Barahogon Association

In the Bankass area of Mali, the Barahogon Association helps to mediate between farmers and pastoralists. The Barahogon literally means "chief of the bush". The association has its origins in the distant past, before colonial times, as a traditional organization that looked after common lands and all shared natural resources - and as well as farmers' fields. Over time, the tradition was abandoned, but in 1999 the Barahogon was re-established as an official association.

Currently the 24 members of the supra-village management committee or "*Comité directeur*" in French (of whom four are women) work in three districts, where they hold regular meetings. Members patrol their own village lands areas regularly to check whether regulations are being respected regarding tree cutting and collection of fruits – as well as overseeing agreements between farmers and pastoralists about resource sharing. In cases of dispute, the Barahogon members act as mediators and help to develop a solution. When regulations are transgressed, the Barahogon ask those involved to pay a symbolic sanction and to present an apology. If the transgressors do not accept this they are taken to the local authorities. Then the fine will be much more severe and prison may even be an option: no wonder that most people prefer to come to a mutual understanding brokered by the Barahogon. As noted, the association plays an active role in the relationships between farmers and pastoralists: many farmers who are themselves Barahogon members have arrangements with pastoralists who stay on the Barahogon's land with their livestock after harvest.

Farmers discussing

Barahogon signboard

Barahogon meeting

When pastoralists need to traverse crop lands with their herds during the rainy season they use dedicated corridors, known in French as *couloirs de passage*, or *bourtouls* in the local language. These corridors are marked and legally recognised by the local authorities. But these *bourtouls* are not always respected by farmers who may resent the encroachment into their potentially cultivable land. Once again the Barahogon Association comes into action as the arbitrator and protector of these "rights of passage".

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No. 12 CONSERVATION AGRICULTURE

Summary

The emergence of conservation agriculture (CA) has been one of the most notable success stories in rainfed agriculture of modern times. Low-toxicity, non-selective herbicides and specialised machinery led to CA taking off in the late 1980s. CA is based on three principles:

i. Minimum mechanical soil disturbance
ii. Permanent organic soil cover
iii. Diversification of crops in sequences and/or associations

It reduces the energy (and carbon emissions) involved in, and costs associated with, preparing land. It also maintains good soil structure and underground biodiversity; reduces erosion, and increases soil moisture in dry zones. FAO has established a "Community of Practice" and a "Framework for Action". Conservation agriculture has grown by three times over the last decade, to occupy approx 2.5% of the world's cropped land. In terms of CA under small-scale farming, Zambia is leading the way in Sub-Saharan Africa.

Principle Purposes

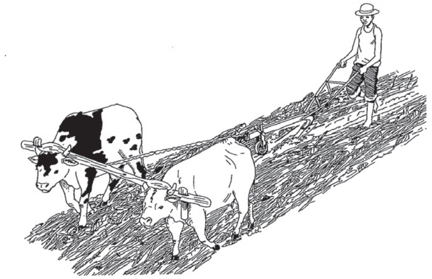
- CA aims to address concerns of sustainable intensification in farming: production, economics and the environment.
- Costs are reduced and profitability improved.
- Environmental benefits are local in terms of soil health and reduced pollution of waterbodies, and global because carbon is captured in soil organic matter – while less fossil fuels are used.

Effectiveness and Upscaling

- CA is growing quickly worldwide, and in Africa, in both area and numbers of farmers: for example in Zambia from a baseline of almost no practitioners in 1999, to 250,000 by 2012. Projections suggest 600,000 (half of Zambia's small-scale farmers) by 2015.
- This has resulted from a campaign using "lead farmers" and training: but also stimulated by direct benefits felt by farmers.

Technical Specifications (Zambia)

- Under the hand hoe system, precision basins are dug in the first year and maintained as permanent planting stations. Basins are 15 cm x 30 cm wide with a depth of about 15cm. They are spaced at 70 cm within lines and 90 cm between lines.
- Under the animal traction system, a single tine ripper, mounted on a plough frame, is drawn by oxen opening shallow rip lines at 90 cm spacing. Only 15% of the overall field's surface is disturbed.
- Fertilizer (or manure/ compost) and lime are precision-placed, and then soil is back-filled. Seeds are planted after the first rains.
- A herbicide is sprayed pre-emergence to kill weeds.


Animal-drawn ripper

Animal-drawn ripper (IIRR and ACT, 2005)

Implementation Requirements/ Suitability (Zambia)

- CA is suited to any area where crops are grown and there is adequate organic mulch to maintain cover: this may be a problem in the driest areas where there is competition for stover as fodder.
- Specific hand tools, rippers/planter-drills and sprayers are needed.
- Other inputs required are seeds, fertilizer, lime and a herbicide.
- There needs to be a market for the crops grown: thus legumes (in particular) should be selected with care.
- Technical skills are crucial, and need to be carefully learnt.

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www.fao.org/ag/ca - FAO's CA website/ community of practice

www.conservationagriculture.org - Conservation Farming Unit, Zambia

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