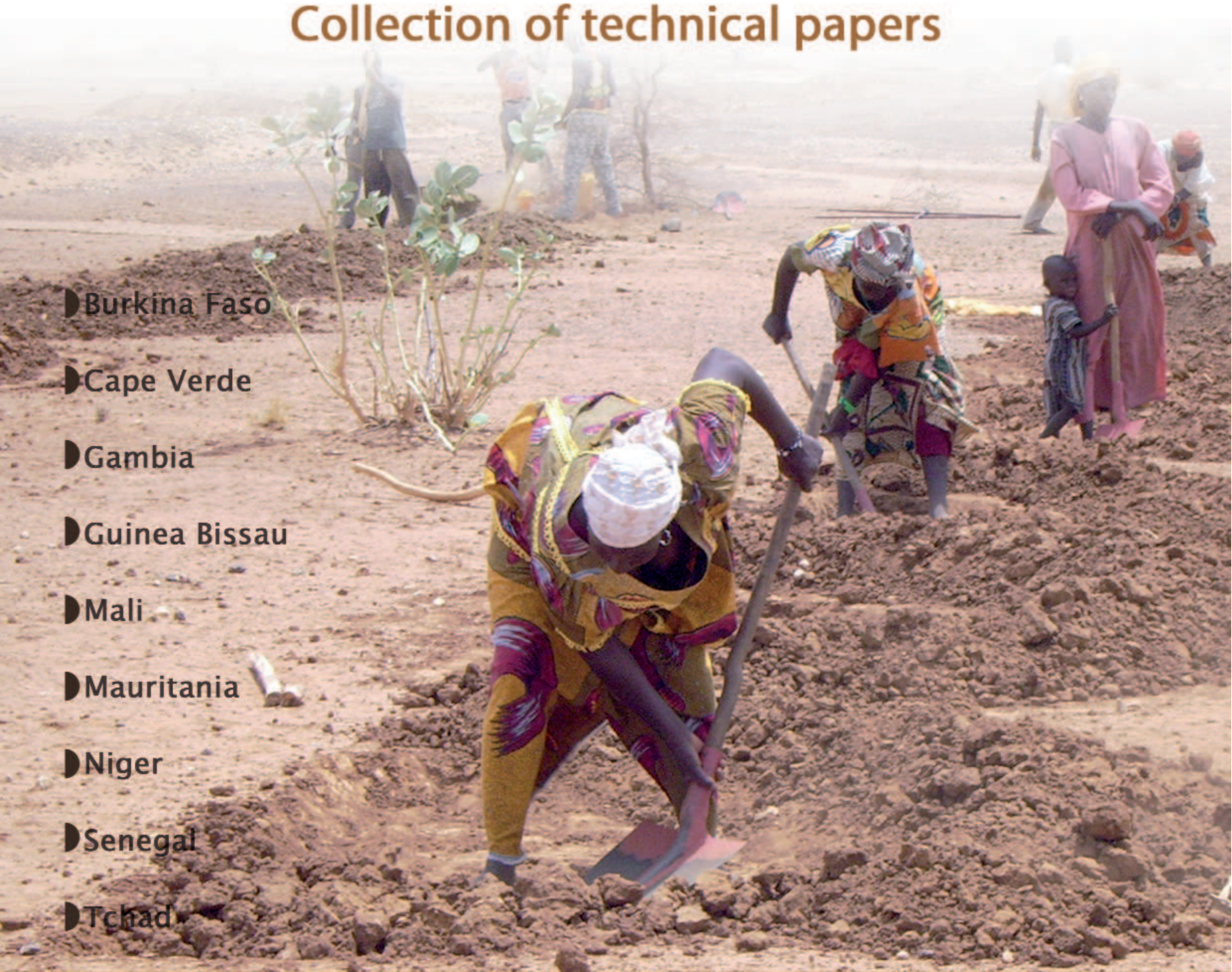
Permanent Interstate Committee for Drought Control in the Sahel

Regional Initiative - Global environment / Desertification control RIGE/DC

Capitalisation of the experiences

Desertification Control Techniques and Technologies

Collection of technical papers



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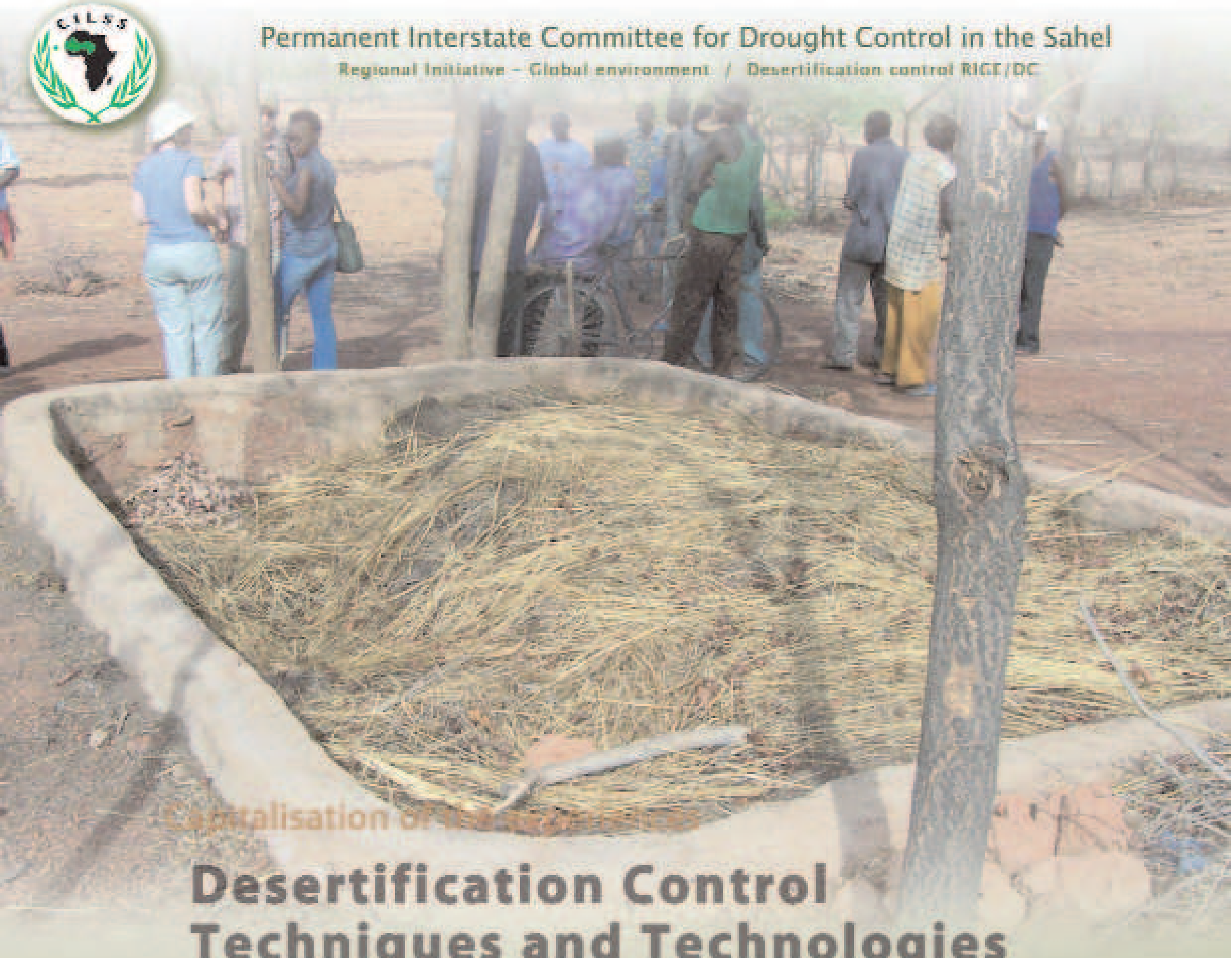

Capitalisation of [illegible]

Desertification Control Techniques and Technologies

Collection of technical papers

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» Introduction

After the major droughts that occurred in 1973 and 1983-84, Sahelian countries had made tremendous efforts in order to adjust to the situation and effectively control desertification. Techniques and technologies for desertification control (DC) were adopted to improve natural resources management and agro-sylvo-pastoral production - a key to rural poverty reduction in the Sahel.

These techniques, technologies and tools are very rich, diverse and suitable for the agro-ecological zones in which they were developed. They are inherently endogenous or introduced through researches and are, in most cases, very simple. That is why they can be easily reproduced and mastered by the rural sahelian populations because they are tailored to the (agro-ecological and social contexts), accessible (to low-income producers) and sustainable (with regard to natural resources conservation, poverty reduction and suitability for climatic changes). They have been tested and improved in the last few years, and their effectiveness and performance have also been demonstrated through several studies (Rochette et al 1989; Reij, 1983; Marchal, 1985; Reij et Thiombiano, 2003, Etudes Sahel, 2007, etc...)

However, their use and adoption by a large number of stakeholders (target communities) are still limited because of some constraints. This is essentially due to inadequate dissemination or the fact that they are unknown or misunderstood (technical and socio-economic conditions for the implementation of those techniques) and also to the serious reduction, in the last few years, of funds allocated to natural resources management [1] .

This document is a compilation of 12 technical papers showing different methods and techniques for the control of desertification, drawn from the micro-projects supported by RIGE/DC. It is most certainly not exhaustive but it represents a contribution to the improvement of skills and knowledge through the dissemination of information relating to desertification control within the context of a highly tensed agriculture and food system in the world. It also intends to encourage the funding and implementation of more suitable methods and appropriate techniques for desertification control.

The collection is composed of the following technical papers:

1. Composting and restoration of organic fertility
2. Erosion control through the construction of stone bunds
3. Rehabilitation of crust soils through the application of the planting pit techniques
4. Rehabilitation of crust soils through the half-moon techniques
5. Rehabilitation of crust soils through the application of the earth bunds' techniques
6. Rehabilitation of mangrove lands (desalination of mangrove rice fields)
7. Reforestation
8. Assisted natural regeneration and restricted areas
9. Silt control (sand dunes fixation)
10. Stabilisation of gullies (treatment by stone dikes)
11. Flood-recession cultivation dike
12. Some methods put in place within the framework of the RIGE/DC projects…for more efficiency and sustainability.

These technical papers, which address the various aspects of desertification control (DC) techniques, were adopted because of:

1. Their sub-regional dimension. Within the framework of projects supported by the RIGE/DC, some techniques are preferred and applied at least in two CILSS member countries in combating drought and desertification effects;

2. Their relevance, socio-economic and environmental impacts have been proved and appreciated by producers;

3. Their easy reproduction and acquisition by target communities;

4. Little or no financial and technical investments are required;

Finally and according to scenarios and forecasts, the current climatic variability in West Africa will most probably increase and intensify. In such a context, these desertification control (DC) techniques can be mobilised today to suit climatic variability and changes. Therefore, they can provide a credible answer to the multiplication of drought episodes, and as well be extended to areas that were not previously affected by drought.

[1] *According to a study carried out by PATECORE, PLT-B, GTZit in 2005, it is estimated that there are at least 500.000 ha of lands with serious erosion risk to be rehabilitated in the Central Plateau of Burkina Faso*

» Foreword

The dissemination and sharing of information constitute one of the strategies of CILSS to boost and promote sustainable alternatives for desertification control in the Sahel.

CILSS, in line with this concern, would like to capitalise and enhance the experience acquired through the implementation of its programme "Regional Initiative-Global Environment and Desertification Control, RIGE/DC".

The capitalisation report of this programme is constituted of three volumes as follow:

1. The first volume is composed of an overview of the programme, summary of results obtained and achievements, lessons and prospects for future actions;

2. The second volume is a catalogue of micro-projects supported by the programme in the 09 CILSS member States. These are summary of technical papers of projects put together per country. These papers contain detailed information on the projects concerning the results/effects obtained and lessons drawn from the implementation of the micro-projects.

3. The third volume (this document) is a collection of 12 technical papers showing different methods and techniques for the control of desertification, drawn from the micro-projects supported by RIGE/DC. These papers, which are illustrated with photographs, deal with desertification control (DC) technologies: principles, techniques, effects (environmental, social and economic), production/construction conditions, and practical means of succeeding, sustainability and costs. The catalogue also provides a series of strategies/approaches suitable for desertification control (devised within the framework of RIGE/DC's projects), which could help development associations and organisations to undertake and realise desertification control in a better and successful way.

The documents were drafted in such a way as to allow for readability.

Composting and restoration of organic fertility

Principle

For the growth of plants and improvement of their production, it is necessary that they be planted on a sufficiently nutritive soil. In areas exposed to desertification and lower yields, the restoration of soil fertility can partially be resolved by the production of compost. Compost facilitates the growth of plants through the improvement of the structure and restoration of biological activities of soils and through the provision of nutritive elements to plants.

Technique

Compost can effectively be produced in earthen pits or containers (bins) built on the surface. The process for the production of compost is as follows:

- Dig a pit of about 9m3 (3 metres by the side and 1m deep) preferably in a shady area (sun rays destroy the organic matter on the surface). If shady area is unavailable for the pit, a rudimentary roof made of straws could be built on top of it;
- Stabilise the walls of the pit with cement rendering and stones collected on the spot (or bricks if stones are not locally available) and provide for an edge of about 20cm;
- Put a layer of straws of about 20cm, add sufficient water and then cover it with ashes. It is recommended that straws be cut into pieces in order to facilitate decomposition;
- Add a layer of manure of about 10cm; water abundantly and cover with ashes;
- Repeat this process (straws/ashes/manure/ashes) until it reaches the top of the pit;
- Water thoroughly twice a week to ensure that the compost remains wet (provide for at least 400L a week) and mix the compost every two weeks in order to accelerate its maturing process.

At the end of 60 days the compost is ready for use. It must be blackish in colour and dusty in nature, without much debris with an odour of wet soils. If the compost was not sufficiently watered and mixed up, the maturation time could be extended.

Domestic wastes can be used for the production of compost as long as they are biodegradable. They are important sources of organic matters.

Application

A minimum of 5 tons/ha is required (that is about 30 carts) to obtain an optimum effect (cereal farms). Compost is only reapplied after every two or three harvests for cereals.

Construction conditions

The building of composting pits requires the following conditions:

- Earth-moving equipments (pickaxes, picks, shovels);
- Stabilisation materials for the pit based on the structure of the soil. For compact soils, three bags of cement per pit with stone blocks or bricks. Concerning sandy soils, 10 bags of cement are needed for brickwork and production of bricks (concrete blocks);
- Materials for the production of compost (a fork and watering equipments).

Compost pits are generally dug by individuals. A technical training is necessary for the digging of a good pit. Pits are constructed during the dry season (when there is little to do in the farms) and composting starts at least four months before the compost will be available for use.

Twins pits are sometimes constructed based on the available means. This facilitates the mixing and turning up every 15 days because with two pits built side by side, the mixing involves transferring the content of a pit to the empty one and vice versa. Another system with 4 twins pits (described as more elaborate) enables a continuous production of compost. This system is useful for those who are engaged in market gardening the year-round.

Environmental effects

The use of compost restores soil fertility and/or partially replaces the use of fertilisers. That is why its effects on the environment are noticeable through:

- The improvement of agricultural yields;
- The reduction in the clearing of new lands for agricultural purpose since the use of compost intensifies the already existing areas;
- The facilitation of reforestation operations (fertilisers for the plantation);
- Exemption from purchasing part of the required fertilisers; this reduces the risks of pollution.

Agro-economic effects

The use of compost in farms enables to obtain high yields of at least +50%, especially if it is combined with water and soils conservation techniques (stone bunds). The gains derived from such enable to recover in 2 or 3 years what has been invested in the operation.

Social effects

The gains in terms of farm yields improve the food security of households, reduce the need to buy cereals during scarcity period and sometimes generate some surpluses, which can be sold.

Money realised from these sales is used to construct new pits, acquire animals and often to pay children's school fees or improve the standard of living (medical care, house improvement, etc.).

Practical means of succeeding

The factors that affect the production of compost are generally the unavailability of manure and water. Therefore, efforts should be made to ensure that (i) beneficiaries of these facilities have sufficient manure for their pits, (ii) that water will be available in sufficient quantity during the process of composting (without water the process cannot start until the rainy season) and (iii) that users must have enough means of carrying water;

The location of a pit must also be considered in terms of transportation constraints: it must be sited at an acceptable distance from the water source and not too far from the farms in which the compost will be used (transportation of several tons).

The compost can be improved with urea or phosphates if the individual can afford them, but this is not compulsory.

Sustainability

The life duration of a stabilised pit is about 7 years. Its maintenance costs are very minimal and concern the wear-out of mixing and watering equipments. In other words, once the pit is constructed, the user is free and doesn't incur specific expenses.

Construction cost

The construction cost will be less on compact soil with stones available near the site. It will be more expensive on sandy soils (bricks or external aggregates to stabilise the pit will be required).
The construction cost of a pit on a compact soil (for example in the Central Plateau of Burkina Faso) will amount to about 45 Euros; this cost can increase to 90 Euros on sandy soils. An average unit cost of 75 Euros including a combined transportation means of water (carts with drums) can be used as a general reference.

» Erosion control through the application of the stone bunds method

Principle

Rains are irregular in the Sahel and are sometimes violent resulting into serious water erosion caused by water runoff. The construction of stone bunds aims at reducing the pressure of surface runoff by slowing water flow on rehabilitated lands. Therefore, it contributes to a better seepage of rain waters and conservation of small particles and organic residue on rehabilitated soils.
An area improved with the use of stone bunds will consequently conserve humidity for a longer period and reduce the erosion of the superficial layer of very fertile soil. In case of rainfall, which is very irregular, this will cushion the runoff effects on cultivated farm crops in rehabilitated areas.

Technique

The construction of stone bunds consists in digging a furrow of 10cm deep by about 30cm breadths according to the contour lines of the area to be rehabilitated. Blocks of stones of 15 – 20cm edge are fixed together into low walls that will rise about 20cm above the land surface once the structure is completed. Soil removed from the preparatory trenches will be used to reinforce further the load of supporting stones in the trench.

Lines of stones bunds are drawn every 20m to 50m according to slope and rainfall. The more sloping the land is and the climate drier, the closer the stone bunds. Stones bunds are not suitable beyond 10% of slope. The rehabilitation of 1ha requires about 40m3 of stones in sahelian areas (about 8 trips of a tipping – lorry of 6m3 at the rate of 0.8m3 of maximum stone per linear metre).

Bunds can measure about 15 metres long or even tens of metres based on the size of the farms and topography. The construction process is completed by slanting wings that are built at the extreme ends of bunds in order to reduce gully erosion at those ends. For longer bunds, it is advised to provide for some slightly lower stone lines (10cm) in order to prevent these big bunds from being swept away by the pressure of running water. Bigger stone bunds should not be constructed (above 100m) because it may likely be swept away by water: several average overlapped stone bunds will be preferred.

Once stone bunds are constructed, they can be strengthened by growing herbaceous plants on them (for example Andropogon gayanus) or by planting some trees upstream of bunds or with grains placed in the supporting furrow. These plants and grains will use the humidity conserved in bunds to ensure their rapid growth.

Construction conditions

For the construction of stone bunds, provision must be made for the following:

- Equipments to draw contour lines (pitch triangle and spirit level) ;
- Equipments for the crushing of stone blocks (sledgehammers, crowbars) and for the transportation of rubble stones (reinforced donkey-drawn-carts or hired tipping lorry and reinforced wheel-barrows for transportation purposes in the farms);

- Equipments for making the supporting furrows (picks, pickaxes);
- A strong mobilisation of labour: 15 men/day are necessary for the construction of 100m of stone bunds;
- A previous technical training is necessary for the construction of good bunds.

Generally, considering the effort required for the construction of bunds, agricultural lands are developed in an individual capacity with the support of villagers. The rehabilitation of communities' lands, especially concerning pasture and runoff areas, is often delicate to realise spontaneously by villagers (extensive areas, strenuous work) and often requires a compensation for this collective work (food or financial support).

Considering the quantity of stones requires for agricultural lands rehabilitation, a lorry is often hired for its transportation to farms. This enables to gain time and to be able to rehabilitate extensive areas. Transportation by carts is more suitable for stones transportation for the maintenance of bunds or for the development of small areas. The daily hiring of a lorry is expensive; therefore its use must be optimised in the following ways:

- Determine adequately areas that are to be rehabiltated;
- Crush sufficient stones in advance in order to ensure that the lorry works maximally throughout the day;
- Mobilise enough workforce (about ten persons) to crush rubble stones and ensure a rapid loading of the lorry;
- Well determine in advance the routes and days in which the lorry will be used in order to ensure a rapid offloading (about ten persons).

Based on the distance between the stones' deposit and the offloading point, a lorry, which is maximally used, can carry stones required daily for the rehabilitation of 1.5 to 2 ha (in arid zone with a bund sited at every 20m) and up to 3 ha (in areas with better spaced bunds)

Stone bunds are built in the dry season when there is little to do in the farm (from December to May in the Sahel).

Environmental effects

By conserving water and very small soil particles for a longer period, stone bunds ensure an optimal growth of crops in the rehabilitated area without erosion (crops cultivation, trees cultivation, pasture).
Small particles and grains trapped in bunds enable the spontaneous growth of plants and local shrubs between stones and upstream of the bund (the most humid part).

By reducing water runoff downstream, stone bunds also contribute indirectly to reducing alluvial deposits in ponds and rivers located in the direction of the current. Lands situated downstream are less affected by water erosion and this can contribute to the maintenance of some biological species. If these rehabilitations are integrated within the range of the watershed, they can highly contribute to reducing silting and gully erosion phenomena.

Agro-economic effects

The rehabilitation of pastoral lands with stone bunds allows for the generation of an abundant herbaceous layer ahead of the bunds (at least 20% gain in dried matters), even if lands were previously bare. This contributes to providing food for livestock and even human beings (the growth of acha is noticeable - a much appreciated cereal in the Sahel).

The statistical analysis of gains derived from yields also shows a significant increase in production resulting from the construction of stone bunds. These gains in yields vary from 33% to 55% according to the nature of lands and recorded rainfall. The combination of stone bunds with planting pits is more effective for it ensures high yields. In fact, the gains in cereal yields by 114%, 116%, and 124% have been observed in the Bam province, Burkina Faso. An increase in peanut yields by 27.4% and millet by 14.1% has also been observed in 2008 in the Thiès region (Samel and Ndjack), Senegal.

Besides, the rehabilitation of agricultural lands with stone bunds allows for the salvage of cereal harvests in case of irregular rain. Couples with the use of organic manure in large quantity, rehabilitated lands can double cereal yields (especially sorghum, which adapts well to these rehabilitations). Stone bunds can therefore be profitable within 4 years, with cereals gains of 400kg/ha every year.

Social effects

By ensuring significant gains from yields and especially by cushioning drought effects, stone bunds contribute to ensuring food security of households. Besides, if stone bunds are combined with the use of organic manure, the average surplus of 400kg/ha resulting from such combination can provide for the major food requirements of two persons in a year.

The rehabilitation of lands by the use of stone bunds is also a means of explaining the land tenure system to an individual or a whole village.

Finally, the construction of stone bunds requires difficult work of crushing, transportation and fixing of stones in farms. Communities are therefore required to organise themselves in a specific way in order to carry out this assignment: the individuals help themselves one after the other in order to develop their respective farms. These arrangements foster social cohesion in villages and families. Generally, men are mobilised for works that require a lot of strength (crushing, loading and offloading) while women spread the stones on targeted lands.

Practical means of succeeding

The various tasks should be well organised since the monetary costs of the operation are mainly related to the hiring of tipping lorry: have enough quantity of crushed stones for the work of the lorry, mobilise enough persons for the loading and offloading of stones, etc.

The fact of rehabilitating lands with stone bunds is often a form of acquisition; therefore, rehabilitated areas should be in line with the land tenure system of the area.

In the context of the rehabilitation of a farm land in an individual capacity, the beneficiary's contribution in terms of labour constitutes its reward to the rehabilitation because the farm will exclusively belong to him thereafter: it is therefore not appropriate to adopt, in this case, a wage-earning approach towards labour.

Specific consideration should be given to ensure that stones are sufficiently available in the area (in large quantity and in big size). The availability of stones in large quantity often conditions the rehabilitation of a big area and it is therefore appropriate to have a prior survey of the area before any plan could be carried out regarding the rehabilitation of an area.

Sustainability

A stone bund, if maintain (replacement of fallen or displaced stones by heavy rains) could last at least 7 years. After 10 years, it will be necessary to raise its height or move it to another location since the erosion control effects would have caused an accumulation of soil that will result into an outcropping ahead of bunds. Its maintenance does not require any particular financial means but the availability of a donkey-drawn-cart. The maintenance will either involve the strengthening of the structures (transportation of additional rubble stones) or a gradual extension of the farm.

Sustainability and genuine reproduction methods are put in place in some areas: "mobile stone bunds". Since stones are not always sufficiently available, bunds are moved from one place to another after about 4 years: at this stage a small layer of vegetation or even shrubs have been developed and can practically play the same role as stone bunds. Stones reclaimed are then taken to new farm lands without much damage to the initially rehabilitated lands.

Construction cost

Based on the distance of stones' deposits and mobilisation of the local labour force, the construction cost per hectare will be between 130 Euros/ha (individual farm with stones available nearby) and 250 Euros (development of pastoral lands requiring additional financial expenses or food provision for the labour force). These average costs take into account the purchase of demarcation and crushing equipments, the transportation means and technical training. There is significant economy of scale benefits in the construction of stone bunds.

» Rehabilitation of crust soils through the planting pit techniques

Principle

The planting pit technique consists in digging small holes on highly crusted soils, which are often bare. During the raining season, these holes will retain water and soil carried along by water runoff thereby creating favourable conditions for the plantation of cereals or trees in those holes. By conserving humidity, these holes (very rewarding during the dry period) allow for the reclamation of bare lands and obtainment of high yield.

Technique

This consists in digging holes of about twenty centimetres deep with 20cm-40cm diameter on glacis soils often abandoned and deforested. After digging the hole, the soil removed from inside is deposited towards the slope. Holes are made alternately at equal distance, between two rows, in order to hold a maximum of water runoff.

The spaces between the lines and between the holes are generally about 1 metre, but can vary according to the size of production (example, sorghum/maize:
80cm x 60cm, millet: 80cm x 80cm).

Two handfuls of manure or compost are put in each hole (2T/ha), which is covered with a light layer of superficial soil (or straws) in expectation of the rainy season. With the arrival of the rainy season, the holes will therefore be filled with rain water and surface runoff and small soil particles carried by water. Based on their sizes, cereals or trees planted in those holes will enjoy the moisture conserved inside, the organic matters brought along by water runoff and a mellow loam.

If the surrounding of the farm is bare or sloping, it is recommended to add a stone bund up-farm to cushion the downward water runoff effects in order to prevent the planting holes from been rapidly filled-up

Construction conditions

The planting pit technique requires very little financial investment; the investment basically concerns labour:

- Equipments for the realisation of planting pits (picks to break the hardpan and pickaxe to dig the hole);
- Organic matter to fill the holes and transportation means (cart);
- A strong mobilisation of labour: one hectare of planting pits requires about 40 men per day of hard work.

The digging work is done during the dry season; farm lands are prepared in an individual or family capacity because of the strenuous nature of the work.

Environmental effects

The realisation of planting pits allows for the restoration or reconstitution of agro-forest lands in areas that were initially bare: it therefore contributes to the reconstitution of the environment. The retention of rain water by planting pits reduces the vulnerability of plants to occasional dry episodes (holes retain humidity for much longer period).

The high density of holes contributes to stopping water erosion effects in the rehabilitated areas, as well as the indirect disastrous effects on lands located downstream (silting of water points, water flow causing gully erosion).

Finally, by allowing for the reclamation of bare lands, planting pits also contribute to reducing land clearing in wooded areas.

Agro-economic effects

The application of the planting pit method on farm lands enables to obtain high yields (sometimes above 800kg/ha in the first year) on lands that were previously bare. It therefore generates an additional production, which strengthens food self-sufficiency of households and provides them, if necessary, with some financial incomes derived from the sale of surpluses obtained from harvested crops.

The application of the planting pit technique for the plantation of trees can also contribute to the regeneration of groves that will have multiple functions, by way of consumption or commercialisation of forest products (woods, fruits, leaves, and medicinal plants).

Social effects

Productions resulting from the application of the planting pit method contribute to ensuring food security of households. In case of significant surpluses, part of the crops could be sold to equip the house, to pay school fees of children or for medical care.

Realisation constraints

The promotion of planting pits is difficult to carry out because part of the labour force of families required for food production activities in the year are devoted to this operation.

The planting pit technique is particularly suitable in contexts where there is high pressure on lands, often experienced in areas of serious land degradation.

Some semi- mechanised systems have also been put in place by way of special animal-drawn plough. These systems are still not well popularised but could enable the development of one hectare by 7 men per day.

Practical means of succeeding

In the context of the rehabilitation of a farm land in an individual capacity, the beneficiary's contribution in terms of labour constitutes its reward for the rehabilitation because the farm will exclusively belong to him thereafter: it is therefore not appropriate to adopt, in this case, a wage-earning approach to labour, more so that the work will have to be repeated every year.

The investment in the planting pit technique implies that manure or compost will be available in sufficient quantity during the holes' digging period. This constraint must be taken into consideration during the planning of activities, for it is necessary to make provision for at least 3 tons of organic manure per hectare.

Planting pits are not suitable on highly sandy soil and in shallows. The diameter of holes will be bigger on concretionary and mellow soils (40cm) than on more compact and clay soils (15cm).

If the surrounding is bare or sloping, it is recommended to construct a stone bund up-farm to cushion the downward water runoff effects in order to avoid planting holes from been rapidly filled-up.

The practice of planting pits should be banned if the average rainfall in the area is above 800mm.

Sustainability

The practice of planting pits is very exacting in terms of labour. New holes must be dug in the second year of cultivation among those already existing, and then come again, in the third year, to the holes that were dug in the first year up to a stage that the whole farm will be gradually fertilised to the extent of allowing classical cropping after 5years.

Its reproduction is simple; once the problem of manure and its transportation is solved, it only requires labour. Furthermore, this method of planting contributes to the reduction of hoeing works during the tillage season.

Generally, by restoring the fertility of abandoned and bare lands, planting pits contribute to the establishment of a sustainable management of agricultural lands.

Construction cost

The production cost of planting pits per hectare, for the first year, amounts to 75 Euros considering the purchase of individual equipments for the digging of holes and transportation of manure. No specific expenses are expected in subsequent years.

Rehabilitation of crust soils through the application of the half-moon technique

Principle

The half-moon is a basin in form of a semi-circle, which collects rain water and focuses it in a place earmarked for crops cultivation. Half-moons are alternately arranged at equal distance according to contour lines to collect a maximum of water and reduce erosion effects. Organic manure is put in the basin in order to ensure an optimum growth of plants.

Half-moons are realised on crust soils or in farms in arid areas. They are generally carried out on less sloping lands (less than 3%).

Technique

The contour lines of areas to be rehabilitated are determined by spacing them out by 4m (or 6m in arid areas) with spirit levels and pitch triangles.

With a compass, semi-circles of 4m diameter, perpendicular to the slope, are drawn on the lines, with the opening of the "crescent" pointing to the top of the slope. Each semi-circle is spaced out by 4m on the same line. The half-moons are spaced out in such a way that they are arranged alternately at equal distance from one line to another.

Thereafter, a hole of 15cm to 25cm deep is dug inside the semi-circles. The surface arable soil is put aside and the soil removed from the hole is put on the edge by the lower side of the semi-circle (outside the dug area) and compacted into an earthen collar.

The floor of the hole is loosen a bit and the arable soil mixed with the organic manure (about one wheel barrow of manure per half-moon). The hole is ready for cropping; about 300 half-moons are required per hectare.

With this method of holes arranged alternately at equal distance from one line to another, a half-moon of about 6m² area will receive water from an impluvium of 10m² (2m space between the lines) or even more based on the distance between the lines (26m² with a 4m space between the lines). By so doing, it will locally focus water, whereas without this operation, rainfalls would have been inadequate to expect a good yield.

Very small half-moons of 2m diameter can also be done and their spaces be adjusted accordingly (2m space between the lines and between the holes). The smaller the holes, the longer the time that will be required to draw the lines per hectare.

The half-moon technique can also be used for reforestation. In this case, very deep basins will be dug to facilitate the growth of trees' roots.

They can also be used without organic manure for the regeneration of herbaceous layer for pastoral purpose.

It is necessary to mention that a mechanised technique for the digging of half-moons exists (Delfino type of carts) but it requires logistic and initial considerable financial investment capacity, which is not beneficial for the fertility improvement of small farm lands or groves within a village. It is more recommended for the rehabilitation of several hundreds of hectares of degraded lands (pasture).

Production conditions

The production of half-moons is an exercise, which is a bit technical and which requires an initial training and a field visit to persons already using the technique. At least two persons are required to draw the lines on the farm land. The equipments required for the operation are less expensive but specific:

- The contour lines are classically drawn with a pitch triangle and spirit level. The drawing must be very precise because a mistake in the orientation of half-moons by some tens of degree will reduce their effects;
- The semi-circle is drawn with a rigid compass or simply with a rope held at one end at the centre of the circle and the other end is attached to a nail in order to draw the semi-circle;
- A pick, a pickaxe and a shovel are required to dig the basin;
- A large quantity of manure or compost is needed as well as equipments to move them to the spot where they will be used;
- A strong mobilisation of labour is necessary but the work, in this case, is less strenuous than the planting pit technique.

Half-moons are simple orientated earthen collars, which must be protected from eventual water runoff from higher surface, in order to prevent them from been filled up in case of heavy rain. They are generally combined with stone bunds in farms affected by dry spells.

The "classical" half-moons described in this write up are suitable for arid (not more than 600mm rainfall) and less sloping areas of the Sahel. In very sloping areas, the earthen collar must be fortified with stones or alternative techniques should be adopted.

Environmental effects

By improving the conservation of water in the basin, the half-moon enables vegetation growth in areas where plants could not previously grow due to shortage of rainfall and the crusty nature of the land. The herbaceous and woody layer can therefore re-emerge. The conservation of water in basins also contributes to recharging ground water through infiltration.

The use of the half-moon method allows, year in year out, for the gradual resurgence of the herbaceous layer between the lines; and woody shrubs also frequently grow close to the earthen collar, thereby contributing to its reinforcement. Whenever 400mm of rain falls, the half-moon effectively focuses the equivalent of 800mm owing to the impluvium in the higher surface. By so doing, it contributes to the return of micro-fauna.

Agro-economic effects

The improvement of soil fertility through the application of the half-moon method enables to obtain high yields (often above 800kg/ha) right from the first year on lands, which were faced with water deficit. In effect, it generates some surpluses, which strengthens food-self sufficiency of households and also provide them with substantial income.

The rehabilitation of forest lands or restoration of pasture through the half-moon technique can allow for the regeneration of grasslands (rapidly) or groves (at least after 4 years) that will be very useful in terms of food, medicinal plants or commercialisation of forest products (woods, fruits, leaves, roots, etc.).

Social effects

Productions derived from the adoption of the half-moon contribute to ensuring food security of households. In case of considerable surpluses, part of the harvest is sold to equip the household, pay school fees of children or for medical care.

Generally, by contributing to the restoration of soil fertility of abandoned and bare lands, it enables the establishment of a sustainable management of lands in spite of the arid conditions.

Practical means of succeeding

The main difficulty lies in orientating well the "mouth" of the half-moon perpendicular to the slope with the opening facing upstream. If it is not done as described, the surface runoff will erode the structure to the detriment of plants.

Digging half-moons on very sloping lands and/or without protection against heavy surface runoff will not provide good results.

That is why during its construction, earthen collar must be implanted outside the semi-circle in order to increase the tillable area and the water retention effects of the structures.

The production of half-moons in large quantities implies that manure and compost will be sufficiently available during the holes' digging period.

This constraint should be taken into consideration during the planning of activities because, ideally, 9 tons of organic manure are required per hectare of half-moons.

In the context of the fertility improvement of a farm land in an individual capacity, the beneficiary's contribution in terms of labour represents his reward for the rehabilitation of the said farm since he will have an exclusive use of the farm thereafter: it is therefore not appropriate to adopt a wage-earning approach regarding labour, more so that the work will have to be repeated every year.

Sustainability

Based on the nature of the soil, half-moons should, more or less, be repaired regularly considering the subsidence of the earthen collar.

The structures are repeated annually on farm lands during the preparation of farms for cropping. Part of the earth removed from the holes the previous year and the residues of input still available in the basin are used for the purpose. In the case of forest lands, the earthen collar built at the mouth of holes are raised on a case by case basis after heavy rains.

Half-moons required an annual work of partial reconstruction but their reproduction is simple in that once the problem of manure and its transportation is solved, what remains is labour.

Production cost

Considering the purchasing of individual equipments for the digging of basins and a cart collectively managed for the transportation of manure, the construction cost per hectare will amount to 75 Euros in the first year. For the subsequent years, no specific investment is expected at least within the next 5 years.

Rehabilitation of crust soils through the earth bund technique

Principle

Erosion control earth bunds are large scale structures (about 80 linear metres) devised to collect water runoff of big glacis. Therefore, very big basins are dug to facilitate in-depth infiltration of water and to ensure the regeneration of plants on bare/glazed lands and reduction of the surface runoff effects on crusted areas towards the slope. They are suitable for a large scale rehabilitation of watersheds with a view to reducing intense gully erosion phenomena.

Technique

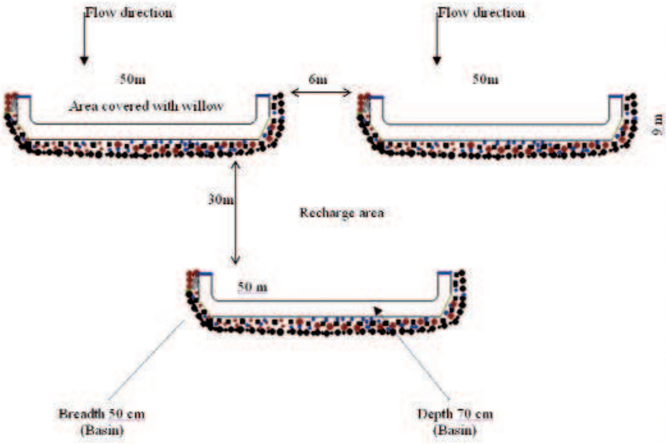
First, contour lines must be determined in areas that are meant for rehabilitation. Since rehabilitation through the application of the earth bund method generally involved several tens to hundreds of contiguous hectares of lands, it is more advisable to seek the service of topographers for some days.

The location of earth bunds is drawn: a straight portion of about 60m perpendicular to the slope with circular wings of about 10m at each end, each facing upstream. Earth bunds are spaced out by 6m on the same contour line. Each bund line is spaced out by about 30m. Earth bunds are arranged alternately at equal distance in such a way as to receive the surface runoff from upstream.

The next task will consist in digging the earth bund: a highly compacted earthen collar of about 70cm high by 2m breadth is implanted at the edge, towards the slope of the drawn area. It takes the form of "C" and stretches up to 80m. Earth is removed from inside of the structure resulting into the formation of a big basin (at least 50m long and 2m wide).

A team of about 8 persons is required per day for the construction of an earth bund. A rehabilitated area averagely accommodates 6 structures/ha (case of Marhaba project, 2006).

Rain falling on glacis is held and conserved in earth bunds. Sowing directly in earth bunds (grasses and local trees) is important because it will accelerate the regeneration of vegetation cover.



Source : Federation MARHABA

Construction conditions

First, identify areas with considerable glacis within a watershed and discuss with people, traditional and public authorities on the possibility of rehabilitating those areas (acceptance, land status, etc.). The availability of big wadis in an expanding phase will facilitate the detection of glacis priority areas for the rehabilitation operation.

Since the operation will be carried out on tens and even thousands of hectares of lands with several persons involved, it will require an excellent training and coordination capacity. Provision should also be made for:

- Topographic equipments with a team of experts in the field to draw contour lines (to be hired);
- Equipments to draw earth bunds' lines (decametre, string line, pick to break up the surface of soil);
- Earth moving equipments suitable for hard soils (picks, pickaxes, shovels wheel barrows, hand compactor);
- Labour in high quantity (at least 80 persons per day to assist the technical staff);

An initial technical training is necessary for operators as well as a regular supervision of sites in order to ensure the quality of structures.

Earth bunds are neither suitable for areas with heavy rainfalls (600 millimetres maximum, if not they may burst), nor for very acute slopes (stony structures or trenches will be preferable), or sandy soils.

Earth bunds are only built in the dry season. The earlier they are completed in the dry season, the more the herbaceous regeneration effects will be rewarding (gradual accumulation of native seeds carried along by the wind into the basin's depression).

Environmental effects

This operation enables to reduce water runoff on very bare areas by conserving soils. A regeneration of the herbaceous and even shrubs layer also takes place in the bunds' basins right from the first year. This contributes to the resurgence of new species (herbaceous and shrubs), which gradually colonise the spaces between the bunds.

Each basin also collects the surface runoff of several thousands of m²: this results into water infiltration for the benefit of vegetation, micro-organisms and ground water.

The rehabilitation of bare lands also enables indirectly to protect vegetations (towards the slope) from the effects of an intense surface runoff. In fact, these structures prevent the expansion of wadis, which are often responsible for the silting of water courses and the destruction of woodlands by gully erosion.

Economic effects

The method directly allows for the reclamation of pasture areas from bare lands. The immediate benefit for animals in these zones is considerable but represents little in terms of economic gain. Consequently, financial investment regarding these structures cannot be directly recouped to the land.

The main economic significance lies in the prevention of disastrous effects (towards the slope) that are very costly in terms of repairs and socio-economic damages. In fact, the erosion of big glacis is often responsible for heavy water flow (of wadis), which destroys road infrastructures (urban and rural) and causes the disappearance of portions of farm lands, market gardens and silts ponds and water courses downstream. The investment is economically rewarding if those factors are taken into account.

Social effects

Earth bunds are built on extensive bare lands, which often belong to communities. Since there is practically no direct financial benefit emanating from these works and considering the extent of works required for the construction of earth bunds, this type of action over hundreds of hectares of land requires financial or food support to operators.

Resources collected by working groups, generally during the dry season, enable to resolve food scarcity problems (common in these climatic zones during the period) and other types of expenses (purchase of drugs, food items, etc.). Consequently, earth bunds contribute to food security of households and reduction of rural-urban migration during the dry season.

Practical means of succeeding

Since land rehabilitations are carried out on extensive land areas without direct and immediate economic benefit, a partial compensation should be provided for operators in return for their efforts to the realisation of the structures. Even if the structures are for the good of their community, it will be difficult to divert the inhabitants from their usual agricultural, pastoral and remunerating activities in order to participate freely in these strenuous, time-consuming and exacting jobs.

The drawing of contour lines and orientation of the "mouth" of the earth bund directly perpendicular to the slope and facing upstream must be carefully respected. If it is not done as described above, the surface runoff will rapidly erode the structures.

Earth bunds are not suitable in sandy soils; stone structures are rather recommended for those areas.

During the construction phase, efforts should be made to position the earthen collar outside the dug area in such a way as to maximise the retention capacity of earth bunds. The height of the earthen collar, which is 70cm after digging, must also be measured in relation to the initial land surface (for example the portion towards the slope): after the rainy season and compression effects, this earthen collar will be left with enough height of about 50cm.

Considering the volume of water that will be retained by these structures, the talus must particularly be well compressed, for example with a manual compactor, in order to avoid successive bursting of earth bunds in case of heavy rainfall.

Finally, considering the logistic requirement and labour, the numerical goals must be well measured with a view to obtaining sufficient labour and if necessary transportation means if rehabilitation sites are very far from homes.

Sustainability

Earth bunds, if correctly compacted, can have a retention effects for a maximum period of 5 years. The spontaneous or re-sown vegetation, which had grown in the impluviums and between the lines, would have been perpetuated after the deadline. Once they are constructed, earth bunds do not require regular maintenance but a minimum control of wandering animals will reduce the deterioration of earthen collars by big animals and also facilitate the resurgence of vegetation.

Construction cost

Since rehabilitations are carried out on extensive and contiguous areas, the final cost of construction will be influenced by the labour cost.

Taking into account the cost of equipments, training, drawing of contour lines and based on a partial compensation of voluntary operators, the construction cost will amount to about 140 Euro/ha (including $^2/_3$ in financial and food support).

PAPER 6

» Rehabilitation of mangrove lands (desalination of mangrove rice fields)

Principle

The use of shallows liable to flooding for the cultivation of rice is common in the mangrove areas of the West African coast (Guinea Bissau, Senegal, Gambia, etc.). Mangroves are located in estuary plains on very rich alluvial soils. Their rehabilitation is very delicate. In fact, the physico-chemical properties of mangroves encourage some reducible chemical reactions, and if these properties are modified (due to deforestation for example) it results into an intense oxidation, which releases some acidic compounds that can lead to the complete sterilisation of soil, which consequently renders them unfit for rice cultivation.

In Guinea Bissau, a traditional method for the cultivation of rice called the "bolanhas" system is used to maintain soil fertility. This traditional method consists in building an earth dike in the shallow of a lagoon oxbow, downstream of the area that will be used for cultivation, so as to prevent the superficial rising of sea water and allow rain water to wash away salt particles in order to reduce the salinity of the area earmarked for rice cultivation upland.

This technique nowadays has some limitations attributed, on the one hand, to lack of rainfall, which no longer allows for a correct downward leaching of those areas by fresh water, and on the other hand, to its traditional drains mechanisms (trees hollowed trunks). In order to solve this problem, a NGO LVIA had modernised this technique, owing to the funding of a CILSS/RIGEDC programme, by using the PVC pipes, which are more resistant and lasting, for the drainage of salty water. This improved method enables to cultivate rice, after two to three years, on this mangrove rice fields that were formerly salty.

Technique

- **Control of water flow :** this procedure consists in building an earth dike (salt control dam). The height and length of the dike depend on the targeted area. This dike controls the water level and isolates the land from the influence of the rising sea water. The characteristics of regions/areas should be taken into account in the planning of the salt control dam.
- **Soil leaching :** in order to facilitate leaching by fresh water and prevent the dike from bursting, provision must be made for two, three or four channels (drains). This drain was traditionally realised through hollowed trunks. But this technique had been modernised with the use of large diameters PVC pipes, which are more resistant and lasting. Rain water will gradually wash away the salt on the superficial layer upstream of the dike and soil aeration will be improved.
- **Maintenance:** the maintenance of the dike and management of water are the major operations required for the sustainance of the structure. These operations are permanent.

Construction conditions

The construction or rehabilitation of earth dikes requires an extensive labour, in other words, it is based on a family or community organisation that allows for the mobilisation of a large number of people sometimes from several villages. Efforts should also be made to ensure an effective support of stakeholders (consensus, land status, etc.). Also, provision should be made for equipments and food for work.

Environmental effects

The bolanhas system aims at substituting the slash-and-burn cultivation of surrounding forest. Therefore, it contributes to the conservation of forests and their light fertile layer. The productivity of a bolanha farm in terms of rice cultivation enables to protect at least twice its area from slash-and-burn cultivation.

It also contributes to reducing deforestation of high lands, and ensures the rehabilitation of lands deteriorated by salinisation through the resurgence of grasses.

Agro-economic effects

- Increase in the size of tillable areas and improvement in rice production;
- Increase in families' incomes and reduction of the vulnerability of households in relation to the fluctuation of prices proposed to cashew-nuts producers.

Social effects

The main advantage is the production of the bolanha rice, which offers a high yield per hectare. This contributes to the food security (production of rice for feeding purpose) of the concerned rural households. The rehabilitated areas often belong to the community and the construction of dikes requires some dialogues and planning. This, consequently, strengthens the organisational capacity of people and also contributes to furthering social relationship in the group.

Sustainability

The sustainability conditions of the rehabilitation of mangrove rice fields are two fold:

- Firstly, the cost effectiveness of this production system in relation to other available productive options;
- Secondly, social and organisational conditions are determinant. In fact, the rehabilitation of dikes requires an extensive collective labour, not only for its construction but also for its regular maintenance. The lack of sufficient labour or an effective social organisation to guaranty collective work affect the operation of dikes, which quickly lose their functions resulting into an increase in the salt content in the soils, thereby preventing the continuation of rice cultivation.

Cost

Considering the community-based equipments (shovels, pickaxes, etc.) and the purchase of big diameter PVC pipes (2 to 3 per mangrove rice field based on the length of the dike), the average cost per dike is estimated at 1,250,000 FCFA. This does not include labour. Also provision should be made to reward workers with food in compensation for their efforts in the construction dikes.

PAPER 7

Reforestation

Principle

Concerning desertification control in the Sahel, reforestation is without doubt the most obvious action to protect and reconstitute a bare environment. An artificial reforestation can be realised through direct seedling and/or plantation.

Reforestation, in the desertification control (DC) projects, consists in the re-establishment of tree crops on bare lands, in farms, restricted areas, areas protected by live fences, sacred forests, along dikes, public places, etc. Reforestation can be collective/community-based, individual or familial.

Plantation technique

Plantation micro-projects are carried out through the implementation of successive operations: selection of sites (geographical, soil and land constraints), provision of farm implements necessary for the plantation, self-production of seedlings in nursery or purchase of seedlings, sowing of seedlings, monitoring and maintenance of plantations. Attention should particularly be focused on the following operations:

- **Digging:** dig plantation holes of 60cm x 60cm and 50cm deep;
- **Plantation period/sowing of seedlings :** In the Sahel, the best period for plantation is the rainy season (June-July) in order to ensure the survival of trees without subsequent watering. Facilitation measures can be introduced (stone bunds, half-moons, trenches…) to increase the water retention capacity of the soil. However, if water sources are sufficiently available, the plantation can be done at any period of the year;
- **Plantation density and choice of seedlings:** the recommended spacing varies from 4m x 4m to 8m x 8m depending on soil fertility;
- **Monitoring and maintenance :** Be constantly available in the days following the plantation. Plants growth will depend on subsequent care (weeding, pruning, mulching, watering, control of bush fire and animal wandering).

Materials and tools necessary for the plantation should also be prepared in advance.

Reforestation conditions

In order to successfully carry out a small scale reforestation (community-based, individual, etc.):

In order to successfully carry out a small scale reforestation (community-based, individual, etc.):

- Discussion should be held with the population of the area concerned with a view to targeting the plant species that will be required for the operation in relation to their needs (forest tree species, fodder or fruit plant species…).
- A technical training in the reforestation techniques should be provided;
- Possess bio-physical information on the species that will be planted, on accepted norms and on the land tenure system of the reforestation site;
- Chose the appropriate period because the plantation must be done in time, as soon as the quantity of rainfall is considered to be satisfactory and based on the ethno-botanical information;
- Take into account the socio-economic factors, which are important for the success of reforestation operations: availability of labour and equipments (shovels, pickaxes, pails, ropes, etc.), distance of the plantation in relation to nursery beds and the village, availability of a water point, monitoring and maintenance strategies after plantation/motivated monitoring, level of generated incomes and sharing of same, land titles that beneficiaries can enjoy;
- Encourage individual or familial plantations that provide good results (rate of survival of trees are very high) compared with community-based plantations.

Environmental effects

Ecological effects are very difficult to quantify in the short-term. However, reforestation brings about the biological reconstitution/regeneration of bare and crust soils, the reduction of surface runoff, the improvement in the life of residual wildlife and the return of species. It also, ensures the resurgence of wind-breaks, sequestration of carbon dioxide, the improvement of water infiltration and the rising of nutritive elements from underground to the surface.

Economic effects

- Production of fire-wood and timbers;
- Availability of forest non-woody produce for households (fruits, dyestuff, medicinal plants) and fodder for animals.

For example, in the case of an eucalyptus plantation, the initial financial investment can be recouped right from the first harvest-year, that is to say after 3 to 4 years of trees growth. An adult mango tree produces an average of 400 kg of fruits/year.

Social effects

- Reforestation works require dialogues and planning. This fosters solidarity and social cohesion in villages and among villages;
- Improvement in the living conditions, especially the reduction of wind speed and all its corollary damages;
- Building of technical, organisation and logistic capacity of people;

Sustainability

The sustainability of reforestations depends on several factors:

- Cost effectiveness;
- Land status/conflicts;
- Non-taken into account the requirements of beneficiaries;
- Form of plantation (live fences/wind-breaks, demarcation of boundaries of farm lands, etc.);
- Lack of plantation culture of or familiarity with forest tree species;
- Organisation capacity of Individuals, groups or associations.

Cost

In the Sahel, a reforested hectare of land costs at least 200,000 FCFA. The cost of a plant nursery (well/borehole not included) is between 500,000 FCFA and 1,200,000 FCFA. The buying price of forest wood species varies from 50 FCFA to 150 FCFA while fruit plants are sold at between 750 FCFA and 1,500 FCFA

» Assisted natural regeneration and restricted area

Principle

The assisted natural regeneration (ANR) is a combination of interventions, which consists in protecting and maintaining the growth of local species that have been identified for their economic, social, and cultural value. The assisted regeneration of local species applies to agriculture, animal breeding, forestry and erosion control.

Restricted areas are areas that are closed to any form of exploitation during a given time in order to allow for plant regeneration in those areas. The restricted area can either be closed (barriers) or opened (under control or surveillance). It is especially applied for the conservation or rehabilitation of forest and pastoral lands.

Technique

Assisted natural regeneration: Its implementation is simple and depends on the following:

- Making an inventory of the existing woody species (sorting out of tree species, observation of the stump) location and identification of sprouts;
- Selection of species and trees that should be protected: 25 adult trees per hectare and 60 to 80 sprouts or suckers per hectare;
- Marking/identification (paint, pegs, etc.) of selected trees;
- Protection and maintenance (dead fence, trimming/pruning, digging of half-moons) around the young plants.

Restriction of an area : It is done by:

- The demarcation of boundaries in order to have an idea about the surface area of the land;
- The materialisation of the boundaries (paint, sign-boards, etc.);
- The opening of fire break around the perimeter;
- The protection and development of the restricted area through the plantation of useful species;
- The provision of guard service for the area (organisation of area surveillance, etc.).


Conditions for Assisted Natural Regeneration

- Target areas that are meant for development (land tenure system, surveillance capacity of the area);
- Clearly define with the people species that should be regenerated and the expected benefit (fodder, fire wood, soil fertility);
- A training in the assisted natural regeneration (ANR) techniques and the management of community-based forests is necessary;
- Provision of suitable farm tools (cutlasses, shearing knives, pickaxes, shovels, ropes, etc.);

- The restriction of an area also entails putting in place a management committee and laying down of simple management rules (by consensus) to guide the various beneficiaries of the forest resources. Make provision for basic equipments. Regeneration can be accelerated on seriously degraded lands through the plantation of trees or direct sowing of herbaceous species and through erosion control measures.

Environmental effects

- Restoration, reforestation and protection of lands (contribution to the restoration of soil fertility);
- Harmonious development of local forest tree species;
- Conservation of the bio-diversity; improvement in water infiltration, reconstitution of the herbaceous layer, resurgence of animals and vegetation species that have disappeared through the reconstitution of habitats.

Economic effects

Availability of fodder and useful local trees (lumbers, fruits, medicinal plants…).

Social effects

The exploitation of forest woody and non-woody produce enables people to meet some of their needs (incomes, food complement). Generated incomes are often reinvested in the family's farm business. Restricted areas are generally community-based, and organisational structure is strengthened through the creation of management committees for the jointly owned natural resources.

Sustainability

- **Assisted natural regeneration (ANR):** It is a very simple activity, which does not involve any particular technical difficulty. Its reproduction is simple and ANR is generally practised on agricultural lands (farm lands); the protected species have socio-economic value (African locust, shea butter tree, etc.).

- **Restriction of an area:** Restricting an area is somewhat simple. The main threats to the restriction of an area (community/village forests) can emanate from the non-observance of management rules laid down (by consensus) by the various users of the forest resources. The sustainability essentially depends on the smooth running of the management committee and the cohesion of stakeholders on consensus reached concerning the conservation of the restricted area (lack of conflicts of interest in the use of the restricted area).

Cost

These are activities that are entirely carried out by peoples (low financial investment). Make provision for farm tools: (cutlasses, shearing knives, pickaxes, shovels, ropes), sign boards and training cost.

PAPER 9

» Silt control (sand dunes fixation)

Principle

The principle consists in stabilising moving sand. The objective is to put off the source of moving sand and also prevent sand from moving thereby protecting lands and infrastructures from sand silting.

Technique

Several techniques can be adopted for the control of silting. These techniques involved two important procedures: the mechanical and biological control of silting. The most adopted methods in the Sahel are described as follow:

Mechanical methods (mechanical fixation)

The mechanical method consists in stabilising the movement of dunes by establishing a protection network against the wind transportation of sand by putting in place a sand fixation mechanism (wattle enclosure). The wattle enclosure can be linear or closed. The linear wattle enclosure or unclosed palisade is generally used in the protection of infrastructures threatened by silting. This method enables to stop and prevent the movement of sand. The closed wattle enclosure is used to stabilise live dunes. It is a network of palisades called screens. These screens are square, rectangular or lozenge-shaped in form and their sizes vary according to the movement of mobile dunes (20m x 20m, 30m x 30m, 40m x 40m). Their length vary between 900 ml/ha and 2000 ml/ha, and their apparent height from 1 to 1.20m. The wattle enclosure is made of unmovable plant materials (Leptadenia pyrotechnica, calotropis procera, Euphorbia balsamifera, Guiera senegalensis, palm trees' leaves, branches of thorny shrubs, etc.). The choice of materials depends on the cost, characteristics of the area and supply facilities. The wattle enclosure can also be realised with synthetic grille (plastic film, polyethylene, etc.).

The wattle enclosure restricts sand movement within the closed area and by so doing, allows the regeneration of the vegetation cover. It also plays the role of wind-break until planted trees are able to perform this function.

Biological methods (biological fixation)

The biological method comes after the mechanical method. It involves the planting of trees among screens. The unmovable materials used for the fixation of sand dunes cannot provide a permanent protection due to their limited life span. Therefore, the biological intervention ensures the continuity of the sand fixation after the wear out of the unmovable materials. The establishment of a vegetation cover, through the plantation of trees or restriction of an area, also requires the best plant species suitable for the ecological conditions of the zone meant for rehabilitation at relatively low cost (of the nursery, plantation and maintenance). For example, the widely used species in the Sahel for sand dunes stabilisation are the following: Panicum turgidum, Prosopis jujiflora, Zizyphus mauritiana, Balanites aegyptiaca, Leptadenia pyrotechnica, Acacia senegal, Acacia radiana, Parkinsonia, aculeata, Australian pine (casuarina equisetifolia), Eucalyptus camaldulensis.

Monitoring and maintenance

After the mechanical and biological fixation, efforts should be made to monitor and maintain the structure: guard service, repairs of damages caused by animals, human beings and fast winds, watering if possible, resurfacing, etc.

Sand dune fixation conditions

- Possess a good knowledge of the ecological factors and wind dynamics of the area to be managed;
- The socio-economic importance of the site meant for protection and side benefits;
- Take into account the requirements of the people of the area and especially their degree of motivation to participate in the operation;
- The status of the sites meant for protection;
- Provide a technical training;
- Sand fixation cost;
- Monitoring and maintenance strategy after the operation.

Environmental effects

- Stabilisation of dunes and restoration of a vegetation suitable for the environment;
- Improvement of soil fertility;
- Some species like the Australian pine has a strong capacity of nitrogen fixation in the same way as leguminous plants and highly contributes to the sequestration of carbon dioxide.

Social effects

- The fixation of sand dunes improves the living conditions of the environment thereby promoting a permanent settlement of people in an area and a transformation of the structure of the habitat. This gives rise to an increasing permanent settlement of nomadic people into villages
- Protection of basic socio-economic infrastructures (boreholes, wells, schools, earth roads/highways,);
- In term of organisation, there is new emerging decision making mechanism (organisational dynamics), which is increasingly making an impact along side the classical structures. This fosters solidarity and social cohesion in villages and native lands.

Economic effects

- Improvement of soil fertility and protection of production sites (market garden basins, oasis, wadis, etc.);
- Improvement of dunal pasture;
- Production of fire wood and lumbers.

Sustainability

The sustainability depends on several factors:

- The objectives and the value of the site;
- Non-taking into account of the requirements of beneficiaries. The objectives of the operation should be in line with the concerns of stakeholders;
- Land status, conflicts among the beneficiaries in the area;
- Monitoring and maintenance strategy.

Construction cost

This involves the cost of the production of palisades and screens, costs of plantation (production or purchase of seedlings), labour (financial or food support), equipments, training and management.

PAPER 10

» Stabilisation of gullies (treatment by stone dikes)

Principle

Gully erosion is one of the visible forms of erosion. The stabilisation of gullies through the construction of stone dikes is one of best methods to stop the progression speed of erosion or deal with the erosive and hydrological constraints caused by heavy rain or rapid water flows. Stone dikes are erosion control mechanisms constructed across gullies perpendicularly to the flowing direction of water in order to prevent flooding during heavy rain (erosion control) and also to facilitate the infiltration of water and sedimentation of solid particles ahead of the dike in a very big area.

Technique

- **Choice of the location of a dike:** the stone dike should be located on a line where the landform is less affected, that is, in the less deep and wider part of the gully.

- **Topographic survey:** For the realisation of a stone dike directing water flow out of a watershed towards fields, a contour line must be drawn for the construction of the structure.

In the case of the management of gullies, the size of dikes should be materialised with pegs according to the following steps:

- Plant a peg on one of the banks of the gully and then stretch a string horizontally in such a way as to reach the other bank;
- Plant other pegs every 5 to 10m according to the breadth of the gully in such a way as to maintain the string horizontally;
- Put a stone at 50cm distance upland to every peg and another stone twice the height of the peg towards the lower area;
- Draw a line in order to join the different stones together. This line forms the limits of the base of the dike.

- **Construction of the stone dike :**
  - Dig the anchor point (20cm deep);
  - Put a layer of gravels in the trench;
  - Then fill with blocks of stones up to the crest in such a way as to obtain a slope of 1 over 2;
  - Reinforce the surface with big stones;
  - Construct a dissipator basin at the level of the gully's bed by putting some blocks of stones in the direction of the water flow;
  - Make some wings of about 5 to 10m long at the tail ends of the dike.

Construction conditions

First:

- Identify the strategic areas of the watershed to be managed and encourage the overall rehabilitation of the watershed;
- Possess geomorphologic and bio-physical data on the area;
- Make provision for the CES/DRS rehabilitation in the area upland with a view to reducing the speed of water flow coming from the watershed;
- Use vegetation species instead of stone dike in case of the unavailability or inadequacy of stones;
- Discuss with people on the necessity, urgency and possibility of rehabilitating the area (land status, etc.);
- Identify seriously affected areas, which are perpetually widening. This enables to target the priority areas to be stabilised;
- Organise training sessions to build up people's capacity in order to ensure the quality of structures;
- Have enough labour (make provision to reward workers with food in return for their efforts in the operation);
- Provide logistic for topographical work and experts to take measurements, draw lines and identify the location of structures;
- Possess appropriate equipments (picks, shovels, pickaxes, crowbars, hand compactors, wheel barrows, etc.).
- Can be used in the sahelo-sudanian zone where rainfall varies from 600mm to 1000mm.

Environmental effects

- Reduction of water erosion;
- Facilitate sedimentation and infiltration upland of the structure;
- Rehabilitation of degraded lands through the supply of vegetation matters by way of surface runoff;
- Biological regeneration of degraded lands.

Social effects

It also contributes to furthering solidarity and social cohesion at the level of the village or among villages and to building technical, organisational and logistic capacity of people concerned.

Economic effects

The stabilisation of gullies promotes the supply of water to plants and soil fertility (expansion of tillable areas), hence the possibility of an improved agriculture and food security.

Sustainability

The participation, mobilisation and cooperation of people are an assurance for the success of the implementation of gullies' stabilisation structures. It guarantees the monitoring and maintenance of the constructed structures. A fair sharing of benefits derived from the implementation of erosion control structures also contributes permanently to the motivation and commitment of people.The land status should be well understood with all its inter-relation and implication consequences. Individuals or family structures are long-lasting, better constructed and maintained; their yields are also high.

Construction cost

This involves the costs of labour, financial or food support, topographic services, hiring of tipping lorry for the transportation of stones, training, equipments and management. Considering the characteristics of the activity, the contribution of people should be in form of unskilled labour.

The construction of these structures should also be directed by an experienced person.

Flood-recession cultivation dike

Principle

This is a traditional method used in the saharo-sudanian zone. The technique has been improved upon thanks to the introduction of development projects. The objective of the dike is to hold surface runoff or water from a wadi in order to compel it to infiltrate the ground. Lands located upland are therefore well humidified and put to agricultural use. Flood-recession cultivation is practised at the end of the rainy season.

Technique

The traditional technique entails the construction of a dike, a simple bund of compacted soil (anchored on the ground) perpendicular to the surface runoff or water flow direction. The height of the dike can attain 3m and its length several metres.

The modern dike is reinforced with stones at the base and equipped with a spillway and an outlet structure to allow for a slow evacuation of water from the retaining reservoir and to protect the dike in case of submersion risk.

Construction conditions

- Availability of labour;
- Taking into account of and understanding issues related to the social and land aspects of the site;
- Provision of equipments (shovels, pickaxes, wheel barrows) and in some cases earth moving machines (bulldozer, etc.). The financial investment in the structure depends on the topography of the terrain and potential of the tillable area;
- The construction of dikes can be individual, familial or collective;
- Dikes should not be sited on major wadis;
- They are generally built in existing depressions whose surroundings are glacis.

Environmental effects

- Reduction of surface runoff downstream, filling up of gullies and ephemeral streams (loam deposit, soil fertility);
- Reclamation of lands and increase in ground infiltration;
- Gradual reconstitution of the herbaceous layer downstream.

Agro-economic effects

- Expansion of cultivable areas;
- Improvement in agricultural production (the minimum production can attain 400kg/ha);
- Availability of water for human beings and livestock.

Social effects

- Improvement in food security;
- Permanent settlement of people into villages;
- Securing community-based, families or individuals' lands

Sustainability

The sustainability of a dike depends on the availability of labour for the maintenance and annual repairs of dikes and especially on the individual or collective organisation. The life span of a dike without an outlet structure is three years maximum.

Cost

In Mauritania, the average cost of a simple traditional dike of about 100 metres long (in 2006) is estimated at 100,000 UM, that is about 225,000 FCFA, while the cost of a modern dike (300m to 400m long) with stone base, equipped with an outlet structure and requiring the use of an earth mover (bulldozer) is estimated at 1,250,000 UM, that is 2,250,000 FCFA.

PAPER 12

» Some approaches developed within the framework of the RIGE/DC projects… for more efficiency and sustainability[2]

1. A new approach to reforestation: "reforestation by contract"

Background

Faced with the failure of classical reforestation like that of village woodlot and collective reforestation approaches, SOS SAHEL International, Burkina Faso had introduced since 2001, the "reforestation by contract" approach within the framework of its projects. This approach, which was co-sponsored by CILSS/RIGE/DC, the European Union, Europe Echange and SOS Sahel, had been used in the implementation of the project "Sustainable management of Natural Resources in fifteen (15) villages of the districts of Tikare and Rouko, Burkina Faso (2006-2008). This approach is in line with the objective of restoring and conserving the environment by reforesting deforested areas and combating the disappearance of certain species through the plantation of trees.
This approach attaches greater importance to individual or collective commitment, which is based on the principle that every interested producer participates in reforestation with his own resources (monitoring/maintenance). He is thereafter rewarded for his efforts after two years. Trees obtained from the forest belong to planter or planters. The project invests on deliverables and beneficiaries are doubly rewarded (financial gains and forestry depot).

Approach description

- Create a contingency fund that will be used to pay motivation allowances after two years;
- Inform and sensitise farmers in order to identify candidates;
- Empower candidates (technical training in plantation and vegetation protection techniques, etc.);
- Arrange and sign a contract between the planter-candidate and the project;
- Define evaluation criteria and agree on allowance by consensus. At this level, the agro-forestry approach in farms is given greater importance: plantation of shea-butter trees, African locust, mango trees, guava trees, acacia albida, acacia Senegal, etc.
- Put in place a tree-census taking committee so as to facilitate the activity. This committee in turn creates tree-census taking teams. Each team must be composed of one representative from the village and two other representatives from two different villages. Each tree-census taking team organises itself in its own way to do the counting in farms. The calculation is done in the presence of the planter who is not a member of the team.
- Finally, pay the reforestation allowances based on the surviving young trees after the two years fixed by producers in concert with the project.

End results

This approach has significantly contributed to the survival rate of young trees (70%) whereas the survival rate is about 10% for the classical approach. In fact, out of the 15,000 trees planted and maintained by 62 producers, 14,032 plants of different species have survived, that is 93.54% and 2,625,025 FCFA (4002 euros) was paid as allowances. Reforestation by contract has reinforced people's accountability with regard to reforestation because it is not only a matter of planting young trees but also a matter of maintaining them. Mr. A Raka, a forest developer, uses his daughter to guard his young trees as it is the case with guarding herd of animals. Besides, the number of developers who are supporters of reforestation by contract is continuously increasing. It should also be noted that the high success rate is due to the principle of making fully accountable individuals and households with regard to the plantation and maintenance of trees. However, it is important to state that besides the incomes, yields improvement, other benefits they derive from forest reconstitution and development, reforestation by contract has had a strong impact on the comportment of people towards their environment. Nevertheless, it should be emphasised that the problem of water to feed some young trees and animal wandering are concerns that contribute to limiting the efforts of stakeholders in this field.

2 For more information on these projects, refer to volume 2: catalogue of micro-projects.

Success conditions

- Voluntary commitment, accountability;
- Evaluation rules are known right from the beginning;
- Free choice of species to be planted;
- Technical training;
- Smooth running of committees.

2. Financing of management committees: an approach which facilitates acquisition and ensures sustainability

Background

The sustainability of the gains of the DC projects has, in some cases, been limited due to organisational weakness of management committees put in place and lack of an internal financing strategy. After the closing of projects, management committees no longer function and equipments and materials acquired deteriorate and are no longer renewed. The major consequences of this established fact is the difficulty in continuing the activities. As a result, people and NGOs are perpetually seeking for new sponsors in order to acquire new equipments to continue the activities.

In Burkina Faso, the Nong-Taaba Association (ANTD) could not avoid this reality. It had witnessed, in the last eight years, some mixed experiences concerning the management of equipments acquired with funds provided by several sponsors. However, within the framework of the RIGEDC's sponsorship for the restoration of soil fertility, it had established an innovative method for the internal management of equipments by management committees put in place by beneficiaries of the project.

Approach description

The association relied on managements committees for the implementation of its project. This approach is, up till now, rather classical with regard to organising the implementation of the project activities at the local level. The innovation brought about by ANTD was their discussion with beneficiaries to ensure that equipments provided by the project are managed on a long-term basis so as to avoid previous obstacles (lost of equipments, deterioration without repairs of equipments, using them for other purposes other than the project, etc.).

End result

This resulted into the laying down of rules for the management of the project's equipments and the creation of a hiring charge system for those who want to use the equipments of the project. The rules are very simple:

- The equipments are kept in a common place and an inventory of same is made in an inward/outward register managed by the management committee's treasurer;
- If someone uses the equipments within the framework of the implementation of the activities of the project, he must be registered and allowed to use them freely;
- If the equipments are used in a personal capacity other than for the project, the user must pay a hiring fee to the management committee according to the nature of the equipment hired. The payment is made in kind (bowls of millet) or in cash;
- The committee collects these fees and constitutes a management cost for the maintenance of the equipments.

Limitations to this approach

- Centralised management of committees' funds by the NGO;
- After three years of project, the equipments (shovels, pickaxes, forks) are worn out or even unusable;
- The system does not allow the renewal of the entire equipments but however, accepts a regular maintenance and gives a "concrete" importance to the management committees' works (at times reduced to local consultation links by micro-projects).

3. Adoption of the watershed approach for the rehabilitation and protection of a pond.

Background

The Tafagou's pond is situated at 305 km, north-west of Niamey in the Tilabery region of Niger. The Gorouol rural township in which Tafagou land is located extends up to the boarders of Mali and Burkina Faso and is generally called Tera-nord by development partners. The Tafagou land is occupied by a population group called Doun farak farak IV, spread across the belt between Dolbel and Kourki in an area of about 100 km2 with a high density in the Tondi Kadia area of Tafagou. This population is estimated at five thousand (5000) inhabitants.

Formerly, the Tafagou's pond, which was semi-permanent with a wooded watershed rich in biological diversity, succeeded in meeting the water needs of the pastoral nomads, Doun Farak Farak IV of the Touareg Kel Tamasheq ethnic group during at least six months in the year. This, consequently, prevented the early movement of animals towards the Gorouol valley where flood-recession cultivations were practised, thereby reducing conflicts among farmers and livestock breeders. Unfortunately, the recurrent dry spells, water erosion and deforestation of the watershed resulted into the lost of the water retention capacity of the Tafagou's pond reservoir, which is a wet land (Sahel) for animals

Approach description

Faced with this fact, the NGO BOGOU with the support of CILSS undertook its rehabilitation. The restoration works included:

- Rehabilitation of the pond's watershed through mechanical actions (recuperation of the glazed portion through the application of the earth bund and half-moon techniques);
- Rehabilitation of the main kori (construction of cribbed weirs, stone dikes);
- Rehabilitation of small gullies (construction of dry masonry weirs and dikes);
- In-depth digging of the pond and raising of the weir's level;
- Plantation of trees.

End results

This approach enabled to rehabilitate the entire basin (about 300 ha) through the combination of different CES/DRS methods (half-moons, stone bunds, earth bunds, planting pits, stone dikes, stone weirs and reseeding with grasses). The combined action of these structures proved to be very effective: significant reduction of the surface runoff speed, sedimentation at the base of structures, reduction of mud and sand silting in the pond's bed.

Finally, in order to improve the management of the pond, a local agreement was drafted, adopted and popularised by competent authorities (Mayor, Prefect). This agreement has already been unanimously accepted by users of the resources of the area.

Success conditions

- Effective organisation and planning of activities;
- Technical supervision of the construction of the structures (stone dikes, stone weirs, etc.);
- Provision of sufficient quantity of basic equipments for lands restoration works;
- Training;
- Drafting of new rules in order to avoid over grazing in the area, which may result from the concentration of animals attracted by the new resources (water and pasture).

4. Delegating the supervision of structures and local accountability

Background

OP OASIS had obtained a grant from RIGEDC to co-fund a pastoral land regeneration project in a mountainous area. The area concerned was very isolated, and it was not easy to enter into a contract with classical service providers for the supply of materials, more so that the access ways by roads are not always motorable.

The OP OASIS of Cape Verde had experimented a very innovative accountability system within the framework of an environmental micro-project to overcome these obstacles.

Approach description

The objectives of the project had clear indications in terms of the pasture area, which is to be rehabilitated by the building of stone bund, and it was difficult to find a supplier that will be able to transport the necessary materials at a price that is in line with the budgetary constraints of the project. The OP OASIS therefore made an arrangement with the local community association of the targeted village: it entered into a contract with the association on the rehabilitation project, taking into account the materials' cost and reward of operators who will participate in the project. Once the contract was signed with the local association, payments were made in instalments based on effective technical realisations. The conformity of structures that were realised was verified by the technical services that received completed facilities.

End results

Therefore, based on the objectives of the contract, OASIS was able to achieve 100% of its objectives of recuperation of degraded lands, without exceeding the budget allocated to the project. The State's services provided the training and ensured the final quality control of structures. The beneficiaries were able to organise themselves freely in order to choose suitable materials, ensure their transportation by local means and share the various tasks among themselves.

Without this approach, it is not certain that 100% of the objectives would have been attained. Also, this direct accountability of the final beneficiaries enables to build local capacity and enhance the technical expertise of the State's employees.

It should also be noted that this innovation lightens a lot the accounting work of the NGO and augments the benefits derived locally from the project.

Success conditions

This very "professional" approach of entering into contract by way of delegating the supervision of structures requires:

- An excellent knowledge of the area and of the existing local associations;
- Organised and reliable local associations capable of managing funds;
- Creation of an environment of mutual confidence and transparency between the beneficiary of the project and the delegated agent.

5. The gum arabic provincial office approach

Background

Forest non-woody produce are of capital importance to majority of sahelian people as they contribute to their socio-economic well-being (food, incomes, drugs, etc.). The gum arabic is one of the produce that also provide incomes for people living in conditions of extreme deprivation..

In Burkina Faso, the Yagha province is one the main production areas of gum arabic. The Acacia senegal, the producing species of the gum arabic and Acacia laeta, whose gum has similar properties as those of gum arabic are abundantly found in the Yagha province. In spite of this potential and the fact that the international demand for gum arabic is growing, the Burkinabe sector of the gum arabic is facing various problems (technical, organisational, infrastructural, marketing, etc.).

In fact, the lack of an effective organisation of the gum arabic sector at the provincial level, capable of absorbing the production, has put producers in a position in which they are unable to negotiate favourable prices for their produce. Besides, the poverty level in the area compels harvesters (children, herdsmen, women, etc.) to sell their produce below cost. Furthermore, local collectors highly depend on exporters from Ouagadougou or Nigerien buyers due to the fact that they do not have enough financial resources to collect large quantity of gum arabic.
This contributes to knocking down prices of producers, thereby impoverishing those who make most of the efforts.

That is why policy makers and development partners have been involved, for the past ten years, in the promotion of this sector. Despite all these efforts, the gum arabic sector is still not organised.

So, in order to contribute to the growth of this sector, the project, Securing and Enhancing Pastoral and Forest Resources in the Yagha Province implemented by the NGO VDS with the financial support of CILSS/RIGEDC and the project "Dry Forest" of CIFOR has developed some actions directed at building the organisational, production and commercialisation capacity of stakeholders of the gum arabic sector through the establishment of a gum arabic office at Sebba, Burkina Faso.

Approach description

The gum arabic office at Sebba involves three (3) stakeholders: producers of gum arabic organised into a producers' union (Gum Arabic Producers' Union of Sebba), CILSS, CIFOR and VDS (financial institution) and the professional exporter (buyer).

The gum arabic office was established in 2007 by twelve (12) groups (currently 15 groups) organised into the Gum Arabic Producers' Union of Sebba. Each group is composed of an average of twenty five (25) members. The union is managed by a board of nine (09) members. Every season, the office set some objectives based on the collection capacity of groups. These groups enter into contract with the union and allocate among themselves the quantity of gum to be supplied based on the harvesting capacity of their members who, in turn, can also augment their capacity by entering into contract with collectors. These collectors will go to other villages that are not members of the union to collect the remaining required quantity.

The various stakeholders ensure, within the framework of the collection of gum, the observance of the production protocol: tap the Acacia Senegal or laeta, wait for two weeks before harvesting with funnel, dry the gum, remove the fibres and impurities and pack them into bags.

Once the production is centralised at the level of the office, the union takes some samples, which are analysed at the Department of Food Technology (DFT) in order to determine the quality of the gum (observance of the international standard). Thereafter, the union packs the gum into bags with the same weight and looks for potential buyers, especially those with better offer.

The innovation of the gum arabic office of Sebba lies in the creation of an average management fund of 50,000 FCFA (76 euros) per collector. This amount is used to buy the gum arabic production at a higher price by entering into contract with the union's groups. The office also communicates and disseminates the price at the beginning of the season. In other words, the office has established a stable market with remunerating prices, which are appreciated by stakeholders (producers, groups and collectors) of the gum arabic sector at the provincial level.

The office also builds the organisational capacity of producers through the planning and evaluation of the season. Productions are bought and kept in a secured store with a view to obtaining a better remunerating price during the sale period. Consequently, producers right from the November harvest no longer sell their gum harvests below cost because prices offered by the gum arabic office are very competitive.

End results

This approach has enabled in the first two years:

- The organisation and capacity building of stakeholders of the sector; the improvement of their social role and their visibility (disadvantaged groups);
- To increase the quantity of collected good quality gum (from two (02) tons and one hundred and forty six (146) kg to six (06) tons in 2008-2009);
- The gum also increased in value as a result of the creation of the office and due to the effective management of the traceability of the gum produced in the Yagha province. The buying price from producers was 300 francs a kg during the 2007-2008 season, whereas before then the price of a bowl of (2½ kg) was sold at 400 francs, that is 160 francs per kg of gum arabic. The office bought a kg at 400 francs for the 2008-2009 season;
- Encouragement of producers for the conservation of the gum arabic stand and the plantation of new ones.

Success conditions

- Existence of a NGO who has an excellent knowledge of the area and of the local existing associations;
- Creation of a management committee whose capacity was built for the enhancement of the sector;
- Provision of a management fund;
- Drafting of rules for the transparent and fair management of the union.