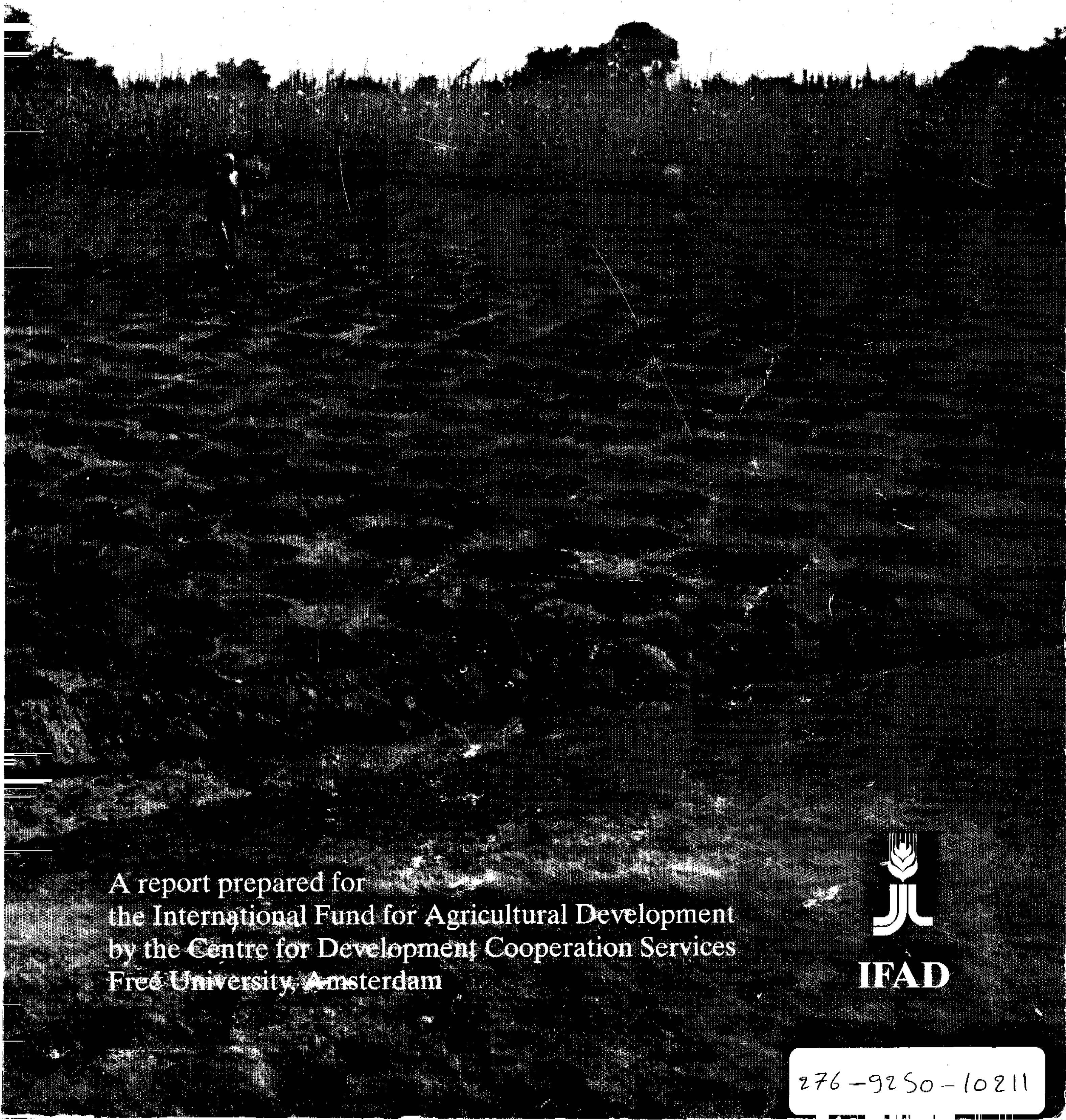
SOIL AND WATER CONSERVATION IN SUB-SAHARAN AFRICA

Towards sustainable production by the rural poor



A report prepared for
the International Fund for Agricultural Development
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IFAD

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Abbreviations

ADB	African Development Bank
CBA	Cost benefit analysis
CDCS	Centre for Development Cooperation Services
CES/AGF	Conservation des Eaux et du Sol/Agroforesterie
CMDT	Compagnie Malienne de Développement de Textiles
CTFT	Centre Technique Forestier Tropical
EDF	European Development Fund
FAO	Food and Agriculture Organisation
FISC	Farm Improvement with Soil Conservation
GCEFS	Gestion Conservatoire des Eaux et de la Fertilité des Sols
GERES	Groupement Européen de Restauration des Sols
GTZ	Gesellschaft fur Technische Zusammenarbeit
HADO	Hifadhi Ardhi Dodoma
ICRAF	International Council for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Centre for Africa
ILO	International Labour Organisation
IRAT	Institut de Recherche en Agronomie Tropicale
NAS	National Academy of Science
NGO	Non-governmental organization
ODA	Overseas Development Administration
ORSTOM	Institut Français de Recherche Scientifique pour le Développement en Coopération
OXFAM	Oxford Committee for Famine Relief
PLAE	Projet Lutte Anti-Erosive
PRA/FD	Projet de Réhabilitation Agricole/Fouta Djallon
PSN	Programme Spécial Niger
RRA	Rapid rural appraisal
SADCC	Southern African Development Coordination Conference
SAFGRAD	Semi-Arid Food Grain Research and Development
SARCCUS	Southern African Regional Commission for the Conservation and Utilisation of the Soil
SDPMA	Smallholder Development Project for Marginal Areas
SIDA	Swedish International Development Authority
SPA	Special Programme for Sub-Saharan African Countries Affected by Drought and Desertification
SRS	Special Resources for Sub-Saharan Africa
SSA	Sub-Saharan Africa
SWaCAP	Soil and Water Conservation and Agroforestry Programme
SWC	Soil and water conservation
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNSO	United Nations Sahelian Office
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USLE	Universal Soil Loss Equation

Acknowledgements

This report is the latest result of several years' collaboration between IFAD and the Centre for Development Cooperation Services (CDCS) of the Free University, Amsterdam. In 1986, as an early step towards design of its **Special Programme for sub-Saharan African Countries Affected by Drought and Desertification**, IFAD commissioned us to produce a study entitled "Soil and Water Conservation in Sub-Saharan Africa: Issues and Options". Following several years' implementation of the Special Programme, during which CDCS provided technical consultancy services for the design and supervision of a number of soil and water conservation programmes, IFAD has requested us to produce the present, updated study, which has been funded through a Dutch grant.

The purpose of this review is to provide information and guidance to those concerned with the design and execution of soil and water conservation programmes. It is intended to assist not only the management and staff of IFAD, but also personnel of other international funding agencies and the officials of African governments who are responsible for this sector. Several drafts of the document received intensive review and comment from an Advisory Group and from IFAD staff. We gratefully acknowledge the assistance received from these sources, while retaining liability for inadequacies which remain. The information and views presented in the document have been developed in a valuable process of interaction and consultation with IFAD, its advisers and the African governments and programme personnel with which it cooperates. Nevertheless, they remain the responsibility of the authors.

Among those at IFAD, we wish specifically to thank Mr B. Mansuri, Director of the Africa Division, for the guidance and support he has given. We are grateful for the assistance of the Advisory Group: Dr P. Blaikie (University of East Anglia); Dr L. Lundgren (Swedforest, Stockholm); and Dr E. Roose (ORSTOM, Montpellier). In Amsterdam, we relied heavily on the support of Ben Haagsma, Wilma Odding, Alie van der Wal and Fred Zaal. Our thanks to you all.

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December, 1991.

Summary

Environmental rehabilitation constitutes one of the main elements of IFAD's Special Programme for sub-Saharan Africa. Soil and water conservation has the potential to contribute substantially to reversing the degradation of the productive capacity of the land in large parts of the region. Such degradation results in lower and less reliable crop yields, a reduced biomass for grazing and browsing, and poorer fuelwood supplies. It is widely accepted that growing human and livestock populations have acted as a catalyst to this impoverishment of the resource base. Although it is difficult to quantify the exact extent or impact of land degradation, the process is prevalent in the humid areas as well as the semi-arid zones, and its effects are being felt by resource users throughout the region.

Soil erosion - the most obvious symptom of land degradation - was identified as a problem by many colonial administrations in Africa. The consequent early conservation projects often relied on sanctions and penalties to achieve their targets. Techniques were imposed from outside, and were often inappropriate. Some of the early mistakes were carried forward after independence, and the dismal record of failed projects was maintained.

It is only recently that more encouraging and positive trends in soil and water conservation programmes have emerged. At the centre of the new movement is the acknowledgement that technical remedies can only succeed if they are attuned to socio- economic constraints. In other words, participation of the resource users themselves is vital to the success of conservation programmes. This implies making use of traditional skills, working through existing local institutions, and involving the intended beneficiaries in the processes of programme identification, design and implementation.

Sensitivity to socio-economic issues is beginning to develop. The role of land tenure is being investigated more closely by planners: there is no clear evidence, for instance, to suggest that individualisation of tenure is a prerequisite to successful on-farm conservation. Furthermore, some innovative programmes are placing the emphasis on local village units of land rather than physical "watersheds". Another example of the new sensitivity is the increasing recognition of the important contribution by women to conservation activities; although so far this is rarely followed up by improving women's access to training and material support. It is also becoming accepted that soil and water conservation programmes may in some cases increase inequalities between or within social groups. It cannot therefore be assumed that the poor automatically benefit.

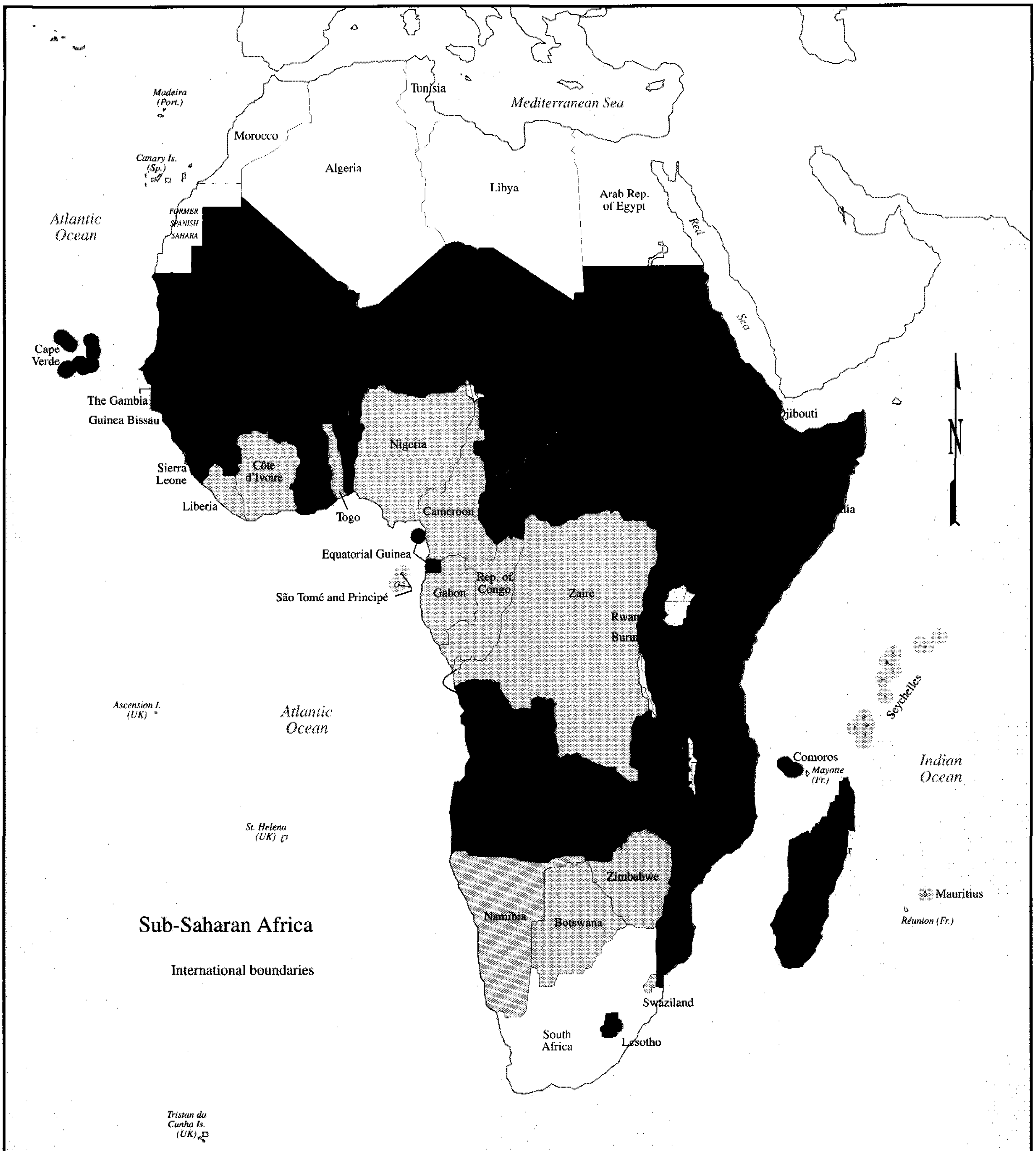
The very wide range of environmental and socio-economic conditions in sub-Saharan Africa calls for location-specific technical solutions. In the various parts of the region, the requirement may range from the need to drain excess water in humid zones, to maintaining rainfall in situ where rainfall is marginal, to employing a water harvesting technique in the driest areas. The presence or absence of stone as a construction material is another fundamental design consideration. In general, little notice has so far been paid to traditional systems of conservation - which are surprisingly widespread. With a little adjustment, these may constitute the most suitable and acceptable techniques. Various factors influence the choice of the best local conservation system. Blanket solutions do not exist.

Recent and promising technological advances include an emphasis on the connection between improved agronomy and better conservation, and the potential for agroforestry techniques and grass strips. "Biological conservation" also highlights the importance of maintaining soil fertility. Fertility is lost rapidly in the early stages of erosion, and soil nutrients can further be mined through exploitative cropping. Infertile soil is, in turn, more vulnerable to erosion, and a spiral of degradation becomes established. More research is required on the impact of various technologies on erosion, runoff, soil fertility and crop yields.

Soil and water conservation should be a national priority in all sub-Saharan African countries, because it forms the essential foundation for agricultural prosperity. Land degradation needs to be confronted with programmes which conserve and improve the natural resource base - in the drier zones as well as the more productive humid areas. The nature of the problem demands a long term commitment, and thus is most appropriately implemented through a "programme" approach where there is integration with existing agencies. Realistic time frames for conservation programmes are seldom much less than ten years: the typical spatially limited "project" lasting three to five years has rarely succeeded.

Conservation programmes must seek to introduce durable activities. This implies not only an organisational framework which can be sustained, but also techniques which are replicable. Appropriate packages are normally characterised by technologies which are relatively cheap, are economical of labour, lead to perceptible yield increases, and are grounded in the environmental knowledge and skills of the beneficiaries. Packages should be designed in such a way that they can be adopted by land users with a minimum of external support. The principal incentive should be the provision of training to improve the capacity of the local population to conserve their own resources and thereby increase productivity.

An innovative strategy towards programme design by governments and donors is required. The chain of steps which has to be followed in designing and approving new programmes is often too long, too complex and too expensive. The emphasis and targets of the programme may alter from one design stage to another. An extended design period would be preferable, and the design process should be simplified. Sometimes, when it comes to implementation, programme personnel follow their own instincts and habits more than the approach set out in the project document. Close supervision is therefore important for the innovative type of programme which this study advocates. Nevertheless, it is important to allow some flexibility in programme execution, and it is vital that monitoring and evaluation are accepted as integral constituents of the overall programme.



Map of Sub-Saharan Africa (courtesy World Bank)

OCTOBER 1991

Countries selected to receive assistance from the SPA I en SPA II programmes (see footnote).

eligible for SPA I and SPA II — eligible for SPA I only — eligible for SPA II only

note: Countries eligible for both SPA I and SPA II are Angola, Burkina Faso, Cape Verde, Chad, Djibouti, Ethiopia, the Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Mali, Mauritania, Mozambique, Niger, Senegal, Somalia, Sudan, United Republic of Tanzania, Uganda and Zambia. Countries eligible for SPA I only are Botswana and Zimbabwe. Countries eligible for SPA II only are Benin, Burundi, Central African Republic, Comores, Equatorial Guinea, Madagascar, Malawi, Rwanda and Sierra Leone.

1. Introduction

As sub-Saharan Africa enters the 1990s, the links between environmental degradation and poverty remain a major concern for governments and international development agencies. In most parts of the region, the majority of the population must continue to seek sustenance directly from the land. Indeed, agricultural production should rise to feed growing rural and urban populations and enhance rural incomes through trade with urban markets. Yet the capacity of land and water resources to support such production is in serious jeopardy. At a time when farm production per unit area should be rising, it is more often static or in decline. Many farmers are faced with declining soil productivity, sometimes leading to the loss of whole productive areas. As the vegetative cover over the land decreases both on and off-farm, the water regimes on which farming depends become less reliable and more destructive of soil resources.

These processes of degradation contribute to the worsening poverty and further marginalisation of rural people in sub-Saharan Africa. If farmers' resource base cannot be secured and rendered more productive, the decline in rural standards of living will accelerate. **Soil and water conservation must therefore be central to strategies of agricultural and rural development in sub-Saharan Africa.** On farm conservation must be linked to enhanced strategies for communal property resource management. Such links will ensure optimum returns from land resources and promote a holistic approach to sustainable environmental conservation and resource management.

Through its Special Programme for Sub-Saharan African Countries Affected by Drought and Desertification (SPA), the International Fund for Agricultural Development (IFAD) included the development of more environmentally resilient farming systems as a major target in its lending to the region during the second half of the 1980s. In that context, environmental rehabilitation and conservation were acknowledged as priorities. Soil and water conservation and agroforestry were identified as a means to this end.

At the start of Phase I of the Special Programme in 1985, IFAD commissioned two sector studies. One concerned small-scale water control schemes in sub-Saharan Africa. The second study, commissioned from the Centre for Development Cooperation Services (CDCS) of the Free University, Amsterdam, was an 'issues and options' review of soil and water conservation in the region (IFAD, 1986a). It was based upon a review of the available literature and of project experience in the sector up to that date. Senior experts on soil and water conservation were invited to serve on an Advisory Group to review drafts of the document.

The 'issues and options' paper provided guidelines and a detailed approach for the design of support to soil and water conservation under the Special Programme. As IFAD funded projects incorporating these principles began to be implemented, CDCS was commissioned to provide technical support to their supervision. Although most of the projects are still at an early stage, valuable practical experience has thus been gained.

As Phase II of the Special Programme is launched, IFAD has commissioned CDCS to produce this revised version of the soil and water conservation sector review. The new study incorporates the most recent international analysis of land degradation problems and conservation approaches, together with IFAD's own experience with the soil and water conservation activities it has funded to date. At the same time, recognising the broad scope of environmental and land management problems, IFAD has commissioned in 1992 a study of common property resources in sub-Saharan Africa. Both studies are supported by IFAD's SRS funds. As with the 1986 'issues and options' paper, this review of soil and water conservation has been produced in a phased series of drafts, which have been reviewed by a senior Advisory Group and by relevant personnel in IFAD.

As noted in the Acknowledgements, the purpose of this review is to provide information and guidance to those concerned with the design and execution of soil and water conservation programmes. **The scope of the paper is limited to soil and water conservation on the rainfed agricultural land of small scale farmers.** It does not deal with the conservation and management of forest, pasture, irrigated crop land or commercial estates. Its focus is on individually held and managed farm land, and not on common property resources. Although these other types of resource conservation are also important issues in sub-

Saharan Africa, they require different solutions. Some of them will be addressed in the above-mentioned study of common property resources and agricultural development in sub-Saharan Africa. Nevertheless, it is recognised that conditions in other sectors significantly influence rainfed arable production. In particular, there are often close links between arable and pastoral production and their respective resource bases. These links are acknowledged at many points in the text.

Soil and Water Conservation is the title chosen for this paper for reasons of continuity, although the terms "Land Husbandry", "Natural Resource Management" or "Conservation Farming" better describe the new, and broader approach to conservation in the sub-Saharan region and elsewhere.

A paper of this length, which attempts to treat soil and water conservation in the whole of sub-Saharan Africa, must largely restrict itself to broad generalisations, supported as far as space permits by examples of specific local experience. It cannot provide a detailed description of desirable soil and water conservation activities for different agro-ecological zones. However, reference will be made to the area specificity of certain measures. Despite the enormous variety of conditions to which they must apply, certain relevant general observations and conclusions can be offered. As is pointed out in the paper, a first step in the design of soil and water conservation policy for a given country or area must be the detailed investigation of the conditions and issues which are outlined here.

2 Land degradation

2.1 Land degradation and poverty

As Chapter 1 makes clear, land degradation is a major cause of poverty in sub-Saharan Africa today. It is one physical manifestation of a complex of demographic, economic and social changes which cause rural populations in many parts of the region to suffer a steady decline in real income.

Land degradation is the term most commonly used to describe the central process in the environmental degradation which is prevalent throughout sub-Saharan Africa. This process results from a multitude of factors. Some are physical, especially those related to the climate. Others are socio-economic, particularly the rise in human population and its associated demands on the environment.

While there is debate about what land degradation precisely constitutes, how widely it has spread over the region and how severe the consequences are for the inhabitants, it is not disputed that land degradation poses a growing threat to the livelihood of millions. Because the primary effect of land degradation is to reduce the productivity of land, the process fundamentally affects all those who depend on the land as a basic resource, whether for crops, livestock or fuel wood.

Many of the rural poor find themselves marginalised from the development process, barely able to maintain themselves at the subsistence level. Their strategies to compensate for loss of productivity may in turn exacerbate the process of degradation. Out migration of male labour, for example, reduces the work force available to maintain soil conservation structures; clearing often unsuitable land to expand cultivation may expose new areas to erosion. The link between land degradation and poverty is direct and intimate over much of sub-Saharan Africa.

This chapter presents a definition of land degradation and its components; reviews the problems of quantifying it; and then outlines its causes.

2.2 Definition and components of land degradation

"Land degradation" is one among a number of similar terms which are sometimes loosely interchanged. Its exact meaning is seldom defined. For these reasons, it is important at the outset to clarify terminology and shed some light on the individual components of the process. Two initial points must be stressed. First, "land" is a broader concept than "soil", as it encompasses vegetation as well as the growth medium itself. Secondly, "soil erosion" is not synonymous with land degradation, although the terms are often used interchangeably. Nevertheless, soil erosion is one of the most important and best documented components of land degradation.

Land degradation can be defined as the loss of the productive capacity of the land to sustain life. Its two main components are:

> **Soil degradation:** a reduction in soil fertility caused by soil erosion and exploitative cropping;
>
> **Impoverishment of the vegetative cover:** a reduction in the available biomass caused by climatic factors, over utilisation of vegetation and reduced soil fertility.

There is an obvious link between the two components. Soil degradation leads in part to a poorer vegetative cover, which in turn makes the soil more vulnerable to degradation by erosion.

Soil degradation is often caused by erosion (water or wind erosion or both), but another aspect of soil degradation is the reduction in fertility status by exploitative cropping. It is now realised that low soil fertility is often the major constraint for production, both for crops and for natural vegetation, which makes fertility management a subject of region wide concern. It should be noted that soil degradation has a number of other possible causes such as salinity and waterlogging, though these are outside the scope of this paper.

Impoverishment of the vegetative cover may result directly from the degradation of the soil, or its primary cause may be climatic, associated with overuse by people and livestock.

The immediate implications for the inhabitants of sub-Saharan Africa are lower and less reliable crop yields, reduced grazing and browsing for their livestock, decreased availability of fuelwood and declining dry season water flows needed for small scale irrigation.

Decreased rainfall, and increased demands on the land by the growing human and livestock populations, are the main contributory factors. The reduction in the vegetative cover has exacerbated the rate of soil erosion. A spiral of deterioration has led to the eventual creation of expanses of barren and unproductive land. In an analysis of arable farming and animal husbandry in relation to the productive capacity of the land, van Keulen and Breman (1990) conclude that in large parts of the region the natural resources are being overexploited.

Extreme cases of degradation in this zone have been referred to in the literature as "**desertification**" (Box 1). This is a term better avoided because of its imprecision and the popular misconceptions which surround it. Land degradation in the semi-arid lands of sub-Saharan Africa tends to be most acute not on the fringes of the desert, but in the relatively heavily populated zones where rainfed cropping is possible, but unreliable. In West Africa this is typically in the Sahelo-Sudanian Zone where the annual average rainfall is 300-700 mm (Box 9).

Desertification

This is a much misused term, and has become associated with the popular concept of an inexorably "marching" desert. Little or no evidence exists to support the theory that the deserts are expanding in this way. There are several rather similar definitions in the recent literature by some who share the concern that the term be used with care (eg Nelson (1988), Bie (1989), Rochette (1989), Young (1989)). Though there is some disagreement about the "reversibility" of desertified land, a concise definition distilled from these authors is as follows:

"Desertification is the process of continued land degradation in drylands caused at least partially by man. The productive potential of the land is greatly reduced and the process is only reversed slowly and with considerable input."

Box 1

Land degradation is also a severe problem in the more humid zones of sub-Saharan Africa, extending into the higher agricultural potential highlands of East and Southern Africa. Here the land affected has not usually been reduced to such a low threshold of productivity as in the more arid areas, but its capability has nevertheless been severely diminished. Soil erosion, often in the form of spectacular gullies, is the most obvious component of degradation in these regions.

There are few precise data on the physical parameters of the land degradation process. Of all the components of land degradation, it is only the effects of soil erosion, in terms of tonnes of soil lost, which are relatively well quantified. Even in the case of soil erosion, there is more speculation than hard fact on how the process affects crop yields. What is not in doubt is that the effect is considerable and that soil erosion is one of the main reasons for decreasing yields in much of Africa. Young (1989, 48) states the case clearly:

> *...recent work on the relations between erosion and productivity has confirmed and strengthened the view that loss of crop production through lowering of yields brought about by soil erosion is substantial.*

Erosion leads to a loss of productivity primarily because it causes a change in intrinsic soil characteristics. There are several components to this change in characteristics. The most important are:

- Fine particles, nutrients and organic matter are disproportionately lost in the eroded fraction, where they form a greater proportion than in the uneroded profile. This is referred to as the "**enrichment factor**" (Box 2).

- Soil affected by erosion loses its structural stability, and the soil aggregates fall apart. The surface becomes crusted and compacted, covered with a surface seal, which sharply reduces infiltration rates and results in increased runoff.

- There is a decrease in available water capacity, caused partially by the loss of organic matter, and partially by the reduction in rooting depth. This suppresses plant growth and the potential for biomass production. This is of particular importance in marginal and semi-arid areas.

Under the prevailing climatic conditions of sub-Saharan Africa the high rate of natural mineralisation of organic matter is a constant threat to soil fertility. A further loss of organic matter and nutrients occurs, when the first rains wash away large quantities of crop residues and animal droppings. The removal of nutrients by cropping mines fertility, unless remedial action - such as manuring or composting - is taken.

Often ignored is the positive role of termites, which process and bury organic matter, protecting it against bush fires. Tunnels dug by termites contribute to the porosity of the soil. A decrease in termite activity results from degradation processes because of reduced availability of organic matter.

The overall result of these processes is a decrease in the potential for sustained production. The soil becomes 'tired', loses its capacity to store water and nutrients, and does not react well to fertiliser.

Partially because of these qualitative changes brought about by erosion, the resultant **reduction in crop yields is not well predicted by the quantity of soil lost**. Stocking (quoted by Blaikie and Brookfield, 1987, 62) laments the fact that the very measure on which there are considerable data - tonnes per hectare of soil lost - is poorly representative of the decline in productivity. The reduction in yields is, however, dramatic and yield losses in the tropics are an order of magnitude greater than those under temperate conditions.

There is a lack of knowledge about the loss of productivity of different soils as they erode. In many cases, the reduction in productivity occurs most rapidly during the early stages of erosion, and then slows down with increasing erosion. However, different soils show different patterns of productivity decline. Particularly worrying is the fact that yield loss caused by erosion appears to be greater on soils of lower fertility. Pieri (1989) points out that cropping in the Sahel region often "mines" nutrients anyway because fallow periods have been reduced or abandoned, and fertilizer and manure applications are inadequate. Erosion further amplifies these losses.

The enrichment factor

The amount by which the eroded material is richer in nutrients than is the soil from which it is taken, is referred to as the enrichment factor. This factor varies from soil to soil. It is a measure of the selectivity of the different erosion processes. Sheet erosion is highly selective vis-à-vis the removal of nutrients and fine soil particles. The overall enrichment factor can be as high as 10. Wind erosion acts selectively as well, removing finer particles. Other erosion processes, such as rill and gully erosion, are less selective, showing enrichment factors close to unity.

Box 2

For certain Alfisols, which are common soils in much of sub-Saharan Africa, Stocking and Peake (1986, 42) quote the rather alarming example of crop yields being halved on 1% slopes, after the loss of only 20-40 tonnes per hectare. Erosion and yield loss then progress to the point that the same authors conclude "most tropical Alfisols may have reached a low and quasi-stable level of dismal productivity". On the other hand, the productivity of many deeper soils is little affected by moderate erosion.

The result of land degradation for the people of sub-Saharan Africa is a general reduction in the productivity of the land. Crop yield potential is lowered. Harvests become less reliable. The biomass available for grazing and browsing diminishes. Supplies of wood for domestic fuel are reduced. The consequence is increased poverty. Land users are more vulnerable to years of low rainfall, and the need to purchase food from outside increases. Livestock suffer; and therefore one of the main sources of cash income is weakened. Seasonal labour migration increases, to make up for the cash deficit. This exacerbates the burden on the women who remain at home. The shortage of fuel wood further increases their work load. Per capita food production and income fall. Because the rural poor are disproportionately dependent on land resources relative to other sources of income, their poverty deepens.

2.3 Quantification of land degradation

Despite some alarmist statements, it is difficult to give an indication of the extent of land degradation in sub-Saharan Africa, as there is no simple or commonly agreed measure of degradation. Nor are consistent data available about the state of land in each country. FAO estimates that between 50,000 and 70,000 square kilometres go out of production each year in sub-Saharan Africa (FAO, 1990, 9). But Nelson (1988, 4) argues that the extent of the "desertification" problem is not well known, and that to a certain extent the deteriorations in the environment are "pulsating" - that is, there can be spontaneous rehabilitation in prolonged periods of improved rainfall. Sandford (1983, 13) is particularly sceptical about the "popular view" of the deterioration of rangelands. He finds that there is "some respectable evidence for long-term changes in the state of the vegetation" but "none for long-term changes in productivity". **Nevertheless, there is general agreement that land degradation is a very serious problem throughout the region.**

The one aspect of land degradation which has been extensively quantified is soil erosion - at least, soil erosion by water. However, it must be stressed again that soil erosion is not synonymous with land degradation (Section 2.2).

Predictive equations and soil loss models

There has been much argument about the usefulness in Africa of the "Universal Soil Loss Equation". The USLE is used to predict rates of soil erosion and was derived from thousands of plot-years of data in the USA, for use in the USA (Young, 1989). A model developed in Zimbabwe, the "Soil Loss Estimation Model", is more appropriate for conditions in Southern Africa and is useful where few data are available (Elwell, 1981). However, researchers are not in agreement about the usefulness of various newly developed models. Caution is needed before drawing conclusions on the applicability of regional models, which are not backed up by sufficient years of measurements.

Box 3

Numerous data for rates of soil loss do exist from experimental plots, on which several predictive equations for soil losses have been developed (Box 3). The potential danger of such data is first of all their reliability, and secondly the "scale" problem. The "scale" factor refers to the inaccuracy involved in extrapolating figures from a small plot to the field scale - or conversely using sediment load measurements derived from a large watershed to calculate soil loss from fields. Soil loss per unit area decreases rapidly with increasing size of catchment area investigated - due to redeposition of eroded sediment.

In Zimbabwe, soil erosion from cropped land is said to range often from 50-80 tonnes/ha/annum (Elwell and Norton, 1988, 5). Similar rates have been reported from experiments conducted in the 1930s under a variety of treatments in Tanzania (Christiansson 1986, 99-115). Roose (1977a, 58) describes how the cultivation of various crops affects runoff in the Ivory Coast. On a 7% slope under groundnuts, the soil eroded was 82 t/ha, and this rose to 92 t/ha with maize. Bare soil gave rise to erosion of 138 t/ha, underlining the effect of a total lack of cover, while a well developed grass sward in the same area reduced runoff to 0.5 t/ha. Erosion can increase enormously on steep slopes when land is cleared. For example, erosion in Burundi was found to range from 440 to 880 tonnes/hectare on bare soil with a 40% slope (Durand quoted in Roose, 1988, 132).

The data quoted give some idea of how severe soil erosion can be in Africa, and how dramatic is the effect of lack of cover, in particular, on erosion rates. There are no widely applicable figures for the rate of soil formation in Africa. Therefore the corresponding "tolerance value" for rates of erosion cannot be computed. An often quoted figure from the USA is 11.2 tonnes per hectare on deep soils, being the maximum tolerable erosion to keep the system in equilibrium. Most soils have lower tolerance levels, depending on climate, type of rock and soil depth.

Though these parameters cannot automatically be applied to the different conditions of Africa, they give an indication of the severe imbalance between soil erosion and the rate of soil formation in many situations. **More important for land users, however, is the decrease in productivity of the land.** Once again, it must be stressed that the analysis of physical rates of soil removal underestimates the importance of selectivity in the erosion of nutrients, fine particles and organic matter, which form the basis of soil fertility.

In an FAO study, Stocking (1986b) indicates that Zimbabwe could be losing an average of 1.6 million tonnes of nitrogen, 15.6 million tons of organic matter and 0.24 million tones of phosphorus each year by erosion. At 1985 prices, US$ 1.5 billion worth of fertiliser would be needed to replace such nutrient loss (nitrogen and phosphorus only). On a per hectare basis, this represents a cost of $ 40 - 50 on arable lands and $ 10 - 80 on grazing land. This does not include costs for losses of other nutrients, organic matter, changes in water holding capacity, reduction in yields or nutrient losses to groundwater. Erosion has a massive hidden cost component.

Rates of soil erosion - and to a lesser degree its extent and impact - are relatively well documented, and soil erosion is a central factor in land degradation. Despite the lack of firm data about the extent and the effect of the other aspects of the process, the inescapable conclusion is that land degradation continues to pose a growing threat in sub-Saharan Africa.

2.4 Causes of land degradation

2.4.1 Physical processes

It is clear that physical environmental factors, especially climate, play a fundamental role in causing land degradation. Climate, more especially rainfall, is particularly important in the process of soil erosion, but also directly affects vegetation, and thus the vulnerability of land to further degradation. The reduction in annual average rainfall in the West African Sahel over the last two decades or so has been the most important external factor contributing to the problems of degradation in the region (Rochette, 1989, 408 - 409).

Nevertheless, **the human factor must be recognised as the catalyst to degradation.** The reduction in vegetative cover is often accelerated by the demand for firewood, and clearing for cultivation, as well as grazing and browsing by livestock. A reduction in the fertility of soils is brought about by exploitative cropping with shorter fallow periods and inadequate return of nutrients to the land. These factors make the soil more vulnerable to erosion. Once eroded, soil becomes rapidly less fertile and less able to support vegetation. Reduced vegetative cover in turn means less defence against erosion. A vicious spiral of degradation is established.

Soil erosion is usually the most visible component of land degradation, and it is certainly the most extensively studied physical process. Soil erosion can be broadly divided into two categories: erosion by water and erosion by wind. The environmental factors which affect soil erosion are well known and well documented.

Erosion by water is predominant over sub-Saharan Africa, except in the arid zones, where wind erosion is more important. Several stages are usually distinguished in the process of erosion by water: splash, sheet, rill and gully erosion. It must be remembered that erosion is a natural phenomenon, and that it can have beneficial effects - such as deposition of fertile alluvium - as well as detrimental effects. Erosion becomes a problem where soil loss significantly affects productivity. This, unfortunately, is the situation which prevails over much of sub-Saharan Africa.

It was recognised as early as the 1940s that **the primary and most important process in water erosion is the effect of rainsplash on the soil.** A falling raindrop is itself an erosive agent, destroying the structure of an uncovered soil surface. Several factors affect the actual rate of soil erosion by water: the erosivity of the rainfall, the erodibility of a given soil, topography, vegetative cover, crop management and conservation practices.

Rainfall erosivity is the capacity of rainfall to cause erosion. It is a function of the rainfall's physical characteristics: energy, intensity and duration. Splash erosion is directly correlated with the energy of rainfall. In the tropics, erosivity is loosely related to the annual average rainfall of a given site (Young 1989, 26; quoting several authors). As average annual rainfall doubles, erosivity approximately doubles also.

Soil erodibility is a measure of the vulnerability of soil to erosion. Some soils erode much more readily than others in similar situations. Clays are more resistant than sands, and the level of organic matter in a soil increases its resistance to erosion.

Topography is important: generally, the steeper and longer the slope, the greater the rate of erosion. Nevertheless, very considerable erosion does take place in many areas of sub-Saharan Africa where slopes are less than one percent. Conversely, in the densely populated zones of the wetter highland areas, the cultivation of steep slopes is one of the reasons for the accelerated erosion in those areas.

Cover is usually the most important factor of all. Where the soil is completely covered by vegetation, erosion is virtually stopped. This is because rainfall is prevented from hitting the soil surface - the primary cause of erosion by water. Roose (1986a, 322), reporting results from West Africa, shows that annual erosion under natural forest cover is less than 0.5 tonnes per hectare even on slopes of up to 65%. The rates from bare soil on equivalent slopes are up to 1,000 times as great. Rates of runoff and erosion can be particularly severe in semi-arid areas because of the scarcity of ground cover, especially at the beginning of the wet season.

Crop management and conservation practices also have very significant effects on erosion rates. There are many different ways of managing crops with different impacts on soil losses. Erosion depends both on what crop is grown and how it is grown. Clean weeding under a coffee crop on sloping fields has a detrimental effect on soil losses, but a well managed surface cover stops erosion effectively. Ploughing up and down slope generally leads to greater erosion than the normally recommended system of ploughing along the contour.

Erosion by wind is most severe in arid zones where cover is poor. Wind erosion is less well studied and documented than water erosion, as it is more difficult to quantify. Moreover, it receives less attention because its effects are normally limited to the drier, less populated areas. Nevertheless, its importance must not be underestimated. The effect of wind erosion can be severe - especially in times of drought. It is particularly pronounced in the West African Sahel.

The term **exploitative cropping** describes the reduction in soil fertility which occurs through the removal of nutrients in the harvested crop, where these are not replaced by adequate quantities of manure or fertilisers. An alternative term is "fertility mining". Many authors (Stocking, 1986a; Roose, 1987; Pieri, 1989; van Keulen and Breman, 1990) consider low fertility as the most important constraint on improved agricultural production, after water availability.

2.4.2 Socio-economic processes

2.4.2.1 Perceptions of the problem

For much of this century, as outside observers perceived an accelerating rate of land degradation, African farming practice was blamed for it. Cultivation methods and grazing densities were claimed wrongly to be symptoms of local land users' laziness and environmental ignorance. A central theme of the extensive colonial soil conservation programmes was therefore the protection of the soil from its indigenous users (Baker, 1984; Annex B). Although the terminology has become more diplomatic, the technocratic approach to the 'bad farming practices' of the rural poor persists in many circles. **While current cultivation and grazing practices may indeed accelerate soil loss, technical remedies will only succeed if they can function within, and address, local socio-economic constraints.** These constraints are themselves often the primary cause of 'bad farming practice'. **While farmers' actions may be the immediate cause of the perceived problem of land degradation in sub-Saharan Africa, the root cause lies in a range of economic and political parameters which are typically outside farmers' control.**

In recent years, the blame for the expansion of land degradation in Africa under colonial rule has therefore been shifted by many analysts to the economic and demographic pressure placed on land users and their natural resources during the colonial period. Some agricultural development projects for small producers were introduced in this period, and the foundations laid for agricultural research programmes which continue today. But in eastern and southern Africa, the amount of land available per person for the cultivation of subsistence food crops and the grazing of livestock was often reduced, as large areas were taken over for use by settlers and indigenous populations were crowded into 'native reserves'. It was further reduced by the tax burdens imposed in this period. These, together with the increased monetisation of the rural economy in general, caused land users to cultivate cash crops for sale to local urban populations or to overseas markets, in addition to their own food crops. These pressures forced an intensification of crop and livestock production. Fallow periods in the typically extensive farming systems had to be shortened. Marginal lands not previously used had to be taken into production. Competition for land developed between arable and pastoral uses.

2.4.2.2 Marginalisation

The term 'marginalisation' is sometimes used to describe the process through which peasants lose autonomous control over their land and labour resources, and are forced to split their subsistence efforts over more than one economic sector. As will be shown below, such marginalisation is often accompanied by land degradation, and in turn can exacerbate such degradation because of the deteriorating land management practices which typically accompany it. Some administrations dispossessed peasants of much of their best land and restricted them to smaller areas of marginal agricultural potential, peripheral to the core of economic growth within the colony. This happened on a large scale in Zambia, Zimbabwe, Kenya, Swaziland, Angola and Mozambique, where Africans had to make way for settlers; Lesotho and the "homelands" of South Africa are other examples. On a smaller scale, there are many cases - both in the colonial days and after independence - where farmers lost their land through the establishment of commercial plantations or state farms, the construction of dams or the privatization of land previously under communal tenure (as in Kenya and Botswana). **In all such cases, a growing population on a restricted resource base with only limited income from other sectors requires intensified agricultural production.** A vicious spiral often develops, in which the land degradation promoted by marginalisation weakens peasants' productive base and removes them further into the dependent peripheries of the economy.

2.4.2.3 Demographic change, agricultural intensification and land degradation

While economic history and the current distribution of productive resources may vary from one country to another in sub-Saharan Africa, the rapidly intensifying pressure of population increase is an almost universal phenomenon, demanding higher food production and increasing land degradation in the process. The population growth rate for the region as a whole is estimated at 3.2% p.a. for 1980 - 1988 (World Bank, 1989, 229).

Agricultural intensification does not necessarily lead to land degradation. Richards (1985, cited by Riddell and Campbell, 1986, 101), points out that for as long as we have any record, African peoples have shifted to and fro along the continuum between extensive and intensive practices without necessarily damaging their environment. Some indigenous farming systems incorporating intensive conservation practices, and giving relatively high yields from restricted resource bases, persist or have only decayed in recent generations. Some were developed by groups who had to sustain themselves in limited mountain areas for security reasons, such as the people of the Dogon Plateau in Mali; the waMatengo of Songea, Tanzania; and the people of the Mandara mountains in Cameroun. Others emerged in response to long established urban markets, such as the Kano Close-Settled Zone.

In some parts of present day Africa, rural communities are successfully intensifying production: raising agricultural yields per unit area while conserving soil and water. Examples include the Kofyar of Nigeria (Box 4) and peasant communities in Burkina Faso, Kenya and Zimbabwe. In other areas, conditions exist for the indigenous development of such conservation-farming systems. But during this transition, there is likely to be much hardship and severe land degradation. Typically, a farming society under demographic pressure expands its production to marginal areas without significantly modifying methods, except to shorten fallow periods; watches crop and livestock production per unit area fall; begins to adopt more intensive cropping methods, incorporating soil and water conservation; experiences severe stresses between the crop and livestock sectors; and perhaps ultimately intensifies livestock production (for example by stall feeding) and enhances village land use management practices, so that a new balance is struck between production and resources - provided the natural and human capacity has not already been too gravely eroded out of the system.

Unassisted, many rural societies may collapse at some stage in the process just described. A number of factors introduced in the colonial period and perpetuated in modern economic systems make the dual burden of agricultural intensification with resource conservation heavier than it was for those precolonial societies who had to take it up:

- The monetary demands of modern society and government may require the use of part or all of the cultivable land base for cash crops. This increases pressure on often ecologically marginal land from which food needs may then have to be met. The cash crops must be sold to meet these modern demands, and sometimes to purchase food, on terms which deteriorated for long periods, both internationally and between the African urban and rural sectors. Cash crop monoculture has in some instances (such as groundnut production in Senegal and Niger) led to soil exhaustion, although certain other cash crops, like tea, provide good ground cover (Figure 1). The IFAD funded agricultural rehabilitation project in the Fouta Djallon, Guinea, promotes the planting of *arabica* coffee along the contour. This combines enhanced farm incomes with soil conservation.

The Kofyar: indigenous change from subsistence to cash cropping

The Kofyar people practised traditional agriculture, based on highly intensive permanent use of plots around their homesteads on the Jos plateau, Nigeria. This included several types of ethno-engineering practices (Table 1). Because of land scarcity on the plateau, the Kofyar started to move in the early 1950s down the escarpment into the plains, clearing bush land and establishing frontier farms. None of the intensive methods were used and farmers relied on bush fallows to restore fertility.

A study by Netting et al. (1989) outlined the changes in agriculture after the Kofyar settled permanently in the plains. The increasing settlement in the plains has led to a re-intensification of agricultural practices with the following characteristics: shorter fallows, crop rotations and interplantings, stall fed domestic animals, purchase of chemical fertilisers and seed dressings. Agriculture continued to be essentially unmechanised; not even animal traction was introduced. Varieties produced continued to be food crops, but much of the output was marketed in the region.

It is significant that this rapid transition has taken place without direct involvement of development agencies or governments. No credit and market facilities were provided, and no extension efforts made. The Kofyar made this transition to intensive cash cropping successfully by basing their decisions upon their own experiences and social organisation. By doing so, they gradually supplemented, rather than replaced, their well developed subsistence system by cash cropping.

Box 4

- In many countries, economic policy has exacerbated rural people's pressure on degrading land resources, by deepening their poverty and narrowing their income generating opportunities relative to the incomes and opportunities of urban populations. Exchange rate policies and internal price structures have favoured urban consumers at the expense of rural food producers. While there have often been incentives for urban dwellers to import consumer goods, the low food prices guaranteed to these urban populations have offered little support to farmers. At the same time rural people, increasingly drawn into a monetised national economy, have had to pay more and more for urban sourced goods and services. The food price subsidies which have so damaged some African economies have rarely been of direct benefit to small farmers. Rather, they have supported urban based middlemen and food processors. Economic development policies, at least in the early decades after independence, favoured urban and infrastructural investment along with large scale farming, irrigation and ranching. Food production and land resource management by the majority of the rural population - the small scale farmers - received less support.

- These modern economic forces often make labour migration necessary for rural households' short term survival. In crowded rural areas facing apparently insuperable problems of land degradation and concomitant decreasing yields, migration to wage employment elsewhere is a rational choice. This is the context of the IFAD financed soil and water conservation programmes in Burkina Faso, Niger and Lesotho, for example.

But labour migration deprives the home farming sector of labour which is often essential for maintaining conservation practices or introducing them while intensifying production (Box 13). The concentration of all a rural population's energies on intensification with conservation is thereby deferred, sometimes until it is too late. IFAD intends to study this issue further, through a grant to SOS Sahel (a UK-based NGO) for research into women's ability to manage and conserve land resources in the absence of their migrant partners.

Other external factors may intervene to exacerbate the situation. Since the 1960s, many parts of sub-Saharan Africa have suffered a series of droughts. These have depressed food production, promoted labour out migration from the farming sector, and accelerated the breakdown of traditional institutions of land management. Government policies have often run contrary to community interests, denying the importance of traditional knowledge and structures. In some parts of the region, an influx of rural migrants (caused by worse drought conditions elsewhere, or by civil wars) has increased pressure on these resources and accelerated land degradation.

In a few cases, the collapse of the farming system may occur when population pressure on an area is relieved. Traditionally intensive conservation-farming systems such as that of the Mandara mountains in Cameroun no longer have the labour available to maintain structures such as terraces, because new political and socio-economic conditions have encouraged out migration to lowland areas. Cape Verde experienced considerable emigration waves in the 1960s and 1970s, disrupting labour availability for maintenance of the stone wall terraces. Hallsworth (1987) cites examples from Tanzania (pit systems of the waMatengo, ridge cultivation of the waErok), where maintenance requirements cannot be met any more due to migration of people to the surrounding plains or urban centres. Modern administrations may ensure the security that permits people to migrate to less crowded lowland areas. Economic developments may create migrant labour opportunities that attract workers away from the mountains, depleting the labour resources needed for terrace maintenance.

At present, too few rural communities in sub-Saharan Africa have been able to contain land degradation while intensifying agricultural production. The pressure of population increase continues to grow. The disintegration of traditional societies has led to the frequent breakdown of communal arrangements for environmental management, notably in the control of grazing resources. (Common property resources are to be the subject of a separate study by IFAD in 1992.)

2.4.2.4 External interventions

In a number of cases, development projects and modernization attempts have directly contributed to accelerating land degradation. This has happened, for instance, when animal-drawn ploughs were introduced without parallel introduction of soil conservation measures; when livestock herds increased due to disease control; or when a more concentrated settlement pattern was introduced, leading to heavy pressure on the land surrounding the new village. There are even cases where soil conservation programmes have increased erosion because of poor technical design, or because of non maintenance by the 'beneficiaries'.

3. Responses to land degradation

3.1 Traditional systems of cultivation

The concept of soil and water conservation was not introduced to Africa by foreign experts. Since ancient times African land users have, under widely varying ecological conditions, attempted to conserve soil and water and to maintain fertility at acceptable levels. Although many indigenous agricultural practices are not overtly aimed at soil and water conservation, they do have a conservation effect, particularly when compared to some modern practices. Despite the increasing disruption of traditional African farming systems explained in Chapter 2, African land users continue to apply a wide range of conservation techniques.

In the humid tropics, systems of shifting cultivation have traditionally been used with long fallow periods allowing the regeneration of the vegetation; ash or compost fertilization; systems of intercropping and crop variety mixtures maximizing soil cover and reducing risks of crop failure; minimum tillage techniques; and crop cultivation on mounds and ridges to avoid waterlogging. Miracle (1967) has drawn attention to the remarkable diversity of shifting cultivation systems. He distinguished no less than 12 sub-systems within the Congo basin, all ecologically sound. But shifting cultivation systems are under growing stress, due to increasing population pressure and large-scale commercial forest exploitation. Land users react constantly to changing conditions of population density and land availability by reducing fallow periods, adapting their crop rotation practices and/or switching part of their land to a more intensive (or in appropriate cases, a more extensive) method of land cultivation.

Shifting cultivation systems have also been used in the semi-arid tropics, but in many places fallow periods have been reduced. In areas of high population pressure, permanent cultivation is now practised. Yield levels of the major food crops (sorghum and millet) grown under permanent cultivation in these conditions are very low, because of soil moisture and fertility constraints. A wide range of indigenous soil and water conservation techniques can be found. Examples of such techniques are: stone lines; trash lines; ridges; furrows; pitting systems; mounds with green manure worked into the soil; stone terraces; mulching; and the protection of stands of *Acacia albida* (a nitrogen-fixing tree).

3.2 Indigenous responses to land degradation

Indigenous soil and water conservation techniques can be divided into "ethno-engineering", agroforestry and agronomic practices. Frequently, combinations of these practices can be found. For Jodha (1990, 67) the term "ethno-engineering" covers indigenous practices such as terracing of mountain slopes, harnessing of runoff and developing small drainage systems. The focus of this chapter is on "ethno-engineering" because the importance of these practices in sub-Saharan Africa tends to be greatly underestimated. ICRAF has recently highlighted the richness and diversity of African indigenous agroforestry systems (Nair, 1989).

Spectacular forms of indigenous terracing can be found in the African mountain regions, such as the Mandara mountains in Cameroun and the Djebel Marra in Sudan. Many mountain regions in Africa have served as a sanctuary or refuge for population groups seeking protection against more powerful tribes. In order to survive on a limited land resource base, intensive systems of agriculture often had to be developed on steep slopes, which had to be terraced. Some mountain regions still have very high population densities (up to 250 persons/km^2 in North Cameroun and up to 800 persons/km^2 in Rwanda), whereas population densities are much lower in the surrounding lowlands.

Table 1 lists some examples of indigenous soil and water conservation in sub-Saharan Africa with prominent "ethno-engineering" practices. This incomplete listing demonstrates the wide variety of such practices. Although international awareness of the importance of indigenous conservation techniques has increased, it is remarkable that our knowledge of these techniques is so limited. The major reason is that, **with only a few exceptions, African and expatriate researchers, soil and water conservation specialists and government staff have systematically neglected or underestimated the potential of**

Table 1 Examples of indigenous soil and water conservation techniques in Africa with prominent 'ethno-engineering' practices

Country	Region	Rainfall (mm)	Population density persons/km²	Indigenous soil and water conservation techniques	Major Crops	Publications
Burkina Faso	Southwest	1000-1100	35	stone bunds on slopes; network of earth bunds and drainage channels in lowlands	sorghum millet maize	Savonnet (1976)
	Southwest	1000	35-80	contour stone bunds on slopes, drainage channels	sorghum millet	Pradeau (1975)
	Central	400-700	29 (1975)	stone lines, stone terraces, planting pits *(zay)*	sorghum millet	Savonnet (1958) Reij (1983) Roose (1990)
Cameroun	North	800-1100	80-250	bench terraces (0.5 - 3 m. high) stone bunds	sorghum peanuts millet	Boulet (1975) Boutrais (1987) Riddell & Campbell (1986) Hallaire (1971)
Cape Verde	S. Antao Island, North Cape Verde	400-1200 (in uplands)	> 100	dry stone terraces (rainfed, irrigated), 0.5 - 2 m. high	sugar cane maize sweet potatoes pigeon peas	Haagsma (1990a) Kloosterboer and Eppink (1989)
Ethiopia	Southwest	1200	100	dry stone terraces (walls 1-2 m. high) rectangular basins (approx. 2 m. x 4 m.)	millet maize cotton	FAO (1990) Hallpike (1972)
Niger	Ader Doutchi Maggia	300-500		stone lines, planting pits *(tassa)*	sorghum millet	IFAD (1986c; 1991c)
Nigeria	Jos Plateau, Central Nigeria	1000-1500	110-450	stepped, level benched stone terraces, rectangular ridges *(sagan)*, mound cultivation	millet maize beans	Netting (1968) Netting et al. (1989)

Mali	Djenné-Sofara, Central Mali	400	20-30	pitting systems	sorghum millet	Ayers (1989)
	Central	500-650	13-85 average 25 (1990)	cone shaped mounds, planting holes, terraces square basins, stone lines, bunds or low walls, millet stalk trash lines	millet sorghum onions	Gallais (1975) Gallais en Sidikou (1978) Kassogue et al. (1990)
Rwanda	Northwest	1100-1400	500-800	terraces *(inyanamo)* (0.5 - 1.0 m. wide), stone contour bunds, contour or graded earthen bunds	beans bananas sorghum	Nyamulinda (1989) Roose et al. (1988)
Sierra Leone		2000-2500	38 (1976)	sticks and stone bunding on fields and in gullies drainage techniques	rice cassava	Millington (1984), (1985)
Somalia	Hiraan region, Central Somalia	150-300	13	earth bunds with upslope wing walls *(caag)* and earth bunds dividing plots of land into a grid *(gawan)*	sorghum cowpeas	Critchley et al. (1991)
Sudan	East	225-400	10-15 (1985)	earth bunds (straight) with upslope wing-walls *(teras)* and water spreading techniques	sorghum	Critchley et al. (1991) Ibrahim (1988) Randell (1963)
	Djebel Marra Highlands, Western Sudan	600-1000	20-37 (1976)	bench terraces	millet sorghum	Miehe (1986)
Tanzania	Uluguru Mountains, Eastern Tanzania	1500	100-300	ladder terraces (trash contour ridges)		Temple (1972)
	Southwest	1000	40	Matengo pit system: digging of pits (1.0 - 1.5 m. in diameter), ridges	millet maize cassava	Allan (1965) Basehart (1973)
	Ukara island, Northern Tanzania	1500	210	earth and stone terraces, tied ridging, stone barriers in gullies, mound cropping	millet cassava rice	Allan (1965) Ludwig (1968)
Tchad	Ouddai	250-650	5-6 (1987)	water harvesting in drier regions: various earth bunding systems with upslope wingwalls and catchment area	millet sorghum	Sommerhalter (1987)
Togo	North	1400	80	bench terraces and contour bunds, (rectangular) mound cultivation	yam millet sorghum rice	Allan (1965) Sauvaget (1981)

indigenous soil and water conservation techniques. Various studies carried out in sub-Saharan Africa between 1940 and 1965 mention indigenous conservation techniques, but follow-up studies are hard to find. Therefore, little or nothing is known about the present state of these techniques. Are they abandoned, maintained or expanded? Several indigenous conservation techniques are known to exist, but have hardly been studied or have not been studied at all. Examples are the traditional stone lines in the Ader Doutchi Maggia (Niger); the pitting systems in the Djenné - Sofara region in Mali; the indigenous water harvesting techniques (*teras*) in the Kassala region in Sudan; the water spreading techniques in the Red Sea Hills of Sudan; and the *caag* and *gawan* techniques in the Central Rangelands of Somalia (Annex A).

It is not easy to explain why "ethno-engineering" practices have been studiously ignored for so many years. The traditional stone lines in the Ader Doutchi Maggia are a striking case. Soil and water conservation projects have been carried out in that region since the beginning of the 1960s. Although numerous international soil and water conservation specialists have visited the region to design, implement, support or evaluate these projects, their reports contain no observations about traditional stone lines, which locally cover substantial areas. They cannot have been overlooked, so they must have been deliberately ignored. A possible explanation is that conservation specialists simply believe in the superiority of their technical package and assume without further verification that indigenous techniques can only be rudimentary. The land users in the Ader Doutchi Maggia "benefitting" from modern soil and water conservation activities have not maintained and expanded the modern conservation works. Traditional stone lines have been abandoned on the most marginal fields, but elsewhere they continue to be maintained and spontaneously expanded. This should have given the conservation specialists food for thought.

3.3 The breakdown of traditional systems

Although adequate information about the present state of sub-Saharan African "ethno-engineering" practices is sorely lacking, the overall impression is that, in many instances, traditional terraces in mountain regions are inadequately maintained or even abandoned. This ultimately leads to their collapse. Reasons for abandonment are diverse:

- **Increased political stability** and **pacification** during and after the colonial period made it no longer dangerous for population groups living in the mountains to move downhill into the plains.

- In some cases governments have made deliberate efforts to draw people out of the mountain regions with a high population density in order to settle them in areas with a low density population and a higher potential for agricultural production. **Planned and spontaneous migration from mountain regions may mean that the maintenance requirements of terraces cannot be assured and fertility management practices cannot be carried out adequately.**

- Although many terracing systems are able to support reasonable yield levels and very high population densities, **returns to labour are low.** When alternative economic opportunities, offering higher returns to labour, become available, more intensive farming systems may cease to be fully viable, because they offer only low level equilibrium.

- Isolation plays a significant role. It acts as a market factor when crops produced in mountain regions are unable to compete with crops more efficiently produced in the lowlands, or even with imported crops. Harsh living conditions in isolated regions, combined with lack of opportunities to earn a cash income to satisfy a growing need for consumer goods, also encourage abandonment of terracing systems.

In general, traditional systems of production have tended to be ignored or overlooked by researchers, technicians and policy makers. As a result, they have suffered from insensitive development policies and interventions. The common practice of equating indigenous systems with "primitive" or "rudimentary" methods, in unfavourable contrast to "modern" techniques, has accelerated the eclipse of these traditional systems.

3.4 Soil and water conservation in the colonial period

Soil erosion was identified as a problem by many colonial administrations in Africa. It became a priority in the British ruled territories in the 1930s, and much soil conservation was undertaken during the decades prior to independence (Annex B offers an analysis of colonial soil and water conservation programmes). Rates of soil loss were not widely measured in the 1930s. Therefore it is not surprising that different groups held widely varying perceptions of the threat posed by soil erosion and of the effects of the conservation works. This is convincingly demonstrated for Lesotho by Showers and Malahleha (1990) (Box 5).

Early soil and water conservation programmes often relied on sanctions and penalties to achieve their targets. This can be illustrated by the case of Rwanda and Burundi (Figure 6). During the period of Belgian administration, a massive terracing programme was implemented in these countries. Just before independence, terraces and forest plantations covered about 795,000 hectares. But the construction of terraces and the planting of trees were done with forced labour.

A type of terrace widely applied was the intermittent contour ditch. Excavated soil was thrown up-hill and as such it can be considered as the precursor of the *fanya juu* terrace in Kenya. While the former was strongly resented by Rwandan farmers, as it was forced upon them, the latter has gained widespread popularity in Kenya as the key element in village conservation activities.

Another feature of early conservation policies was that they typically ignored indigenous soil and water conservation. In some cases, modern soil and water conservation techniques were superimposed on existing indigenous techniques. In the Uluguru mountains of Tanzania, ladder or step terraces were the most widely employed and generally accepted soil conservation method on the western side of the mountains. But in 1950, the Uluguru Land Usage Scheme introduced compulsory bench terracing in shambas of medium gradients, with reafforestation of steeper slopes, involving their closure to cultivation of annual crops. Basically, large bench terraces were superimposed on indigenous ladder terraces. The Uluguru Land Usage Scheme was abandoned in 1955 after serious riots.

Perceptions of soil erosion in Lesotho

An analysis of written records and interviews with old Basotho farmers shows very different opinions about the existence and nature of the threat of soil erosion in the 1930s. The British officials' and the missionaries' perceptions of the condition of the landscape were influenced by the condition of the roads they travelled and the degradation of the heavily used grounds of mission stations and government camps (Showers, 1989). According to the Basotho informants the fields as well as the lowland pastures were largely free of soil erosion at the time. This view is confirmed by some reports written in the 1930s. Erosion was not a serious problem in the cultivated fields, because grassed field boundaries were well developed and maintained. Despite this, contour banks were installed in the fields and lowland pastures. The Basotho informants disapproved of the construction of contour banks, because they reduced the size of the fields. Furthermore, contour banks breached, and if they did not break, the outlets invariably became gullies (dongas). In other words, many gullies, the origin of which was attributed by the British administration to "unusual weather", were the direct result of the water concentrated by the contour bank system (Showers and Malahleha, 1990).

Box 5

3.5 Soil and water conservation after independence

People in the former Belgian, British and Portuguese colonies often associated soil and water conservation with coercion, discriminatory land policy and insensitive imposition of inappropriate, irrelevant and/or economically restrictive regulations. It is therefore not surprising that **in the decade after independence, soil and water conservation received low government priority.** In East and Southern Africa little happened in the sector in the 1960s. In fact, the trend was sometimes negative. In several countries, terraces constructed during the colonial period were deliberately destroyed. In Rwanda it was not until the second half of the 1970s that soil conservation activities were introduced again. A National Soil and Water

Conservation Programme was initiated in Kenya in 1974. Influenced by the major drought hitting large parts of Africa in the period 1968 - 1973 as well by the first U.N. Conference on the Environment (Stockholm, 1972), and the U.N. Conference on Desertification (Nairobi, 1977), many governments ultimately sought to reestablish a soil and water conservation programme.

In several soil and water conservation programmes initiated in the 1970s, mechanized conservation staged a come-back. This was the case, for example, in Malawi (Lilongwe Land Development Programme), Lesotho (Thaba Bosiu Rural Development Project) and Swaziland (Rural Development Area Programme). However, experience shows that **many conservation programmes relying on the use of heavy machinery for construction of conservation works combine poor design with poor maintenance by the "beneficiaries".** As a result, conservation banks breach or are considerably reduced in size. Grassed waterways created to evacuate excess water are transformed into gullies.

The situation in francophone West Africa was quite different, in that little or nothing had been undertaken in the field of soil and water conservation before independence. Shortly after independence the large-scale GERES mechanized soil and water conservation (SWC) project was initiated in the Yatenga region of Burkina Faso and operated from 1962 to 1965. Entire catchment areas were covered with graded channel terraces. Although this costly operation was done according to the textbook, land users were not involved and refused to maintain the conservation works. The failure of this programme scared donor agencies away from soil and water conservation until the beginning of the 1970s. Ivory Coast and Niger were the only other francophone West African countries initiating soil and water conservation activities in the 1960s, but on a much smaller scale than in Burkina Faso. Most activities in Niger were concentrated in the valleys of the Ader Doutchi Maggia region.

In the lusophone countries, little soil and water conservation was done before independence and, with the exception of Cape Verde, little could be done after independence. Cape Verde launched an important soil and water conservation programme in 1976, but it had to start almost from scratch.

3.6 Lessons learned

3.6.1 The potential of indigenous conservation systems

In many parts of the region, traditional farming systems are under pressure and indigenous terracing practices are breaking down. But in mountain regions, on plateaus as well as in lowlands, many examples can also be found of the maintenance and expansion of indigenous conservation techniques. In parts of Burkina Faso, Mali and Niger, traditional stone lines and planting pits are increasingly used to rehabilitate degraded land (Figures 2 - 5). The IFAD financed soil and water conservation programme in Niger is at the forefront of this trend. Traditional forms of water harvesting continue to be extensively used and even expanded in the Central Rangelands of Somalia and the eastern plains of Sudan (Annex A). High population pressure on available land resources, which are subject to severe degradation processes, can provide an important impetus for the maintenance and expansion of indigenous conservation techniques. The use of indigenous conservation techniques can also yield **important benefits**. If these techniques can be used to rehabilitate degraded land, they allow expansion of the land resource base, which is of utmost importance where land users urgently need extra productive capacity. The difference between the "with conservation" and the "without conservation" situation is obvious in such cases.

Building on indigenous practices

The IFAD funded soil and water conservation programme in Niger's Illela district limited itself in its first year to the implementation of a number of conservation techniques well-known in the region, notably half moon structures (demi-lunes). In its second year (1989/90) the programme suggested the improvement of traditional planting pits (tassa). Improvements comprised an increase of their size and depth as well as the application of organic matter at the beginning of the dry season. Rainfall in 1990 was low and erratic. Observed yields from the improved tassa were well above average. Land users reacted enthusiastically (Annex A).

Box 6

Our current knowledge of the wide range of African indigenous soil and water conservation practices is extremely limited. Learning more about them should receive high priority, for a number of reasons:

- First, **many soil and water conservation projects have failed**, whereas some indigenous conservation techniques continue to be maintained and expanded. Although factual evidence to support the assertion is limited, **there are reasons to assume that indigenous conservation techniques could be used as a starting point for new programmes.** Where this has been tried, for example in Burkina Faso and Niger, land users have reacted enthusiastically and have spontaneously revitalized abandoned techniques (Box 6). According to Nyamulinda (1989, 12) the indigenous conservation techniques used in the highlands of Rwanda essentially lead to agricultural intensification and could be integrated into permanent structures built on the contours.

- Second, **indigenous African farming systems and the conservation measures integral to them are infinitely varied and often highly location specific.** This local variability is generally not taken into account by conventional agricultural development approaches and standard soil and water conservation measures. As Chapter 4 makes clear, **an appreciation of such variability is vital for successful conservation design.** Much can be learned from the way African land users have attuned their farming practices to variations in ecological conditions. This will also create a better base for defining the circumstances allowing the successful transfer of particular conservation techniques to other regions.

- Third, **indigenous conservation works, such as terracing systems in African mountains, represent major economic assets**: not only for the protection of cultivated lands on slopes, but also for the prevention of downstream damage. Lack of maintenance and abandonment leads to their collapse. In some cases, analysis may show that rebuilt traditional conservation works are the most cost effective means of protecting land resources and maintaining agricultural production. Areas of resettlement (urban centres and lowlands) cannot always cope with the arrival of large numbers of settlers from areas where intensive production-with-conservation systems have collapsed. When land users migrate from such areas to regions with lower population pressure on the natural resource base, they tend to abandon these intensive systems. Accelerated land degradation can result in the areas of resettlement.

3.6.2 Project experience

With some exceptions, the results of soil and water conservation projects carried out since 1960 have been disappointing. There were two major problems. First, **"beneficiaries" did not, or did not adequately, maintain the conservation works,** which were sometimes constructed at great cost. Second, **land users did not adopt the project inspired conservation techniques, which implied that at the end of a project all conservation activities came to a halt.** IFAD's policy paper on "soil and water conservation in sub-Saharan Africa: issues and options" (IFAD document SPA/86/I/R11 of 25 November 1986), was one of the first papers producing a systematic and comprehensive analysis of reasons for failure in African soil and water conservation. Some reasons for failure advanced in this paper are:

- most approaches to soil and water conservation in the region have been of a top down nature, which means that conservation specialists (outsiders) determine the techniques to be applied, the modalities of implementation and the areas needing treatment;

- an emphasis on an engineering approach to SWC, leading to the introduction of techniques of considerable engineering complexity (e.g. graded channel terraces), implying the effective exclusion of land users from processes in which they should feel fully involved;

- the introduction of inappropriate techniques: in semi-arid regions of Burkina Faso and Niger, it took well over a decade before the shift was made from soil conservation and in-situ moisture conservation techniques to water harvesting techniques;

- due to an uncritical use of food-for-work as an incentive, land users may closely associate soil and water conservation with the distribution of food aid. In many cases, land users now refuse to implement conservation activities unless they know that food aid will be distributed. In such instances, the incentive (food-for-work) effectively acts as a disincentive;

- training of land users in simple techniques of land survey, in principles of construction and in a number of complementary measures has been neglected, which prolongs their dependence on outsiders and reduces their ability to adopt conservation techniques;

- the unit of analysis and project design has often been the natural catchment. But the priority of land users may be the treatment of their own cultivated plots. The catchment area is in most instances not perceived as the logical unit of management and decision making. Catchment based project design tends to emphasize technical parameters and first world' methods, such as remote sensing and land evaluation;

- projects have too often emphasized the long-term benefits of soil conservation and the interest of future generations. These arguments are unlikely to be convincing to land users facing food shortages. Inadequate attention has been given to the short term benefits (i.e. yield increases) of soil and water conservation;

- different donor organisations favour different conservation techniques, different approaches to land users, different funding philosophies and different procedures for project planning, implementation, monitoring, evaluation and reporting. This situation complicates organization and management of the programmes at the level of the ministries involved. Different modalities of implementation cause friction and competition between projects at field level.

Considering the disappointing results of soil and water conservation since independence, it is interesting to compare colonial soil and water conservation with post-independence soil and water conservation. A major difference is that the colonial authorities sometimes used coercion and sanctions rather than extension messages and incentives. But despite the growing use of the latter methods since independence, **the top-down approach in some modern soil and water conservation projects may lack effective incentive schemes and land users continue to be blamed for failure** (Box 7). In many countries the coercive legislation has remained on the statute books. Although this legislation has not been enforced, the temptation to enforce it may well increase as those responsible for soil and water conservation look for additional tools to control the "intractable" problem of soil degradation.

When British colonial administrators decided in the 1930s and 1940s that soil erosion was a growing threat and something should be done about it, they acted quickly. Some administrators were sent to the USA for observation and training and as a result, contour terracing programmes were launched. In the case of Lesotho, the Basotho were, in 1937, among the first to experience an untested and little understood technology. There is a striking parallel between the 1930s and 1940s on the one hand and the 1970s and 1980s on the other. In the 1930s, largely untested technology was transferred to Africa to combat erosion. In the 1970s, donor agencies and governments were convinced that something should be done about Africa's environmental crisis and major soil conservation programmes were initiated, often relying on heavy machinery and a simple standard conservation package. In both cases the complexity of African farming systems was not taken into account and the results of the programmes were disappointing.

3.6.3 Recent trends

3.6.3.1 A growing interest in the participation of land users

The early 1980s witnessed a growing interest in land user participation in soil and water conservation, as well as in indigenous technical knowledge. Recent papers dealing with conservation policies strongly emphasize the need for land user participation in most or all stages of the project cycle (IFAD, 1986a; Shaxson et al., 1989; FAO, 1990). Although the need for land user participation is now commonly accepted and proclaimed by conservation policy makers, experience shows that a considerable gap remains between policy and practice. The IFAD funded project in the Fouta Djallon region of Guinea is designed to perform regular 'diagnostic surveys' and discuss the results with farmers, who prioritise the issues raised. Agricultural research tests are done in cooperation with farmers, with additional work done at the research station.

3.6.3.2 A growing awareness of the importance of indigenous soil and water conservation techniques

IFAD's first policy review of soil and water conservation strongly emphasised the potential and importance of learning from small farmers and their traditional techniques.

The way it works:
a tale from southern Africa

Stocking (1988b: 381) gives an interesting description of what he calls the classic approach to soil conservation. He describes the circumstances of an imaginary family in Southern Africa, the Mafutas.

In his youth Watch Mafuta worked at the mines. Now, at age 40, he is tired, and his yearning for his communal ancestral home has brought him back to the family "shamba" or farm. Largely through Mrs. Mafuta's diligence, a thriving home garden supplies vegetables and some of the staple cereals, maize and sorghum. Watch cultivates cotton and maize on an extensive plot allocated by the chief, away from the village. Declining yields force him to plough more land each year. Weeding is a real problem on the extra land... Concerned because of reports about land degradation, the government agricultural officer, a local extension assistant, and a foreign aid worker call on the Mafutas. They take the classic three-step approach to soil conservation [as outlined by Sanders, 1988, 13 - 15]:

1. Identification of the problem: *these technicians see the degrading arable land, the overgrazed range, the poor crop stands, no fertilizer use, and not a single measure they could call "conservation". If the visitors bother to ask, they may even identify some critical constraints in the farming system, such as late-planting because of the lack of animal traction for ploughing or of labour demand during land preparation and weeding. The analysis concludes: erosion is confirmed serious; soil conservation and land reclamation are urgently needed.*

2. Planning of control measures: *soil loss rates are calculated and packages of remedial measures designed to reduce degradation. Technically good, these measures will work, the experts argue. "We only need cooperation from the community", they say.*

3. Implementation of the plan: *the plan is explained to the Mafutas. Encouragement and persuasion, even subtle threats, are employed. Typically, the household is shown photographs of eroded land, statistics on soil loss, and embellished descriptions of the dire consequences of allowing erosion to continue. Appeals based on patriotism, their custody of the land for future generations, and the security of the state are launched. Demonstration plots and field days show what can be done. Hoe in hand, the Mafutas set to.*

The farmer and local administrators, inarticulate in the face of such an onslaught, can rarely muster convincing arguments against such plans. Nearly always nods of agreement, smiles and handshakes ensue. The experts' plans are accepted. Implementation proceeds.

Successive stages in the scenario could be summarized by these headlines: "soil conservation project hits teething problems", "Targets not met in conservation plan", "Government minister urges unity to fight menace of erosion", "Lazy farmers blamed for erosion", "Heavy rains destroy contour terraces", "Aid agency pulls out".

The innocent and guilty are thus exposed. Foremost among the innocent is the aid agency. Didn't it do its best? The government minister and the experts too are blameless. Didn't they warn of erosion's dangers? Watch Mafuta, his family, and the millions of households like theirs that failed to heed the warnings and do the necessary work. They are the guilty; they now suffer the consequences. If nothing else, justice at least is done.

Box 7

IFAD's Special Programme for Sub-Saharan African Countries Affected by Drought and Desertification

During the early 1980s the socio-economic crisis that affected sub-Saharan Africa provoked a re-examination of international development efforts in support of the rural poor in the region. IFAD summarized the causes of the crisis as follows:

- a declining natural resource base;
- inadequate delivery systems (of farm inputs, credit and extension services) to support small agricultural producers;
- inappropriate development strategies;
- deficient institutional support mechanisms.

It noted, however, that sub-Saharan Africa remains rich in indigenous agricultural expertise, and that small-scale farmers and pastoralists retain an important comparative advantage in the production of a number of commodities. It recognized also that the traditional or indigenous farming sector in Africa with its dominant role in the economy of the region, especially in the all important sector of food production, possesses a resilience and dynamism which makes it a viable foundation for investment and growth.

In 1986 IFAD, concerned in particular with problems of twenty-four African countries affected by drought and the process of desertification, launched its Special Programme for Africa (SPA). The SPA was designed on the basis of a set of specific initiatives aimed at a specific target group in a selected number of priority countries in sub-Saharan Africa. It would supplement IFAD's regular activities in the region, not only in terms of additional resources but also in sectoral coverage. The central objectives of the SPA were to: (i) help bring about a quick recovery in the production capacity of smallholders; and (ii) introduce measures to enhance family and community food security in drought-prone areas by promoting farming systems that are more resilient to environmental stress. The provision of basic tools, implements and inputs, the rehabilitation of services and infrastructure serving the smallholders and the promotion of the better use of available capacity in the agricultural sector were the basic instruments selected for the SPA to achieve the first objective. The introduction of soil and water conservation, agroforestry measures, the development of small-scale water management schemes and the promotion of drought tolerant traditional staple crops were the range of measures planned to reach the second objective.

In developing SPA policy and operations, IFAD commissioned three reviews of aspects of the crisis and options for tackling them. One of these was the first edition of this study under the title of "Soil and Water Conservation in Sub-Saharan Africa, Issues and Options" (IFAD, 1986a). This second edition of the review is intended in part to help IFAD assess experience with the SPA to date in relation to recent trends in natural resource management in sub-Saharan Africa, with particular reference to some SPA programmes which especially emphasize environmental protection and rehabilitation.

The early SPA programmes adopted the previous study's recommendation that an extended time frame be adopted, with a long lead period for investigation of indigenous practices and the piloting of appropriate support activities. They vary in important ways. In Burkina Faso, the programme builds on the sucessful approaches of earlier projects. The Niger programme is innovative in being based partly on indigenous methods. In Lesotho, the SWaCAP programme has a major component of institutional innovation; restructuring agricultural extension services. The programmes in Guinea and Senegal aim to develop small-scale agriculture through the integration of biological and vegetative conservation techniques into the farming system. One to three years after these programmes began, preliminary observations can be made about their progress and that of the SPA approach overall. In general, the results to date are encouraging. Farmer response is enthusiastic.

Box 8

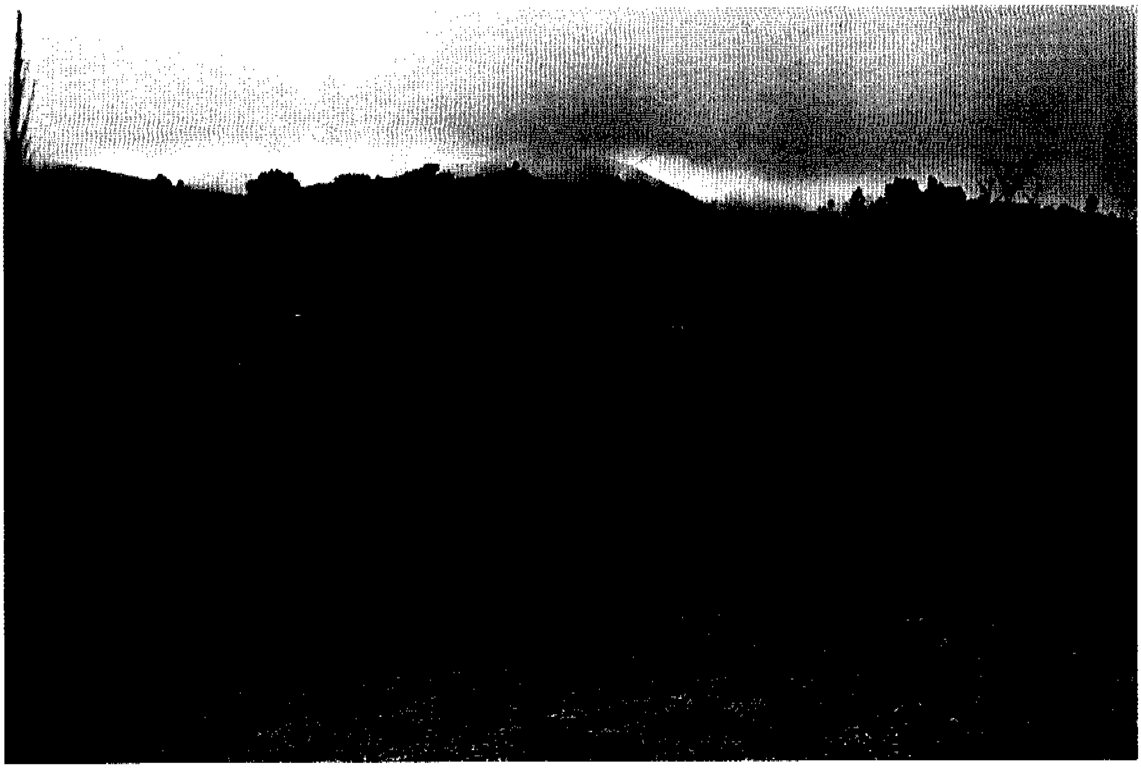


Figure 1 Rwanda: tea provides excellent soil cover

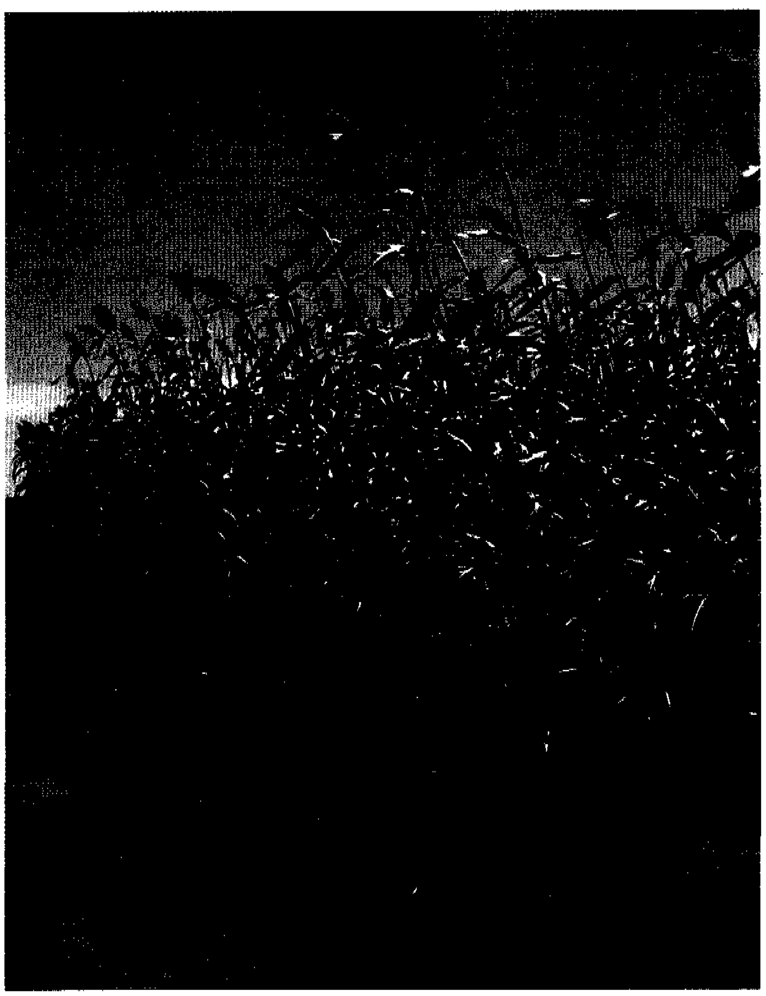


Figure 2 Mali: traditional pitting techniques in Djenné-Sofara region

Figure 3 Dogon plateau: construction of fields on bare rock (Mali)

Figure 4 Burkina Faso: rehabilitation of degraded land using improved traditional stone lines (IFAD - CES/AGF)

Figure 5 Niger: improved traditional planting pits are rapidly adopted (IFAD - PSN)

Figure 6 Rwanda: a massive terracing programme was implemented in the colonial period

Figure 7 Guinea: integration of agriculture and livestock (IFAD - PRA/FD area)

Figure 8 Cape Verde: stone wall terraces for irrigation of sugar cane at Santo Antao

This recognition has spread, as demonstrated by the first resolution of the 6th International Soil Conservation Conference (Ethiopia and Kenya; November 6 - 18, 1989):

> *"Recognizing the immense wealth of traditional know-how, especially in agricultural systems, we should learn from the principles behind their success or failure in the handling of soil and water management."*

3.6.3.3 A more systematic association of soil and water conservation with agroforestry and agricultural intensification

Soil and water conservation measures alone will not lead to sustainable yield increases. A range of complementary measures also need to be taken to optimize the impact of soil and water conservation. Several projects funded under IFAD's Special Programme for Africa (Box 8) promote soil and water conservation in combination with agroforestry (tree planting along conservation works) and agricultural intensification (compost pits and use of natural phosphates). For example, the Guinea programme combines agroforestry techniques with soil and water conservation and the increased production of compost. This will improve yields on both *tapades* (fields near the house) and the *champs extérieurs* (more distant fields).

3.6.3.4 More attention to biological techniques of conservation

The traditional engineering approach is beginning to give way to biological measures, including better crop cover and vegetative barrier techniques. Fertility management techniques are gaining ground, and are becoming increasingly integrated in conservation activities.

3.6.3.5 A wider range of techniques applied in a wider range of ecological zones

In the past the emphasis was often on soil conservation. There is clearly a growing interest in moisture conservation and water harvesting techniques in the arid and semi-arid areas, whereas in the more humid areas greater attention is now paid to the use of vegetative barriers.

3.6.3.6 More attention to the role of women in soil and water conservation

Almost all projects have a gender clause in policy statements, but experience shows that although women play a major role in the construction of conservation works, they do not yet have adequate access to training.

3.6.3.7 Growing interest in common property resource management and in village land use management

In francophone West Africa, the emphasis has long been on the conservation of soil and water on cultivated fields and on the rehabilitation of degraded lands. Awareness has grown that this is not sufficient and that more should be done to address the problem of the continuing impoverishment of vegetation on the non-cultivated parts of the village territory. In other parts of sub-Saharan Africa, atrophied indigenous forms of village land use management sometimes persist (collective decisions about the opening and closing of grazing lands, for example).

3.7 The need for assistance

Land users *can* make the transition to more intensive production with appropriate resource conservation; but they need an appropriate policy environment; a suitable framework of local institutions; and external support (at the national and international levels). This external support can help them to accelerate the transition to sustainable, increased production. It can also help to minimise hardship and reduce land degradation while the transition takes place. Although soil and water conservation has already been the subject of numerous aid programmes in sub-Saharan Africa, it is clear that much of this aid has been misdirected.

Inappropriate technical methods have been employed, with inadequate attention to indigenous conservation practices. Local socio-economic realities have not always been appreciated by project designers; extension and incentives approaches have rarely resulted in optimum participation by the affected land users. Despite the investments already made, land degradation continues to accelerate, drawing rural incomes downwards with it into a tightening spiral of poverty.

There is therefore an urgent need for stronger support to the rural people of sub-Saharan Africa as they struggle to maintain agricultural productivity by combating land degradation. But this support must take into account the lessons offered by experience in the sector to date. The first phase of IFAD's Special Programme for Africa (Box 8) was an early attempt to do this. On the basis of previous experience, including that of the Special Programme to date, Chapter 4 reviews issues which arise in the planning and execution of soil and water conservation programmes.

4. Design issues in soil and water conservation

A variety of issues must be considered in the design of successful soil and water conservation programmes. Some concern environmental and technical aspects of appropriate methods. Other issues are socio-economic in nature. A third consideration must be the many institutional and policy parameters which affect interventions in this sector.

4.1 Technical issues

4.1.1 Environmental variability

Sub-Saharan Africa is characterised by its wide variety of environmental conditions. Rainfall, temperatures, altitude, topography, vegetation and soils vary enormously within the region, and often within countries. Modern techniques, such as remote sensing and geographic information systems, have increased our knowledge of the variability of natural resources in different agro-ecological zones. There is no single climatic or environmental zone which typifies sub-Saharan Africa (Box 9).

Rainfall zones and conservation objectives

For soil and water conservation purposes it is useful to distinguish between three broad zones, determined by the amount of rainfall and posing differing technical objectives. These, approximately following the categorisation of Roose (1990), are as follows:

high rainfall zone (Sudanian-Guinean): above 1000 mm annual average rainfall

- objective: to dispose of excess rainfall while conserving soil.

medium rainfall zone (Sudanian): 700 -1000 mm

- objective: to hold total rainfall in situ while conserving soil.

low rainfall zone (Sahelo-Sudanian): 300-700 mm

- objective: to concentrate rainfall runoff by water harvesting from a catchment area while conserving soil in the cropped area.

Box 9

Even in areas which are similar in this respect, the socio-economic conditions may differ considerably. The implication for resource conservation programmes is that **the range of technical approaches must also be broad, and specific techniques matched carefully with the environment - both physical and socio-economic.**

Early SWC programmes were implemented mainly in areas where agricultural potential was good, rainfall relatively high and where soil erosion was perceived as being a threat. The emphasis was therefore on conservation of soil and safe disposal of excess runoff to avoid further erosion of productive land. The technical approach was to introduce systems which had been developed in the USA - systems which were often ill adapted to the very different conditions of most of Africa.

The first concentration of development assistance was thus on the wetter, relatively more productive areas - and techniques which emphasised safe disposal of excess rainfall while conserving soil. These systems were based on structures, and most commonly comprised terraces made by machine. Soil conservation was viewed as an engineering exercise, and departments of conservation in colonial and early post colonial Africa were built around engineers, surveyors and machinery. The failure of the majority of the early soil conservation programmes has already been discussed (Chapter 3). Not only was the approach inappropriate, but systems were often inflexible, too expensive, and farmers did not appreciate the systems or benefit significantly from them.

A new wave of thinking began to emerge during the 1980s. A central argument is that better farming itself is the key to improved conservation, while directly benefiting the land user. A further development has been the increased coverage of dry areas by conservation programmes. This has been in response to the Sahelian droughts in the last two decades. Here, the emphasis has been on "in situ moisture conservation" where season rainfall is marginal, or "water harvesting" in the more arid areas (Box 9). In both of these zones the accent is on conservation of water rather than prevention of soil erosion, and the immediate result is an improvement in the reliability of harvests. These techniques are, significantly, of most relevance to the very poorest land users in Africa, who live in these drier areas.

4.1.2 Choice of technique

4.1.2.1 Engineering structures

The conventional approach to soil and water conservation is for projects to introduce engineering support structures, such as terraces and waterways. However, experience has shown that these are expensive and rarely maintained, except in specific circumstances. There is also a danger that poorly maintained structures may overtop, leading to collapse and the development of gullies. The construction of bench terraces in mountain areas in wetter climates can increase the risk of landslides due to saturated soils, in case of shallow soil depths on impermeable rock material. Certainly in the wetter zones, where crop production is relatively reliable, there may be more merit in promoting conservation through better biological methods: better husbandry supplemented by the use of permeable vegetative barriers. This is why the IFAD funded programme in the Fouta Djallon region of Guinea aims at both targets by promoting such techniques as vegetative barriers above the fields; live fences; field preparation along the contour; and improvement of soil permeability and fertility through the use of compost (Figure 7).

Engineering structures are useful, however, in the marginal and semi-arid are as where rainfall limits crop growth (Figure 8). This is because earth or stone bunds hold rainfall and/or spread runoff better than vegetative barriers, which in any case are more difficult to establish in these zones. An example of successful structures are the level *fanya juu* terraces built in eastern Kenya, whose objective is to hold rainfall within the fields. Improved moisture conservation leads to increased and more reliable yields. This is the main reason for their popularity. In the dry Sahelian zone of West Africa, the water harvesting techniques of contour stone bunds and permeable rock dams are increasing in popularity due to their positive effect on crop yields. Because these structures are permeable, they do not concentrate water in spillways, which are often a weak point in design. Nevertheless, stone is not available throughout the region and such techniques are therefore limited in applicability.

4.1.2.2 Vegetative practices

Grass strips

Grass strips are receiving increasing attention as alternatives to engineering structures in soil and water conservation. One advantage of such "vegetative barriers" is that they can be cheaper to establish than engineering structures and are, to a certain degree, self-maintaining. The strips slow runoff and filter out sediment, thus building up into terrace banks over time (Figure 9). Indeed, this can occur quite rapidly. Nevertheless, grass strips are not as well suited to the drier areas, where they are more difficult to establish, and are not as effective at holding or spreading runoff.

In every agro-ecological zone suitable grass species can be identified. Special attention is being given to local varieties. Grass strips can be used in combination with stone bunds. *Andropogon gayanus* has been widely used in the semi-arid zones of Mali, Burkina Faso and Cameroun. This species is grown traditionally around field boundaries and used for weaving into mats. It is helpful for decreasing both water and wind erosion.

A number of grasses have been tested in different countries and are showing promise for use as grass strips or in stabilization of terrace banks. Examples are Napier grass (*Pennisetum Purpureum*), Bana grass (*Pennisetum Purpureum* x *P. americanum*), Guatemala grass (*Tripsacum laxum*) and Makarikari grass (*Panicum coloratum*). Special attention is being given to the potential of Vetiver grass (*Vetiveria zizanioides*)

Vetiver grass

Vetiver (Vetiveria zizanioides) began to receive considerable attention towards the end of the 1980s as a suitable grass species for barrier strips. This was largely due to a vigorous campaign by the World Bank, particularly in India, which is very optimistic about its future as an alternative to earth bunding. Vetiver apparently thrives over a wide range of conditions, establishes rapidly from splits and does not compete aggressively with adjacent crops. Nevertheless, supporting evidence of its viability and acceptability at the field level - in India and Africa at least - is still limited.

Box 10

(Box 10). The new IFAD funded programme in Katsina State, Nigeria, will use Vetiver on a wide scale, as a boundary demarcator and for grass strips along contours.

The reactions of the land users themselves differ greatly. They sometimes resent the space taken up by grass strips. This has led to width being reduced in some situations. The strips introduced in Swaziland in the 1930s, for example, are becoming narrower as demand for land rises. More recently, grass strips in Mali, introduced under the PLAE project, have been reduced in size as well as being spaced further apart. Farmers sometimes also complain that the strips harbour weed species and vermin. Some plants tend to invade farmers' fields, either by seed or by stolons, thereby competing with crops for scarce nutrients and water. This competition must be taken into account, especially where land is steep and terraces or strips closely spaced.

However, in some situations grass strips are directly profitable. In Kenya, for example, Napier grass produced on terrace banks is cut and used for feeding dairy cows. Fodder grasses have become a cash crop in some areas and in locations close to Nairobi, farmers are even removing wattle trees and replacing them with Napier grass for sale.

Agroforestry

Project planners are increasingly interested in the potential of agroforestry for conservation and production (Box 11). Of all the forms of agroforestry, barrier hedges are perhaps the most promising technique for soil and water conservation. Barrier hedges work in the same way as grass strips. Dense hedges are established along the contour, controlling erosion and slowing runoff. Terraces eventually develop. If the hedging species can be directly sown from seed, this is a relatively cheap technique, although costs rise if cuttings are planted and escalate if seedlings have to be raised in a nursery. Again, there is much more written about the potential of such techniques than can be reported from experience with farmers.

Young (1989, 60) divides agroforestry practices for soil conservation into "direct" and "supplementary" functions of trees. Barrier hedges act directly, as do trees planted as windbreaks. In the Maggia valley of Niger, windbreaks have been shown to improve crop production by diminishing wind erosion and shading plants from wind. Planting tree species on earth bunds to stabilise these structures is an indirect or "supplementary" function. In an area adjacent to the Maggia valley, the soil and water conservation programme in the Illela district, funded by IFAD, does not plant densely spaced barrier hedges, but it has introduced an interesting innovation. It promotes improved traditional pitting, but also *demi-lunes*. In these *demi-lunes* (of which there are 313 per hectare), crops are grown (primarily millet and sorghum). In each *demi-lune* a tree is planted (usually *Acacia* spp). The survival and growth rates of these trees is excellent, because they benefit from the collection

Agroforestry

Since the mid 1970s, the science of agroforestry has burgeoned. Institutes (notably ICRAF) were established, experiments were set up, publications proliferated, and projects in sub-Saharan Africa began to incorporate agroforestry components in their design. The growth of interest in agroforestry is, in part, an acknowledgement of the importance of traditional African agriculture, where trees and crops are commonly combined in farming systems. There is an enormous variety of possible tree/crop/grass combinations, and several agroforestry practices have been shown - or are hypothesised - to confer benefits in terms of soil and water conservation. Young (1989, 77) considers that "all agroforestry practices can and should be included as an element in integrated watershed management and land use planning".

Several of IFAD's Special Programme for Africa projects include an agroforestry component (Figure 10). It is too early at present to comment on the effectiveness of these initiatives, as by nature agroforestry systems take several seasons to become effective. However, it should be noted that institutional arrangements for the promotion of agroforestry can cause problems. This is because of the implicit "location" of the discipline of agroforestry midway between departments responsible for crops and conservation and departments responsible for forestry. Too often this is not adequately recognised, and agroforestry activities remain inappropriately located within departments of forestry. Further work is needed to establish bridges between departments before agroforestry work can proceed smoothly.

Box 11

and concentration of runoff water as well as from the manure land users apply to the *demi-lunes*. Ultimately, however, the trees may compete with the crops unless managed through selective pruning (Figure 11-12).

Complications in agroforestry can arise from property rights to land and trees. Whose is the land and whose are the trees planted on it? Who has usufruct rights? Does tree planting change land titles? Forest codes in some Sahelian countries, for example, deny farmers control over trees growing in their fields. Government permission may be needed before a farmer can lop branches to feed livestock.

Cultural methods: improved agronomy

In most soil and water conservation projects, the emphasis remains on engineering structures or vegetative barriers against erosion. These represent the tangible "evidence" of conservation that is much favoured by donors and executing agencies. However, **husbandry factors can be as important in reducing runoff and erosion as structures, and they are often more effective.** Traditional practices which some African peasant societies have used for generations, such as multiple cropping and minimum tillage, have exactly this effect.

The effect of rainsplash on the soil surface is the basis for the concept of ground cover as an anti erosion measure. In other words, the better the cover of vegetation, the less the erosion which results from the soil beneath. By paying more attention to increasing crop canopy through better agronomy, the dominant factor in the process of erosion is directly addressed. Covering the soil surface with crop residues, when possible, is an additional technique to reduce the effect of rainsplash.

The provision of a protective layer on the soil surface by mulching has proved to be very effective. Mulched coffee and tea plantations in Eastern Africa experienced no erosion losses over a period of 40 years (Roose, 1988). Mulch is as effective as forest cover against erosion. Mulching stimulates termite activity, thus improving the porosity of the structure of the soil. In semi-arid zones however, it is difficult to find enough mulching materials.

The practical implication for planners is that **good husbandry itself leads to a reduction in erosion, because there is a positive relationship between degree of ground cover and yields.** This obviously conflicts with the narrow, conventional approach to conservation, based on structures which are measured in terms of kilometres built. Indeed, Young (1989, 40) differentiates the "cover" approach from the "barrier" approach. The "new wave" of thinking links conservation to productivity - a concept which has much more appeal to African farmers than conserving soil for posterity.

Nevertheless, there are limitations. In the drier areas of sub-Saharan Africa, structures will always be important, because water harvesting systems are invariably based on the bunds or ridges needed to impound runoff. Vegetative cover alone clearly does not have this effect.

Soil fertility maintenance in Burkina Faso and Guinea

The IFAD funded CES/AGF programme in Burkina Faso not only funds the construction of conservation works and the planting of trees alongside the bunds; it also gives major emphasis to agricultural intensification in order to justify the investment in conservation works. Land users are encouraged to construct compost pits (5 m3). 20% of those who have filled their pits can receive an incentive payment in the first year of 400 kg. of burkinaphosphate from the programme, to add to the contents of the pits. (Soils in the region have a phosphate deficiency.) The number of pits constructed by land users has increased substantially and the demand for burkinaphosphate cannot be met. Recently it was decided to increase the budget available for agricultural intensification Figure 15-16).

The IFAD funded agricultural rehabilitation programme in the Fouta Djallon region of Guinea is introducing a number of technical innovations, including (1) augmentation of production of organic fertiliser; (2) protection and rehabilitation of the soil; and (3) gradual (re)introduction of chemical fertilisers. The first is done through the digging of compost pits next to existing stables. The second is achieved by planted stone lines or live fences along the contour, and small drains combined with live fences. Together with modest application of chemical fertilisers, these measures should improve and maintain soil fertility.

Box 12

Furthermore, on higher slopes in more humid areas, barriers of one type or another will normally be required to supplement cultural methods.

Maintenance of soil fertility

Conservation of soil does not end with control of soil erosion. Maintenance of soil fertility, that is the capacity of the soil to support plant growth, requires action to sustain and improve physical and chemical characteristics. Degradation of soil fertility in the West African Sahel, for example, is usually a gradual, long term decline. Fallows traditionally helped the soil to recover its productive capacity, but this practice is diminishing, or has been abandoned altogether, due to pressure on land resources. In the Sahel, Pieri (1989) estimates that in the order of 60-100 kg/ha of mineral nutrients are lost each year from cropped land. It is essential that the nutrients removed by cropping - and erosion - be replaced with regular application of organic manures and inorganic fertilizers. Trees can also be used for this purpose, as is attempted by the IFAD funded agroforestry programme in Senegal. There, the planting and protection of *Acacia* species in fields not only improves soil fertility and soil structure, but also creates windbreaks to protect crops.

Some argue that the available biomass in the Sahel does not allow adequate manuring of the fields, and that therefore soil and water conservation which leads to higher yields only increases fertility problems unless adequate quantities of inorganic fertiliser are used (Breman, 1991, pers. comm.). Prices of inorganic fertilisers in the Sahel are very high. Their use for cereal crops is currently negligible. It is therefore predicted by some analysts that a few years after conservation measures are implemented, yields will fall again. Unfortunately, soil and water conservation projects have rarely undertaken to measure the evolution of yields over a longer period (minimum five years) on the same farmer managed plots, so there is no hard evidence to refute the argument. Improved traditional pitting systems in semi-arid regions seem to be a rational answer to both water and fertility constraints. The pits concentrate water and land users systematically apply manure, which attracts termites (Figure 13-14). Land users state that this allows them to cultivate these fields for at least ten years, or even permanently (Annex A).

There is a clear connection between the maintenance of soil fertility and the control of erosion. Indeed, for Young (1989), these are the two components of soil conservation in its broadest sense. Fertile soil supports good plant growth, thereby reducing its susceptibility to erosion. Conversely, soil which is eroded loses its fertility and the spiral of degradation is established.

Where water harvesting systems permit plants to grow in dry areas, the fertility of poorer soils may be effectively "mined". With the increased availability of moisture, crops are enabled to exploit soil nutrients which would not otherwise have been tapped. These nutrients have to be replaced for yields to be maintained. **Conservation planners always need to consider soil fertility maintenance as well as erosion prevention.** This is beginning to happen in parts of West Africa where conservation programmes have introduced compost pits (the IFAD funded CES-AGF programme in Burkina Faso) and improved manure producing cattle pens (the Netherlands funded CMDT Projet Lutte Anti-Erosive in Mali).

4.1.3 The existence and value of indigenous soil and water conservation techniques

As noted earlier, a wide variety of indigenous soil and water conservation techniques can be found in all the agro-ecological zones of sub-Saharan Africa (Chapter 3). At least 70 examples of such techniques are recorded (Reij, 1990b, 5). IFAD presented an extensive discussion of these techniques in 1986 (IFAD, 1986a, Chapter III and Annex A).

There is growing recognition of the potential and value of such techniques, as many project-inspired conservation approaches have not been readily adopted by African farmers. In fact, evidence strongly suggests that indigenous soil and water conservation techniques can successfully be used as a starting point for new programmes (Annex A).

The first step in the design process of a new soil and water conservation programme should therefore be the identification of indigenous farming systems and their conservation techniques. The next step should be to determine whether and how these conservation techniques can be used as starting points or building blocks for a new programme and how their efficiency can be improved, if necessary. The role and contribution of each species in the farming system should be known before a final choice is made. This would require a longer experimental or data collection phase before implementation. The limited and deficient knowledge of the present state and future perspectives of indigenous farming systems and their conservation techniques implies that more time has to be spent on project design than is now usual.

This is an approach which is used by IFAD in its recent soil and water conservation projects in sub-Saharan Africa. For example, in Ethiopia, IFAD has financed the preparation of an inventory of different forms of traditional soil and water conservation measures and agroforestry practices in the highlands. Quite often, traditional techniques developed in one region can be adopted in another region with similar characteristics. In the Illela region of Niger, IFAD's soil and water conservation project for the region is successfully replicating the traditional techniques developed in Burkina Faso.

4.1.4 Construction methods, maintenance requirements and support systems

Despite the importance of vegetative techniques, construction will probably, and in some cases necessarily, remain an important feature in many soil and water conservation projects. Therefore, project designers should carefully consider how to build the required structures. The following reflections apply in particular to situations where tractors and other machinery are normally not available. In some countries, for instance Zimbabwe, Lesotho, Swaziland, Kenya and Sudan, access to tractors is sometimes facilitated through tractor-hire agencies.

The use of machinery is often attractive to donor agencies and governments, because it permits rapid and effective construction of conservation works. Many soil and water conservation projects have relied, and some continue to rely, on the use of bulldozers, graders and tractors for the construction of bunds, or on lorries for the transport of stones. Despite the obvious advantage of quick and effective implementation, the use of machinery has various disadvantages:

- a lack of land user involvement since the activities are designed and planned by outsiders;

- due to the scale of mechanically constructed conservation works, an imbalance is created between the maintenance requirements of conservation works and what land users are willing and able to invest in maintenance;

- when machinery has been used for construction, the beneficiaries often refuse to maintain the structures and spontaneous adoption of the techniques by the land users is virtually nil;

- it is difficult to continue operations in the post-project phase, since in most cases neither Governments nor beneficiaries can afford to operate a fleet of machines after withdrawal of the funding agency (Critchley et al., forthcoming).

- the vulnerability of heavy machinery: frequent breakdowns, lack of spare parts and fuel, often hinder effective use in projects.

Once heavy earth-moving equipment is introduced, it is unrealistic to expect, as some projects do, that land users will maintain bunds by hand or with ox-drawn equipment. Some projects using heavy machinery have deliberately over dimensioned conservation works in order to reduce or eliminate maintenance needs. However, this is not a solution, as all conservation works need some adjustments, repairs and maintenance. Deliberate "over design" may at best delay short-term maintenance needs, but at considerable cost.

Two opposing schools of thought exist about the use of machinery in soil and water conservation. Some conservation specialists advocate heavy reliance on machinery, as they do not believe in the ability of land users to rehabilitate and manage their own environment. As one conservation specialist remarked, "erosion goes faster than a donkey cart". Others reject a heavy reliance on machinery for reasons already mentioned, and prefer to rely as much as possible on local "participation" and the use of tools (pick axes, shovels, etc.) and means of transport (wheelbarrows, donkey carts) that can be managed by the land users themselves (Figure 17).

Given the considerable disadvantages of heavy machinery, an emphasis on local participation usually offers better long-term perspectives. This does not mean, however, that there is no place for the use of machinery in projects that rely on local participation. The conditions under which machinery can be used

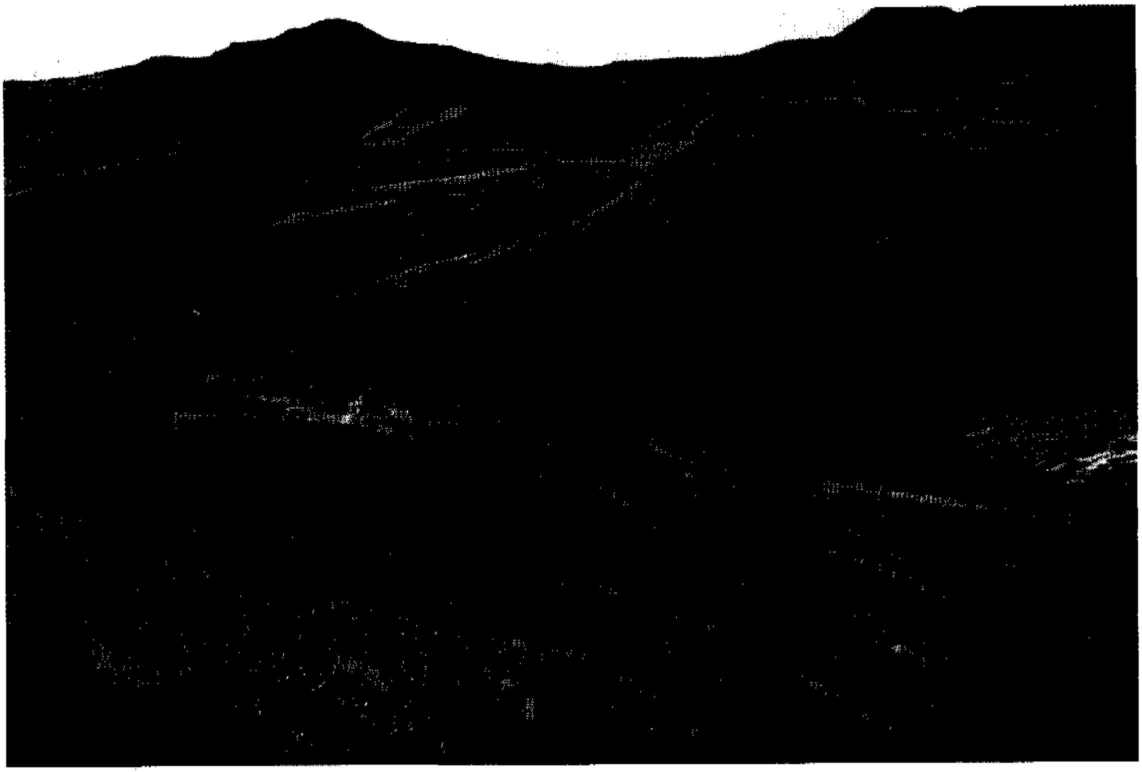


Figure 9 Lesotho: grass strips have developed into terraces

Figure 10 Lesotho: fruit trees on terrace banks: the model for IFAD - SWaCAP

Figure 11 Niger: demi-lunes for growing trees and food crops show spectacular results (IFAD - PSN)

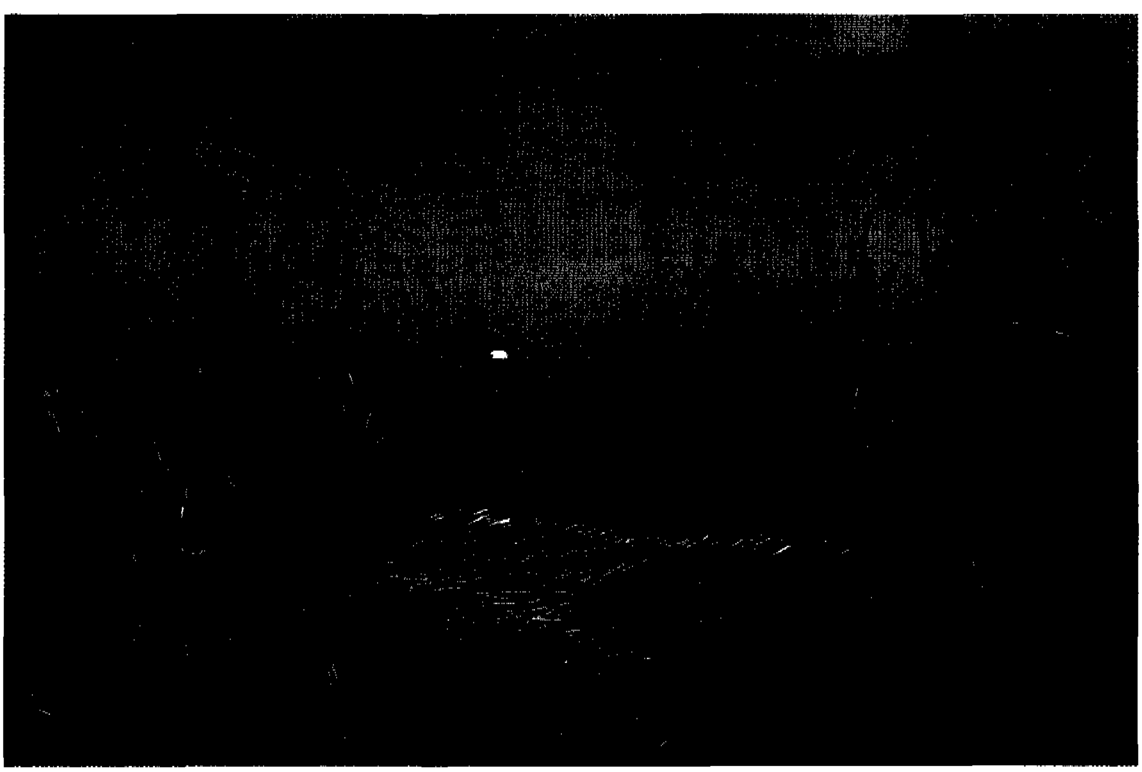


Figure 12 Niger: farmer with 1991 harvest from 'demi-lunes' (IFAD - PSN)

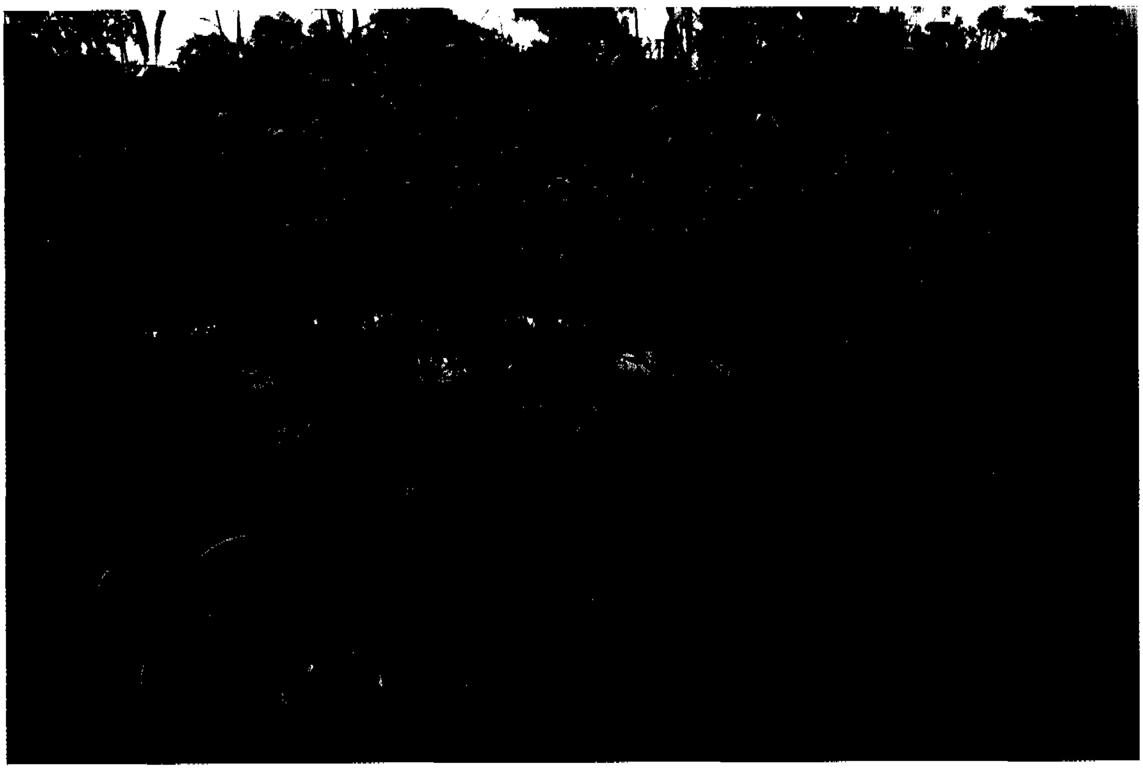


Figure 13 Burkina Faso: zay concentrate water and nutrients

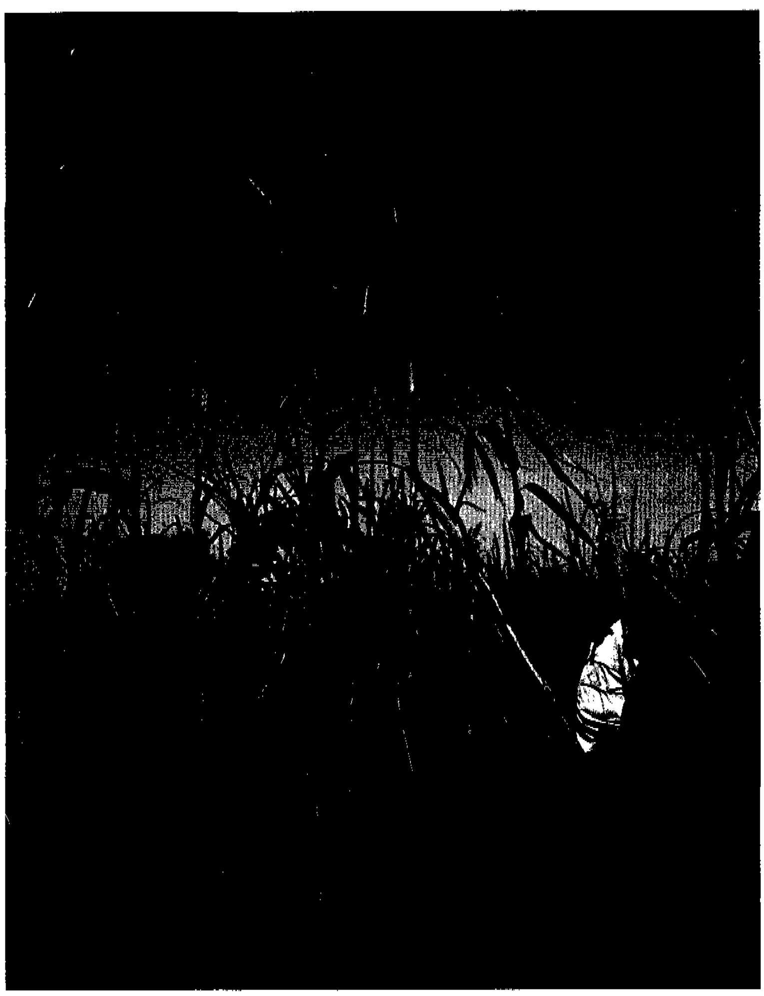


Figure 14 Niger: improved traditional planting pits (tassa) produced a spectacular harvest in 1991 (IFAD - PSN)

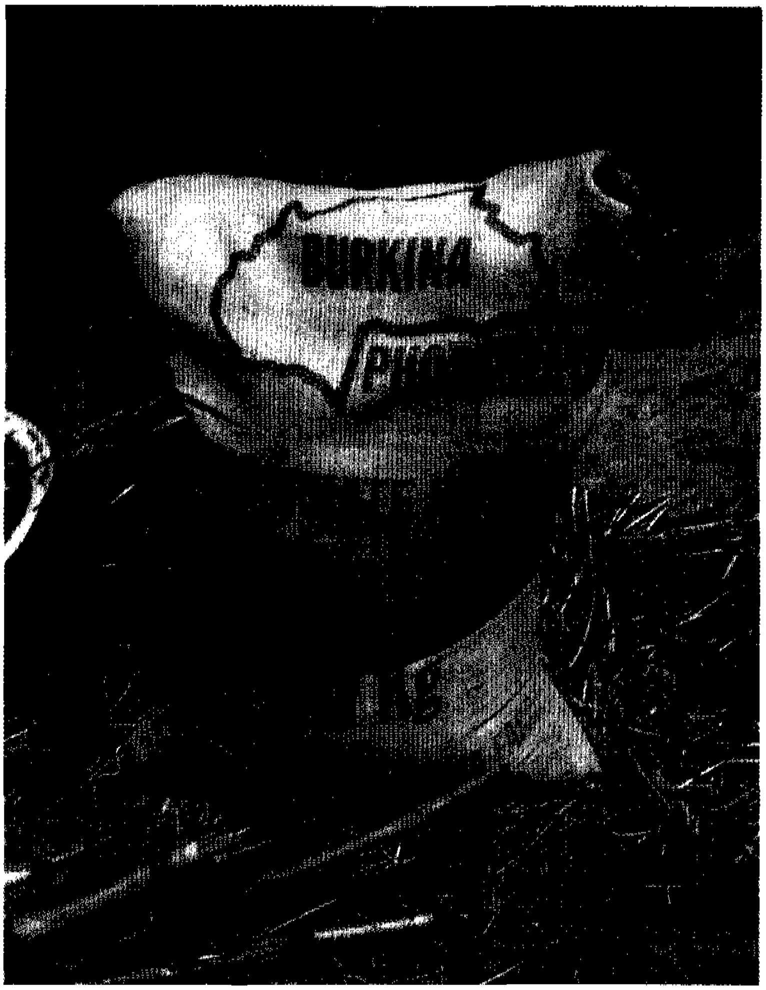


Figure 15 Burkina Faso: demand for burkinaphosphate is increasing (IFAD - CES/AGF)

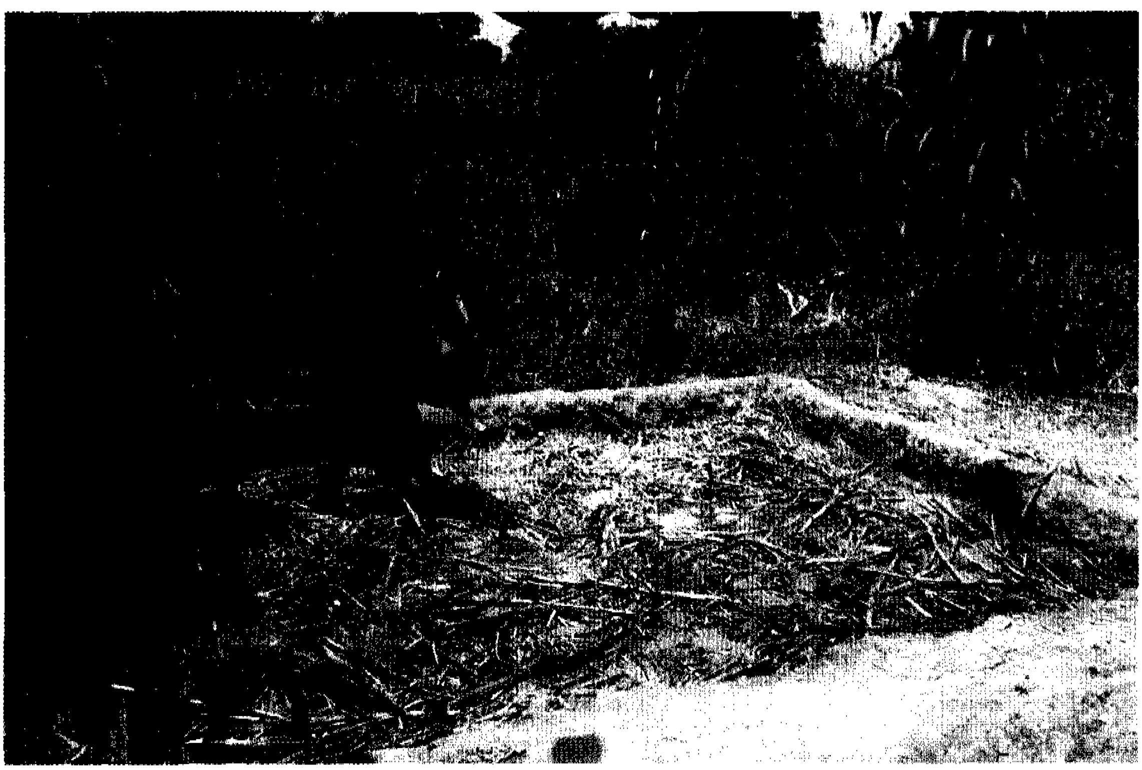


Figure 16 Burkina Faso: compost pits are rapidly becoming more popular (IFAD - CES/AGF)

Labour requirements for conservation construction

Contour terraces (Kenya): up to 300 person days/ha (Wenner, 1986, pers. comm.).

Trapezoidal bunds in North Turkana (Kenya), which impound 3200 m2: 380 person days (Critchley, 1987).

Demi-lunes (Niger): 40 - 80 person days/ha (Mulder: quoted in IFAD 1986f).

Contour terraces (Niger): on a 2% slope 90 - 110 person days/ha (Viertmann, 1985).

Contour stone bunds (Burkina Faso): height 0.15 - 0.30 m, 10 - 25 m. horizontal interval, 400 - 1000 m/ha: 50 - 60 person days/ha in the Yatenga and 150 person days/ha in Sanmatenga: (Wright, 1982; Begemann, 1986)

should be carefully analysed and defined, in order to avoid as much as possible the disadvantages mentioned above. If the scale and dimensions of conservation works require a collective commitment from villagers to construct a number of large structures, some form of support with heavy equipment may be necessary. Another case where the use of heavy machinery may be justified is in regions of low population density, but special care should then be taken to balance the size of the area treated with the land users' capacity to maintain the works constructed and with local and sub-regional needs for products, such as fuel, fodder and poles for construction (Figure 18).

Construction by hand can be a slow and cumbersome process (Box 13). High labour requirements per unit area can be an important constraint on the rapid construction of conservation works or the planting of vegetative barriers.

The challenge is to create a situation in which a steadily growing number of land users become sufficiently motivated to apply conservation measures to their fields. The initial successful application of these measures by a small number of farmers should stimulate other farmers to copy them. In this way adoption can be accelerated considerably, creating a promising multiplier effect. From the perspectives of adoption of techniques and maintenance of conservation works, it is preferable that large numbers of land users treat half a hectare each over a number of years, than that heavy machinery be relied upon to construct conservation works on the same area of land in a shorter period. The voluntary construction of conservation works by hand automatically matches maintenance requirements and the local capacity to carry out maintenance (Figure 19).

Conservation projects should give land users adequate access to tools and simple means of transport (wheelbarrows and donkey carts). For example, the IFAD funded Fouta Djallon programme in Guinea provides credit schemes to help farmers acquire such equipment. In the IFAD funded soil and water conservation and agroforestry programme in Burkina Faso, delays in procurement and supply of implements and to some extent its poor quality, has significantly affected farmers ability to undertake conservation measures. This slowed down implementation of soil and water conservation activities. Moreover, lack of tools, wheelbarrows and donkey carts meant that women had to carry stones on their heads so that their labour burden was aggravated. In response to this situation IFAD modified the type of equipment supplied, while increasing substantially the original budget allocated to this purpose.

Provision of tools and transport (wheelbarrows and donkey carts) to land users has several positive effects. First, they facilitate the construction of conservation works. Second, they are indispensable for various other activities associated with SWC (for instance transport of manure). Third, when such tools and transport equipment can be produced and repaired locally, the spin off in terms of employment and income generation can be substantial. It has sometimes been argued that participatory soil and water conservation is unattractive to donor agencies, because it would not allow large disbursements. However, the provision of adequate material support to tens of thousands of land users also requires significant investment. Although this has not yet been implemented on a large scale by any programme, the indications are that there is a considerable potential for this approach.

4.2. Socio-economic issues

4.2.1 The role of incentives

Many conservation activities require a major labour input. This is the case in projects involved in construction of conservation works as well as in projects promoting the planting of vegetative barriers. As voluntary participation has been difficult to achieve, conservation planners have been quick to compromise and pay villagers for soil conservation labour with food or with a combination of food and cash. In this way, bottlenecks in motivation can be bypassed and physical targets achieved. Indeed, it is sometimes argued that conditions are so severe that an element of relief assistance is justifiable in soil conservation projects: that the people who have not migrated cannot survive without subsidy while they conserve rapidly eroding land resources. But practice shows that **if land users are given any form of payment by government to conserve their land and water, they tend to assume that government will also be responsible for maintenance of what has been constructed, either by paying them or by undertaking maintenance itself.** They regard themselves as labourers rather than as participants. Rural people may even come to expect that when conservation activities are introduced in their area, they will be accompanied by food payments. Government may thus be rendered dependent on sources of food aid - usually external - if conservation activities are to be extended. Farmers may otherwise refuse to contribute their labour (Box 14 and Annex C (Ethiopia)).

These arguments do not mean that the use of incentives or subsidies for soil and water conservation should be wholly discarded. Erosion can cause substantial off-farm and downstream damage (for example, siltation of reservoirs in valleys and lowlands, damage to irrigation systems) and this can be a justification for subsidising on-farm prevention of such costs. As noted in Chapter 3, intricate terracing systems can be found in several African mountain regions. These terracing systems, which have been built over several centuries, are now increasingly abandoned. This leads to their collapse. In certain cases, economic justification may exist for a subsidy for the repair of terraces. This would help prevent irreversible damage to such systems, which represent a considerable investment. In other cases, where conservation work relates to maintenance or creation of public assets (such as drainage from roads or rehabilitation of badly degraded public lands), there will be a clearer rationale for using direct or indirect incentives.

A useful distinction in deciding on the use of incentives is that between conservation by individual land users on their own lands, and conservation activities collectively undertaken by villagers on communal land. In the case of individually used land, farmers could be supported with training - which can act as a stimulus in itself - and small equipment in order to improve the quality of their work and to facilitate as well as accelerate the rate of construction. The conservation activities carried out by individual land users on their own fields should lead to short term yield increases. Provision of inputs such as seed and inorganic fertiliser to enhance these first season benefits may be a justifiable incentive, subject to analysis of local farm budgets to assess the longer term feasibility of any innovations included in the incentives package. Where there are significant yield increases, clearly sustainable with the farmer's own resources, these can act as an important incentive to continue the conservation activities. In case of collective conservation of communal land, food aid could be provided in years of serious food shortages (e.g. through village cereal banks), while in years of food self sufficiency, food aid could be replaced by other incentives in the form of community infrastructure, e.g. a well or a village health clinic, or in the form of tools, fertilizers etc.

For rehabilitation efforts on **state land**, often situated in upper catchment areas, different arrangements on incentives and subsidies have to be found. Contractual agreements between government and land users on appropriate management of these lands, in which benefits accrue to both interested parties, have to be formulated. It is the objective of the new IFAD funded programme in Cape Verde to form herders' associations which will gain usufruct rights on reforested rangelands, in conformance with conditions laid down in the National Forestry Code. A basic input in this proposal is a proper livestock development plan, which takes biomass production and rangeland carrying capacity into account.

Macro economic measures may also have a part to play. To date, few pricing policies have specifically considered the impact they might have on the utilisation and conservation of natural resources.

4.2.2 Land users' participation in soil and water conservation

A principal reason for most project conservation work to date being so short lived is that land users have either been ignored or instructed, rather than being consulted or trained.

Grappling with incentives policy:

Niger

The IFAD funded SWC project in Niger's Illela District operates in a region where "food-for-work" is the standard. In a neighbouring district a project will soon be initiated, which intends to reward all "participants" with "cash-for-work". When the IFAD funded project suggested that it wanted to replace "food-for-work" by "tools-for-work" and "community infrastructure-for-work", land users reacted negatively. They insisted on receiving "food-for-work" rations. National project staff, charged with the burdensome task of food aid distribution, slowly became convinced that "food-for-work" can act as a disincentive. They are now convinced of the need to reduce dependence on food aid. Gradually, land users also seem to be more receptive to alternatives. Nevertheless, "food-for-work" can only be phased out gradually. The 1990 rainy season was dramatically bad and some form of food aid was required. Project staff now consider channelling food aid through cereal banks, which still have to be created.

Lesotho

Inspired in part by the SIDA funded Farm Improvement with Soil Conservation project in Mohale's Hoek district, the IFAD funded Soil and Water Conservation and Agroforestry Programme (SWaCAP) was designed to provide various incentives, in the form of farm inputs, to farmers in four northern districts who adopted land husbandry practices through the programme's Conservation Incentives Scheme. Government policy on incentives for conservation has since evolved; payments in cash or in kind for on farm work are no longer thought appropriate. SWaCAP has therefore reviewed the circumstances in which incentive payments are made. A unified approach is being developed in consultation with Government and other donor funded projects. Circumstances in wich material support is given to farmers are carefully defined.

Ethiopia

The IFAD funded soil conservation programme in Ethiopia received different responses on the need for incentives in reaction to the same technical measure (bund stabilisation by grass planting) in two different regions. So far, the project has suggested intensifying the dialogue with farmers to induce them to accept this recommended practice.

Guinea

The IFAD funded agricultural rehabilitation programme in Guinea provides no material incentives, on the premise that the techniques promoted will produce yield increases that offer adequate encouragement.

Senegal

The IFAD funded agroforestry programme in Senegal aims to use short term yield increases (from agricultural intensification) to offset the early costs of longer term conservation measures by farmers.

Box 14

They usually responded with indifference, incomprehension or hostility. Lasting success is more likely when soil and water conservation methods are identified, tested at farm level and evaluated in partnership with farmers.

Since IFAD's first soil and water conservation policy review stressed the issue, a consensus has emerged on the role and importance of land users' participation in SWC. Although there is agreement at the policy level on the issue of participation, little or nothing appears to have changed at project level. Conservation specialists continue to determine which technical package will be introduced and what the modalities of implementation will be. **Despite rhetoric about and lip service to participation, land users' priorities and perceptions are largely unknown and continue to be ignored.** Chambers (1991, 2) warns that

> *"soil conservation programmes around the world have provided examples of arrogant ignorance and insensitivity, of imposing standardised bad practice on rationally resistant small farmers. Often "we" - professionals - have been confident that our bookish education has given us superior insights, that "we" know and "they" are ignorant, that "we" should plan for "them", that our packaged technology from research stations and laboratories is superior; that, in short, we know best and they know worst. But the ignorance has often been ours."*

Although the number of truly participatory soil and water conservation projects (usually small-scale projects funded by NGOs) is undoubtedly growing, most approaches to soil and water conservation in the region have been and continue to be of a top down nature. The new agricultural and livestock development programme in Cape Verde, funded by IFAD, will have to take appropriate measures in drawing up its proposed master plans for watershed and livestock development. Elsewhere, such plans tend to be specific, detailed and often mandatory, frustrating local participation. The Cape Verde master plan should consist of flexible guidelines allowing for discussion with beneficiariers and easy adaptation.

Whether land users are able and willing to engage in soil and water conservation depends on a range of often interrelated aspects, such as incentives, land tenure, labour availability, the selection of techniques, training opportunities, the impact of conservation techniques on yields, crop prices and the economic position of the land users. Several aspects mentioned here will be analyzed in more detail.

4.2.2.1 Labour availability

Conservation project planners often overestimate the availability of labour for the construction of anti-erosion or water harvesting works. They sometimes assume that labour is almost freely available during the dry season, as there seem to be few or no alternative employment opportunities in that period. However, in most cases this is not true. In many regions, the young men are absent during the dry season and mostly women, children and old men remain behind. The young men who stay can be involved in a range of activities varying from trade in cereals to off farm employment. Important and time-demanding social activities, such as funerals and marriages, are often postponed to the dry season. Or, as Ostberg (1987, 12) remarks: "Soil conservation is important, but so are many other things. Some farmers will choose to use their time and money on something other than soil conservation". **Availability of labour is therefore often a major constraint to the implementation of large scale soil and water conservation measures.** Smaller scale conservation activities suffer fewer labour constraints. Design of the IFAD funded agroforestry programme in Senegal took labour constraints into account, but they have nevertheless continued to hinder farmer participation in the activities proposed. Ultimately, land users' preferences for specific techniques depend on a large number of elements, including labour requirements for construction, but also labour requirements for maintenance.

If labour can be a constraint in the dry season, it can be an even greater problem during the rainy season. Projects planning the planting of vegetative barriers have to take into account the fact that the planting of perennial grasses by splits in the beginning of the rainy season coincides with a peak in labour input for agricultural activities (land preparation, sowing and a first round of weeding).

Women and conservation: Kenya and Niger

In parts of Kenya, women's 'mwethya' groups play a prominent role in the construction of fanya juu terraces and other conservation and income-generating activities (Ostberg, 1987, 43).

In Niger's Keita District, women and young girls can represent up to 95% of the work force engaged in the construction of conservation works. They do much of the heavy work, such as digging trenches for tree planting, collecting stones, loading trucks with stones and carpeting the earth bunds with them (Monimart, 1989).

Box 15

4.2.2.2 The role of women

In many rural areas, women constitute well over 50% of the adult population, as men have migrated to urban centres, commercial plantations and mining areas. An increasing number of rural households are managed by females. Male labour migration is also shifting more of the responsibility for natural resource management to women. Not surprisingly, **women often play a major role in the construction of conservation works** (Box 15).

With dwindling amounts of male labour available, **women's growing contribution to soil and water conservation activities tends to increase their already heavy workload.** But an analysis of the role of women in desertification control activities in the West African Sahel has shown that although they play a major role in these activities, they derive only limited benefits from them (Monimart, 1989). So the extent to which women benefit from soil and water conservation must be assessed in programme design, and the constraints to their participation addressed. Benefits may include: (1) the construction of conservation works on private fields of women or on fields belonging to women's groups (enhancing production over which women have direct control); (2) yield increases resulting from soil and water conservation activities on family fields; (3) the improvement of skills as a result of training provided by projects; (4) shorter distances to cultivated lands, if those near the villages can be rehabilitated and travel to ever more distant fields obviated; (5) shorter distances to firewood, where rehabilitation programmes include successful plantings near villages.

The important contribution by women in soil and water conservation activities is usually recognized by the various agencies involved. But **women are often allocated the most physically demanding jobs.** They do not get adequate access to training in land survey techniques and in principles of land husbandry. Tools and means of transport (e.g. donkey carts) that can be used to alleviate their workload are often allocated with priority to men, and monopolised by them. They do not easily get access to land they have rehabilitated or to trees they have planted and nurtured. These are challenges facing the IFAD-funded soil and water conservation projects in Burkina Faso and Niger.

Practice shows that wherever women have been trained in land survey techniques and in principles of bund construction, they perform as well as or better than men. **Projects should therefore provide women with adequate access to training and material support, and help them to get access to land and trees.** Project design should specifically acknowledge the constraints to women's participation and address these through such measures as appropriate timing of activities; sensitive extension and mobilisation methods; and provision of tools and equipment to lighten the construction load. **Although major cultural and practical obstacles have to be overcome in many parts of sub-Saharan Africa, the energy and skills of women as natural resource managers may be a decisive factor in the battle against land degradation.**

4.2.2.3 The poorest groups

Unlike many parts of Asia, sub-Saharan Africa is not yet confronted with large numbers of rural landless. But in regions with high population densities and a contracting resource base, for instance Rwanda, Burundi and the Highlands of Ethiopia, numerous land users cultivate less than 1 ha. Under such conditions, soil and water conservation measures will only be accepted by these small-scale farmers if their planting or construction do not lead to a reduction in the size of the land they cultivate. Vegetative barriers can be productive in the sense that grasses, shrubs and trees are sources of fodder and other products, and

Figure 17 Burkina Faso: donkey cart for stone transport reduces dependence on external support

Figure 18 Niger: one pass operation for tree micro-catchments is efficient

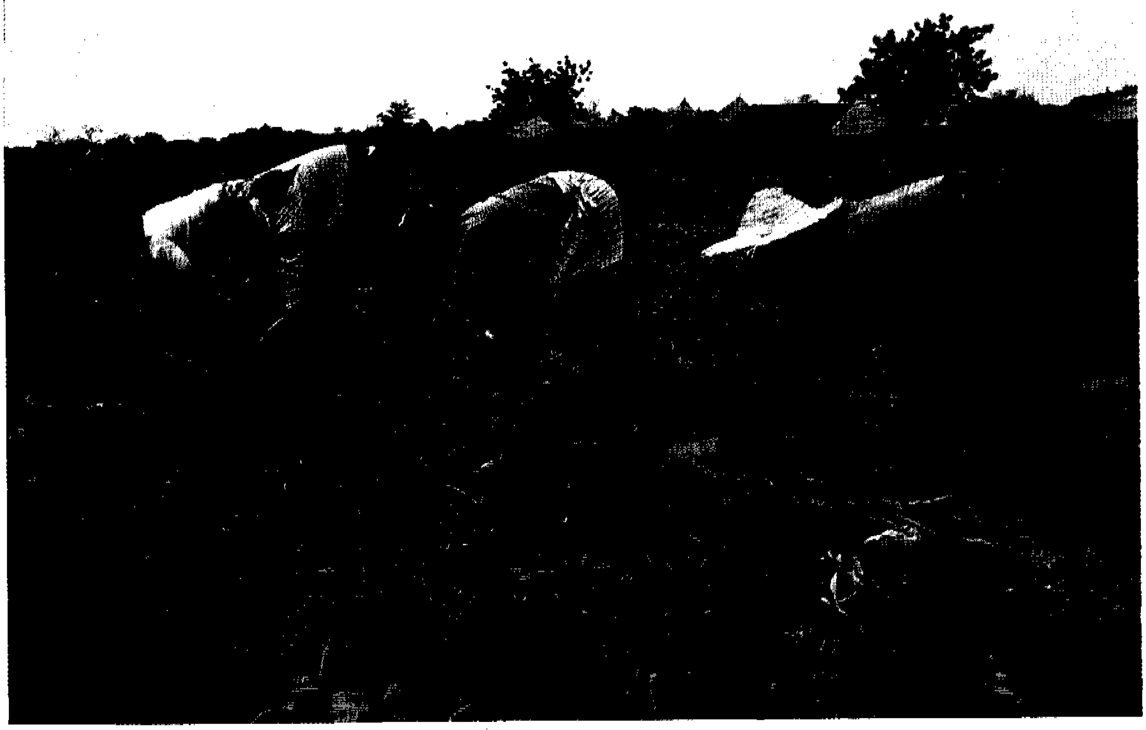


Figure 19 Burkina Faso: maintenance requirements of contour stone bunds are low (IFAD - CES/AGF)

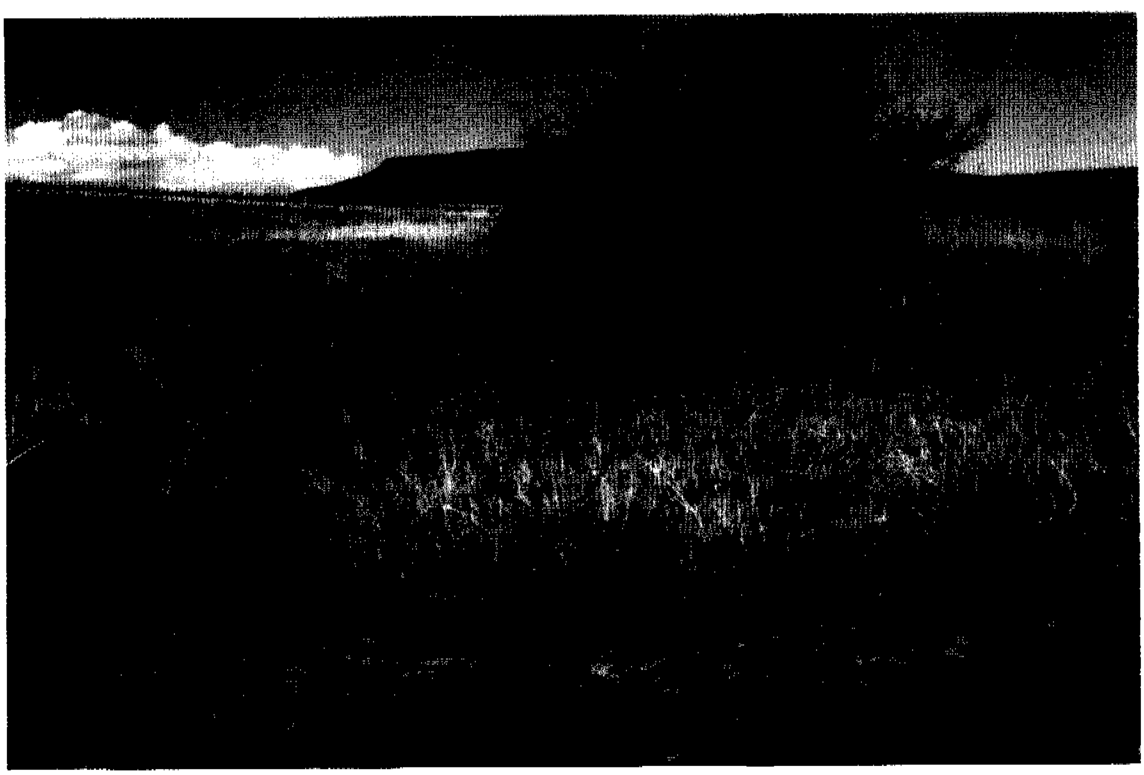


Figure 20 Lesotho: rehabilitated gullies could be allocated to landless families (IFAD - SWaCAP)

terrace risers should be planted with fodder grasses. Very often the trenches in front of the terrace risers are planted with bananas and other perennials.

Like other rural development activities, soil and water conservation may in some circumstances increase economic differentiation between groups of land users. Although everybody can be trained to construct contour stone bunds or semi-circular hoops (*demi-lunes*) and everybody can dig improved traditional planting pits, the indications are that the relatively rich can do so more easily than the poor. The relatively rich have more land and labour; they can also more easily hire labour for the construction of conservation works on their fields, which channels some benefits back to the poorest. Although everybody benefits from these soil and water conservation techniques, some will benefit more than others. The challenge is to design interventions and techniques which not only raise production for the rural majority, but also give special recognition to the constraints surrounding the poorest groups.

Most soil and water conservation programmes have little information about the socio-economic characteristics of land users benefitting from their activities, or of those who refuse to adopt the technical packages proposed. Therefore they are unable to take any remedial action and adjust the packages or the implementation arrangements. **More research on the socio-economic aspects of soil and water conservation is urgently needed and should be integrated into regular project monitoring and evaluation.** A sensible early step in programme design and implementation is a detailed inventory of household resources in order to obtain its access profile to land, labour, food reserves, draft power, equipment, knowledge and skills, off-farm income, credit and so on. Rapid Rural Appraisal (RRA) techniques can facilitate this process.

Innovative approaches are needed to help the poorest groups. Restoring degraded land to productivity is an important feature of soil and water conservation in semi-arid regions. When such rehabilitation is a project inspired and supported activity, opportunities should be created to link it with forms of production by the poor and the landless. New tenurial arrangements can be created to allocate the rehabilitated land to landless people (Box 16).

Access for the landless to rehabilitated areas

If the rural poor have little or no direct access to land, soil and water conservation design should take this into account. The design of the IFAD funded SWaCAP programme in Lesotho gave some attention to this issue, recognising that new initiatives were needed to allocate degraded areas such as gullies to landless families and to develop appropriate rehabilitation and production practices for them. However, ways in which these initiatives could be pursued were not fully specified. New efforts are now being made to this end by the project, since the widespread achievement by the project of new production opportunities for the landless would be a major contribution to development for the rural poor in the country. In general, such tenurial innovation is perhaps the most challenging form of institutional development. 'Degraded' areas are often already in use for other purposes, notably grazing. New institutional arrangements may often have to be negotiated for their allocation to individual use (Figure 20).

On the Cape Verde islands thousands of marginal land users and landless are employed in so-called work groups (frentes de trabalho). These work groups construct roads, terraces and stone bunds. They treat gullies and plant trees. Some of the work benefits the rich (absentee) farmers, but most is carried out on state-owned land. Tens of thousands of hectares have been rehabilitated in this way. The poor survive on wages earned in the work groups, but they do not have access to rehabilitated lands. In some cases, neighbouring communities have been allowed, under the supervision of forestry personnel, to prune trees and to graze their livestock in these areas (Reij, 1990). The new IFAD funded programme in Cape Verde aims to regularise the land tenure status of members of farmers' associations, converting sharecropping arrangements into rental contracts which conform to the Agrarian Reform Law.

The new IFAD funded programme in Katsina State, Nigeria, aims to rehabilitate degraded communal land, which will then be distributed to individual members of the target group. The beneficiaries would gain additional income from the sale of fodder and firewood from their newly acquired holdings.

Box 16

A way to help the poor participate

The relatively poor land users in the Yatenga region of Burkina Faso do not always have the labour to construct contour stone bunds on their own fields, or they are hired to construct stone bunds on the fields of others. The Oxfam funded Agro-Forestry Project therefore decided to create food loans. These loans are managed by well organized village groups. The relatively poor members of the group can get a food loan, which allows them to organize a traditional work party on their fields. Those who help with the construction of stone bunds get food and drinks. The loan has to be reimbursed after the next harvest. Normally the yield increase should permit reimbursement (Ouedraogo and Butcher, 1986).

Box 17

Access to credit is often a major constraint for poor land users. Creative forms of loans can be important instruments to promote participation of this group (Box 17).

4.2.3 Costs and benefits

Land users' assessment of the costs and benefits of soil and water conservation is typically more comprehensive and less fragmented than that of governments or aid agencies. Many of the factors they take into account have been discussed in the sections above on incentives and participation. Alternative demands on time, labour and other productive resources must be set alongside those of soil and water conservation practices, and the ratios of these costs to their social and economic benefits compared. In some cases this implies a comparison of agricultural production (and the conservation practices which support it) with off farm economic opportunities, such as labour migration to urban areas. To the extent that they can be gauged, the price response of farm input and produce markets to new input demands and higher yields must be taken into account. Where soil and water conservation involves physical structures like terraces, land users consider maintenance costs as well as construction costs. Although farmers will rarely adopt conservation practices which do not lead to significant yield increases in the short term, they must correlate higher yields with the higher production costs that usually go with them. Absolute maximum yields are rarely sustainable, given these costs. Food security, risk aversion and optimum deployment of productive resources across available income generating sectors are the more subtle calculations which rural households have to make. The design of soil and water conservation programmes rarely matches the sophistication of land users' benefit/cost analysis.

Despite the enormous amounts spent by aid agencies in this sector, **data on the costs and benefits of soil and water conservation are limited, incomplete and often of dubious quality.** Available cost estimates do not always take into account the costs of labour for construction and maintenance. Not uncommonly, the total project costs are simply divided by the number of hectares treated to derive the average costs per hectare. Even less is known about the benefits of soil and water conservation techniques. The calculation of benefits is usually limited to the measurement of yields on a number of selected field plots. Sometimes, yield data for selected field plots are compared with yield data from control plots. But the characteristics of the control plots are often quite different from those of the selected field plots, which makes any estimation of the impact of soil and water conservation techniques on yields unreliable and arbitrary. The value of stover (fodder) and off-farm benefits are seldom taken into account.

The financial costs of soil and water conservation techniques vary from less than US$ 100/ha. to well over US$ 1000/ha. The costs per hectare are largely determined by the quantities of earth or stone that have to be moved, and less by the method of construction (Box 18). Some mechanized projects are cheap, because they concentrate on techniques which can be executed in a quick one-pass operation. This does not guarantee that they will be maintained, or show an attractive rate of return. Other mechanized projects have high costs per hectare, because large bunds are constructed. Labour intensive projects using food-for-work have high financial costs per hectare, because the value of food-for-work distributed to the "participants" is substantial. **In determining appropriate execution methods, it is therefore necessary to consider the long term viability of conservation works.** This depends largely on maintenance by land users, which in turn depends not only on the feasibility of their doing this without machinery, but also on the extent to which they participated in the original construction.

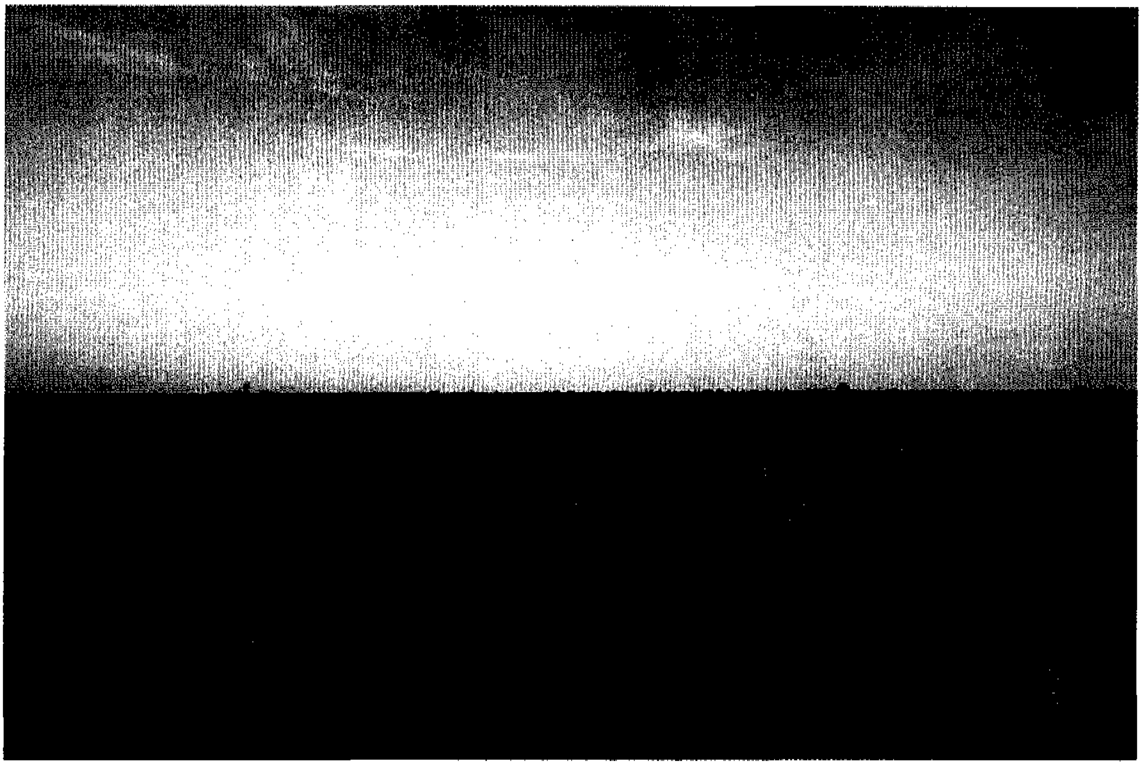


Figure 21 Niger: successful range rehabilitation using 'demi-lunes' (IFAD - PSN)

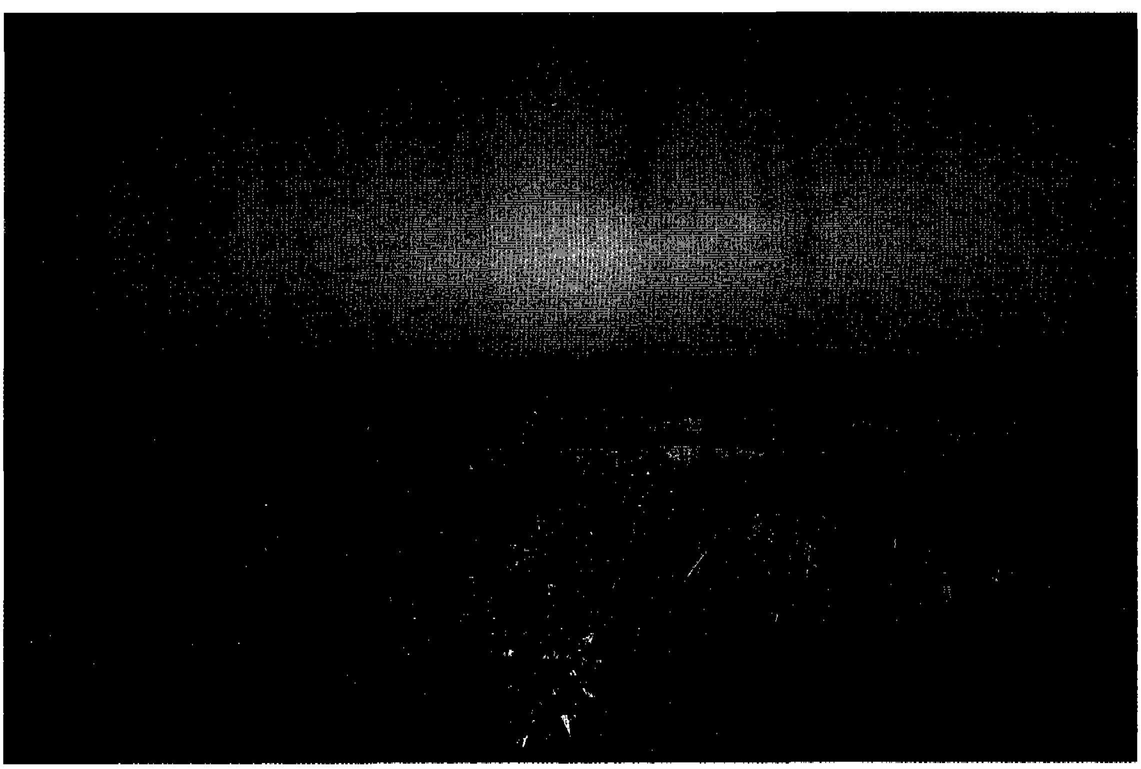


Figure 22 Niger: successful range rehabilitation using bunds; villagers will design a management plan (IFAD - PSN)

Figure 23 Tanzania: Village Grazing Associations are responsible for controlled grazing of rehabilitated rangelands (IFAD - SDPMA area)

Figure 24 Burkina Faso: villagers are trained to manage nurseries (IFAD - CES/AGF)

Some donor agencies seem not to be particularly interested in the costs of conservation activities. They are prepared to spend US$ 1000/ha. or more, as long as the techniques are successful in rehabilitating land or in increasing yields. But **in general, the higher the costs per hectare, the smaller the chances that the techniques will be adopted by land users.** If aid agencies are interested in cost-effectiveness, they should require that the higher the costs, the more spectacular the benefits should be. That is usually not the case.

There has been little economic analysis of the costs and benefits of soil and water conservation in sub-Saharan Africa. Exceptions are the work of Nobe and Seckler on Lesotho (1979), Hedfors (1981), Holmberg (1985) and Lindgren (1988) on Kenya, and Matlon (1986) on Burkina Faso. Since 1986, the Lesotho-based SADCC Coordination Unit on Soil and Water Conservation and Land Utilization has paid considerable attention to the theme of cost-benefit analysis as a tool in the appraisal and evaluation of conservation projects (Bojö, 1986). Bojö (1989), who reviewed 20 cost benefit analyses (CBA) of soil and water conservation projects (with three case studies from sub-Saharan Africa) remarks that the quantification of output in the with/without situation is often the weakest part in CBA studies.

The Lesotho analysis by Nobe and Seckler (1979) indicates that conventional conservation works are not cost-effective in terms of increased agricultural productivity. The Kenya studies suggest that *fanya juu* terraces achieve rapid and sustained yield increases and are cost-effective. Lindgren's analysis of the SIDA funded soil conservation project in Machakos District, Kenya, suggests that from society's and lending agencies' perspective, this is a distinctly 'bankable' investment. The internal rate of return ranges from 59% on justifiable assumptions (interest rates, output prices, yield increases etc.) to 11% in the worst case scenario. From the farmer's point of view, Lindgren's farm budgets show that "For an additional cost of 232 KSh... excluding labour cost, the farmer gets a return of 15,609 KSh...", although overall "the return per manday is not very high, only 21 KSh which is only slightly higher than the wage for casual labour..." On the other hand, marginal analysis shows that "the income from additional labour put into soil conservation is very good, as much as 82 KSh per manday" (Lindgren, 1988, 22 - 29).

Construction costs and transport distance

Several conservation projects on the Central Plateau in Burkina Faso are involved in the construction of permeable rock dams for the rehabilitation of gullies. The cost of these dams depends on their size and on the distance over which stones have to be transported. Considerable yield increases have been measured, which seem to warrant the investment. However, in some cases stones can no longer be found near the sites of construction and they are now transported over a distance of 20 km. A simple cost-benefit analysis could well indicate that the maximum distance over which the transport of stones can be economically justified is 5 km.

Box 18

In Burkina Faso Matlon (1986, 13 - 22) measured the impact on yields of a package comprising contour stone bunds, tied ridges, a low dose of chemical fertiliser and the ICRISAT white sorghum variety ICSV 1002. The economic analysis of the results of the first year showed that over a 15 year period and using a 15% discount rate, a sustained average annual yield increment of at least 155 kg/ha. is required to cover the initial labour costs and recurrent fertiliser costs implied in the package. The costs of the bunds constructed by the North West Region Agricultural Development Project in Somalia's Hargeisa region were about U.S. $1000/ha. Yield increases varied from 0 - 20% and did not at all warrant the high investment per hectare (Critchley et al., forthcoming). With an estimated internal rate of return of 14%, the IFAD funded agroforestry programme in Senegal is expected to double yields at an average cost of $450 - 550 per hectare.

An important dimension to cost benefit analysis of soil and water conservation should be calculation of the economic, social and political costs of doing nothing. Farmers and governments all lose if action is not taken. Agricultural production declines and the many costs of migration must be met. Such analysis, often requiring the use of surrogates and shadow pricing, may have to include future costs of famine relief, urban infrastructure and the downstream damage of floods and silt deposition from eroded areas. The World Bank is now making major efforts to calculate the costs of environmental degradation.

All major conservation programmes should be concerned about the cost effectiveness of the packages they promote. Without this information they will not be able to adapt the packages, to define limits to their interventions or to introduce alternatives. This requires a systematic collection of data about the costs and benefits of the technical packages they promote. There is no excuse for not doing so. The example in Box 18 shows the obvious need to monitor costs. IFAD funded soil and water conservation projects include monitoring and evaluation components intended specifically to address the costs and benefits of soil and water conservation activities. Although there is a temptation to regard M&E as an 'add-on' element of less importance than central project activities, it is vital that M&E activities be initiated timeously and given thorough technical support and supervision.

4.3 Institutional issues

4.3.1 Unit of intervention

From a hydrological point of view, the catchment presents the rational and technically appropriate unit of intervention for soil and water conservation. Most soil and water conservation projects have been organised on this basis. The catchment may be large or small - it can be an entire river basin or merely a single small tributary valley. Governments and projects have conventionally based their activities on the integrated planning of land and water use for various sizes of catchments. However, this has led to two particular problems.

First, whatever the size of catchment, it is rarely perceived as the appropriate management unit by land users and village communities. Land users often consider their own fields as the starting point for conservation efforts without due consideration of their neighbours, leading to conspicuous differences in the field. Secondly, because the catchment is essentially an "artificial" unit, surveyed, mapped and planned by outsiders, it leads inevitably to the enforcement of the "top-down" approach. This bypasses local people's priorities and skills and leaves them as onlookers. **Ways must be found of reducing the scale and redefining the unit of intervention to one with which land users are more familiar.** Expansion can take place from this base.

Soil and water conservation projects which have concentrated on individual land users, and their privately managed crop land, have been more successful than those focusing on the catchment or watershed. When the appeal is to the individual and the benefits accrue directly to the land user, the picture changes dramatically.

Where projects with an individual land user approach do succeed, there are still, literally, gaps left to fill. This is the land which is communally used for grazing and collection of fuelwood, as well as some communally operated crop land. As populations have risen, and rural communities have become marginalized (Chapter 2), traditional regulations governing grazing and tree cutting have broken down. In some of the drier areas, there is not enough land remaining to rest during the rains for grazing during the ensuing dry season. In the more humid areas - even those where land adjudication has taken place - uncultivated land is often used on a free-for-all basis. **One of the most urgent priorities now is for programmes to address the problem of communal property management.** In rehabilitating and developing common property resources, special efforts should be made to target benefits to the poorest in the rural communities. Opportunities for this often exist, as the poor have fewer individually owned productive resources and may therefore be better motivated to undertake activities on communal land. Indeed, opportunities should be sought for allocating some rehabilitated communal land to the landless and to female headed households. The IFAD funded SWaCAP programme in Lesotho attempts to do this.

4.3.2 Village land use management

There needs to be a progression from individual fields to an integrated plan including conservation of communal land. However, **rather than a strictly defined hydrological catchment or watershed as the physical basis for planning this expansion, the village boundary is the natural unit in much of Africa.** This is where "village land use management" takes conservation a step further. It must be noted that in many parts of Africa such management of communal resources has been a tradition, although in some areas it has now disintegrated and in others it only remains in atrophied form.

Village land use management as a project planning concept has been emphasised by recent programmes in the West African Sahel, where there are few or no remnants of traditional communal property management. In Burkina Faso, the number of programmes involved has warranted a national coordination unit for village land use management (the *Programme National de Gestion des Terroirs*), which was established in 1988. **Village land use management attempts to address the problems of the whole village territory, but does so from the perspective of the villagers themselves, who are involved in land use planning and coordination of activities** (Box 19). The technical accent of village land use management is on the management of the communal resources of grazing land and firewood, in addition to conservation of privately cropped land.

Village land use management: PATECORE, Burkina Faso

PATECORE, the GTZ funded "Projet Aménagement des Terroirs et Conservation des Ressources dans le Plateau Central", has been operating in Bam Province of Burkina Faso since 1988. This resource conservation project introduced the concept of village land use management in the region. The village land use management process begins with traditional land classification. This involves villagers identifying different land use categories from aerial photographs. Project personnel then help the villagers to plan improved use of the different units of land in "participatory land use planning". PATECORE has also facilitated the creation of a Provincial Committee which coordinates the activities of projects and Government Services in the area (Eger and Bado 1989).

Guinea

The IFAD funded programme in the Fouta Djallon region of Guinea aims to establish village associations to manage communal grazing resources and village credit schemes. At the same time, conservation farming on individuals' fields is promoted, and individuals are trained in the application of certain techniques.

Box 19

A variation on the theme of village land use management has been proposed by Roose (1987). This is "Gestion Conservatoire des Eaux et de la Fertilité des Sols" (GCEFS): loosely translated "the conservation management of water and soil fertility". It comprises an integrated development plan for village land, structured over a period of ten years or so. The components of the plan include the integration of livestock into the overall system, the use of manure on fields and the division of the countryside into management blocks. Although much of the technical content is not new, the involvement of the villagers in the structured planning and execution of the programme is the essence of the innovative approach.

4.3.3 Local institutions

True participation implies that land users are fully involved in the design of conservation packages and accept a major responsibility for their implementation. **The necessary dialogue between conservation projects and land users is greatly facilitated where local institutions already exist**. Such institutions can assist in mobilising and organising land users, managing equipment provided to support conservation activities and sanctioning those who do not respect locally established rules for communal property management.

But in many rural areas, it is hard to identify adequately functioning local institutions, be they government extension agencies or village groups. In a discussion on the decentralisation of natural resource management in francophone West Africa, a participant remarked in some despair: "everybody talks incessantly about the need to transfer responsibilities for natural resource management to local institutions, but where are they?" In the short history to date of the IFAD funded agroforestry programme in Senegal, the importance of village groups for the introduction of innovations has already been made clear. Much effort therefore goes into organising and motivating them, but the process takes time.

It is a great advantage when new programmes can be based upon already functioning local institutions, such as government technical services and village groups. Where these do not exist, they have to be created or revitalized. This is a difficult and time consuming process. In

Conservation and land rights

In parts of the Ader Doutchi Maggia region in Niger, small half moon structures are used to rehabilitate degraded lands. On some sites the half moons are not planted with millet; or, when millet is planted, it is not taken care of. The major cause is in most cases a conflict between the former "owners" and the new users (IFAD, 1990d). Also, tree planting on rehabilitated land frequently causes tenure conflicts. As soon as trees are planted alongside bunds, former "owners" suddenly appear to exercise their rights.
Bunding in the North West Region of Somalia is popular because it infers land tenure rights (Critchley et al., forthcoming).

Box 20

such cases, a new conservation programme will not produce many tangible results in the first few years. As in Senegal, the IFAD funded programme in Guinea has had to recognise that an extended period of support and motivation will be needed before new village organisations are likely to become self sustaining. These delays may be hard for many donor agencies, national governments and the media to accept.

4.3.4 Land tenure

How essential is the individualisation of arable land tenure as a condition for success in soil and water conservation? Several decades of debate on the subject of land tenure and agricultural investment have produced little agreement. The common supposition holds that communal land tenure is inappropriate for conservation, because it affords the farmer inadequate incentive to invest labour or other resources in the land. Conservation policies for Africa have therefore regularly included a call for the individualization of tenure.

In fact, little clear evidence can be adduced to support these arguments. In the debate on this issue, two conclusions do seem to be warranted and are beginning to be supported by research results. First, **African farmers themselves often feel secure on communally owned arable land.** They rarely shrink from improving their agriculture because of a feeling that the land is insufficiently 'theirs' (Barrows and Roth, 1990). Secondly, **some of the effects of individualisation of tenure are certainly negative.** Landlessness is typically exacerbated and absentee land holding by urban dwellers may develop.

Although farmers can feel secure on their land without owning it individually, insecurity may arise in some cases due to demographic, economic or political pressures. In Kenya, for instance, programmes of adjudication and registration of individual title have been under way for some time in relatively crowded, high potential agricultural areas. Agricultural development and soil conservation programmes have been implemented in these areas too, often offering higher profitability for the farmer, but requiring significant investment in soil conservation. Those who have obtained individual title to their farm land have been observed to be more interested in such investments than farmers in areas not yet adjudicated who are still uncertain about their future tenure. Furthermore, a land title makes someone eligible for a loan. In areas where such individualisation is taking place, the costs for those without access to the new individual title may of course be severe. In sub-Saharan Africa the number of people without access to arable land is still, compared to South Asia, very limited. But the proportion is likely to increase in the coming decades.

Land use conflicts may arise where degraded land is rehabilitated in a project inspired collective effort (Box 20). The question is whether the rehabilitated land will be allocated to those who used that land in the past and still exert land use rights, or to those who actually rehabilitated it. In other instances there may be no question of any previous individual rights to such land. Here, an important opportunity exists for seeking ways of allocating some of the rehabilitated, previously unproductive land to the landless on an individual basis. This is a challenging innovation. But **if the landless poor can be given newly conserved land, the links between conservation and production may serve an essential extra purpose by helping the poorest rural households.**

4.3.5 Legislation

A major failing of early soil and water conservation policy was its assumption that the environment could be protected by legislation. National and local decrees required that cultivators engage in certain activities and desist from others. There was little consultation or explanation about such laws. Where such legislation was enforced, it roused widespread hostility. Elsewhere, land users might often be aware that laws existed but they knew also that there was no way the thinly spread colonial authorities could check on whether they were obeyed, or punish offenders.

For a long time many independent African governments were reluctant to have anything to do with soil conservation. But in some cases the regulations remain on the statute books. Also, as new international schools of thought gained influence in African policy, a new type of national legislation began to appear. This created a variety of statutory bodies - national environmental commissions, for example - and new enabling legislation expressing in general terms the state's right to protect the environment and control its exploitation.

A 'thou shalt not' approach thus continues to prevail, and Africa is full of toothless environmental control agencies (Baker and Kinyanjui, 1980). It is therefore worth stating some basic principles. First, as Baker and Kinyanjui suggest, **national policy-makers should concern themselves not so much with protecting the environment as with developing ways for the poor to exploit it without damaging it.** Such an effort should be based upon an understanding of available natural resources and on agreed land use plans. Secondly, careful consideration should be given when drafting environmental legislation as to whether the land users will consider it technically feasible and economically attractive, and whether it will or can be explained to them with the help of available extension resources and mass media. **Where the law concerns the environment, poor extension, unpopular enforcement or non-enforcement can lower respect for the environmental principles legislators seek to promote.**

The overriding principle should be that land using communities monitor and regulate their own environmental behaviour. Only when such responsibilities are worked out and acted upon within the local community can adequate popular consensus be expected to produce a healthy agreement about the need to exploit the environment without degrading it. It is thus better for a locally appointed group to protect a forest reserve than for scouts of the national forest service to do so; or for members of a village conservation committee to monitor farmers' maintenance of terraces, rather than extension agents.

Grazing control and range management should similarly be a village or tribal responsibility - with offenders punished within the local legal system - rather than having anything to do with the police (Figure 21 - 22). **The principal role of government authorities should be to help local communities in managing their environment themselves.** At a higher level, enabling legislation should create the necessary framework for decentralized management of natural resources.

4.3.6 Research

In this section some research needs and priorities will be indicated. These will of course vary for each country, depending on what has been undertaken so far. In Rwanda, for instance, considerable research has been done on vegetative barriers by the Nyabisindu project (Annex C), but elsewhere less has been done in this field. Little research has been carried out anywhere, for example, on water harvesting techniques. Some research needs and priorities are discussed below.

Contrary to the belief of some policy makers, more **research is needed on soil and water conservation techniques**, because the techniques are not yet sufficiently developed. For example, there is a growing consensus that vegetative techniques should play a more prominent role, but at present the techniques of direct seeding of perennial grasses, such as *Andropogon gayanus*, and of woody perennials, are inadequately understood. Recently, research on *Vetiveria zizanioides* has been initiated worldwide. The outcome of such research should be carefully analyzed. Wherever needed, research efforts should then be complemented. As noted before, research on indigenous soil and water conservation techniques has until now been neglected.

Research on agroforestry systems in arid and semi-arid regions is still in its infancy. The

IFAD funded SWaCAP programme in Lesotho includes an agroforestry research component, and attempted to institutionalise research - extension links in its design. Other IFAD funded soil and water conservation programmes, such as the one in Burkina Faso, include cooperative agreements with local research institutes. However, **research - extension links are often weak.** It is essential to strengthen them. Support to research is of little value unless findings can quickly be converted to useable extension messages and farmer training programmes. Local researchers and extension staff themselves have to be trained in applied research methods, so that these activities are institutionalised and a self-supporting cycle of research, extension and training is established. Recently approved IFAD funded programmes in Cape Verde and Tanzania intend to establish functional research-extension linkages.

Research on reasons for adoption or non-adoption of techniques: researchers, for example in the West African Sahel, have spent much energy and resources in the last decade on tied ridges. Many research reports have been written on this subject. But there are no indications that land users are adopting this technique. Present knowledge about reasons for adoption or non-adoption of conservation techniques remains inadequate.

More research is needed on the **costs and benefits of soil and water conservation. Land and tree tenure issues** in relation to soil and water conservation also require more attention.

More precise information is needed about **fertility in relation to soil and water conservation.** More should be known about the longer term evolution of soil fertility under field conditions. Water harvesting techniques stimulate crop production, but may lead eventually to fertility mining, when nutrients are not being replaced. In such cases immediate higher yields would not be sustainable in the long run. However, there are some indications that where water harvesting techniques have been used in semi-arid areas, yield levels did not decrease as anticipated, despite the limited quantities of manure applied by land users. The role of nutrient harvesting and soil fauna (termites) in such cases needs to be understood.

The role of **livestock management in relation to land rehabilitation** is a most important issue, which can arouse passionate debate amongst land users. It deserves more attention from researchers. Should livestock be stabled to allow regeneration of the natural vegetation, the successful planting of trees and an increased production of manure? Or would rotational grazing be efficient enough? Some argue that livestock should be excluded from the production cycle altogether, and this was attempted for some time in the Swedish funded HADO project in Tanzania. The IFAD funded smallholder development programme in marginal areas of Tanzania will now try to support the step by step (re)introduction of livestock under controlled grazing conditions, in consultation with Village Grazing Associations. In another target area, the same programme has opted for consultation with village authorities for a destocking strategy within the village boundaries (Figure 23).

Particularly in arid and semi-arid regions, stabling of livestock would imply a profound transformation of rural production systems. In Burkina Faso some projects have made steps in this direction; but researchers have not monitored its effects on important parameters, such as livestock husbandry, regeneration of the natural vegetation, labour requirements, gender aspects, income and soil fertility. Range management will be one of the main themes to be covered by IFAD in a forthcoming review of common property resources and agricultural development in sub-Saharan Africa.

Although substantial research has been done in some ecological zones on runoff and erosion, sometimes too little is known about **the extent and importance of erosion, erosion processes and the impact of various soil and water conservation techniques on erosion, runoff and yields.** In such cases fairly basic research is still required, extended over a long span of years.

The preceding remarks demonstrate that much remains to be learned. Soil and water conservation programmes should therefore always include funds for applied research.

A final remark should be devoted to research methodologies. On-station soil and water conservation research can be relevant. But in some cases, although on-station research on various techniques produces promising results, results under on-farm conditions are disappointing. More research should be done directly with the land users, for instance in the form of simple land user managed trials stimulated

Conservation projects with active research components

Some projects have made more than average research efforts. The Projet Lutte Anti-Erosive (PLAE) in South Mali was initiated in 1986, but research on local production systems and on soil and water conservation techniques had already started in 1979. In 1984 and 1985 a package of conservation techniques, including vegetative barriers, was tested in two villages. The outcome was considered successful and a major programme was introduced in 1986. Research continued on a range of subjects, such as fodder crops, regeneration of vegetation and reasons for non-adoption of techniques (van de Poel and Kaya, 1990).

The IFAD funded soil and water conservation projects in Burkina Faso and Niger each have an applied research component, which allows research on issues such as the extent of erosion and indigenous soil and water conservation techniques (Niger); agroforestry techniques and the long term impact of conservation techniques on yields and soil fertility (Burkina Faso).

Box 21

by, and in close collaboration with, researchers (Box 21). Research should be a two way process between farmer and researcher; together they should formulate the research agenda. Several IFAD funded programmes follow a similar sequence of research methodologies. Starting with diagnostic baseline surveys, which are used to formulate a research agenda, they move on to a first set of trials on station, and finally on-farm trials testing potentially suitable packages. While in itself a logical sequence, such a scenario runs the risk of getting stuck on station, postponing the on-farm stage. On-farm trials should preferably be planned at an initial stage, as they also provide an excellent learning opportunity for researchers on local farming systems and indigenous conservation methods.

Rapid rural appraisal (RRA) techniques have been developed in order to match quick surveys with limited resources of manpower, finances and time. They can be applied throughout the project cycle: identification, formulation, (mid term) evaluation and monitoring. A specific example of the application of RRA is the acquisition of information on the access profile of land users, which must play a vital role in the design of conservation programmes.

4.3.7 Training for extension staff

Adequate training for field staff must be an integral part of all soil and water conservation programmes. Prior to this, the essential first step is training of trainers. Although formal agricultural training at colleges may include some soil and water conservation, this is often inadequate and needs to be reinforced by in-service training (Box 22). Such courses can also help staff to keep abreast of developments: improvements to techniques as well as changing approaches, such as participatory land use planning.

Where there is already an established system of in-service training for agricultural extension staff, such as in Kenya (under the "training and visit system") it is relatively easy to introduce specific modules on soil and water conservation. These can be included at appropriate times of the year, for example in preparation for the annual soil conservation campaign which takes place after the harvest. The reorganisation of the extension service in Lesotho under the IFAD funded SWaCAP programme specifically includes five modules for in-service training of staff, of which conservation farming is one. Monthly workshops are also proposed for extension staff at the newly established Resource Centres.

Extension training in Mali

The Projet Lutte Anti-Erosive (PLAE) was set up under CMDT (the Malian textile development company) as a response to the problems of land degradation in the cotton growing region of southern Mali. PLAE has relatively few staff itself, and operates as a training cell for the field workers of CMDT. Training covers a broad spectrum of conservation technologies, as well as the "global approach" to land management. CMDT extension staff learn how to motivate villagers by means of audio-visual methods, including flannelgraphs and slide sequences (Hijkoop et al., 1989).

Box 22

A relatively innovative concept is for area based programmes to organise training for the staff of other projects, and government services, working in the same area. One advantage is that it helps to standardise techniques and approaches among development organisations working in the same area. This is the approach adopted by the GTZ funded PATECORE project in Burkina Faso, which has established training facilities at the project headquarters, and offers training both in techniques, such as permeable rock dams, and in aspects of village land use management. The IFAD funded SWaCAP programme in Lesotho, which only covers some districts directly, has recently agreed with Government and other projects an integrated approach to extension refresher courses throughout the country.

4.3.8 Training of land users

Land users normally have a much better knowledge of their environment than outsiders. They adapt their land use practices to changing conditions and they experiment with crop varieties and mixtures. In the past, changes such as population growth were slow. Land users had time gradually to adapt their farming practices. During the last three decades, the pace of change has accelerated. Local economies have been integrated more strongly into international systems. Population growth rates have increased. Indigenous farming systems and conservation practices have come under increasing pressure and need to be improved. Land users now have less time to adapt to changes. **The injection of new knowledge and skills is necessary for survival.**

Training of land users is a precondition for sustained efforts in the sector. In order to achieve replicability, conservation must be done by land users themselves. While a valuable foundation often exists in indigenous knowledge, this must be built upon with enhancements and innovations, through training (Box 23). Training in land survey techniques should be a core element in many farmer training programmes. The IFAD funded programme in Cape Verde originally included the use of survey equipment for levelling terraces, but this approach needs to be modified to include training of farmers to do the job themselves, thereby contributing to programme replicability.

Until recently, training of land users was, with some exceptions, almost entirely neglected in francophone West Africa. The situation has now improved somewhat, but there is still a long way to go. One of the lessons learnt is that training at village level is more efficient than training in so-called farmer training centres. Maximum impact can be obtained when training is accessible to a larger number of villagers and not only to a selected few. Another important lesson is that **direct exchange of on-farm experience between land users is more efficient in getting the message than any presentation by outsiders, such as extension agents and conservation specialists.**

Training for and by farmers:
Niger and Burkina Faso

The IFAD funded soil and water conservation programme in Niger's Illela District has sent a group of land users to the Yatenga region in Burkina Faso to look at contour stone bunding and planting pits (zay). This has influenced the re-introduction of traditional planting pits (tassa) in the Illela District.

Land users in the Yatenga region have the impression that they are working in a most difficult environment. They are proud of their success in rehabilitating degraded fields with stone bunds and planting pits. In 1989, the OXFAM-funded Agro-Forestry Project organized a field visit to the Djenne-Sofara region and the Dogon Plateau in Mali. In the Djenne-Sofara region, the people from Yatenga saw several spatial arrangements of planting pits which were new to them. On the Dogon Plateau they met land users working in an even harsher environment and creating new fields on bare rock (Annex A). A group of Dogon are to pay a return visit to Yatenga.

The 'Projet Aménagement des Terroirs et Conservation des Ressources' (PATECORE) dans le Plateau Central in Burkina Faso has trained land users in the interpretation of aerial photographs (scale 1:10,000). Land users can now use aerial photographs to delimit the village boundaries, to identify suitable sites for the construction of permeable rock dams and to plan other interventions based on present land use.

Box 23

In Kenya, training of staff and land users is an integral part of the Swedish funded soil and water conservation programme. By 1989 about 300,000 small scale farmers had been trained during soil conservation field days and nearly twice that number had been reached with soil conservation messages through the existing National Extension Programme. Out of two million farms requiring conservation measures, about 800,000 farms are now fairly well conserved (Mbegera et al. 1989, 11).

Practice shows that land users quickly master simple land survey techniques (water tube level, line level, etc.), which enable them to undertake soil and water conservation without having to wait for the arrival of a survey team equipped with a theodolite. Other elements of a training programme can include principles of bund or terrace construction, management of village nurseries, the production of compost, village level conservation planning and ox training. On-farm trials also offer good possibilities for training in appropriate, simple research techniques. At the same time, they offer an excellent opportunity for programme staff to listen to farmers' comments and learn about their farming systems (Figure 24).

The acquisition of new skills has an enormously stimulating effect on land users, as it makes them more independent of external support.

5 Elements of strategy

This chapter offers recommendations on strategies to counter land degradation, based on the observations made earlier in the paper. It begins by looking at the place of soil and water conservation in national development programmes. It goes on to indicate key principles which should be applied in the design of soil and water conservation programmes.

5.1 Soil and water conservation: a national priority

Soil and water conservation should be a national priority in sub-Saharan African countries because it forms the essential foundation for agricultural growth. It is also a major factor in determining household and national food security. However, it is by nature a low profile activity compared with other potential forms of investment, like airports or highways. The recommendations in this paper may tend to lower its profile still further, by stressing small, localised interventions with relatively long preparatory periods. The situation can be intermittently reversed when droughts and 'desertification' hit the headlines. These painful reminders of the critical importance of conservation -and the ill prepared responses they often provoke- may be averted if governments accord national, long term priority to resource conservation and the low profile activities it entails. This should be mirrored by long term commitments from aid agencies.

The baseline strategy for the sector must therefore be a formal commitment by government to accord national priority to soil and water conservation over an extended period. These strategies should be articulated in, and meaningfully supported by, an appropriate policy framework and adequate resource allocation. Where such national strategy statements are not yet in place, their preparation and adoption should be an early priority for governments and the international agencies supporting them in this sector. The IFAD funded conservation programme in Ethiopia is intended to contribute to the formulation of a coherent national policy on soil and water conservation. In the current post war situation this is extremely important. In this context, a new formula for tackling environmental degradation must be sought.

5.1.1 Broader environmental horizons

There has been a clear trend in conservation thinking during the post colonial period in sub-Saharan Africa. Initially, soil erosion was identified as the problem and soil conservation as the strategy to counter it. Gradually, perceptions of the problem and appropriate responses have broadened. **The links between soil, water and vegetative cover are now widely recognised, as are the functional relationships between different types of land use in the various units of the landscape** (such as grazing and cropping, mountains and valleys). Increasingly, there is recognition of the impacts on rural resources of non agricultural economic activity and of urban demands (notably for fuel wood).

In the pre- and immediately post-independence periods, there was a bias towards the more productive, higher rainfall regions of countries for soil and water conservation programmes. The rationale was clear: the economic return to conservation activities was likely to be greater in these regions. **The debate continues about where to channel limited funds, though it is becoming increasingly acknowledged that the drier areas have a strong claim for support with conservation activities.** Most of the IFAD funded activities under the Special Programme for Africa take place in marginal, drought prone areas which have high population densities. Not only are these regions most prone to drought, but they are also home to an expanding population on a particularly vulnerable resource base. Furthermore, there are some simple technologies now available - especially water harvesting systems - which can help to rehabilitate abandoned land and mitigate the effect of low rainfall on food crops. While the most productive land in each country must continue to be protected from degradation, the cost of not investing in soil and water conservation in the more marginal areas is potentially enormous.

Some governments have now drawn up national environmental policies and plans. A national soil and water conservation policy is likely to be most effective as part of such a broader environmental strategy, provided that the environmental commitment is real and not just a gesture in the direction of the current vogue in international development thinking.

5.1.2 Integration with other agricultural strategy and services

Appropriate conservation strategy, while pursuing the area by area introduction of new or reinforced practices, should anticipate long term, integrated extension support to all aspects of rural production from the land. Discrete project investments must then be tied into longer term and more spatially extensive plans for the comprehensive support which resource conservation requires. Once again, the importance of a coherent national strategy is underlined.

Project enclaves should be avoided in conservation planning. Specially funded support to the sector should be channelled through existing agencies; new administrations and cadres should be used only as a last resort and if their sustainability is assured. Separate soil and water conservation programmes may be justifiable as an interim measure; separate soil and water conservation cadres, rarely. As already noted, it is normally appropriate for conservation investment to aim at better integration of agricultural extension services. At central government level, better coordination of different departments responsible for aspects of rural resource use is desirable. However, the capacity of government departments to innovate or to take on new tasks should not be overestimated. A redirection of existing capacity and a reassessment of existing tasks are more feasible, and can often achieve significant results.

5.1.3 Programme scale and duration

In this section, it is assumed that some national strategy is in place which gives priority to agricultural resource conservation. How should this support to land users be structured over space and time?

Fundamentally, there are two policy perceptions of how to support land users in combating land degradation. Much policy and programme design fails to distinguish them clearly. **On the one hand, it is commonly assumed that land degradation is a discrete problem which can be tackled once and resolved.** After this one time effort, the need for an often ill defined 'routine' package of extension support to land users may be recognised. But the emphasis is on area by area 'treatment' of degraded or threatened regions, until the whole country has been covered and the problem is under control.

Alternatively, support to land husbandry may be provided through a flexible package of extension inputs and conservation measures which, in appropriate combination from region to region, permit land users to regain, maintain or enhance productivity while conserving natural resources. This is a longer term approach which, while allowing for the area by area introduction of innovations, assumes that conservation orientated extension support is an open ended process.

In a few countries in sub-Saharan Africa, national conservation programmes have been at least partially effective and the emphasis should from the outset be on the design of flexible, long term extension support. This is the case in Lesotho, as is recognised in the design of the IFAD funded SWaCAP programme. In many countries, however (notably in the Sahel), it is necessary to work from area to area on basic rehabilitation and conservation. In these countries, it is important to combine the short term 'emergency' perspective with the longer term view

Why conserve marginal areas?
The Central Plateau in Burkina Faso

Mossi migrants from the Central Plateau in Burkina Faso contribute considerably to the deforestation of the south western part of the country, which causes severe environmental damage. Although the Central Plateau is considered to be an area with low potential for agriculture, soil and water conservation techniques have in some areas produced perceptible yield increases and have therefore been readily adopted by land users. In these circumstances, soil and water conservation increases yield security and contributes to the attainment of food self sufficiency at family level. **It will be evident that soil and water conservation is not the final solution: a whole set of additional measures is required.** But it may help to attach people to their land longer, and thus buy some of the time needed to develop other sectors of the economy.

Box 24

of how productivity increases and conservation will continue to be supported.

Whatever the approach, the ideal would be to integrate it from the outset with routine agricultural extension programmes, nationwide. This is unlikely to be feasible. Resources are limited; new methods must be piloted; land users and extension workers must often be trained. While 'enclaving' must be avoided, discrete interventions in the form of projects or programmes must therefore be designed.

Most development thinking is too narrowly confined by the project as unit of design and analysis. While discrete interventions are normally necessary, it is important to plan for their integration into routine activities by land users and governments and not to erect barriers around project areas or staff cadres. With this emphasis, it is possible to think more critically about levels of external input and about the scale and duration of programmes.

This paper deliberately refers to 'programmes' rather than 'projects' because of the connotations the latter term has acquired. Common perception of 'projects' stresses finite duration (typically five years or less); a restricted set of activities or inputs; segregation from government institutions; and little emphasis on what happens afterwards (except that another project is likely to follow). **Programmes imply an extended duration and may therefore offer a better prospect of integration with the long term content of national extension services.**

Ultimately, it may be desirable to effect the innovations offered by a resource conservation programme throughout an agro ecological zone, or throughout the cultivated and grazed areas of a country. But the area(s) covered in the early years of a programme should be small. This will permit the exploration of indigenous practices and fine tuning of proposed innovations which are advocated elsewhere in this paper. Expansion and acceleration in spatial coverage should not be allowed to outpace the integration of the programme with established farmer practice and extension services. If they do, the effectiveness of the programme will be jeopardised by the problems of maintenance and replicability discussed earlier in this chapter.

All the above points to an extended duration for resource conservation programmes. Projects lasting less than five years rarely achieve lasting results in this sector. Seven to ten years is a more realistic length for a resource conservation programme. This raises problems of budgeting and external funding. The key to their solution may lie in the concepts of flexibility and redesign which are recommended later in this section.

5.1.4 Appropriate units for conservation planning

The technical range and spatial scale of conservation interventions in a given landscape must be determined with care. The technocratic land use planning which governments favoured in the 1960s and 1970s was rightly rejected in favour of a conservation approach which stressed the on-farm concerns, indigenous skills and local resources of individual farmers. But this may leave serious gaps in off- farm resource conservation which threaten the gains made in field soil protection and crop production. **Any return to catchment planning or conventional watershed management should be viewed with caution.** The starting point should remain interventions - normally on crop land - which directly affect rural people's income. Nevertheless, it will often be appropriate to select other initiatives in communal property management to complement on-farm work, and to identify other units of intervention such as village grazing areas or administrative territories. This requirement reinforces the need for careful, extended local planning in consultation with resource users. It emphasises the importance of understanding local resource management institutions. In the Sahel, these structures for village land use management must often be revitalised or created anew. Elsewhere in sub-Saharan Africa, indigenous institutions may continue to offer a workable platform for new initiatives.

5.2 Programme planning principles

5.2.1 The long term perspective: replicability

To translate national strategy into sustainable activity, replicability must be recognised as the single most important criterion in the design of soil and water conservation programmes. Replicable conservation techniques are those which land users continue to apply themselves with no or minimal external support. The issue of replicability is now receiving increased attention, but until a few years ago it rarely figured as a design issue.

One of the great weaknesses of project inspired soil and water conservation activities in sub-Saharan Africa is that the majority come to a grinding halt as soon as external project funding is withdrawn. This may be because inappropriate techniques have been used; because of institutional failings at local or government level; or because government cannot meet the recurrent costs. Little attention has been paid by conservation specialists to the capacities of governments to continue implementing conservation activities without external funds. Nor have specialists adequately considered the capacity and willingness of African land users to adopt conservation packages. The reality is that some projects are not interested in replicability. They come in with a number of experts, machinery, blanket solutions, clearly defined targets to be attained within a specified number of years, and plenty of food for work. This type of project is almost bound to fail.

Deliberate efforts should be made to design conservation packages so that their potential for adoption by land users, with no or minimal external support, is optimized. For this to be achieved, conservation techniques should conform to the characteristics set out below.

5.2.2 Technical principles

Soil and water conservation techniques should be low cost. The higher the construction and maintenance costs in terms of labour requirements and/or financial costs of using machinery, the smaller the chances that the techniques can be adopted by resource-poor land users.

Soil and water conservation techniques should lead to significant short-term, sustainable yield increases. The time scales of African land users and soil and water conservation specialists differ fundamentally. The latter have often emphasized that the effects of soil conservation need a long time to materialise, but land users coping with a high risk environment are principally interested in what immediately affects their welfare and guaranteed subsistence. Land users' interest in soil and water conservation will therefore grow proportionally with substantial and sustainable increases in yield achieved, as long as the conservation activities proposed match their specific farm situation. Conservation policy is now slowly recognising that conserving soil for future generations is not an argument that will convince resource-poor land users to engage in soil and water conservation. Short-term yield increases of 10 - 20 % in the first year may not be sufficiently attractive to farmers. Net yield increases of 50 % will be more convincing. In arid and semi arid regions, water harvesting and moisture conservation techniques often permit such increases.

Soil and water conservation techniques should be relatively simple. Whenever possible, land users should be able to install techniques themselves without having to wait for external support. This means that the techniques must be carefully selected. Vegetative barriers and stone bunds (permeable and semi-permeable techniques) are easier to design than, for instance, graded channel terraces. Again, existing "ethno-engineering" skills influence what can be done.

Labour requirements for construction and maintenance should be as low as possible. For land users, construction and maintenance of conservation techniques are real costs, as they could spend the time and effort in many alternative ways. One reason why stone bunds have become increasingly popular in West Africa is that, although labour investments for construction can be high, maintenance requirements are low. The popularity of stone bunds is at the expense of earth bunds. The latter need less labour for construction, but often considerably more labour is required for maintenance.

Soil and water conservation techniques should where possible build on indigenous practices with which land users are already familiar, rather than introduce new technical packages.

Soil and water conservation techniques should be tailored to the specific situation. Variability in natural and socio-economic conditions must be recognised at all times. What works in one place may not work in another. Engineering structures to dispose of surplus water while retaining soil may be appropriate in one part of the country. Structures to concentrate runoff on cropped land may be needed elsewhere. In other places, the appropriate emphasis might be on new crop varieties, intercropping or agroforestry practices. Similarly, two areas with similar natural environments may differ significantly in their population densities, market opportunities, use of livestock or labour availability. A conservation structure, construction technique or cropping practice which is adopted in one area may be rejected in the other because of such differences. Conservation programme designers must study local variability carefully, and not assume that what works in one district will work in the next. These apparently obvious suggestions have only been made clear by decades of projects which imposed inappropriate technologies on unresponsive environments and populations.

5.2.3 Socio-economic principles

5.2.3.1 Local knowledge as the foundation

The soil and water conservation strategies of governments and aid agencies must be grounded in the environmental knowledge, agricultural skills, economic context and local institutions of the affected rural people. Deviation from this guiding principle is likely to diminish participation, increase costs, cut replicability and reduce the cost effectiveness of conservation programmes.

This means that such programmes must be designed in close consultation with rural resource users. In 1991, after some years of international emphasis on people's participation and the value of indigenous environmental knowledge, this recommendation may sound like a truism. In fact, there is more lip service to these concepts than effective field commitment. Interventions in the resource conservation sector, if they are to be designed in real partnership with resource users, must be planned and researched over extended periods in rural areas. Careful design attention should also be given to the past and existing experience of other projects and organisations. Current design arrangements, as will be noted below, rarely allow for these detailed investigations. The proposed improvements to the design process have cost implications. These should be balanced by streamlining other components of the lengthy design chain and reducing their cost (Section 5.3)

5.2.3.2 Participation

People's participation is now accepted as a vital component of successful soil and water conservation programmes. This simply means that the beneficiaries need to be involved in all aspects of project identification, design and execution as well as monitoring and evaluation. **Strategy at national and programme/project level must acknowledge the importance of participation and actively solicit the involvement of resource users and their local institutions.**

An issue which requires sensitivity in programme design concerns the gender and socio-economic characteristics of resource users. Rural people's interest in resource conservation, and their ability to undertake it, vary with their dependence on farming; their wealth; their gender; their social status within the community; their access to land, labour, livestock and other productive resources. Too many conservation programmes assume that everyone in the community will, or can, participate. Too few assess their potential impact on women as contributors of labour, managers of resources or potential beneficiaries of conservation practices. The consequences of differential participation by different socio-economic groups are rarely considered. If, as is often the case, interventions are intended to help alleviate poverty by securing the rural resource base through conservation, the access of the poor to these rural resources is a crucial issue. How or why should the landless undertake soil and water conservation? Strategies to link conservation with new modes of access to and tenure of land may be required. This is being attempted in the IFAD funded SWaCAP programme in Lesotho.

5.2.3.3 Subsidies, incentives and sustainability

An inappropriate approach towards subsidies and incentives can destroy the long term prospects of any development programme - however well designed it may be technically. The issues have been discussed in the previous chapter. Direct incentive payments to land users should only be used where absolutely necessary. Where they are indeed needed, they should be merely sufficient to stimulate people's involvement without "buying" participation. The form and conditions of the incentives are critical, and are likely to be site specific.

Programme strategy should focus on the design and extension of simple conservation technologies that people accept, and the provision, where necessary, of the basic tools and inputs that the beneficiaries may require: pickaxes, wheelbarrows, seeds and cuttings, for example. In limited instances, heavy transport may also be appropriate to help people assemble rock and other construction materials which are needed in larger quantities than they can handle. Design should ensure that subsidy of such inputs is necessary only at the time of construction, and will not recur during maintenance. (It may be important, however, to ensure that supplies of equipment and other inputs remain available for purchase in the post project period.) Training activities can also provide important incentives to land users.

Designing sustainability into soil and water conservation requires detailed comprehension of the benefit/cost calculations which the land user and his/her household must make when appraising proposed innovations. It is therefore necessary to consider the economic implications and options at the family, community, regional and national levels, and to take into account the effects that changes at one level may have at another. Can land users afford the tools that a proposed technique requires? Are farm prices high enough to make it attractive for family members not to migrate to employment elsewhere but stay at home to do the additional work on soil and water conservation which will in turn give higher yields? Will farmers fear that the new practices and their higher yields draw too many household resources away from other economic sectors into agriculture, risking disaster in a drought year? As was noted in Section 4.2.3, few conservation programmes have given these micro- and macro-economic considerations the attention they deserve. Optimal macro level incentives through input and producer prices require a degree of control over market and price mechanisms which cannot always be achieved.

5.2.4 Institutional principles

5.2.4.1 Training

Training is a vital ingredient of conservation programmes at all levels. It is necessary for both programme personnel and for the participating resource users. Developing skills amongst the beneficiaries not only "demystifies" technology, but also acts as a powerful incentive to increased involvement in conservation activities. Too few projects have made the effort to move away from complicated design, to methodologies which can be readily taught to farmers by project personnel who themselves are comfortable with both the technology and the rationale for the interventions.

5.2.4.2 Research

Research in conservation programmes has often been misdirected. Like other elements of conservation strategy, it should as far as possible be managed by land users themselves, with support from research officers. Activities at the research station should be kept to the minimum, and academic complexity avoided in research design. The research which is most valuable for soil and water conservation is primarily that which is carried out on farmers' own land, designed in consultation with them, and as far as possible monitored and supervised by them.

5.2.4.3 Extension

As soil and water conservation is integrated more with other interventions in agriculture and rural resource management, it becomes increasingly appropriate to execute it through the existing extension services rather than through a separate cadre. Fragmentation of extension services persists in many countries, but support to soil and water conservation should aim to have an integrating effect and avoid the creation or reinforcement of separate conservation cadres. This is particularly important in view of the central strategy recommended in conservation extension: that proposed measures be linked directly, and in the short term, to significant yield increases for participating farmers. However important off-farm conservation may also be, the key to arousing interest and commitment remains rapid, and visible, yield increases. This clearly requires an integration of agronomic and conservation recommendations, rather than the artificial separation of these activities between different extension cadres. Where closer cooperation can be promoted between extension services responsible for crops, range, livestock, horticulture, forestry or other disciplines, this has positive implications for village land use management.

Agroforestry, by definition, requires the integration of the traditional disciplines of agriculture and forestry. Existing domains of professional expertise and departmental structure must be replaced by a combined approach to the promotion of bushes, shrubs and trees as part of the farming system. Illusions that this is a task for conventional forestry must be removed. Extension training programmes must be redesigned so that field workers can support land users with a comprehensive understanding of the role of agroforestry in land husbandry. Extension cadres should be broadened and restructured so that, without necessarily increasing total staff numbers, there are more 'generalist' extension workers able to deliver land husbandry and conservation-with-production messages (including an agroforestry component).

5.2.4.4 Collaboration between organizations

Increasing concern with environmental issues and commensurate growth in interest in soil and water conservation are now leading to interventions in this field by a multitude of donors and agencies. Quite often there is no arrangement for coordination between such institutions. Moreover, the governments concerned are in most cases not adequately equipped to ensure such coordination. Differences in strategies, approaches and even technical methods may lead to duplication of effort and confusion or resentment on the part of land users. Within their overall strategies and national plans for resource conservation, the governments concerned should devise specific arrangements and establish a harmonious framework within which the various donors should operate.

It would be mistaken to expect that this task of coordination could be assumed effectively by any single donor. Instead, donors should assist governments in the creation of functional national capacity for sector-wide coordination. It is highly desirable that one major donor, or a small group of donors, assume responsibility for assisting the government in this area, in close consultation with all other donors. Donors themselves should adopt coordination as a major principle in their programmes of assistance. As part of its support to soil and water conservation in Lesotho, the IFAD funded SWaCAP programme has promoted the establishment of a Conservation Task Force for this purpose and has funded a study on the coordination of conservation policies.

Government programmes should acknowledge the presence, and the potential, of non governmental organisations (NGOs), which often have comparative advantages in contact with resource users at local level. There is much to be gained by collaboration with such organisations.

Both in programme design and in execution, NGOs can make a valuable contribution. Recent technical innovations in soil and water conservation in the West African Sahel (contour stone bunding and level permeable rock dams) are to be credited to volunteer staff working for NGOs and not to conservation experts or researchers. NGOs' local insights and links with local institutions may offer important advantages. Their administrative procedures may be simpler and their overheads lower, all of which may mean a more direct impact on a larger number of land users. Governments and NGOs therefore need to coordinate their activities more closely. International agencies, some of which have indicated an interest in working with NGOs, should try harder to make this commitment operational. However, collaboration with NGOs does not offer a panacea. Their capacity to implement conservation programmes should not be overestimated. Where tasks are allocated to NGOs, commensurate assistance to increase their capacity should also be provided.

5.3 The programme design chain

Given the complexity of most programme design procedures, what is an appropriate strategy for the future? **This paper recommends innovations in the design of resource conservation programmes. It concurs with the widespread perception that urgent and accelerated support to African land users is needed if irreversible land degradation and production decline are to be avoided.**

Action must therefore be expedited, and that action must be innovative. The current structure for converting programme design to field execution usually obstructs both requirements.

Despite the best efforts of many concerned administrators in governments and development agencies, the chain of steps to be taken in designing and approving a new programme is long and expensive. It is common for three or more design missions to be fielded, perhaps as much as six months apart. Much of the material reviewed and written up by each mission team may duplicate work done by other missions.

Quite apart from the expense of this process and the delays it imposes in the face of urgent needs for action, it is difficult to maintain continuity of design through the various stages. Different people are often involved in the identification, preparation and appraisal missions. While this has the advantage of adding new perspectives and critiques to the design process, it dilutes any effort an agency may be making to communicate a strong and simple message through programme design to impacts on the ground. This is particularly true when the message is innovative and unfamiliar (or perhaps unattractive) to some of the consultants called in for design missions. However strong and simple the message, care is needed in adapting it to local conditions in a particular country so that it is locally appropriate but still consistent with the main theme. **Sometimes, programme content suffers radical swings in direction from one design stage to the next.** Continuity can also be impaired by the lack of adequate participation of host governments' executing agencies and local institutions at the project design stage. As emphasized earlier, the participation of intended beneficiaries in programme design and intensive consultation during various stages will help the design team to develop a better knowledge of local conditions, to understand the potential of indigenous techniques and practices while ensuring acceptability of proposed changes.

5.4 Project versus programme approach

As with other types of development aid since independence, a project approach to soil and water conservation has been taken in sub-Saharan Africa. Budgeting procedures of donors and lending agencies lead to thinking in terms of finite projects rather than long term programmes. Donors like to see tangible benefits in the short term, and loans require such benefits to finance repayment. Successful soil and water conservation requires a long term approach, which means in the first place that political commitment is needed to carry on conservation activities as part of recurrent operations rather than solely as projects on the development budget. Such commitment is hard to achieve, considering the severe financial constraints most African governments already face. It is for this reason that soil and water conservation is so often carried out as a one-shot process. There are exceptions: the SIDA programme in Kenya is a long term commitment by both the donor and the Kenyan government. The country programme approach adopted by IFAD for soil and water conservation in Ethiopia, Niger and Burkina Faso is conceived within such a context. The same principle was applied to an IFAD supported programme in Kenya's Arid and Semi-Arid Lands (ASAL) areas. In this case a long term strategy for ASAL was developed with the participation of Government and major donors, preceding the design of the specific investment project.

A process approach would be more conducive to success in soil and water conservation, if harder to implement from the point of view of governments and aid agencies. The process or programme approach emphasizes the need to start activities, preferably perceived by the local population as priorities, on a small scale and gradually to expand them on the basis of experience gained during implementation. It implies constant adjustment to realities as perceived and expressed by the local population. It is not only a learning approach: it is also open ended in the sense that inputs and outputs for years four or five are not determined at the outset - or if they are, they can be substantially modified in the light of experience during implementation. Rather, it is hoped that by responding to the felt needs of the target group and demonstrating the profitability of certain innovations, these will gradually gain momentum.

The process approach is particularly suited for soil and water conservation in situations where the most appropriate and locally acceptable package of techniques has not yet been identified. Conservationists should always bear in mind that the package giving the highest yield increases is not always preferred by the local population. In such instances, compromises are necessary.

Making the process approach operational is not easy. It has to be accepted that government and aid agencies will continue to need specific advance planning for budget periods probably not exceeding five years. In these circumstances, the first part of a plan period for conservation support in a new area should be for extended investigations of local conditions, indigenous techniques, existing government activities and capacity, and effective inputs. Beyond that, planning documents should allow as much flexibility as possible to ensure that lessons can be learned from mistakes during implementation and that the support remains relevant. But the principal requirement for a process approach is long term commitment on the part of both government and donor agency. Conservation, in order to succeed, needs to be a priority for at least a decade in most of Sub-Saharan Africa.

5.5 Programme execution

5.5.1 From design innovation to field execution

Assuming that the broad policy features desired by an aid agency and host government survive all the stages of the design process, innovation is further inhibited at the execution stage. Local and international programme personnel are then required to implement a programme in whose design they were typically not involved. Their only briefing on its philosophy may come second hand from relatively short discussions with superiors, or from a reading of programme preparation documents (when these are available in the field). **Programme personnel tend to pay more attention to their own experience and habits than to the content of design documents**. Whether they learn from their experience and converge with originally intended design innovations, or continue with their conventional ways, depends on individual personalities and on the efforts of those involved in programme supervision. In the case of the policy innovations contained in IFAD's Special Programme for Africa, not all the agriculture and conservation professionals normally employed for programme execution in the field are already actively aware of such concerns and able to put them into practice.

It is easier to identify these problems than to suggest solutions. **Key agents in ensuring consistency through the long chain from policy innovation to field execution are supervisory staff in aid agencies and host governments. There are good reasons to keep the bureaucracy small in both types of organisation. But the staff available are usually so inundated with missions, consultants and administrative paperwork that they are unable to fulfil their programme supervision role effectively**. Sometimes they rotate through key posts quickly, so that continuity with regard to specific countries or projects is lost. One way to clear some space around such supervisors is to reduce the number of new projects being processed. This is inherent in the programme approach, where external inputs are packaged over a longer term. Another useful measure is to enhance the coordination of aid agencies and their inputs to the agricultural sector, so that policy lines are clearer and superfluous projects are avoided.

Slow starts in Niger and Cape Verde

The IFAD funded soil and water conservation programme in Niger was deliberately given a slow start, because it was recognised that new techniques and methods had to be tried out first. The project set itself the challenge of promoting simple and replicable techniques. The number of hectares to be treated expands from year one to four of the programme as follows: 80 ha., 270 ha., 1,170 ha. and 3,120 ha. The programme is at present in its third year. Given the recent boom in the adoption of improved traditional planting pits (tassa), the project will probably achieve these targets (Annex A).

The new IFAD funded agricultural and livestock programme in Cape Verde will treat its first three years as an experimental phase for the range land component. During this phase it will test livestock development technologies for reforested range land. They will then be introduced in the subsequent phase.

Box 25

Loans are widely used for international support to agricultural resource conservation in sub-Saharan Africa. Financial institutions, including IFAD, have certain rules with regard to loan repayment or payment of loan service charges. Deviation from these rules can, understandably, not be sanctioned. As a result of defaults on loan repayment or difficulties with loan management, disbursement by the lending agency can be temporarily suspended. If such a suspension hits a soil and water conservation programme during the dry season (the major season for the execution of conservation activities), it may mean that the objectives set out in the annual work programme cannot be achieved. This may also negatively affect the relationship between the programme and the land users. Such difficulties afflicted the IFAD funded soil and water conservation programmes in Niger and Burkina Faso in 1991.

It would be beyond the competence of this paper to argue convincingly for a greater emphasis on grant finance as a means of ensuring that policy innovation is efficiently converted to appropriate action on the ground. But simpler procedures and tighter supervision are clearly issues which require the attention of aid agencies and governments in sub-Saharan Africa. The gap between policy and practice in soil and water conservation needs to be closed.

One thing is evident: more time needs to be spent by programme designers in the field, talking to the resource users whom the programme is intended to benefit. The use of local capacity (for example, consultants or research agencies) may make extended field design periods more feasible. During these extended planning periods, detailed information should be gathered about local environmental conditions; indigenous farming and land management systems; and land user reaction to potential programme content.

5.5.2 Slow starts and flexibility

Appropriate conservation programme strategy normally requires a slow and modest start to execution. However extended and thorough the design process, many things will change when implementation starts. Design assumptions about the fielding of international staff, the allocation of local personnel and the acquisition of vehicles and buildings are normally too optimistic. More significantly, conservation programmes must have time built into them for learning from design errors and early mistakes in execution. Further time will also be needed for additional consultation with land users on technical and institutional matters. Indeed, there may be cases where such consultation leads to radical shifts in programme direction and content. **Flexibility must be viewed as a necessary virtue in programme execution. This means that governments and funding agencies must be prepared for major interim reviews during which programme content and budget are reexamined.** Such adjustments should not always be deferred, or restricted, to a mid-term review.

5.5.3 Programme implementation

The process of international funding for soil and water conservation inevitably involves administrative complexity and international protocol. The technical content and benefits to resource users can often be obscured. It is outside the scope of this paper to make detailed recommendations on how to remedy the situation; but certain observations have been made about elements of the programme design chain which might help to simplify it. A further conclusion is that the greater the number of participants in programme administration, the smaller the chance of coherent policy direction. The more consultants and administrators are involved, the less likely it is that they will all appreciate why a programme was designed in a certain way, or which factors are crucial to its success. These problems are magnified when one international agency is responsible for design and funding, and a second for administration and execution. Field personnel and consultants may come from a number of additional sources. In such circumstances, it is clear that only the very simplest of projects can expect consistent execution and supervisory decision making.

A common feature of projects supported by IFAD in sub-Saharan Africa is the obligation to submit detailed annual work plans, whose preparation requires much time and labour. These plans may not help project progress, unless their preparation includes target group participation. Their usefulness will depend on the degree of data reliability and predictability of work events which is realistic in practice. Work plans are necessary, but should be based on quantifiable project experience, and should preferably function in a looser way as strategic guidelines.

In the midst of this complexity, there is also an appropriate sense of urgency about achieving progress on the ground. This is quite often translated into actions aimed at expediting projects' or programmes' physical establishment in the field, at the cost of focus on the technical content of a programme and its beneficiaries. **Emphasis should return to the technical content of a programme; its monitoring and evaluation; and, above all, the response of rural people to the support it proposes.**

5.5.4 Monitoring and evaluation

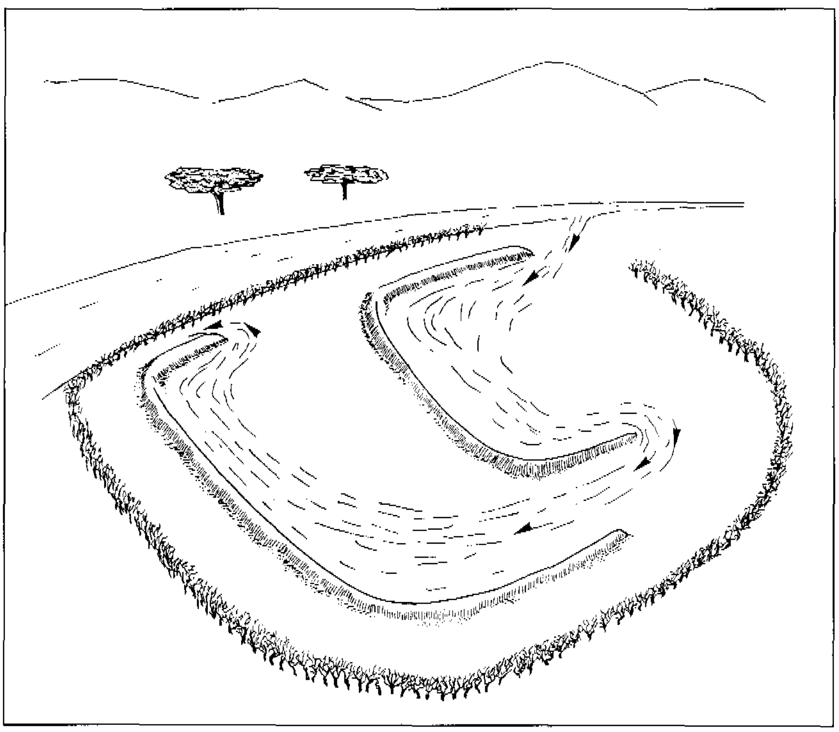
An important element of conservation strategy which has rarely received adequate attention is monitoring and evaluation. **Despite the huge number of conservation projects undertaken in recent decades, information about their impact is scanty, and often based on unsubstantiated estimates.** It is essential that programme execution include capacity for gathering routine information about participation and yield or income increments achieved. This information should then be fed into periodic reviews of programme costs and benefits, leading where appropriate to redesign and rebudgeting. Especially where programmes introduce innovative approaches, monitoring and evaluation are crucial.

Annex A. Indigenous soil and water conservation

Traditional small-scale water harvesting in Somalia

The Central Rangelands of Somalia are home to a tradition of small scale water harvesting, which has been a locally important component of the production system for generations. In Hiraan Region, north of Mogadishu, annual rainfall averages between 150 and 300 mm, and is split between two seasons. Although the popular conception is that the people of this area are pastoralists, the majority are more accurately described as agropastoralists - combining some crop production with the management of their livestock. It is primarily for food crops that the water harvesting systems have evolved, though the stover makes a valuable stock feed as well. The inhabitants of Hiraan Region say that rainfed cultivation would simply not be possible in such an arid region without such techniques. There is evidence that the systems have developed over several generations, and though there are some technical shortcomings, such as breaching of bunds and occasional waterlogging, the cultivators are able to design, manage and maintain the systems themselves.

The techniques used vary, but the principle remains the same - to collect runoff and concentrate it on cultivated plots to make crop production more reliable. The objective is to conserve moisture, rather than to conserve soil. Water spreading from toogs (ephemeral water courses) is used in certain parts of the region, but more widespread are the water harvesting techniques employed on the individual field scale. These are locally termed the Caag and the Gawan systems.



The *Caag* system

The *Caag* system is a technique to impound runoff from small water courses, gullies or even roadside drains. Sometimes ditches are dug to divert water into the fields. Runoff is impounded by the use of earth bunds. These were traditionally made by hand, though some cultivators now hire tractors to build the bunds with disc ploughs. "Contour" or cross-slope bunds are the basis of the system, and one or more of these bunds are built across the entire plot which may be a hectare or more in size. The alignment of the bunds is achieved by eye and by experience. The bunds have "arms" which extend up slope (Diagram) and one arm is usually longer than the other to allow for excess runoff to flow around it. In this system, runoff is impounded to a maximum depth of 30 cm. If water stands for more than five days or so, the bund may be deliberately breached to prevent waterlogging.

The *Gawan* system is used where the land is almost flat and runoff is less. Small bunds are made which divide plots into "grids" of basins. Individual basins are in the order of 500m2 or above in size. In some cases the basins are closed, and they function by merely holding rainfall in situ: in other situations, where some runoff is expected from outside the field, gaps are left in the bunds and runoff is encouraged to circulate through the plot. Each field differs in layout.

In both of these systems, sorghum is the usual crop grown, though cowpeas are also common. The seeds are often sown without first digging or ploughing the plot, and some cultivators practice "dry planting", that is planting before the advent of the rains. If the rains permit, two crops are taken each year. Sorghum grain is harvested for home consumption, though cowpeas are often sold locally. Stover from both crops is collected and stored for animal feed in the dry season. Even when the crops "fail", whatever dry matter is produced is useful for fodder.

Very little is known about the details of the systems, or even their extent, as they have not yet been systematically studied. This is despite some research by the Central Rangelands Development Project, and brief investigations by the World Bank's Sub-Saharan Water Harvesting Study (Reij et al., 1988; Critchley et al., forthcoming), from which the information in this section is derived. It is particularly significant that these water harvesting systems are entirely indigenous, and they are implemented and maintained by the agropastoralists themselves, at their own expense. The priority now should be to carry out a detailed study in view of the potentially important lessons to be learned for the growing number of water harvesting projects in SSA which have met a variety of problems - financial, technical and socio-economic. A further aim of a study would be to strengthen and support the development of such techniques in Somalia.

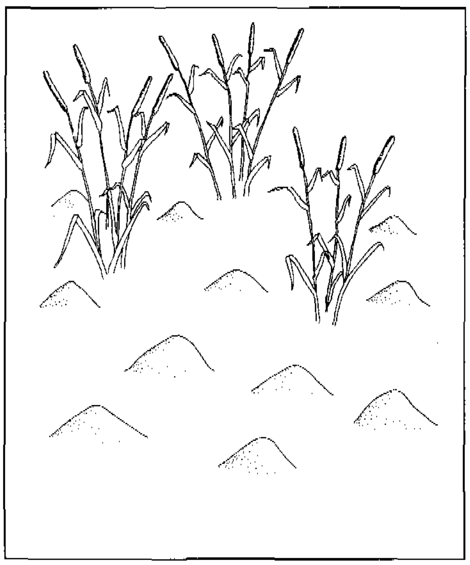
Traditional techniques of soil and water conservation on the Dogon Plateau (Mali)

The Dogon plateau is better known for the tourist attractions of its spectacular villages perched on the escarpments than its traditional agriculture. But to the student of indigenous farming systems, the soil and water conservation techniques which are used by the Dogon are as fascinating as the landscape.

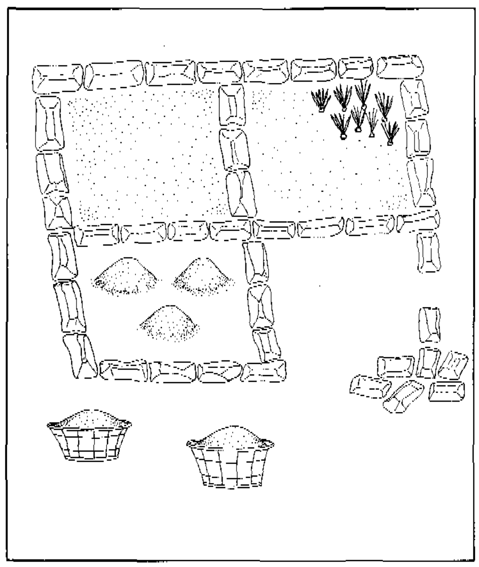
The Dogon rely largely on rainfed agriculture for their livelihood, despite the fact that there is only a poor cover of soil on the plateau, and the little soil which exists is shallow and prone to erosion. A further constraint to rainfed agriculture is the low rainfall which has diminished further in recent times - the long term annual average of 555 mm has shrunk to 465 mm over the last 20 years. The Dogon have, through necessity, devised systems of conserving both soil and moisture. These techniques are varied, and specific techniques are used in particular situations.

Some techniques have survived better than others - **hillside terraces** for example are being progressively abandoned due to the amount of labour required to maintain them, and also because people are gradually moving down from the escarpments to the plains now that there is improved security from cattle raiders. Trash lines of millet stalks and tree branches are also diminishing in importance. Recent legislation forbids the lopping of trees for such purposes.

The most widespread technique is the formation of **earth mounds** which are made between plants during weeding. Weeds are heaped together into piles and covered with soil. The resultant mounds help to slow runoff, but also act as mini-compost heaps, building up the fertility of the soil. Also common are the wide and deep planting pits which are not exclusive to the Dogon plateau - the zay found in neighbouring Burkina Faso are very similar.

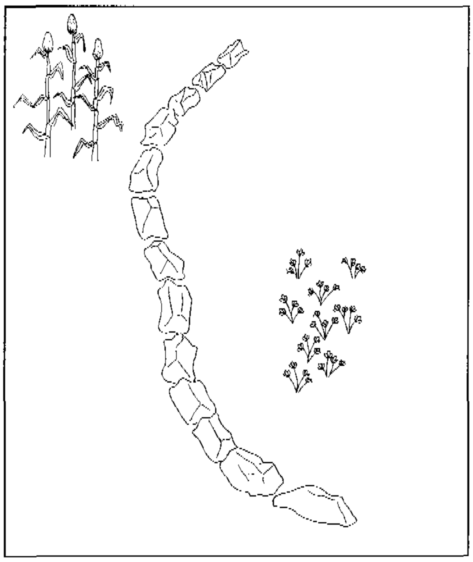


Earth mounds

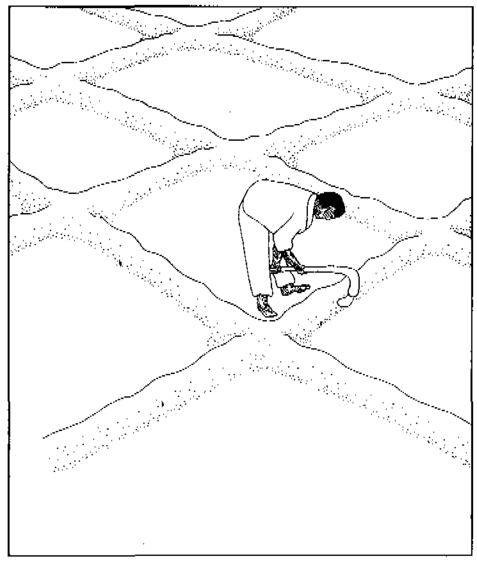


Transported earth gardens

Stone lines and stone bunds (Figure 19) are formed across fields wherever there is a good supply of loose stone - in some cases rock is even broken with hammers to provide material. These structures, though often rather crudely built, act by slowing runoff and encouraging deposition of silt. Small earth basins are formed in areas where the soil is relatively deep. This is the most effective technique of all, as the basins ensure that all rainfall is conserved where it falls.



Stone lines



Earth basins

Perhaps the most unusual and ingenious technique of soil and water management is that of **"transported earth gardens"** for vegetable growing. Irrigated vegetable gardens have long been a feature of the Dogon plateau, but in many areas the flanks of the watercourses are denuded of earth. The Dogon simply construct a network of stone squares on the naked rock, and then fill these squares with silt and soil - principally carried from the river bed (Figure 3). Manure is added and a fertile growing medium is established.

The soil and water conservation techniques on the plateau demonstrate a rich heritage of indigenous knowledge which to date has been barely acknowledged, let alone studied. This should now be a priority. It is interesting to know which techniques are increasing in extent, which are decreasing, and what the reasons are for these dynamics. Of most importance to the Dogon is the future of the plateau. Despite the extent of the conservation systems, erosion continues to reduce the amount and the fertility of the soil available for cultivation. Help is required to assist the Dogon to improve their own techniques.

Improved traditional pitting systems in Burkina Faso and Niger

In the Yatenga region of Burkina Faso farmers traditionally rehabilitated crusted barren land (*zipelle*) by digging small pits (*zay*). This was usually done on a small scale. At the end of the 1970s a farmer from the village of Gourga improved the traditional pits by increasing their dimensions and by adding manure. The idea was picked up by the OXFAM-funded Projet Agro-Forestier (PAF). This project combined *zay* with contour stone bunds. Thousands of hectares of barren land have now been rehabilitated in this way. The procedure is that farmers break the crust, dig pits with a diameter of about 30 cm and a depth of about 20 cm. They put some manure in the pits, which attracts termites. These termites digest the manure, start digging holes and in this way they increase soil fertility and the infiltration capacity. *Zay* permit the concentration of water and nutrients. Yields of sorghum and millet on these rehabilitated lands can be over 1000 kg/ha in a year of average rainfall. Even in years of below average rainfall *zay* give fairly good yields, because they collect and concentrate runoff (a water harvesting technique).

All the farming systems studies made on the Plateau Central in Burkina Faso indicate that the highest yields are obtained on the *champs de case*, which are small well manured fields directly next to the huts. Good yields are also obtained on the *champs de village*, which because of their proximity to the huts also receive some manure. The lowest yields are obtained on the fairly large *champs de brousse*, which are bush fields at a larger distance from the village. Yields are low, because no manure is applied. In the Yatenga region this general picture no longer holds. The village fields have in many villages become less important than the bush fields rehabilitated by *zay* and contour stone bunds. They are bigger than the village fields and have higher yields.

The IFAD funded CES/AGF project concentrates on the collective treatment of village fields. Farmers who have dug a compost pit can get 400 kg of burkinaphosphate from the project to be mixed with the contents of the pit. The farmers were supposed to apply the manure to the treated village fields. In the Yatenga region they applied it instead on their fields rehabilitated with *zay*.

In 1989 a group of farmers from the IFAD funded soil and water conservation programme in the Illela district of Niger (Tahoua department) paid a visit to the Yatenga region. In parts of the Illela district, pits (*tassa*) were used traditionally to rehabilitate degraded land (*fako*), but their dimensions were small, the excavated soil was not necessarily put down slope of the pits and no manure was added. Some farmers decided to improve their traditional pits on the basis of their observations in the Yatenga region. The IFAD project supported them and introduced small experimental plots where not only manure was applied to the pits, but also some inorganic fertilizers. In 1989 3 hectares were treated with improved *tassa*, in 1990 78 ha. and in 1991 there is an exponential increase in improved *tassa*. In July and August 1991 hundreds of farmers already started digging improved *tassa*, so they could benefit from the favourable moisture conditions. The main reason for this rapid adoption of improved *tassa* is that farmers observed at least some yields in 1990 on fields treated with *tassa*, whereas rainfall in 1990 was low. Rainfall in the district was good in 1991 and yields of the major crops on fields rehabilitated with *tassa* looked very promising, which provided an important incentive for adoption. The difference between the with and without situation is striking as there is no yield at all in the without situation. Another element that does not escape farmers' attention is that the rehabilitated fields do not (yet) show any signs of infestation by a parasitic weed (*Striga*), whereas this is a major problem on many fields which have been cultivated for a long time.

At least three general conclusions can be drawn from this experience. (a) The rapid adoption of improved traditional pitting systems in Burkina Faso and Niger provides supporting evidence to the argument that it makes sense to identify whether and how traditional conservation techniques can be used as a starting point for new programmes. (b) It also shows that farmer-farmer extension is a very effective tool, which is still underrated by many projects. (c) In both regions population pressure on available land resources is high; improved pitting systems allow the expansion of the resource base through the rehabilitation of degraded land. These techniques can easily be replicated, they are efficient in the sense that they lead to considerable and sometimes even spectacular yield increases compared to the without situation; they only require a considerable input of labour.

Annex B. Soil and water conservation in the colonial period

Concern about the degradation of soil resources in the region began to be voiced by a few British colonial administrators as early as the turn of the century, but it was not until the 1920s that such problems began to receive any serious official recognition. Drought and subsequent heavy rains in the early 1930s combined in some areas to produce visible acceleration of soil loss. Sedentarisation of some mobile groups and the more general restriction of African populations to specified areas within the British colonies - other regions being set aside for white farmers - were also beginning to cause serious soil erosion and degradation of vegetation cover. These developments were mixed in colonial perceptions with a growing belief in the environmental irresponsibility of African populations. Not only was the environmental condition of some 'native reserves' beginning to threaten colonial stability; there was danger (real or imagined) of damage to adjacent white farming areas in certain cases. At the same time, the economies of British colonies were under pressure in the 1930s as the effects of the international depression spread to Africa. Similar pressures were felt at this time in America's 'dust bowl' crisis, and colonial concerns and methods were often cross referenced to developments in the United States (Anderson, 1984). Soil conservation became a priority for British administrators during the 1930s; indeed, all colonies in the Empire were instructed in 1938 to begin regular reports to London on measures being taken to combat erosion. Conservation concerns were integrated by the end of that decade with nascent ideas of developing agriculture and colonial economies overall, rather than simply administering the natives and promoting settler and metropolitan interests as had previously been the case.

Colonial conservation was typified by an interventionist approach to local farming systems and the environment. This was more justified in settler areas than among African farmers. The dichotomy between the two sectors was of course marked, with settlers often (but not always) enthusiastic about new conservation measures and heavily subsidised for their introduction. In both sectors, the techniques introduced were in their infancy internationally, and were often inappropriate for African conditions. Emphasis in the early decades of soil conservation in the British colonies was mainly on structural measures for the control of run off and on tree planting. Contour bunds, diversion channels, earth dams and other structures were built across farm land. Heavy earth moving equipment gradually replaced mass African labour as the source of the motive power for the major construction programmes undertaken. By contemporary colonial standards, enormous resources were mobilized for what, by the outbreak of World War II, had become an Empire-wide campaign. In terms of physical quantities, the British colonial conservation programmes were an impressive achievement, proudly recorded in annual reports as the miles of terraces constructed or acres 'treated'. Despite the enormous resources devoted to these efforts, there were few attempts to quantify costs and benefits. Only in the last 20 years has it been widely recognised that capital intensive, structure based conservation campaigns are rarely cost effective. The Agricultural Adviser to the Colonial Office, however, had begun to reach this conclusion as early as 1938 (Anderson, 1984, 342).

Other types of soil erosion and conservation research were pursued by the colonial authorities, for example at Ukiriguru and Lubaga in Tanzania from 1949 (Stocking, 1985c). Research was one of the initiatives proposed by the Inter African Conference on soil conservation and land utilization at Goma in 1948, which led to the establishment of an Inter-Governmental Commission for Technical Cooperation in Africa South of the Sahara and four regional agencies. SARCCUS, the agency established at that time for southern Africa, still functions in atrophied form.

Post war technical experience suggested a move towards a more coordinated land use planning approach, with more thorough appraisal beforehand of water and soil resources in a catchment and an attempt to impose overall design on the farming landscape. While many of the early campaigns of construction had been completed or phased down by the independence decade of the 1960s, this area based, land use planning approach to soil and water conservation was handed over to the new governments of some states and adopted by them.

These were the states where the colonial administrations had not been forced totally to abandon soil conservation by independence because of the social and political opprobrium it had attracted. Although many dedicated and competent officers participated in colonial conservation programmes, and some achieved a genuine understanding of the cultural environment in which they worked, colonial conservation policy was largely insensitive to local needs. It was by its nature biased in favour of imposing regulations rather than obtaining the commitment of the supposed beneficiaries. There was little extension to explain the purpose of the disruption of the landscape, let alone consultation to discover what farmers already knew about erosion and conservation or thought should be done about them. At most, some schemes used local Africans as labourers for construction and planting work. The most general effect of colonial conservation policy, apart from disrupting farming operations during construction and setting aside arable land for various works, was the constriction of the African agrarian economy by legislation. Wide ranging and often detailed regulations were introduced requiring Africans to desist from certain practices and engage in others, on pain of severe punishment. Particularly unpopular were the regulations prohibiting cultivation in certain conditions (e.g. near rivers), or grazing at given times or places.

African farmers were typically bemused or angered by colonial attempts to manipulate the natural environment which they understood better than most British officials. In the arable sector this was particularly so when these new impositions took farm land away or required extra labour at scarce seasons. Resentment was higher still in the case of attempts at range conservation through grazing control or - some administrations suggested - destocking. Serious political instability resulted from attempts to introduce the latter, as it did locally from some terracing programmes (as in Tanzania and Lesotho). During the 1950s nationalist politicians capitalized on popular anger about soil conservation policy in their campaigns for independence throughout British east and southern Africa. While in the 1930s the colonial media were filled with urgent concern for the conservation of Africa's soil, the years prior to independence a quarter of a century later resounded with popular condemnation of such conservation ideals as the British had imposed them. For years after independence, soil conservation was therefore viewed with circumspection by many African politicians.

In the sub-Saharan territories under French colonial rule, there was substantial research on erosion and run-off, but little soil conservation (Guillaume, 1951). As for Belgian administered areas, soil and water conservation had high priority in Ruanda-Urundi, where 745 000 ha. had been treated by 1960, largely on a compulsory basis (Musema-Uwimana, 1983, 89). As in the British colonies, there was much emphasis on rules and regulations. In the Portuguese territories, soil and water conservation was applied mainly as part of settlement programmes; very little was done in areas of indigenous cultivation (Coelho, 1987).

Annex C. Soil and water conservation since independence: selected country summaries

While there was much political transition in Africa in the 1960s, the decade appears to have ended with much the same soil conservation thinking being implemented by independent governments - where resources permitted - as had been practised at the end of the colonial era. The essence of this thinking was that soil conservation required the control or diversion of run-off on arable lands, so as to minimize the erosion damage such running water could cause. Appreciation of how landscapes are moulded by flowing water led, as indicated above, to a land use planning approach where the hydrology of a whole catchment was examined and conservation measures were designed on that same broad basis. Being designed to control running water, such measures mainly comprised mechanical measures such as bunds or terraces of various types, diversion ditches, grassed waterways, dams and gully stabilization structures such as rock walls and gabions. In mixed farming areas, land use planning continued commonly ineffective attempts to design controlled rotational grazing and in some instances to plant fodder. Tree planting remained, as always, a major component of soil conservation. In some instances it was the direct responsibility of conservation agencies and/or a component of conservation/land use planning programmes. In other countries, conservation itself has been placed under departments of forestry.

In the years after independence, physical considerations thus predominated in the design of African soil and water conservation. The approach was to take a catchment at a time, and appraise its resources, hydrology and land use. This typically required an extensive process of remote and ground survey. An appropriate conservation package would then be designed. A logical extension of this was to make integrated recommendations for the development of the local farming system on the basis of the newly appraised and conserved resources. This area-based approach fitted well with the concept of the project as vehicle for the design and delivery of development aid. The project, now the universal unit of development currency, is in essence a finite input of additional resources able (it is assumed) to achieve specified results in a limited period -not often more than five years. The 'once off' approach to conservation just described and the concept of development delivery by project thus complemented and reinforced each other well as African agriculture became the subject of intervention by international agencies in the decade after independence. (It is notable that, while indigenous 'professional' thinking had by definition been largely absent from colonial departments of agriculture, the thinking of local civil servants in the sector after independence was almost totally subordinated to that of international development 'experts'). Typically in the 1970s, an area-based approach to land use planning and the conservation of land and water resources in a catchment or catchments formed the foundation for the delivery of an integrated rural development package over limited project periods.

Less integrated or non-catchment orientated conservation has persisted in a few countries in recent decades - notably where terrace building or grass strip construction were already widespread and national support could be given to these activities. Such support might take the form of reinforced extension programmes or food aid work where the labour intensive construction of mechanical conservation measures was perceived as a worthy activity. But some form of catchment approach was paramount: anything less integrated or broadly based is still often criticized as a suboptimal use of resources and possibly damaging rather than conservative, since flows of water controlled through a 'conserved' part of a catchment may be uncontrolled in other parts.

Selected country experience

Eastern and Southern Africa

Malawi

The experience of Malawi since independence typifies the processes outlined above. Emphasis on catchment based land use planning and physical conservation structures led to the conservation component of the Lilongwe Land Development Programme, which between 1968 and 1977 covered about 280,000 ha. with such measures. The programme constructed some 2,573 km of crest roads as part of the catchment plans, together with 7,725 km of drainage ditches and 933 km of artificial waterways, with heavy reliance on earth moving machinery leading to a total cost of K5.5m (Douglas, 1984, 21). Farmers watched this come and go, and have shown very little interest since in the maintenance of these structures, in whose building they were not properly involved. Many diversion ditches are now apparently silted up, and poor design combined with low maintenance has led to severe gullying in some of the waterways that were built to carry runoff safely away. More recent research and extension in Malawi have led to a less grandiose approach concentrating more on tillage practices and biological measures.

Lesotho

Lesotho has long been famous among agriculturalists for the severity of its soil erosion, and a major programme of mechanical construction work took place throughout the lowlands and foothills during the colonial period. From the late 1950s, a greater concern with land use planning became apparent, and the first integrated rural development programme based on the conservation of soil and water in a catchment took place at Tebetebeng in the late 1950s. International aid to the country's agriculture in the 1970s developed these approaches into several major area-based integrated rural development projects, each covering a river basin. Soil conservation programmes were a major component in particular of the Khomokhoana Project and the Thaba Bosiu Project. Major mechanized construction activities were combined with food aid labour by peasants and attempts to involve village level conservation committees. Since the principal area-based projects terminated in the late 1970s, the Ministry of Agriculture has continued with a catchment land use planning approach, reducing its emphasis on mechanization. This has gradually been eclipsed by a new wave of externally funded projects, such as the Swedish funded Farm Improvement with Soil Conservation (FISC) project; the Netherlands funded Soil and Water Conservation Project; and the UNESCO/German funded Integrated Programme for Arid Lands. On a larger scale, IFAD has funded the Soil and Water Conservation and Agroforestry Programme (SWaCAP) in four northern districts. This aims to integrate soil and water conservation with normal farming and extension activities, and link it directly to higher farm incomes. It therefore includes a substantial institutional element, restructuring the extension service. During the 1980s, common property resources have received increasing attention, notably through a series of USAID funded range management projects and Swedish funded land use planning activities. The World Bank is currently funding a major Land Management and Conservation project to enhance village resource management capacity and corresponding Government resources. A National Environmental Action Plan has been approved by Government. Major resources thus continue to be devoted to environmental protection in Lesotho, and there have been some impressive physical achievements since independence. But Lesotho soil conservation is still plagued by problems of maintenance and replicability. These are exacerbated so far by the availability of high incomes off farm to the many male household heads who migrate to work in South African mines. Unless it can offer short term benefits remotely comparable to off farm opportunities, soil and water conservation can be of little direct interest to rural people. This is the goal of the FISC and SWaCAP programmes.

Swaziland

In the 1950s about 112,000 km of grass strips were laid out in Swaziland, protecting virtually the entire cultivated area. A change of emphasis was proposed in the 1960-1964 Development Plan: "....as is obvious from a number of areas, grass stripping by itself is not sufficient to halt erosion, and must be augmented by a carefully planned system of mechanically constructed discharge furrows". In reality, little construction took place. Soil conservation received a new impetus in 1970 with the start of the Rural Area Development Programme, which abandoned grass strips in favour of short-based terraces. Grass strips were considered inadequate for the protection of arable land, although this was not properly demonstrated. As a consequence, they were destroyed on those sites where terraces were built. USAID provided several loans to the Government of Swaziland for the procurement of heavy earth moving equipment for terrace construction and road building. Results of the Rural Area Development Programme between 1977 and 1983 were disappointing, due among other reasons to excessive equipment downtime. As Spaargaren (1977) remarked: "In the past few years, the standard soil conservation activities, and structures built were not maintained" (Hunting Technical Services Ltd., 1983, Annex E; Reij, 1984).

Kenya

Kenya was the scene of one of the bitterest struggles over colonial soil conservation. The long history of structure orientated conservation efforts by the British administration was intimately linked in the people's minds with discriminatory land policy and the imposition of inappropriate and/or economically restrictive regulations. It is therefore not surprising that in the decade after independence, soil conservation received low government priority. In the last 15 years, however, it has returned to prominence in official policy and in popular awareness, particularly in the more densely populated and heavily exploited areas.

This remarkable resurgence has been prompted at the official level by serious concern about the degradation of land resources under the pressure of Kenya's rapidly expanding population. Among the rural people, it has been stimulated by a combination of political, economical and social developments. The philosophy of self help has been promoted and has found expression in groups working on soil conservation structures. National action to protect the environment has been endorsed by the President since 1977 and actively sponsored since 1980, by the Permanent Presidential Commission on Soil Conservation and Afforestation. While the continuing programme of land adjudication and individualisation of tenure has meant hardship for the growing proportion of landless rural households, it has encouraged those with secure title to invest in the demanding conservation measures promoted by government.

The National Soil and Water Conservation Project, funded by SIDA, is a programme of extension, technical design, training and material support which has been the centre of Kenya's soil conservation programme since 1974. The Ministry of Agriculture's Soil Conservation Branch coordinates all activities. Many other donors have also been involved through area-based projects; the SIDA input has been on a longer term, programme basis. Much work has been done over the past 15 years to develop appropriate administrative and technical methods for the implementation of the programme. The National Soil and Water Conservation Project has recently expanded country-wide, to cover all Districts. Although efforts were made to build upon existing conservation methods (like the well known fanya juu terraces) and to ensure appropriate, simple techniques, it is recognised that some mistakes have been made in the field and that there has been too much of an emphasis on mechanical methods. Nevertheless, policy is changing, and at the beginning of the 1990s more attention is being paid to the role of cultural methods of conservation as well as grass strips and agroforestry.

The historical legacy of over emphasising material targets and achievements - kilometres of terraces built, numbers of farms "conserved" - has been continued. Much of what has been built shows signs of inadequate maintenance. But the programme has been able to realize and demonstrate short term benefits in some areas on terraced land, notably in Eastern Kenya, although the reasons for these benefits have not been adequately researched. Nor have the levels of the improved yields themselves been systematically recorded. Overall, despite the problems, Kenya has made much better progress than most African countries with soil conservation and is unique in its commitment at many levels to further work in this sector.

Tanzania

Tanzania is perhaps the classic case of colonial and post-colonial experience with soil and water conservation, at least in anglophone Africa. During the German and British administrations, local people suffered much official interference with land use patterns and systems - partly to make way for settler and metropolitan interests, and partly so that the colonial authorities could protect the environment against the supposed depredations of native exploitation. An interesting, but little known aspect of this environmental preoccupation has been the creation of National Parks and Game Reserves at the expense of areas used by farmers and/or pastoralists. People were driven out of areas which they had long cultivated and occupied (Kjekshus, 1977).

Colonial efforts to conserve the soil were largely unsuccessful. There was no attempt to adapt conservation measures to existing agricultural systems or to incorporate indigenous conservation practices, although these were sometimes recognised (Berry and Townshend, 1972, 251). As in many other countries, the authorities attempted to impose conservation by detailed regulation of African land use. This was deeply resented and became a focus of civil disturbance and political opposition. As a result, most of the colonial projects, like the Sukumaland Development Scheme and the Uluguru Land Usage Scheme, had been abandoned some years before independence in 1961.

It was not until the late 1960s that conservation began to be rehabilitated into official Tanzanian policy. As a response to environmental degradation, natural resources surveys and land use planning activities were conducted on a large scale, creating a voluminous data base, but with little actual implementation at village level. Conversely, the villagisation exercise was based on minimal survey or land use planning and had a profound impact on land use and resource degradation by concentrating the exploitation of natural resources around the new settlements. Some readjustment has now begun with the establishment of 'satellite' villages in certain areas. Villagers renewed the cultivation of former plots, living there during the planting season.

Gradually, environmental degradation became a real policy issue, promoted especially by increased deforestation and rangeland degradation.. Numerous donors finance SWC activities, in both low and high potential areas. The SIDA funded HADO project in the erosion prone Dodoma region has been a catalyst in conservation policy and implementation. The project started conventionally in 1973 by employing heavy machinery to carry out conservation works. Degradation by overgrazing continued at a higher speed than the project could counter with contour bunding. As an emergency measure the project, fully supported by the party and government, decided in 1979 to destock completely the so-called Kondoa Eroded Area, an area of 1,250 sq km (Ostberg, 1986). The rehabilitation of natural vegetation in this area, already considered irretrievable in the 1930s, has been remarkable and more cultivable land has become available to the farmers. This offsets the loss of grazing land they suffered. Since the mid 1980s, there have been calls to reopen the Kondoa area, establishing a zero grazing system for high grade dairy cattle. This presents a unique possibility for land use planning and resource management at village level, but so far progress has been extremely slow. An important institutional drawback is the fact that the HADO project resides under the Forest Division of the Ministry of National Resources and Tourism. Weak institutional linkages with other relevant ministries hinder discussions and effective decisions with respect to new forms of land use management.

From 1976 onwards, the FAO supported Rift Valley Rice Project (RVRP) demonstrated the benefits of a low cost and small scale approach to irrigation development, based on traditional rice growing practices. More recently, lessons have been learned with livestock exclusion from degraded areas within village territories. The Hifadhi Ardhi Shinyanga (HASHI) project, which started in 1986, received massive support from farmers, who excluded animals from almost 800.000 ha. until now.

The experience with RVRP, HADO and HASHI indicated the direction for following projects. Recent programmes in the Babati and Shinyanga areas follow a bottom-up approach, involving local people, stimulating a mobilization of peoples own resources. They follow a much wider range of activities than the three earlier projects. For example, the IFAD-funded Smallholder Development Project for Marginal Areas adopted this approach. It aims at the improvement of land husbandry and involves activities of agriculture, livestock, agro-forestry, on-farm research and trials, community development, land-use planning and strengthening existing extension services.

The experience with HADO indicated the direction for subsequent projects. Recent programmes in the Babati and Shinyanga areas follow a bottom-up approach, involving local people, stimulating a mobilization of people's own resources. They cover a much wider range of activities than HADO, aiming at the improvement of land husbandry, involving activities of agriculture, livestock, wildlife, forestry, fisheries, community development, land use planning and strengthening existing extension services.

Somalia

Because almost the entire country of Somalia is semi-arid, and the economy relies heavily on pastoralism, there is no nationally coordinated soil and water conservation policy. However, there are a few soil and water conservation projects in parts of the country where rainfed cropping is important. There are also some interesting traditional techniques, which are little known and poorly documented.

Somalia's highest profile soil and water conservation initiative is the "bunding" programme in the North-West Region, which was started in the 1960s. Both USAID and latterly the World Bank have been involved in this programme, which involves constructing large earth bunds by heavy machinery in rainfed sorghum fields. While there are some indications that yields have improved as result, crop husbandry in the area has not, and the bunds have not been maintained by the land users. Similar structures established under the North Rangelands Development Project to collect runoff for fodder plots failed due to poor design. OXFAM's Erigavo project made local progress in the 1980s with a variety of erosion control works, but the project found that the crux of conservation in the area was the control and modification of grazing - which proved very difficult to influence.

Traditional water harvesting structures in the Central Rangelands have been used by generations of agropastoralists - both for rainfed crop production and for fodder. Floods from *toogs* (ephemeral water courses) are diverted by means of temporary embankments, and on a smaller scale individual land owners construct a variety of systems using earth bunds to impound runoff on cultivated plots. In Bay Region, south of Mogadishu, where rainfall is more reliable, there is a tradition of making a checkerboard pattern of earth basins in the fields to hold rainfall *in situ*. These squares are locally termed *deshek*, and are normally constructed by hand, using a pull-push shovel.

Ethiopia

For a long time the fertile Ethiopian highlands were able to support the expansion of the growing peasant community, as there was an ample supply of land. Environmental degradation occurred only in the vicinity of settlements. Population growth in this century closed the option for expansion in many parts of the highlands, with serious impacts on land use. A spiral of degradation appeared, especially in the northern regions, with declining fertility and yields. The droughts of the 1970s exacerbated this trend.

This famine toppled the monarchy and the Revolutionary Government brought soil and water conservation to the foreground of national policy. Government programmes to combat degradation in priority catchments included the building of terraces, the closure of hillsides, the planting of trees and the construction of irrigation schemes, as well as the relocation of people on a local level (villagisation) and on a regional or national level (resettlement). The World Food Programme (WFP) and the European Economic Community (EEC) provided grain and edible oil, while other donors provided hand tools and technical equipment. The peasants were massively mobilised in labour intensive employment schemes, while the Ministry of Agriculture organised the work as well as supervision and training. These schemes are run as food-for-work programmes.

Up to 1987, a total of US$ 250 million had been spent on SWC activities. In the 1980s 1.5 million kilometres of stone and soil banks and hillside terraces were constructed, 80,000 ha. of hillside closed off and 300,000 ha. afforested. But these huge efforts are still dwarfed by the sheer size of the problem. Perhaps 10% of the land at risk has been treated, and even there erosion still occurs. External evaluations (1988-1989) revealed several common themes and concerns: physical achievements have been impressive and food aid has reached people in need without negative effects on local food production. However, arable land was removed for afforestation and communal resources were developed at the expense of private interests and needs. Closing areas meant a transfer of grazing to nearby hillsides, causing greater pressure on the remaining land. Clear rules for the management of communal assets (use rights of trees and woodlots) are lacking. There are reports of lack of maintenance and even destruction of soil conservation works by peasants. A major reason for the lack of peasant support for Ethiopia's conservation programme is the coercive nature of previous government policies, which have reduced people's sense of responsibility for environmental rehabilitation. Farmers are well aware of the link between environmental degradation and declining yields, but a recent survey demonstrates that they are not prepared to continue conservation works unless supported by food-for-work (Yeraswork Admassie, 1988). If SWC becomes part of urgent drought relief work, questions must be raised about farmers' readiness to undertake such measures without these incentives.

After a decade with two major famines and a prolonged civil war the farmers are exhausted, and a new national policy towards SWC is needed, which addresses people's participation and secures increased support from external sources (Stahl, 1990). Conservation activities have to be implemented within the broader context of rural development, formulating an integrated land use policy for crop production, livestock and forestry which responds better to the interests and preferences of the farmers. Recent economic analyses (Keddeman 1990) show increased economic returns to soil conservation by well managed livestock activities and cultivation of high value crops. Ownership issues have to be addressed urgently, as they remain a major factor in explaining land degradation. There is also a strong need for diversification of conservation efforts with more emphasis on biological control measures and improved farming practices instead of structural methods.

The IFAD funded 'small-scale irrigation and soil conservation programme' tries to respond to these calls for changes, with regard to participation and integrated land use. As yet little can be said about results, as field activities have only recently started. However, one component, support to women's development, i.e. vegetable gardens and credit for income generating activities, has shown a promising start in arousing interest and participation.

Rwanda

During the Belgian colonial administration, soil and water conservation activities started with the digging of intermittent contour ditches, with grass covered back slopes, as excavated earth was thrown up slope. This in fact strongly resembles the *fanya juu* terraces, well known from Kenya. A whole set of well developed, traditional practices of the farmers was entirely overlooked.

The Nyabisindu project, started in the 1970s in the Butare region, south Rwanda, has attained a certain degree of success. This is a comprehensive agro-pastoral-forestry programme based on the ecodevelopment approach. A serious attempt has been made to design, in consultation with farmers, measures that could raise production while maintaining the long term productivity of the soil. The emphasis is on low input, diversified production, geared to the needs and constraints of the small farmer.

The main erosion control method used in this project is the digging of trenches along the contour, above and below which are vegetation strips planted with grass and leguminous trees and shrubs (Leucaena, pigeon pea, Sesbania and others). On average, some 300 trees per hectare are planted, which is enough to meet the farmers' fuel needs. Fruit and fodder are also produced from these strips, while the litter helps to fertilize the soil.

Between the anti-erosion strips, intercropping and the rotation of sweet potatoes, maize, beans and soya beans are practised. Research is being carried out to develop an even greater diversity of crops, including bananas, cassava and pigeon peas. The rotation includes planted fallows, in which plants with nematicidal and bactericidal properties are used. Where fodder crops are planted, one quarter of the crop is used as green manure.

The project also has components dealing with veterinary and animal production services, as well as processing and marketing of produce. By 1980, nearly 4,000 farmers were participating in the implementation of the methods developed by the project, although only 70 had adopted the full package. The total size of the target group to which extension was directed was about 50,000 (Zeuner, 1980).

The IFAD funded Byumba Integrated Rural Development Project, started in 1984 in the north, combines soil and water management, land reclamation and afforestation to improve soil fertility and environmental protection. Crop production has increased sharply, both of traditional crops and rather recently introduced crops. Extension, adaptive research and community mobilization and organization are essential components of the programme. General living conditions have also been improved by community actions.

The Sahel

In this region, major soil and water conservation projects on arable lands have been carried out in Burkina Faso, Niger, Cape Verde and to a lesser extent in Mali. The emphasis in Senegal is especially on coastal sand dune fixation.

Mali

1986 was a pivotal year for Mali in terms of soil and water conservation. It was during that year that the first soil and water conservation seminar was held at Segou. Also in 1986, Mali's first significant soil conservation project - the "Projet Lutte Anti-Erosive" - was set up. PLAE is a unit of Mali's textile development organisation (CMDT), which promotes cotton production in the relatively humid part of southern Mali. A number of technical innovations have been adopted from an earlier research project in the same area, and progress is now being made in the "global approach" to village land use management. This project is still young and in its own words "the current erosion prevention programme ......is only a drop in the ocean for the Southern Mali zone" (Hallam & Campen, 1985; Hijkoop et al., 1990)

The majority of Mali is semi-arid or arid, and water harvesting techniques are appropriate in many areas. A seminal workshop on water harvesting, organised by the World Bank's Sub-Saharan Water Harvesting Study, was held in Segou during 1989. This brought together several projects, all started in the last few years, which have embarked on water harvesting techniques. For example, the Near East Foundation at Douenza has initiated a programme of helping villagers to construct permeable rock dams. In Djenne and Koro, CARE has begun to implement several techniques of soil and water conservation and water harvesting, including contour stone bunds. On the Dogon Plateau the "Projet Vulgarisation Agricole" has a small soil conservation section and is introducing improvements to the traditional stone bunds in that area.

There is a tradition of indigenous soil and water conservation in parts of Mali. The most noted example is on the Dogon plateau, where a range of indigenous techniques have permitted the Dogon to continue producing rainfed crops in an area with scanty rainfall and very limited resources of soil (Kassogue et al. 1990). Traditional techniques can be seen also between Djenne and Sofara, where planting pits - which collect and concentrate rainfall runoff - are widely utilised.

Burkina Faso

Between 1962 and 1965, the European Development Fund financed GERES project treated about 120,000 ha. with graded bunds on the Mossi Plateau of what was then Upper Volta. Graders were used to treat entire (sub)catchments from the top downwards. From a technical point of view this project was adequately designed and implemented. Its fatal shortcoming was that it did not associate the population with its activities. Crops were planted on the bunds and villagers did not change the old network of footpaths. Land users refused to maintain the bunds, which led to their rapid dilapidation. In many places their remnants can still be observed. Already before the end of the project it became clear that it was a costly failure (Marchal, 1979).

It was not until 1972 that another donor decided to finance soil and water conservation activities. The World Bank financed Rural Development Fund (FDR) built contour bunds on about 1,000 ha. between 1973 and 1975. During subsequent phases of FDR implementation accelerated considerably, and around 1985 well over 10,000 ha. per year were treated not with contour bunds, but with graded bunds. The decision to change from contour bunds to graded bunds was taken at the end of the 1970s. The objective was to reduce the damage to the contour bunds caused by runoff from untreated lands. Although this has apparently reduced damage, land users are unhappy to see runoff diverted, in particular in years of poor rainfall (Reij, 1983).

Lack of maintenance as well as deliberate breaching of earthen bunds has been a permanent problem. Most earthen bunds are considerably degraded after two or three years. The Rural Development Fund (since 1985 Fonds de l'Eau et de l'Equipement Rural - FEER) therefore systematically encourages land users to plant elephant grass (*Andropogon gayanus*) to stabilize the bunds. To date, only a relatively small percentage of the structures have been protected in this way.

In terms of soil and water conservation the period 1980 - 1982 was of crucial importance. Two important technical breakthroughs occurred in this period. In the Yatenga region, the OXFAM-funded Agro-Forestry Project introduced contour stone bunds and in the Kongoussi region a French volunteer designed the first level permeable rock dam. Land users systematically combined contour stone bunds with traditional planting pits and used these techniques to rehabilitate degraded land (*zipelle*). Each year thousands of hectares are rehabilitated in this way. Permeable rock dams are used for gully rehabilitation. Hundreds of such level rock dams have now been built.

Experimentation is one of the most striking features of soil and water conservation on the Central Plateau of Burkina Faso. Every project makes its own efforts to adapt techniques. Various types of rock dams are now promoted by the French volunteers, the GTZ funded PATECORE project and by the Dutch funded PEDI project. French researchers have been testing and measuring various techniques, mainly in the Yatenga region (Dugue, 1986; Roose and Rodriguez, 1990; Serpantie and Lamachère, 1989). The IFAD-funded CES/AGF project is experimenting with contour earth bunds equipped with spillways and is measuring the impact on yields of spacing and dimensions of contour stone bunds.

Niger

In Niger, official soil and water conservation efforts began in 1963, but on a much smaller scale than in Burkina Faso. Almost all activities were concentrated in the Tahoua Department. In its Maggia valley a few hundred hectares were treated each year with contour earth bunds, the back and top of which were covered with stones for protection at moments of excessive runoff. These bunds were built by villagers on payment of a small amount of money for each metre constructed. Recent policy is in general to pay with food aid rather than cash. An EDF-funded project for the Badeguichiri valley (1972 - 81) treated about 4,300 ha. with contour bunds. Both sides of this valley have been almost entirely covered with a dense network of bunds. Most structures have not been adequately maintained by the villagers. One of the striking features of the Badeguicheri Valley in 1991, a decade after the end of the project, is the positive impact of the remaining bunds on tree growth.

In 1984 an integrated rural development project was initiated for the Keita Valley. This project is funded by Italy and Niger and implemented by FAO. From its start, this project has made a considerable effort to rehabilitate degraded lands. In this field as well as in forestry, the project has been imaginative and innovative. Water harvesting techniques have been used for the rehabilitation of degraded plateaus. The project is facing several problems. (a) Despite bold innovation and high investment per hectare (up to $ 1,800 for the rehabilitation of 1 hectare of degraded plateaus), crop yields were very low in 1990, a year of low rainfall. (b) The project relies on efficient mechanisation and on a systematic use of food-for-work. So far, land users have not bothered to apply the techniques to their own fields. In other words, replicability is close to zero. (c) Large scale rehabilitation of degraded lands almost inevitably creates land tenure problems. Former owners suddenly remember that they traditionally had rights to specific plots of rehabilitated land.

Since 1984 several more innovative projects have been initiated in Niger. The Ourihamiza project which basically started in 1974 in an area north of Tahoua has expanded more strongly since the mid 1980s. This project introduced *demi-lunes* for crop cultivation (millet) and tree planting. *demi-lunes* are now widely recognised as an efficient and low-cost technique that allows plant growth in regions with 200 mm - 600 mm rainfall. Although the technique is efficient and low cost, its expansion occurs in the framework of projects. In 1988 an interesting pilot project was undertaken in the Damergou region (Zinder Department). Specially designed tractor drawn implements were used to construct micro *demi-lunes* and to construct tied ridges. The former were used for direct seeding of tree species and the latter for growing crops (sorghum, etc.). The area had normal (about 300 mm) rainfall in 1988 and results were quite impressive. The costs per hectare were low (less than $ 100), because only one-pass operations were made. Mechanisation was seen as essential in order to treat significant areas of land where population density is low. A third innovative project is the IFAD funded SWC project in the Illela District of the Tahoua Department. This project concentrated in 1989 on the construction of *demi-lunes* and on deep ploughing, but from 1990 it recognized the importance of traditional planting pits (*tassa*) and it made a deliberate effort to improve its efficiency (Box 27).

Cape Verde

Since its independence in 1975 the Government of Cape Verde has put a major emphasis on soil and water conservation, but it had to start from scratch as during colonial times little had been undertaken in this sector. The physical and socio-economic context for SWC is quite different from mainland Africa. The climatic conditions are extreme: the semi-arid and arid regions of the islands face prolonged droughts, but on average every five years important rainfall events occur (200 - 300 mm in 24 hours, but 600 mm within 15 hours at Santo Antao in September 1984). Rains fall on steep, often barren, slopes (30 % - 80 %).

Population pressure on available land resources is very high and the average density per square kilometre of cultivated land in 1988 was 458 persons/km^2 on Santiago island and 385 at Santo Antao. The average size cultivated by a family in 1988 on Santiago island was only 1.16 ha., but rural inequalities are considerable. At the beginning of the 1980s 42 % of the families on this island were landless. The Government therefore created a rural employment scheme for the construction of roads and conservation works. Between 1975 and 1990 about 20 % - 30 % of the rural population was employed by so-called work fronts (*frentes*) and quantitative achievements have been impressive (Reij, 1990).

Between 1975 and 1987 more than 20.000 check dams were constructed for gully control, more than 30,000 km of earth and stone bunds were constructed and almost 40,000 hectares were planted with trees. Due to the low rainfall in many areas, tree planting can only succeed when it is closely associated with the collection and concentration of runoff (water harvesting). *Demi-lunes* (*caldeiras*) are used systematically for tree planting and many degraded lands (including steep slopes) have been reclaimed in this way, albeit at considerable cost. Most SWC activities have been carried out on non-cultivated state lands and not on farm land.

The work fronts have reduced rural unemployment and provided a minimum income to the poorest. However, fifteen years' experience with these work fronts also shows low labour productivity. The workers do not benefit from the SWC works they have constructed and their lack of maintenance is a problem. Since 1986 the tendency therefore is to reform the work fronts (*frentes reconvertidas*). The "work fronts new style" should work on cultivated lands and involve the land owners in the construction and subsequently in the maintenance of conservation works. Results so far are inconclusive (Haagsma, 1990a).

Besides the "work fronts new style", other recent changes in SWC on the Cape Verde are: (a) the introduction of pigeon pea (*Cajanus cajan*) at the end of the 1970s, which plays an increasingly important role in rural production systems; (b) diversification of trees planted (fewer *Prosopis juliflora* and more *Acacia holocericea*; introduction of *Grevillea robusta* in the subhumid zones); (c) a growing awareness of the need to involve the local land users in the management of the state lands which have been rehabilitated.

The recently approved IFAD funded Community Based Agricultural and Livestock Development Project will concentrate its efforts on upland rainfed agriculture (integration of mixed crop and livestock production systems) and sylvopastoral development of reforested rangelands. The creation of farmers' associations carrying out conservation activities on their own lands will be a key activity of this project. Credit, training, extension and research are essential supporting activities.

Glossary

Degradation processes

Land degradation

Land degradation is the loss of productive capability of the land to sustain life. "Land" includes soil and vegetation and other environmental factors. "Environmental degradation" is an alternative term. Components are:

a. soil degradation
b. impoverishment of vegetation

Soil degradation

Soil degradation is the loss of the capability of soil to produce vegetation. Components are:

a. decrease in fertility (by exploitative cropping)
b. soil erosion

Desertification

Desertification is the process of sustained land degradation in drylands, caused at least partially by man. The productive potential of the land is greatly reduced and the process is only reversed slowly and with considerable input.

Conservation processes

Land rehabilitation

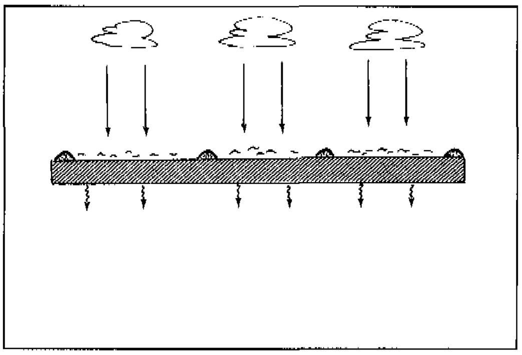
Land rehabilitation is the restoration to productivity of highly degraded land.

Soil conservation/ Soil and water conservation

Soil conservation is the conservation and maintenance of the soil's productive capability. It comprises protection from (excessive) erosion and maintenance of fertility.

Soil and water conservation emphasises the conservation of soil moisture as well as the soil body itself.***In situ* moisture conservation**

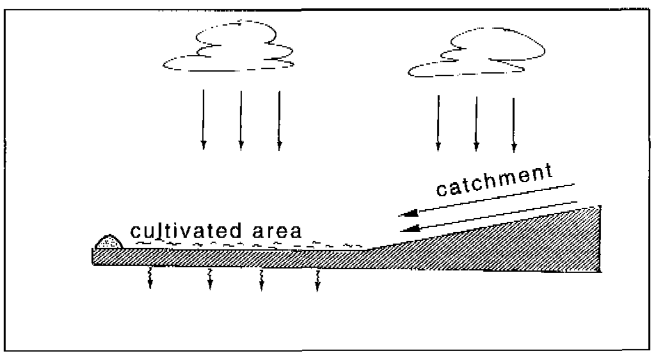
In situ moisture conservation is a form of soil and water conservation in which all rainfall is conserved where it falls and no runoff is permitted. Soil conservation is achieved simultaneously.



In situ moisture conservation

Water harvesting

Water harvesting is the collection and concentration of rainfall runoff for (in the context of this paper) plant production in dry areas. Soil is simultaneously conserved in the cropped area.



Water harvesting

Land husbandry

Land husbandry is an alternative, recent term used to describe soil and water conservation. "Land husbandry" emphasises the importance of plant productivity as the ultimate goal, and stresses cultural methods of conservation as the primary path to that goal. "Conservation farming", "land management" and "land conservation" are equivalent labels used by different authors.

Village land use management

(*Aménagement/Gestion de Terroir Villageois* in French)

The integrated management of the village territory as a whole, by the villagers themselves. Incorporates various measures for the different land categories. *Gestion Conservatoire des Eaux et de la Fertilité des Sols* ("the conservation management of water and soil fertility") is a structured form of village land use management, which includes detailed treatments for specific land categories phased over a period of several years.

Agroforestry

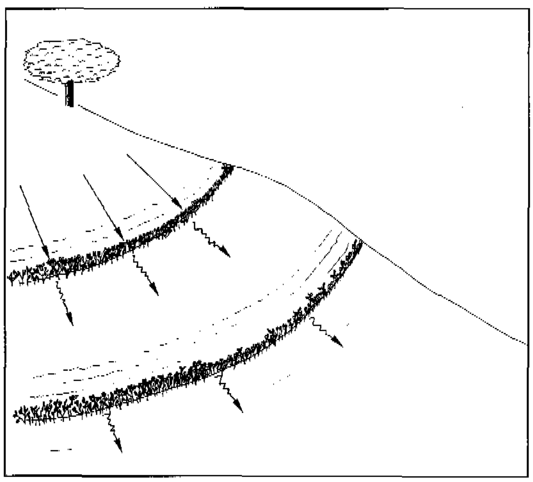
Agroforestry is the name given to land use systems in which woody perennials (trees and shrubs) are grown in association with herbaceous plants (crops, fodder, grass etc).

The use of the trees or shrubs in conservation is either **direct** (eg barrier hedges) or **supplementary** (e.g. planting trees on earth bunds).

Conservation techniques (and their components)

Barrier hedges

Barrier hedges are hedges formed from densely planted trees or shrubs, aligned along the contour (or at least across the slope) which slow runoff, collect sediment, and gradually lead to the formation of terraces.



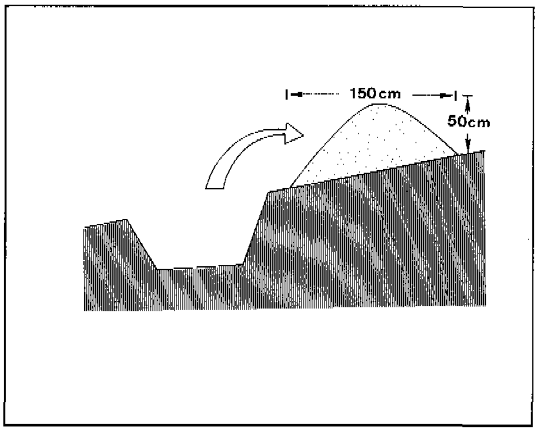
Barrier hedges

Grass strips

Grass strips are similar to barrier hedges in layout and effect, but grass species are used in place of woody perennials.

Fanya juu Terraces

Fanya juu terraces ("do up" in Kiswahili) are formed by throwing soil up slope from a trench to make bunds on the contour (or sometimes on a gradient). The inter-bund area levels off in the course of time and bench terraces eventually develop. *Fanya juu* terraces are usually protected by a cutoff drain or diversion ditch.



***Fanya juu* terraces**

Cutoff drain/Diversion ditch

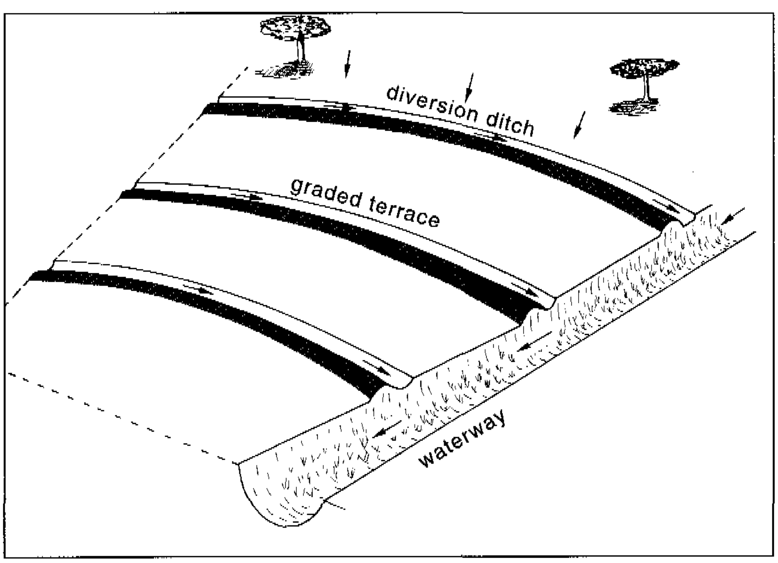
Cutoff drains or diversion ditches are trenches dug above fields (or buildings, roads, gully heads etc.) to protect them from runoff. The trench may be sited on the contour with no outlet, in which case it is termed an "infiltration trench" or aligned on a gradient and designed to discharge into a waterway.

Waterway

A waterway is an artificial or natural channel which permits disposal of excess runoff at non-erosive velocities.

Graded channel terraces

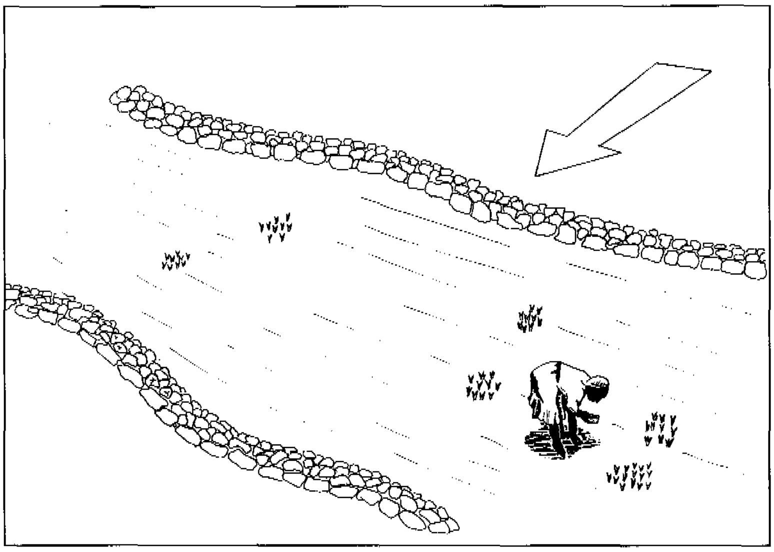
Graded channel terraces consist of a channel up slope of an earth bund. They are often formed by a motor grader or similar machine. The channels are sited on a gradient and lead excess runoff from the field into a waterway, while conserving soil.



Graded channel terraces

Contour stone bunds

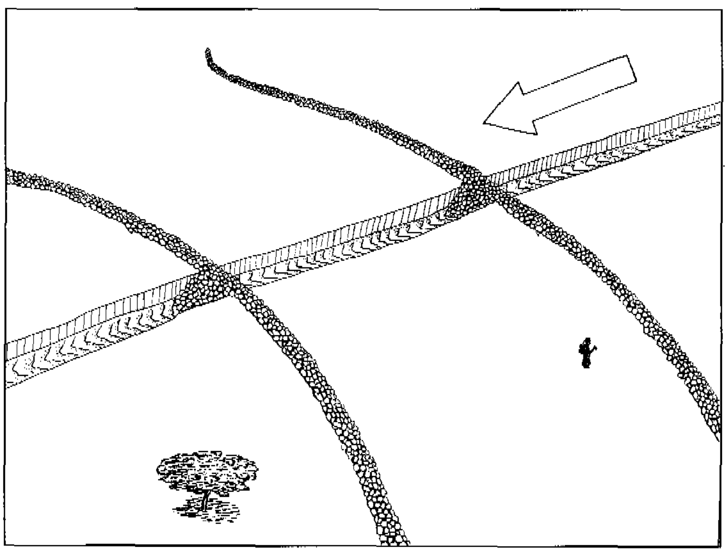
Contour stone bunds are small stone structures (usually 25-30 cm high) built along the contour and set in a shallow foundation trench. The structures are permeable, and function by slowing and filtering rainfall runoff. On low slopes in semi-arid areas these are water harvesting structures, though they may equally be used on hillsides in more humid areas.



Contour stone bunds

Permeable rock dams

Permeable rock dams are long (often over 100 metres), low (usually 50-70 cm high), level structures made from loose stone. They are constructed across valleys in semi-arid areas and spread water for crop production while healing gullies.



Permeable rock dams

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