SECTION 4:

Conservation techniques

INTRODUCTION

This section of the Training Manual brings together a brief description of some simple techniques and methods which have been applied in conservation projects and a series of case studies which show how groups of rural women have used these ideas. This section is not meant to be a textbook, field manual or guidebook. It does not have all the recipes for a successful project but it should encourage groups to ask questions, discuss ideas and seek advice from technically qualified people. Often the extension service will have information which is useful or national NGO groups could offer specialist advice.

The techniques described here are well tried and tested and have been successful in some areas of Africa. However, there are often local well adapted methods which are similar and work well. Not every idea will work every time, in every new location. Therefore this section of the manual is complementary to sections I, II and III which illustrate how to use the advantages of women's groups to tackle environmental problems and how success has already been achieved in many cases. This final section is a sourcebook which sketches in some of the methods used. Trainees will note there are several blank pages for your own ideas, and the listing of local sources of support such as extension officers, research centres and non-governmental organisations working in the field.

It would be an impossible task to include all the possible conservation practises in only a brief section of one text. Therefore the techniques included are selective and have been linked to the case studies. The idea is to give a flavour of what can be done, rather than describe every technique in detail. This section will therefore not enable you to construct a 'caag' but it will tell you what it is.

SOIL EROSION AND CONSERVATION

Soil erosion is fast becoming one of the most worrying agricultural problems in Africa today. Millions of tonnes of soil are lost through this process each year. Though erosion is a natural process that is as old as the earth itself, recent trends of land use are causing increasing concern throughout the continent. The main causes of soil erosion stem from people's efforts to settle, feed themselves and their animals, and to make an income from the land. These efforts include the clearing of forests and of land, incorrect or excessive cultivation, overstocking and over-grazing of livestock, poorly designed roads and urbanisation.

Erosion results in loss of the top soil, which largely determines the natural fertility of the land. That loss reduces productivity of the land, on a continent where the backbone of most economies is agriculture. With an annual population growth rate of 3 percent - the highest in the world - pressure is mounting on agricultural resources. Consequently, many people have been forced on to marginal lands which have fragile ecosystems that are easily degraded if not handled with extra care. Other people have moved onto steep slopes, which are more prone to erosion than flat land.

Over-stocking and over-grazing have also caused untold damage in Africa in the past few decades. In arid areas, soil is compacted around water holes, vegetation cover is destroyed and erosion results. Rotational grazing or de-stocking can counter the effects of over-grazing and over-stocking, but community agreement is essential.

Soil is among the world's most precious natural resources, yet it is not always valued as it should be. Problems of soil erosion increase when land users do not, for various reasons, take into serious consideration the need for long-term management and protection of top-soil. This may be due to lack of awareness of the problems or solutions among farmers and other community members. Such a situation determines the extent of degradation which has already taken place, as well as the likely trends in future.

Erosion starts off a chain reaction of events of which the first sign is a decline in crop yields. Then, as soil is lost and gullies form, the use to which land is put must be changed. Crop-land becomes pasture, pasture turns to scrub. Eventually, nothing useful can be grown on that land. Consequently, the people struggling to eke a living are confronted with a situation where food becomes scarcer and expensive. Malnutrition becomes common among their families. The repercussions of food shortages and higher prices, are felt by urban dwellers who may not appreciate that they are suffering directly from the effects of erosion. To tackle such a situation, community members need to be reminded that efficient soil conservation could enable the land to support populations more than 50 per cent larger than if erosion were allowed to continue unchecked.

Preventing soil erosion is a great deal easier than curing it. Soil washed down fields and carried to the valleys below can never be returned. But once erosion has been controlled, it is usually possible to restore fertility to the land, increasing its productivity.

Where traditional soil and water conservation techniques are used, the most logical step is to use them as the starting point. These techniques are not widely known because they are not well documented. Conservation experts have therefore tended to ignore them.

Where soil and water conservation projects have to start from scratch, the local population should be involved, as closely as possible, in the planning and design. All too often such projects are characterised by a 'top-down approach', with outsiders imposing what they consider best for the local population. A "bottom-up" or participatory approach would achieve better results.

Ideally, techniques should be simple enough for farmers to apply with little or no external support. Complex techniques, some of which may require complicated calculations, should be avoided whenever possible. The techniques introduced should be productive, leading to perceptible short-term benefits where possible to motivate the people to continue applying them in future. The maintenance requirements of soil and water conservation structures should be minimal, otherwise farmers will not maintain them due to time and labour constraints.

Experience in many places has shown that farmers give the highest priority to conservation measures in their own fields. For the participatory collective approach, some form of incentive is needed to maintain momentum without which the number of volunteers may dwindle rapidly. Conservation structures built collectively are also seldom adequately maintained. In Burkina Faso fields with rock bunds built by groups usually get a lower priority than the family fields of group members. This in most cases is reflected in lower yields.

Soil conservation methods

Strip cropping

Different types of crops can be planted in alternating parallel strips along the contours. These crops mature at varying times throughout the year and the taller crops in the strips act as windbreaks. The farmer may plant strips of fodder grass on the contours at intervals. The grass serves to hold the soil in place and prevent a gradual move of precious soil downslope.

Contour ploughing

In this method farmers plough along the contour, that is following a level line across the slope. The ridges and hollows left after ploughing are on a level, and so they catch and hold the rain. Ploughing up and down the slope leaves the ridges and hollows running up and down the slope, so rain runs downhill taking soil with it. This beneficial effect is improved if planting, cultivation, and weeding are also done along the line of the contour. This is called contour cultivation.

Contour belts or bunds

There are many kinds of cross-slope barriers, all of which are laid out on a level line along the contour so that they slow the downhill movement of soil and water.

* strip cropping

Strips of different crops are planted in bands along the contour. This slows the movement of water downslope, and also strips of crops with dense vegetation will intercept some of the soil washed down from a more open crop on a higher strip.

* stop-wash lines

Can be lines of grass, or shrubs, or stones, or sticks. Trash lines are the same but built up with crop residues, or from hand weeding, perhaps with soil added. Any combination of materials can be used - whatever is to hand.

* contour bunds, contour furrows

These need more labour but can be more effective for catching or holding the surface run-off. A ditch is dug on the contour, and the soil used to build a bank (or bund) below the ditch. A variation used in Kenya is 'fanya juu' where the bank is built on the uphill side of the ditch.

Cut-off drains

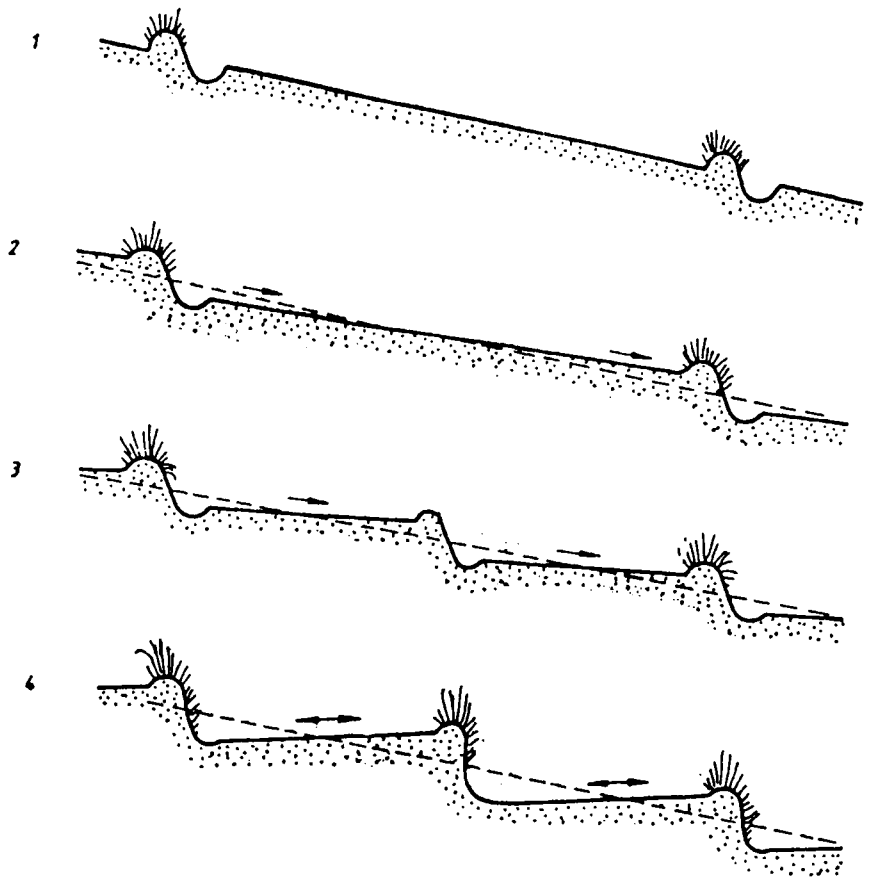
A cut-off drain is a channel dug to divert water from a field or a farm. This kind of drain prevents the field from being flooded where it may wash away the crop and soil. To be effective, the cut-off drain must have safe discharge gutters and it must be complemented by other soil and water conservation measures like grass waterways, grass strips and terracing.

Case study: Rwanda

The success of the Project Agro-Pastoral (PAP) whose low-cost agricultural technologies have helped improve the natural potential of farms in Rwanda, can be largely attributed to indigenous knowledge. The popularity of these technologies have been high because they are built upon traditional agricultural practices.

Rwanda is a small country whose population growth rate of 3.8 per cent per year and 230 habitants per square kilometre puts it among Africa's most densely populated countries. There is no spare land to bring into cultivation so Rwanda must find a way to intensify its smallholder agriculture. Farm sizes are small - 70 per cent of the farmers have less than 1 hectare from which they produce meagre amounts of maize, sorghum, sweet potatoes, cassava, beans and bananas for their families. Soil erosion coupled with poor soils result in very low crop yields.

Figure 15: The 'fanya juu' method of terracing



1. Terraces built at 2m vertical interval by throwing excavated soil up-hill to form a ridge, which is planted with fodder grasses,
2. Movement downslope by cultivation and erosion starts to build up a lower terrace.
3. Main terrace banks built up higher, and intermediate terrace added.
4. Final profile is nearly level terraces with well-vegetatedterrace risers.

Under the circumstances, the challenge is to come up with a viable agricultural system which will increase productivity, protect the environment and minimise purchase of external agricultural inputs.

Chemical fertilizers are not really the answer. Transportation costs covering 1,800 km from the nearest port, make fertilizer prices in Kigali, between two and three times the world price. The small farmer cannot afford this expensive commodity, nor can the government subsidize the price given its limited sources of foreign exchange.

Responding to that challenge, the Rwandan Ministry of Agriculture, Livestock and Forests set up PAP in Nyabisindu. Originally established as a dairy improvement programme, PAP has evolved into a development and training project focusing on livestock production, erosion control, soil fertility and agroforestry systems. It is estimated that between 10,000 and 14,000 farmers receive information generated by the project.

PAP's training emphasizes the value of mulches, animal and green manures, erosion control and raised beds, which were already known to many Rwandan smallholders. The production systems promoted are based on existing farming practices in the country, and cover annual and perennial crops, livestock and trees.

Farmers are encouraged to build compost mounds in their fields. Livestock are confined in specially built structures where animal manures and vegetable waste are composted. Livestock are fed upon grass and legumes grown on field borders and erosion-control strips, and animals are staff fed.

Integrating trees into the farm make a major contribution in meeting energy needs of families. Also, planting of trees along contours, together with grasses and shrubs, reinforces erosion control structures such as terraces.

Farmers are made aware that unsuitable agroforestry practices can reduce yields of intercropped annual crops due to competition for light and nutrients from the trees. Systems are therefore structured such that the various components complement instead of compete with one another. Competition by the trees for water and nutrients may be controlled by pruning back the roots of trees each year.

The integration of various farming practices which are low technology has brought real hope for the future to many a Rwandan farmer.

Plate 19 - Soil degradation in Kenya; the construction of a check dam Machakos. Credit: FAO.

Water conservation methods

Earth dams

Surface water can be stored through the construction of earth dams. Large dams, or dams on large streams need technical advice, but small earth dams can be built simply, by individual efforts or by a group as a community-based project. The stored water may be used for many purposes including watering livestock, for irrigating a vegetable garden or a tree nursery or a horticultural project, or for fishing.

The dam is built across a stream or waterway, and holds up water in the basin on the upstream side. Soil is scooped out from the upstream side of the dam and this increases the size of the basin which stores water. The soil is carried to the dam wall and packed down by ramming with poles. It will pack more tightly, and be stronger, if the soil has some moisture. If the soil is very dry and there is water available it may be worthwhile carrying water to sprinkle on the soil as it is placed in the dam wall because this will allow it to be packed down better. Organic material like leaves and roots should not be included in the wall as this will decay and reduce the strength of the dam.

Villages need to be alerted to the danger of earthen bunds failing. The pressure of water can break through the bunds, particularly during the first season after construction, before the bunds have consolidated. It is not correct to assume that the bigger the bund, the less likely it is to break. If not spotted in time, it only takes a small crack, or a tunnel caused by a rodent to lead to failure, because once the water has found any small passage through the bund it will enlarge itself. Grass and small shrubs will add to the strength and durability of earth bunds or earth dams, but trees should not be allowed to grow there because dead roots can allow tunnels to form.

Construction of the dam can be managed either by individual efforts or by a group as a community-based project.

Sand dams

Water can be stored below ground as well as in open ponds. If a weir is built across a stream that carries a lot of sediment during floods, the storage space will gradually be filled up. When water washes over the weir it carries with it the silt, clay, and floating debris leaving the heavier sand particles behind. A surprisingly large amount of water is stored in the space between the sand particles, and this can be extracted from shallow wells. Water stored in this way is not lost by evaporation, and is kept free from contamination. When the sand dam is full to the level of the weir, the weir can be built higher to increase the storage volume.

Weirs

Sometimes a weir may be more suitable than an earthen dam. The difference is that when the storage is full the water will flow over the top of the weir so it has to be built of something which will not wash away. Concrete or rocks set in mortar are best, or a cheaper but less permanent method is to build the weir of gunny bags filled with sand. You do need a rock bar to give a solid foundation to the weir.

Water harvesting from rock outcrops
Where there are naturally occurring outcrops of rock as found in many African countries, these can be used to provide good quality water for domestic use or livestock. A collecting channel is made by building a low wall of brick or masonry which catches the water running down the rock and leads it into some form of storage. This could be a brick tank above or below ground, or for domestic use it might be worth using a corrugated iron tank, or a large scheme might be used to fill an earth dam.

Wells
Hand-dug wells can provide water in areas where the water levels are not too far below the ground water surface, and where a layer of rock does not lie below that surface. To select the best site to sink the well, women and the older residents should be consulted since they are the most likely to be the best informed among villagers on the availability of water.

Well-digging projects, often seen as a quick way to provide communities with water, have failed in many places. A major reason is that those responsible for projects have often sunk wells without consulting the local people, and inappropriately locating the new water sources near main roads to markets, leading to overcrowding. These watering points tend to be over used by both people and livestock who trample the surrounding area. This may lead to soil erosion.

The construction of hand dug wells is often dangerous and the following guidelines may prevent accidents and prolong the life of the well.

- If the well is deeper than a woman's height, the sides should be supported by timber or a stone wall. In sandy soils, wells of any depth may need to have the sides strengthened.

- There should always be a kind of wall or raised bank around the well to stop surface water carrying in dirt and disease.

- Livestock should never be allowed to drink directly from the well. Make a lined drinking trough some distance away so the well is not contaminated.

- Also make a separate place for washing some distance away from the well.
- For wells which are used by many people make a simple frame over the well so that buckets pulled up by rope come straight up the middle without hitting the sides.

Planning water conservation
Some measures used in water harvesting may seem obvious, but they are often overlooked. One needs to take the trouble to find out what people are doing themselves, then build on the traditional technique rather than introducing techniques completely new in the area. Building on what is locally available gives greater acceptability to such an undertaking.

There is a need to determine the people's problems and priorities against their social-economic background before introducing a measure which may appear totally unrelated to their immediate needs. Unless this is done, community participation is likely to be minimal. Participation should be encouraged among the local people basing it on their perceptions of a situation.

Sophisticated systems, which the people cannot afford, replicate or maintain themselves, should be avoided at all costs since they are doomed to fail in the long run. A flexible approach should be adopted, whenever possible, rather than a rigid one. This calls for gradually evolving techniques, admitting mistakes and making room for modification as the need arises.

Making water available should be seen against the wider context. Efforts should not be wasted to avail water in vast quantities for agricultural use where, for example, soil fertility is poor and the chances of getting good crops are minimal.

Case studies: water harvesting

Caag in Somalia
The 'caag' system (pronounced 'aag') is a simple water-harvesting technique using earth bunds to contain run-off from small gullies. The bunds are commonly made by a simple two-person push-pull shovel. The main earth bund is made approximately on the contour and extended up the slope at both ends into a U-shape but with one tip shorter than the other, allowing excess run-off to flow around it. This then automatically controls the depth of flooding, which is usually not more than 25cm at its deepest. Sometimes a piece of 300mm diameter plastic pipe is set in the bund and can be unplugged to allow excess water to drain away. There may be more than one U-shape bund down the slope, and the area may have a live thorn face to keep out livestock.

Teras in Sudan
Near Kassala in Eastern Sudan - a country believed to have the richest tradition of rainwater harvesting in sub-saharan Africa - there is a unique system virtually unknown outside the area. The small-scale rainwater harvesting applied here is known as "teras", the Arabic word from which the English word "terrace" originates. Teras refers to the earth bund which forms three sides of each plot.

Each teras, of about two hectares in size, has a catchment of at least double that area. Using earth bunds, a teras forms a catchment which traps the water from several directions.

The main bund, about 40 cm in height is sited across the slope, approximately on the contour, which ensures an even spread of water behind it. Side bunds then extend up the slope. Sometimes extra bunds divide the teras into sub-units. Run-off flows into the 'open end' of the plot and the excess finds its way round the tips of the bunds, higher up the slope.

Water harvesting in Ethiopia
One water conservation project in Tigray in northern Ethiopia, illustrates that water and soil conservation activities are often inseparable. Under the project, various forms of water harvesting are employed in which the farmer takes advantage of erosion-causing run-off from the mountainous terrain which is a common feature in Ethiopia. Terraces and soil ridges are constructed at the base of a mountain on a gentle slope, below a stonelined ditch. The terraces and ditches are cut to form right angles to the slope of the mountain.

Figure 16 - The Caag System

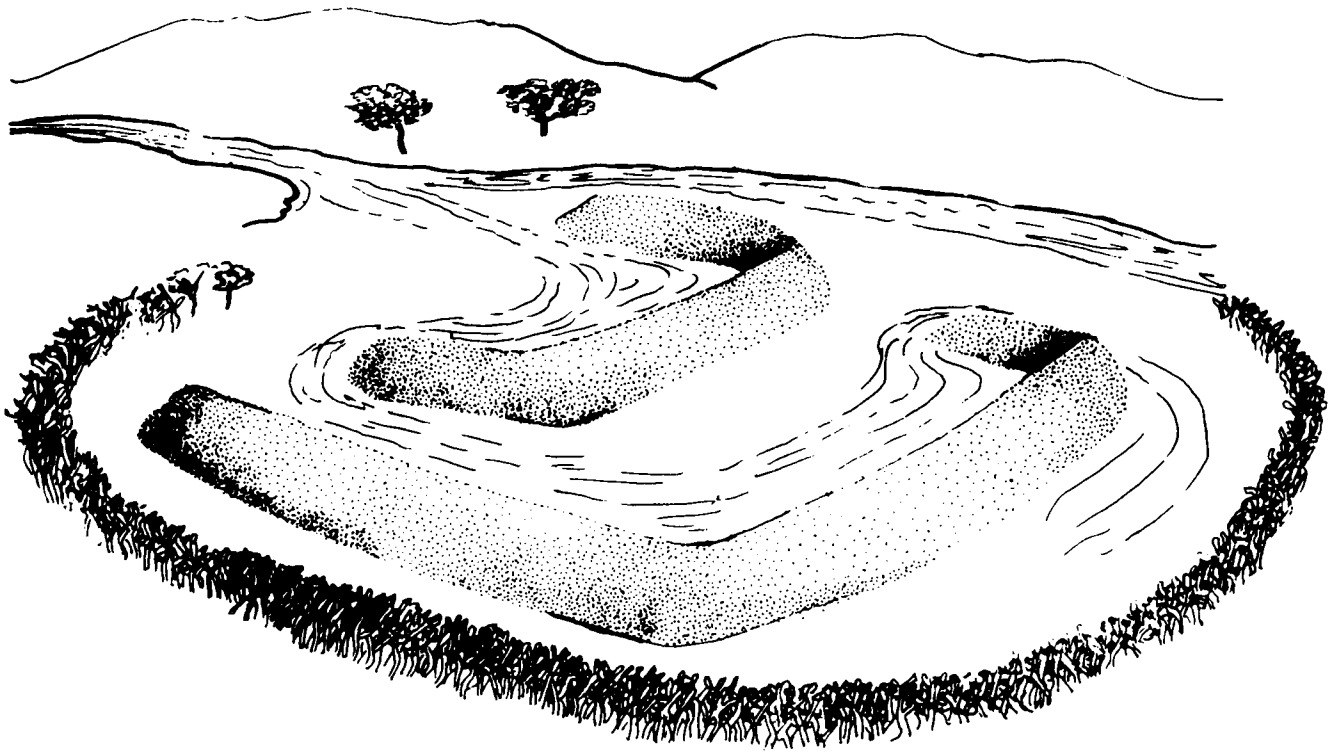
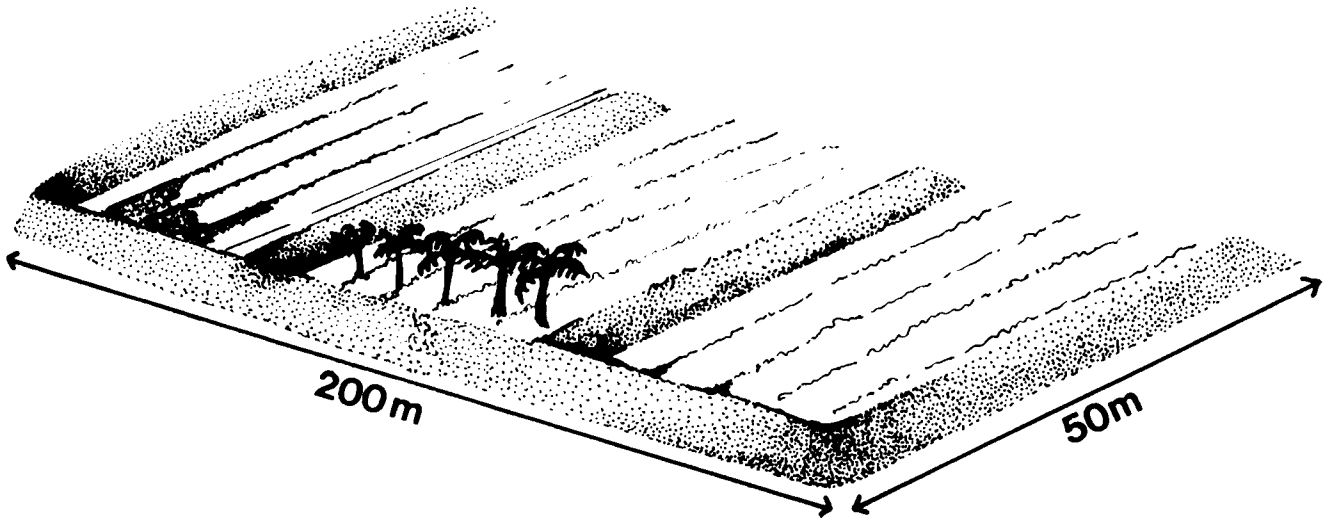


Figure 17 - The Teras System of the Sudan



During flash floods, water drains at high speed from the mountain into the ditch which protects the terraces by breaking the momentum of the flood. From there, the water flows down the feeder canal and through the weir into the terraces on both sides.

The project is labour intensive, requiring tools such as spades and matocks for use at a rate of 1,000 person days per hectare. Such organisation, which is necessary for communal work, is lacking in much of Africa. Though traditional communal organisation still exists all over Africa, it has rapidly eroded due to colonialism, new forms of land tenure, cash cropping, population pressure, warfare and rural-urban migration.

Taking advantage of flooding in Nigeria

In many areas flooding is frowned upon as being among the natural disasters, but in parts of Hausaland in Nigeria, this calamity is put to good agricultural use.

The use of "fadama" land, which are areas seasonally water-logged or flooded such as low-lying areas adjacent to streams and depressions, is an important practice for farmers. Mostly, they are in the hands of rich farmers who use them to grow high value crops such as vegetables for sale in urban areas, or perennial crops such as sugarcane.

Fadamas tend to be neglected in the wet seasons, but in years of poor rainfall they can be employed as a seasonal mechanism for planting additional crop. At the end of a poor wet season it is often possible to plant a rapidly maturing variety of maize in the fadamas, which are also used to grow rice.

Case study: the women's dam

The great agricultural potential of Burkina Faso's Yatenga plateau has been hampered, year after year, by severe water shortages. The rains, which are erratic and quickly disappear into the soil, render most farming attempts futile.

Most of the villagers, who cannot afford drills and pumps, employ traditional means of collecting surface water to meet the daily needs of their families and their animals. The methods used include hand-dug drinking holes, wells and small earthen dams.

For years, villagers of Saye talked of building earthen dams to catch rain water and retain it for the next dry season. Finally, in 1979, during one of the most severe water shortages known in that area, village women organised a meeting where they decided that should their men refuse to help them build a dam, they would do it themselves. The women succeeded in enlisting help from hundreds of people of all ages in Saye and the two neighbouring villages. The timing was perfect; everyone came as it was the dry season and there was little other work to be done. Women, youth groups and children worked to the music of the older "griots" (traditional court singers), who together with some youths had come armed with drums. The women composed songs on what they would grow around the dam in future. The old men who would not work sat under trees encouraging the workers, and looking after babies. Some grandmothers worked in the gravel pit, loading baskets and pails for the younger women to carry four kilometres to the work site. The project finally complete, the entire group celebrated together.

Similarly taking up the challenge, the nearby village of Somiaga set about building their own dam. With 1,600 in habitants, Somiaga had almost four times as many workers as Saye, so they constructed their dam in three months.

Through setting up the two dams, the villagers learnt a significant lesson: the importance of self-reliance.

Case study: water treatment at household level

Sudanese women living along the Nile use the seeds of the Moringa oliefera tree to treat muddy river water. In so doing they provide safer water and better health for rural households, using simple technology which costs little.

The women crush the seeds and mix them with a little water to form a milky solution which is then stirred into the turbid water and left to settle for at least an hour. The powdered seeds cause mud particles to cling together, forming larger, heavier particles which sink to the bottom, leaving the water above clear.

This technology is based on traditional knowledge - that of women - and available raw materials. The technology covers an aspect of water supply which is often overlooked, having been overshadowed by a host of efforts to find solutions to a sufficient water supply. Where turbid and polluted water supplies are the only available water source, the usual treatment proposed by Western-trained experts for household and communities in the Third World have been sedimentation by storage, sand filters and chlorination.

Using the seeds, the women have avoided high technology solutions which involve various technical and financial considerations to install, and once in use, create import dependency, as well as problems with operation and maintenance.

This technique can be taught to rural women with neither the money nor other technical and financial considerations to benefit from a modern drinking water supply based on advanced technology within their natural environment. The technique can be taught to leaders of women's groups who in turn convey these purification techniques to the rest. But this technique may not have an impact unless the women are assured that the tree can be grown easily and fast, yielding plenty of seeds year after year.

Moringa oliefera, a fast-growing multi-purpose tree believed to have originated in India, is grown in many other countries in tropical Africa, Asia and the Americas - although mostly for uses other than water clarification. The tree, which can be cultivated on marginal land, has various uses in other countries. It has high potential as a food source; people in Burkina Faso eat up to 80g each of the leaves daily.

Moringa oliefera leaves contain as much Vitamin A as carrots, and are richer in Vitamin C than tomatoes, carrots, peas and radishes. The protein content of the leaves is equivalent to that of

peas, beans and radishes. The leaves also have calcium and phospherous amounts that are higher than other vegetables. Cultivation of the tree in home compounds and terraces is practiced in Southern Ethiopia, where the leaves are an important vegetable during the dry seasons.

Moringa oliefera has also been identified as a valuable fodder tree for the maintenance of livestock in hilly, rainfed areas not suited to intensive cultivation all year round. Roots of this tree are used as condiments, but more important are the oil seeds, which have different traditional uses in Egypt and Southern Madagascar, and are used for cooking oil.

Therefore this species is a good example of a multi-purpose tree which serves a variety of uses. Often these species are well known and are more suited to agroforestry programmes than imported exotic species. The challenge is to identify these species and encourage nursery propagation, and mobilise community interest in planting.

ORGANIC FARMING

Principles

Environmental degradation not only leads to soil erosion but also to declining soil fertility. Soil may be physically damaged when it is repeatedly worked with heavy equipment in wet weather, or when it is compacted around water holes in grazing land. Damage may also occur when soils are deprived of their natural nutrients and their organic matter or humus content.

The nutrients required for plant growth can be replaced by the artificial, or chemical fertilizer. Such fertilizers cannot, however, replace the humus content; only crop rotation and good farming practices can. Artificial fertilizer is also expensive, requires transportation and often has to be imported. By reviving traditional sound husbandry practices, it is possible to obtain good yields, build up soil fertility and soil condition.

Organic farming is based on the mixed farming principle and makes optimal use of humus by composting organic matter produced on the farm by both plants and animal. The result is a better moisture holding capacity of the soil, less erosion and better plant and animal health. Also, the crops are better able to resist drought conditions, insects become less of a problem, better yields are sustained over longer periods, and the environmental pollution caused by non-organic or chemical fertilizer does not occur.

When little attention is paid to maintaining humus in the soil, the biological activity of the soil becomes imbalanced, resulting in an increase in pests and diseases: a decrease in water holding capacity of the soil, and an increase in soil erosion. As with the undernourished human being, poorly fed soils produce undernourished crops and animals, which easily fall prey to pests and diseases. Where land is intensively mono-cropped, it becomes increasingly difficult to maintain soil fertility. Also, diversity in production means less risk and improved diet and health. Production is based on recycling of organic waste and careful handling of manure and compost and careful soil cultivation.

Weed control is based on crop rotation and physical methods. Pest and disease control is sustained by understanding and maintaining physical, biological and ecological balances. These include traditional methods.

Therefore organic farming may be defined simply as a method growing crops without dependence on artificial fertilizers and chemical pesticides, with the aim of maintaining a healthy and balanced environment where plants can thrive.

The three major benefits of organic farming are increased yields, reduced costs and a healthy environment. Soil fertility is improved through composting, cultivation practices, crop rotation, intercropping, agroforestry and natural control of insects and diseases.

Crop rotation

When a farmer grows one crop on the piece of land continuously for many years, several things may happen. The soil fertility declines, weeds grow in number and pests and diseases affecting the crop increase more than previously. The situation can be arrested through crop rotation. The farmer who does not practice crop rotation is likely to experience heavy losses from parasitic fungi, nematodes and pests, all of which increase where similar crops are planted repeatedly. Plant diseases caused by fungi and bacteria living in the soil, increase if the same crop is planted season after season.

Crop rotation also helps reduce damage of crops through those insects that attack only a limited number of plants. For instance, when maize is grown continuously in the same field, the stock-borer invades it. Wireworms attack roots and tubers when potatoes are planted in the same field season after season.

Growing a variety of crops in the field improves the nutrient supply to individual crops. Crops with a lot of leaf growth like maize, spinach, cabbage and kale, have different nutrient requirements from the root and bulb crops like cassava, sweet potatoes, onions and carrots.

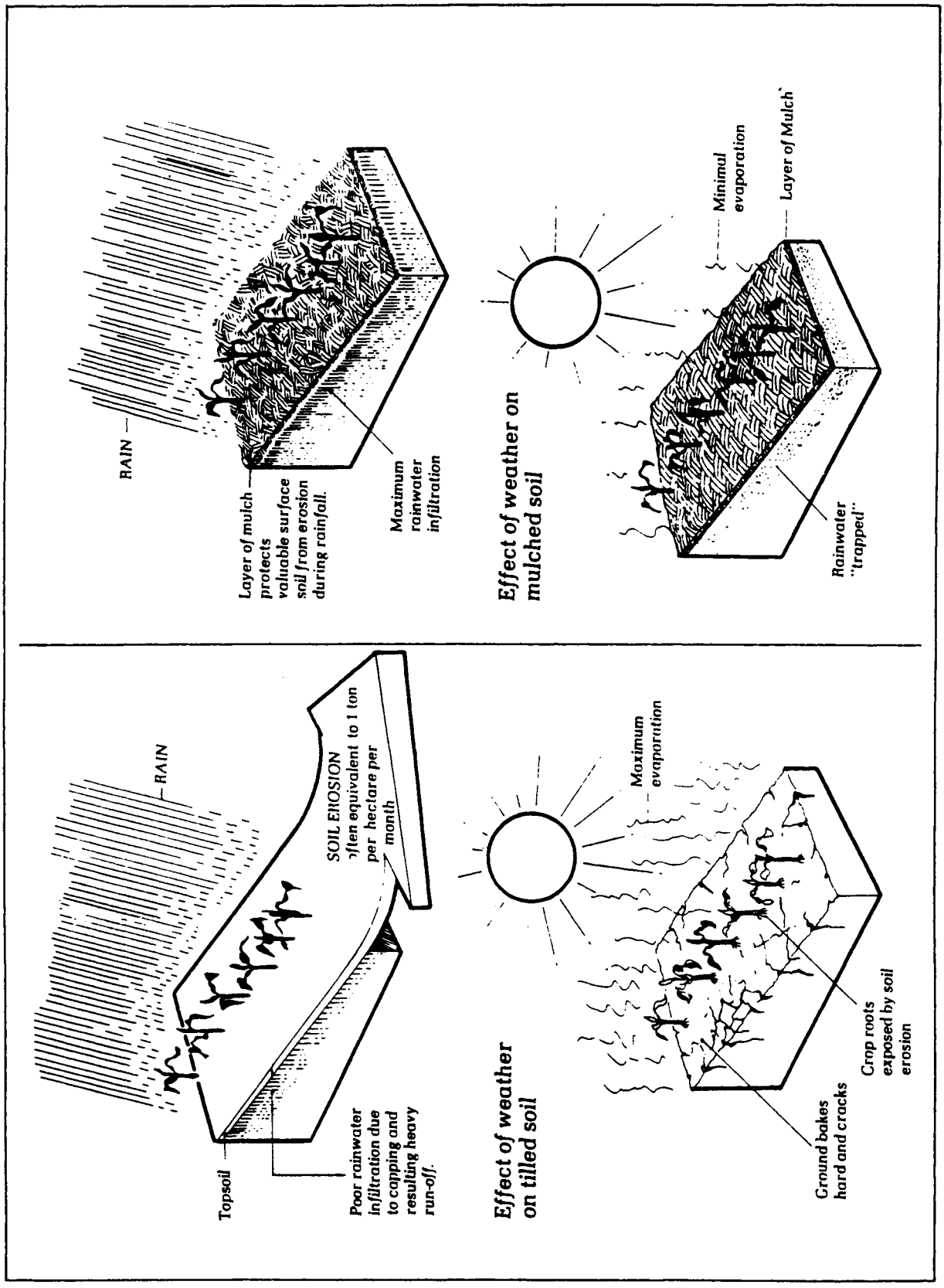
Mulch, legumes and pigeon peas

Enriching soil through composting or mulch

A farmer can use compost to obtain a good crop without having to apply expensive chemical fertilizers. Compost can be made by converting manure, leaves, crop stalks, roots, kitchen waste and other vegetation into humus, which is valuable plant food. When applied, compost provides food to the plant without first having to be broken down by micro-organisms in the soil.

The making of the compost can be hastened by mixing in top-soil, which contains micro-organisms, vegetation and old manure, under a moist and airy atmosphere. To enrich compost the ash from domestic fires can be added as it contains valuable nutrients. To hasten this process even further, the mixture should be turned every two to three weeks. Processed this way, the compost should be ready for use between six to nine weeks.

Figure 18 - Mulch for erosion prevention.



In contrast inorganic fertilizers consist of chemicals with little or no organic matter. Though chemical fertilizers supply nutrients that are readily available after application, they are expensive, often unavailable and generally do little to improve soil structure. Many farmers have difficulty calculating how much chemical fertilizers to apply, often leading to under-fertilization or over-fertilization neither of which produce the desired results.

Many tropical soils which are sandy cannot hold the chemical nutrients long enough for the plants to use them or in clay rich soils the clay particles holds or 'fixes' fertilizers which are unavailable to the plant. Often the first rains wash fertilizers out of the soil. Correct application of inorganic fertilizers is, therefore, necessary and critical.

Often, traditional crop patterns adapted by local farmers turn out to be the best use of the land as well as the best combination for providing essential proteins for human diets. Field extension workers planning to introduce new species should consider the potential of indigenous crop mixtures as a starting point for the design of soil management practices.

Legumes

Legumes, including beans, ground-nuts and peas, contain nitrogen-fixing bacteria in their root systems. Legumes are often grown in association with other crops in intercrop or crop rotation systems to provide nitrogen for other plants. For example, peas or beans are often grown with maize in a naturally beneficial system. Such multi-cropping practices reduce the need for chemical fertilizers. All food crops can benefit from being grown in rotation with leguminous plants, like beans and peas, which take nitrogen from the air and transfer it into the soil through nodules found on their roots. The legumes can be planted to help the soil recover after long periods under food crops. Nitrogen is replaced without using fertilizers for the same purpose.

In addition to their compatibility in the field, legume and maize combinations complement each other nutritionally. By eating both, human beings can receive their complete protein requirements - without adding meat and dairy products. Other plants have similar relationships, both symbiotic and nutritional.

Pigeonpea for food and shelter

Scientists in Malawi, Nigeria, India and northern Australia suggest that the perennial pigeonpea which is a legume can produce as much biomass as Leucaena leucocephala, which is the most productive tree species in the world. The pigeonpea produces food, fodder and firewood. Its leaf litter improves soil fertility.

Field trials by scientists working on genetic improvement of dry land crops for the International Crop Research Institute (ICRISAT) in India, show that the pigeonpea produces a total of 15 tonnes per hectare of dry biomass composed of two tonnes of grain per hectare; three tonnes of leaf litter per hectare; and one tonne of crop residue left on the field. The scientists in India have demonstrated the crop's usefulness by building a hut of the thin stalks and a fence with the thick stalks.

Alternatives to pesticides

Farmers usually know the plant species in their area that have insecticidal properties. There are about 1,600 plant species known to possess pest-control properties, and encouraging farmers to use indigenous plant materials, rather than chemical pesticides will reduce costs and may be safer. Such plants with insect repelling properties include tobacco, pyrethrum, onion, garlic, chillies, the castor oil plant and the neem tree.

Crop management practices

Rotation: Many traditional agricultural practices rely upon rotation as a method to control insects, weeds and plant diseases.

Intercropping: Intercropping can reduce the spread of pests and disease organisms. By growing non-susceptible crop plants with host plants in the same field, the spread of pest and disease organisms among susceptible crops can be considerably reduced.

Planting date: A change in planting time can help to prevent attack by insects and disease. Insect reproduction cycles are often attuned to the growth of plants. However, if crops are planted a few weeks before or after the normal time, farmers may be able to by-pass the stage of the insect that causes the most damage to the crop. Early maturing varieties may also escape insect attack.

Plant spacing: Modifying the spacing of crop plants by decreasing or increasing plant densities may provide a measure of pest control. For example, densely planted grain crops suffer less from insect attack, whereas narrow-row planting of cotton can discourage boll weevil infestatons.

Sacrificing host crops: If a certain type of crop is preferred by a pest, one way to control the pest is to plant that crop along with the desired crop and sacrificing the alternative crop that serves as a trap to the pest.

Resistant varieties: Some crop varieties are resistant to attack by disease or insects. Local farmers should be asked to identify such varieties and encouraged to plant them.

Mechanical control practices: Sometimes the easiest, least costly and most environmentally sound means of controlling pests on agricultural land is by using mechanical control methods, which might, for example, involve:

- burning a field prior to planting
- flooding the field
- normal tillage practices such as ploughing and harrowing
- killing insects by trapping
- trapping birds in nets
- smoking out or trapping rats

Therefore organic farming has much to offer the smallholder farmer. Most of the techniques are simple and involve no costly inputs. However they may require extra labour which can only be supplied by group effort. It would be wrong to believe that chemical fertilizers are always

dangerous or environmentally unsuitable. Soil erosion for example is at its most dangerous when land is bare. This is often a direct result of infertility which can best be overcome by adding nutrients. Chemicals do have a place but other methods work also.

CONSERVING INDIGENOUS GENETIC RESOURCES

General information

In many African countries food production and rural incomes have been based upon the introduction of new improved or hybrid cultivars in food and cash crops. As a result, traditional crops are being ignored and local crop varieties are rapidly lost.
The conservation and sustained exploitation of indigenous plant genetic resources offers tremendous potential for addressing Africa's problem of food insufficiency. Utilisation of indigenous food crops goes a long way to improve the nutritional quality and food diversification of both rural and urban dwellers. Both modern and traditional cropping systems could be combined to conserve these genetic resources, which in the long run provide insurance against the failure of one dominant crop. This can be done through communities that utilise these resources on a daily basis for their livelihood.

The strength and resistence in indigenous crop cultures should not be underestimated. Though they may not be as productive as the exotic or hybrids in the short run, the long term gains are invaluable. The dependence on external sources of seed or planting material is reduced and the market often offers a premium for local varieties which are considered to be better tasting. Conservation of indigenous crops starts from the seeds, thereby reducing dependance on commercial suppliers of expensive and at times, unsuitable or unreliable seed. Unlike indigenous crop seed, hybrid seed does not reproduce itself and has to be bought each season. Traditional crop seed, by contrast, is harvested on the farm, and except for times of disaster, is always available.

Traditional plants are often suitable to the local environment, making up for lower productivity by being more hardy than the newly introduced improved crop varieties and exotic plant species. Also, high yield hybrids require costly chemical inputs such as fertilisers and pesticides, which rural farmers can ill afford.

There are many problems and challenges farmers will continue to face unless they are made aware of the issues concerning genetic resource conservation and its utilisation. A major issue is that use of hybrid cultivars will continue to undermine the gene pools of indigenous plant species, yet the latter are resistant to disease, are well adapted to the local environment and have a host of many uses ranging from food to fuel, fodder and medicine. The potential of these species will be lost forever unless tapped. Future research in plant breeding will need a source of these older varieties to utilise in breeding experiments.

Although there has been some progress in public awareness of that potential, there is insufficient environmental education in general and genetic resources in particular. Against this background, technical services provided by agricultural and forestry extension workers often promote the introduced species.

However, farmers alone cannot be expected to become guardians of a nation's genetic resources. The attraction of increased yields from new hybrid varieties is very clear to the farmer who is usually aware of the varieties available and the advantages and disadvantages of each. There is a clear need for the National Agricultural Services to be aware of older varieties and preserve a collection. Farmers will usually assist by growing plots of the less popular varieties if encouraged to do so and the need for this genetic preservation is explained. However, no farmer will sacrifice short-term yield increases for the rather hazy notion of genetic preservation.

Indigenous crops

A quarter of Africa's population - more than 100 million people - constantly grapple with food insecurity, a situation which exposes them to serious health risks and famine. Food self-sufficiency can only be achieved if households can produce it, and where they do not farm, are able to buy enough food for an active and healthy life.

Why are people starving in Africa, a continent that used to be able to feed itself? Among many other reasons, one is that hunger and famine are caused by underuse or misuse of existing food resources. The world contains at least 20,000 edible plant species. However, throughout history mankind has used only a fraction of these for food, and over the centuries the tendency has been to concentrate on fewer and fewer species. Today, most of the world's food comes from a mere 20 crop species.

Growing the almost forgotten indigenous crops would broaden the base of Africa's food supply. Africa, known as the world's "hungriest continent" because of the severity of the food shortage, would benefit greatly by utilising available foods.

In Africa the selection of crops is notably narrow, with many of Africa's major foods - like maize, ground-nuts, sweet potatoes, Irish potatoes and yams - having originated elsewhere. Africa's indigenous knowledge base for food production, especially traditional food crops, is gradually being lost. Traditional food crops are abandoned because they are looked down upon as being inferior to exotic crops or because the farmer has no scientific backing and local varieties are ignored by agricultural researchers. Some food crops are simply viewed as weeds by researchers and thought to be nutritionally inferior by farmers. Because of low demand and subsequent poor prices, commercial farms are not interested in many of these crops.

Though increasingly ignored, these traditional food crops have an advantage over exotic ones in that they are environmentally sound and culturally accepted. Historically, the use of indigenous knowledge in food production has been the basis of a sustainable, agricultural livelihood in Africa. The erosion of that knowledge began during the colonising of the continent in the seventeenth century. Through international trade, new agricultural practices were enforced on indigenous communities who had to meet the demand of the industrialised by growing export crops as well as crops for local consumption of a growing European community based in Africa. Thriving indigenous food systems gradually declined as a result.

Today, also due to international trade, agricultural crops are African countries' main foreign exchange earners. There is a tendency for women to grow less food for family use and men to grow cash crops. Therefore tea and coffee replaced staple foods like sorghum and millet on the

best land. Women spend more time helping men care for the cash crops, leaving the women with less time to cultivate their own plots where they grow food.

The overall result is that less food is grown or is grown on marginal land. Less food grown means less food at the family level, and at the level of the nation it means famine. Rising food prices mean poor families go without food or buy cheaper food which may not be nutritious. The implications for a community which is not able to grow enough food have to be considered where cash cropping is the major agricultural occupation. Women may take initiatives to balance this situation by forming groups to devise ways to improve food supply by setting up kitchen gardens - vegetable plots near their homes. Fruit trees could also be grown in the home compound and farmland.

It can never be over-emphasised that women are central to Africa's food security since most African farmers are women, and increasing their productivity will determine both agricultural performance and rural incomes.

Drought resistant crops

Ye-eb

The "ye-eb" is a small leguminous bush native to the border region between Somalia and Ethiopia. This plant, which produces a nutritious and tasty nut, survives in the Ogaden Desert where rainfall is sometimes as low as 150 millimetres per year. The seeds taste like cashews, hazelnuts or macadamia nuts. With their high level of protein and oil they make highly nutritious and balanced food.

The plant is so hardy that during drought it's seed is sometimes the only food that nomads can find. It is therefore a very important famine food which is largely ignored until drought and famine strike. During the 1984 and 1985 drought years in Sudan many people existed in the western provinces by searching out such foods, to bridge the hunder gap until the rains arrived or aid agencies provided grain.

In the arid hinterland of Somalia, where the ye-eb once grew profusely, the plant is now so reduced by regional droughts, war and refugee concentrations, that it is threatened by extinction. Experimental trees have been planted in other parts of Somalia, in Kenya, Botswana and Israel. Experiment and research may save the plant that may become one of the most valuable of all arid land resources in future.

Tef

The cereal grain tef, which has great tolerance to drought conditions and is the main staple of Ethiopians, is little known outside the country. Tef's potential as human food has been overlooked, though it contains a lot of iron and other nutrients; in a few places it has been successful as fodder. The cereal, an Ethiopian native, is also grown extensively in South Africa where it is cut to make high quality hay.

Tef is a grass, has high potential as a crop for countries with low rainfall or soil problems. Scientists are now only beginning to recognise the nutritional excellence of tef, which is consequently gaining recognition as a potential world crop. A similar crop called 'acha' is also

used in the Jos Plateaux of Nigeria where the harvesting of a local grass provides a welcome addition to the diet.

The Marama bean
This bean is an African desert legume which grows as a wild vine in the Kalahari region of Southern Africa. This savanna plant grows prostrate, sending out long, spindly stems along the soil surface in different directions. Below the ground it produces a tuber often larger than a sugar beet, while above the ground it produces nutritious, tasty seeds.

The vine, found mainly in the savanna is a staple of Africans living in the Kalahari Desert. The seeds are a rich source of protein and energy that nourish people in areas where few conventional crops can survive. After roasting, they have nutty flavour comparable to that of cashew nuts.

The seeds have a protein content almost as high as soya beans, and an oil content twice as high. This puts the marama bean in the same category as the world's premier protein crop. The bean has the advantage of being able to store well and remain edible for years.

The Winged bean
A crop native to South-East Asia, the winged bean has great potential for feeding many in the Third World. The bean is beginning to make its way into Africa.

The popular name for the winged bean is "supermarket on the stalk", since one can eat almost every part of it. The leaf, rich in vitamin A, tastes like spinach; the shoot, like asparagus; the flower, like mushroom. The seed virtually duplicates soyabeans in nutritional value while the tuber contains two to four times the protein of a potato.

The bean has other advantages. It is relatively easy to grow, fast-growing and drought resistant. This crop has nitrogen-fixing capacitities which enable it to make its own fertilizer. It demands little space; one hectare of winged beans produces nourishment equal to five or six hectares of most other crops.

Currently there are known 2,000 varieties of the winged bean, which is a potential money maker. However, the bean will not grow in areas with temperate climate. Although it is mostly pest resistant, it is recommended that farmers grow more than one variety as different species are affected by different pests.

Sorghum
Sorghum, an increasingly undervalued crop, produces a grain of similar food value to maize yet provides a more consistent yield in areas of marginal rainfall.

Sorghum's ability to resist drought is due to a number of factors. Sorghum leaves can recover and function efficiently after wilting. If the main shoot is damaged through prolonged drought, new shoots can grow away from the base when moisture becomes available. The plant's root system occupies the soil more extensively than maize roots, and trials have shown that sorghum will outyield maize not only where moisture is deficient but also where excessively wet conditions exist.

However, there are a number of problems affecting sorghum production. The main problem with sorghum is that there is a universal preference for maize, and throughout Africa farmers try to grow maize where sorghum would be ecologically more suitable. The only solution to this problem can come from breeding, or selecting, improved varieties of sorghum.

AGROFORESTRY AND COMMUNITY FORESTRY

General information

Agroforestry is a relatively new word used to describe all land-use systems and practices in which woody perennials are deliberately grown on the same land as crops and animals. The practices may involve trees with crops, trees with pastures, trees with animals, and trees planted in special places in the landscape. The different components interact biologically and economically. For example, nitrogen-fixing trees may improve crop yields. In fact African farmers have always mixed trees with farming but the new science of agroforestry improves methods and species.

If agroforestry is to serve people's needs in a variety of rural settings, it is important to see it as an 'approach' rather than as a fixed arrangement of plants, or a particular combination of animal and plant species. Balanced land-use should provide useful products that conserve and restore natural resources, and build self-reliance rather than create dependence on expensive imported materials.

Agroforestry practices serve many purposes and supply many products to a wide variety of land users. Trees may provide food, shelter, energy, medicine, cash income and raw materials for handicrafts. Trees may serve as savings or investments and improve the quality of natural resources - including soil, water, vegetation and wildlife.

Indigenous knowledge

In order to be effective, any land-use system should be based on the traditions, knowledge, skills and ongoing experimentation of the rural communities. Currently, many of the succesful traditional systems are being forgotten due mainly to modernisation and increasing demands of growing populations on natural resources.

The challenge is to maintain those agroforestry systems which are now under threat, and to improve and adapt long-standing practices to the changing circumstances. It cannot be stressed often enough that various systems of this kind have in fact sustained people for generations in a variety of African environments. Only recently have efforts been made to systematically record the medicinal uses of trees.

Agroforestry in Africa

Listed below are some of the common locations where agroforestry is practiced in Africa:-

Croplands
Trees, usually permanent and full sized, are often dispersed in croplands either singly or in clumps. Some farmers plant trees to obtain valuable products; to increase production of the surrounding crops; or to improve the soil and water conditions for crop growth. The 'parkland savanna' landscape around Kano, Northern Nigeria is an example where farmers have left valuable trees in fields.

In contrast to dispersed trees in cropland is the arrangement where closely spaced trees are intercropped with annual plants. While this practice is more common in humid areas, it may also occur in the drier zones of Africa in both rainfed and irrigated croplands.

Contour vegetation strips with multipurpose trees and tree crops are usually introduced to prevent soil erosion on sloping croplands, while at the same time providing useful products such as food, fodder or wood. Multipurpose trees, grasses and other herbaceous plants are often combined along the edges and cultivated spaces of soil and water conservation structures, ranging from contour bunds and ditches to bench terraces on cropland. These plant combinations can produce useful items for home use or sale while helping to stabilize and protect conservation structures from direct exposure to rain.

Alley cropping
Alley cropping often consists of dense hedges of multipurpose trees planted in rows between wider strips of annual crops. Branches of the hedges are cut to produce mulch, which is applied to the cropped areas to fertilise and cover the soil. Alley cropping has now become an exact science in many areas with careful choice of species and great attention to detail such as the width of rows.

Fallow cropland
Fallows are croplands left without crops for periods ranging from one season to several years. The objective is to control insect pests, diseases and weeds associated with previous cropping, and to recover depleted soil nutrients. By planting or encouraging the correct tree species the nurient levels can be recharged quickly. Deep rooted trees which are nitrogen fixing are especially important. The case study of gum arabic (Acacia senegal) in Sudan is an illustration of this technique.

Pastures and rangelands
Farming systems combining naturally occuring trees and shrubs of particular value for animal fodder, are widespread throughout sub-Saharan Africa. In addition to high-protein fodder for livestock, the trees may provide building poles, fuelwood, fruit or cash crops. The practice of stall-feeding animals rather than allowing them to roam encourages fodder production off the farm.

Boundaries and border species
Living fences are used throughout Africa to protect people and their dwellings, crops, animals and other property. Boundary markers are different from living fences, as their main purpose is to make boundaries clear. Windbreaks are often located on boundaries between properties and may take various forms, ranging from shelter belts surrounding whole villages to individual windbreak strips for one field or a single homestead.

Stream or river banks
Gardens may be located along the flatter, more stable portions of river and stream banks or on the edges of lakes and ponds. These gardens often include trees, shrubs, and woody vines as well as vegetable crops, medicinal plants, spices and root crops. These sites have a unique production potential because of their access to water and fertile soils.

Home compounds
Agroforestry practices in home gardens range from a few trees and shrubs in a small vegetable garden to a dense plot of fruits, vegetables, herbs and cash crops trees planted for timber, fuelwood and fodder. The home garden may serve as a specialised plot within a larger production system, or it may represent the main cultivated plot and major source of food and cash income for the family with little arable land. Improved varieties of fruit trees are very important for these gardens.

Public and shared places
The use of woody plants in public places may range from a single tree of religious or cultural significance or as shelter. Trees that provide shade, fruit or fodder may be planted in sites such as market places, or close to wells, clinics, places of workshop or meeting places.

Public planting may be in woodlots, plantations or gardens, which combine trees with shrubs. Roadside planting may be used to demonstrate agroforestry species and practices; this has worked well in parts of India with trees also planted along irrigation canals. People may harvest the grasses or cultivate annual crops in these tree-lined strips of public land.

Woodlots involve more intensive management of trees and other plants in a smaller area. Permanent woodlots may be sited almost anywhere in the landscape, from cropland to pastures, and are very important in the protection of watershed areas. It is now recognised that protecting the year round flow of any river needs good vegetative cover throughout the catchment. Often this may require the reafforestation of hill slopes which have been added. The Save catchment of Zimbabwe is being treated in this way following the silting of the river, and damage to dams.

Agroforestry plays a part in this and can make wooded areas more useful by protecting and improving soil and water resources, by increasing the production of tree products or by adding new plants and animals. This may involve the selective cutting and protection of existing forest plants, or it may extend to the introduction of multipurpose trees, crops or livestock.

Where trees are planted to prevent, or reverse erosion in forest clearings, they may be combined with soil and water conservation structures, as well as plants for ground cover.

Women and agroforestry

Women who live in an area and use its resources possess valuable knowledge about the land and its uses. Often they can identify useful species and areas where one can get high quality plants and seeds. For any given species they may know the plant habitat, growth rate, methods of propagation, compatibilty with other plants and interaction with animals and insects. The women

also have a wealth of information on what pest and diseases attack specific trees, as well as the uses, management and ownership of trees. Such knowledge - even where local plant species are not used directly in agroforestry systems - can help in choosing new species and combinations which may be compatible with the chosen planting site. The women's past experience, traditional knowledge, judgement, and skills make a significant contribution.
Women's involvement through active local participation, will help ensure that new practices in agroforestry are widely adopted. Throughout Africa, women engage in agroforestry mainly through their home gardens. Although these gardens may be managed by either sex, they are most often managed by women, whose mobility is limited by custom, and responsibilities of child care, food processing and preparation.

Home gardens provide land where women can cultivate agricultural crops and they are often seen by women as an extension of the home. The gardens make it possible for women to practice farming even in a small way.

Women and fuelwood

Wood and charcoal have become the mainstay fuel for nearly half the people in the world. But wood is in short supply and the situation is rapidly worsening. The poor are worst affected, with women bearing the largest burden.

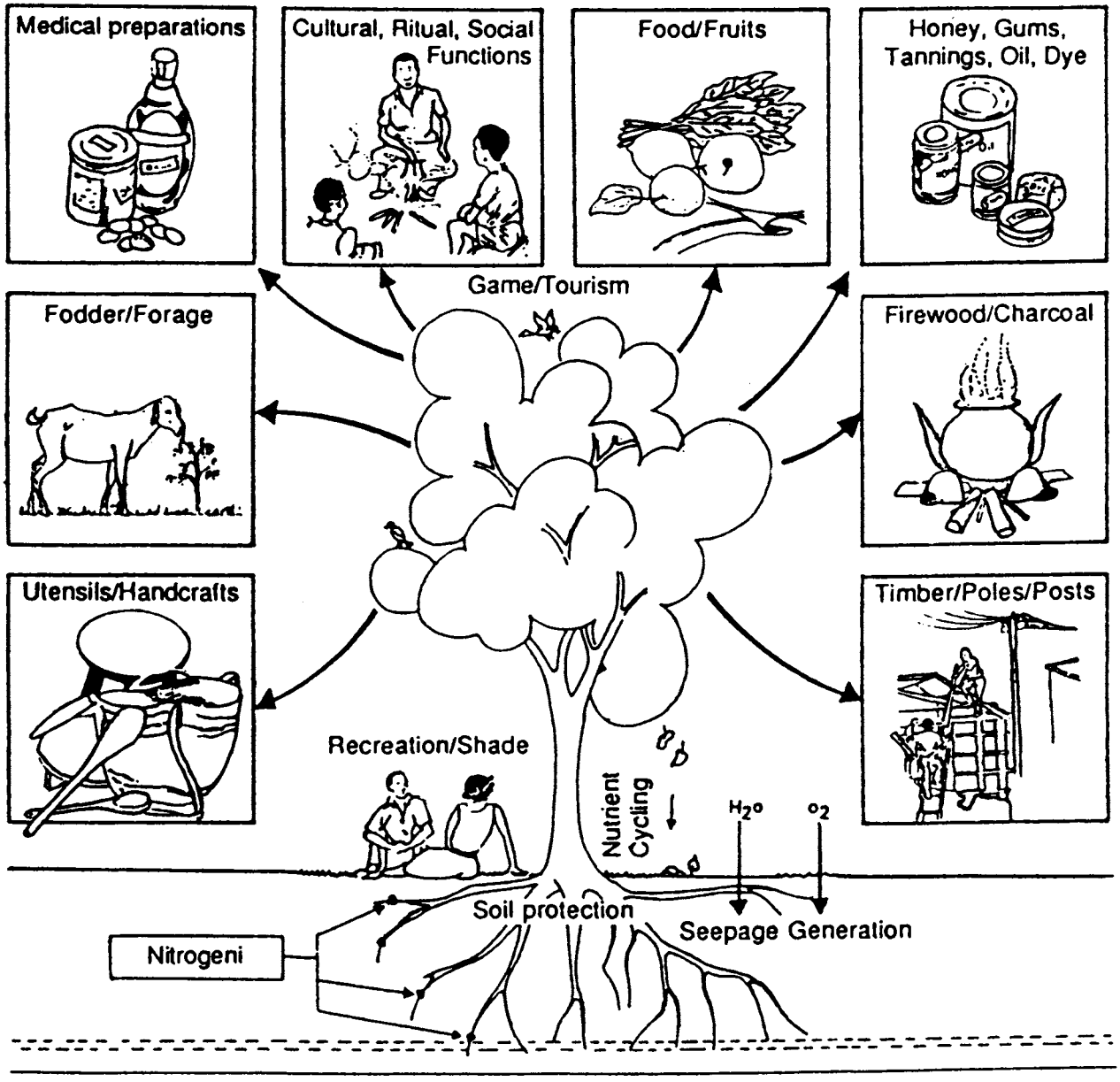
Women throughout Africa spend a substantial part of their day gathering wood, and are forced to walk further and further to fetch the dwindling supplies as the fuelwood situation worsens.
The weight causes them to suffer from back and head pains. Some women may hope to spend one whole day collecting a wood supply to last them three days. Journeys of more than 25 km are common in Niger.

The shortage of firewood supplies have affected the urban poor also, as the price hikes correspond with the increased demand for the commodity. Scarcity may force women to prepare foods that cook quickly, which may be less nutritious. In the rural areas, substitute fuel from animal dung, and agricultural residues means that these are no longer available to fertilize the soil, so crop yields drop.

The only energy most people can afford is what nature provides, and that usually means the few plants and trees around their homes. For decades to come, before African countries can afford geothermal, wind and solar energy, wood will still remain the main fuel. So trees and woodlots must be cared for today.

People are beginning to recognise the importance of the link between women and fuelwood. Reafforestation projects now consider the involvement of women who start the seedbeds and tend the young plants. As the main gathers of wood, women are well placed to be its guardians. Fuel for cooking and heating is a concern closer to women than to men, therefore it is in the interest of the women to protect forests from being cleared. Women have accumulated knowledge about indigenous trees and plants, as well as problems of introducing new species; tapping into this pool of information can save both time and money.

Figure 19 - Trees provide many products and services
Source: ICRAF



What kind of trees should be planted? Fruit, fuel, fodder? If women are expected to provide the fuel for the community, it is essential that their requirements for cooking be taken into account. A cooking stove which uses less fuel, does not emit eye-stinging smoke and noxious fumes, can also make a woman's life more pleasant. Also, if the stove can be adapted, or a communal one constructed which allows her and her neighbours to smoke fish for sale in the market for instance, then new horizons begin to open up.

Case study: fuel efficient stoves in Togo

Cooking fires account for much of the wood consumed in Africa where the majority or rural women cook their family meals over an open fire, often with the cooking pot balanced on three stones. With this method only some of the heat warms the cooking pot; the rest escapes into the air. Environmentalists believe trees can be saved if women used more fuel-efficient stoves to cook. There are many types of these stoves, but the principle is the same with all of them; if heat is concentrated in the stove instead of being allowed to escape, less fuel is needed to cook a meal.

Women in Togo now benefit from such a stove, which is nothing more than a cooking pot resting on three stones over a fire with a mud wall built tightly around it to hold heat. This simple technology was introduced in Kara region of Northern Togo by the Centre for Appropriate Technology and is being promoted by the Ministry of Public Health, Social and Women's Affairs.

The Ministry's programme to teach farmers about the stove is simple and includes training many women who are illitrate. Once the trainers have been taught, they gather their neighbours together for instruction. Since the stove takes only a few hours to make, it costs next to nothing and is constructed from local materials, at the end of the training session each woman is ready to build her own stove. So popular has the stove become that the village of Koumonde alone already has over 2000 of the new stoves.

A government study covering Kara region found that over 95 per cent of the new stove users were satisfied with the savings of wood they had achieved. The study found that the savings varied with the size of the stoves. While small ones used 20 to 30 per cent less wood than regular stoves, larger ones achieved savings of 40 to 50 per cent.

The new stove is of great benefit to the women users in Togo, where cooking accounts for 87 per cent of total wood use, and consequently, wood supplies are becoming scarcer and dearer. Some women are forced to walk up to 10 kilometres to gather enough wood. Kuomonde women are delighted with the amount of time they can save with the new stoves. Not only do they gather wood half as often as they used to, but they have time for their work both around the home and beyond it. Besides, the fire in these cooking stoves is under control, so there is no risk of anything being set on fire. Also, children do not get burnt as easily, with these stove.

While this stove is gaining popularity in rural area, Togolese women in the towns prefer a metal charcoal stove designed by researchers at the University of Benin in Lome. According to its

designers, this stove, which is under further modifications to improve its efficiency, allows a fuel savings of 30 to 40 per cent. This is a boon to low-income urban families, who sometimes spend more than a quarter of their income buying fuel.

Case study: protection of forests in India

In the early 1970s rural folk in the northern villages of Uttar Pradesh in India witnessed a remarkable, non-violent ecological movement which is now popularly known as the Chipko Movement. The movement clearly demonstrated as no other movement did before, that women have a deep commitment to preserving their environment.

The first incident in a series that launched the movement took place in March 1973 in Gopeshwar village where 300 ash trees in its vicinity were destined to be cut by a sports good manufacturer, having been authorised by forest officials.

Having decided not to allow a single tree to be cut down, the villagers - mainly women - walked in a procession in which they beat drums and sang traditional songs. They embraced the trees to prevent them being felled, forcing the agents of the sports company to retreat.

The Gopeshwar incident triggered a chain of similar protests, in which the participation of women was very evident. With their newly acquired confidence as a result, they began demanding to be members of village councils to ensure the protection of forests. The women also appointed watch women who received regular wages to supervise the extraction of forest products as well as to plant saplings.

The original purpose of the industries was to improve the quality of rural life; but now commercial interests have become paramount. At another level, there is a clash between men and women over the use of trees. Not only are women doing battle with the authorities over what trees should be planted where, but there husbands also have their own interests. All parties concerned are trying to answer the question:

What kind of trees should be planted?

"Fruit trees", shout the men in Gopeshwar, home of the Chipko movement. "No," the women resist. "The men will take the fruits and sell them by the roadside . The money will only go to buy liquor and tobacco. We want trees for fuel and fodder", the women insist.
In this case both trees are planted, but only because the Chipko movement women have grown strong enough to have their views respected.

Food from trees

In many parts of Africa, tree species providing food grew wild traditionally. A growing number of farmers on the continent are now planting such trees either for commercial purposes or for domestic consumption.

The best known human foods from-trees are fruits, leaves, nuts, seeds, oils and extracts, besides indirect foods like honey and insects. Most of these are only available for certain periods of the year. Trees that provide food for people in the lean period, and fodder for animals in the late dry or very early seasons, can be especially beneficial to farmers and their families. Fruiting periods vary and can occur at different times of the year, lasting for periods of one to six months. Growing a range of fruit trees can ensure a fruit supply for the family throughout the year.

Mangos produce at the beginning of the rains. Citrus such as orange and lime produce mostly at the end of the rains and in the early part of the dry season. Citrus fruit is usually available in large quantities for relatively short periods.

Besides fruits which are directly consumed, some trees provide food which is prepared in a number of ways. The locust bean is a perennial tree legume in Africa. The beans of this savannah species in West Africa mature in the dry season during February and March, and are fermented into a high protein and fat food, "dawa dawa" which is used as a soup ingredient. Dawa dawa stores well.

The baobab and the tamarind may be eaten fresh, but they can also be cooked. Both species are now recognised as having great potential for commercial production of drinks, jams and confectionery. Baobab is an important source of dietary calcium.

The mongongo-tree is a staple food of the Baswara - or Bushmen Kalahari, in Botswana. The mongongo begins fruiting in April at the end of the wet season, and harvesting continues until September. The fruits are prepared by steaming and peeling, and are then cooked to separate the flesh from nuts. The flesh is then eaten, and the nuts roasted and cracked.

Other tree foods are available all year round or can be stored. The oil palm provides fruit which is a valuable source of vitamin A and energy in West Africa. The plant starts to yield three to four years from transplanting and crops throughout the year, reaching a peak in the early rains. Palm wine is also a part of the diet to varying degrees.

Food availability over an extended period can be achieved through the "storage", of some fruits on trees, or picking and drying them for storage in the home. Nuts such as those of the mongongo trees can be stored. Perennial and seasonal tree foods can be relied on in famine or years with poor yields. Fruits, nuts, seeds and berries can all serve this function.

There has been very little emphasis and encouragement on growing indigenous food trees on a farm. Extension workers instead promote the cultivation of exotic species on which husbandry information is available. The workers also prefer exotics for their commercial value which have an established commercial market and provides the farmer with an income.

Nevertheless, the potential for exploitation of indigenous tree foods can be explored.

Case studies

The "miracle tree"

In many languages, Leucaena leucocephala has become known as the "miracle tree". Its products can be eaten, fed to livestock, harvested for fuelwood or charcoal, used for timber, spread as green manure on farmland, and planted to stabilise and enrich soil.

Young pods and seeds can be safely eaten in small quantities, but they contain the poison 'mimosine' which if too much is eaten causes illness and loss of hair. It does not affect ruminants. A most important attribute of the multi-purpose Leucaena is it's nitrogen-fixing capacity, which rates it as an ideal tree for agroforestry. For this reason farmers grow it on an estimated 2 million hectares, in every tropical region in the world. There are 13 species of the genus Leucaena in the extensive family of legumes.

Farmers in South-East Asia have exploited these "living nitrogen factories" for decades by interplanting Leucaenas in their maize fields. Before the maize is planted, the trees are cut and branches are spread on the ground where they shed their leaves which provide fertilizer. The trees are often cut again later to nourish the young plants. After the maize is harvested, the Leucaena is allowed to grow tall to provide wood for fuel and to suppress weed growth.

Leucaena grows quickly during rainy seasons and can survive long drought. While they grow best in areas where annual rainfall is more than 1000 millimetres, they can survive, once well established, with annual rainfall as low as 500 millimetres. Annual yields are commonly reported in the range of 45 to 70 tonnes of fresh wood per hectare if growth conditions are suitable, grouping it among the world's most productive trees. However, it should be mentioned that Leucaena does not tolerate acidic soils; does not grow fast on land that is over 1500 metres above sea level; and has an abundant seed production that has made it a weed in many places.

Gum arabic in Sudan

The Acacia senegal has a most interesting drought defence system; to avoid dehydration when the wind, animals or insects damage its trunk, it secretes a thick liquid known as gum arabic. The tree's rough thick bark protects it from the heat. Its main roots can descend one metre, and its secondary roots are long and supple and can spread out through the sand so the strong winds from the desert cannot uproot the tree.

The six metre tree, with its low thorny branches, is well adapted to the Sahelian climatic conditions. In Mauritania, northern Senegal, Niger and Mali, shepherds and nomads collect the gum when they go in search of new pastures for their flocks and herds. The gum tree is specially enjoyed by goats, cattle and above all - camels. People have long harvested gum arabic as something rare and precious. It is used for glue, sweets, pills and lozenges; it stabilizes wine and fizzy drinks; it is a fixative for paintings and ceramics; and people use it for starching their traditional costumes, for cooking, and for medicine. Both pastoralists and farmers tap the trees but there is now little export demand for the gum, and incomes from gum arabic are reduced despite having local use.

Sudan is the most important of the gum arabic producing countries, with 80% of the market. The Sudanese farmer grows millet for five years on her/his land then plants gum trees. They help to

refertilize the land as the gum tree is leguminous and fixes atmospheric nitrogen in the soil. This fallow period lasts about 15 years during which the farmer gets profit from the land by harvesting the gum, and at the same time enriches the soil. At the end of the period when the trees are no longer productive, millet can be grown again for five to six years. A further advantage of this system is that the gum can be collected during the dry season when other agricultural activity is minimal.

Doum

The livelihood of rural folk in sixteen villages in one area in Mali is increasingly tied up with the doum palm. Like the coconut palm, wherever it is grown, every part of the doum has some use for the Malian villagers living near the doum palm forest Tarabe, which is an area along a tributary of the River Niger in N'Gouma district, of Douertza Region.

The villagers around the forest, use doum palm leaves to make mats, baskets, ropes, brooms and thatching. The stems provide timber, firewood and high quality charcoal. Parts of the doum go into the manufacture of dye. The fruit is edible and so is the pith, which is also a source of medicine.

The doum tree is currently under threat due to the mounting demand for the raw materials which the trees supply. Population pressure, coupled with a drop in cereal and animal production levels, make the local populace increasingly dependant on the palm as a source of income and food. Tarabe has also absorbed many migrants - mainly women - from northern Mali where the effects of drought and over-exploitation of the doum are more severe.

Traditionally, doums were not regarded as the property of either an individual or one village, but rather as a communal resources to which everyone had unlimited access. Since the colonial era the forest has been State property. However, due to few resources being available for government forestry services, forestry management is limited to little more than granting permits to cut wood and imposing a fine for unlicensed cutting.

So far, the State system of permits and fines has not managed to curb over-use of palms, which may lead to extinction. Under these circumstances, the local community have not fought against illegal cutting since they have no power to challenge anyone holding an official permit.

The situation raises the question as to what the most appropriate management technique the locals or the State could adopt to safeguard the precious palms. To find solutions certain factors have to be taken into account. One is that the over-exploitation of the doum palm is only one aspect of wider economic crises evident in cereal deficits and loss of livestock. Attempts to conserve the doum should therefore be part of an attempt to stabilise agricultural production as a whole. In the same vein, the doum palm forests should be seen as an integral part of Mali's forestry resources in general, all of which need conserving.

Case study: conservation among pastoralists in Kenya

Turkana pastoralists in northern Kenya have a long tradition of making the best of a harsh environment. They are able to adapt quickly to changing circumstances by applying indigenous knowledge. The pastoralists of Turkana district who occupy the northern part of Kenya's rift valley, have survived on what is largely arid and semi-arid land and continue to do so through evolving - over long periods of time - land and resource management strategies in keeping with their culture and environment.

Many of the land management strategies revolve around trees, making trees vital to the Turkana way of life. Indeed, the woody vegetation constitutes one of the most valuable resources the district has. Because of the relative importance of trees and other vegetation, the Turkana living in the district often possess very detailed and extensive knowledge about trees and bushes. This knowledge reflects the life style of the pastoralists, who attach great value to trees and will rarely cut down a valuable tree. Trees are used on a sustained conservation basis. Thus important ones are not cut because of their relevance to the survival of people and livestock, while the less important trees and bushes may be cut without permission from the elders.
During the dry season small branches will be pruned and pods harvested from trees for livestock feed from specific trees like Acacia tortilis and Acacia albida. The only woody species that are actually cut are the less useful bush species which are used for fencing homesteads and livestock enclosures. With reference to woodland management it has been found that there is no evidence of deforestation or other forms of environmental abuse in South Turkana in the recent past because the people have adapted their lifestyle to the ecosystem. Consequently the vegetation survives better, for longer periods, and often continues yielding during the dry season while retaining fodder quality.

As pastoralists the Turkana have tried to manage their environment to the optimum, and getting the most out of it in terms of livestock production without destroying the rangelands in the process. They still apply a traditional method, where grazing is carried out under a co-operative grazing community known as "adakar" which represents a semi-permanent cluster of homesteads which come together in the wet season.

Though stock tend to move seasonally, goats, sheep and camels usually forage in the vicinity of the homestead. Cattle are grazed near the homestead in wet seasons. When it gets drier, stock will gradually move to the hills where they will graze during most of the dry season. This system makes optimal use of the flush of annual grass and bushes in the lowland, while giving the vegetation a chance to set seed.

Within this grazing pattern, the Turkana set aside varying amounts of land for reserve grazing. This usually takes the form of hills reserved and guarded, and may cover thousands of hectares. The reserve grazing is used, at the discretion of elders, during the dry season or drought years.

NOTES FOR TRAINERS

This section of the manual is designed primarily as a reference, to show readers the range of conservation field techniques available, and to direct interested users to sources of further information. A trainer would do best to take training participants to the field to see the techniques in place, and to hear from the local rural women how they developed these methods. There are also several exercises which trainers could use to stimulate interest in the local conservation techniques practised by women and men of the area.

Exercise 7: Traditional knowledge acknowledged

Background
In many rural areas, women and men have been using their own conservation measures for years. It is all too easy to ignore these traditions while seeking for new answers and techniques. This exercise is a means of reminding participants of the body of knowledge, beliefs and practical measures which rural people make use of in their agriculture.

Method
Ask the participants to think of some things they have seen in their fieldwork which they found intriguing or interesting - traditional agricultural practices which the farmers use, beliefs about the relationship between humankind and nature, local terms for particular natural resources, and so on. Allow the participants to think over this request and report back the next morning. Often it proves difficult to jog people's memories on these traditions, but once a few are identified, it becomes much easier. Be ready with a couple of your own examples, to start off the process if necessary. Make a list of each practice or belief identified. Below is the result of a brainstorming session by a group of soil and water conservation officers in Kenya.

Box 15: Farmers' beliefs and practices reported by participants at a Rapid Rural Appraisal workshop in Kenya as intriguing, unusual or untested.

1. Grevillea planted with coffee reduces pests on coffee;
2. Cutting the sacred fig tree leads to landslides;
3. Insert 4-5 nails into the trunk of citrus to help bear fruit;
4. Insert nails into trunk of coconut to prevent leaves from falling;
5. Mix maize flour with cement to control rats;
6. Planting Croton too near the house will lead to the roots spreading to the house, causing a series of deaths, beginning with the husband, wife and the children;

continued ..

Box 15 continued

7. Married women cannot harvest banana;

8. Insert a stick in the trunk of a papaya to change the sex from male to female;

9. A landslide was caused when an uncle snatched a farm from a son who had inherited it following the death of his father. The son left for Nairobi, and the farm thought - I cannot be farmed by anyone except for my family, so it jumped into the river;

10. If soil is placed into the top of a young coconut, then if it is attacked by Rhinocerus beetle the soil will become lodged between the head and the carapace and thus the beetle will die.

Source: Pretty, J.N. 1990. Rapid Catchment Analysis for Extension Agents: Notes on the Kericho Training Workshop for the Ministry of Agriculture, Kenya. IIED, London.

Exercise 8: Do-it-yourself case studies

Background

A brief exercise encouraging participants to place conservation measures in the context of the local cultural environment. This exercise can also add to the trainer's repertoire of local case studies, for future training activities. Ideally, this work would be done following a field trip to look at local conservation measures.

Method

Ask the participants to identify a particular conservation measure which is important in the area with which they are familiar. If there are many participants ask them to divide into groups of 3 or 4, each group to write up a brief case-study of the use of one measure. Try and get a range of measures, perhaps one from each of the main headings in this section of the manual, i.e. soil conservation, water conservation, organic farming, agroforestry and indigenous crops. Ask the participants to include details on who is responsible for the conservation measure (introduced from outside or an indigenous practice; done by women or men) and what level of labour is required for undertaking the work.

Finally, ask each group to read their case study to the other groups.

NETWORKS AND NGOs CONCERNED WITH ENVIRONMENTAL CONSERVATION AND AGRICULTURE

1. Kweng Rural Development Association (KADA)
   Private Bag 7
   Molepolole
   BOTSWANA

2. Association for the Advancement of Agricultural Sciences in Africa
   P O Box 30087
   Addis Ababa
   ETHIOPIA

3. Ethiopia Service of Documentation and Communication Development
   P O Box 5788
   Addis Ababa
   ETHIOPIA

4. Ghana Assembly of Women
   P O Box 459
   Accra
   GHANA

5. Duksfofu Habsbs
   P O Box 200
   Kpando
   Volta Region
   GHANA

6. African Network for the Development of Ecological Agriculture (ANDEA)
   P O Box 444
   Mamprobi-Accra
   GHANA

7. African NGOs Environment Network
   P O Box 53844
   Nairobi
   KENYA

8. International Council for Research in Agroforestry (ICRAF)
   P O Box 30677
   Nairobi
   KENYA

9. Green Belt Movement
P O Box 67545
Nairobi
KENYA

10. Environment Liaison Centre International
P O Box 72461
Nairobi
KENYA

11. Kenya Energy and Environment Organisation (KENFO)
P O Box 48197
Nairobi
KENYA

12. Materi Girls Centre
P O Box 194
Meru
KENYA

13. Mokhatlo oa Thero ea Malapa Lesotho
P O Box 340
Maseru
LESOTHO

14. Khau ea Khosona Mohato
P O Box MS 6
Maseru 100
LESOTHO

15. SWAPO Women's Council
P O BOx 1071
9000 Windhoek
NAMIBIA

16. Youth Environmental Programme for West Africa (YEPWA)
University of Ife
Adeyemi College of Education
P O Box 199
Ondo Campus
Ondo State
NIGERIA

17. Women's Environmental National Company of
Church Society
P O Box 3063
Lagos
NIGERIA

18. Bayande Small Farmers Association
c/o Project Co-ordinator
P O Box 24
Kambia
SIERRA LEONE

19. Sudan Environmental Conservation Society
P O Box 4274
Khartoum
SUDAN

20. Women Environment Network
P O Box 321
Khartoum
SUDAN

21. Chama Cha Uzazi na Malezi Bora Cha Tanzania
P O Box 1372
Dar-es-Salaam
TANZANIA

22. Uganda Women Tree Planting Movement
P O Box 10351
Kampala
UGANDA

23. Grass-Roots Operation
P O Box 22
Kampala
Uganda

24. Zambia Council for Social Development
P O Box 51053
Lusaka
ZAMBIA

25. African Link
P O Box 72723
Ndola
ZAMBIA

26. IRED, South Africa
P O Box 8242
Causeway
Harare
ZIMBABWE

27. Regional Network of Environmental Experts (ZERO)
P O Box 5338
Harare
ZIMBABWE

28. National Federation of Women's Institute of Zimbabwe
P O Box 8263
Causeway
Harare
ZIMBABWE

29. Biomass User's Network (BUN)
African Region
Private Bag 7768
Causeway
Harare
ZIMBABWE