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Consultancy Report

SOIL EROSION CONTROL AND LAND RECLAMATION PROJECT IN BOROMA AND BAKI DISTRICTS OF AWDAL REGION - SOMALILAND

RANGE MANAGEMENT CONSULTANCY REPORT

by

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SUMMARY

The report describes the observations and recommendations resulting from a range management consultancy in support of the Soil Erosion Control Project implemented by the NGO Cooperazione Internazionale (COOPI) in Borama and Baki Districts, western Somaliland, and funded by the European Community. During the mission, focus was on biological measures to reduce soil erosion, in particular through range management techniques, and rehabilitation of eroded land. Because the first phase of the project ended early May 1997, recommendations aim especially at the proposed second phase.

Half of the project's target villages were visited and issues related to range, livestock and forests were discussed with community members; range condition and erosion problems were inspected around the communities and the project's and private nurseries were visited as well. Observations and conclusions are described in the report.

Recommendations for range improvement and management include introduction of rotational / deferred grazing systems (with application of correct stocking rates), establishment of local dry season grazing reserves and revegetation of degraded areas. Vegetation trend should be monitored; methods are described. Problems of livestock feeding concern mostly cattle and could be solved by larger scale hay production. Establishment of village nurseries, improvement of the project nursery and options for afforestation are discussed, and a list of recommended tree species is given.

Two projects are proposed, but depending on timing and financing they could be combined. The first concerns FAO support to the SECP-phase 2, in order to address the essential range management and monitoring aspects of rehabilitation of degraded watersheds and prevention of further erosion. The second project aims to assist the government (Ministry of Livestock, Forestry and Range) with the development of a masterplan for range management and fodder production, needed as part of the process to rebuild the country after the recent civil war.

1 INTRODUCTION

1.1 BACKGROUND

After several years of war, Somaliland has started the process of rebuilding, both of physical structures destroyed during the fighting and of a government system that has collapsed at all levels. The country is thereby supported by a number of international agencies and NGOs, working at various scales and addressing a variety of problems. One of these organizations is the European Community (EC) which is, amongst others, involved in the environmental and livestock sectors.

One of the implementing agencies of EC-funded projects in Somaliland is the Italian NGO Cooperazione Internazionale (COOP.I.), which has a long experience in developing countries in a number of subjects including health, agriculture, water, livestock, education and income generating activities. Since 1991 it has implemented several EC funded projects in NW Somalia, focusing on human health, animal health, livestock export, water supply and soil erosion, and additional projects funded by other donors. The present range management consultancy is connected with the Soil Erosion Control Project that COOPI is implementing in the Borama area, and is executed by FAO with EC funding. The mission took place between 18 March and 17 May 1997, of which the period of 22 March to 11 May was spend in Somaliland.

1.2 PROJECT DESCRIPTION

From November 1995 to May 1997, COOPI has implemented the first phase of the Soil Erosion Control and Land Reclamation Project (SECP) in Borama and Baki Districts of Awdal Region. The goal of this project was to protect rural areas from further soil erosion and land degradation. The project aimed also at increasing awareness among rural people about environmental issues in order to create suitable conditions for further actions in the same sector. Achievements during the first phase included construction of more than fifty checkdams and several kilometres of earth bunds and stone lines, planting of more than 10,000 seedlings of sisal for live fencing, and protection of about 3,500 hectares against further erosion.

The project has established an extension service in collaboration with the Regional Agriculture Office in Borama, and holds meetings regularly in 16 target villages to discuss topics related to soil conservation, afforestation and specific erosion control measures. Contacts between project and communities are facilitated by 'extensionists' recruited in each village.

A follow-up of the SECP with another project of two years is being proposed. The purpose of this second phase is to continue "protection of cultivable land from further degradation, in particular by erosion, in the medium and in the long term" and to establish an environmental database and monitoring system (COOPI, 1997). Based on experience of the first phase, the project aims to combat land degradation with a combination of physical and biological

measures. Physical activities were already implemented during the first phase, but biological interventions not yet. This range management consultancy was intended to strengthen the project in this respect around the middle of the first phase, but because of long delays the mission started only at the end of the project. Thus, the focus changed to providing advice for a biological component for the second phase, in particular with regards to range management and monitoring. The terms of reference below should be interpreted with this in mind; those for the second mission should be revised in accordance with the approved outline of the new project.

One of the goals of the consultancy was to train project staff in techniques for range improvement and management, but only a skeleton staff was present at the actual time of the mission. Nevertheless, a two day workshop was held for 15 people including present and previous project staff, and representatives of government departments, local companies (e.g. nurseries) and NGOs. During the first day, basics of range management, improvement and monitoring were discussed, and on the second day proposals for interventions were explained and range monitoring measurements were practised in the field.

1.3 TERMS OF REFERENCE

To assist the Project in the area of range improvement and management, FAO has been requested to field a consultancy mission with the following terms of reference:

Title:	Management and Development of Rangeland and Fodder Trees: Formulation Mission
Implementing Agency:	FAO
Duration:	Two missions, a total of three months.
Duty station:	Borama, Somaliland

First (current) mission:
Under the operational supervision of EEC and technical guidance of FAO and in close collaboration with COOPI and appropriate National Authorities the consultant will travel to Somalia to advise collaborating NGO (COOPI) on the management and development of rangelands and fodder trees. More specifically the consultant shall:

1. Review existing literature on the region and in other similar ecological zones to orientate possible rehabilitation actions and possible systems of improved management of the area;

2. Discuss with the full time agronomist of COOPI, ongoing activities, study present practices, and identify possible field sites for the establishment of pilot rangeland areas to be improved;

3. Prepare a programme of possible interventions to be carried out within the duration of the project. Advice will be provided on species selection, seeding techniques, nursery management, and appropriate use of improved species. Recommendations will be given for improved management and grazing techniques of degraded rangelands;

4. Assess the condition of existing grazing areas and advise on possibilities for setting up a monitoring system with particular interest in the sustainability of the grazing system;

5. Train the international agronomist and national staff by both practical work and a workshop, in the suggested techniques of range improvement, management;

6. Devise a year-round feeding system for sedentarised ruminant livestock and submit a list of addresses and prices for the purchase of improved fodders to be established in pilot areas for demonstration purpose;

7. Submit to EEC, FAO and COOPI a concise report at the end of the mission, in three copies and a diskette compatible with the institutions' software.

Second mission:
In close collaboration with the international agronomist and under the technical supervision of FAO the consultant will provide the follow up to his previous consultancy as follows:

1. He will give planting instructions and supervise all details concerning set-up of a small nursery, and identification of suitable sites for direct seeding and necessary agronomic practices;

2. Visit Jojhoma with the international agronomist and other relevant national staff to collect information and establish links for collaboration between two similar ecological zones;

3. Design and prepare in collaboration with national and international staff a long term proposal thought necessary to the improvement and adjustment of grazing patterns to ensure a positive impact on sustainable livestock production. A quantification of the type of intervention on the natural resources, a budget and operational implications will be presented along with the proposals;

4. Discuss the proposal with beneficiaries (namely pastoral people) and adjust it to their priorities and capacity of participation to an improved system of use of natural resources for grazing purpose;

5. Continue the vegetation observation and the monitoring system initiated during the first mission;

6. Submit to EEC, FAO and COOPI a concise report at the end of the mission, in three copies and a diskette compatible with the software of the three institutions.

1.4 ACKNOWLEDGEMENTS

The co-operation and assistance is gratefully acknowledged of all government and agency staff with whom the consultant has had contact, particularly within the Ministry of Livestock, Forestry and Range, the Regional Agriculture Office, EC, COOPI and FAO.

2 MAIN FINDINGS AND CONCLUSIONS

2.1 MAIN FINDINGS

2.1.1 Target communities

The first reconnaissance trips comprised visits to eight of the villages where the Soil Erosion Control Project (SECP) is involved in erosion control and/or extension work, and to the project nursery and six private nurseries for tree propagation. The visits to the villages focused primarily on discussions with elders and other community members, in particular about their livestock, rangelands and fuelwood sources. This helped to get an understanding of present and past practices, and about the directions of possible interventions where improvement and changes in management of natural resources is needed. The latter is especially important because it would be futile to attempt activities that are not desired and supported by the local land users.

Range condition was not checked in great detail during these early trips in March, because it was too soon after the start of the rains to get a good idea about the composition and condition of the vegetation (in particular grasses and forbs). Moreover, the grazing lands appeared in an even worse state because of the below average rainfall of the previous year. Thus, a second series of field trips was made after the first week of April when range vegetation had started to develop.

The villages visited were: Arro-qolab, Asho-ado, Bon, Dumbuluq, Hayayabo, Hol-hol, Idhan and Quljed, all in Borama District. Villages in Baki District were excluded because of some earlier difficulties experienced by COOPI staff (towards the end of the mission a brief visit was made to Baki to see activities carried out by the SECP as well as the vegetation between Borama and Baki). The number of families per village ranged from about 30 in Arro-qolab to 500 in Bon. While the inhabitants of all communities were in general agropastoralists, there was some variation in what was considered the main economic activity: in Asho-ado, Dumbuluq, Idhan and Quljed people focused on agriculture, while in the other villages the accent was on livestock production. This difference was apparent in the reported average number of smallstock per family: where people depended mainly on livestock, the average family owned 70 to 80 sheep and goats, while in predominantly agricultural areas this number was up to 30 (in Idhan less than ten). In all areas families had a few camels and two to ten head of cattle. The latter are kept for milk, especially nearer Borama, and as draught animals (oxen for ploughing).

In general, people did not express a concern about feeding of their livestock, even though the rains were below normal in the previous year and some animals were reported lost around Bon due to dry conditions. Cattle are most vulnerable to the seasonal changes. They are kept near the village and graze around the farms. After harvest they are also fed crop residues and in the dry season hay from around the farms or, more commonly, dry grass collected

from the mountains. The other livestock is taken to the grazing lands away from the village. Depending on the availability of forage the animals are taken farther into the mountains. As the vegetation is most often wood- or shrubland dominated by Acacias, livestock depend to a large extend on browse (camels and goats). Branches lopped from trees, pods and seeds form a valuable part of the diet of the animals. Some people, in particular nomads, take their livestock farther away during the dry winter season, travelling as far as the coastal plains to the north.

Grazing systems were not functioning in any of the areas surveyed, but used to exist in the form of seasonal grazing reserves. In this region, these were located Southeast of Bon (Abase Valley), Southeast of Quljed (Jir-jir), near Old Baki, just outside Borama and near Idhan (info Mr. Suleiman, Regional Agricultural Officer). Remnants of the Reserve near Borama still show the high potential of this area, with a good grass cover under *Acacia etbaica* woodland. People in the communities visited did in general recognize the benefits of the past system, but foresaw considerable difficulties with introduction of grazing management on local level because of the traditional communal utilization of range resources by people of several villages as well as nomads. Where focus was mainly on agriculture, there was less interest in grazing management and difficulties appeared even greater because much of the land was claimed as cropland and fenced. Some of these "farms" included land unsuitable for agriculture as well as cultivated land, a practice which was often not appreciated by others because traditionally all grazing land is for common use and movement of livestock became often blocked by thorn-fences.

Fuelwood collection and charcoal production form another cause of degradation of the environment, again most severely around the villages, where few, if any, trees remain. Fuelwood, essential for cooking, is now mostly being collected in the mountains surrounding the communities, requiring greater efforts as distances increase. Charcoal is produced from the larger trees and is sold for use in the cities and for export. As it affects their daily lives, some people recognized that action needs to be taken to manage their wood resources, but little has been done so far. Only the people in Bon reported that at least charcoal production was being reduced, and that only a few of the poorer families were allowed to continue this practice. In Idhan, the community tried to safeguard a large stretch of trees that used to be a "Forest Reserve", before the civil war managed by the Government and guarded by rangers. While grazing had always been allowed (against a grazing fee), the area is now heavily overgrazed, none of the trees has escaped lopping of large branches, and several trees have been cut down completely. The people in the community who were concerned about this forest found themselves unable to control the removal of wood, but they reportedly did halt encroachment of farms by demarcating the boundaries.

Fodder production does not form a part of the agricultural practices. Crops are grown under rainfed conditions and comprise mainly sorghum and maize. More recently leguminous crops (beans and cowpeas) have been included in Quljed and Idhan, and farmers in the latter village commented on the positive effect this had on their soil. Cultivation practices are generally simple and

improved crop varieties are not used. Also the locations are not always suitable, contributing to the gully erosion problems common in the valleys where the better soils are found.

2.1.2 Rangelands

The predominant vegetation type around the communities visited in Borama District is wooded bushland, characterized by shrubs and low trees of some three to four meter height with scattered emergent trees up to nine or ten meter. This is in particular the case on the stony hillsides. In the valleys with better soils, larger trees are usually found.

In Hol-hol the main grazing area consists of mountainous landscape with rocky soil and *Acacia* shrubland. Shrubs are mostly up to about 3 meter high and have a combined cover of 20 to 30%. The most common species are *Acacia etbaica* ('Sogsog'), *A. bussei* ('Galool') and *A. nilotica* (*arabica*?; 'Maraa'), while *A. senegal* ('Adaad') and *A. tortilis ssp. spirocarpa* ('Kura') are also present. The understory is formed by several species of dwarfshrubs and some forbs and grasses. Its cover was only about 15 to 20%, but this may increase with the progress of the growing season. In general, the vegetation was considered to provide good grazing; most plants stay green until winter and only about five percent of the vegetation consists of unpalatable plants. A general deterioration of the vegetation has been observed by the local people, especially with regards to the tree cover. However, the risk of erosion should be considered low in the main grazing areas, in particular because of the coverage of rock and stones protecting the soil surface.

In Asho-ado the grazing areas had a similar vegetation. In some areas the shrub vegetation reached greater densities (30 to 40% cover) and more low trees (up to six meter high) were present. Species included the *Acacias*: *A. bussei*, *A. etbaica*, *A. nilotica* and *A. senegal*, while also *Balanites aegyptiaca* ('Quud') was observed. Presence of small plants of these species indicates that natural regeneration is taking place. The lower layer consisted also here of dwarfshrubs (including several species of legumes), grasses and forbs, and had a cover of an estimated 15%. On the slopes the soil was stabilized by rocks and stones, but in the valleys the soil was deeper and finer, and erosion problems occurred.

In Dumbuluq the vegetation of the grazing areas was basically the same, dominated by the same *Acacia* species. In one of the areas surveyed *A. etbaica* was dominant and *A. nilotica* second. Natural regeneration was taking place, but all the bigger trees had been cut. Coverage of the shrub layer about and that of the heavily grazed underlayer were both about 20%. In another area *A. bussei* was more common than the other species and, because of pressure from a nearby concentration of houses regeneration was not apparent and the lower layer was severely degraded. Erosion problems did occur in that area wherever the soil was not rocky or stony. A local variation on the general vegetation type was an area with almost only *A. senegal* and a

cover of more than 50%. The area appeared to be protected but it was unclear whether this was for the harvest of gum from the trees or for another reason.

The vegetation in Hayayabo was checked along the southern valley, starting at a location where COOPI had constructed checkdams and an diversion channel. The condition of the range in the upper valley was quite poor, with only a 10% cover of the shrub layer and 20% cover of the heavily grazed lower layer. At least four grass species occurred in the area, including some *Chrysopogon plumulosum* ('Dareemo'), indicating a good potential for grazing (it was reported that more *Chrysopogon* can be found on better soil in the lower plains, where it is also cut for hay). *Acacia bussei* was the dominant shrub/tree species, followed by *A. etbaica*, *A. nilotica* and *A. senegal*, while *A. tortilis ssp. spirocarpa* occurs lower down along the river bed. Other species included *Balanites aegyptiaca* and several species of small shrub in the lower layer. *Acacia mellifera* ('Bilel'?) was also found on deeper soils lower in the valley. Also in Hayayabo severe gully erosion was taking place in the valleys, where soils are soft and deep. Hill sides were more stable with their stony soils.

In Arro-qolab two range areas were surveyed. In both *Acacia etbaica* was dominant; *A. nilotica*, *A. bussei* and *A. senegal* followed with some variation in ranking, while *A. tortilis ssp. spirocarpa* and *A. mellifera* were less common. Shrub cover on the hill sides ranged from 10 to 25% and cover of the lower layer of dwarfshrubs, grasses and forbs from 15 to 20%, of which very little was unpalatable. It was evident that the area most susceptible to erosion was most heavily grazed (a fact that was confirmed by local livestock owners), as those areas had at most five percent vegetation cover (lower layer). This has also here led to severe gully erosion.

2.1.3 Nurseries

The Soil Erosion Control Project has started a nursery in Amoud and supported two private nurseries in Borama. Three other private nurseries were visited in and around Borama, as well as a nursery started by a local NGO in Bon.

In the project nursery about 2000 seedlings of *Agave sisalana* (sisal) were being propagated, intended for life fences around the nursery to replace traditional barriers of thorny acacia branches. *Acacia* had also been sown, using seeds from two local sources of the species *Acacia etbaica* ('Sogsog'), *A. nilotica* ('Maraa') and *A. tortilis ssp. spirocarpa* ('Kura'). A total of 200 bags had been planted for each source and each species, i.e. a total of 1200 bags. Success rates varied considerably, and were roughly estimated at over 50% for *A. etbaica*, 25% for *A. tortilis ssp. spirocarpa* and 6 - 15% for *A. nilotica*. The time of sowing was November 1996 and the tallest seedlings in early April 1997 measured about 20 -25 cm (15 cm for *A. tortilis ssp. spirocarpa*).

Half of the *Acacia* seedlings were placed under a small piece of shade netting and some of the sisal was shaded by large trees around the nursery. Because

no protection from direct sunlight was provided, many of the bags of the outside row of sisal had disintegrated and needed replacement.

Water is provided from a pump installed by COOPI, but is taken to the nursery in cans by wheelbarrow because no pipe could be installed.

The project supports two small nurseries in Borama: ECO and ERO. For water supply a berkad was made in the former, while cement lining and cover was provided for a shallow well in the latter. Plastic bags for plant propagation were also supplied and in return, the project received 4000 to 5000 plants of sisal which were planted around farmland in Hol-hol respectively Hayayabo. Now sisal is propagated directly in the soil at both nurseries. Other species raised at ECO included *Azaridachta indica* ('Neem Tree'), *Acacia bussei* ('Galool'), *Leucaena leucocephala* ('Luushiina') and *Casuarina sp.* Some of the plastic bags used were originally not intended for this purpose; these were much too narrow. At ERO *Acacia nilotica*, *Leucaena* and *Parkinsonia aculeata* had been planted. In contrast to the other nursery, this one had recently not been maintained well.

Other nurseries included one in a private farm near the project's nursery in Amoud, from where COOPI had previously taken 4000 sisal seedlings for plantation in Arro-qolab. Because the owners had temporarily moved away, the nursery was now abandoned, though the farm continued to be in operation.

Owners of a small nursery in Borama raised *Leucaena*, sisal and several *Acacia* species in addition to production of vegetables. The seedlings were provided free to people in and around town. Plastic bags used were of the only variety available locally, made of thin white plastic and too narrow for seedlings of trees and shrubs. The same bags were used in a nursery in Abu Qais, about 10 km from Borama, where the success rate was very low except for sisal. Other species sown were *Ziziphus mauritiana* ('Gob') and *Acacia nilotica*; of the latter only one seedling was alive.

Ziziphus mauritiana was the main species in a nursery of a local NGO in Bon. Other trees being produced were *Schinus molle* ('Miri miri'), *Tamarindus indica* ('Hamar') and there was one specimen of *Acacia tortilis ssp. spirocarpa*. The NGO had provided suitable plastic bags and the success rate was higher than at some of the other locations. It intends to sell the seedlings locally and use the proceeds to continue operation.

2.2 CONCLUSIONS

2.2.1 Target communities

The Soil Erosion Control Project has started activities in 16 communities during its first phase. In some of the villages physical works were implemented to combat soil erosion (e.g. construction of checkdams and bunds), and/or distribution of sisal seedlings was started in a programme to eventually

replace much of the thorn-branch fencing which has a detrimental effect on the shrub vegetation. In all villages a dialogue with the communities had been started and an extension programme was being carried out to increase environmental awareness. The latter was implemented through a mobile extension team (in co-operation with the Regional Agricultural Office) and a village extensionist in each community. Involvement of COOPI in other aspects of development was also evident in some villages, in particular related to water supply and human health.

Half of the SECP target villages were visited during the early part of the consultancy, and aspects of community life related to renewable natural resources were discussed with some of the people. As agropastoralists, people are strongly concerned with the condition of the grazing and soil resources in their vicinity, while their dependency on wood for energy makes availability of forest resources also of great importance. However, although it was widely recognized that degradation of essential resources was taking place, no action was being taken at community level to reverse this trend. Only in Bon joined action to reduce charcoal production was mentioned and in Idhan measures had been taken to prevent cultivation in an adjacent former forest reserve. At least some mechanism appears to exist to arrange communal activities, through the elders of a village.

2.2.2 Livestock

In half of the villages visited rainfed agriculture was the primary activity and smallstock numbers were relatively low (up to 30 sheep and goats per household), while in the other half livestock was considered most important and more sheep and goats were kept (average of 70 to 80 per household). In general, feeding of livestock was not mentioned as a serious constraint. Considering the vegetation of the grazing lands, certainly raising camels and goats should not be a problem because they depend largely on browse. (The non-herbaceous component in the diet of different livestock species is estimated at 70% for camels, 60% for goats, 30% for sheep and 10% for cattle; D.I. Field in Sweet 1988). For sheep it may be slightly more difficult, but apparently sufficient grazing is still found in the dry winter season, even if it is farther away in the mountains. Cattle are most difficult to raise because of their feeding habits (grazing rather than browse) and the fact that they are kept near the village. Crop residues fulfil some of the requirements in the winter season, but some stock of additional fodder is usually needed. Some farmers store hay for this season, while others bring dry grass from the mountains as needed. In either case, there is little nutritive value in the fodder provided; even the hay is cut well after the flowering stage of the grass. Undoubtedly improvements can be made in animal feeding during the most difficult time of the year, by improved techniques for hay making and by addition of highly nutritious ingredients such as Acacia pods and seeds, and other fodder crops.

2.2.3 Agriculture

Rainfed agriculture is practised in the valleys of each village. Methods are primitive in all aspects, from soil preparation to crop varieties. No early maturing varieties are used, fields are not fertilized and even the benefits of rotation between cereal and leguminous crops are almost unknown. Sorghum and maize are the main crops and beans and cowpeas are only recently being grown in a few locations. Fodder crops to supplement livestock feed are not grown. The cropland is usually located on highly erodable soil, and with the lack of structures to check the flow of rainwater and general lack of vegetation cover, gully erosion has become common in the agricultural areas. That this is not a new phenomenon can be deducted from the large shrubs and small trees that grow in some of the gullies. It is often, however, an extensive problem, from the foothills to the valleys, requiring a complex of measures in the areas of soil conservation and vegetation improvement, followed by sustainable management.

2.2.4 Rangelands

Most of the grazing lands in those locations in Borama District where the SECP is involved are more or less mountainous areas with *Acacia* shrubland. On hill sides, soils include rock outcrops and are further often covered with stones and gravel, while valleys have deep, sandy soils. The vegetation is dominated by *Acacia* shrubs and low trees, with as most abundant species *A. bussei* ('Galool'), *A. etbaica* ('Sogsog') and *A. nilotica* (*arabica*?; 'Maraa'), accompanied by *A. senegal* ('Adaad'), *A. tortilis ssp. spirocarpa* ('Kura') and occasionally *A. mellifera* ('Bilel'?) and *Balanites aegyptiaca* ('Quud'). Composition of the shrub vegetation does show some variation, e.g. *A. tortilis ssp. spirocarpa* is more frequent on deeper valley soils than on rocky slopes and *A. mellifera* also seems to prefer the valleys. Cover of the shrubs and trees varied from 10% to locally more than 50%, also depending on the rate of cutting/lopping of trees for fuelwood and charcoal and shrubs for fencing material. Natural regeneration was observed in several places, indicating that at least locally overgrazing is not too severe.

The lower layer of the vegetation consists normally of dwarfshrubs of various species, several grasses and forbs. The facts that perennial species dominate and that unpalatable plants are uncommon are positive indicators of the range condition, even though the cover of the lower layer was not more than 15 to 20% early in the growing season. First signs of overgrazing are normally the disappearance of the most preferred species, and farmers in several locations commented on the fact that a very important range grass such as *Chrysopogon aucheri* is almost or completely gone. While the low cover may be reasonable at very stony sites, on deeper soils at the foot of the slopes and in the valleys a denser vegetation should be expected. In such areas the range deterioration is apparent and a combination of overgrazing and poor management of agricultural land had led to often severe sheet and especially gully erosion.

2.2.5 Resource management

None of the communities had initiated any joint management of natural resources, either as a village or in combination with neighbouring villages and the nomadic population. However, in each community visited, previous grazing management in the form of seasonal grazing reserves was mentioned. That system, whereby large areas of grazing land were set aside for use in the dry season, used to be implemented by the Government. Regulations were enforced by rangers, normally employed from nearby villages, and fees were charged for use of the rangelands. Many of the people in the villages acknowledged the benefits of the system, but they considered themselves unable to implement such grazing management without the Government or even at a smaller, local scale. However, the problems of environmental degradation are partly due to lack of resource management and for any improvement to take place and be sustainable, adoption of proper management techniques will be unavailable. It is evident that this requires a two-pronged approach of assisting the Government to reconstitute an overall rangeland management programme and supporting communities to take action at local level to safeguard their remaining grazing, woodland and soil resources. In both cases this will involve determination of land capability and adherence to developed land use plans.

2.2.6 Afforestation

Afforestation should form an important component of a programme to restore degraded natural resources in any part of Somaliland. Even in Borama District, which has relatively well developed tree and shrub vegetation, are the effects of over-exploitation of wood resources evident, in particular around towns and villages. Fuelwood and charcoal have to satisfy about all the domestic energy requirements in the villages and most of the needs in the larger towns where some alternative fuel sources may be available. While on a national basis the demand for fuelwood and charcoal does not exceed the overall forest increment, harvesting is generally done in the more accessible places, causing removal of forest cover from extensive areas (FAO Forestry Project Proposal 1993, in Herzog 1996). This in turn has contributed to the land degradation and soil erosion such as occurs in the project areas of the SECP.

A survey of fuel requirements in Borama, carried out by the Somali Relief and Rehabilitation Association (SORRA) in February 1995, illustrates the extend of the problem. It was estimated that the approximately 12,000 households in Borama, using four kilogram of charcoal per day each, require about 17,520 metric tons per year. Fifteen eateries, each using 75 kg charcoal daily, and 45 tea shops, each burning eight kg per day, would need another 542 metric tons annually. If an average mature tree produces six bags of 20 kg charcoal, the annual charcoal consumption for Borama alone would require 150,000 trees! The situation is aggravated by the very inefficient methods of charcoal production, whereby trees are set on fire (even while still standing) and then buried in sand to halt the combustion process. Also, the process is very

selective because specific tree species are preferred: especially *Acacia bussei* ('Galool'), *A. etbaica* ('Sogsog') and *A. nilotica* ('Maraa').

There is little doubt that wood will remain the main source of energy. To prevent further deterioration of the forest resources however, it will be essential to introduce management systems that allow for sustainable use of trees and shrubs. This will require action by communities as well as the Government. Communities must take responsibility for management of the area under their control and for rehabilitation of degraded land. As fuelwood will always be needed, they should incorporate future wood requirements in their land use plans. Already people in several communities expressed concern about the charcoal/fuelwood problem and some villages intended to strongly reduce charcoal production. However, the problems should not be shifted to common land away from the villages, and Government involvement will be required to achieve sustainable management of the resources there.

2.2.7 Nurseries

Production of seedlings for re-afforestation should be the responsibility of each individual community. As already proposed for the second phase of the SECP, COOPI should assist each community to select a (future) nursery specialist and help with the establishment of the nursery (water supply, equipment, training and supervision). The proposal indicates a goal of 30,000 tree species for each village nursery. Selected species should be suitable for fuelwood / charcoal production, fodder and/or soil conservation. As acceptance by the local people is essential, mainly well known indigenous species should be used.

Selection of species could be more flexible in the project nursery in Amoud. It is foreseen that 50,000 seedlings will be produced there in the next two years of the project, but the site could serve for demonstration purposes as well. First however, significant improvements will have to be made in water supply to the area where plants are propagated (now some 100 meters away), in shading and in the way plastic bags are arranged. In the meantime, private nurseries can continue to be supported, in particular for production of *'accepted' species*.

3 RECOMMENDATIONS

3.1 RANGE IMPROVEMENT AND MANAGEMENT

3.1.1 Grazing management

Rangelands are in general in a fair condition around the communities in which the SECP is operating. As is usually the case, there are signs of overgrazing in the more immediate vicinity of settlements, but the grazing areas farther away still have a vegetation dominated by perennial species (mainly dwarf shrubs but also grasses) and with a very low proportion of unpalatable plants. Improvement of the vegetation in such areas means increase of the available grazing and browse, i.e. increase of plant density and cover; re-introduction of different species is not an issue in such areas. Methods to achieve such vegetation improvement focus on grazing management. They aim at enabling individual plants to develop vigorous growth, with a large amount of green matter as well as a strong root system. As such development is hampered by continuous grazing, plants should be given a period of rest at regular intervals. Adoption of a rotational grazing system would allow this.

Because improvement of the vegetation, in particular that of the lower layer of grasses and dwarf shrubs, enhances water infiltration and reduces flow of run-off, as well as increasing the amount of forage available for livestock, it is strongly recommended that grazing management plans be introduced in each community where the project is active. In fact, controlled grazing should be part of any agreement to construct soil erosion control works such as check dams and bunds, because unless run-off is controlled in the upper watershed, erosion problems will persist.

As grazing lands are communal, implementation of a grazing system requires the co-operation of all range users in the area under consideration. Through traditional systems of communication, led by the elders and supported by a facilitator ('extensionist') linked to the project, all people in the community must become involved in the process of introduction of grazing management, and a committee or grazing association should be formed to implement the programme. In the meantime, the SECP should try to enhance the understanding of the range users about technical means of improvement by emphasizing range issues in its extension programme. Depending on the degree of acceptance by the community, the grazing area should be divided in blocks that are as large as possible, to be rested respectively grazed in rotation. As improvement of vegetation cover is of first concern, the first area, including all hillsides and valleys affecting the area where erosion control measures are being taken, should be closed for two years. This will allow plants to develop, set seed and regenerate naturally. After the first two years the vegetation can be grazed, adopting a stocking rate suitable for the amount of forage available (only half of the total forage should be used), and the next area should be closed. Eventually the whole grazing area should be improved and utilized under a grazing system that allows each part to be rested in rotation to facilitate further regeneration.

3.1.2 Grazing reserves

To reduce pressure on the land during the dry season, when grazing is very limited in the vicinity of the village but trampling affects the soils, it is recommended that communities set up dry season grazing reserves. Previously such reserves existed under control of the Government, but their use was abandoned during the civil war. Although several people mentioned that they would like to see that system re-established, communities should be encouraged to look after the grazing resources themselves, with support of the Government primarily in the form of suitable policies. The size of the seasonal reserve obviously depends on the number and species of livestock for which it is intended and on the amount of forage that is available. Detailed estimates can only be obtained by field measurements of available forage. Samples are taken representing mapped vegetation units or at random throughout the proposed reserve. Available grazing and browse is estimated by clipping the consumable part of the vegetation, separated in the different vegetation components. Samples should then be dried and the amount of dry matter (DM) calculated per hectare. To maintain plant vigour, only half of the total available forage should be used. Total 'usable forage' should then be divided by the daily intake per livestock unit to assess the number of grazing days. Further calculations will give the total time that a given number of animals can graze a certain area or the area required to feed a certain number of animals for the desired period of time. Daily intake is estimated at 2.5% of body-weight of the animal, i.e. about 5.5 kg DM per Animal Unit of 220 kg (= 1 cow = 10 sheep or goats = 1 camel where additional browse is available above two meter, the maximum height of clipping). A methodology for estimation of grazing capacity is presented in annex 2. Examples for various types of range areas can also be found in Heemstra 1980 and 1981a, b and c.

3.1.3 Revegetation

Natural recovery of the vegetation by protection from utilization (grazing as well as cutting of trees and shrubs) is the most cost-effective method of range improvement. Range re-seeding is normally practised only where there has been such range degradation that seed supplies of the desirable herbaceous species have been seriously depleted, or where the native forage species are considered of inadequate nutritional value to support domestic livestock. Neither of these situations applies to the Project Areas, where even in deteriorated range areas 'good' plants are often still present, out of reach, under the thorny shrubs.

However, re-seeding and planting of shrubs and trees could be practised on a smaller scale in the degrading watersheds, on the deeper soils from the foot of the slopes to the valley bottoms. Because of overgrazing, such areas have often little vegetation in the herbaceous layer and soils are eroding. It is recommended that demonstrations are set up in the communities, showing the benefits of re-vegetation. One demonstration site should be located in the upper watershed, aiming primarily at arresting further erosion, and another

lower in the valley, focusing on hay and fodder production while stabilizing the soil.

As the Project is not in a position to experiment with different species during its 2-year second phase, it is recommended that sowing of grass is limited to two species: *Cenchrus ciliaris* ('Garraw' ?), one of the best grasses for erosion control in semi-arid areas and a palatable forage grass (FAO 1990), and *Chrysopogon aucheri* ('Dareemo'). Both species occur in Somaliland; *Chrysopogon* reportedly used to be abundant in the Project areas but has become uncommon. Seeds can be obtained locally or from other countries (e.g. Australia). For future expansion of reseeded areas, seed should be collected from the sown areas. For *Cenchrus*, germination is poor for fresh seeds but good 3 to 12 months after harvest.

Sowing should be done just before the expected rains, i.e. in late March / early April. Some form of seed-bed preparation and a degree of seed protection will be required; this can be done respectively by ploughing (parallel to the contour) and dragging branches to cover the seeds. As sowing rate 2.5 kg/ha should be tried for both species (FAO, 1990 indicates 2.5 kg/ha for *Chrysopogon* and 0.5-4 kg/ha for *Cenchrus* according to expected rate of full ground cover).

Chrysopogon grows on rocky ground as well as deeper soils. In the upper watersheds it can be sown on sandy soils towards the rocky slopes, while *Cenchrus* is planted nearer the centre of the valley. To further reduce run-off and improve soil stabilization, belts of shrubs (*Acacia spp.*, *Balanites aegyptiaca*) can be planted following contour lines. Once established, they will help to protect the area from continuous grazing. The improved areas in the upper watersheds can eventually be included in the grazing management system, making certain that stocking rates correspond to allowable grazing (half of the herbaceous forage production). If the grasses are established but shrubs need a longer period of protection, grass may be cut for hay.

Areas of deeper soil around eroded valleys and around farmland can be sown with mainly *Cenchrus ciliaris*; where cultivation is impractical nucleus stands of grass may be developed by scattering of seed in places where the soil is disturbed and around trees and shrubs. Areas around farmland can be grazed after harvest of the crops but all livestock must be banned from areas in eroded zones. There grass production can be used as hay (cut and carry) for feeding during the dry season. The grass should be cut at the early flowering stage. *Cenchrus* makes reasonable-quality hay when cut at that time, while old grass, after seed has been harvested, gives low-quality roughage only. Belts of shrubs and trees should be planted around cropland, in particular to form, with strips of grassland, a buffer between farm and gullies.

A special opportunity for production of fodder in the form of hay exists in the previously reserved forest near Idhan. Although management of this area ceased with the collapse of government services, some of the people in nearby communities have taken an interest in maintaining the forest, and are concerned about starting gully erosion in the area. As the area has good soil

but is severely overgrazed and almost non-producing with regard to the herbaceous vegetation, the project could initiate a demonstration of forage production by reseeding an area of at least one hectare with *Cenchrus ciliaris.* Also other grasses could be tried, e.g. seed could be collected from the species present in the previous grazing reserve at Borama and sown in Idhan. Once a good pasture has been established, grass could be cut for hay for the cattle in surrounding villages; eventually a large area could be brought under production and excess hay sold to support the livestock export from Berbera.

3.2 RANGE MONITORING

3.2.1 Methodology

Monitoring of range trend is a tool to determine effects of resource use (grazing and cutting of trees and shrubs) as well as that of improvement and management interventions on the vegetation. A variety of parameters can be measured, depending on desired detail of vegetation analysis and availability of time and expertise. As the primary goal of the SECP is to improve the amount of vegetation in order to reduce run-off and soil erosion, plant density is of main interest, i.e. the number of plants per unit area. At the same time plant frequency can be determined; this gives a measure of changes in plant composition, indicating whether less palatable plant species become more frequent an early sign of overgrazing, or whether the more preferred species increase, showing improvement of range condition. Measurement of plant cover, separated for tree/shrub and herbaceous layers would require considerably more time and is not considered essential for the soil programme. Cover is more susceptible to climatic changes in addition to grazing, and should be assessed in comparison with measurements in a nearby exclosure (similar environmental conditions, but no grazing or cutting).

The methodology selected for monitoring had to meet the following requirements:

⇒ the methods must be sensitive; the expected changes are normally of small amplitude and can only be detected by precise measurements;

⇒ the methods must be statistically acceptable for precise comparisons;

⇒ the methods must be simple and give constant results when used by different observers; this means that estimations should be avoided and only real measurements should be used;

⇒ the methods must not be too time consuming, otherwise the factor of fatigue enters, causing human errors.

The selected methodology is comparable with systems developed in several other countries, inciuding Botswana (Animal Production and Research Unit of the Ministry of Agriculture), Somalia (Northern Rangeland Development Project; Heemstra, 1981) and Saudi Arabia (Range and Animal Development

Research Centre; Heemstra, 1990). While the actual measurements are simple, a thorough knowledge of the vegetation and/or access to a good herbarium are essential.

3.2.2 Site establishment

Main criteria for selection of the monitoring site are that the vegetation is representative of that of a much wider area and that the site is homogeneous. Locations too near a settlement, watering point, road or other disturbance should be avoided. As measurements are made along permanent transect lines, the location of the site should be noted as precise as possible.

Each site consists of a cluster of three transect lines, each 100 meter long, originating from a central point, line A points due North and lines B and C towards 120 and 240 degrees. The centre point and the end of each line are marked with re-enforcing rod (2 cm diameter) cemented into the ground, leaving about 10 cm exposed.

3.2.3 Data collection

A general description is given for each site, including location, topography, soil, vegetation type, intensity of grazing/browse, signs of erosion and notes about plants collected for identification. Measurements are made along a 100 m tape measure stretched straight between two transect markers, as close to the ground as possible. The first plot is at 10 meters from the centre marker. Photographs are taken for each line from the centre marker and of plots 3, 6 and 9 of each transect. This will help to relocate lines if markers are lost, and to illustrate changes in vegetation.

Plant frequency and density is determined at 10 meter intervals, on alternate sides of the tape, the first one on the right. 100 x 100 cm quadrats (inside measurements) made of wood or steel are used for the herbaceous layer. Each plant species rooted inside the square is identified and for perennial species the number of plants is recorded, while presence of annuals is just marked. Similarly, frequency and density of trees and shrubs (including their seedlings) is determined in 10 x 10 meter quadrats, laid out with a tape measure of at least 30 meters (outside corners can be temporarily marked with pins at 10 respectively 20 meter).

For both vegetation layers the number of samples is ten per transect line or 30 per cluster. Plant frequency is derived from the percentage of quadrats in which a certain species is recorded, while plant density is calculated as the average number of plants per quadrat.

Vegetation cover may be recorded with the 'bar method'. A metal rod (diameter 1 cm) is lowered vertically at 20 cm intervals along the right side of the tape and anything hit by the rod is recorded. The canopy of higher shrubs and trees should be projected on the ground, taking care to keep the rod in a

vertical position. The aerial cover is recorded in the height classes: higher than 2 meter, 0.25 to 2 meter and below 0.25 meter. Each plant species is recorded separately and standing dead wood is noted as such. Basal cover is recorded at the same time and includes the categories: vegetation (by species), litter, dung, stone (>2 cm, including rock), gravel and bare soil.

The total number of measuring points is 500 per line or 1500 per cluster. The cover is derived from the percentage of hits along the lines. For the aerial cover the total cover is calculated for the three categories: annuals, perennials and shrubs & trees as well as for the total vegetation. The total is not necessarily the same as all components together because more than one species may be recorded at one point, either in the same height class or at different heights.

3.2.4 Comparison between years

With the data obtained from the quadrats for frequency and from the transect readings on cover, a comparison between years can be made. The statistical tests to be employed to detect significance of change are:

⇒ a Chi squared test for the frequency (comparing differences between identical quadrats between years);

⇒ a Students "t" test for the species density (comparing the mean species density of all quadrats between years);

⇒ a paired "t" test for the percentage cover (comparing the difference in cover for any particular 20 meter part of a transect between years).

Changes at the 0.01% level of significance can be indicated with ++ or --, those at 0.05% level with + or -. Relative importance values can be calculated for the perennial plant species and for shrubs & trees. The frequency, (aerial cover) respectively density of each individual species is expressed as a percentage of the total for all species in the category, and the species are ranked according to the totals of the two or three parameters.

3.3 LIVESTOCK FEEDING

Year-round feeding of livestock becomes problematic mainly for the species that largely depend on grazing; browse is more widely available and during most of the year. Camels and goats, with an estimated 70-80% respectively 60-70% browse in their diet, will therefore have little difficulty finding enough to eat in the grazing areas of Borama and Baki Districts. But browse forms only 30% of the diet of sheep and 10-20% of that of cattle, making those species more difficult to feed, at least during the dry season. Sheep are usually taken to areas in the mountains where dry herbaceous vegetation is still standing, but cattle are kept near the villages and depend on what is available locally.

Cattle are highly valued because of milk production, draught power (ploughing) and the monetary value they represent, but little extra is done to improve their productivity. During the growing season, cattle graze the local rangelands and uncultivated farmland around the village, in the dry season they are fed crop residues (mostly maize stalks) and dry grass brought from the mountains. Few farmers make hay for supplemental feeding and none of those met grew fodder. The animals will get some nutrition from *Acacia* pods, but in general their diet is poor.

Improvement of cattle raising should mainly focus on production of good grass, to be grazed during the growing season and stored as hay for the dry period. Establishment of the grasses *Cenchrus ciliaris* and *Chrysopogon aucheri* around farms and in degraded valleys is already mentioned in section 3.1.3. Once established, these resources should primarily be utilized for feeding of cattle by grazing where soils are stable and hay making where trampling would increase the risk of soil erosion. With the start of the dry season in November, the cattle should primarily be fed hay, supplemented with remaining crop residues and, to increase nutrition, *Acacia* pods. Assuming an average weight of 220 kg, each head of cattle will require 5.5 kg dry matter per day or 165 kg per month. The total amount of feed needed for each head of cattle until the start of the rains (four to five months) will therefor be 660 to 825 kg.

Hay should be made at the optimum date to maximize yield and still have the percentage of digestible dry matter necessary to meet the nutrient needs of the livestock. It is best cut early in the flowering stage. When cut earlier, the nutritive value is higher but yield is lower and the moisture content is too high for easy curing. If cut after flowering, the increased yield does not compensate for decreased palatability and nutritive value. It is important that the grass is dried quickly and not unduly exposed to the sun. It is important that the grass is dried quickly and not unduly exposed to the sun. When stacked the grass should be kept off the ground and covered to protect it from sun and rain (FAO, 1990).

3.4 NURSERIES

The proposal for a second phase of the Soil Erosion Control Project includes propagation of 650,000 plants for afforestation and erosion control. Over a period of two years, 50,000 of these plants should be raised at the Project Nursery in Amoud and 30,000 in each of 20 local nurseries. The latter should preferably be located in the villages where physical activities are carried out, but they could include enterprises in larger villages or cities if distances to planting sites are not too great.

3.4.1 Village nurseries

Some of the minimum requirements for establishment of a village nursery should be:

- acceptance by the community: the usefulness of a nursery for propagation of forest, fodder, fruit trees and other plants should be recognized so that people will support the enterprise; at the same time the community should already demarcate areas for afforestation and other plantation in accordance with a general land use plan;
- availability of water during the whole year: as seedlings will be planted early in the rainy season (usually April), water supply during the preceding dry season will be critical;
- availability of a site with suitable ('agricultural') soil near the water source; some species, e.g. sisal, could be propagated in seedbeds rather than plastic bags; the site should also have some large trees to provide shade for the seedlings;
- identification of a suitable candidate to be trained as village nursery specialist;
- written agreement with the community over the operation of the nursery, specifying land and water rights, compensation of the nursery specialist, etc.

The project will provide equipment for operation of the nursery: 'one donkey cart, three wheelbarrows, hand tools, seeds and plastic bags'. In most cases it should be possible to raise the seedlings in semi-shade, making use of trees in the area, otherwise a shed should be erected using locally available materials. Construction of a shade-house, using a sturdy frame and professional netting, should only be considered if it is expected that the nursery will become a viable enterprise after involvement of the project ceases. In that case a shade-house of 15 x 20 meter should be sufficient for 10,000 -11,000 seedlings.

Water should be piped to the nursery to reduce distance involved in irrigating the plants. To avoid disturbing the soil, a watering can with a sprinkler head or a shower head at the end of a hose should be used. Plants should be arranged in large compact blocks to reduce the overall perimeter where sun heat dries the soil faster and causes disintegration of the polythene bags. The block should be twice as wide as the reach of the nursery worker during irrigation (15 bags when using a watering can) and at least 50 bags long. Soil should be placed as high as the bags along the perimeter on the sides exposed to direct sunlight.

In order to reach the goal of about 30,000 seedlings over a period of two years, 20,000 should be sown/planted the first year and the balance in the second year, taking into account the success rate of the first year. The mix of species will vary according to preferences of the community and conditions at the sites to be planted, but in general the following selection is recommended for the first 20,000 plants:

⇒ *Agave sisalana* (sisal) 5,000; sufficient for 2,500 meter of live fencing; an easy to grow plant for a variety of soils; also useful for strong ropes and mats;

- ⇒ *A. bussei* ('Galool') 1,500; an abundant indigenous species; on soils of various depths; useful for fodder and fuelwood; favoured for charcoal production;
- ⇒ *A. etbaica* ('Sogsog) 2,500; abundant indigenous species; use for re-forestation on shallower soils; useful for fodder, fuelwood and erosion control/soil conservation, one of the favoured species for charcoal production;
- ⇒ *A. nilotica* ('Maraa') 3,000; abundant indigenous species; can grow on various soils; used for fodder, fuelwood, timber and other wood products, useful for erosion control/soil conservation, improvement of soil fertility, river bank stabilization; favoured for charcoal; fast growing;
- ⇒ *A. senegal* ('Adaad') 1,500; common indigenous species; on various soils, often on poor rocky soil; produces gum arabic, fodder, fuelwood, charcoal; used for erosion control/soil conservation, soil improvement; planting of this species is mainly of interest if gum production will be practised commercially;
- ⇒ *Acacia tortilis ssp. spirocarpa* ('Kura') 2,000; common indigenous species; use for plantation on deeper soils in degraded river beds; valuable for e.g. fodder (good pod production), fuelwood and charcoal; slow growing;
- ⇒ *Schinus molle* ('Miri miri') 2,000; introduced, common in towns and villages; tolerant of most soils; extremely drought resistant once established; good shade tree, produces spices (Pepper Tree), fuelwood; useful for erosion control or soil conservation; not browsed;
- ⇒ *Ziziphus mauritiana* ('Gob') 2,500; introduced, now widespread; in light to medium textured soils of various depths; valued for the fruit, also for fodder, fuel and other wood products, erosion control or soil conservation, live fencing, river bank stabilization; fast-growing for dry areas.

Seeds of all species can be collected locally by the community or through the Regional Agriculture Department. They can be stored for a considerable period of time, but might as well be collected each year. To improve germination, boiling water should be poured over the seeds of the *Acacia* species and they should be left to soak for 24 hours. For *Ziziphus*, the hard seed cover should be cracked before planting, while *Schinus* does not require pre-sowing treatment. In general, seeds can be sown as soon as available and seedlings can be raised until the following planting season, usually after the start of the rains in April. Because of low germination rates, two or three seeds should be planted in each plastic bag and the weakest seedling(s) removed if more than one germinates. Bags in which still no germination takes place should be replaced.

Success of the village nursery programme should not be assessed from the amount of seedlings raised, but from the number of plants successfully planted in the community. This may be achieved by providing a bonus of e.g. 1 US$ for each ten trees surviving after a certain period of time (e.g. two months) and linking further interventions in the village to the success of the community in protecting the trees from livestock. Responsibilities of the village nursery

specialist should thus include planting of seedlings, initial and, if necessary, subsequent irrigation, and replacement of dead plants.

When it is not feasible to establish village nurseries and the number of plants also exceeds the capacity of the project nursery, local private nurseries could be engaged. The project already has established a working relationship with some of them in Borama, and that programme could be expanded. A contract should be made with each enterprise stipulating the species and numbers of seedlings required, as well as the location of planting and the after-care. It is recommended that also in this case payment is related to the number of plants successfully introduced in the field. The main initial need of the nurseries will be for propagation bags. As these are not available locally, the project could provide them as a credit, deducting the cost when final payments are made.

3.4.2 Project nursery Amoud

The project nursery in Amoud, operated in conjunction with the Regional Agriculture Office, should function as location to propagate seedlings for communities in which the SECP is active but where establishment of a village nursery is not feasible, to carry out trials with species other than those recommended for the village nurseries, to establish seed production plots for grasses such as *Cenchrus ciliaris* and perhaps to try other grass species. Already several thousand seedlings of sisal and three *Acacia* species are being produced, and facilities are suitable for expansion.

To be able to operate the nursery more efficiently, it will be necessary to make water available where plants are raised. This could possibly be done by laying a pipe from the pump to the nursery and installing a storage tank from where water can be taken to the plants. Layout of the 'plots' should be improved by changing the present groups of 100 plants to larger blocks of at least 15 x 50 bags (with the present watering method up to eight plants can be reached from each side), separated by about two foot wide paths. This will decrease the total space occupied and reduce the total perimeter. Soil should be placed along all sides exposed to the sun, up to the height of the soil in the bags. This will reduce evaporation in the outside bags and their disintegration in the sun.

The proposal for the second phase of the SECP foresees production of 50,000 seedlings over two years time. Because the success rate is always less than 100%, the goal for the first year should be 30,000 plants. Part of these could be raised utilizing shade of existing trees, while a shade house can be constructed for about 12,000 plants. A structure of 15 x 21 meter should be sufficient, allowing for two rows of eight blocks of 750 seedlings each (15 x 50 bags), with 0.5 m spacing between blocks and 1.3 m between the rows.

Species to be propagated are the same as those for the village nurseries, plus some species which are at present not common in the villages:

⇒ *Azadirachta indica* (Neem Tree); introduced in arid and semi-arid regions, very drought resistant and does well on poor soils; fast-growing

after the first year; useful for fuel and other wood products, shade, fodder, erosion control/soil conservation, improvement of soil fertility, windbreaks, etc.; seeds can be stored for up to one month only, no pre-sowing treatment necessary;

⇒ *Prosopis cineraria*; occurs naturally e.g. in Yemen and Oman; grows in light, well drained soils of various depths; useful for fodder (leaves and pods), fuelwood, charcoal, erosion control / soil conservation, windbreaks; good for soil improvement (doubled biomass production under the trees in Oman, Zaroug 1984), considered best browse plant for cattle, sheep and camels in Jodhpur, India.

Leucaena leucocephala, an excellent fodder species originally from Central America and now adopted widely in the tropics, is not recommended for this area under rainfed conditions. Minimum rainfall requirements are 750 mm/yr (FAO, 1988); ICRAF lists its range as 600 to 3,781 mm/yr (von Carlowitz c.s., 1990). Also, sufficient good browse, most of it leguminous, is already available in the area.

The following target numbers could be adopted for the various species (presuming blocks of 750 plants each):

	plants	blocks
Acacia bussei	2,250	3
A. etbaica	3,000	4
A. nilotica	3,750	5
A. senegal	2,250	3
A. tortilis	3,000	4
Azadirachta indica	1,500	2
Prosopis cineraria	3,000	4
Schinus molle	3,000	4
Ziziphus mauritiana	3,000	4
Agave sisalana	5,250	7
Total	30,000	

3.5. AFFORESTATION

Trees produced in the nurseries are intended for different purposes, such as:

⇒ Restoration of forest cover, i.e. reforestation of areas where all shrubs and trees have been removed or increase of density where woodland cover has been reduced significantly. In most cases, this will be along water courses and on the lower slopes. Rocky/stony slopes have in general enough shrub cover left, but need improvement of the herbaceous layer, which is to be achieved by deferment of grazing. Indigenous species should be used for this purpose. *Acacia etbaica* should be the most suitable for shallow soils, but *A. bussei*, *A. nilotica* and *A. senegal* occur in such areas as well. All *Acacia* species recommended to be raised in the nurseries are suitable for deeper soils;

A. tortilis ssp. spirocarpa should be planted nearer the main drainage channels.

⇒ Establishment of buffer zones to reduce run-off and arrest soil erosion in the upper parts of the watersheds. This concerns the deeper soils at the foot of the slopes and around the upper drainages. A combination of actions including prohibiting grazing, broadcasting grass seeds and planting shrubs and trees aims to increase vegetation cover, which will reduce water flow and its eroding action. To restrict movement to such sensitive areas, belts of shrubs and trees should be established along the contour at the foot of the slopes. These can include the regular *Acacia* species, as well as *Ziziphus mauritiana*. Trees could be planted in three rows, spaced at three meter within the row and four meter between rows. Depending on the distance between foothills and the riverbed, and density of shrubs and trees already present, more belts could be added parallel to the first, or overall density could be increased. It should however be stressed that density of the vegetation in the lower layer has the greatest effect on reduction of water flow.

⇒ Stabilization of soil around cropland. Increase of the area farmed has led to a severe increase of erosion problems. Although bunds have been constructed in several places to catch rainwater, un-checked run-off from bare cropland still contributes to expansion of the gullies. In addition to improvement of agricultural practices so that land is under crops for a longer period of time, permanently vegetated buffer zones of 50 to 100 m should be created between cropland and gullies. Such areas could be utilized to improve livestock feeding if they are sown with grass that can be cut for hay (e.g. *Cenchrus ciliaris*). Further, shrubs could be planted that provide fodder and later fuelwood, but are not invasive. Acacias and *Ziziphus* should be suitable for such areas. *Azaridachta* and *Prosopis* spread more easily and might become weeds. The practice of planting live fences of sisal, promoted during the first phase of the SECP, should be continued. This creates another crop, which produces fibre and poles, while reducing the cutting of thorn shrubs. Several other species would be suitable for live fencing, including the Acacias, *Balanites aegyptiaca* and perhaps *Euphorbia tirucalli*. While *Balanites* is an indigenous species and can provide edible fruit, fuelwood and other wood products, *E. tirucalli* is an introduced, fast growing, poisonous plant that is of little use except for live fencing.

⇒ Reclamation of degraded lands. In large gullies where crop production is unfeasible and in areas with deep and narrow gullies, vegetation cover could be improved and soils stabilized by planting shrubs and trees that can eventually be utilized for fodder and/or fuelwood. All species propagated in the nurseries should be suitable for such areas, but faster growing species such as *Ziziphus mauritiana*, *Azadirachta indica* and *Acacia nilotica* would be preferable. A few areas should be selected to determine the performance of *Prosopis cineraria* under such conditions, both by plantation of seedlings and by direct sowing in disturbed soil. Direct sowing should also be tried for the other species; those that

establish well with this technique should be preferred for reforestation on larger scale.

⇒ Establishment of woodlots, shelterbelts and shade trees. Although efforts should be made to improve the efficiency of use of wood for cooking, and alternative fuel sources should be promoted in particular in larger towns, a demand for fuelwood will persist. At present, wood is being cut anywhere around the villages, at increasing distances because nearby resources are becoming exhausted. To satisfy future needs, woodlots should be planted now. They should be located within a short distance from the village, and be large enough to fulfil expected future needs under sustainable management (where wind and dust affect living conditions, the plantation could serve as shelterbelt on the side of the prevailing wind direction). All species recommended for the nurseries are suitable for fuelwood production; selection could depend on local preferences although faster growing species are to be preferred. Due to its unpalatability, *Schinus molle* is already the most common shade tree in the villages. The number of trees of this species could well be increased by making seedlings available to the inhabitants. Also *Azaridachta* could be planted as shade tree, but the seedlings will need protection from livestock.

3.6 PROJECT PROPOSALS

3.6.1 Range management in the Soil Erosion Control Project

After establishing and introducing methodologies for mechanical anti-erosion measures in its first years, the SECP proposes to put serious efforts into development of biological measures in the second phase. These will aim at prevention of further erosion as well as at reclamation of degraded land. This biological component requires two technical fields: forestry and range management. The first will aim to introduce proper use and management of the woodlands, including planning for future fuelwood needs, so that further deterioration of this resource will be avoided. It will establish nurseries and collaborate with rural communities to replant selected areas (see section 3.5). These forestry inputs will be facilitated by the appointment of a forester as project manager, as foreseen in the project proposal for the second phase.

Range management as a discipline is not yet included in the project, even though the condition of the grazing lands has a direct impact on the severity of erosion in the upper watersheds. In fact, the lower layer of herbaceous plants and dwarfshrubs, with its higher number of plants per unit area, has a greater effect on run-off and water infiltration than shrubs and trees, and mechanical erosion control measures will not stop erosion unless the amount of water intercepted before reaching the streambeds is increased. Therefore, focus of range management inputs must be in the first place on improvement of vegetation cover in the upper watersheds. Other aspects that should be covered are monitoring of vegetation trend, estimation of grazing capacity in

particular for grazing reserves, and revegetation of selected areas with grass for hay.

As range expertise is not foreseen in the present proposal for the next phase of the SECP, it is recommended that a range management component is included, and implemented in collaboration with FAO. It would require an international consultant for seven months over the two year period of the second phase of the project (during which a range programme can only be started; the nature of rangeland work demands much more time before substantial results can be expected), and appointment of a full time national specialist by the project. In more detail, responsibilities should be distributed as follows:

FAO

FAO will provide a consultant for a total period of seven months over a two year period, and will be responsible for technical backstopping. The consultancy will consist of four missions:

1. Autumn 1997, duration six weeks, within the period of September to November. Prerequisites: the second phase of the project has started and the project has appointed a national staff member with education in a discipline related to range management or botany.

   Because of the lack of literature in Somaliland, the consultant should spend one week at FAO Headquarters to select and photocopy relevant documents. He/she should also identify essential literature to be purchased by the project (e.g. floras of the region).

   During the first mission the consultant will train the national counterpart in general principles of range management, develop relevant extension materials, introduce local extension officers to range management methodologies suitable for the area, visit communities to initiate a programme of discussion about range improvement and grazing systems, prepare specifications of equipment to be purchased by the project and establish a work plan for the national specialist.

2. Spring 1998, two months, mid-April to mid-June. The second mission will focus on fieldwork. Range improvement and grazing management plans will be drawn up, and range monitoring sites will be established and transects read. This will be done in those communities where commitments were made to introduce and generally support such interventions, and where grazing associations were established as responsible parties representing the communities. A collection of range plants will be started to serve as reference for future vegetation work. A work plan will be prepared for the national specialist to continue fieldwork and start data analysis.

3. Autumn 1998, six weeks, September - October. The third mission will be a follow-up to complete analysis of field data collected in spring, identify collected plants, carry out additional fieldwork related to range improvement

and management planning, review the extension programme and establish the work plan of the national specialist.

4. Spring 1999, two months, May-June. Fieldwork will be carried out including the second measurements of the range monitoring programme, establishment of sites and initial measurements in 'new' communities, checking of previously established range improvement and management sites, and identification of new management plans to be prepared by the national specialist. Further, a final report will be prepared discussing the results of the complete consultancy and recommending further actions.

COOPI / SECP

The COOPI Soil Erosion Control Project will employ a full-time national staff member with background in range science or botany, provide transportation, equipment and literature, and facilitate accommodation and use of office space including access to a computer. The project will maintain its regular contacts with the participating communities and advise the range unit where agreements have been made that include range improvement and management activities.

The national specialist will be trained by the international consultant and implement established work plans under the overall supervision of the project manager. His work will at first involve extension work, discussions with communities about range improvement and management principles, and, together with other project staff, establishment of grazing associations. This will be followed by identification of the general sites where interventions are to be carried out and, after further training, fieldwork to determine grazing capacity, demarcate areas for deferred grazing and grazing reserves, and start the range monitoring programme. Finally, duties will also include analysis of collected data, maintenance of a small reference herbarium and preparation of reports.

Budget

The budget for a range management component in the SECP with collaboration of FAO and COOPI will total around US $ cluding:

Through FAO:	international consultant, 7 mm	US $ -
Through COOPI:	national specialist, 22 mm transportation (car rent) 450 days equipment & materials publications communications	US $ -

Required equipment includes:

1 computer
2 compasses

2 grass clippers
3 pruning shears
3 spring balances, capacity 500 g, graduation 5 g
3 tape measures, metal, 100 m length, graduation in cm
3 tape measures, metal, 50 m
2 tape measures, 3 m
1 set surveyor pins
3 quadrats, metal or wood, inside dimensions 100x100 cm
2 plant presses, 500 sheets blotting paper, 100 ventilators
herbarium paper: 500 mounting sheets, 200 genus covers
reinforcement rod at various lengths
cement, 2 bags per monitoring site

3.6.2 Development of a range management programme for Somaliland

Grazing is the most common land use in Somaliland and provides a livelihood for the majority of its people. The product, livestock, is the most important factor of the economy of the country, constituting almost all the exports (in 1994 almost 1.7 million sheep and goats, 56,000 cattle and 38,000 camels were exported from Berbera, mostly to Saudi Arabia; EC - FAO 1995). Because condition of the grazing lands determines to a large extend livestock productivity (fodder production is almost not practised), range management and related topics have had considerable attention during the last decades. The British already established a network of forest, range and wildlife reserves with the related protective legislature when Somaliland was a Protectorate, and those reserves more or less continued to function after independence in 1960.

In the 1970s and '80s three FAO-supported projects were implemented, the Survey of the Northern Rangelands Project (1970-'72), the Rangeland Conservation and Development Project ('72-'73) and the Northern Rangeland Development Project ('77-'85). The latter included units for range ecology, range management, fodder production, forestry, animal health, and extension. It was implemented together with a soil erosion control and water harvesting sector subcontracted to a private firm, while the task of aerial surveying of the northern rangelands was carried out by Resource Management and Research (RMR) of London. During the project, grazing capacity studies were carried out and management plans prepared for a variety of grazing reserves and co-operative ranches. Also, fodder production units were developed to provide supplemental feeding in case of drought and to support the livestock export through Berbera. A significant number (about 70?) of local, seasonal grazing reserves were demarcated at the request of individual communities, and a range management technical school was established..

Around the same time (1976) the National Range Agency was established, with overall responsibility for rangelands, forestry and wildlife in the country. Based in Mogadishu, it comprised eight departments: Transport, World Food Programme, Training and Planning, Administration and Finance, Wildlife, Range Management, Forestry, and an Anti-Desertification Unit. The institution

covered the country through 18 regional directors, who were responsible for forestry, range and wildlife management within their assigned areas.

The situation today, after several years of civil war, is that little remains of previous achievements. The network of regional offices and its staff at various levels is gone and all activities that were controlled by the Government have stopped. Therewith the various grazing, forest and wildlife reserves have ceased to function, as well as the nurseries, fodder production units, etc., and the training facility for range staff. All publications, maps, aerial photographs and plant collections have reportedly been looted or destroyed.

A new Government has now been formed for Somaliland (still politically not recognized) and efforts are underway to rebuild the country. Because of the importance of the livestock industry for the country, and of the rangelands as primary source of feed, improvements in these areas are of high priority, but because almost nothing remained of what was done before, it is difficult to know where to start. The Director General of Livestock, Forestry and Range has enquired whether FAO could assist the Ministry to develop a 'masterplan for range management and fodder production' for the country, including advice about policies and regulations to be adopted, and recommendations for re-establishment of a programme in the field.

To assist the Government of Somaliland with the establishment of a range management programme, a one year project could be set up, with as full-time staff one international and one national rangeland specialist, and an international fodder production consultant for a period of three months. Objectives of the project would be to establish a basis of information and data, to determine priorities for range improvement and management, and to strengthen the fodder production system in relation to the export of livestock through Berbera. More specifically, the project should address topics such as:

⇒ Reference materials: collection of publications, literature and maps to set up a centrally located, basic library to enable local and visiting specialists to work; the first priority should be to obtain copies of reports and maps prepared during previous projects and studies; options for establishment of a herbarium and links with similar institutions elsewhere should also be investigated.

⇒ Ongoing activities: identification and evaluation of international and national organizations currently involved in studies and activities related to range, forestry, livestock and wildlife.

⇒ Present range condition: assessment of range condition, grazing practices and land use in various parts of the country; if feasible, repeat readings at monitoring points established by Resource Management Research during its survey and inventory carries out in the early 1980s.

⇒ Priorities for action: restoration of the various types of grazing reserves, needs for erosion control and vegetation improvement, etc.; this should include promotion of community involvement, e.g. where communities

should be responsible for improvement and management of renewable natural resources, and where this should primarily be the responsibility of the government.

⇒ Fodder production: analysis of present practices, in particular for feeding of livestock being exported; provide advice for improvement without adverse effect on the rangelands or the living conditions of the Somali pastoralists.

⇒ Legislation: recommendations for rules and regulations to legally support measures to improve and properly manage rangelands and other renewable natural resources, and to enforce sustainable utilization of these resources according to land capability.

⇒ Future assistance: proposals for specific projects in the sector, requiring assistance of foreign donors, specialized agencies and NGOs.

The budget for a one year project is roughly estimated at US $ [illegible], i.e.:

international range management specialist for 1 year	$
international consultant - fodder production 3 mm	
national range specialist for 1 year	
transportation - rent of 1 car for 300 days	
publications	
equipment (computer, office & field equipment)	
communications	
miscellaneous	

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Annex 1

NOTES ABOUT RECOMMENDED PLANT SPECIES

1 GRASSES (FAO, 1990)

1.1 Cenchrus ciliaris L. - African foxtail; Som.: Garraw (?)

Tufted or spreading perennial 12 - 120 cm tall. Deep rooting. Occurs in the hotter and drier parts of India, Mediterranean Region, tropical and southern Africa, now widely introduced. Natural habitat is open bush and grassland. Likes in particular lighter textured soils of high phosphorus status, but thrives also on heavier soil. Prefers pH 7 to 8. Altitude range sea level to 2,000 m. Annual rainfall 375 to 750 mm. Very drought resistant.

The grass is very palatable when young and fairly palatable at maturity. It produces reasonable quality hay when cut in early-flowering stage; old grass, after the seed has been harvested, can give low-quality roughage for drought feeding with supplements. It is best sown just before the expected rainy season at 0.5 to 4 kg/ha, according to seed supplies, costs, and expected rate of full ground cover. One kg contains 450,000 to 703,000 seeds. Freshly harvested seed has poor germination and after-ripening for 3 - 12 months is desirable (seeds remain of mature heads for about two to three weeks). Soil disturbance is generally essential for initial establishment, i.e. *Cenchrus* should be sown in a rough seed-bed (ploughing or disc-harrowing). It can also be broadcasted in scattered locations where soil is disturbed to develop nuclei from where the grass can spread naturally.

C. ciliaris will stand considerable grazing once it is established. Newly established pastures can be used during the winter and spring (dry season) following planting and, if necessary closed to grazing during the following rainy season to set seed and increase plant density. Frequent grazing improves nitrogen content. If used for hay, part of the stand should be excluded so that seed can be collected to expand the pasture area.

1.2 Chrysopogon aucheri (Boiss.) Stapf var. quinqueplumis (A.Rich.) Stapf - Aucher's grass; Som.: Dareemo

Tufted perennial up to 50 cm high with slender, wiry culms; forms low cushions. Occurs in Afghanistan, Pakistan, Iraq, Iran, Somalia, Kenya, Uganda, in general on dry, gravely, often alkaline soils with grass or semi-desert cover. Prefers sandy soils or lava ash, but grows on rocky ground as well. Dominant grass growing on aridisols high in gypsum in Somalia. Altitude range: sea level to 2,000 m. Annual rainfall 250 to 625 mm. Excellent drought tolerance.

It is a leafy grass of high nutritive value, highly palatable to grazing animals. Should be sown in summer at 2.5 kg seed per hectare (one kg contains about 450,000 pure seeds). It is a poor seeder.

2 TREES AND SHRUBS (Carlowitz cs 1990, ICRAF '92, Mbuya cs '94)

2.1 **Acacia bussei** - Som.: Galool Fam.: Mimosaceae

Indigenous shrub or small tree, characterized by swollen white spines; spreading crown, open canopy.
Rainfall: 580 mm/yr; drought hardy
Soils: medium - heavy texture, neutral, deep, well drained
Uses: shoot or leaf fodder (lopping); fuelwood, poles, charcoal, fencing; medicine, fibres, etc.
(only one entry in Tree and Shrub Database)

2.2 **Acacia etbaica Schweinf.** - Som.: Sogsog Fam.: Mimosaceae

Indigenous shrub or tree with pairs of recurved thorns; deep rooting
Rainfall: 460 mm/yr
Soils: medium texture, alkaline, shallow, well drained
Uses: shoot, leaf, pod or seed fodder; fuelwood, charcoal; erosion control or soil conservation, etc.
Propagation: seedlings
(only one entry in Tree and Shrub Database)

2.3 **Acacia nilotica (L.) Willd. ex Del.** - Som.: Maraa Fam.: Mimosaceae

A highly variable species with several subspecies; indigenous shrubs or trees with rounded crown and thin, greyish straight thorns; deep rooting; medium to fast growing on good sites
Rainfall: 580 - 1000 (mean 800) mm per year; drought hardy
Soils: from light to heavy texture, deep or shallow, alkaline to neutral, well drained or waterlogged
Uses: fodder (shoots, leaves, pods); fuelwood, charcoal, timber, poles, fencing, farm implements; erosion control, shade, windbreak, soil improvement, river bank stabilization; gums, medicine, tannin, etc.
Propagation: natural regeneration, seedlings, direct sowing; 7,000 - 11,000 seeds per kg; germination rate 60 - 90%; pre-sowing treatment not necessary for fresh seed, soak stored seed in cold water for 24 hours

2.4 **Acacia senegal (L.) Willd.** - Som.: Adaad Fam.: Mimosaceae

An indigenous shrub or tree to 12 m, rounded crown, small thorns in groups of three, the central one hooked downwards, the two laterals curved up; deep rooting; slow growing
Rainfall: 200 - 1,200 (mean 430) mm/yr; very drought resistant, tolerates high daily temperatures and long dry season
Soils: from light tc heavy texture, shallow or deep, acid to alkaline, well drained or waterlogged (often on poor rocky soils)

Uses: main species for production of gum arabic; fodder (shoots, leaves, pods); fuelwood, charcoal, poles, fencing; erosion control, windbreaks, improvement soil fertility, dune fixation; medicine, fibres, etc.
Propagation: natural regeneration, seedlings, direct sowing; 8,000 - 11,000 seeds per kg, germination rate low // or 10200 - 33,000 seeds/kg and germination rate 70 - 100 % (depending on source of information!); soak seed in cold water for 24 hours

2.5 Acacia tortilis (Forssk.) Hayne ssp. spirocarpa (Hochst. ex A. Rich.) Brenan - Som.: Kura Fam.: Mimosaceae

A widespread indigenous tree with flat-topped or umbrella-shaped crown, often along rivers but can also grow in shallow soil; has pairs of small hooked thorns and pairs of long white spines; produces numerous spirally twisted pods; slow growing
Mean annual rainfall 515 mm; produces very deep roots to collect water
Soils: sandy to loamy, well drained
Uses: pods represent the main value of this species; also browse, fuelwood, charcoal, timber; soil conservation, fencing, nitrogen fixing, shade, fibre, etc.
Propagation: natural regeneration, seedlings; 12,000 - 31,000 seeds/kg; slow germination, pour boiling water over seeds and leave to soak for 24 hours; seed can be stored for a very long period

2.6 Agave sisalana - Sisal Fam.: Agavaceae

A woody herb with whorls of spiny leaves at ground level; flowering stem reaches 6 meter; some flower buds become thick and hard and will root when planted ('bulbils'); drought hardy; whole plant dies after flowering
Soils: sandy loam to clay
Uses: live fences, poles, strong ropes, mats; cut the large leaves to grow a suitable hedge
Propagation: suckers and bulbils; produces little viable seed

2.7 Azadirachta indica A. Juss. - Neem Tree Fam.: Meliaceae

Originally from north-east India and Burma, now widely planted in arid and semi-arid regions of Africa; fast growing, medium-sized evergreen tree with dense, leafy, oval shaped canopy; roots grow deep and wide
Rainfall: 50 - 1500 (mean 870) mm/yr; very drought resistant
Soils: from light to heavy texture, acid to alkaline, deep and well drained; does well on poor soils
Uses: shoot or leaf fodder, fuelwood, poles, timber, charcoal; erosion control or soil conservation, windbreaks, improvement soil fertility, shade; oil, insecticide, medicine, cosmetics, etc.
Propagation: natural regeneration, seedlings, direct sowing, etc.; pre-sowing treatment not necessary; seed can be stored for up to one month;

4,400 to 6,300 seeds per kg, germination rate 35 - 65%; spreads easily and may become a weed in some areas

2.8 **Prosopis cineraria (L.) Druce** Fam.: Mimosaceae

Originally from Punjab, western India, Afghanistan, Iran; a low tree with slender grey branches, spiny, deep rooting
Rainfall: 50 - 850 (mean 340) mm/yr; drought hardy
Soils: light / sandy, alkaline / neutral, shallow or deep, well drained
Uses: fodder (shoots, leaves and pods), fuelwood, charcoal, poles, etc.; erosion control/soil conservation, nodulating, windbreaks; (was highly regarded as browse plant for cattle, sheep and camels in Jodhpur, India, with high yields and high palatability and nutritive value; can stand recurrent and severe loppings; FAO 1988)
Propagation: natural regeneration, seedlings, direct sowing; 25,000 - 27,000 seeds/kg, germination rate 60 - 90%; may become invasive

2.9 **Schinus molle L.** - Pepper tree; Som.: Miri miri; Fam.: Anacardiaceae

Originally from Peru, now commonly planted in dry warm climates throughout the world; a very common, tree in towns and villages in Somaliland; up to 15 m, evergreen, with weeping foliage; reaches maturity in less than 20 years; shallow rooted
Rainfall: 300 - 620 (mean 550) mm/yr; extremely drought resistant
Soils: light to heavy texture, alkaline or neutral reaction, deep soils
Uses: spices (from berries and leaves); fuelwood, charcoal, posts; erosion control / soil conservation, shade, ornamental, windbreaks, live fence; medicine, latex
Propagation: seedlings; pre-sowing treatment not necessary; 31,000 - 44,000 seeds per kg; germination rate 40 - 80 %; seeds can be stored

2.10 **Ziziphus mauritiana Lam.** - Som.: Gob Fam.: Rutaceae

Originally from south-east Asia, now widespread in Africa; common in Somaliland; a much branched, spiny tree up to 7 m, with drooping angular branches and a rounded crown; fruit rounded, 1-2 cm, edible, with 2 seeds in a large stone; strongly developed root system
Rainfall: 246 - 2690 (mean 720) mm/yr
Soils: light to medium texture, neutral to alkaline, shallow or deep, well drained; best in areas with high water table
Uses: edible fruit; fodder (leaves and fruit); fuelwood, timber, poles, charcoal; soil conservation, live fence, shade, windbreaks; medicine, tannin
Propagation: natural regeneration, seedlings, root suckers, direct sowing, cuttings; 650 - 3,500 seeds per kg; germination rate 30 - 70 %; crack hard seed cover to release 2-3 seeds; seed can be stored up to 1 year

Annex 2

METHODOLOGY FOR ESTIMATION OF GRAZING CAPACITY

The following methodology was used in the Northern Rangeland Development Project to assess grazing capacity for various types of grazing reserve and co-operative ranches (Heemstra 1980, 1981a, b and c):

Using available aerial photographs and/or satellite imagery, a map was prepared showing the basic features and the different vegetation units. The area of each of these units was measured with a planimeter and its size was calculated in hectares.

For each unit available forage was assessed at a representative site (more than one for very large units), using a method of combined measurements and estimates. Along a transect line a one square meter quadrat was placed at ten meter intervals. In the first few plots those parts of the vegetation that would be grazed or browsed were clipped, separating the different components of the vegetation (grasses, forbs, dwarf shrubs and shrubs; the last were clipped up to a height of two meters only). The various parts were weighed and samples were kept for drying. After four days those samples were weighed again to obtain a correction factor to determine air-dry weight. After clipping the first plots (e.g. 3), the following quadrats were partly estimated, partly clipped. Generally every fifth plot was clipped, but those where estimation proved difficult were clipped as well.

The total number of plots was not fixed, but was reached as soon as the last mean total weight did not differ by more than a desired relative value (e.g. 5%) from the preceding mean and fell between the two preceding means.

Using the correction factor obtained from the air-dried samples, available forage was calculated in gram per square meter air-dry, which was translated into kilogram per hectare. Before converting this to grazing capacity, the proper use factor of the key species had to be determined, that is 'the proportion of the plants that may be eaten while leaving enough to maintain the vigour and the quantity of vegetation on the range'. Under good range conditions this will normally be 50%, but lower rates should be adopted where rangelands are in poor condition and soil erosion is of concern. In such cases overgrazing of the more palatable species should be prevented, and total utilization may be only 28% if utilization of those key species is to be 50%.

After determination of the utilization rate, the amount of usable forage can be determined for each of the vegetation units (= total available forage x a factor between 0.28 and 0.50). This will be sufficient to feed a certain number of animals for a certain period of time. As basis for calculation of grazing capacity an Animal Unit with a live weight of 220 kg has been used. This corresponds to the average weight of cattle in Somalia and to half a Standard Stock Unit, a measure used elsewhere ('one S.S.U. = a mature bovine with a live weight of 450 kg and consuming 4100 kg DM/year'). Allowing for a daily dry matter intake of 2.5% of live weight, one A.U. will consume 5.5 kg DM/day; the total

number of Animal Units that should be allowed on the range and the duration of grazing can be calculated accordingly. For other livestock classes the following ratio can be used (based on average live weights): 1 A.U = 1 cow = 10 sheep and goats = 2.5 donkey = 1 camel where sufficient browse is available (presuming that camels will get part of there diet from a greater height than what was clipped) or 0.45 camel if browse is insignificant.

The importance of browse depends on the classes of livestock; it is low for cattle (10%) and sheep (30%), but high for goats (60%), donkeys (60%) and camels (70%).