DESERTIFICATION CONTROL IN AFRICA

ACTIONS AND DIRECTORY OF INSTITUTIONS

VOLUME I

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UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

DESERTIFICATION CONTROL IN AFRICA

ACTIONS AND

DIRECTORY OF INSTITUTIONS

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CONTENTS

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ABBREVIATIONS

Abbreviations of titles of national organisations mentioned only under the country concerned are not included in this list

ABEDA	Arab Bank for Economic Development in Africa
AFESD	Arab Fund for Economic and Social Development
AGFUND	Arab Gulf Programme for United Nations Development Organizations
CDA	Co-ordination for Development in Africa
CEAO	West African Economic Community (Communauté Economique de l'Afrique de l'Ouest)
CIDA	Canadian International Development Agency
CILSS	Permanent Interstate Committee on Drought Control in the Sahel
DANIDA	Danish International Development Agency
DESCON	Consultative Group for Desertification Control
ECA	Economic Commission for Africa
ECE	Economic Commission for Europe
ECWA	Economic Commission for Western Asia
EDF	European Development Fund
EEC	European Economic Community
ETMA	Environmental Training and Management in Africa
FAO	Food and Agriculture Organisation of the United Nations
IAEA	International Atomic Energy Agency
ICIPE	International Centre for Insect Physiology and Ecology
ICRISAT	International Crops Research Institute for the Semi-arid Tropics
IDA	International Development Association
IDB	Islamic Development Bank

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IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Centre for Africa
ILO	International Labour Organisation
IPAL	Integrated Project on Arid Lands, UNEP/UNESCO
ITDG	Intermediate Technology Development Group
IUCN	International Union for Conservation of Nature and Natural Resources
KFAED	Kuwait Fund for Economic Development
MAB	Man and the Biosphere programme, UNESCO
MIRCENs	Microbiological resources centres
NEF	Near East Fund
OAU	Organisation of African Unity
OECD	Organization for Economic Co-operation and Development
ORSTOM	Office for Overseas Scientific and Technical Research (Office de la Recherche Scientifique et Technique Outre-mer)
SADCC	Southern African Development Co-ordination Conference
SAREC	Swedish Agency for Research and Development Co-operation with Developing Countries
SIDA	Swedish International Development Authority
UNCDF	United Nations Capital Development Fund
UNCHS	United Nations Centre for Human Settlements
UNCOD	United Nations Conference on Desertification
UNDP	United Nations Development Programme
UNDTCD	United Nations Department of Technical Co-operation for Development
UNEP	United Nations Environment Programme

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UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNSO	United Nations Sudano-Sahelian Office
UNU	United Nations University
USAID	United States Agency for International Development
USNRC	United States National Research Council
WADB	West African Development Bank
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization
WWF	World Wildlife Fund.

INTRODUCTION

One of the programme objectives of the UNEP Desertification Control Programme Activity Centre since its establishment as the Desertification Branch in early 1978 has been to promote the transfer of desertification control methods successfully utilized in African countries. The basic strategies adopted to accomplish this objective have included:

(a) The organization of international and regional training workshops, seminars and courses on desertification control for technicians and specialists from developing countries;

(b) The dissemination of information and development of educational programmes to increase general knowledge through the preparation, publication and distribution of teaching and management manuals and a biannual bulletin entitled Desertification Control;

(c) The use of films and other media for the mass circulation of information;

(d) The preparation of an annotated directory providing information on individuals and institutions involved in anti-desertification activities in African countries.

In decision 10/18, adopted in May 1982, the Governing Council of UNEP urged the Executive Director to provide additional resources to facilitate a process of exchange of information and expertise on desertification matters among the countries of the Sudano-Sahelian region, and between them and the other countries of the African region which have similar problems.

Follow-up to decision 10/18

To comply with this decision, a project entitled "Promotion of exchange of information and expertise on desertification matters" (FP/1700-82-08) was developed by UNEP. The Desertification Control Programme Activity Centre arranged for consultants to visit five countries in North Africa and six countries in Eastern and southern Africa that are prone to desertification in order to compile:

(a) A draft survey of available information and experience in desertification control technology;

(b) A draft directory of national, regional and international institutions within Africa involved in research and training or responsible for the implementation of desertification control projects.

A similar draft survey and draft directory were compiled by consultants engaged by the United Nations Sudano-Sahelian Office (UNSO) for all the countries of the Sudano-Sahelian region.

The consultants were given terms of reference to enable them to:

(a) Draw up a draft survey containing information on:

(i) Current anti-desertification programmes;

(ii) Records of successes and/or failures in earlier and current anti-desertification activities;

(iii) Successful and interesting programmes, pilot projects and activities suitable for duplication (with modifications if necessary) in other African countries;

(iv) Available information and experience on desertification control technology which could be of benefit to other African countries, and could therefore be transferred to them;

(b) Draw up a draft directory containing information on:

(i) National, regional and international institutions involved in research and training on subjects relevant to desertification, including soil and water conservation, irrigated and rain-fed agriculture, range management, animal husbandry, forestry and tree planting, use of wildlife, demography, and the social and economic problems of arid and semi-arid lands;

(ii) Governmental organizations responsible for the implementation of desertification control projects;

(iii) Non-governmental organizations concerned with desertification matters.

In North Africa, the consultant visited Algeria, Egypt, Morocco and Tunisia. Information on the Libyan Arab Jamahiriya was obtained from secondary sources. The 19 countries of the Sudano-Sahelian region were visited: Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Djibouti, Ethiopia, Gambia, Guinea, Guinea-Bissau, Kenya, Mali, Mauritania, Niger, Nigeria, Senegal, Somalia, Sudan and Uganda. In Eastern and southern Africa, the consultant visited Botswana, Lesotho, Madagascar, the United Republic of Tanzania, Zambia and Zimbabwe.

It was not possible to obtain information on all the countries affected by desertification in Central, Eastern and southern Africa, and Angola, Burundi, the Central African Republic, Malawi, Mozambique, Namibia, and Swaziland were omitted. UNEP hopes that in due course these countries will provide relevant information for the completion of the survey and directory.

Meeting on Promotion of the Exchange of Information and Expertise on Desertification Matters in Africa

The reports of the consultants' missions were reviewed at a meeting held at UNEP headquarters in Nairobi from 6 to 8 September 1983. Participants included one representative from CILSS and one from UNSO, in addition to those from the UNEP Desertification Control Programme Activity Centre, the Information Service, the Regional Office for Africa and the Environmental Education and Training Unit. Only one of the consultants was able to attend. The purpose of the meeting was:

(a) To review the consultants' draft surveys and directories and determine their adequacy for the preparation of a consolidated document;

(b) To recommend ways of ensuring maximum distribution and use of the final document;

(c) To propose a detailed follow-up programme to ensure that the broad objectives of the Governing Council decision would be fulfilled.

The comments of the meeting on the content and organization of the draft surveys and directories are reflected in the present document.

The experience gained in the planning and implementation of anti-desertification projects in the Sudano-Sahelian region countries revealed that:

(a) The most successful desertification control projects had been those with specific, well-defined goals of a limited nature;

(b) Too many projects failed to involve the local population in the planning and implementation phases, and this contributed significantly to failure to achieve their objectives;

(c) There was not sufficient planning in many countries, due in part to the fact that local manpower was inadequately trained;

(d) Although CILSS could provide limited financial and technical assistance, it was for Governments to decide on priority areas, and to formulate projects and take responsibility for funding them.

The exchange of information between the French-speaking and English-speaking countries of North Africa is somewhat limited. Arabic might help to bridge the gap, but cannot be of use in exchanges with non-Arabic speaking countries.

Organization of information

The five mission reports are presented in two volumes. Volume I is entitled "Actions" and contains a survey of available information and experience on desertification control activities and technology during the past five years, and the performance of past and current projects and programmes considered to have potential for replication in other African countries. It is divided into three parts, one for each of the subregions, and each part has an introductory summary to facilitate a comparison of levels of anti-desertification activity.

Volume II is a directory of institutions involved in research and training or in the implementation of desertification control programmes, and lists available manpower in terms of scientists and specialists. It is divided into three parts corresponding to the 3 subregions, and each part contains chapters on the countries of the subregion. Each chapter contains information on national, regional and international organizations and institutions. Scientists and specialists are listed under the institutions. For the countries of the Sudano-Sahelian region, information on institutions was gathered from various sources, including field project personnel and consultants. In both volumes there are likely to be information gaps in respect of activities, institutions and lists of scientists and specialists, and UNEP hopes that both the institutions concerned and knowledgeable individuals will co-operate in filling these gaps by forwarding additional information to the Desertification Control Programme Activity Centre in Nairobi.

Promotion of the exchange of information and expertise: the utility of the report

The principal objective of decision 10/18, paragraph 5, and accordingly of this report, is the exchange of information and expertise on desertification matters in Africa. It is envisaged that the report will be distributed as widely as possible to African countries and to international institutions involved in assisting African countries affected by desertification. In addition, however, UNEP hopes that the two-volume document will not only be a useful reference source but will stimulate and encourage:

(a) Discussions within individual countries, by institutions, scientists and specialists, drawing from experience and expertise gained locally and from elsewhere in Africa. Seminars and workshops will be a particularly useful means of stimulating these exchanges;

(b) Contacts and exchanges of information and experience on desertification causes, processes and control technology between the institutions in the three subregions as well as between scientists and specialists. Regional and subregional seminars and workshops might provide a further means of achieving this objective;

(c) The mobilization or deployment of available scientific and specialist manpower at the national, subregional and regional levels.

There are various approaches which could be employed to enhance the utility of this report. UNEP would welcome additional suggestions to this effect from concerned institutions and individuals.

Acknowledgements

This document could not have been published without the co-operation of the Governments, institutions and individuals of the countries surveyed in it. The UNDP country offices and other locally based international institutions also played a key role in facilitating the task of the consultants. Dr. Hisham el Shishiny carried out the consultant missions in North Africa, while Professor Michael B.K. Darkoh carried out the consultant missions in Eastern and southern Africa, both on behalf of the Desertification Control Programme Activity Centre. Mr. Jeffrey A. Gritzner and Ms. Sian Steward gathered information for the directory of institutions from various sources in the countries of the Sudano-Sahelian region on behalf of UNSO. Mr. John Kundaeli consolidated and edited the reports prepared by the consultants. UNEP wishes to express its gratitude to them and to all others who contributed in any way.

PART I

NORTH AFRICA

GENERAL OBSERVATIONS

1. In North Africa the critical desertification zone lies between the 400 mm and 100 mm isohyets; the zone below the 100 mm isohyet is arid to hyper-arid, situated within or closely bordering the Sahara. The arid and semi-arid zone covers approximately 206,579 square kilometres in Algeria, 91,220 square kilometres in the Libyan Arab Jamahiriya, 66,880 square kilometres in Morocco and 58,510 square kilometres in Tunisia. Winter precipitation, typical of the Mediterranean climate, and long, hot dry summer months are a feature of this region. Egypt has approximately 2.7 million hectares of arable land; 96 per cent of the country is desert.

2. Livestock raising is the major traditional economic activity of the peoples of this region; sheep are the most important animals and are raised for their wool and meat. Also important in the more humid areas is the cultivation of grains, particularly wheat and barley, and this has been encouraged by the introduction of mechanized agriculture and the exploitation of underground water sources. Arboriculture, of olives, almonds, figs, citrus fruit, grape vines, and date palms (at oases), occurs along the Mediterranean coast and in parts of the hinterland.

3. The people of the arid zones still lead a nomadic life, although Tunisia is changing this mode of life by encouraging sedentarization based on mixed farming. A similar process is taking place in other countries, for example in Algeria and the Libyan Arab Jamahiriya, where it is supported by increased incomes from oil and natural gas. This enhanced power to invest in capital development and in agriculture has had a telling impact on grazing lands and woody vegetation formations alike. Agriculture has encroached into alfa and steppe grasslands and there has been increased tapping of underground water sources for irrigation and stock supplies. Unfortunately, these developments have not always been accompanied by ecologically sound patterns and practices of land use. And most of the human population of the drylands is not yet sufficiently well informed or motivated to be committed to soil and water conservation.

4. Closely related are the demographic factors of population growth and movement. The depopulation of rural areas is a marked feature of the oil-rich countries of the region, and there is considerable movement from rural areas to urban centres. In these and the other countries of the region there is also movement to Europe in search of employment, with earnings remitted home to be added to revenues from the oil industry.

5. Desertification is thus a product of complex human factors linked to climate, soils and water, and exacerbated by inappropriate land use patterns and practices. The collection of wood for fuel and other needs, and uncontrolled forest fires, have combined to reduce vegetation cover and induce both wind and water erosion. In areas of irrigated agriculture, especially where the land is better-suited to grazing, and around oases, there have been problems arising from salinization.

6. In short, the degradation of land resources has meant lower productivity, desert encroachment and rural poverty.

7. For some time now, Governments of the region have been taking measures at local and national levels to combat desertification. These have included afforestation and reforestation programmes, for example the "Green Dam" in Algeria, the stabilization of sand dunes and sand drift in Libya, land reclamation in Egypt, oasis development in Morocco, soil, water and forest conservation, and the management and development of grazing areas. Some have placed emphasis on research and pilot projects, in particular with regard to sand dune stabilization and studies of native and exotic species suitable for drought-prone desert environments. For example, a desert species seed bank is now being established in Algeria which will be of benefit to the other countries of the region.

8. Progress in combating desertification has been hindered by social, financial and, in some countries, technical problems. Programmes and projects have not always given adequate attention to social aspects, particularly those introducing new approaches to land use and economic productivity. The involvement of the people in the evolution, planning and implementation of activities has been shown to be very beneficial. Where possible, emphasis should be placed on measures that prevent rather than cure problems such as overgrazing, unsuitable cultivation practices, the collection of wood for fuel, the use of bush fires, and unplanned agricultural expansion involving the removal of woody vegetation cover or the clearing of land for grazing. Also important is the rationalization of areas to be reafforested, where attention is not always given to grazing needs.

9. Insufficient trained manpower and patterns of financial resource allocation have hampered progress in the control of desertification in most of the countries of the region. This has affected not only research, pilot projects and land use plans, but also the promotion of an awareness of conservation needs among the people of the rural areas. Nevertheless, as can be seen from the various activities covered in the report, there exists a wealth of experience in desertification control of relevance to other parts of Africa.

CHAPTER 1: ALGERIA

A. Problems of desertification and current status

10. Arid and semi-arid areas account for more than 65 per cent of the total surface area of Algeria. They extend right along the Saharan Atlas and cover over 20 million hectares. Woody vegetation formations (forests, maquis and bush) cover approximately 3.6 million hectares or 11 per cent of northern Algeria, while alfa and steppe grasslands occupy 4.6 million and 15 million hectares respectively. Approximately 60 per cent of the 3.6 million hectares of ligneous vegetation has been degraded, mainly by fire which burns about 40,000 hectares per year, by disease and by deforestation. The collection of wood for fuel adds a further constraint to the stability of these woody formations.

11. The alfa and steppe grasslands are subject to overstocking and overgrazing pressures, clearing for cultivation (which has put some 1.1 million hectares of otherwise good grazing lands under cultivation), and unplanned development in general. The livestock population stands at about 12 million head, with sheep (10 million head) being the most valued for wool and meat. Livestock raising is the most important economic activity of the population and nomadism is a major mode of life, particularly in the drier areas.

12. Large areas of the arid and semi-arid zones have been transformed and degraded due to human and livestock pressures. Wind erosion is particularly serious in the steppe while water erosion is particularly serious on the denuded slopes of the foothills of the Tellian Atlas and Saharan Atlas. Following the degradation or even disappearance of the plant cover, which performs a soil stabilization function, sand has invaded areas north of the Saharan Atlas, with discontinuous sand dunes extending several kilometres from west to north-east. Some large settlements and cultivated lands are threatened by shifting sand dunes and sand drift.

13. The Government of Algeria has adopted a variety of programmes for desertification control, such as the Barrage Vert ("Green Dam") in the marginal part of the steppe between the 200 mm and 300 mm isohyets. This area, 1,500 kilometres long and an average of 20 kilometres wide, covers almost 3 million hectares and stretches from the Tunisian border at one end to the Moroccan border at the other. The objectives of this project are being pursued through integrated activities based on the need to protect land against wind and water erosion and to meet the needs of the people living in the region.

The intensification of diversified activities (reafforestation, dune fixation, rangeland improvement, infrastructure and so on) stems from a determination to introduce rational agricultural practices. The ultimate goal is to restore the ecological balance, and at the same time to maintain productivity in line

with the demands of the people. Accordingly, the development programmes have been implemented as follows:

- Reforestation of large forest areas, strips, green belts and wind breaks;
- Rangeland improvement by enhancing plant cover and forage production;
- Mobilization of water resources;
- Establishment of a socio-economic infrastructure in keeping with the national policy of balance betweens the regions;
- Development activities on land of high potential;
- Promotion of soil conservation activities on eroded and desertified land; and
- Adaptability testing of various species which are to be introduced in the Barrage Vert area.

B. Current Anti-desertification Programmes and Projects

14. The sand dune fixation in desert areas programme, started in 1983: This on-going programme was initiated by the Ministry of Water Resources, the Environment and Forests. Its most urgent objective, in view of the increased generalised movement of sands in recent years, is to stabilize continental sand dunes in the most severely affected areas. These areas include the wilayates of Djelfa, Msila and Naâma in the pre-Saharan zone and Tamanarasset in the Saharan zone.

15. Amelioration of horticulture project, started in 1983: This is a three year project financed by FAO, UNDP and the World Food Programme (WFP). Its objective is to develop the production of fruit and olive trees. The project also aims at raising the income of the population living in the semi-arid area of the Tellian Atlas.

16. Study of Bayoud disease (Fusarium oxysporum albedinis) attacking palm trees (Phoenis dactylifera): Bayoud is an important disease which attacks palm trees, causing a decrease in vigour and fruit production. The fruits or dates are the main food of the desert population. The National Research Centre for Arid Zones (Centre National de Recherche sur les Zones Arides (CNRZA)) is studying the biology of date palms in order to increase production. A genetic study is also being conducted to select species resistant to this disease. In addition, the biological and chemical control of Bayoud is being investigated.

17. Phytosociological and floristic study of the region of Djelfa and El Hamel: This project started in 1975. It is a joint activity of CNRZA, the Ministry of Agriculture and the Ministry of National Defence. The activities undertaken under this project include:

- a biological and cytological study of the alfa Stipetum tenacissima L. and a biochemical study of its leaves;
- preparation of a vegetation map of the El Hamel region;
- determination of the chromosomic number of various species of the region of Djelfa; and
- a micro-biological study of alfa soils.

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18. Eco-physiological study of the mammals of arid and semi-arid areas: This activity is being undertaken by CNRZA and comprises the following studies:

- a study of the physiology of reproduction;
- a study of physiological adaptation mechanisms to desert conditions.

19. The desert species gene bank : This project started in 1983 and is a joint research project of CNRZA and the Haouari Boumedian University. It is financed by the National Office for Scientific Research (ONRS). Its main objective is to establish a gene bank of the plant species of the Algerian Sahara. The project also aims at the conservation of desert species and the regeneration of some of these species. The activities of this project are conducted at the El Golea Research Station.

20. Study of the fungus Terfezia: Terfezia is an edible fungus growing naturally in desert areas. It represents an important element in the diet of the desert inhabitants of Algeria. This research activity is conducted by CNRZA and involves the study of the biology and physiology of Terfezia.

21. North African Green Belt: Algeria has joined Libya and Tunisia in signing a protocol for this transnational project which was begun in 1979. The project is managed by a Permanent Joint Committee of members of the participating governments, under the direction of ALECSO. Regional training programmes, studies and seminars on desertification control have been conducted.

C. Records of Successes and/or Failures

22. The Green Dam Programme: This most important programme started in 1971 and is being conducted by the members of the Algerian Army National Service. Its purpose is to arrest the process of desertification in the Algerian steppe by the plantation of a forest approximately 1500 kilometres in length and approximately 20 kilometres in width, stretching from the west to the east of the country along the Saharan Atlas. This integrated development effort will cover in total a surface area of some 3 million hectares, and will involve:

- Reforestation on degraded soils;
- Planting forage species in order to raise rangeland potential;
- Agricultural development in suitable areas;
- An expansion of the infrastructure through the construction or improvement of rural roads and water points.

The main species used for the Green Dam were initially Pinus halepensis and Stipetum tenacissima.

23. The major problems encountered during the early stages of the programme were:

- the danger of having a predominance of a single species (Pinus halepensia) in the forest areas, as this renders them more susceptible to fire hazards and forest diseases;
- the high density of trees (2000 trees per hectare) given the scarcity of water resources;
- the lack of consideration given to soil characteristics and local conditions; and
- the diminution of grazing areas due to the extensive plantation of forests.

24. Corrective action is now being taken through the introduction of other tree species, mainly Atriplex parvifoluis lowel, Atriplex halimus, L.; Pistacia atlantica, and Lygeum spartum, L. In addition, socio-economic factors are being taken into consideration. The area involved in the project sustains a population of approximately 4 million people and measures such as the establishment of water points, village construction and the creation and improvement of grazing areas are being undertaken.

25. The methodology currently being adopted in the programme combines desertification control with the development of the resources of each region. There has been some species diversification and there are now 24 forest and forage species used in the forest belt, including:

- Cypres Arizona
- Cypres Sempervirens
- Acacia Cyanophilla
- Acacia Farnesania
- Acacia Picnantha
- Fevier d'Amérique
- Prosopis Juliflora
- Tamarix Sp.
- Casuarina Sp.
- Olivier de Bohème
- Atriplex Halimus
- Atriplex Cannescens
- Pistacia Atlantica.

26. Protection of the Abadla Perimeter (Bechar) programme: In the 1970's the Government of Algeria started an ambitious agricultural development programme for the desert region of Abadla in the south-west of the country. A dam was constructed (the Djorf Torba Dam) and a water distribution network designed. Agricultural projects in this area are threatened by wind erosion, shifting sand dunes and sand drift. Since 1974 the Algerian National Institute of Agricultural Research (INRAA) in collaboration with INRF has been conducting a programme aimed at the protection of the Abadla Perimeter. The main objectives of this protection programme are the improvement of existing tree species, the stabilization of sand dunes, the selection of species suitable for wind breaks, the creation of a green belt surrounding the perimeter and the identification of tree species resistant to drought

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and salinity. Valuable experience in the field of wind break construction and green belt plantation has been gained during the implementation of this programme.

D. Information and Experience in Desertification Control

27. Plant species utilized in sand dune fixation: The following plant species have proved to be effective in sand dune fixation:

- Aristida pungens
- Retam retam
- Calligonum comosum
- Tamarix gallica
- Prosopis juliflora
- Acacia farnesiana
- Acacia ebernua
- Parkinsonia aculeata.

These species are characterised by their fast growth rate, moderate water requirements and resistance to sand drift. Prosopis juliflora was found to be the most successful species.

28. Plant species utilized in wind-breaks : The most efficient plant species used in Algeria for wind-breaks are:

- Casuarina tenuissima angustifolia
- Cupressus sempervirens
- Tamarix articulata
- Eucalyptus accidentalis
- Eleagnus
- Punica granatum
- Acacia cyanophylla
- Acacia farnesiana.

29. The use of green belts for the protection of Abadla region against wind erosion: It has been found that the most effective green belt structure to protect the region of Abadla (desert area) against wind erosion is the following:

- first three external rows: Acacia farnesiana
- next three rows: Eleagnus angustifolia
- next eight rows: Tamarix articulata
- next ten rows: Casuarina tenuissima
- next three rows: Cupressus sempervirens
- next three rows: Parkinsonia aculeata
- next two rows: Acacia cyanophylla
- last two rows: Punica granatum
- one row of Takaaboucht.

The distance between rows is 1.8 metres and between trees is 1.2 metres. The water required for irrigation is 600 to 800 cubic metres per hectare. The frequency of irrigation is as follows:

- first year: 8 times
- second year: 6 times
- third year: 4 times
- fourth and fifth year: twice.

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CHAPTER 2: EGYPT

A. Problems of Desertification and Current Status

30. Only about 2.8 per cent of the total land area is cultivated; deserts account for about 96 per cent of total land area. About 2.7 million hectares are arable, of which 134,000 hectares are under permanent cultivation. There has been an average of 0.83 per cent annual expansion of cultivated areas over the period 1965 - 1978, mainly due to irrigated agriculture centred on cereals and cotton.

31. Forest, including artificial plantations, covers a negligible area, about 2,000 hectares, principally along the Mediterranean coast, the Nile Delta and in pockets along the Red Sea coast. The River Nile Valley and Delta is the most agriculturally productive area. This is also the area sustaining the greater part of the rural population which for millenia has tapped the waters of the Nile for irrigation. There is a relatively high cattle, including buffalo, population (44 per cent of ECWA region), integrated with crop production. In addition to the River Nile, underground water sources are being exploited for irrigation in the New Valley, the fringes of the Nile banks, and the Wadi El Salhia and Siraf oases. There is however an estimated potential of 0.5 milliard cubic metres of underground water for future development of the Nile and Delta areas.

32. The problem of desertification revolves around the salinization of irrigated areas, grazing intensity and the removal of woody vegetation which accelerates wind and water erosion, land speculation, and removal of silt from good agricultural land for brick manufacturing. A further constraint is the extension of agriculture into more marginal areas and the loss of fertile arable land to urban expansion and development. Approximately 25,000 feddans (1 feddan = c. 0.42 of a hectare) are lost in this way every year. At the same time the increase in population density aggravates the problems of desertification (the growth rate was about 2.6% in 1981). The New Valley is facing serious problems of degradation due to a lack of planning - pumping projects were carried out before the completion of relevant surveys and investigations.

B. Current Anti-desertification Programmes and Projects

33. The Government of Egypt has instituted various measures and programmes to control desertification and to increase land productivity. They include water resources management programmes, research into drought and salinity resistant plants under arid environments, stabilization of sand dunes, and systematic ecological investigations such as the studies under way along the Mediterranean coast which seek to provide a scientific base for the planning of the development of these areas. Individual projects are described in the following paragraphs.

34. Master Land Plan for Egypt: Phase I of this project started in 1982. The Ministry of State for Housing and Land Reclamation is the responsible agency for the planning, implementation and administration of this project. The long-range objectives of the project are to enable the Government to optimize the development and use of land and water resources.

35. The immediate objective of the project is to prepare a Master Plan for the optimum development of land resources for future agricultural expansion. The project is designed to determine priorities for short and long-term land reclamation plans and investment policies.

36. The study area covers the land outside the present cultivated Nile Valley and Delta. Physiographically, it can be divided into the following regions:

- East of the Delta
- North of the Delta
- Sinai Peninsula
- High Dam Lake
- West of the Delta
- Mid Delta
- Middle and Upper Egypt (both sides of the Nile Valley)
- New Valley and South New Valley

37. The study comprises two phases. Phase I is concerned with areas having already available soil maps and sufficient information to classify and arrange them in order of priority according to their suitability for economic agricultural development. Phase II will be concerned with areas not covered during Phase I of the project, for which reconnaissance and semi-detailed soil surveys exist.

38. Master Plan for Water Resources Development and Use (Phase II): This phase started in January 1982. The overall purpose of the project is to optimize the utilization of water resources through a balanced development and use policy aimed at improving agricultural production and environmental protection. The main achievements of Phase I were the establishment of a nucleus for water planning, the creation of the Water Planning Data Bank, the development of tools and methodologies for water planning, and the creation of awareness on the part of decision makers regarding the imperative need for integrated water planning.

39. During Phase II the Water Planning Team will continue the water planning process started in Phase I with emphasis on expanded planning outputs. It will:

(i) Draft a five-year investment schedule (1983-1987) for water resource development and management;

(ii) Revise the long-term (20 years) framework plan for resource development and management projects and programmes;

(iii) Prepare policy guidelines for the allocation of water for complementary and conflicting uses based on the economic value of water and national policies and priorities;

(iv) Continue analytical and planning support to Government units concerned with water resources; and

(v) Design survey programmes to obtain data deemed essential for water resource planning and management.

The project is funded by UNDP and executed by the World Bank; the Ministry of Irrigation is the implementing agency on behalf of the Government.

40. New crops for arid and semi-arid lands project: The purpose of this project is to test the possibility of introducing new plant species that can resist drought and salinity in arid lands. Activities include detailed studies of the effect of drought and salinity on the growth of these species, a survey of agricultural pests affecting them, and suitable pest control methods. The project is part of the Applied Science and Technology Project financed by USAID and sponsored by the Academy of Scientific Research and Technology. Responsibility for implementation lies with the National Research Center in co-operation with the Faculty of Agriculture of El Azhar and Ein Shams Universities. Several sites have been selected for field studies and include El Baharia Oasis and Koum Ouchim in Fayoum.

41. Groundwater study of North-east Africa: This project comprises the Egyptian national component of the Transnational project "Management of Major Regional Aquifer - North-east Africa" which was approved for development by the United Nations Conference on Desertification (UNCOD) in 1977. It started in 1982 for a duration of five years and is partly financed by UNEP, the United Nations Department for Technical Co-operation for Development (UNDTCD) and the Government of Italy. The long range objectives of the project are:

- to evaluate the size of the Nubian Sandstone reservoir and its recharge sources;

- to provide guidelines for the agricultural development of desert lands which include anti-desertification measures; and

- the implementation of the study plan in Egypt and Sudan as a first step towards the extension of the project to other countries in north-east Africa, and the implementation of similar projects in the Arabian Peninsula.

42. The immediate objectives of the project are to:

- test the effectiveness of the use of modern survey techniques in the search for groundwater reservoirs in remote areas;

- demonstrate the optimum use of groundwater in land reclamation and desertification control;

- train the staff of national research institutes in modern survey and reservoir management techniques;

- prepare the necessary maps and reports required in the exploitation of underground reservoirs;

- study appropriate means for establishing a bank for the data collected;

- co-ordinate studies in the field of groundwater research;

- promote the exchange of information in the field of groundwater utilization in desert areas between the concerned countries; and

- provide technical advice to the governments of these countries in the field of planning and management of groundwater reservoirs.

43. The national programme for sand dune fixation: This programme started in 1980. It is financed by the Academy of Scientific Research and Technology and implemented by the Desert Institute. Its main objectives are to study the geology of sand dunes, the distribution of sand dunes in Egypt, the plant ecology of sand dunes and means and methodologies for sand dune fixation. Several pilot areas were chosen for this study including El Khanka near Cairo, El-Arish in the Sinai and El-Kasr in the north-west coastal region.

44. The achievement of this programme has been the development of a technique for sand dune fixation through the use of petroleum sheets as a temporary means of sand dune fixation (2 years) and the use of Acacia, Prosopis and Atriplex species (drought and salinity resistant) as permanent tools for sand dune fixation.

45. The programme has also carried out experiments on the use of mechanical fences adapted to the aerodynamics of each region.

In spite of the importance of this programme, it is hampered by budget limitations and a lack of properly trained personnel.

46. Agricultural development for areas of the Sinai: This project is financed by the Academy of Scientific Research and Technology and implemented by the Desert Institute. Its objective is to study the water and soil resources, vegetation cover and agricultural potential of several pilot areas in the Sinai in order to identify appropriate agricultural development methodologies suitable for arid areas.

47. The project has established an experimental farm at Ras Sudr (60 km from Suez) where field studies are conducted to explore the proper use of available soil and water resources under Sinai conditions.

48. Desert Development Demonstration and Training Programme (DDC): In 1979 the American University in Cairo started a programme aimed at conducting research and undertaking demonstrations and training in desert development. The major emphasis is on applied research into alternative integrated approaches to arid land agricultural and community development. The programme also seeks to develop and demonstrate economically viable systems that can be used by Government and private enterprises in establishing communities in desert environments.

49. The specific objectives of this programme are to:

- search for appropriate technologies in desert agriculture where water and nutrients are scarce and energy expensive;
- harness the abundant renewable energy resources of the desert and develop technologies useful in desert environments;
- identify and demonstrate desert community development strategies that are socially acceptable, compatible with local resources and which protect the natural environment; and
- disseminate the results through demonstration sites, consultation and training.

50. The DDDT title was given to what was originally one project initiated in 1979 by the American University in Cairo. This activity attracted a number of funding agencies, each sponsoring a specific project under the general title of Desert Development Demonstration and Training. The sponsoring agencies include the Egyptian Government, the International Development Research Centre (IDRC), the Near East Foundation (NEF), the World Bank, UNDP, FAO/UNDP, the Egyption Supreme Council of Universities, USAID, Finnish AID, the Rubin Foundation, and a number of private individuals (John Goelet, Niazi Mostafa) and business organizations (ARCO Solar, Misr Iran Development Bank). Recently, the American University in Cairo (AUC) decided to consolidate the above activities and changed the status of the DDDT project to "The AUC Desert Development Centre (DDC)". Within the context of these objectives, a number of general areas for conducting applied research have been identified to demonstrate small farmer-oriented arid land development and also, pilot models for agro-industrial activities. The DDC headquarters is in Sadat City and it has another site at South Tahrir. Alternative desert development systems are being demonstrated by choosing appropriate irrigation practices, optimum water use methods and soil management techniques, as well as application of renewable energy technologies whenever feasible.

51. Development of a water pump, using windpower, for lifting water in remote desert areas: The mechanical engineering laboratory of the National Research Center in co-operation with the Intermediate Technology Transfer Group of London is currently developing a wind turbine, simple to manufacture and maintain, to operate a water pump for lifting surface and groundwater. This pump is specially designed to draw water from desert wells for irrigation purposes.

52. Multi-objective modelling for planning the development of desert lands in Egypt: This is a one year project which was begun in 1983 jointly by the IBM Cairo Scientific Center (established under an umbrella agreement with the Academy of Scientific Research and Technology) and the Water Master Plan Project (c.f. para. 38 above).

53. The purpose of this model is to analyze resource requirements and allocations in order to achieve specific desert land development goals, taking into consideration the preservation of the dynamic equilibrium of the ecosystems of these zones. The model will be applied in one or possibly two desert locations in Egypt.

54. Proper management for improving the productivity of sandy soils: This project began in 1984. It is being implemented by the Department of Soils of the Faculties of Agriculture of Ein-Shams, Assuit and Minia Universities and is financed by the University Linkages Project. Its main goal is to determine the most suitable cultivation practices for the newly reclaimed sandy or sandy-calcareous soils where water and nutrient supplies are the primary constraints. The experimental work is being carried out at the following three sites:

- the agricultural experimental station of the University of Assuit at El-Gharieb (20 km south of Assuit);
- Shosha village at Samalout (El-Minia Governorate); and
- the green houses of the Faculty of Agriculture of Aim-Shams University.

55. Field experiments will first be conducted in virgin sandy soils at El-Gabal, El-Asfar, El-Kalag or Shebein El-Kanatar in El-Kalubia Governorate. Experiments will also extend to areas belonging to certain Co-operative Agricultural Societies that are under reclamation.

56. Applied Research, Demonstration and Training in Desert Development: This project is being implemented by a consortium of Egyptian and American Universities. The University of Alexandria is the lead Egyptian university while the American University in Cairo is the lead US university and project co-ordinator. The project is financed by USAID through the Supreme Council of Universities Foreign Relations Coordination Unit. The three-year project began in 1984. It aims at providing alternative approaches to integrated desert development. The project is being implemented at the DDC-AUC desert sites at Sadat City and South Tahrir and its major activities are:

- to conduct applied research on alternative technologies of desert agriculture, with emphasis on fodder, cattle and biogas.
- to conduct applied research on renewable energy resources and technologies which could be utilized in desert development, with emphasis on hybrid systems, for example solar photovoltaic, wind-solar thermal, biogas, etc.
- to demonstrate representative models of desert communities consisting of single and multiple family farm units and a dairy processing agro-business unit, with emphasis on passive solar architecture and renewable energy sources.
- to develop training programmes for both the private and public sectors in the areas of desert agriculture, renewable energy applications and socio-economic problems in desert development.

C. Records of Successes and/or Failures

57. West Nubariya new lands development project: This project aimed to reclaim 24,000 feddans in the Western Delta. The project area was part of a larger reclamation zone. About 162,000 feddans in the area were reclaimed during the 1960's. Of the 162,000 feddans already reclaimed less than 110,000 are currently under cultivation and at only marginal levels of production. A major reason for this is the widespread waterlogging due to inadequate soil studies prior to reclamation, and the failure to provide adequate drainage. Other factors which have lowered productivity include: breakdown of pumping stations, insufficient anticipation of non-agricultural infrastructure needs, and inability to develop an effective organisation and management system in the post-construction period. This project received support from the World Bank.

58. SAMDENE and REMDENE projects: Systems analysis of the Mediterranean Desert Ecosystems of Northern Egypt (SAMDENE) was initiated in 1974. The main goal was to develop a better understanding of the structure and dynamics of the major ecosystems of the western Mediterranean coastal area of Egypt. The major achievements include:

- the collection and synthesis of a substantial amount of ecological information about the desert ecosystems of this region; and

- preliminary evaluation of the impact of human manipulation and environmental perturbation on the structure and functions of desert ecosystems as a step towards laying the foundations of sound land-use schemes in the region.

59. The activities of SAMDENE were then followed by the initiation of the Regional Environmental Management of Mediterranean Desert Ecosystems of northern Egypt Project (REMDENE) in 1979, with the following main objectives:

- survey and assessment of land resources of representative sectors of the region;

- evaluation of the impact of different land-use types (grazing, rainfed and irrigated farming, human settlements etc.) on the environment, and of the value of resources; and

- synthesis (using modelling techniques) of the collected information for use by decision-makers as a guide for management of resources and optimization of production.

60. The information collected in the SAMDENE and REMDENE projects on the structure and functions of natural and man-manipulated ecosystems, and the surveys of natural resources and land-use patterns in some sectors of the western Mediterranean desert of Egypt, provide a scientific base for management-oriented research that would guide the formulation of rational land reclamation policies in the region.

61. The SAMDENE project was sponsored by Alexandria University and REMDENE by the Academy of Scientific Research and Technology. Both projects are financed by the Environmental Protection Agency of the United States of America, the Ford Foundation and the UNESCO/MAB Programme.

D. Information and Experience in Desertification Control

62. Merits of RAPG in sand dune fixation and desert agriculture: This research project is financed by the International Atomic Energy Agency (IAEA) and implemented by the National Atomic Energy Authority. The work aims at preparing a polymeric gel conditioner suitable for sand dune fixation and desert agriculture. Field work is conducted in the Inshas zone which is representative of Egyptian desert regions. RAPG (Reclaimer-Ameliorator Polymeric Gel) is an amphoteric acrylonitrile base telomer grafted upon a cellulose substrate. RAPG is prepared from propylene gas which is a by-product of petroleum refinery and petro-chemical processes. The cellulose substrate is prepared by treating otherwise useless agricultural waste. RAPG application does not require any pre- or post-hydration of soils.

63. The production cost of RAPG is comparatively low, given its evident success in sand dune fixation and desert agriculture. Its application reduces the amount and frequency of irrigation and could save about two-thirds of the fertilisers normally required.

64. Mapping of the western Mediterranean coastal region: This activity is within the framework of the REMDENE Project (c.f. para. 59 above). Its objective is to establish maps of actual land occupation in the regions of the western coastal desert between Burg El Arab and Salloum, and to make an inventory of existing vegetation and human density. Each isophene is located on the final version of the map using the most recent aerial photographs.

65. Mapping is considered to be one of the most efficient tools for synthesizing and integrating ecological information in a form that can be readily utilized by decision makers in planning management policies for arid and semi-arid lands. It is a joint activity of the REMDENE project and the staff of the phyto-ecology section of the Centre d'Etudes Phytosociologiques et Ecologiques of the Centre National de la Recherche Scientifique, Montpelier, France.

66. The use of remote sensing technology in soil and ecological surveys: The Remote Sensing Centre in Cairo has conducted studies for several national projects concerned with regional mapping, inventory and monitoring of natural resources. Most of the projects have a direct bearing on the desertification problem, especially in the newly reclaimed areas. A geological and hydrological investigation has been conducted of the New Valley area, where certain sand dune belts have been delineated on different dates, in order to study sand dune movement by comparing topographic maps made in the 1930's with aerial photographs taken in the 1950's and 1960's, and sequential coverage of LANDSAT data available every 18 days since 1972. Studies also include geological structural alignments and drainage mapping of Egypt (scale 1:1,000,000) from the interpretation of LANDSAT images (1980). Details of quaternary sediments, particularly sand dunes, salt crusts, and sabkhas are shown on these detailed maps.

CHAPTER 3. LIBYAN ARAB JAMAHIRIYA

A. Problems of Desertification and Current Status

67. Only about 5.7 per cent of the country's total surface area (1.75 million square metres) receives more than 100 mm rainfall per year. Rainfall is irregular, evapo-transpiration high and subterranean water supply very limited. Droughts are frequent and desert encroachment due to poor land use patterns and practices over the past generations has caused severe degradation of woody formations and grazing lands, loss of soil fertility, and wastage of rain water through surface run-off.

68. Forests and maquis, mainly in Djebel el Akhdar and Benghazi regions, occupy only some 300,000 hectares while grasslands cover 14.2 million hectares, providing scarce to moderate ground cover (5 to 30 per cent). Livestock raising is the most important agricultural activity, followed by cultivation of grains (mainly wheat and barley) in suitable areas occupying some 5.3 million hectares each year. Sheep (about 5.5 million head in 1980) are raised for wool and meat and constitute the most important stock. Degradation of land resources, and therefore desert encroachment, is directly linked to overgrazing and the conversion of grazing and other rangelands for cultivation. Wind erosion is particularly serious in cultivated areas of the Jeffara plain (110,000 hectares) and the Gharian Plateau (92,000 hectares) where dry farming is practised. Shifting sand dunes and sand drift are of particular concern. Irrigated agriculture is expanding and as a result the area available for grazing is decreasing further.

B. Current Anti-Desertification Programmes and Projects

69. Sand dune fixation in the Jamahiriya. This pilot project is executed by the Secretariat of Agrarian and Land Reform. It aims at increasing ten-fold the present rate of sand dune fixation, currently 3,000 to 5,000 hectares per year, by developing new labour-saving techniques and methods. Cost effectiveness has not yet been evaluated. The total cost is estimated at US$ 16,825,000 over 5 years.

70. The project covers more than 0.5 million hectares of the north central plains of Libya and its principal objectives are to enhance local programmes concerned with sand dune fixation, undertake research on fixation methods and on the properties of sand, and experiment on species best suited for afforestation and dune fixation.

71. Development of Jedaida Nursery. The duration of this project is five years and its estimated total cost is US$ 6,529,200. The project aims at the development and expansion of the Jedaida Nursery to enable it to serve national and regional needs. The project will add 40 hectares to the existing 24 hectares of the Jedaida Nursery which will increase seedling production to more than 30 million a year by the fifth year of the project. Other objectives of the project include the study of water requirements of different tree species raised in the nursery with a view to designing an efficient irrigation system, and the introduction of appropriate machines based on research and experiments for different nursery operations, in order to reduce cost and manpower needs. It is also expected to provide training, and facilitate the sharing of experience with and provide seedlings to other countries in the region.

C. Records of Successes and/or Failures

72. Integrated Development Plan for the Jeffara Plain Programme: This programme started in 1972 within the framework of a ten-year plan set up by the former Council for Agricultural Development (now the Council of Land Reclamation and Rehabilitation). The programme includes an area of about 27,640 square kilometres which is triangular in shape, with the Tunisian border forming the base and the Jebel Nafusa Mountain and the Mediterranean Sea coast forming the other two sides. The objectives of the programme are to:

- protect the natural resources of the area (soil, water and natural vegetation) from degradation and to introduce necessary improvements for their optimum exploitation;

- utilize available resources (surface and underground waters, soil and natural pastures) to create agricultural and pastoral community settlements to be owned by the farmers themselves, and to train the farmers in various modern agricultural methods to ensure the good management of the farms; and

- increase agricultural production.

73. Fifteen different development projects were implemented in the Jeffara Plain on the basis of studies undertaken on soils, surface and subterranean water resources, topography, natural vegetation and human resources. These development projects aimed at:

- water and soil conservation by building terraces, sinking water wells, building embankments, using drip irrigation for fruit gardens and fixing sand dunes;

- the improvement and rehabilitation of natural pastures through artificial sowing of drought-resistant fodder plants, and by preparing the soil in perpendicular strips to the direction of the wind;

- the protection of agricultural villages, farms and lands by installing windbreaks around them;

- an increase in cultivation using agricultural rotation;

- the training of farmers to use modern agricultural equipment;

- the construction of houses for the farmers.

74. The integrated development plan for the Jeffara Plain is a good example of a comprehensive programme for the proper use of natural resources and the struggle against desertification. The programme could be of value to other countries with similar ecological conditions.

75. Sand dune fixation of the coastal region: This programme was carried out under the supervision of the Forestry and Pastures Department, Secretariat of Agrarian and Land Reform.

76. Sand dunes near the coastal belt lie within a populated, agricultural region covering approximately 250,000 hectares, extending from the common border with Tunisia to Ajdabia. There are two kinds of shifting sand dunes in this area. Seashore sand dunes of marine origin occupy the immediate coast while the hinterland plain dunes are of continental origin. Fixation was implemented in two phases. The first phase involved mechanical fixation of the surface of sand dunes. The second phase involved biological fixation through planting trees and shrubs able to resist the environmental conditions characteristic of the region.

77. Two main methods were used for the mechanical fixation of shifting sand dunes. The first used locally available dry plants which were buried to a depth of about 15 cm leaving a further 35 cm above ground. These barriers were built to allow air and fine sand grains to pass through thus avoiding the pile-up of sand behind them. The second used, as a temporary measure, heated petroleum products. These were sprinkled on the dune surface under a certain pressure. Biological fixation involved the planting of seedlings of shrubs that can adapt to sand dune conditions, reduce wind intensity and at the same time provide conditions for natural regeneration to cover and naturally fix the sand dune.

78. Approximately 100,000 hectares of seashore and continental sand dunes had been fixed by September 1976. Although the Libyan experience in shifting sand dune fixation is still limited to a pilot project, it could be useful in the fixation of areas with similar ecological conditions in other countries.

79. Bir Ayyad eucalyptus plantation: This afforestation project started in 1974 in the Bir Ayyad Perimeter and was implemented by the Yugoslav Hydro-project Company. The project aimed at the establishment of a eucalyptus plantation of an average annual wood yield of 20 cubic metres per hectare. By the end of 1976, nine water collection and storage dams, three flood and silt control dams and eight downstream dams had been constructed and 1,281 hectares planted with E. camaldulensis, E. sideroxylon and E. microtheca.

80. In 1977, a considerable number of the trees started to show signs of failure of adaptation to local site conditions and died before the end of that year. Investigations have shown that:

- rainfall of an annual average of 120 mm cannot provide enough moisture;
- the species used in the plantation could not withstand severe drought and calcareous soils;
- the ridge planting method was not appropriate for arid zones;
- the irrigation period (one hour for a row 700 metres long) was too short, and
- the expected yield of 20 cubic metres of wood per hectare was unrealistic.

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81. Planting new areas with eucalyptus was therefore stopped and fodder shrub species such as Atriplex halimus, Acacia victoriae and Prosopis dulcis were planted. The Government then started the necessary studies to develop the entire area of the perimeter for the establishment of grazing farms only.

D. Information and Experience in Desertification Control

82. The use of petroleum products in sand dune fixation: Experts started to test the appropriateness of using petroleum products in sand dune fixation in Libya in 1961. Heated petroleum products (45 degrees centigrade) are sprinkled on sand dunes under specific pressure (100-120 lbs per square metre). The substance forms a thin black, relatively permeable layer which sticks well to the surface layer of the sand and prevents the dislodging of sand grains by wind. The surface of the dune is almost completely covered and protected from wind erosion.

83. Oil products last longer on the sand than dry plants, and the oily layer helps to retain moisture near the surface of the dune. Moreover, tree roots are protected from denudation. This method is used on continental sand dunes. More experiments are under way to improve the efficiency of this technology.

84. Species used in Libya for sand dune fixation: The main species used for biological fixation of continental dunes include Acacia cyanophylla, Acacia cyclops, Eucalyptus camaldulensis, Eucalyptus gomphocephala and Tamarix articulata. Of these Acacia cynophylla, Acacia cyclops and Tamarix articulata have been found to be the most suitable on seashore dunes. The present trend is to combine Acacia spp. (40 per cent) and eucalyptus (60 per cent) to exploit the advantages of both on one site. Acacia plants improve soil fertility and provide sufficient shade for the growth of a layer of wild vegetation which reduces wind intensity. The main dry plants used for mechanical fixation of dunes are Imperata cylindrica, Aristida pungens and Retama retam. Imperata cylindrica is often used for continental sand dune fixation and Aristida pungens for seashore dunes. However, Retama retam is not much used because of its high price. Palm stalks are also used in areas with palm trees.

85. Centre-Pivot Sprinkler Irrigation: This irrigation technique has been used in the regions of Kufra and Sarir. It consists of a long handle connected to a pump which can irrigate an area of 100 hectares from subterranean waters.

86. This technique is useful in areas of perpetual drought, but where underground water exists. The Centre-Pivot Sprinkler has been used successfully to irrigate more than 20,000 hectares in Libya.

CHAPTER 4: MOROCCO

A. Problems of Desertification and Current Status

87. The desertification problem appears significantly in the southern governorates of Morocco, in particular in Ouarzazate and Errachidia, where important development projects are being implemented. The high population density in these fragile ecosystems has resulted in severe degradation. Sand drifting and shifting sand dunes are now threatening irrigation canals, roads and oases.

88. As in the other countries of the region, the degradation of land resources is directly linked to human and livestock pressures: livestock raising extending into forested areas, uncontrolled fires, deforestation, the collection of wood for fuel and other needs, and grain cultivation (wheat and barley) in marginal lands. Grazing lands (natural forests, steppe and alfa grasslands used by nomads and settled inhabitants) cover about 20 million hectares. Livestock in the arid zone stands at about 7 million sheep, at a stocking rate of about 1.1 sheep/hectare, which is considered to be too high. During the last 10 years fires have destroyed an estimated average of 3,000 hectares of forests and alfa grassland per annum, and were especially serious in 1980 in reafforested and alfa grasslands where more than 6,000 hectares were burned causing an estimated loss of US$ 1.4 million.

89. Cultivated areas, about 7.9 million hectares, are subject to wind and water erosion and sand encroachment. The cultivation of areas more suitable for grazing, over-cropping, insufficient fallow periods, and inappropriate cultivation methods and practices are responsible for accelerated wind and water erosion, which in turn result in decreased cereal production. Frequent droughts, especially in the eastern, central and southern regions of the country have aggravated this situation and anti-desertification measures have not always been able to attain their intended objectives.

90. Anti-desertification measures have centred on the control of water and soil erosion, rangeland management, reafforestation and forest protection, and the stabilization of shifting sands, including the protection of oases from sand invasion. A strategy for water erosion control has been under way since 1970, it is based on an integrated approach where technical and socio-economic aspects are given full consideration. The management of natural artificial plantation forests is also given high priority as is the establishment of national parks and reserves. However, there are technical, social and financial constraints which impede the progress of many anti-desertification activities and dictate the level of achievement attained to date. Nevertheless, Morocco has acquired experience in desertification control which could be shared with the other countries of the region that have similar ecological conditions and problems.

B. Current Anti-Desertification Programmes and Projects

91. Protection of palm trees against sand drift and shifting dunes project: This important project was started in 1980 for a duration of four years and is financed by UNDP (Project MOR/78/017). The governorates of Ouarzazate and Errachidia, where important development projects are undertaken, are suffering from desertification. The vegetation cover has to a large extent been destroyed and wind action is causing sand drifting and dune mobilization. Shifting dunes occasionally cover roads, irrigation canals, agricultural lands and oases. The main objective of this project is to develop a methodology for the stabilization of continental sand dunes in these regions. The project is focused on the improvement of Tamarix aphylla with regard to resistance to drought, salinity and sand drifting.

92. An original method for re-profiling sites covered by shifting dunes has been developed. This method consists of giving an aerodynamic profile (similar to aeroplane wings) to the parts of the road which tend to become covered by sands. This profile accelerates wind speed and prevents sand from being deposited on the road. The method has been tested on the Tarda road at Errachidia and has proved to be very efficient. (It is noted that this approach has also been applied in China and the USSR).

93. Arid lands agriculture: This activity started in 1981 and is being conducted by the Institut National de la Recherche Scientifique (INRS) and implemented by the Regional Centre at Settat. It aims to study different cultivation techniques appropriate to arid areas, and search for species adapted to drought and salinity.

94. Struggle against desertification: The activity started in 1978 and is conducted by INRA and implemented by the Regional Centre at Marrakesh. Project activities include: cartography of the vegetation of arid areas and the study of plant species adapted to sand dune fixation.

95. Rehabilitation of the Eastern Moroccan Plateaux programme: This programme started in 1977 under the Ministry of Agriculture. It studies optimum stocking levels in a pilot area of 10,000 hectares in the eastern Morocco plateaux region, and is developing a grazing rotation calendar. The programme is also conducting an evaluation of the impact of grazing on the regeneration of vegetation in this zone.

96. The struggle against erosion project: This project is being executed by FAO. The main activities undertaken include:

- a soil study of different water basins;
- a land classification study with respect to erosion;
- a study of the socio-economic aspects of the erosion problem;
- the identification and evaluation of the different factors affecting erosion;
- the development of an integrated plan for soil protection against water and wind erosion.

97. The Ait Chouarit Dam on the Oued Lakhdar project: This important project started in 1982 and is expected to be completed in 1986. Its objective is to construct a dam to provide irrigation water to 40,000 hectares in the semi-arid plain of Marrakesh.

98. Integrated development of Ellokous Basin: This project aims at soil conservation and improved farming practices in order to minimize soil erosion. The total project area is 59,000 hectares.

99. National forest survey programme: This programme started in 1976 under the Department of Water and Forests and Soil Conservation of the Ministry of Agriculture. It aims to conduct a survey of all the forest zones of Morocco during a period of ten years. A cartographic report of all forest areas greater than 4 hectares is being prepared.

100. Soil conservation and erosion control programme: This five year programme aims at studying the Anawen and El-Nakla basins in order to identify the causes of water-induced erosion and to set a plan for its control. It also includes the stabilisation of 1,800 hectares of littoral dunes and 2,000 hectares of continental dunes. The total cost is estimated at about US$ 22 million.

101. The struggle against Bayoud (Fusarium oxysporium) programme: The date palm trees in southern Morocco are severely affected by the fungus Bayoud (Fusarium oxysporum), which threatens to progressively destroy them. In 1978 the INRS Central Desert Agronomy Station, in collaboration with the Office of Agricultural Development of Ouarzazate and Tafilalet, began a programme to control this disease through the selection and production of resistant species, the introduction of resistant exotic species from the United States of America and experimental research to ascertain resistance to Bayoud.

C. Records of Successes and/or Failures

102. The National Forestry Fund: The National Forestry Fund was established by the Ministry of Agriculture in 1949 with the objective of encouraging the population in rural areas to afforest their land. The aid given by the Fund is either in the form of subsidies in kind and in cash at the rate of DH. 75 (DH. 8 = US$ 1) per hectare, long-term interest-free loans, or work executed by the Water and Forests Administration in co-operation with the farmers.

103. From its formation in 1949 to 1981, the National Forestry Fund spent approximately DH 161 million, and helped in the afforestation of only about 75,618 hectares. The interest of the farmers in the activities of the Fund is declining due to the low level of subsidies and loans it offers in relation to the actual costs of afforestation.

104. Sand dune fixation around the city of Essaouira: The creation of Essaouira in 1960 has resulted in the destruction of the surrounding vegetation cover giving rise to mobile dunes which now threaten this city. The techniques utilized and recommended for the fixation of shifting dunes include:

- the creation of a littoral dune,

- the stabilization of the sand by a cover consisting of branches of Ononis natrix, Anquistissima and Retama monospera,

- the planting under this cover of species which will constitute the vegetation cover of the dunes, and

- the simultaneous seeding of Retama monosphera and Ononis natrix which will be used to fix other dunes.

105. Experience has proved that it is preferable to plant tree seedlings on bare dunes rather than on soil covered with other vegetation. It has also been noticed that Ricinus communis, which was utilized previously, is inefficient in sand dune fixation and its use has been discontinued.

106. The success of the techniques applied to stablize sand dunes in Essaouira encouraged the fixing of 13,000 hectares of sand dunes. Similar dune fixation activities have been undertaken all along the Atlantic coast area of the country. Other countries with similar ecolocial conditions and problems could benefit from this experience.

D. Information and Experience in Desertification Control

107. Species utilized in fixing littoral sand dunes. The following is a list of species which have proved effective in fixing sand dunes in the Moroccan littoral zone and which could be used in other countries having similar ecological conditions.

Pinus halepensis	Agropyron junceum
Cupressues sempervirens	Ammophila arenaria
Cupressus macrocarpa	Hyparrhenia hirta
Juniperus phoenicea	Aristida coerulexens
Agave sisalana	Cenchrus ciliaris
Pistacia lentiscus	Eragrostis curvula
Populus alba	Oryzopsis miliacea
Populus euphratica	Saccharum aegyptiacum
Acacia cyanophylla	Tricholaena rosea
Acacia cyclops	Atriplex halimus
Acacia longifolia	Atriplex nummularia
Robinia pseudacacia	Atriplex cesicaria
Retama monosperma	Atriplex semibaccata
Cytisus albidus	Traganum moquinii
Ricinus communis	Ononis natrix ramosissima
Tamarix gallica	Ononis natrix angustissima
Tamarix africana	Lotus arenaruis

108. Ammophila arenaria was found to be the best plant specie adopted for littoral sand dunes exposed to violent wind. For compact calcareous soil the mix of Juniperus phoenicea, Retama monosperma, and Onosis N. angustissima plant species was recommended. On the other hand, for deep sandy soil a mix composed of either Eucalyptus gomphocephala or E. Camaldulensis with Acacia cyanophylla, Retama, and Ononsis N. angustissima plant species, was recommended. For sandy silty soil, the mix of gomphocephala, cyanophylla, and Onosis N. angustissima was found to be effective. The most effective mix adopted for alluvial, silty, compact and saline soil was found to be occidentalis and cyanophylla.

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CHAPTER 5: TUNISIA

A. Problems of Desertification and Current Status

109. Arid and semi-arid zones in Tunisia cover about 80 per cent of the country and extend southwards from the foothills of the Tunisian dorsal ridge, or roughly south of a line drawn from Kasserine to Enfidaville. The overall area can be divided into two zones: one described as 'arid', with an annual average rainfall of between 350 and 100 mm covers approximately 5.5 million hectares; the other described as 'desert', with an annual average rainfall of less than 100 mm, covers approximately 6.5 million hectares. Rain falls mainly during the winter months but can also occur in spring. Hence there is a very marked dry summer season, which is characteristic of the Mediterranean climate.

110. The natural vegetation is steppe-like except in the mountains where there still remain natural forests (.39 million hectares), consisting basically of Pinus halepensis and Juniperus phoenicea. However, woody vegetation formations cover about 2.5 million hectares and include maquis and bush. Among the shrub formations, vestiges of wooded savanna with Acacia raddiana can still be seen in just one dry part of this area (Djebel Bou Hedma). Alfa grassland covers about 625,400 hectares but is subject to an annual reduction of about 3.25 per cent due to conversion to agricultural purposes.

111. Population density in the desert zone is estimated at 31.8 inhabitants/square kilometre. Livestock numbers in the arid zones are high, with 4.7 million head on 5.5 million hectares in the mountains (goats) and the lowlands (sheep, goats and camels). In southern Tunisia the stocking rate is 2 hectares/head.

112. The sedentarization of nomads and the expansion of rainfed and irrigated agriculture without improved land use practices are largely responsible for land degradation. Mechanized agriculture has encouraged the clearing of large areas. In addition to cereals, however, fruit trees (olives, almonds, figs, and vines) are cultivated and this compensates somewhat for the lack of woody vegetation cover.

113. In addition to deforestation caused by intensive fuelwood collection, especially around towns and settlements, desertification can be seen in the sand invasion and salinization of oases and irrigated areas. This problem is a major concern of the Government and numerous studies on erosion and desertification control have been undertaken since the 1960s. Control measures have included soil and water conservation, wind erosion control, the development and improvement of grazing lands, reafforestation and sand dune stabilization, water supplies and rural development.

B. Current Anti-desertification Programmes and Projects

114. Water and soil conservation programme in southern Tunisia: The governorates concerned include Gabes, Medenine and Tataouine. This region suffers from desertification caused mainly by overgrazing, abusive soil exploitation and the use of certain mechanical agricultural equipment. Water and soil conservation work is conducted in three pilot areas: the Oued Fessi basin, which covers a surface area of 214,000 hectares, and the El-Ababsa plain, an area of about 95,000 hectares.

115. These three zones were the subject of an integrated planning study which took into consideration water and soil conservation requirements. The study focused on the collection of runoff water in jessours and tabias, the protection of villages from inundation, and the generation of employment. It also included the creation of micro-zones suitable for agriculture, combating erosion, increasing agricultural production and increasing water infiltration necessary for the regeneration of plant cover. The very old technique of jessours (very small dams made of stones) is still utilised and has proved to be very efficient. Approximately 13,000 hectares in Gabes, Medenine and Takaouine are cultivated using this technique. The jessours must be consolidated with plantations, and the most successful species utilized are fig, olive and palm trees.

116. The creation of pastoral reserves by plantation of forage plants: This national project started in 1982 and is expected to be finalized by 1986. The project is being implemented by the Department of Forests of the Ministry of Agriculture. The major objectives include the creation of further pastoral reserves (the creation of pastoral reserves began before 1966 on state forest land), the improvement and increase of forage production, the protection of sheep and goats during drought periods, and the generation of employment. The total project area is 37,000 hectares.

117. Protection of oases and struggle against sand drift: This national project is mainly concerned with the governorates of Gabes, Gafsa, Medenine and Kairouan. Its objectives include the protection of roads, agricultural lands and tourist areas against sand drift, the creation of forage resources, the socio-economic development of arid zones, and anti-desertification measures in general.

118. The traditional techniques utilized to fight sand drift consist of stopping the sand that feeds the dunes, and planting fodder species to fix dunes so that they do not increase further in size.

119. Sand is stopped by the creation of artificial dunes perpendicular to the dominant wind direction, surmounted by a barrier of palms or boards which are raised regularly until the dune reaches its equilibrium profile. These traditional techniques have produced excellent results compared to other sand fixation methods. The project resulted in a net improvement of the productivity of oases.

120. Afforestation of desert and arid areas project: This national project concerns principally the governorates of Sidi Bouzid, Gafsa, Medenine, Gabes, Sfax, Mahdia, Kasserine and Kairouan. Its aim is to encourage afforestion in arid and desert zones in order to protect the soil and arrest desertification, reduce evapo-transpiration and wind erosion, increase rainfall infiltration in forest soils under trees, and provide the population of these areas with wood for domestic use. The techniques used in this project were evolved by the Institut National de Recherche Forestière (INRF) and consist mainly of the selection of appropriate species and soil preparation. Limited results have been obtained due to unfavourable climatic conditions for afforestation, high population pressure in the areas where afforestation has been implemented and the use of inappropriate afforestation techniques.

121. Improvement of grazing areas project: This project is concentrated in the governorates of Gabes and Medenine. It aims at the rational exploitation of grazing areas, the cultivation of complementary forage species, and measures to combat desertification resulting from overgrazing. The results achieved to date are very promising and include the creation of 138,000 hectares of pastoral reserves in central and southern Tunisia, the determination of optimum stocking levels for the Thenin Douiret and Oglat Merteba zones, and pasture improvement in an area of 30,000 hectares.

122. Improvement of animal production in arid areas: This project is financed by the Government of Qatar and is being implemented by FAO in collaboration with the Institut des Regions Arides (IRA). Its main objectives include the gathering of information on animal husbandry in arid zones, the development of appropriate animal husbandry techniques for arid areas and a study of forage production in the oases.

123. The protection of littoral oases project: This national project is financed by the Government and is being implemented by the IRA. It aims to test drip irrigation techniques and to study ways of improving horticulture in the oases.

124. Improvement of grazing areas and rural integrated development project: This project is financed by UNDP (TU/78/007) and is being implemented by FAO in collaboration with the IRA. Its main objectives include the improvement of grazing areas, rural development and socio-economic studies of rural areas.

125. Integrated research on arid lands project (IPAL, Tunisia): This project is being financed by UNEP and implemented by UNESCO in collaboration with the IRA. Its main objectives include the study of desertification and sand drift problems, sand dune fixation techniques, and studies of the different varieties of camels living in Tunisia, the wild fauna of arid zones and pasture plants suitable for cultivation in this area.

126. Project for strengthening the Seed Bank: This project is being carried out by the Forestry Department. Its total cost is estimated to be US$ 3,528,787 and its duration 5 years. It aims at the provision and regional distribution of seeds required by the different projects, through the establishment of a seed bank. The main objectives of the project are:

- to raise the capacity of seed production from 20 to 80 tonnes per year (60 tonnes forest and 20 tonnes pasture seeds),
- to ensure the supply of good quality forest and pasture seeds from known origins for desertification control programmes in the regions,
- to develop techniques for seed harvest and treatment,
- training.

127. Extension and creation of awareness for desertification control: This project is being conducted by the Institute of Arid Regions of Medenine in co-operation with a management council representing the interests of the population and the different development services. The cost is estimated to be US$ 3,823,659 for a period of three years. The project is located in Bir Lahmar District where the annual rainfall is less than 200 mm, and it covers 12,000 hectares, of which 9,150 hectares are farmed. The total human population of Bir Lahmar is 3,130, the small stock population 5,000 head.

128. The long-term objectives of the project are to combat desert encroachment through the development of protected zones and an increase in public awareness, and to improve the living conditions of the population in the arid and semi-arid regions of Tunisia. The short-term objectives include the launching of a campaign against desertification based on the participation of the local population and the training of rural organizers capable of sustaining and enhancing such participation.

C. Record of Successes and/or Failures

129. Soil and water conservation project (WFP 425 and 428): This national project aims at decreasing runoff water losses in order to recharge underground reservoirs, create micro-zones with a micro-climate favouring olive and fruit tree plantations, and protect agricultural lands against inundation. The project is being carried out in the governorates of Kasserine, Sidi-Bouzid, Kairouan, Mandia, Sfax, Medenine and Gafsa with the co-operation of the foreign consultancy firms SOGHETA, SCET and BDPA. During the first phase of the project poor results were obtained due to the absence of basic studies and the unrealistic objectives of the project. Soil and water conservation work was implemented without taking land users into consideration. As a result there was little participation by the local population in work and subsequent maintenance. This demonstrates the importance of taking social factors into account in project implementation.

130. The use of 'sand stop' for sand dune fixation: 'Sand stop' is a product extracted from wood powder and developed by the Swedish companies Hulmens Bruk AB and Crest Development. When the 'stand stop' powder is spread on sand dunes and irrigated, it forms a cover for the dune. A joint research activity was started in 1979 between the Swedish University of Lund and the IRA for a period of 17 months to test the usefulness of this product in sand dune fixation. It was originally thought that 'sand stop' would reduce evapo-transpiration and help plant growth. Experiments conducted on continental dunes proved that this product is inefficient in sand dune fixation and does not allow the use of the soil after its application. 'Sand stop' is also an expensive product and is no longer used in Tunisia.

131. The El Ouadiane oasis project: The objective of this project is to establish an irrigation system that will reduce water infiltration and create new water points and thus overcome the problem of water shortages in the oasis. Water originating from the the new water points has been distributed to four other oases (Degache, Sabaa Biar, Krir and Ceddada). The Department of Rural Engineering of the Ministry of Agriculture finalized all engineering work in 1975.

132. Nefta oasis project: This project was implemented in 1978 and was financed by the Federal Republic of Germany. Its objective was the installation of an irrigation and drainage network, to improve the productivity of 800 hectares at Nefta Oasis. The work was conducted by the Department of Rural Engineering of the Ministry of Agriculture. However, the irrigation network did not increase the productivity of the cultivated land, partly because the farmers did not adopt the new irrigation system and preferred their traditional techniques. Also, farmers considered the water coming from sources on their land to be their property and prevented its circulation to neighbouring land. This situation resulted in some farmers having too much water, while the rest had too little.

D. Information and Experience on Desertification Control

133. The technique of jessours for soil and water conservation: This old technique is still used in Tunisia. The jessours are very small dams made of stones to an average height of 2 metres and a width of less than 1 metre. They are usually constructed in series and the water is used for watering crops. This technique is effective for reducing run-off water losses. It also increases water infiltration and protects the soil from water.

134. The erosion map of Tunisia: A map has been prepared by the Soil Division of the Ministry of Agriculture for the northern and central regions of Tunisia (scale: 1:200,000). It is a synthesis of the problems of accelerated soil degradation resulting from erosion. The technique used shows zones which are heavily affected by erosion, and guides erosion control activities. An erosion map is a useful tool which permits inter-regional comparisons and explains the different factors leading to erosion. This technique could be duplicated in other countries having similar problems.

135. Pasture species used in sand dune fixation: The following pasture species are used in sand dune fixation in Tunisia:

Argyrolobium uniflorum
Hedysarum spinosissimum
Rhantherium suaveolens
Plantago albicans
Salsola vermiculata
Helianthemum lipii
Aristida pungens
Hyppocrepis bicontorta.

136. Implementation of windbreaks (a research programme carried out with IDRC): The species Acacias Prosopis was chosen to construct windbreaks as the result of the experimental selection of forest trees in the arboreta in the south of the country.

PART II

SUDANO-SAHELIAN REGION

GENERAL OBSERVATIONS

1. This part of the report focuses on anti-desertification activities undertaken by UNSO on behalf of UNEP in the 19 countries of the Sudano-Sahelian region. Although it relates to these countries, the information provided should be of relevance to desertification control activities elsewhere.

2. In the selection of representative projects, emphasis has been placed on the current projects of bilateral or multilateral institutions rather than on the projects of non-governmental organizations. It is important to stress, however, that all the projects listed are integral components of national programmes to combat desertification. Information concerning the efforts of non-governmental organizations in the Sudano-Sahelian zone can be found in the following documents:

> Directory of Non-Governmental Organizations in OECD Member Countries Active in Development Co-operation, Organization for Economic Co-operation and Development (OECD)(1981), Paris.
>
> U.S. Non-profit Organizations in Development Assistance Abroad, Eighth Edition, Technical Assistance Information Clearing House of the American Council of Voluntary Agencies for Foreign Service (TAICH)(1983), New York.

Additional information can be found in TAICH country reports, regional directories, bibliographies, and special reports.

3. In general, the more successful projects have been those in which the rural populations affected have been directly involved in their formulation and implementation. This is particularly true when local secular or religious leaders have been involved in project design and implementation. It is also true that many of the more successful projects have been small, village-based projects, maintained at low levels of funding. The often-stated belief that further efforts in training or additional surveys must precede the implementation of urgent projects, is of doubtful validity and has sometimes been shown to cause unnecessary delays.

4. However, many development projects seem to neglect the environmental context at the planning stage. For example, a thorough study of the environmental history of a project area will often reveal unexpected factors contributing to degradation. Such knowledge leads to a more realistic assessment of the potential of the area and can help in the identification of effective ways of restoring critical ecological processes. Similarly, a more systematic approach to constraint analysis would be of benefit to many projects. Because of the nature of ecological and socio-economic systems, it is important that constraints such as restrictive land tenure, inadequate water supply, limited markets and poor soil characteristics are taken into consideration in an appropriate order.

5. Other issues such as a simple absence of incentive to individuals to protect or rehabilitate their environment can affect the success of a project. Success can also be strongly influenced by the attitudes, motivations, and capabilities of government agents and expatriate technicians. Considerations of project duration are also of importance in combating desertification. In general, commitment should be long-term, in view of the nature of the problems being addressed.

6. In some instances, the objectives of village forestry projects could perhaps be better achieved through more imaginative species selection, or through alternatives to plantation establishment such as natural forest management. Work on these subjects is progressing well in various areas of the Sudano-Sahelian region. Innovation might also be considered in the area of animal husbandry. For example, several governments and donor agencies have expressed interest in the further development of camel husbandry; camels are well adapted and valued by rural populations in many areas of the Sudano-Sahelian region, and are less damaging to the environment than most other forms of livestock. Consideration should also be given to the often neglected potential of wildlife, not only as a source of food, but also as a vehicle for seed dispersal and, through browsing, the stimulation of vegetative growth.

7. Official development assistance activities in the member countries of the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS) are well documented in the country reports prepared by the CILSS/Club du Sahel forestry sector analysis and programming missions. Further information can also be found in the following publication:

> Official Development Assistance to CILSS Member Countries from 1975 to 1981, two volumes, CILSS/OECD/Club du Sahel (1982), Paris.

CHAPTER 6: BENIN

A. Problems of Desertification and Current Status

8. Some northern parts of Benin border the southern Sahelian region and are influenced by the north-east dry, hot winds which blow across the Sahara. Although the southern part of the country is on the sea, the pattern of rain-bearing winds and other physiographic and oceanographic factors make this area dry. It belongs to the dry "Dahomey Gap" which separates the west African moist forest block from the Congolese moist forest block. The central area of the country is, however, more humid and is covered by woodlands. Subsistence cultivation and livestock raising in areas free from tsetse and black-flies are the principal economic activities of approximately 3.6 million people.

9. Deforestation and fuelwood collection are the major causes of desertification in Benin. Anti-desertification efforts are currently being integrated into the Government's decennial programme for economic and social development (1980 - 1990), with assistance from UNSO. The decennial programme provides for the conservation of natural resources, the sustainable development of forest resources, and water-supply and range improvement. The re-establishment and conservation of vegetation are aimed mainly at reversing the process of deforestation caused by the excessive cutting of trees and woody shrubs for fuel. Complementary programmes are being formulated or implemented for rural road construction, soil improvement, the inventory of degraded sites, the monitoring of forests and rangelands, and the establishment of plantations of multiple-use trees.

10. The drier provinces of Atakora and Gorgou in the north, where anti-desertification efforts are now focused, have received little attention in the past and suffer chronic manpower shortages in areas critical to the successful implementation of environmental rehabilitation projects. Furthermore, trained personnel find it necessary to devote considerable time to administrative chores, often at the expense of their field responsibilities. Additional foresters are currently being trained in Nigeria, the Ivory Coast, France, and the Union of Soviet Socialist Republics (USSR). Notwithstanding the shortage of trained manpower, the Government has been successful in mobilizing local populations. This is currently reflected clearly in increased agricultural production, and it is probable that the existing and proposed anti-desertification programmes will also profit from local participation.

B. Current Anti-desertification Programmes and Projects

11. Development of forest resources: The objectives of the project are to promote forestry activities at the village level, establish nurseries, provide seedlings for the commercial production of teak, provide seedlings of eucalyptus and various leguminous species for general distribution, and to produce charcoal. Support for the further development and management of forest resources in Benin has been provided by UNDP and the Federal Republic of Germany.

12. Multiple-use tree plantations: The project is intended to establish plantations which will satisfy local requirements for fuelwood, building materials and other forest products, while increasing soil fertility and supporting wildlife populations. The principal sources of suppport for the

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project have been UNSO, with contributions from the Government of the Netherlands, the Arab Gulf Programme for United Nations Development Organizations (AGFUND), and UNDP.

13. Fuelwood plantation project. The objective of the project is to establish fuelwood plantations in selected villages and administrative districts throughout Benin. The project is supported by the African Development Bank (ADB).

14. Project to strengthen Benin's Agrometeorological Service. The Service provides meteorological data of direct relevance to anti-desertification efforts in Benin. The project is supported by UNDP.

15. Access roads to supervise the protected areas of the North. This project, supported by the European Development Fund (EDF), has been undertaken to allow better supervision of the national parks and increased protection of wildlife populations.

C. Records of Successes and/or Failures

16. Anti-desertification efforts in northern Benin have suffered somewhat from changing priorities, limited financial resources, and the unpredictability of donor commitments. An important well-drilling project was suspended in 1980, the potentially important pilot project on the management of tropical ecosystems based at Djougou and Malanville was discontinued in 1978, and environmental rehabilitation projects with long-term implications have often been much too short. Rapid turnover in the staff of donor organizations has also contributed to discontinuities in anti-desertification programmes.

CHAPTER 7: BURKINA FASO

A. Problems of Desertification and Current Status:

17. Burkina Faso is encountering serious problems of desertification engendered by bush fires in the south, clearing land for cultivation and cutting trees for fuelwood in the Mossi Plateau, and overgrazing in the north. These problems can only become more severe very rapidly unless urgent steps are taken to protect the environment. Given the pressure of human and animal populations on the natural vegetation, it would appear that the problems will not be solved unless outside help is received, and an alternative means of support is offered to the population.

18. The declared policy of the National Revolutionary Council is to encourage the safeguarding of the environment by the Burkinabe people themselves; it has made the Ministry of the Environment and Tourism, the Ministry of Agriculture and Livestock, and the Ministry of Water, responsible for helping the people to:

- protect and restore the soil, and expand and manage the forests;
- achieve self-sufficiency in food requirements;
- increase and make most efficient use of water points and schemes.

The Government is carrying out a survey of anti-desertification activities, including the efficient use of forestry resources, the fight against uncontrolled grazing and bush fires, and the promotion of fuel efficient stoves. At the present time the Government, together with CILSS and UNSO, is preparing a national strategy to combat desertification.

B. Current Anti-desertification Programmes and Projects

19. National programme to combat desertification: The national programme to combat desertification continued and intensified the reafforestation and forest management project begun by the Federal Republic of Germany. It was designed to counteract the damage done by desertification and provide the population with forest products. A "green belt" is being created around the town of Ouagadougou, to serve an aesthetic purpose and to combat the encroaching dunes.

20. World Bank forestry project: The objectives of this project are to strengthen the national forestry service, to establish and maintain a 1600 hectare plantation, manage 1000 hectares of natural forest, create approximately 325 hectares of village woodlots, and undertake appropriate studies and support training. The project is receiving financial support of $ 14.5 million from the World Bank. UNDP and FAO are financing a complementary project, the purpose of which is to evaluate the country's requirements as far as forestry products are concerned, and to determine how far these needs are being fulfilled. The data will be used in forestry planning and to maintain and supplement the Forestry Service.

21. Village woodlots projects: The individual village woodlot projects being undertaken in Burkina Faso aim to promote the self-sufficiency of the people in fuelwood and wood for building and related purposes, and to combat desertification.

- The village and family woodlot project financed by UNSO and the Government of Sweden is concerned with forest management and reafforestation in the provinces of Bulkiemde (Koudougou) and Sanguié (Reo) in the western central area of the country. The budget for the first phase of this project was $750,000 over the three-year period 1982 - 1985. A second two-year phase has been approved.

- The village woodlot project financed by the Government of Switzerland is being conducted in the provinces of Kadiogo, Naouri, Zoundweogo, Oubritenga, Ganzourgou, Bazèga, Yatenga, Gourma, Tapoa, and Gnagna and provides support programmes in extension, management, reafforestation and the promotion of fuel-efficient stoves. The cost of the project is estimated at $ 2 million.

- A village woodlot and rehabilitation of vegetation project is also being carried out in the provinces of Sanamentenga, Bam, Sourou, Mouhoum and Kossi. It is being financed by the Government of the Netherlands for a period of five years (1980 - 1985), at a cost of approximately $ 3 million. The project has planted a total of 850 hectares in 425 villages during the five-year period.

22. Support for the Dindérasso Forestry School. The principal objective of this school is to provide in-service training to senior staff to ensure the protection of the country's wildlife heritage. USAID provided assistance for the expansion of the forestry training school at Dindérasso and the management of the nearby forest reserve. The Government of Burkina Faso took over responsibility for the school when USAID ended its funding and technical assistance in April 1985.

23. Fuel-efficient wood stoves. A nation-wide programme to promote fuel-efficient wood stoves was set up by the Ministry of the Environment and Tourism. The wood stoves were designed by the Energy Institute of the Ministry of Higher Education to encourage the efficient use of fuel wood. Support for the development and promotion of fuel-efficient stoves has been provided by the Voluntary Fund for the United Nations Decade for Women, and UNSO. The promotion of the fuel efficient stoves is an integral part of the village woodlot and reforestation projects mentioned in para. 21 above. In addition, UNSO and the Government of Sweden are financing a project to promote the stoves in the provinces not covered by the woodlot projects and to train extension workers and craftsmen for the country as a whole.

24. Programmes to strengthen agro-meteorological services in the Sahel. The objective of these activities is to support the gathering, analysis and dissemination of meteorological data of relevance to risk avoidance in agriculture and animal husbandry. The programme is funded by UNDP at a cost of $ 980,000 for the period 1984 - 1986.

25. The project to combat desertification in tropical zones (LAT). This project was initiated in 1976 by the Scientific and Technical Research Department (DGRST) of France and the Tropical Biology and Ecology Research Institute (IRBET) of Burkina Faso, and established a research station near the

Oursi swamp. The project has just been completed and a final report is now being prepared. Its major objective was to contribute to the control of desertification in the Sahel by improving knowledge of ecological and socio-economic conditions in the Sahel.

26. The Sambonai Project (Man and the Biosphere Projects Nos. 3 and 13). This was a pilot project to investigate the people's perception of the most recent drought and their view of their own role in modifying the environment. It was implemented jointly by UNESCO and the Burkina Faso Scientific and Technical Research Department, and its objective was to study the ways in which the different ethnic groups living in the Sahel perceive their environment and how they respond and adapt to change.

27. The Sampone Project. Originally Man and the Biosphere Project 601, the Sampone project is now a research component of an IRBET project funded by UNSO to carry out reafforestation in the Sapone area.

C. Records of Successes and/or Failures.

28. In addition to the problems of uncontrolled fires and overgrazing, major plantation projects have failed for a variety of other reasons, such as the absence of local support and participation, and an emphasis on exotic species which produce little more biomass than natural forest species and less than other native species that might have been selected. The persistent droughts of recent years have greatly increased the mortality rate of young plants. In view of these setbacks, there has been a rethinking of overall strategy and emphasis is now being placed on the motivation and involvement of the population in the village woodlot projects. Vital to the succes of this new policy is the greater integration of agriculture and forestry. The focus of forestry activities has moved to the development of natural forest, as opposed to relatively expensive artificial plantations, for the provision of firewood.

The National Revolutionary Council has stressed that success in combating desertification depends on the will of the people themselves to make beneficial changes in their environment.

CHAPTER 8: CAMEROON

A. Problems of Desertification and Current Status

29. Desertification in its most severe forms is found in relatively well-defined areas of northern Cameroon, South of Lake Chad and around Kousseri and Maroua. These are livestock raising areas, some of which have had to absorb additional livestock numbers arising from the general deterioration and droughts which affected the entire region during the 1970's. In addition to livestock raising, the inhabitants of the region carry out subsistence cultivation. Population expansion has also meant increased pressures on rangelands from cultivation, livestock and fuelwood collection. There has thus been both water and wind induced erosion in this region which borders the Sahel.

30. A strategy for combating desertification in the country was formulated in 1979 in collaboration with UNSO. Thus far, efforts have focused on data collection, research into drylands ecosystem functions, and on the socio-economic impact of environmental degradation.

B. Current Anti-desertification Programmes and Projects

31. Rural development project: This World Bank-assisted project will extend the shelterbelt system of the Diamare and Mayo-Danay districts for another 750 kilometres, for a period of five years.

32. Re-afforestation and rehabilitation of the Mayos: The objectives of this project are to rehabilitate the environment around Maroua, and in the Mayos Mountains of the Gawar region. The Government has initiated a feasibility study to continue "Operation Green Sahel". External assistance is being sought from the World Bank, USAID, and the Government of France for the implementation of the project.

33. Integrated planning for the semi-arid regions of northern Cameroon: This project involves the study of semi-arid zone ecosystems and the development of plans for appropriate development and conservation. The project is supported by UNEP and UNDP.

C. Records of Successes and/or Failures

34. "Operation Green Sahel" was successful in combining the efforts of students with those of the rural population in re-afforestation activities in northern Cameroon, but was lacking in technical expertise. The current project concerned with environmental rehabilitation around Maroua and in the Mayos mountains hopes to complement this highly positive popular participation with increased technical support and training.

35. Efforts to establish shelterbelts in the Diamare and Mayo-Danay districts of northern Cameroon date from 1956. Some 300 kilometres of shelterbelts were planted around farms and along roadsides. The species used, Cassoa siamea, is avoided by livestock, and fencing was therefore not required. However, because of its shallow rooting system, C. siamea should be combined with other species in shelterbelts. Additional species are being considered for inclusion in the World Bank Rural Development Project.

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D. Information and Experience in Desertification Control

36. Several shelterbelt projects have been successfully undertaken in the Sudano-Sahelian zone of West Africa. The projects give greater stability to agricultural and livestock production, and afford protection against wind and wind-blown sand. Well-designed shelterbelts can also provide food, fuel, fodder, building materials, and various tertiary products, such as gum and medicinal plants. They also provide habitat for wildlife, thereby increasing the availability of wild meat. An overview of shelterbelt establishment in the United Republic of Cameroon, Nigeria, Niger, and Senegal appears in Environmental Change in the West African Sahel, National Academy Press, Washington (1983).

CHAPTER 9: CAPE VERDE

A. Problems of Desertification and Current Status

37. The Cape Verde islands lie off the coast of Senegal and Guinea-Bissau, within the Sahelian belt. Although surrounded by sea, the islands receive the full impact of the dry, hot harmattan winds from the mainland, and have experienced the same dry climatic conditions as the neighbouring mainland countries of the Sahel. The problems of desertification revolve mainly around land use practices, the most important of which relate to livestock, the cultivation of food crops, and the excessive cutting of wood for fuel and other purposes. Woody vegetation cover has been seriously depleted and there has been severe soil and water erosion, aggravated by the topography of the islands. Demographic factors and livestock have adversely affected grazing and crop producing land, with a consequent reduction in the productivity of these areas. With continuing climatic instability and these land use pressures, desertification remains an important problem.

38. Anti-desertification programmes currently place emphasis on the following: adult education (curriculum reform to increase emphasis on the natural sciences, extension of the period of mandatory schooling, and the training of extension workers), mother and child welfare together with family planning, agrarian reform, the development of more sustainable agricultural systems, further emphasis on run-off farming where appropriate, research into unconventional systems of irrigation, the rehabilitation and integrated management of soils, water, and vegetative cover, and renewable energy. Emphasis differs on the various islands depending on local needs. Assistance in formulating a plan of action to combat desertification is being provided by UNSO for 1984.

B. Current Anti-desertification Programmes and Projects

39. Pilot project to counter desertification in the valley of Sao Joao Baptista, Island of Sao Tiago: The objectives of this project are to curb soil erosion through reafforestation and other measures, and increase groundwater recharge to support irrigated agriculture. The project is supported by UNSO.

40. Soil and water conservation: This project provides expert consultation in soil and water conservation. It is supported by UNDP.

41. Sao Nicolau development project: The objectives of this project are to improve domestic water supplies, further develop agriculture, develop an infrastructure, conserve soil and water, and initiate efforts in reafforestation on the island of Sao Nicolau. The project is supported by the Government of France.

42. Research and development of water resources: This project has been undertaken to better assess the water resources available for development activities. It is supported by UNSO and UNICEF.

43. Hydrogeological research: This project provides expert consultation in hydrogeology. It is supported by the Government of Switzerland.

44. Desalination and provision of water to the villages of Moiaoia and Porto Mosquito. The project provides volunteer assistance and equipment to desalinate and supply water to Moiamoia and Porto Mosquito. It is supported by the Government of Italy.

45. Species trials. The objective of this programme is to identify drought-tolerant trees, shrubs, grasses and new crops suitable for use in development projects in Cape Verde. It is sponsored by the United States National Research Council, and has been undertaken in co-operation with the Ministry of Rural Development and USAID.

46. Forestry Project, Islands of Sao Tiago and Maio. The objectives of this project are to strengthen the forestry capabilities of the Ministry of Rural Development, conduct forestry research and undertake reafforestation efforts on the islands of Sao Tiago and Maio. The project is assisted by FAO and the Government of Belgium.

47. Watershed management project. The objectives of this project are soil and water conservation in areas of rainfed cultivation, the control of surface water runoff to facilitate aquifer recharge in order to provide irrigation water for a 200-hectare tract of cultivable land. The project is financed by USAID and involves four watersheds on the island of Santiago.

48. Santo Antao development project. This project is concerned principally with soil conservation, reafforestation and agroforestry. It is assisted by the Government of the Netherlands.

49. Development and utilization of wind energy. The objective of the project is to provide training and equipment in order to harness wind energy for the production of electricity. The project is supported by UNSO and the Danish International Development Agency (DANIDA).

50. Development of renewable energy. This project aims at developing renewable sources of energy, and receives support from USAID and the Government of the Netherlands.

C. Records of Successes and/or Failures.

51. One of the greatest assets of anti-desertification activity in the Cape Verde islands is the industriousness of their inhabitants. This attribute may well represent the critical factor in the successful arrest and reversal of desertification. Further, the relatively low (by Sudano-Sahelian standards) fuelwood consumption on the islands, of only 360 grams per person per day in rural areas, should permit the existing and proposed reafforestation projects to satisfy the country's fuelwood needs by the year 2000.

52. Constraints to the successful implementation of anti-desertification programmes include land tenure systems that discourage prudent land use, inadequate forestry laws and limited trained manpower. It can also be noted that, in some instances, conservation efforts could be better sequenced. Activities should begin upstream. The need to stabilise flow on the slopes and all sections upstream of the watersheds makes it imperative to construct check dams at the bottom of valleys in order to control the surface flow. The advantages include:

- A decrease in the speed of flow and consequently an increase in the quantity of water, which in turn aids aquifer recharge;
- Catchment of soils upstream of the check dams, which makes possible the reclaim of land for irrigated cultivation;
- Protection of irrigated areas downstream.

D. Information and Experience in Desertification Control

53. Because of the atypical social conditions and geographical situation of the Cape Verde islands, caution should be exercised in recommending the duplication of successful projects elsewhere. Nevertheless, it might be well to keep track of selected projects in which success or failure will be determined largely on the basis of economic and technological considerations. For example, should the desalinization project for the villages of Moiamoia and Porto Mosquito be successful, it might have direct application to problems of water supply in the coastal deserts of Mauritania and Djibouti.

CHAPTER 10: CHAD

A. Problems of Desertification and Current Status

54. The northern parts of Chad lie within the Sahara while the south grades progressively from arid to semi-arid with woodland grasslands replacing the dry, mainly shrub and grassland vegetation cover of the central and northern areas of the country. The population in the drier areas leads a nomadic life-style with livestock raising as the main activity, while further south the people follow a semi-nomadic to sedentary life-style pursuing mixed farming (crop production and livestock raising) in response to the more favourable, although still dry, climatic conditions. In an effort to improve the economic situation of the country there has been an over-exploitation of underground and surface water resources for stock and crop production. At the same time there has been agricultural expansion into grazing areas and cutting of woody vegetation for fodder, fuel and other domestic uses. Given also the dry climatic situation during the past years, the persistent droughts and political instabilities, desertification has remained unchecked. The indiscriminate use of bush fires, especially in the south, continues to aggravate this situation. Thus wind erosion, sand encroachment and shifting sand dunes, deterioration of both grazing and crop lands, exacerbated by a general concentration of livestock in the south due to much reduced grazing in the northern parts, generally typify the desertification problem in Chad. There has also been a general deterioration of irrigation systems due to lack of maintenance.

55. Anti-desertification programmes currently place emphasis on the following areas: increasing awareness of environmental issues, bush-fire control, forest protection, reafforestation and the use of an agroforestry approach. Anti-desertification activities are co-ordinated by the Inter-ministerial Research Department, and are largely executed by the Forest Service (Direction des Eaux et Forêts, Chasse et Reboisement).

B. Current Anti-desertification Programmes and Projects

56. Although Chad was at one time a leader in the struggle to stem desertification, armed conflict and political instability have resulted in the termination or suspension of most activities. National Arbor Week is still observed, with its related nursery programmes and popular participation in the outplanting of seedlings. A limited number of other activities, including the supervision of selected national parks and classified forests, are being pursued with reduced manpower and limited financial support.

C. Records of Successes and/or Failures

57. Despite recent difficulties, many of the more successful anti-desertification projects in the Sahel have been undertaken in Chad.

58. CARE Chad's Acacia Albida Project: This project, undertaken with financial support from USAID and in collaboration with the Forest Service of Chad, resulted in A. albida being established on some 3,500 hectares of farmland. A. albida is of particular interest because it drops its leaves at the beginning of the rainy season, thereby supplying soil with nitrogen and other critical nutrients, and it comes into leaf during the dry season, providing shade and fodder for livestock. In addition, 122.5 kilometers

of living tree fences were established, largely using Commiphora africana, and shelterbelts composed of Azadirachta indica (neem) were also established in the project area. The project is believed to have involved approximately 12,500 farmers and members of their families.

59. Acacia senegal project: Although the involvement of Agricole du Tchad (a private sector enterprise) in the commercial exploitation of gum arabic (Acacia senegal) was relatively short lived, some important lessons can be drawn from its efforts. Working in collaboration with the Chad Forest Service, Agricole du Tchad established a 700 hectare plantation of gum arabic near Massakori and participated in the wild gum campaign. Despite the turmoil in Chad, the plantation has contributed significantly to environmental stability and was an important source of income for the local villagers who assisted with its establishment and maintenance. Few public sector efforts have been as extensive or have received as much support from local populations. It should also be noted that the costs of establishment, in wages and materials, was substantially less than for similar donor-financed efforts. The plantation was directly seeded by hand, thus eliminating nursery expenses and costly equipment.

60. Agricole du Tchad's wild gum arabic campaign was noteworthy for its direct involvement of traditional leaders in promoting the campaign. Not only were they able to effectively mobilize local populations and greatly increase production, but they also initiated several village "gum garden" projects. Several nomadic community leaders requested, and were given, gum arabic seeds to establish stands in the pastoral zone.

61. In most instances, the "failures" in Chad's anti-desertification efforts are understandable and, hopefully, temporary. It might be observed, however, that while the restoration of most projects will be largely a function of security and adequate financial support, for some the destruction of the resource is so extensive that is is doubtful that reactivation can be accomplished in the foreseable future. An example would be the devastated Ouadi Rime-Ouadi Achim Faunal Reserve north of Abeche.

D. Information and Experience in Desertification Control

62. Both of the projects described in Section C above could be duplicated in other areas of the Sudano-Sahelian zone.

CHAPTER 11: DJIBOUTI

A. Problems of Desertification and Current Status

63. Djibouti is an arid country and its main indigenous economic activity is centered on livestock raising. The desertification problem is a result of overgrazing and herding practices and the degradation of woody formations. Wind erosion has given rise to sand encroachment and shifting sand dunes.

64. There are relatively few trained agricultural or forestry extension workers in Djibouti to assist with project implementation, and the problem is compounded by a general absence of training facilities in the country. Perhaps direct co-operation with traditional leaders of the Afar and Somali communities in project development could partially compensate for the current lack of trained manpower.

B. Current Anti-desertification Programmes and Projects

65. Multi-sectoral project for the integrated development of the coastal Plain: AGFUND is the principal source of support for the project.

66. Restoration of the Day Forest: This is a rather comprehensive effort involving a resource inventory, ecological studies, the establishment of a meteorological station, work on windbreaks and pasture improvement around the periphery of the Day Forest, and measures to increase public awareness. The project is supported by the Government of France in collaboration with the National Institut Supérieur d'Etudes et de Recherches Scientifiques et Techniques (ISERST).

67. Tree planting in the city of Djibouti: A project has been initiated by the Government to encourage the planting of ornamental trees in Djibouti.

68. Project for research and development of renewable energy: This project, executed by ISERST, has been undertaken to develop alternative energy sources to satisfy the demands of Djibouti.

C. Records of Successes and/or Failures

69. Because these projects have only recently been initiated, there is insufficient data to determine their success. It would appear, however, that the projects concerned with environmental rehabilitation would profit from a more basic study of the environmental history of the region, as well as from ecological impact analysis. It would also appear that successful efforts in environmental rehabilitation will require greater regulation of the pastoral sector. The current livestock inventory of Djibouti - 500,000 sheep, 400,000 goats, 65,000 asses, 40,000 camels and 30,000 cattle - could perhaps best be maintained in an environmentally sound manner through the introduction of more effective range management systems, possibly along the lines of the pre-Islamic hema system of range reserves which has been successfully re-introduced in Syria and Saudi Arabia.

CHAPTER 12: ETHIOPIA

A. Desertification Problems and Current Status

70. Desertification in Ethiopia extends from the lowland regions, situated mainly in the eastern parts of the country, to the highlands, and is directly linked to the large numbers of livestock and herding practices, and to land use patterns and practices. Overgrazing is a problem which is not limited to the lowlands and mid-elevations, but extends into the highlands. Almost as damaging is the severe depletion of woody vegetation for firewood and construction purposes, especially around urban centers and settlements. Similarly, overcropping due to reduced arable lands, and bad soil husbandry resulting from poor cultivation and cropping methods have generally contributed to both the degradation of croplands and to severe water erosion. In addition, much of the forest in the mountain and lowland woodlands have been under severe pressure from agricultural expansion in response to the increasing population. So, while both water and wind erosion are severe in the lowlands of the east and most of the drier northern parts of the country, water erosion is without doubt the single most important problem in the highlands.

71. A further complicating factor has been out-migration to the marginal lowland areas, due to population pressure in the highlands. It has resulted in increased pressure on land resources from livestock and cultivation. Thus the northern regions of the country have experienced severe desertification and some, such as Wollo and Tigrai, are almost uninhabitable.

72. The salinization of irrigated areas is another problem which has led to decreased crop production and in some cases abandonment of the land. However, the Government is also encouraging the cultivation of resistant crops.

73. Current anti-desertification efforts emphasize soil and water conservation, land rehabilitation, rangeland development, the establishment of new settlements, and the development of renewable energy. A national plan for combating desertification is under preparation with assistance from UNSO.

B. Current Anti-desertification Programmes and Projects

74. Sirinka pilot catchment project: The principal objective of this project is to determine the most effective ways of rehabilitating the highlands through the application of integrated land-use practices. The project is supported by the World Bank.

75. Colina-Hormat catchment rehabilitation: The objective of this project is the reclamation of 62,000 hectares through reafforestation and slope stabilization. The project is supported by the Government of the Netherlands.

76. Soil and water conservation project (Phase II): This project was undertaken to strengthen and assist the Ethiopian Soil and Water Conservation Department in arresting soil erosion and general environmental degradation through technical support for the water development project (c.f. para. 79 below). The project is supported by UNDP, and FAO.

77. Soil conservation project: In this project, the Government of Switzerland is supporting research, experimentation and training, as well as providing personnel and equipment.

78. Kambatta Hadiya rehabilitation: This project is concerned with drought rehabilitation and development. It is supported by the Lutheran World Service.

79. Rural water supply: Several rural water supply projects are being supported by the Governments of Italy, Sweden and Canada.

80. Water Management: IDEC is supporting research by the University of Addis Ababa in the management of water supplies at the local level.

81. Plant Genetic Resources Centre: The Federal Republic of Germany has provided experts and equipment for the development of a germ-plasm bank to supply high quality, documented seeds for development projects.

82. Rehabilitation of forests, rangelands and agricultural lands: The chief objective of this project is to increase agricultural productivity on degraded lands in nineteen selected catchment areas, focusing on the Tigrai, Wollo and Hararghe regions. The project is supported by UNDP, the Federal Republic of Germany, and the World Food Programme (WFP).

83. Energy surveys: Major energy surveys are being supported by the Government of Italy and UNDP.

84. Fuelwood plantation project, Addis Ababa: This project, supported by the African Development Bank (ADB), is being undertaken to provide fuelwood for Addis Ababa.

85. Fuelwood plantation establishment, Nazret and Debre Birhan: Fuelwood plantations will be established on a labour-intensive basis to satisfy fuelwood demands for these two towns by 1990. The project is financed by UNSO.

86. Hydropower development: UNDP is providing personnel, training and equipment for the further development of hydroelectric power in Ethiopia.

87. Exploitation of geothermal energy: The Government of Italy and the European Development Fund (EDF) are providing personnel and equipment for the development of geothermal energy in the Tendaho region.

88. Kobo-Alamata Integrated Development Project: The principal objective of this project is to increase agricultural productivity through the application of modern farming techniques. The project is supported by the Federal Republic of Germany.

89. Forest inventory and demarcation project: This survey project is supported by the Swedish International Development Authority (SIDA).

90. Land-use planning project: The main objectives of this project are to assist the Government in developing a national capability for land-use planning, to inventory and evaluate the country's resources, to recommend appropriate land management systems, and to train qualified nationals. The project is supported by UNDP and FAO.

C. Records of Successes and/or Failures

91. The rehabilitation of forests, rangelands and agricultural lands project (c.f. para. 82 above) has been particularly successful. The initial objectives of the project were achieved through excellent co-ordination and supervision, through the provision of field technicians for work in critical project areas and, perhaps most importantly, through the effective motivation and mobilization of the local population. As a result of the successful completion of the initial phase of the project, it has been expanded and extended to 1986.

92. Anti-desertification efforts in certain areas of Ethiopia have been complicated by political instability.

CHAPTER 13: GAMBIA

A. Current Status and Problems of Desertification

93. Agricultural expansion and uncontrolled bush fires, often deliberately set, are among the principal causes of environmental degradation in the Gambia. The problems are deeply engrained and will require widespread public participation in efforts to resolve them. The problem of agricultural expansion might best be addressed through the elaboration of a national resource management plan based on local needs and priorities. The preparation of such a plan should precede other, more specific interventions. The recent USAID and Federal Republic of Germany technical co-operation-supported resource inventories have generated data of direct relevance to such a plan.

94. A persistent problem that seems to be a factor in the die-back of mangroves and other adverse effects on the country's vegetation is saltwater intrusion into the Gambia river and groundwater basins. UNSO is supporting studies of the groundwater basin of the Banjul area and the possible salvaging, harvesting or protection of mangroves, looking forward to the time when a proposed anti-salt barrage may be constructed.

95. Efforts to combat desertification in the Gambia place emphasis on the following activities: protection of land around watering points and pasture improvement, fire protection and the management of natural vegetation, the establishment of greenbelts around urban areas, and fuelwood conservation through the use of fuel-efficient cooking stoves. A national plan of action to combat desertification is being prepared with assistance from UNSO.

B. Current Anti-desertification Programmes and Projects

96. Pasture development and protection of land around livestock watering points: The principal objective of this project is to protect the environment around water points. Phase II of the project is financed by the Arab Gulf Programme for United Nations Development Organizations (AGFUND) and UNEP.

97. Fire protection and the management of natural vegetation: The objectives of this project are to prevent desertification, to control bush-fire damage with the active participation of local populations, to improve the fire fighting capability of the Forest Department, and to increase the productivity of forests through appropriate management. The project is assisted by UNSO.

98. Species trials: These trials have been undertaken to identify drought tolerant trees, shrubs, grasses, and new crops suitable for inclusion in agroforestry and environmental rehabilitation projects in the Gambia. They are sponsored by the United States National Research Council, and are undertaken in co-operation with the Department of Forestry, the Gambia-Federal Republic of Germany Forestry Project, and USAID.

99. Establishment of green buffer zones around urban centres: This project has been undertaken to establish and maintain greenbelts around urban centres, to provide fuelwood, and to provide the population with fruits, nuts, and other forest products.

100. National Tree Planting Festival: This is an annual festival which takes place during the second week of July. The aims of the National Tree Planting Festival are to "foster a national consciousness of the value and importance of forest cover, and to maintain and improve the environment, both rural and urban, by a tree-planting campaign carried out by the people of the Gambia." Initial support for the establishment of nurseries was provided by FAO and the Arab Bank for Economic Development in Africa (ABEDA).

101. Energy Master Plan: This project emphasizes the ecologically sound utilization of wood resources, and has been supported by UNSO and the World Bank.

102. Gambia forestry project: The project consists of five components designed to assist in increasing the efficiency of wood production and utilization, on a national basis. These are training, outreach, technical assistance, production, and utilization. The project is assisted by USAID.

103. Assistance for the Gambian Forestry Service: This project stresses the conservation of forests and the intensification of forest industries. Components of the project include training, forest inventory, demarcation, species site trials, and various support considerations. The project is assisted by the Federal Republic of Germany.

104. Mixed farming and resources management project: The purpose of this project is to assist the Government in intensifying crop and livestock production, using practices which are ecologically sound and which are likely to increase net rural family incomes. The project is supported by USAID.

C. Records of Successes and/or Failures

105. An excellent summary of anti-desertification efforts in the Gambia is contained in: Forest and Forestry in the Sahel: The Gambia - A Case Study, Club du Sahel, Paris, 1981. With regard to bush-fire control, donor efforts to simply reinforce governmental fire control activities, without the direct involvement of local populations, are unlikely to meet with success.

CHAPTER 14: GUINEA

A. Problems of Desertification and Current Status

106. Although more humid than the other Sahelian countries to the north and east, Guinea has not escaped the severe drier climatic conditions of the past decade. The regions most affected are those bordering the Sahel while the Fouta Djallon Massif and the Mount Nimba ranges have favoured more moderate to humid environmental conditions. Desertification problems are thus linked to land use practices which include grazing, subsistence agriculture, severe deforestation especially of the Fouta Djallon Massif, and the excessive uncontrolled bush fires that are frequent in the medium to high grass Sudanian woodlands. In these and the mountain slope regions, water induced soil erosion is a problem that is regional in scope in that it directly affects the catchment of the Niger River. Overgrazing has been aggravated by a general movement southwards from the Sahel by herdsmen in search of pasture.

107. A national strategy to combat environmental degradation was elaborated in 1981 in collaboration with UNSO. Particularly high priority has been given to watershed management, accelerated reafforestation, bush-fire control, and the sensitization of the rural population to issues of environmental degradation. Guinea is of particular importance in the Sudano-Sahelian context because three of the principal west Sahelian rivers - the Gambia, the Senegal, and the Niger - rise in the Fouta Djallon massif and associated highlands.

B. Current Anti-desertification Programmes and Projects

108. Restoration and integrated development of the Fouta Djallon Massif. This project aims at protecting the natural resources of the massif by biological means, which should influence not only the conditions of the region but also the flow patterns of the Gambia, Niger and Senegal rivers in the western Sahel. The project is supported by UNSO, UNDP, and the Organization of African Unity (OAU).

109. Water resources management plan. This project is being undertaken to inventory water resources and formulate a master plan for their utilization. It is supported by UNDP and the World Bank.

110. Hydroelectric development (Grandes Chutes) II. The objective of this project is to improve hydroelectric production and transmission in the region of Kindia. Increased production of hydroelectric power permits greater fuelwood conservation. The project is supported by the Government of France.

C. Records of Successes and/or Failures

111. These projects were initiated too recently to determine success or failure. Because of the regional importance of the Gambia, Senegal, and Niger rivers, however, every effort should be made to ensure the success of environmental rehabilitation projects undertaken in the Guinean highlands. To date, project implementation has been hindered somewhat by insufficient manpower, financing, and planning.

CHAPTER 15: GUINEA-BISSAU

A. Problems of Desertification and Current Status

112. Like Guinea, Guinea-Bissau is relatively humid and only the extreme north-east approaches semi-humid to semi-arid conditions. However, almost similar desertification agents are at work: deforestation, uncontrolled fires, overgrazing, collection of wood for fuel and other purposes especially around settlements and urban centres, and subsistence food production methods. A further constraint to land use is the occurrance of the black-fly which leads to abandonment or sparse human occupation. The lowland areas, especially those along the coast, are liable to salinization problems.

113. An assessment of the problem of natural resources degradation and a review of ongoing and proposed activities relevant to the implementation of the plan of action to combat desertification and protect the environment were undertaken by UNSO in 1981. The Government of Guinea-Bissau has attached particular importance to integrated development projects in degraded areas, community re-afforestation and bush-fire control.

B. Current Anti-desertification Programmes and Projects

114. Project to strengthen the Department of Soils: This project is being undertaken to restructure, consolidate, and equip the Department of Soils. The project is supported by FAO and DANIDA.

115. Inventory of water resources: The objective of this project is to rationalize the use of water resources in the country. The project is supported by the Government of France.

116. Integrated Development of Zone II, Bafata and Gabu: This project has been undertaken to sensitize the inhabitants of Bafata and Gabu to the problems of environmental degradation, and to address these problems through measures such as establishing plantations and controlling bush fires. The project is being supported by the European Development Fund and the Government of France.

117. Protection of vegetation: The objective of this project is to establish an integrated national effort to protect vegetation. The project is supported by USAID.

118. The reclamation of saline soils for rice production: The objective of this project is to reclaim saline soils in the southern region for rice production without destroying forest cover. The project is supported by FAO, BREDA, and the Canadian International Development Agency (CIDA).

119. Protection to increase agricultural production: The objective of this project is to increase agricultural output through the use of fertilizers. It is believed that increased use of fertilizers will eliminate the need for fallow and allow a reduction in cultivated land as production is intensified. The project is supported by FAO and DANIDA.

120. Agricultural development project: This project has been undertaken to increase agricultural production while decreasing environmental degradation through the application of modern, ecologically sound agricultural practices. The project is supported by USAID.

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121. Livestock development project. The purpose of this project is to relate better the management of cattle to the carrying capacity of the land in order to avoid environmental degradation and permit sustained production. The project is supported by the Government of Switzerland.

C. Records of Successes and/or Failures

122. The Government of Guinea-Bissau appears to have successfully reconciled issues of conservation and development in the various projects cited above. Nevertheless, there are fears that a lack of trained manpower will pose a serious constraint to project implementation.

CHAPTER 16: KENYA

A. Problems of Desertification and Current Status

123. Desertification problems in Kenya are the result of erratic climatic conditions over 75 per cent of the country, and increasing human pressures caused largely by a very high population growth rate, currently about 4 per cent and among the highest in Africa. Closely related has been the increasing expansion of both rainfed and irrigated agriculture into marginal lands, aggravating the existing over-stocking problem of these drylands. The collection of wood for fuel and charcoal, although now subjected to more stringent controls, has generally contributed to the degradation of woody vegetation formations. The arid northern and north-eastern parts of the country have been severely affected by drought and this has caused accelerated desertification characterised by wind erosion. The expansion of water supplies for stock has also contributed to decreased protective vegetation cover around water points and along existing streams and rivers.

124. Inappropriate cultivation and cropping methods both in the highlands and lowlands, together with overgrazing, have led to serious soil erosion and have affected both the quality and quantity of available surface water. The silting of dams and degradation of marine ecosystems are a direct result of inappropriate or poor land use practices.

125. Acknowledging past neglect of the arid and semi-arid regions of the country now affected by desertification, the Government has attached considerable importance to the development of means and techniques that will increase the productivity of these regions. In order to alleviate poverty and rehabilitate land and water resources, the Government has promoted mixed farming and livestock development projects in order to reduce risk through diversification. Also emphasized is the need for an integrated approach to the development of Kenya's arid and semi-arid regions along the lines of the Machakos Integrated Development Project and the Kerio Valley Project. The establishment of a mechanism within Government to co-ordinate the implementation of the plan of action to combat desertification in Kenya was supported by UNSO.

126. The magnitude of anti-desertification efforts in Kenya is considerably greater than in many areas of the Sudano-Sahelian region. It has been estimated, for example, that more than 85 non-governmental organizations (NGOs) are involved in tree-planting activities. They include churches, women's groups, schools and youth clubs, and research organizations, as well as community service and commercial organizations. Although the merit of these efforts is obvious, further attention should be devoted to co-ordination, seed documentation, and technical support. Further support and encouragement might be given to Kenya Non-governmental Organizations (KENGO), a coalition of non-governmental organizations active in Kenya, to serve as a clearing house for NGO-sponsored efforts in conservation and development.

B. Current Anti-desertification Programmes and Projects

127. East African Microbiological Resources Centre (MIRCEN): The principal objective of MIRCEN is to increase productivity in the agricultural and forestry sectors through the production and distribution of rhizobial inoculum. The rhizobia permit nitrogen fixation in legumes, thereby increasing productivity and resistance to stress, as well as making nitrogen available to other organisms. The project is assisted by UNESCO.

128. Hurri Hills development project: The objectives of this project are to plant trees and harvest fog in order to improve and sustain an adequate ground-water level. The project maintains a nursery, provides seminars on land cover, reafforestation and other methods of arresting erosion and desertification, distributes seeds and farm tools, and provides the services of local agriculturalists for advice and practical illustrations in the uses of appropriate technology. It is assisted by Lutheran World Relief.

129. Dryland afforestation research project: The objective of the project is to evaluate the performance of approximately forty species of trees on various sites in order to identify those most appropriate for use in rehabilitation projects. The project is supported by the Kenya National Council for Science and Technology (KNCST) and United States National Research Council.

130. Machakos District development project: The objective of this project is to assist in the development of semi-arid region ranching systems and ranching/mixed farming co-operatives in the Machakos Distict. Assistance is provided in the areas of crop improvement, marketing, land tenure, irrigation, soil conservation, animal husbandry, veterinary services, and farm management. The project is assisted by Technoserve, Inc.

131. Run-off agriculture: The objective of this project is to develop water harvesting to serve the agricultural needs of Lokitaung. The project is assisted by the Salvation Army, in co-operation with the World Vision Relief Organization and Voluntary Service Overseas.

132. Grazing block development: The objectives of the project are to plan and develop grazing blocks, and devise appropriate systems for their management. The project was initiated by USAID, and is currently supported through Government resources.

133. Evaluation of the co-operative ranching development strategy in the semi-arid areas of Kenya: The objective of the project is to determine the appropriateness and efficiency of co-operative ranching in the drylands of Kenya. The project is assisted by the KNCST.

134. Masailand Rural Development Programme: The project promotes improved range management, supported by a series of rural service centres, and reafforestation efforts. It is assisted by the United Methodist Committee on Relief.

135. Expansion of the Kiboko Range Research Station: The project focuses on the development of range and livestock management systems which can be operated by local pastoralists, and which will maximize livestock production on semi-arid rangelands while conserving and improving range resources. The project is supported by Winrock International.

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136. Range management and ranching demonstration project: This project is designed to help the Samburu tribe to establish ranching as an alternative to their nomadic life-style. It is supported by the World Vision Relief Organization.

137. Forestry cover mapping and land use and habitat mapping: The objective of this project is to determine trends in environmental change in relation to the management of rangelands and forests. The project is supported by the World Bank and the Government of France.

138. Integrated Project in Arid Lands (IPAL): IPAL was undertaken to conduct practical, long-term multidisciplinary research into the ecological and socio-economic problems associated with environmental degradation. It was initiated with UNEP support and is being implemented by UNESCO. It is currently assisted by the Federal Republic of Germany.

C. Records of Successes and/or Failures

139. The preceding are but a few of the many projects currently under way in Kenya. Others, such as the Baringo Semi-Arid Areas Pilot Project, various soil and water conservation activities, and renewable energy development including efforts to exploit Euphorbia tirucelli, are also of interest and are relevant to efforts to combat desertification in other parts of the Sudano-Sahelian region.

D. Information and Experience in Desertification Control

140. The successful mobilization of women's groups, such as the National Council of Women of Kenya and the Digoi Women's Group, to participate in environmental rehabilitation efforts is of relevance to countries throughout the Sudano-Sahelian zone and elsewhere. They have been effective in increasing environmental awareness and substantially augmenting the labour force available for rehabilitation projects.

CHAPTER 17: MALI

A. Problems of Desertification and Current Status

141. The northern parts of Mali lie within the Sahara and are hyper-arid. But this changes progressively southwards through the Sahel proper into the more humid Sudanian woodlands along the border with Guinea and Ivory Coast. The population of the regions of the Sahara and Sahel proper is nomadic, and livestock raising is the major economic activity. Settlements and crop production are concentrated mainly along the Niger River and in the parts of the southern region where tsetse-fly and black-fly do not impede human occupation.

142. Desertification problems have been aggravated by the severe climatic situation characteristic of this region, which was especially severe from the 1970's to the present, and amplified by the degradation of range and arable lands through over-grazing, excessive collection of wood for fuel and other domestic purposes, and much reduced fallow of cultivated areas. Droughts have forced livestock to concentrate in the southern regions, increasing existing pressures. The development of a network of water supplies for stock in the form of wells and temporary surface dams has aggravated desertification problems further. Attempts to increase food and cash crop production through irrigated agriculture, in particular along the Niger, have not only introduced the problem of salinization but have also encroached on grazing lands. With poor cultivation methods, the combined effect has been a general degradation of grazing areas leading to severe wind and water erosion, sand encroachment especially in the southern regions, shifting sand dunes, and general desiccation. The generally poor environmental conditions have given rise to rural out-migration which has lead to the abandonment of croplands and to urban congestion. Abandoned croplands have been invaded by bush whenever climatic conditions have permitted. In addition, the Government has had to provide relief for the drought-displaced people.

143. Efforts to combat desertification place stress on the need to:

(a) increase public awareness of the problem of environmental degradation;

(b) undertake appropriate research;

(c) train manpower to undertake effective soil restoration;

(d) undertake re-afforestation projects; and

(e) promote integrated development in the pastoral zones.

A national strategy for combating desertification is being prepared in co-operation with UNSO.

B. Current Anti-Desertification Programmes and Projects

144. Water Management Synthesis II Project: The purpose of the project is to assist the Government and donors in their efforts to improve institutional capabilities in irrigation system design, construction and operation, with emphasis on the allocation, distribution and use of water resources. The project is supported by USAID.

145. Domestic water supply: The objective of this project is to drill wells to provide water to twenty villages. The project is supported by the World Vision Relief Organization.

146. Species trials: The objective of these trials is to identify a broad range of drought-tolerant trees, shrubs, grasses, and new crops appropriate for inclusion in agricultural and environmental rehabilitation projects. The trials were initiated by the United States National Research Council, and have been undertaken in co-operation with the national Forest Service, the British Voluntary Service Overseas, the International Crops Research Institute for the Semi-arid Tropics (ICRISAT), the International Livestock Centre for Africa (ILCA), the United States Peace Corps, the Sahel Institute and USAID.

147. World Bank Forestry Project: The principal objectives of the project are to strengthen forestry institutions and establish state-managed plantations.

148. Industrial and village re-afforestation in the region of Gao: The objectives of the project are to increase the availability of poles and fuelwood, provide forage for livestock, and promote environmental rehabilitation. The project is supported by UNSO.

149. Renewable energy project: The objectives of this project are to conserve fuelwood and explore the use of other forms of renewable energy. The project is assisted by USAID.

150. Fuel-efficient wood stoves: The objective of this project is to reduce fuelwood consumption by promoting the use of fuel-efficient stoves. The project is assisted by FAO and UNSO.

151. Drought recovery project in Tin Aicha: This project has provided alternative employment, training, and other forms of support for the inhabitants of the Lake Faguibine region. It is assisted by the American Friends Service Committee.

C. Records of Successes and/or Failures

152. The development of the forestry sector in Mali has been encouraging, and many agricultural and livestock projects include shelterbelt establishment or other components which contribute to an amelioration of the environment. However, the impact of the various projects described will not be felt for several years. As in other Sudano-Sahelian countries, very few wildlife management projects have received donor support.

153. Information currently available indicates that: forestry projects in the higher rainfall (over 600 mm) areas of Mali have a good chance of success, adequate techniques for re-afforestation have been developed, and relatively intact forests exist in some areas. Swiss technical co-operation and USAID resource inventory efforts are generating much needed baseline data.

CHAPTER 18: MAURITANIA

A. Problems of Desertification and Current Status

154. Desertification problems in Mauritania, as in other Sahelian countries, are the result of severe degradation of rangelands due to overgrazing and overstocking, and the excessive cutting of woody vegetation especially for fuelwood. The prevailing dry conditions of the 1970's had the effect of amplifying this already serious problem which, in addition to encouraging herdsman to cut woody vegetation to provide fodder, later forced them to concentrate in the southern parts of the country and Senegal. Croplands in these regions were further affected by salinization which in turn led to abandonment and bush encroachment. Sand encroachment and shifting dunes have affected many areas, in particular around urban centers and settlements. The problem of fuelwood persists, and traditional livestock herding practices remain unchanged.

155. The Government attaches great importance to anti-desertification efforts. The Ministry of Rural Development, in collaboration with the United States National Research Council and USAID, sponsored an environmental workshop in September 1979 to sensitize Government officials and the population as a whole to the problems of desertification. The results of this workshop are reported in the publication Environmental Degradation in Mauritania, National Academy Press, Washington (1981). Forestry laws are being adjusted to the needs of the country and in the newly created settlements on the outskirts of Nouakchott, families must now plant and maintain four trees on their plots, rather than clear away vegetation, in order to retain title to the land. The designation of a national arbor day (the second Sunday in August) has increased environmental awareness and has contributed to the development of mechanisms for seedling production, distribution and outplanting.

156. Anti-desertification programmes in Mauritania currently place emphasis on the following areas:

- erosion control and sand-dune stabilization;
- groundwater exploitation and the construction of earth dams;
- the establishment of nurseries;
- the restoration of gum arabic stands;
- the establishment of shelterbelts and fuelwood plantations;
- pasture improvement;
- the establishments of firebreaks;
- the development, construction and dissemination of more fuel-efficient stoves;
- wildlife inventory;

- efforts to increase the management capabilities of the Service for the Protection of Nature; and

- the training of additional staff to implement anti-desertification projects.

Support for the formulation of a national plan to combat desertification was provided by UNSO.

B. Current Anti-desertification Programmes and Projects

157. Nouakchott greenbelt project: With support from the Lutheran World Service, the Nouakchott greenbelt project was initiated in 1975 to protect the city from wind-driven sand and dust. Current dune stabilization efforts are being supported by DANIDA.

158. Exploitation of ground-water resources: The objective of this project is to drill and equip thirty six wells, and to provide facilities and trained personnel to maintain them. The project has been supported by UNSO and the African Development Bank.

159. Earthen dam construction: The purpose of this project is to improve the collection and utilization of surface water flow. The project has been supported by UNSO and other organizations of the United Nations system.

160. Species trials: The object of this programme is to identify drought tolerant trees, shrubs, grasses, and new crops suitable for inclusion in anti-desertification projects in Mauritania. It is sponsored by the United States National Research Council, and has been undertaken in co-operation with the Mauritanian Agricultural Service, the Service for the Protection of Nature, the Lutheran World Service and USAID.

161. Establishment of forestry nurseries: The objectives of the project are to create regional nurseries, train nursery personnel, provide seedlings for re-afforestation efforts, and sensitize local populations to the problems of environmental degradation. Support has been obtained from the CEAO.

162. Gum arabic project: This project is intended to promote Acacia senegal or gum arabic regeneration and increase the production of gum. It is supported by the European Development Fund.

163. Trarza integrated development project: This project includes the establishment of nurseries and village plantations, as well as measures to protect the environment. The project is supported by UNICEF.

164. Fuel efficient stoves: The project was established to select, construct, and promote the use of fuel-efficient stoves in Mauritania. It is supported by OXFAM, the Association for the Development of Renewable Energy in Mauritania and the Voluntary Fund for the United Nations Decade for Women.

165. Oases development project: Elements of the project include the establishment of tree fences, more efficient water use, fuelwood production, and pasture improvement stressing the use of well adapted forage trees and shrubs. The project is supported by USAID.

C. Records of Successes and/or Failures

166. Few countries in the Sudano-Sahelian zone have had greater difficulty in successfully implementing anti-desertification projects. In some instances projects have been undertaken without sufficient regard for the environmental history or ecological processes of the area. In other instances, manpower shortages, uncertainties concerning donors' contributions and schedules, the over-riding concerns of prominent individuals or special interest groups, limited financial resources, and other constraints have contributed to project failure. The failures have had a profoundly demoralizing impact on donors and Mauritanian officials alike.

167. While manpower shortages are being addressed by several projects, including the USAID supported Human Resources Development Project and the Sahel Manpower Development Project, it is doubtful that existing efforts in manpower development can satisfy the needs of current and proposed development and anti-desertification projects. Unfortunately, there is often a tendency to over-estimate the need for formally trained manpower, under-estimate the existing capabilities of the rural workforce, and defer necessary actions until trained manpower is available. In many instances, the problems posed by inadequate manpower could be surmounted by more direct and systematic mobilization of rural populations in project development and execution.

168. Perhaps in part because of the difficulties of successfully implementing projects in Mauritania, a disproportionate amount of donor support has been channelled into relatively unproductive studies or surveys. This ambivalence extends to field projects which are often inadequately designed, poorly staffed, and of excessively short duration. As donor efforts progressively gravitate toward the "higher potential areas" of the Senegal River valley, there is a corresponding neglect of the pastoral zone. Potentially important anti-desertification projects, such as the Renewable Resources Management Project, have been prematurely terminated, and other promising programme areas, such as wildlife management have received little donor interest or financial support.

169. It should also be noted that some anti-desertification projects, such as those concerned with the development of groundwater resources, could in fact contribute to further desertification if not better linked to a realistic understanding of recharge rates, soil/water/vegetation interactions, and ecologically sound livestock management systems. Similarly, while rural roads projects can be highly beneficial, they can also result in an intensification of economic activity which, if unregulated, could contribute to further environmental degradation. This potential problem is illustrated by the role of rural roads in the Chemama in facilitating the destruction of the Acacia nilotica forests of the region.

170. In addition to the successful governmental initiatives and aid-assisted projects cited in paragraphs 155 and 157 - 165 above, special mention might be made of the forest reserve maintained by the inhabitants of Boumdeid, a small oasis on the western margin of the Awkar basin. This effort, initiated and supervised by the religious leaders of the community, illustrates the extent to which existing non-western social organizations can contribute to environmental conservation when it is in their interest to do so. Because of their considerable accountability and authority among rural populations, traditional religious and secular leaders should be more directly involved in

development and conservation efforts. For example, clerics associated with the Qadiriyya or Tijaniyya religious brotherhoods and the more recently formed Fadiliyya and Muridiyya orders would be logical collaborators in the formulation and implementation of anti-desertification projects in Mauritania, Senegal, the Gambia and indeed almost all countries in the Sudano-Sahelian region.

171. From 1976 to 1979, the Nouakchott Greenbelt Project placed emphasis on the establishment of Prosopis chilensis at a density of 2500 trees per hectare to protect the city from shifting dunes and dust storms. Although the success of the project was hampered by prolonged drought, unexpected costs, nursery techniques and supplemental water schedules that discouraged tap-root development, and other factors, it contributed greatly to the stabilization of the project area and has resulted in the spontaneous regeneration of a broad range of native and exotic plant species, including economically important species such as gum arabic (Acacia senegal). Since 1980, the project has stressed the use of a native succulent, Euphorbia balsamifera, planted at a density of approximately 10,000 cuttings per hectare. The survival rate of this euphorbia has been high, around 50 per cent, and the spontaneous regeneration of other species in response to increased stability has been unexpectedly great. Some twenty one plant species have appeared within the project area, and many species of birds, hares, jackals and other forms of wildlife have re-established themselves in the greenbelt. It might be added that E. balsamifera has long been used by Mauritanians as living fences for fields, compounds, and livestock enclosures. Individuals familiar with Mauritania have observed that the declining use of E. balsamifera fences has corresponded to an increase in environmental degradation in the country.

CHAPTER 19. NIGER

A. Problems of desertification and Current Status

172. A large part of Niger lies within the Sahara and the whole southern region lies within the Sahelian belt. A large proportion of the population leads a nomadic life-style and livestock raising is the major economic activity. Most crop production occurs along the Niger River and depends mainly on water from this river for irrigation. When better climatic conditions prevail cultivation of drought resistant crops such as sorghum is practiced in parts of the Sahel. The Government recognised the economic importance of livestock development (in April 1985 it conducted a national debate on the subject at Tahoua) and gave priority to the exploitation of underground water resources. This altered normal livestock movement patterns and contributed to a large extent to rangeland degradation. This, together with the excessive cutting of woody vegetation for fuel and fodder has created an ecological imbalance and led to severe desertification. Although livestock numbers were very much reduced during the droughts of the 1970's, which still persist, there has been a general recovery of stock numbers.

173. The salinization of irrigated areas along the Niger River and of oases, has led to a decrease in crop production. In some instances, the rural population has therefore had to abandon croplands or cultivate resistant crops. In addition to salinization, desertification manifests itself in erosion caused in particular by the strong, hot and dry harmattan winds, and in sand encroachment, shifting sand dunes, poor crop yields and much reduced forage supplies.

174. Niger's efforts to combat desertification essentially date from the formulation of the country's 1976 - 1978 Triennial Development Programme. Under this programme, all projects in the forestry, livestock and agricultural sectors were evaluated to determine their compatibility with the environmental characteristics of the country. In addition, in May 1984 a national debate on desertification was conducted, one result of which was the Maradi Agreement. UNSO is assisting the Government in completing a national strategy for combating desertification.

B. Current Anti-desertification Programmes and Projects

175. Forest and land-use planning. This project has been undertaken to strengthen capabilities in resource management, determine the distribution and productivity of the country's natural resources, establish model sites for resource conservation and production, and develop management plans for forest reserves, agro-silvo-pastoral production, and resource conservation. The project is assisted by USAID.

176. Technical Assistance Forestry Project (Phase II). This project includes the following components:

- rural tree plantations,
- state-managed rain-fed tree plantations,
- irrigated tree plantations,
- watershed management and erosion control,

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- management of natural forests,
- bush-fire control,
- training,
- research, planning and monitoring, and
- the strengthening of the project unit.

It is supported by the World Bank.

177. Tahoua greenbelt project. The principal objectives of the project are to protect Tahoua from desiccation and sand-laden winds, provide fuelwood and building materials, and contribute in general to the environmental stability and productivity of the Tahoua region. The project is assisted by UNSO.

178. Species trials. These trials are being undertaken to identify and evaluate drought-tolerant species of trees, shrubs, grasses and new crops suitable for inclusion in agro-forestry and environmental rehabilitation projects. The project is supported by the United States National Research Council and is being undertaken in co-operation with the United States Peace Corps, the Government of Switzerland and USAID.

179. Protection and regeneration of Acacia albida. The project has been undertaken in the Doso area to protect and promote the natural regeneration of Acacia albida, and to establish A. albida plantations. The project is assisted by the Government of France.

180. Management of the Borassus aethiopum groves of Dallol-Maouri. The objectives of the project are to determine the distribution of the Borassus aethiopum palms, develop a management plan for their conservation and development, and sensitize the local population to the importance of the trees. The project is currently assisted by the Government of Switzerland.

181. Fuel-efficient wood stoves. This project supports the development and promotion of fuel-efficient stoves in order to conserve fuelwood. It is assisted by UNSO.

182. Wildlife conservation. This project has been undertaken to explore the possiblity of establishing a wildlife reserve in the Aïr region to conserve desert wildlife, as well as to deal with general issues of wildlife conservation in the "W" National Park. The project is supported by the International Union for Conservation of Nature and Natural Resources (IUCN) and receives financial contributions from the World Wildlife Fund (WWF).

183. Integrated livestock production project. This is a relatively comprehensive project which is attempting to reconcile livestock production with measures intended to contribute to environmental rehabilitation. The project is assisted by USAID.

184. Workshop on Desertification and Measures to Strengthen the National Strategy to Combat Desertification. This activity was supported by UNSO.

C. Records of Successes and/or Failures

185. Donor efforts in Niger have occasionally lacked continuity because donor technicians have been unable to justify the continuation of certain projects on technical or scientific grounds. Various donors, for example, have undertaken Acacia albida projects, and then abruptly discontinued them even though the value of the trees is quite evident on empirical grounds. Similarly, it is evident that agro-forestry systems are characteristically more stable and often more productive than alternative agricultural systems in the Sudano-Sahelian region, but why this is the case is unclear in scientific terms and many donors remain reluctant to undertake agro-forestry projects.

186. Various shelterbelt projects in Niger could be duplicated elsewhere. The practice of leaving ten-metre wide bands of natural woodland as buffers between farmland, instituted in 1964, is an early example of a successful effort to maintain environmental stability while affording protection to crops. In the late 1970's some 250 kilometres of two-row windbreaks, composed of neem (Azadirachta indica), were established in the Majjia Valley in Bouza District. More recently, Acacia nilotica, A. senegal, and A. tortilis have been included in shelterbelt plantings sponsored by CARE. These efforts have been supported by the local population and have made a significant contribution to environmental stability in the Bouza District.

CHAPTER 20: NIGERIA

A. Problems of Desertification and Current Status

187. Northern Nigeria borders the southern Sahel and receives the full impact of the dry, hot, dust laden harmattan winds which blow across the Sahara. Located within the Sudanian woodland grasslands belt, it is the most important region in the country in respect of the production of beef, grains, groundnuts and cotton. In addition to the dry weather which has occured in the region during the past decade, desertification problems are the result of the extensive clearing of woody cover, bad land use practices in particular over-grazing, cropping methods which, due to population pressure, no longer allow fallows, and the excessive cutting of woody vegetation for fuelwood and charcoal. These have been further compounded by water development projects for livestock and irrigation, which have resulted in the destruction of grazing areas. The general deterioration of these rangelands has resulted in severe water and wind erosion and sand encroachment. Deforestation still remains among the most important problems in the region and is unlikely to ease in view of considerable and growing population pressures.

188. In Nigeria, the National Committee on Arid Zone Afforestation is the main co-ordinating body in efforts to combat desertification in the five nothern states affected by desertification, namely, Bauchi, Borno, Kaduna, Kano and Sokoto. Forestry sector activities are given emphasis and include the establishment of nurseries, the distribution of seedlings, the provision of fencing material, support for the establishment of individual woodlots, the establishment of model woodlots, the establishment of shelterbelts, studies of alternative sources of fuel, forestry vocational training, and the further development of extension services. The Forestry Research Institute supports research on shelterbelts and the University of Sokoto provides training and carries out research on dryland forestry. Activities also include watershed management and erosion control, land reclamation, water supply development, and wildlife conservation.

B. Current Anti-desertification Programmes and Projects

189. Arid zone afforestation: The objectives of the programme are to establish and develop nurseries; encourage the establishment of community and private woodlots, and encourage public participation in forestry activities and public support for extension efforts. The programme is supported chiefly by the Federal Department of Forestry through the National Committee on Arid Zone Afforestation and by the state governments of Bauchi, Borno, Kaduna, Kano and Sokoto. UNSO is providing programming assistance to the Committee.

190. Shelterbelts and rural afforestation, Kano State: The objective of this project is to alleviate the effects of the harsh climatic conditions in the north-eastern part of Kano State through by establishing of shelterbelts and supporting rural afforestation efforts. The project is being carried out mainly by the Shelterbelt Research Station, Kano City, supported by the Forestry Research Institute in co-operation with the National Committee for Arid Afforestation.

191. Establishment of the Dorayi Forestry Vocational Training Centre, Kano State. The purpose of this project is to provide training to forest supervisors and superintendents, silviculture assistants, forest assistants and forest guards. Training is mainly at the middle level and its purpose is to help conserve forest reserves, combat deforestation and increase afforestation activities. The Centre was established by the National Committee on Arid Zone Afforestation on which it depends for financial and practical support.

C. Records of Successes and/or Failures

192. The Arid Zone Afforestation programme has resulted in the establishment of approximately 114 nurseries and the production of more than one million seedlings each year. In addition to these nurseries, two fruit tree nurseries have been established in each of the five northern states. Further plantations have been established on some 3000 hectares. A forestry vocational school has been established at Kano and public awareness of forestry issues has increased.

193. Despite these advances, manpower shortages remain a problem. There is some local resistance to forestry activities by agriculturists and pastoralists who are competing for limited land with reduced carrying capacity. Insufficient financial resources have also affected the progress of conservation and development efforts in Nigeria.

CHAPTER 21: SENEGAL

A. Problems of Desertification and Current Status

194. While the southern parts of Senegal are relatively humid, the northern and eastern regions are semi-arid to arid. In the south there are also large areas of Sudanian woodland forests and here uncontrolled fires are a problem. The drier areas of the north sustain both food and cash crop production, and livestock raising. Traditional practices are used in livestock raising, including nomadism in the semi-desert regions of the north-east and mixed farming, in particular along the Senegal River. Here the inhabitants have generally followed a cropping cycle timed to coincide with the flooding cycle of the Senegal River. Again, like other Sahelian countries, excessive grazing and the depletion of woody cover have contributed to desertification. Wind erosion, sand encroachment and shifting sand dunes are charateristic of most of the northern dry belt of Senegal. In the south, water erosion due to deforestation, cropping systems (including shifting cultivation especially in areas infested by black-fly or simulium-fly, and tsetse-fly), and frequent fires, poses a problem affecting the normal flow of both the Gambia and Senegal rivers.

195. The general desiccation of the Sahelian region forced many herdsmen to move south from both Mauritania and Mali in search of grazing, thus adding to the existing problems of livestock grazing pressure.

196. Salinization of irrigated areas, mainly along the Senegal River has further exacerbated the desertification problem in the country. Current plans to expand irrigated agriculture along the valley and in adjacent regions of the basin need to give full consideration to this potential problem.

197. The Senegalese Government supports a wide range of anti-desertification programmes. Particular attention is directed toward soil improvement and conservation, the rational management and exploitation of water resources, the establishment of plantations of fast-growing trees to satisfy local needs and relieve pressure on natural forests, the protection and rehabilitation of natural forests, and the reintroduction of trees in agricultural regions through the establishment of shelterbelts, living fences, and village woodlots. Assistance in formulating a national plan to combat desertification was provided by UNSO. The Government has also initiated efforts to develop a national conservation strategy based on the World Conservation Strategy with advice from the International Union for Conservation of Nature and Natural Resources (IUCN).

B. Current Anti-desertification Programmes and Projects

198. Reafforestation and dune stabilisation: The chief objective of this project is to stabilise coastal dunes in the north of the peninsula and the dunes that threaten pockets of cultivated land (Niayes). The project is being carried out in three locations: a) the Saint-Louis Louga sector, funded by ACDI, b) the Lompoul-Kébémer sector, funded by FAO and c) the Kayar-Mboro sector, funded by USAID.

199. West African Microbiological Resources Centre (MIRCEN): MIRCEN has established centres at Bamisey and Dakar to provide rhizobial inoculum to increase the nitrogen-fixing capabilities of leguminous trees, shrubs, and crops in West Africa. The availability of this inoculum is of critical importance to the success of environmental rehabilitation projects involving

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legumes in the Sudano-Sahelian zone. The centre was established by the United States National Research Council in collaboration with the Government of Senegal, UNESCO, Office de la Recherche Scientifique et Technique Outre-mer (ORSTOM), and other institutions. It is currently supported by UNESCO and the Foundation for Microbiology.

200. Casamance forests: This project has been undertaken for the ecologically sound development of the Tobor Forest by means of better production, the establishment of firebreaks and improved management. The project is supported by UNDP, UNSO and FAO, with financing from the Government of the Netherlands.

201. Reafforestation in the east central (Sine-Saloum) region: This project is concerned with the improved management of natural forests, the establishment of tree plantations, and the promotion of better uses of wood and wood substitutes. It is financed by the IDA, CCCE, FAC and UNDP/FAO.

202. Reafforestation in the Ferlo: This is one of several projects supported by the Federal Republic of Germany in the semi-arid regions of northern Senegal. Initially a gum acacia reforestation programme, it has now been extended to other species and to the sylvo-pastoral management of species.

203. Species trials: Trials involving some 190 accessions of drought-tolerant trees, shrubs and new crops have been undertaken by the United States National Research Council in co-operation with USAID, the Government of Switzerland, the German Forestry Mission, and others.

204. Community forestry in the Groundnut Basin: The objective of the project is to promote and assist the development of woodlots and other forestry sector activities in the Groundnut Basin. The project is supported by FAO and the Government of Finland.

205. Fuelwood production: The principal objective of this project is to provide technical assistance in establishing a major fuelwood plantation in the Bandia Forest. The project is currently supported by USAID.

206. Woodlots. USAID, in co-operation with Africare and the United States Peace Corps, has undertaken a project to establish small fuelwood plantations around Diourbel. A similar project, implemented by Africare, is focusing on the needs of the Gossas District.

207. Gum arabic production and pastoral zone revegetation (Phase II): The objectives of the project are to systematically upgrade the production and quality of gum arabic by conducting research on Acacia senegal and A. laeta trees of various provenance to select species of native and exotic drought-tolerant trees capable of supporting livestock populations, and developing sylvicultural methods appropriate for the establishment of vegetation around wells. The project is supported by the International Development Research Centre (IDRC) of Canada.

208. Pasture improvement and livestock development: This project, supported by USAID, is one of several livestock projects with a strong range rehabilitation component. The European Development Fund, the Government of France, the German Forestry Mission, IDRC, and others are engaged in complementary range improvement activities.

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209. Inventory and monitoring of the Sahelian pastoral ecosystems: This project is providing technical and material support to the Government of Senegal in an effort to develop a dependable system of rangeland monitoring. The project is chiefly supported by UNDP and FAO.

210. Fuelwood conservation: The objective of this project is to study, develop, and market fuel briquettes made of groundnut shells, peat, or other materials as a substitute or supplement to the use of fuelwood. The project is supported by UNSO in co-operation with DANIDA.

211. Renewable energy: With support from USAID, this project is concerned with the development of a simple but fuel-efficient mud-and-sand stove as a potentially important fuel conservation measure.

212. Village woodlot project at Bakel and Louga: This is a community reforestation programme which also includes an education component to encourage the people to make careful use of energy resources.

213. Irrigated plantations: This is a project to irrigate plantations of fast growing species along the Senegal River. It is financed by FAC.

214. Cashew plantations in the Sine-Saloum region: The cashew is an agro-forestry species that is easily integrated into village reforestation programmes. This project is being funded by the Federal Republic of Germany.

215. Training charcoal producers: The objective of this project is to rationalize charcoal production in order to reduce pressure on woody formations. It is supported by USAID.

216. Forest protection - fire fighting: Two major projects are involved in forest protection in southern Senegal. An ACDI project, located at Casamance is concerned both with preventive measures and active fire-fighting. The other project, financed by the African Development Bank, is making use of Acacia senegal as a fire protection measure. These activities to protect vegetation from fire are receiving considerable support from the Project for the Protection of Nature, which is supported by the Government of Japan and by a loan from Argentina.

217. "Gonakier" and "Pôles Verts" projects: The projects' purpose is to reconstitute formations of Acacia Nilotica tomentosa in the Senegal River region and to set up development centres to encourage the most efficient use of available water for agriculture, forestry and stock grazing.

C. Records of Successes and/or Failures

218. Although potential forestry production and consumption rates are relatively well balanced at the present time, centres of production and consumption are often widely separated, resulting in major transportation problems and considerable expense. Hence, emphasis on plantation establishment and reafforestation in the more densely populated areas is understandable. Furthermore, these forestry sector initiatives should have a positive impact on soil conservation, water management, and wildlife management.

219. Reforestation achieved through community efforts rose from 500 hectares in 1978 to 7,500 hectares in 1984 and it is expected that these figures will continue to rise. Community activities have in fact achieved more than official operations, which reforested an area of 2,500 hectares in 1984. The work to renew, expand and protect forest areas has been assisted by the increasingly widespread use of fuel-efficient stoves.

220. The serious lack of fuelwood and building materials in the Groundnut Basin and other densely populated agricultural regions is a problem that is being resolved through closer co-operation between officials and community leaders, to encourage the rural population to take concerted action.

CHAPTER 22: SOMALIA

A. Problems of Desertification and Current Status

221. The characteristically dry environment of Somalia is a product of the less moist sub-continental north-east monsoon and the deflected, moisture deprived, south-east monsoon. These winds blow almost parallel with the Somalia coast and are generally responsible for the accelerated sand encroachment and sand dune formations in the areas adjacent to the sea. Livestock raising is the most appropriate land use form for practically the whole country, with the exception of a small area in the south where irrigated agriculture has been made possible by the Shebeli and Juba Rivers. Livestock is also the most important foreign exchange earner. However, most if not all of the grazing land has been overgrazed and overstocked resulting in severe degradation and bush encroachment in some parts. Furthermore wood is the only source of energy for most urban and domestic uses. There has therefore been continuing depletion of this resource, especially around urban centres such as Mogadishu. These two activities are to a very large extent responsible for desertification problems in Somalia and possible solutions are discussed in the following sections.

222. An assessment of the status of desertification in Somalia, as well as a national plan of action to combat desertification were undertaken and completed with support provided by UNSO. Current anti-desertification efforts stress the following areas: soil and water conservation, sand-dune stabilization, nursery establishment and other forestry sector activities, range development, and settlement programmes.

B. Current Anti-desertification Programmes and Projects

223. Strengthening and intensification of coastal sand-dune fixation activities. The immediate objective of this project is the stabilization of sand dunes on 1200 hectares in five locations in the Shallambot area of Lower Shaballi Province. Activities include practical research trials on plant species and techniques suitable for sand-dune fixation, a survey and classification of shifting dunes in all coastal areas of Somalia, and the development of a programme for the extension of activities to other affected areas. The project is supported by UNSO.

224. Brava community dune fixation: This is a self-help project undertaken to stabilize an area of 30 hectares around the coastal community of Brava. Assistance has been provided by Africare.

225. Water reservoir rehabilitation project: This project involves the supply of pumping equipment, fencing, technical assistance, and the training of reservoir maintenance teams for the rehabilitation of 33 reservoirs in south-central Somalia. The project is supported by UNDP, UNSO and the United Nations Capital Development Fund (UNCDF).

226. Northern rangeland development project: The principal objectives of the project are to formulate and implement a comprehensive programme of range management in northern Somalia. The project is supported by the Kuwait Fund for Arab Economic Development and USAID.

227. Central rangeland development project: The objectives of the project are essentially the same as for project 226 above but focus on the central districts. Support for the project has been provided by the World Bank, International Fund for Agricultural Development (IFAD), USAID, and the Federal Republic of Germany.

228. Refugee areas forestry project (Phase I): The project is principally concerned with institution building, reafforestation and fuel production, fuelwood conservation, a natural resource/land use survey, a fuelwood supply/demand assessment, and project monitoring and management assistance. This is a Co-ordination for Developmnt in Africa (CDA) project supported by USAID.

229. Arbor Day: A national arbor day has been decreed to increase general awareness of the importance of reafforestation in combating desertification. It is sponsored by the National Range Agency.

230. Self-help rangeland and re-afforestation support projects: These projects encourage range development and re-afforestation efforts by labourers willing to accept food for work on a self-help basis. They are undertaken with donations from the World Food Programme.

231. Gedo region community development: This project, supported by the Inter-Church Response for the Horn of Africa, includes several activities designed to stem desertification and increase productivity. These include water-resource development, forestry, agricultural development, and alternative sources of energy. Similar activities in the Gedo area are being supported by the Mennonite Central Committee.

232. Settlement programmes: These programmes have been established to develop livelihood alternatives for displaced pastoralists. Thus far, agricultural settlements have been formed in the Juba and Shabelli regions, and fishing communities have been established or expanded at Srava, El Ahmed, Adala, and Eil. Anti-desertification projects include the establishment of shelterbelts and multiple-use tree plantations for protection, fuel, and fodder, the identification of alternative sources of energy, and environmentally sound agricultural development. The development of agricultural settlements is supported by the Arab Fund for Economic and Social Development, the World Bank, the European Development Fund, the Government of Netherlands, USAID, the Federal Republic of Germany, and the World Food Programme. The development of the fishing communities was initiated with support from the USSR in the 1970s. It is currently supported by CIDA, FAO, The United Kingdom Government, and the World Food Programme.

233. Short-cycle vegetable crops: Although undertaken principally to satisfy the immediate food requirements of refugee camps, the project has further implications with regard to the development of sustainable agriculture in Somalia. The project is supported by OXFAM-America.

C. Records of Successes and/or Failures

234. The community involvement aspect of sand-dune stabilization projects in Somalia, as well as the selection of appropriate species for use in anti-desertification projects, have been quite successful. Further consideration is planned for the eventual inclusion of economically attractive plant species in the project areas.

Small trial sites could be established in the project areas without difficulty, to evaluate the commercial potential of various plants known to perform well in similar conditions elsewhere.

235. Notwithstanding manpower shortages, problems in recruiting foreign experts, delays in the delivery of equipment and transportation problems, the Northern Rangeland Development Project has been relatively successful. More than 70 grazing reserves have been established in co-operation with pastoralists, wells have been drilled to provide water during periods of drought, several nurseries have been established, fodder production units have been organized, and demonstration ranches have been established. The project has provided both formal and non-formal training, as appropriate, and has established a training school for forestry and wildlife at Afgoi and a range management institute at Burao. These training centres offer two-year courses to develop middle-level technicians. The project has also resulted in the establishment of a national herbarium. The management aspects of the project could perhaps profit from greater knowledge of the organization of ranch co-operatives elsewhere, such as the successful reintroduction of the hema system of range reserves in Syria.

236. Several projects have failed because objectives were unrealistic, local populations were not directly involved, or because of inadequate support and continuity. For example, a major project was undertaken in the 1970's to strengthen forestry and wildlife management. While the project was relatively successful in initiating activities in soil conservation and sand-dune stabilization, nursery establishment, species trials, resource inventory and training, there was little follow-through. The nurseries were neglected, seed quality and documentation were poor, the records of the species trials were lost, the plantation was established on unsuitable terrain, and various studies were discontinued. A major objective of the project, the establishment of forest reserves, was not realized. Projects of this kind sharply reduce the willingness of Government officials, donors, and local populations to commit their time, effort, and resources to subsequent projects, regardless of their merit.

D. Information and Experience in Desertification Control

237. Several elements of the sand-dune stabilization projects described above are suitable for duplication elsewhere, particularly the community involvement aspects and the use of well-adapted native plant species. This would be particularly relevant to current efforts in dune stabilization in Mauritania. The use of Commiphora sp. in Somalia is somewhat analogous to the use of Euphorbia balsamifera in dune stabilization projects in the coastal zone of Mauritania.

238. Somali nomads are known to be outstanding in the field of camel husbandry and export camels to other countries. Camels are well adapted to the harsh conditions of many Sudano-Sahelian countries, are less damaging to dryland ecosystems than other kinds of livestock and therefore merit greater attention in livestock improvement programmes throughout the region.

CHAPTER 23: SUDAN

A. Problems of Desertification and Current Status

239. Current anti-desertification programmes reflect closely the environmental problems confronting the Sudan. It appears, however, that further efforts in clarifying the environmental history of the country would be useful in establishing a meaningful environmental baseline and in realistically determining the biological potential of the regions affected by desertification. Not only has the exploitation of forest products in modern times altered the character and content of the landscape, but substantial tracts of Acacia tortillis and allied species were destroyed for metal smelting and to satisfy the domestic needs of successive kingdoms established in northern Sudan. The success of various shelterbelt programmes in the north indicates that many of these denuded areas would probably respond well to reafforestation efforts. Similarly, the progressive environmental deterioration of the Khartoum-Omdurman area might be arrested if a well conceived urban-fringe rehabilitation project was implemented as an extension of the Government's Khartoum Greenbelt Project.

240. Ground-water recharge and the general management of water resources require attention, not only to satisfy the immediate needs of man and his crops and herds, but also to maintain critical ecological relationships.

241. A national plan of action to combat desertification was formulated in collaboration with UNEP, UNDP and FAO in 1976. Current anti-desertification progammes in the Sudan place emphasis on: the protection of existing vegetation by encouraging traditional conservation practices and proper land management, including the re-establishment of traditional Acacia senegal-based bush-fallow systems, species trials involving drought-tolerant tree species, re-afforestation efforts, and the identification of alternative sources of energy to replace fuelwood and charcoal.

B. Current Anti-desertification Programmes and Projects

242. Land reclamation project, Northern Region: The objectives of the project are to develop shelterbelts capable of protecting agricultural lands from desert encroachment and to assess the economics of land reclamation. The Project is supported by the IDRC.

243. Research into native leguminous trees: The purpose of this research is to identify and improve fast-growing, multiple-use, nitrogen-fixing trees suitable for inclusion in dryland development projects. The research is supported by the United States National Research Council, and has been undertaken in co-operation with the University of Gezira at Wad Medani.

244. Joint afforestation project in the Northern Region: The objective of the project is to establish shelterbelts to protect agricultural lands from desert encroachment. The project is supported by the Church World Service.

245. Restocking of the Gum Belt for desertification control: The objective of the project is to assist farmers in northern Kordofan in the rehabilitation of their gum arabic (Acacia senegal) gardens, thereby increasing environmental stability and eventually permitting the augmentation of local incomes through the sale of gum. The project is supported by the Government of the Netherlands.

246. Management of grazing resources around permanent water supplies in cental Kordofan: The objective of the project is to restore range productivity through the introduction of more effective management systems. The project is supported by UNSO.

247. Mesquite project: This project has been undertaken near Sheikh as-Sidiq in the White Nile Province in order to identify accessions of Prosopis suitable for inclusion in anti-desertification projects in Sudan. The project is supported by the IDRC.

248. Western Sudan agricultural research project: Among the objectives of this project is the development of sustainable agricultural systems in Darfur and Kordofan. The project is supported by the World Bank and USAID.

249. Western Savanna Development Corporation: The Corporation began operations in South Darfur in 1978. It was established for the following purposes: to promote integrated rural development, establish migratory and trade cattle routes, develop rural water supply, and support mixed farming. Support is provided by the Governments of Sudan and the United Kingdom, the Abu Dhabi Fund for Arab Economic Development, the Saudi Fund for Development, and the World Bank.

250. Support for the National Desertification Control Co-ordinating and Monitoring Unit: The objectives of this project are to promote desertification control activities, carry out desertification monitoring and strengthen national mechanisms for the co-ordination of anti-desertification efforts. Support for the project has been provided by UNSO.

251. Obstacles to the application of modern knowledge and technology to the management of arid lands: The objective of this project is to assess obstacles to the application of modern science to arid-land management. The project is supported by the United Nations University.

252. Assessment and monitoring of desertification in Umm Ruwabah, Ar-Rahad Region: The objectives of this project are to assess the current status of desertification around Umm Ruwabah and to monitor desertification trends over an extended period of time. Support for the project has been provided by the Swedish Agency for Research and Development Co-operation with Developing Countries (SAREC) through Lund University.

253. Indicators of desertification: The objective of the project is to identify and monitor indicators of environmental degradation in seven areas in central Sudan. The project is supported by USAID (through ETMA).

254. Baseline survey and monitoring programme for the Northern Kordofan rural water supply: The objective of the project is to collect basic data, implement a rural water-supply programme and monitor water use in northern Kardofan in order to develop appropriate management systems. The project is supported by CARE.

C. Records of Successes and/or Failures

255. As past experience in the Sudano-Sahelian zone has demonstrated, many of the water-supply projects that have been described as efforts to combat desertification will almost certainly intensify environmental degradation. Attention should be given to reconciling project design more closely to the dynamics of environmental systems in order to increase project impact by, for example, taking advantage of effective winds, wadi flow, and livestock movement in seed dispersal. The support of wildlife management in the northern regions can be justified in terms of the important role played by browsing herbivores in plant stimulation and seed dispersal. Wildlife is also a source of game meat and of revenue, through controlled hunting and tourism.

256. The species trials currently being conducted in the Sudan are providing promising results, although they are somewhat limited in terms of the range of species considered. Furthermore, with the important exception of Acacia senegal, there has been a tendency to under-estimate the potential importance of native species, such as A. tortillis. At the trial site near Sheikh as-Sidiq, A. tortillis appears to outperform the introduced Proposis spp. when subjected to similar livestock pressure. Perhaps more attention should be devoted to the promotion and improvement of native species. In this regard, the results of the small research programme at Wad Medani concerned with native, leguminous trees are of potential relevance to other forestry-sector activities in the Sudan.

257. There are many desertification research and monitoring activities being undertaken in the Sudan and consideration should be given to better co-ordinating and consolidating these efforts. There is often a tendency for development planners to under-value existing knowledge relevant to the formulation and implementation of anti-desertification measures, and they therefore undertake research and monitoring activities rather than more practical projects.

D. Information and Experience in Desertification Control

258. There are several potentially important Sudanese contributions to the struggle against desertification in the Sudano-Sahelian zone.

259. The traditional Acacia senegal based bush fallow system could serve as a valuable model for the development of stable, productive dryland agro-sylvo-pastoral systems elsewhere in Africa.

260. The inhabitants of Sheikh as-Sidiq have been relatively successful in protecting and managing a remnant forest located near their village. Several elements of the Sheikh as-Sidiq experience are directly transferable to other areas of the Sudan and to other regions of the Sudano-Sahelian zone. A similar example of local initiative has been described for Mauritania (c.f. para 150).

261. Several elements of the Northern Region shelterbelt project supported by the Church World Service, and implemented by the Government of Sudan and the Sudan Council of Churches, are suitable for duplication elsewhere in the Sudano-Sahelian zone. The transferability of the various technical and biological components of the project would naturally be influenced by site-specific considerations.

CHAPTER 24: UGANDA

A. Problems of Desertification and Current Status

262. Uganda is generally humid to sub-humid with the exception of the north-eastern region of the country, in particular Karamoja, which is semi-arid. In the semi-arid land the people follow a subsistence, transhumance life-style based on livestock raising and subsistence farming. The entire northern region is subject to frequent droughts. Desertification problems revolve around deforestation, overgrazing and poor cultivation practices.

263. Although political instability during the 1970's delayed the initiation of anti-desertification efforts in Uganda, a general approach for combating desertification was formulated in 1981 in collaboration with UNSO. Among the Government priorities are the following: afforestation, the development of alternative sources of fuel and building material, improved range management practices, water resources development, and the provision of relief supplies as needed.

B. Curent Anti-desertification Programmes

264. The Karamoja Development Programme: This is a general development programme designed to develop water supplies, conserve soil, increase range productivity, support reafforestation efforts, and improve veterinary services in Karamoja. The programme is supported by the European Development Fund, the ILO and UNICEF.

265. Water programme: This project is concerned with the protection of springs and the excavation of shallow wells in the Gulu and Kitgum districts. It is supported by Auro-Action and ACORD.

266. Borehole drilling, repair and maintenance: This project provides drilling equipment, spare parts and maintenance for 500 boreholes. It is assisted by UNICEF and UNCDF.

267. Environmental trends in north-eastern and western Uganda: The objective of this project is to assess environmental trends in areas of Uganda subject to desertification. The project has been funded by Longmans Publishing Company and is being executed by the Department of Geography at Makerere University.

C. Records of successes and/or failures

268. It is too soon to judge accurately the results of the anti-desertification activities currently being implemented in Uganda. In view of the range of projects described above, there should perhaps be some concern that water development projects have so clearly taken precedence over environmental rehabilitation efforts such as soil conservation, range improvement around and spacing of watering points, and reafforestation.

PART III

EASTERN AND SOUTHERN AFRICA

GENERAL OBSERVATIONS

1. With the exception of Madagascar, the countries included in this section lie within the great African savanna woodlands and grasslands. Bioclimatically they include sub-humid areas of moderate to high rainfall characteristic of parts of Zambia, Tanzania, Madagascar and Lesotho, and semi-arid and arid areas, characteristic of, for example, Botswana. The climatic pattern is influenced by the south-east monsoon and, to a lesser extent, the north-east monsoon (in particular in the countries lying along or close to the eastern coast of Africa, and Madagascar), by the cool southwest Atlantic air mass (which influences climatic pattern in Zambia, Zimbabwe and Botswana) and by the Inter-Tropical Convergence Zone (ITCZ) which has a particularly marked influence on Zambia and Zimbabwe. The ITCZ is a belt of low air pressure which moves north and south with the sun. And while the northern parts of Tanzania experience two rainy season peaks, areas further south are characterized by only one long rainy season (5 to 6 months) and by cold and hot dry seasons. Botswana, Lesotho and Zimbabwe, as well as southern Madagascar, are sub-tropical and experience cool to frost conditions during winter. On average, rainfall in these drylands ranges from about 1000 mm or above in some parts of Tanzania and the highlands of eastern Zimbabwe and Madagascar, to about 200 mm per year in the driest parts of Botswana and south-western Madagascar. An important climatic feature is the unreliability of rainfall, particularly in most of Botswana, central Tanzania, southwestern Madagascar and southern Zimbabwe; in Botswana there is at least one severe drought every 5 to 7 years. Droughts are not uncommon and have been particularly serious during the past ten years; almost all the countries of the region are currently experiencing drought. This has affected agricultural productivity and aggravated desertification problems.

2. The population of the region has grown rapidly over the past few decades with growth rates well over 2.5 per cent per year for some countries (in Zimbabwe the growth rate was 3.1 per cent from 1969 to 1982). Although these increases are notable in rural areas, there has been an accelerated migration into urban areas, resulting from population pressure, the degradation of land resources, the deterioration of rural environments and mass rural poverty. A large proportion of the population of the region is still carrying out subsistance farming, of crops and livestock, which, together with population growth and ecologically unsustainable land-use cropping practices, has seriously exacerbated desertification problems. Further contributing factors are the land tenure problem and the difficulty of containing or managing rural populations.

3. To stem mass rural poverty and to produce surplus for export, governments of the region have encouraged the cultivation of cash crops. In countries such as Tanzania and Zimbabwe, country-wide resettlement schemes have been implemented. In most cases, however, these agricultural expansion and resettlement schemes have not given adequate attention to the environmental and ecological constraints characteristic of the soils, climate and other natural resources of these drylands. Especially relevant are the excessive exploitation of surface and groundwater resources, the clearing of indigenous vegetation to produce agricultural crops in areas unsuited to these crops, overstocking with livestock, and the neglect of valuable or potentially valuable wild plant and animal products. Consequently some of these development programmes have contributed directly to the initiation of desertification processes.

4. The combination of land tenure, land allocation, land use practices, increase in population, under-development of rural areas and severe climatic conditions accounts to a very large extent for the desertification problems of the region. In cultivated areas, the effects of desertification are seen in accelerated water erosion, the loss of productivity due to inappropriate cultivation methods including over-cropping, a general degradation of woody vegetation formations due to excessive collection of wood for fuel and other purposes, the destruction of woody cover due to clearing and conversion of land to other uses, and salinization and alkalinization of irrigated areas. The ground cover of grazing areas is degraded due to uncontrolled fires (this also applies to woodlands) and overgrazing, particularly around water supply points and settlements. This in turn gives rise to accelerated water and wind erosion, the latter being particularly noticeable in south-western Madagascar and Botswana where sand drift and sand dunes are becoming a problem in the Kalahari region.

5. As will be seen from the following sections, each country is making an effort to combat desertification and increase the productivity of the land. However, few countries have approached these problems systematically and comprehensively. Co-ordination at both the regional and national level has been lacking in most of the countries of the region, with the recent exception of the Southern African Development Co-ordination Conference (SADCC). This is to some extent a reflection of the severity of the desertification problem and the lack of trained manpower in individual countries and in the region. It is encouraging, nevertheless, to see the seriousness with which the Governments of Botswana, Lesotho, Zimbabwe and Tanzania are tackling desertification problems. With better co-ordination in the planning and execution of anti-desertification programmes and a mobilization of available financial and manpower resources, much can be achieved.

6. It is important to note that the various programmes and projects described in the following sections have a direct impact on rural populations. In Botswana, Lesotho and Zimbabwe efforts have been made to involve the rural communities of affected areas in anti-desertification activities; this is true of tree planting programmes in all the countries. There is, however, a general need to involve the community in all aspects of development activities if lasting success is to be achieved. This is true of destocking programmes, since most livestock owners value quantity more than the quality of stock, since stock numbers represent wealth and status. Conservation awareness programmes have been found to increase the involvement of local people.

7. More thorough, scientifically-based planning processes can avoid wastage of resources and enhance the achievements of projects and programmes. Many countries have now embarked on land capability surveys and assessments, for the purpose of rationalizing land use allocation. Others are assessing their water resources potential. However, few have taken seriously the need for environmental impact assessment even for such activities as tree planting and afforestation. Impact assessment is an even more important requirement in irrigated agriculture and in cases where access will be denied to the local people affected. In this connection, too, recognition must be given to the existing dependency of the local people on wild plants and animals and the significant contribution these make to local economies in provision of food and other useful products. There is potential for further exploitation of these resources as an alternative food source. Such diversification of land use becomes increasingly important in areas of declining rainfall. Many of the countries already have large wildlife conservation areas and in Zimbabwe an effort is being made to develop wildlife utilization schemes. Interestingly, some of the national parks and forest lands have helped to relieve the effects of drought by providing water supplies and grazing for livestock.

CHAPTER 25, BOTSWANA

A. Problems of Desertification and Current Status

8. Botswana is bioclimatically a dryland. Rainfall decreases and become more erratic from the north-east, south-westwards. Droughts are therefore more frequent and persistent in the central and south-western part of the country, creating a near desert environment - the Kalahari Desert. The past ten years have been particularly dry and drought still persists. Woodland grasslands are typical of the vegetation cover in the more humid north-east, the cover changes to thorny bush and shrubs, or wooded grasslands, towards the west and south.

9. Only about 5 per cent of the country's 580,000 square kilometres is suitable for cultivation. Over the whole country, including the area suitable for cultivation, livestock raising is the principal economic activity. Most of the land is under communal or tribal grazing tenure while a small proportion is leased freehold for large scale commercial ranching. Botswana is also endowed with a rich variety of large and small wild ungulates which share grazing with livestock, specific areas have been set aside as national parks and game reserves, in order to protect the wildlife.

10. Botswana has experienced a particularly rapid population growth during the past decade, from about 574,000 inhabitants in 1971 to 936,000 in 1981, which represents an increase of 63 per cent in 10 years. The livestock population has also increased rapidly, the estimated population in 1979 was 3.5 million cattle and 1.77 million small stock. Together, they have strained the ecological balance between man and livestock on the one hand, and land resources and wildlife on the other. Cultivation has encroached into areas better suited to grazing. The development of a market oriented livestock economy has placed high value on cattle and has encouraged water prospecting and borehole drilling to enable cattle ranching to push farther west into the Kalahari sandveld. Consequently, there has been extensive, in places severe, degradation of rangeland due to overstocking, overgrazing, trampling, and uncontrolled fires, characterized by accelerated wind, sheet and gully erosion. The quality and quantity of forage available to stock have been reduced due to encroachment by annuals and unpalatable perennial species. These conditions are common in areas under communal land tenure and land use systems and can be seen all over eastern Botswana. In Kgatleng, for example, basal cover has dropped from 6-15 to 0-2 per cent.

11. The Government of Botswana is fully conscious of, and has made tremendous efforts to find solutions to, the problems posed by droughts and desertification. Research and open discussions have been encouraged. The Botswana Society and the University of Botswana have co-sponsored several conferences and symposia involving national and international experts to examine the problem closely. On the basis of these activities, the Government has evolved and adopted new land-use and land tenure policies. A great deal of effort has been made through a series of small and large scale programmes to halt, reverse and mitigate the impact of desertification and drought. These programmes are discussed in the following sections.

B. Current Anti-desertification Programmes and Projects

12. Range monitoring programme: This is an on-going country-wide programme initiated in 1973 and implemented by the Land Utilization Unit of the Ministry of Agriculture. Its objective has been the early detection of degradation of grazing areas based on observed changes in basal ground cover and vegetation composition. Three criteria were adopted as indicators of range degradation: (a) increase in bare ground; (b) increase in the density of woody species; and (c) changes in the botanical composition of herbaceous cover, especially the increase of poor quality forage species.

Using ground and aerial photographs, data were recorded from fixed points along permanent transects located in areas with known grazing regimes. Starting with 8 permanent observation sites, the number has now increased to 27 to include all major ecological zones in the country. Tentative results indicate increases in bush density over most grazing areas.

13. Small dam building project (AG 07): This is an on-going project initiated in 1973 for eastern Botswana. The Ministry of Agriculture is the implementing agency. The project will cost an estimated P 1.6 million (P 1. = US$ 1.5). Actions have involved the construction of small earth dams and haffirs to provide water for livestock and thus exploit more fully the national rangeland. Results have been mixed; during dry years most of these dams dry up.

14. Tribal Grazing Lands Policy (TGLP): The TGLP is a continuing, country-wide programme initiated in 1975 under Government supervision. Its main objectives are to arrest and reverse the degradation of grazing lands, increase livestock production, and reduce income disparities between livestock owners. The TLGP components include the demarcation of ranches and the granting of exclusive leasehold rights to individuals and groups. Larger cattle owners were supposed to move their herds out of already over-crowded settlement areas to remote areas, with exclusive rights to land which they could fence. Individuals and associations already established in these remote areas were also to be given leaseholds. Tribal lands were divided into: (a) commercial areas with leases giving 50 years exclusive rights, where modern ranch management techniques were to be applied; (b) communal areas comprising present settlement areas, in which no change in tenure was foreseen; and (c) reserved areas set aside for future generations of cattle owners, for those with few or no cattle, and for wildlife, mining and cultivation.

15. Preliminary zoning of the country has been completed. The surveys for the zoning exercise revealed that there were less unused grazing areas than the TLGP had postulated and that non-livestock owning populations in cattle-post areas were substantial. Consequently, progress with the designated commercial areas has been slower than anticipated. The implementation of TLGP has brought to light a number of important issues that are presently being addressed. These include: (a) the need to benefit the large number of small herd owners who will continue to operate in the designated commercial areas; (b) the relative lack of scope for future expansion of grazing either in the heavily stocked communal areas or the potential commercial areas; (c) the need for flexibility in the promotion of productive groups; (d) the long time-frame over which the benefit of the commercialization of livestock production will be realized; and (e) the impact of land tenure changes on non-stock owners living in remote areas.

16. The second livestock development project (AG 14): This is an on-going project in the Kalahari sandveld initiated in 1978, under the Ministry of Agriculture. It was designed as part of the overall Government strategy to protect rangelands and promote rural development within the framework of the TGLP. Its purpose was: (a) to develop over a five-year period more than 100 ranches on land designated as "commercial" under the TLGP, and 14 communal grazing units to test different grazing systems in areas designated as communal lands; (b) to make available small loans to communal management associations for livestock development; (c) to establish an Agricultural Credit Division within the National Development Bank; (d) to improve stock handling and marketing infrastructure; and, (e) to provide technical services including research, monitoring and training in livestock and ranch management. The total cost of the project was estimated at US$ 13.4 million, of which US$ 7.3 million was provided by the World Bank. The following have been accomplished: the establishment of the Agricultural Credit Division and the Ranch Management Training Centre at Ramatlabana, and improved cattle herding facilities at railway sidings between Francistown and Lobatse. Otherwise progress has been slow and little has been achieved in respect of the control features of the project.

17. Rangeland and livestock management project (AP 10): This is an on-going, country-wide project initiated in 1978 to assist small farmer groups in developing and managing communal areas within the framework of the 1978 Agricultural Act. This Act gives legal status to registered groups or associations of ten or more farmers in communal areas. Under the Act these associations can secure leases and loans as part of a credit scheme to establish ranches based on the grazing cells model developed by the Animal Production Research Unit (APRU) of the Ministry of Agriculture. Matching grants for improvements undertaken are provided by the Agricultural Management Association. The project is under the general supervision of the Ministry of Agriculture. Information on the progress of the project is not immediately available.

18. The group ranch development project (AE 13): This is a country-wide project implemented between 1979 and 1985 under the aegis of the Ministry of Agriculture. Its objective is to promote group development involving the owners of small to medium herds in commercial area ranching in order to relieve grazing pressure in communal areas. It is expected that up to 32 ranches will be developed by 1985, of which 12 will be part of a pilot scheme in southern Ngwaketse. Information on progress to date is not immediately available. The estimated cost is P 847,000.

19. Water points survey: This on-going project was initiated in 1979 by the Ministry of Agriculture in collaboration with the Centre for International Studies of Cornell University, USA, and is concerned with the communal areas of eastern Botswana. It involves the survey of watering points with a view to providing policy guidelines for the future, and the implementation of both dam construction and water development under the TGLP and Arable Lands Development Programme (ALDEP). One of its preliminary conclusions is that restricting livestock access during the wet season improves forage quality around these watering points. Restricted access to open wells, sunk in scattered sites of the basin, provide a viable option for controlling stock numbers, conserving forage and monitoring cattle conditions. Preliminary project results have been published.

20. Country-wide wildlife and range assessment programme (GA 13): Under the Ministry of Commerce and Industry (which is responsible for wildlife conservation), the assessment covered an area of approximately 240,000 square kilometres, encompassing almost all the Kalahari desert within Botswana. Its ultimate goal was to produce a land-use plan for the Kalahari taking full account of all the natural resources of the area, and a long-term programme for the development and exploitation of the wildlife resources of the Kalahari. The project involved mapping the patterns of wildlife distribution and movements, estimating population sizes and describing the range resources upon which these depend. The main technique used was aerial surveys correlated with ground verification. On the basis of the survey results, wildlife conservation areas have been demarcated in the Kalahari. The project has cost P 150,000.

21. Wildlife management and development (GA 02): This on-going project in the Kalahari Desert region was initiated in 1979 by the Ministry of Commerce and Industry as a follow-up to the country-wide wildlife and range assessment programme (c.f. para. 20 above). It involves repetitive productivity studies of the most important herds of wildlife as a basis for setting sustainable annual hunting quotas. It also aims to promote a series of specific management projects connected with wildlife utilization. Information on the results and progress of the project is not immediately available. Its estimated cost is P 1,017,000.

22. Rural training centre (AE 01): Implemented between 1967 and 1974 under the Ministry of Agriculture, the project aimed to establish farmer training centres in Gaborone (Denman), Mahalapye and Maun. Additional centres are now planned for Francistown and Pelotshetlha at an additional cost of P 737,000.

The centres have been used to provide general farmer training courses as a back up to the field work of agricultural demonstrators. They also provide in-service courses for family welfare educators and District Council staff.

23. Dryland farming research project (AR 08): Located at the Selebi Agricultural Research Station, this on-going project began in 1971 under the Ministry of Agriculture. It involves the study of the major constraints to crop production and the investigation of a minimum tillage farming system that makes more efficient use of available moisture and reduces draught power requirements.

Although elsewhere mixed results have been obtained from tests carried out under field conditions, significant increases in yield have been achieved at the research station. The estimated cost of the project is P 90,000.

24. Evaluation of Farming Systems and Agricultural Implements (EFSAIP): Initiated in 1976 under the Ministry of Agriculture, this on-going project covers the Kgatleng District. The project's objective is to introduce improved farming technology in arable areas by testing techniques and equipment in farms around Kgatleng and at rural training centres. During the first two years the project evaluated recommendations and equipment resulting from the first phase of the Dryland Farming Research Project (c.f. para. 23), including the Makgonatshothe Tool Carrier developed by the Machudi Brigades. Field trials revealed many problems, due mainly to the number of operations required under the system and the continual breakdown of

equipment. The equipment of the Dryland Farming Research Scheme was abandoned and subsequent work concentrated on the tool carrier. Tests on the recommended farming systems using farmers' own equipment including mould-boare ploughs, imported planters and cultivators have been reasonably satisfactory. The project also demonstrated the poor condition of the farmers' implements and the difficulties of finding spare parts. The estimated cost of the project is P 90,000.

25. Integrated farming pilot scheme (AE 09). This is an ongoing project located at Pelotshetlha in the Southern District which was initiated in 1975 under the Ministry of Agriculture. The scheme introduced the new "minimum tillage farming system" in a community of 300 farmers at Pelotshetlha using extension methods designed to reach all members of the community, and to reveal other constraints on production such as input credits and marketing. A mid-project evaluation was conducted in 1979. The project has been extended for five more years as of 1981-1982. The total estimated cost is P 475,000.

26. Agricultural extension small projects programme (AE 10). A country-wide, ongoing project initiated in 1978 under the Ministry of Agriculture, it is an umbrella fund for small capital development projects being generated at the village level and implemented by villagers. It requires a minimum of bureaucracy to assure rapid funding. The programme provides funds for projects costing up to P 5,000 to existing community groups to improve or establish village infrastructure and conduct productive activities related to agriculture. Projects are submitted through district or regional agricultural services, most involve the provision of funds for the erection of drift fences to separate grazing from cultivation areas, and field enclosures to keep livestock away from crops. The programme fund is P 600,000.

27. Arable Lands Development Programme (ALDEP) (AG 09). This ten-year programme was started in 1980-1981 for the communal areas of eastern Botswana (Ngamiland, Ghanzi and Kgalagadi Districts) as a major Government effort aimed at increasing smallholder production of basic grains and legumes, as well as cash crops, in all but the poorest rainfall areas. Its objective is to achieve sustained self-sufficiency in food at rural and national levels, and to produce surpluses for export. In this way it is hoped to raise and assure equitable distribution of incomes, and to create employment opportunities in the agricultural communities, which, it is hoped, will reduce rural to urban drift.

28. It is expected to involve 60,000 to 70,000 small farmers, who plough less than 10 hectares each and who produce the bulk of agricultural crops. Technological inputs include the provision of water and fencing facilities, credit, marketing, input supply (implements and machinery repair and servicing), physical and social infrastructure, technology packages and financial incentives. The estimated cost of ALDEP is P 11.9 million.

29. Ngamiland irrigation project (AE 16). This is an ongoing experimental, irrigated rice production project in the Okavango Delta area initiated in 1979 by the Ministry of Agriculture in co-operation with the Government of China. The long-term objective is to develop rice varieties suitable for different soil types and seasons characteristic of the Okavango area, and eventually to produce rice locally. A nursery on a 1/15 hectare plot (about 666 square

metres) has been established at the Thamalakane River, some 7 kilometres south of Maun. Progress has been satisfactory so far, however, the project has experienced difficulties in procuring suitable seeds. The estimated cost of the project is P 960,000.

30. Remote area resettlement scheme (West Hanahai Settlement Scheme): West Hanahai is the first of four settlements for remote area dwellers originally planned in 1976 under the District Land and Water Development Project for the Ghanzi Farm Block. The present project began in 1978 under the Ministry of Local Government, and it is still being implemented. The objective is to resettle about 4,500 Basarwa residing on the farm by providing land and water to enable them to be self-sufficient.

In 1978 a borehole was successfully drilled and equipped. About 40,000 hectares in several areas of the farm block around the borehole have been allocated and settled. Improved cattle management practices, fence construction, leather work and the growing of vegetables have raised the subsistence level of the West Hanahai people.

31. Evaluation of underground water resources (GS 10): This project was started in 1978 by the Ministry of Mineral Resources and Water Affairs and is to continue until 1985. Originally it was intended to evaluate underground water resources and compile a complete inventory of potential future reserves for the whole country. This was abandoned due to the high costs of research and drilling of test boreholes. Instead, it was decided to limit the project to basins in the Kweneng and Serowe areas which are typical Karoo (sandy) regions.

Studies indicate the unlikelihood of current recharge through the Karoo sands in the Kweneng area, although further studies are under way. In western Botswana significant water extraction has resulted in water quality variations. Saline ground water is a matter of great concern to cattle ranchers in these areas. This problem has been investigated. The total estimated cost of the project is P 360,000.

C. Records of Successes and/or Failures

32. The range and livestock management project (AP 10): This project ran from 1973 to 1976 under the Ministry of Agriculture. Its objective was to test three models of group ranching for adoption by small stock owners in communal areas. It was expected that the models would soon be popular and become an accepted practice in managing communal grazing areas. This expectation was, however, too optimistic. Initially the project attempted to impose a replicable management system upon the groups. Operations were completely revised in mid-1976 and no further attempts to promote the acceptance of the models were made. Attempts were made to identify, support and build upon group efforts already initiated by communal area stock owners. The revised project supported traditional syndicates, spontaneous new groups, farming associations and entire communities willing to improve their grazing areas.

33. First Livestock Development Project (LDPI) (AP 12). This project started in 1972 and ended in 1978. It was implemented by the Ministry of Agriculture in co-operation with the World Bank, the International Development Association (IDA) and the Swedish International Development Authority (SIDA). It was a major rural development effort to increase beef and Karkul sheep pelt production by making use of the vast resources of the semi-arid rangelands of the western Kalahari, and in so doing, reduce overgrazing around villages. It was also a land reform measure through which farmers would gain access to newly opened grazing lands with exclusive rights under leasehold tenure. Ranch development included the drilling and equipping of boreholes and the construction of perimeter fences. Once established, the farmers would move their herds on to the ranches and take out loans to cover initial development costs.

34. The project had two components: (a) the Western State Lands Project, which consisted of constructing 25 fenced ranches near Neojane in Ghanzi District to be leased to large herd cattle owners from adjacent villages, establishing water supplies, providing credit for the constructions of 11 Karkul sheep ranches, trek-route development and some range research. A SIDA-supported range ecology project was established in 1975 specifically to monitor the impact of grazing. The project was constantly impeded by limited manpower and by the logistics of working in this remote and isolated area. (b) The Botswana Livestock Development Corporation Project is a parastatal cattle production and marketing operation with an 83,000 hectares ranch at Makalamabedi in Ngamiland and four fattening ranches in eastern Botswana. The Makalamabedi ranch operated successfully to the advantage of herd owners in Ngamiland who profited from producer prices well above previous levels. However, high capital costs, insufficient throughput, inadequate unit profits and, in particular, the outbreak of foot-and-mouth disease put an end to the operation in 1977.

35. Lessons learned from the two projects: Problems emerged during the implementation of the two projects which initially were not anticipated or dealt with. In the case of the first livestock development project, most, if not all of the ranch occupants at Neojane were absentee ranchers, who visited their herds occasionally. The majority viewed the ranches simply as new places to graze their stock and did not put much time and effort into their care. The lack of extension input for project personnel at the early stages undoubtedly contributed to the management problems. Other factors included a lack of co-operation from ranchers in paying fees for the use of the fattening ranches, the slow development of a marketing infrastructure, and the failure to carry out some of the technical studies budgeted for in the project. Inflation contributed also to the economic problems of the Karkul Sheep Farm Project in the south.

36. There were other lessons to be learnt from this project: (i) groups at the village level should be formed only on local or village-based initiative, to meet a defined need or in response to a specific local problem. In the past, many agricultural field staff used extension approaches conceived by the Ministry of Agricuture, which had proved ineffective in attempts to establish farmers committees under the Village Area Development Programmes; (ii) group associations require a management committee to provide leadership and

direction, undertake fund raising, draft by-laws or a constitution and ensure smooth operations during and after the completion of the project. The group should be in a position to function without depending on the local extension worker for day to day support; (iii) for groups to continue to play an effective role in the economic development of Botswana, there should be available adequate technical and organizational support; and (iv) attempts at group ranching have led planners to rethink and revise strategies which include: a shift away from a technological approach to group ranches towards a concentration on schemes to meet more immediate needs through highly capitalized groups; and the need for close consultation in organization and planning at the local level in view of the diversity of potentials and problems particular to each area. The result has been the evolution of Communal Development Area planning (CDA) to promote group decision, group action, community interaction, group management and group organizational skills and to reduce ethnic tensions. It is wider in scope than previously planned and ongoing projects, and places much greater emphasis on production and employment than has been the case in previous district plannning.

D. Information and Experience in Desertification Control

37. Restricted grazing: In the Molopo Valley in the south-western corner of the country, a World Bank project has successfully encouraged Karkul sheep farmers to fence paddocks and reticulate water supply locations. It is now proposed to develop 50,000 hectares in southern Kalahari, using this approach in range management and livestock development.

38. Sand dune fixation project: Although there has been a small pilot project initiated in 1979 at Bokspits in the south-western corner, there has been no large scale sand dune fixation project. About 5.52 hectares of almost barren and overgrazed land was fenced off to allow the natural recovery of vegetation cover. The rate of recovery was monitored and experiments carried out with indigenous and exotic trees known to grow in such areas. There has been remarkable natural regeneration of vegetation where cattle have been kept out for specific periods. Perennial tussock grasses such as Stipagrostis amabilis, S. obtusa, S. ciliata and Eragrostis lehmaniara were found to be extremely useful soil stabilizing agents.

39. Windmills: Two programmes in the development of new and renewable energy resources are at present under way. The first was begun in 1978 by the Rural Industries Innovation Centre (RIIC) at Kanye. It aimed at developing advanced windmill designs suitable for pumping water from waterholes. The main technical problems that had to be surmounted were gaps in knowledge of local wind conditions, the need to drive a rotary pump and the availability of water only at great depth. Until recently efforts were concentrated on the "Fillipini vertical axis rotary windmill" design which proved to be too weak to compete against the high winds which occur occasionally. Future work will concentrate on a "horizontal axis model" being developed by ITDG, and already successfully used in Kanye, with a rotary transmission and clutch to drive a mono pump. The transmission is now almost complete and a prototype friction clutch has been developed. The dog clutch used on the Fillipini windmill has been abandoned owing to its high rate of wear.

40. A second experimental vertical axis windmill is about to be tried. Unlike the Fillipini windmill, this model is very lightweight in design and can withstand high winds. One of the key elements in the programme is the matching of the windmill to the pump it operates and this aspect probably offers the greatest scope for improving the efficiency of water pumping using wind energy. Efforts are focusing on the further development of a clutch to overcome the high initial torque necessary to start the mono pump, and on the development of a variable speed transmission to allow the pump to run at an optimum speed at all times.

41. The second and separate programme of windmill testing, under the Department of Water Affairs in collaboration with the Ministry of Agriculture, will assess the performance of commercially available windmills. Eight such mills have been installed at water supply points in some of the major villages. Another eight will be installed for the Ministry of Agriculture at various locations. In addition to providing valuable data on performance, the programme will gradually provide Government staff with experience in windmill technology. Associated with the windmill programmes and essential to their development is a programme to gather data on wind conditions. The Department of Water Affairs has ordered anemometers to measure the incidence of wind within selected speed bands. These are to be installed alongside commercial windmills to compare the volume of pumped water to the theoretically available wind energy.

42. Biogas: Experiments have been carried out by the RIIC at Kanye to develop a slightly modified diesel engine using biogas produced by a methane digestor. Although a number of serious problems related to construction and the prevention of cracks and leaks are yet to be overcome, the units have functioned successfully under experimental conditions. RIIC, through the Ministry of Commerce and Industry and UNIDO, has obtained advice on the design of larger biogas digestors. Work is under way on a different design of a 300 square metres plant, which is the size the RIIC considers would be required for a cattle post.

43. Introduction of a new plant species (Jojoba): The Botswana Technology Centre (BTC) has initiated pilot projects and experiments in jojoba and buffalo gourd cultivation, hitherto neglected by local agricultural research agencies. As the result of experiments by the BTC Manager and the efforts of a volunteer amateur horticulturist, it has been shown that these plants can be grown successfully in Botswana and the relevant government agencies are becoming interested in expanding cultivation. Although initially expensive to establish seedlings (1 hectare of jojoba costs as much as 1 hectare of rice), once established, jojoba is hardy and has potentially useful industrial applications (hair oil, sprays, etc.). Jojoba therefore offers not only good prospects for the prevention of desert enchroachment but also for the provision of employment in oil extraction and processing.

44. Producer gas: The BTC is currently preparing a project to develop and test stationary engines powered by producer gas, as a substitute for diesel in standard diesel engines, to drive water pumps. This technology was used extensively in parts of Europe during the 1930's and 1940's and offers considerable potential for non oil-producing countries. The engines can be

powered by coal or wood, which widens the scope for use by a broad range of countries. It is hoped that industrialized countries will invest the necessary resources to develop and make this technology available. Coal gas may also prove to be a valuable source of energy in rural areas where its use today is very limited. The BTC plans to commission feasibility studies for making coal widely available in these areas.

CHAPTER 26: LESOTHO

A. Problems of Desertification and Current Status

45. Lesotho is experiencing desertification mainly as a result of severe damage to the landscape by human activity, which in turn has reduced productivity and increased social distress. Major contributory factors are overstocking and resultant overgrazing, unsound and inadequately controlled farming practices and poor maintenance of physical conservation works. Periodic cycles of drought have exacerbated existing problems.

46. Since colonial times the country has made concerted efforts to assess the problem of desertification and to find practical solutions. Past and present practical programmes have included contour terrace construction, grass buffer strips on slopes and stream banks, solid grass zones in high erosion risk areas, planting of trees in and around gullies, and dam construction. In the second and third Five Year Development Plans which began respectively in 1975 and 1980, the Government clearly outlined measures to increase soil productivity through conservation and improved range management.

47. The national programme for anti-erosion activities was based on two fundamental concepts: firstly, the management of crops and grazing lands in response to the needs and capabilities of the different soil types occurring in each location, using appropriate, locally available practical measures, and secondly, co-operation with farmers through technical assistance provided by experienced working groups of the Soil Conservation Unit of the Ministry of Agriculture.

48. A great deal of progress was made in soil conservation during the Second Five Year Plan. This included the education of villagers, field demonstrations, field tours and the formation of village conservation committees. Soil surveys covering almost 300,000 hectares were also carried out, and a considerable number of conservation works were constructed and maintained. Several donor countries and organizations provided technical and financial support to the Government of Lesotho for the formulation and implementation of agricultural and rural development projects, most of which included a soil conservation component. In order to provide measures to rehabilitate and stabilize degraded lands, the Government enacted a new land use law, the 1979 Land Act, which among other measures enables individuals to hold titles to grazing land. It is widely believed that title to land will encourage land owners to implement conservation measures.

B. Current Anti-desertification Programmes and Projects

49. Land Conservation and Range Development Project (1981-1988): This is a country-wide project and is being undertaken in co-operation with USAID. Its main objective is to increase the productivity and incomes of the rural poor engaged in crop and livestock production. Its ultimate goal is to conserve and develop national farmland and rangeland resources through appropriate conservation measures, and land use and land management practices. It also

includes a component to strengthen the institutional capability of the Ministry of Agriculture for the purpose of implementing these activities. The project will expand the current conservation programme, develop technical procedures for the management and improvement of rangelands, and initiate a programme to prepare and implement on-farm cropping and conservation plans with farmer participation. The principal achievements to date include the establishment of an institutional framework to conduct conservation programmes and the development of guidelines, procedures and practices on which to base an expanded conservation programme. The estimated cost of the project is US$ 16 million, of which USAID will contribute US$ 12 million.

50. Mphaki Mountain Livestock Project Phase I (1978-1982). This project is being conducted in the Mphaki mountains of Quthing District and covers approximately 110,000 hectares. Phase I began in 1978 and Phase II has just been launched. The overall objective of the project is to increase levels of livestock and crop production in a mountain area considered to have high potential. It was designed to benefit the farmers of the Mphaki area through the provision of inputs needed for the projected increase in production, and to improve methods of crop and animal husbandry by providing farmers with practical demonstrations.

51. The overall progress of Phase I has been disappointing. On the positive side, the supply of inputs for both agriculture and livestock has been good. The Livstock Selling Centre has become operational. Almost all the planned purchases of materials and equipment have been made, including those for the repair and maintenance of equipment for cultivation using draught animals. On the other hand, little work on road communication has been undertaken, the land use survey has not been completed, dip tanks and wool sheds are not maintained, radio communication with Maseru has not been installed and grain threshing equipment has not been ordered.

52. Some of the causes of the delay in implementation of Phase I are: (a) insufficient co-ordination between the various activities of the project; (b) inadequate Government support, particularly in the provision of agreed staff members; and (c) delays and difficulties in the procurement of material. Because of slow disbursement of funds, particularly for the construction of roads and access tracks, all funds were temporarily withheld for three months to allow a review of the overall situation. Phase II has just been launched. The estimated cost of the project is US$ 2 million, the European Development Fund (EDF) is contributing to the cost.

53. The Phuthiasatsana Project (1980-1982). This project is located in the Phuthiasatsana area, and its aim is to increase levels of livestock and crop production through soil conservation programmes, improved range management, fodder crop production, and improved livestock marketing. The estimated cost is $ 892,540 of which the EEC has provided $ 595,000 and the Government of Lesotho $ 297,540.

54. Agriculture Economist/Advisor (FAO) (1978-1981): The objectives of this UNDP/FAO supported project were to strengthen the Government Planning Division, establish a framework for project monitoring and evaluation, assist in drawing up agricultural development plans, and carry out studies on farm management and appropriate subjects. FAO executed the project by providing one expert to the Planning Division. The estimated cost was $ 135,328.

55. The Intensive Arable Area Conservation Project: This country-wide project began in 1976 and terminated in 1982, and its objective was to introduce sound agronomic production systems, soil conservation and range management. The project placed emphasis on biological and mechanical measures. A workshop and housing for field staff were provided and eight areas were involved. Information on project performance is not immediately available; the estimated cost was M 1.6 million, of which only M 1.3 million has been approved to date (Maluti 1 = US$ 1.22). Funding from the Overseas Development Administration of the Government of the United Kingdom came to an end in March 1982.

56. Hololo Valley Project (1977-1986): This is a ten-year project initiated in 1977 which receives support from the Government of Ireland as a direct result of the 1975 Donor Conference held in Lesotho. It is a self-help, rural development scheme aimed at increasing small-farm production of food, fodder and cash crops. Strategies for achieving this include assisting small farmers engaged in irrigation schemes with the necessary equipment, credit facilities for seeds, dairy and poultry development assistance, tractor services and fertilizers, the marketing of products, and development of rural infrastructure. Extension and advisory services on farming practices and animal husbandry are provided.

57. Soil conservation has been undertaken at three locations, with guidance from the Soil Conservation Unit of the Ministry of Agriculture, using physical control methods such as diversion ditches and silt traps for the planting of fodder crops, fruit trees and woodlots. A school programme has also been instituted to inculcate soil conservation ethics and practices; awards are given to individual students for best essays. Dairy cow owners have formed an association in order to derive more benefit from the project. A project council composed of 26 members representing a wide range of interests was formed in 1979, to provide a local base for the management and development of the project.

58. There has been no expansion of irrigated areas beyond the approximately 9 hectares established in 1979, on which there are 13 households organized on a communal basis. Individual high yields of staple crops such as maize, sorghum and beans have been reported, while potatoes have been encouraged as a cash crop (40 acres of table potatoes and 7 to 8 acres of seed potatoes had been established by 1980-1981). Fodder production has been extended to 31 acres and 8 out of the 16 planned poultry houses have been completed. Some difficulties have been experienced with frost damage, weed and pest control, and the marketing of horticultural produce. The Government of Ireland estimated the cost of the project to be $ 1.3 million and there has been an input from three American Peace Corps volunteers in addition to Government staff from the Ministry of Agriculture.

59. The Basic Agricultural Services Programme (BASP) (1978-1983): This project concerns all the lowland areas of Lesotho. It is designed to increase crop output by providing the Ministry of Agriculture with training and technical assistance, providing stores for input distribution and crop marketing, up-grading rural roads, and providing equipment repair and credit facilities.

60. The project has already encountered several problems; it has become difficult to maintain a viable marketing organization because of increased domestic consumption of grains and consequent declining sales. It has not been easy to integrate the regional operation of a diverse group of donors into the framework of the Ministry, and the promotion of a simple technical package of fertilizer and insecticide is not achieving the expected results, even though the projections were modest. However, the project is helping to strengthen the Ministry's management and services and to provide infrastructure. The total estimated cost is $ 31.4 million.

61. Agricultural Planning Project: This is an on-going project initiated in 1981 in co-operation with USAID, to strengthen the Planning Division of the Ministry of Agriculture at Maseru and its regional offices. The project is intended to supply long-term experts for 20 man-years who will serve as in-line officers. It includes a large training component to ensure proper counterpart education and training for new and existing staff. Information on progress is not immediately available. The total estimated cost is US$ 5.4 million of which US$ 4.5 million is being provided by USAID.

62. Farming Systems Research Project (1979-1984): This is a country-wide ongoing project being carried out under the Ministry of Agriculture in co-operation with USAID and Washington State University. Its objectives are three-fold: (a) to create farming systems that are mixed rural enterprises to improve farmers' productivity; (b) to create farming systems which are appropriate to the managerial ability of farmers and to available resources, and protective of the land base; and (c) to increase the capacity of the Research Division of the Ministry of Agriculture to respond to the priority agricultural needs of Lesotho. The project has been involved in research on cultivated and grazing lands, backed up by on-station trials. It has also trained personnel at all levels including research, and improved research capacity by providing equipment and policy development. The project has focused on an estimated 12,000 people living in three prototype areas.

63. Thaba Tseka II: Integrated Rural Development Programme (1978 to present): The Thaba Tseka Mountain Development Project, which covers an area of 130,000 acres, began as a range management project. However, the first two years (1976 to 1978) were primarily concerned with infrastructural development for the creation of the new town of Thaba Tseka. In 1978 it was decided to widen the scope of the project and re-name it the Thaba Tseka Integrated Rural Development Programme. The main thrust of the programme is the development of a planning process through local participation. Project components include: range management, crop development, village technology, rural industries, rural infrastructure, health care, and adult education. Agricultural components are also included. Of equal importance is the search for

appropriate forms of public involvement. Public meetings (lipitse) have been used, but have not proved effective in inducing change or effecting dialogue. A more gradual approach is being evolved using community development and technical field staff, village level committees, and other associations and individuals. Regular surveys of highland villages have been introduced. The project is receiving support from CIDA and the International Bank for Reconstruction and Development (IBRD).

64. The Mphaki Project Phase II (1979-1987). This project in Quthing District covers an area of 110,000 hectares with the following general objectives: to increase rural incomes from food and fodder crop production using improved farming systems, to implement the Land Act of 1979 and Range Management and Grazing Control Regulations of 1980, by means of destocking measures and improved marketing facilities, and to rehabilitate and protect the basic natural resources of the project area by legal and physical measures. The main target group of the project is the subsistence farmers in the project area who are currently living and farming in difficult conditions. The project's components include crop and livestock development, forestry, irrigation, and training. Soil conservation involves planting grasses in gullies and other selected sites, repairing existing erosion control structures, and engaging in specific demonstration of biological control.

C. Records of Successes and/or Failures

65. During the period 1935 to independence in 1964, the British Administration developed and financed a soil conservation programme which covered approximately 80 per cent of arable lands. It involved 547,000 acres of terraced cropland, 188,218 acres with buffer strips, construction of 27,900 miles of terraces, 4,000 miles of diversions and 1,400 miles of grassed water-ways, demarcation of 5,658 dongas (gullies), construction of 787 dams and the planting of 4.5 million trees. With time, however, these structures deteriorated due to lack of maintenance and, in part, to structural failures.

66. During the early post-independence era, various area-based projects included major conservation components, many of them heavily dependent upon structural measures, whose purpose was the rehabilitation of land that had been terraced under the British Administration; however, these projects caused more problems than they had been expected to solve.

67. A common failure of almost all soil conservation projects was lack of maintenance. The assumption that Lesotho farmers would accept responsibility for maintaining the conservation works provided by the projects on land they cropped proved to be over-optimistic. Furthermore, small scale and area-based projects containing major conservation components suffered because of the low cost-benefit ratios of the cropping system. There has been no uptake by farmers outside the demonstration plot and pilot project areas despite their many achievements. Other reasons for the inadequate performance of the projects have been over-optimistic goals and low acceptance rates by farmers, under-estimates of the hazards of farming in Lesotho, of crop losses due to soil erosion, and the high costs required to construct physical earth works to control soil erosion. There has been a failure to convince farmers of the benefits offered by the projects.

D. Information and Experience in Desertification Control

68. Examples of successful and interesting pilot projects and programmes with techniques suitable for transfer to other countries in Africa are few in Lesotho. Some of the previous projects described above, such as the Hololo Valley Project and the Farming Systems Research Project, are on-going projects which are doing well and have institutional and technological components which are interesting and could be recommended for duplication in other African countries. However, they are relatively new projects and it is too soon to predict whether they will succeed or fail.

69. Since its inception in 1973, the Lesotho Woodlot Project has consistently performed well and has initiated replicable innovations. It is a country-wide project continuing until 1985 with support from the ODA, the Anglo-American Corporation and from the Government of Lesotho. Its objectives are:

- to establish woodlots throughout the country for the provision of fuel and small building materials;
- to provide trees for water and soil conservation purposes;
- to determine a rational afforestation policy for the Ministry of Agriculture and Marketing; and
- to train Lesotho nationals to assume responsbility for the operation of a Forest Service.

70. By March 1983, 260 woodlots had been planted covering 3,650 hectares of land in locations throughout Lesotho. Trees are planted up to 2,000 metres above sea level with a few experimental plots up to 2,600 metres. Most of the trees planted are eucalyptus and wattle. Six nurseries supply about 1 million trees per year for use by the project and by other Government divisions and individuals. The constraints at present include a lack of trained Lesotho technical field staff, shortage of suitable land and inadequate knowledge of appropriate tree species for planting at altitudes above 2,000 metres.

71. An interesting aspect in the progress of the project has been the faster sustained growth rates achieved by conifers compared to eucalyptus on certain poor sites. Conifers are more vulnerable to fire than eucalyptus and do not coppice after burning, cutting or grazing. There is evidence that under certain circumstances these drawbacks can be outweighed by the extra amount of wood conifers can produce over a period of years compared with eucalyptus. The former produces a stable ground cover of matted needles while the latter produces a thin ground cover of leaves which are easily disturbed by the feet of grazing animals so that serious trampling may result. Further investigations are presently being carried out on this matter by the Research Section.

72. The project has been very successful and well received by the people of Lesotho. There has been an increasingly large number of requests for woodlots from villages. Considerable research activity has been initiated on the growing of frost-resistant tree species and, according to the project's General Manager, the potential for providing other countries with information is already considerable and is growing. It is believed that the project will play an important role in energy development, soil fertility and soil conservation.

CHAPTER 27: MADAGASCAR

A. Problems of Desertification and Current Status

73. The primary symptoms and probable causes of desertification on the island of Madagascar are related to the problem of soil loss and deforestation caused by shifting cultivation. While some soil erosion occurs in the coastal areas, the most significant problems of soil loss occur in the inland areas, in particular on the elevated plains of the highlands, where most of the population is concentrated. It is estimated that 200,000 hectares are converted to agriculture each year as a result of shifting cultivation, especially in the forested regions of the eastern highlands. As a result of continued shifting cultivation, associated bush fires, the natural weakness of the soils in the upland areas and other factors, as much as 65 per cent of the land surface of the country may be insufficiently covered by vegetation to prevent soil degradation. This is especially problematic since frequent periods of intensive rain in many parts of the country can rapidly erode these areas.

74. On the inland plateau, overgrazing is one of the major factors contributing to soil loss. The consequences of intensive cattle raising are compounded by the widespread application of fire to remove thickets and forests to create pasture. One million hectares of cover were reportedly lost in this way in 1979, but officials claim that this rate was brought down to 100,000 hectares in 1980.

75. The southern part of the country (Tulear) has been suffering from desert-like conditions for a long time. The degradation of the eco-system of this semi-arid area, where rainfall is generally 300 mm. per annum, is not merely a function of the region's inherent vulnerability, but more important, of the pressures of overstocking and overgrazing.

76. The Ministry of Agricultural Production and Agrarian Reform (Ministère de la Production Agricole et de la Reforme Agraire) is responsible for co-ordinating all matters relating to environmental problems in Madagascar. It is the principal Government agency implementing desertification control programmes.

77. Although there is a general awareness of the problem in Government circles, not many of the projects being executed at the moment are oriented towards combating desertification. The primary desertification control measures in operation (mainly in the arid southern part of the country) include: development and improvement of water resources, measures to reduce excessive evapo-transpiration, planting wind-breaks to check wind erosion, establishing woodlots or plantations to provide the population with firewood and to alleviate the destruction of the natural vegetation, pastoral improvement schemes to reduce the destruction of natural pastures by cattle, and the protection of watersheds.

B. Current Anti-desertification Programmes and Projects

78. Land reclamation project (1973-1983). This project covers the east coast region of Madagascar and receives support from UNDP and the Government of Madagascar through the Ministry of Water and Forests. Activities include reclamation of the degraded 'savoka' which covers 5.4 million hectares, through the stabilisation of settlements within the development area, the improvement and diversification of animal and vegetable production, the creation of village woodlots, the promotion of integrated rural development, and follow-up action to test the effectiveness of the new techniques and their impact on the life-styles of the rural population.

79. Three test villages were selected for the initial pilot reclamation work. Aerial photographs of the three areas have been taken and land-use maps prepared. Areas for irrigation have been identified and badly eroded areas afforested, with support from the World Food Programme.

80. Afforestation by communities of the Sloping River Valleys of Antananarivo (1979-1984). This project concerns the Antananarivo Plains, an area of 300,000 hectares, and it was implemented by the Department of Water and Forests with the involvement of the local communities of the plains. Its objective was the afforestation of some 200,000 hectares to check periodic flooding and to protect the Basin.

81. The establishment of the Ampijorova Forestry Station, Ankarafantsika (Project No. 1911, 1983-1985). This project is supported by the World Wildlife Fund and is being implemented by the Laboratory of Zoology of the University of Antananarivo. The project is one of a group of measures to protect the more important eco-systems of Madagascar. The Ankarafantsika Plateau is an integral natural reserve still carrying original forest cover in an area of about 60,520 hectares. It is threatened by bush fires and uncontrolled human intrusion. The Forestry Station is assisting surveillance of the reserve, carrying out scientific studies and opening up the area to an informed public. In order to achieve these objectives, the project is also assisting in the education of the local population, and offering training for suitable personnel.

82. Study of the vegetation in the Ambohitantely Forest, Ankazobe (Project No. 1912, 1983-1986). This project is being conducted in the Tampoketsa region high on the Madagascar Plateau. Its principal objective is to protect the vestiges of climax vegetation in the Ambohitantely Forest area which are constantly threatened by bush fires. The project has the added advantage of providing a living laboratory for the students of the university, and it provides local employment. Since this is a new project it is too early to report on its progress. It is supported by the WWF and the estimated cost is FMG 13 million (US$ 1 = FMG 494).

83. Mobile unit for sensitization and mass information (Project No. 1951, 1982-1985). This is a country-wide project carried out by the Department of Water and Forests, in collaboration with the WWF. Its objective is to obtain support for the conservation activities undertaken by the Government of

Madagascar and to make the public aware of the need for environmental conservation and the sustained development of renewable resources. The project involves the acquisition of an all-terrain vehicle fitted with audio-visual equipment.

84. Assistance in the establishment of an Institute of Economic Planning (MAG/82/001, begun in 1982): The objective of this project is to assist the Government of Madagascar in setting up an Institute of Economic Planning in Antananarivo, as an instrument for research in socio-economic development planning.

85. Reinforcement of the national production of rice, maize and groundnuts (MAG/81/001, begun in 1981): As a medium-term objective, the Government has set itself the task of attaining self-sufficiency in food, in the long term it seeks to produce excess for export. To attain these objectives, the Government has requested assistance from UNDP in: drawing up a national plan for the development of grains; preparing financial dossiers for the initiation of the grain plans; and identifying areas requiring priority action. Preliminary assistance has been received for the formulation of the Grain Plan.

C. Records of Successes and/or Failures

86. Développement de l'Androy (MAG/77/011, 1973-1981): This was an integrated rural development project, whose purpose was to improve the quality of life in a particularly under-privileged region of the country. The affected area is some 25,000 square kilometres of the dry zone in the extreme south of Madagascar, where the mean annual rainfall is less than 300 mm. per annum. The project involved the introduction of mixed farming, veterinary and animal husbandry, the construction of wind-breaks, the construction of boreholes and the installation of tanks to collect water from roof tops for human and animal consumption and for irrigation. The agronomy aspect of the project included pasture improvement and the improvement of rice production. The forestry component included tree planting to protect crops against wind action. The principal trees introduced were eucalyptus and cactus (the latter to serve as windbreaks).

87. After 8 years of operation (1973-1981), the project ran into difficulties. Besides unfavourable geographical conditions, in particular a hostile climate, other problems rendered it increasingly difficult and precarious. Some of the difficulties encountered were a lack of telecommunications, poor infrastructure, and a lack of sufficiently trained and qualified personnel.

88. Its accomplishments included the realisation of an aerial photographic coverage of some 25,000 square kilometres, and a socio-economic study. Some small measure of success has also been achieved in the animal production sector. But the agronomic sector has been a failure.

CHAPTER 28: UNITED REPUBLIC OF TANZANIA

A. Problems of Desertification and Current Status

89. Tanzania is experiencing desertification due to both natural and man-made conditions that have resulted in accelerated soil erosion by sheetwash, wind and gullying. The most intensively degraded area lies in the semi-arid centre of the country and includes the Kondoa-Irangi District and Dodoma Region. The sub-humid mountain areas with heavy small farm cultivation of steep slopes are also subject to deforestation and accelerated erosion.

90. The primary causes of desertification in the semi-arid areas of Tanzania are: overcultivation and poor land management, overgrazing and trampling, excessive collection of wood for firewood and charcoal, deforestation and extensive burning of grasslands and woodlands, the incidence of prolonged drought, and to a limited extent, waterlogging and secondary salinization (in Kahe Division, Moshi District)

91. Numerous efforts have been made to arrest desertification in Tanzania through the proper use of soil and water resources. Past conservation policies lacked a sound base and were often improperly implemented. The major attempts at comprehensive rehabilitation schemes during the colonial period failed as a result of their own technical deficiencies and the resistance they provoked among the rural population. Subsequent piecemeal measures have not contributed much to an improvement of the situation.

92. Since independence, efforts have been renewed and interest in conservation revived. As yet, however, no comprehensive programme to arrest desertification has been implemented in the country. Current efforts have, therefore, been unco-ordinated and mainly involve tree planting programmes. Government strategy for rural development has emphasized villagization through which such single-set programmes are implemented.

93. The Ministry of Livestock Development (which has since been reunited with the Ministry of Agriculture) launched a five year destocking campaign and prepared a "National Policy of Livestock Development" to guide official action for the next ten years. The policy aims to stimulate the development of the livestock industry in order to increase national income and net foreign exchange earnings, attain self-sufficiency in food production, and consolidate the policy of socialism and self-reliance. The following measures are planned for the improvement of the rangelands: improvement of the forage base by systematic bush clearing to destroy the habitat of tse-tse flies, the propagation of appropriate range grass and legume species over denuded regions, the use of fire as a tool for range improvement, organized destocking based on proper land-use planning so that areas not suitable for crops and livestock may be utilized, and the establishment of water supply points for livestock in the grazing areas.

94. In March 1983, the Ministry of Agriculture launched its own "National Agricultural Policy". The policy document (The Tanzania National Agricultural Policy, Interim Report, October 1982) was prepared by a special task force headed by the Permanent Secretary, Dr. S.M. Mbilinyi. The report emphasized land-use and soil conservation. In accordance with its terms, the Ministry (now combined with the Ministry of Livestock Development), in collaboration with the Ministry of Lands, Natural Resources and Tourism is planning to carry out a national survey of land-use patterns and compile detailed national, regional and district land-use maps which will assist planners and implementers to make decisions for land allocation. A directorate is to be established at the Ministry's head office to deal with the issue of land-use planning and soil conservation.

95. One of the most important accomplishments of current attempts to combat desertification in Tanzania is the preparation of land-use plans. A land-use planning committee, under the chairmanship of a member of the Prime Minister's Office, has been established and a number of physical plans have been prepared for the use and management of ecologically important areas, including entire watersheds, and forest and game reserves.

96. For the purpose of physical planning and integrated development, the Tanzania mainland has been divided into five physical zones, Uhuru Corridor Zone (Morogoro, Iringa and Mbeya), Lake Zone, Northern Zone, Southern Zone and Central Zone. Regional plans for the first two zones have been completed and preparation for the Northern Zone is under way. The Uhuru Corridor Zone physical plan is currently being implemented.

97. It has also been recommended that land use plans be prepared at the village level to avoid problems of overgrazing and bad agricultural practices. In the case of grazing, it was suggested that communal grazing lands should be allocated, and the onus was placed on the Ministry of Agriculture and Livestock Development to identify good and bad rangelands at the village level, and to communicate this information to land-use planners and the general public.

B. Current Anti-Desertification Programmes

98. The Afforestation Campaign and the Village Afforestation Programme (1980 to present). This programme involves eight regions - Mara, Mwanza, Shinyanga, Tabora, Singida, Dodoma, Arusha and Kigoma - all of which contain large areas of drylands that are subject to desert encroachment. The programme is being implemented by the Forestry Division of the Ministry of Lands, Natural Resources and Tourism in co-operation with the Institute of Adult Education, and with assistance from SIDA and FAO.

99. The whole programme is aimed at arresting deforestation, protecting forests and forest reserves, and promoting better practices in the utilization of cultivable and grazing areas and wood resources. Great emphasis is placed on extension work (using radio, pamphlets and meetings), on conservation education, especially on the subject of uncontrolled fires, and on the people's participation in afforestation activities.

100. Nurseries to provide seedlings have been established in many parts of the country, thousands of seedlings of various species have been distributed to villagers to reach set district and regional targets. In May 1981, the total number of seedlings planted in Shinyanga, Mwanza, Singida, Tabora and Dodoma was reported to be 8,485,906, covering an area of 7,657 hectares. The target for the five regions was 11,484,834 seedlings, intended to cover an area of 10,365 hectares. By December 1982 it was estimated that a total of 12,050 million seedlings had been planted in the eight campaign regions, as the result of the 1981 afforestation campaign.

101. The Arid Zone Afforestation Project (1979-1983, Phases I and II): This project is specific to the Dodoma Region and is being executed by the Forestry Division in co-operation with the IDRC. The principal objective of the project is to discover suitable species for the afforestation of the arid areas of Dodoma. It is also a multi-purpose project involving research into fuelwood, fodder, construction materials, and so on. The first phase of the project, which was concerned with the determination and selection of suitable species, has been completed. Phase II, concerned with pilot plantations, was launched in July 1983.

102. The Makonde Escarpment Project: This project was begun in 1983 and is being implemented by the Forestry Division. It is concerned with the reclamation of some 87,000 hectares of degraded land in the Masasi and Newala Districts of the Mtwara Region, in south-eastern Tanzania. The villagization programme has had considerable impact on farming systems on the escarpment. The fallow period, which used to be about five years, has virtually ceased, with consequent depletion of soil fertility. There has also been a sharp increase in the population on the slopes of the plateau, in spite of a certain amount of out-migration. Villages in some areas of the escarpment have had rural reserves created around them, along the escarpment, and the people have been relocated. Provision has also been made to remove nearly 500 houses in Masasi District and almost 300 in Newala District. The aim is to conserve the soil and reduce the incidence of soil erosion on the escarpment. It is estimated that 200,000 people in Newala and Masasi Districts have been affected, compensation has been provided.

103. The Ngorongoro Conservation Area Project : This project is located in the Oldeani - Karatu area of Arusha Region. It began in 1982 and is being implemented by the Institute of Resource Assessment (IRA), with the co-operation of UNESCO. It is a multi-purpose land use and soil conservation programme. Mechanized agriculture on both the large estates and the smallholder plots and the collection of fuelwood have had a damaging effect on the forests, which have consequently suffered from soil erosion by wind and water. The worst effects can be seen on slopes of about 10 to 15 degrees in gradient on which cultivation is carried out without contour-ridging. Yields of such crops as coffee and wheat have been very much reduced in the last few years. Soil fertility depletion has been the result of this over-cultivation, and drought has exacerbated the problem. This multiple land use and soil conservation programme is intended to arrest this deterioration and to benefit some 20,000 pastoral Maasai people.

104. Wildlife Inventory Project: This is a country-wide project that will be implemented between 1982 and 1987 with the support of FAO. Its main objective is to undertake an inventory of important wildlife areas. The data gathered will be used to plan the optimum utilization of wildlife resources. The project components include: carrying out an aerial census in wildlife areas, with emphasis on population, distribution and habitat of the common species, analysis of the data to assist in planning wildlife conservation and management on a sustained yield basis, training wildlife personnel who will continue to monitor the project, and the preparation of maps of wildlife areas.

105. National Soil Service Project (URT/73/006): This project was carried out between 1978 and 1982. Its objective was to establish a National Soil Service in Tanga that would undertake soil surveys and analyses. A semi-detailed soil survey and related land-use suitability study of the Dodoma Capital City District has been completed. Soil moisture studies were carried out in Mlingano area, to determine the water requirements and drought susceptibility of basic crops and to formulate a basic methodology. The project has been faced with a shortage of technical personnel which has led to a curtailment of activities. Steps have now been taken to form a project programming committee and to establish project sub-centres. The project is being considered for extension for another four years, again with UNDP support. The project's budget was US$ 3.1 million.

106. Crop Monitoring and Early Warning System (FSAS/URT/047/NET): This is a country-wide project being implemented with assistance from UNDP. Its aims are to provide improved advance information on crop production and food supply, and to alert all those concerned well in advance of an impending food shortage, so that suitable and timely remedial action can be taken. The project is carrying out systematic crop/weather analyses of current agro-meteorological conditions throughout the country.

107. The Security and Prevention of Food Losses: This is a UNDP/FAO/IPF supported project. Its main objectives are to create a co-ordinated framework for assessing food security policy and national policy for the prevention of food losses, to promote investment in storage facilities in order to reduce pre-harvest losses, and to train personnel at various levels in the management and operation of Government programmes. Project components include the building of strategic grain reserve stores, large scale and local rural storage facilities, plant protection, bird control and aerial applicator training. The project was begun in 1982 and is due to end in 1987.

108. Rural Electrification Programme: The aim of this country-wide programme is to supply electric power to small townships and villages. This is an alternative energy source to fuelwood resources which are rapidly being depleted in several areas of the country, with consequent problems of soil erosion and desertification. During the second Five Year Development Plan (1969-1974) the following districts were supplied with electric power:

Liwale, Monduli and Megazano townships, Chamwino, Nduruguni, Kigwa, Butiama, Magango and Kyabakari. By 1977-1978, funds had already been allocated to supply electricity to a total of 23 towns and villages. However, a shortage of funds for implementing the programme has caused delays and the Government has been seeking soft loans and grants from international organizations and friendly countries.

109. The Kidatu Hydro-Electric Power Plant and the Mtera Dam. The Kidatu Hydro-Electric Power Plant (completed in 1975) and the Mtera Dam (completed in 1980), are managed directly by the Tanzania Electric Supply Company (TANESCO). Construction of the hydro-electric power plant at the Great Ruaha River and the building of storage reservoirs at Kidatu and Mtera has been completed. The power plant has a capacity of 2 x 50 megawatts. The reservoir has an estimated storage capacity of 3,200 million cubic metres. Hydro-electric and irrigation potential are among the important resources of the Rufiji Basin, and the power plant and dam are a vital consideration in the Rufiji Basin Development Authority (RUBADA)'s overall planning. RUBADA is currently undertaking a land-use survey of the Ruffiji Basin as a whole.

C. Records of Successes and/or Failures

110. Hifadhi ya Ardhi Dodoma (HADO) Project (Soil Conservation Project, Dodoma). This was an afforestation and engineering project carried out between 1973 and 1980. It was directed at the prevention of further land degradation and the reclamation of eroded lands in the Kondoa District. Rehabilitation has involved the construction of contour ridges and bunds, the planting of elephant grass and sisal in gully bottoms, tree planting, the establishment of nurseries, the distribution of seedlings, the provision of equipment for soil reclamation, and relocation of human settlements in the project area.

111. By 1980, about 1,275 hectares had been planted with trees and a further 235 hectares planted by villages and schools. An interesting aspect of the measures taken to rehabilitate the degraded areas of Kondoa (and which has in a large measure accounted for the success of the project) was a political decision to enforce a 1968 by-law prohibiting grazing in the project area. This decision was implemented with only minor civil disobedience. The prohibition of grazing has initiated an almost unbelievable ecological transformation from a desolate landscape of bare ground, heavily browsed shrubs and scattered trees to impressive vistas of grass and vigorously sprouting shrubs. After only two rainy seasons, grass cover appeared to exceed 50 per cent, and woody sprouts were 1 - 2 metres tall. The programme has cost an estimated $ 555 million, provided by the Government of Tanzania and SIDA.

112. Sukumaland Resettlement Scheme. This scheme was implemented during the British Administration between 1944 and 1958, in Shinyanga and Mwanza regions. The main objectives were to educate the people in proper methods of land-use and to resettle excess population and livestock on prepared expansion areas. The agricultural objectives included the improvement of crop culture, proper land utilization, the conservation of crop residues for dry season

fodder and manure production, gully stopping, and the planting of live hedges. These objectives were enforced by means of rules and orders. The veterinary effort was aimed mainly at the reduction of livestock densities and the encouragement of mixed farming practices. Compulsory culling of livestock at a rate of 5 per cent per annum was introduced with the agreement of the people. At the same time, undeveloped land was surveyed for orderly and controlled resettlement.

113. The project affected 1 million people, 2 million head of cattle and 2 million sheep and goats in an area of approximately 23,040 square kilometres. To achieve better livestock distribution, a large programme of water development was undertaken in the settled areas and in the new development areas. In common with other schemes where rules and orders formed the basis of improved agriculture, there was strong political antipathy towards this scheme and in 1955 the cultivation rules were relaxed. As a result there was widespread abandonment of such improved methods as tie-ridging and manuring. The project was finally abandoned in 1958.

114. Destocking and Resettlement Schemes, Mbulu District and Masailand. Implemented between 1945 and 1960, the schemes were concerned with the effects of the concentration of excessive numbers of cattle in restricted areas. In Mbulu, the objective was to tackle the problem of overstocking and overgrazing through planned clearing of tsetse-fly infested bush in bordering areas, together with compulsory cattle culling and a small land development scheme for the settlement of people from the more densely populated areas. Strenuous steps were also taken to enforce soil conservation measures in the cultivated areas of this hilly district. While some success was achieved during the life of the scheme, there was insufficient control of the numbers of stock entering areas cleared of tsetse, and in 1960 when the scheme terminated, many parts of the district still suffered from chronic overstocking.

115. In Masailand, the development scheme was essentially concerned with the provision of more and better water supplies, in order to obtain a better distribution of stock and to enable wet season grazing to be used for a longer period, it also included clearing tsetse-infested areas. No provision was made to control livestock numbers at dry season watering points or to provide for an annual cull large enough to check the growth of the livestock population. The provision of more watering points had the disastrous effect of more rapidly ruining large parts of northern Masailand.

D. Information and Experience in Desertification Control

116. The Ujamaa Village Programme. The Arusha Declaration of January 1967 committed Tanzania to the creation of a socialist state, with development in the rural areas based on agricultural communes (Ujamaa villages) where all life and activity was to be run on a co-operative basis. The inhabitants of a communal village were expected to live together according to the social norms of production and the traditional extended family, exercising "mutual respect and obligation, universal obligation for everyone to work, and a sharing of joint production", and to work "for the good of all". Each village was to be run by democractically elected leaders who would organize its activities and

formulate plans. Each village was created as a specific political, social and economic unit where Government programmes and services would be administered on the basis of ujamaa villages or groups of villages. Individual village plans would be integrated into district and regional programmes and then integrated vertically into sectoral programmes for national planning purposes. By mid 1979, about 86 per cent of the rural polulation of Tanzania was living in some 7,700 registered villages, each containing at least 250 families, which is the minimum number required. Given sufficient time and financial resources it should be easier to plan and execute environmental conservation at ujamaa villages than scattered homesteads, for it is possible to:

- organize and carry out farming in block farms and excercise land use measures
- allocate land according to use:
  cropping
  grazing
  afforestation
  central buildings, etc.
- impose grazing by rotation
- and enact by-laws and enforce them through the villages' own governments.

117. Serious problems have, however, been encountered in connection with the ujamaa village programme. Most villages were located without proper planning and consideration for the carrying capacity or the suitability of the land for crop production. Consequently, several of these are currently over-populated beyond the maximum 600 families stipulated in the Village and Ujamaa Village Act of 1975. Many are facing problems of land deterioration due to the change from shifting cultivation to permanent cultivation and of soil erosion induced by overgrazing.

118. For other African countries interested in introducing similar resettlement programmes, one important lesson from the ujamaa programme is that in planning such schemes, it is necessary from the outset to ensure that the resettlement programme does not simply transfer the agro-ecological problems of the old land onto the new lands being resettled. It is also important to ensure that on the lands being resettled, adequate provision has been made for environmental conservation, and that appropriate land use practices are maintained.

119. Biogas technology: Two digestor types of biogas plants have been built. The Small Industry Development Organization (SIDO) digestor is based on the Indian design and uses a single floating gas holder made of mild steel. The Arusha Appropriate Technology Project (AATP) design is a floating gas holder made from seven discarded oil drums connected by lead or plastic pipes. The 1978 cost of the SIDO design ranged from TS. 5,400 for 2 square metres of gas storage capacity to TS. 35,000 for 23 square metres storage capacity. The

AATP 2 square metres capacity, seven-barrel design, which relies on the oil barrels being available as scrap, cost TS. 720 in 1978. A biogas plant with a gas capacity of 3 square metres requires a minimum of 5 head of cattle to provide 50 kilograms of cow dung per day. The energy output from this would be sufficient to meet the needs of a village family of ten.

120. SIDO has installed 95 digestors in different parts of the country, while the AATP has installed 104 digestors in Arusha and other regions. SIDO has also a section specifically devoted to providing training in biogas technology and extension work. So far over 50 individuals have been trained in building, commissioning and operating biogas plants.

121. The technology of biogas is thus in its infancy in Tanzania and it is too early for final conclusions to be drawn. Nevertheless the major problems appear to have been identified and their solution is in sight. However, rapidly rising costs of building and maintaining digestors are a considerable deterrent to the propagation of their use. Operating problems have also been encountered. Reports blame the failure of some installations on lack of maintenance, difficulties in collecting cow-dung, shortages of water, and lack of interest. It would appear that the continued establishment of animal manure-fed biogas plants will depend on sufficient quantities of manure being available and accessible, and on economic incentives for digestor construction at the village level.

122. Gasification by partial combustion technology: The development of a gasification by partial combustion technology project is already being undertaken by SIDO in collaboration with the Trente University of Technology in the Netherlands. The project is located in Arusha, where a prototype unit has been in operation for the past two years. This unit is now being taken for field trials in selected villages. The fuel supply is provided by maize cobs and the utilization of the unit is at present linked to maize milling. Social and economic studies of this energy source and its potential for wider application are to be carried out in collaboration with the Institute of Resource Assessment (IRA).

123. From the limited experience gained so far, gasification by partial combustion is a technology which could be of great benefit to developing countries. Its potential applications range from small-scale village uses to urban industry. It will allow economies in diesel fuel to be made using indigenous resources. It does not require advanced skills in its operation or maintenance. A major point in its favour is that it will only be introduced where a diesel engine is already in operation, so that basic technical skills are already available.

124. Windmill technology: Experiments with windmills have been carried out in a number of areas in Tanzania. Machines have been imported from abroad and indigenous adaptation has been developed by the Arusha Appropriate Technolgy Project (AATP). The success rate in windmill installation has, however, been

poor and few appear to be working successfully. Machines have broken down, been abandoned or scrapped because of lack of maintenance and spare parts. Despite the disappointing results of windmill trials, it is important that such feasibility experiments continue. Windmills can be effective, particularly for water pumping in rural areas, such as Dodoma, Singida and Tabora, that have suitable wind regimes.

CHAPTER 29: ZAMBIA

A. Problems of Desertification and Current Status

125. Deforestation is the principal problem in Zambia. Shifting cultivation (the chitemene system) has affected a large part of the woodland areas and has contributed greatly to soil erosion and consequently to the desertification process. Until the 1930's, the problem of soil erosion was not widespread in Zambia. Since then, the dramatic increase in its extent and intensity can be traced to the increasing pressure on agricultural land induced by European settlements and changes in demography, settlement patterns and economic life of the African population. Other factors responsible for desertification in Zambia today include: firewood collection and charcoal production, logging operations, open-pit mining, and over-stocking in the drier areas of the country.

126. The original impetus for soil conservation came as a result of the serious erosion of some reserve lands in the 1930's. During the early years, the programme consisted of a series of ad hoc physical conservation measures in the areas where soil erosion was most severe. Prior to independence, conservation policies were discriminatory and unpopular with the indigenous farmers, who were compelled to comply with the measures introduced. Since independence, this element of compulsion has largely been removed and some areas are well protected against erosion, although there are other equally vulnerable areas which are in a precarious condition.

127. Soil conservation activities have focused largely on the protection of arable land, which is periodically exposed to the full erosive impact of rainfall during the planting and early growing season, and where poor farming practices can cause adverse changes. Conservation activities have sought: (a) to develop systems of cropping and land-use that minimise structural and nutrient deterioration of the soils in order to keep soil erosion and loss of fertility to a minimum; (b) to reduce run-off from cultivated land and prevent the passage of erosive water over large areas of susceptible soil, and (c) to channel unavoidable run-off water along well-defined, gently sloping outlets.

B. Current anti-desertification programmes and Projects

128. Conservation of Natural Resources Project (1979-1983): This country-wide project was the responsibility of the Ministry of Lands and Natural Resources and was implemented between 1979 and 1983. Its objective was to assess soil, water, forest and fauna resources, to obtain data that would assist in the drawing up of a National Conservation Strategy. Actions included a deforestation survey, a gully erosion survey, bush fire management, and anti-poaching campaigns. Deforestation reports and maps in draft form have been completed and are to be published soon; badly eroded areas have been rehabilitated, poaching slightly reduced, and uncontrolled bush fire incidence slightly reduced. The estimated cost of the project was US$ 7,633,000, which was provided by the Government.

129. Integrated Development Project.: This project is located in the Serenje, Mpika and Chinsali Districts in north-western Zambia and will affect a total population of approximately 220,000. It will be implemented between 1982 and 1992 by the Ministry of Agriculture and Water Development, and its objective is to raise the incomes and living standards of the rural population, primarily by increasing agricultural production in the areas where the population is concentrated. In the short-term, during the project investment period, the project is expected to achieve self-sufficiency in food production in the three districts. In the longer term livestock and forests are considered to be the most appropriate land use forms and the project will lay the foundation for developing production. Further components of the project include investment in agricultural inputs, rural infrastructure, livestock, health and support services, bee-keeping and fish culture.

130. It is expected that there will be an improvement in farmers' incomes and agricultural production, as a result of the increased use of farm inputs, better animal husbandry, the use of draught oxen, and an improved rural infrastructure involving roads, water supplies and health services. The major long-term benefits are expected to accrue from livestock development and small-scale irrigated agriculture, and secondary benefits from bee-keeping and fish culture. The estimated cost of the project over the ten-year period is K.11 million, of which capital costs make up 53 per cent of the total (K.1 = US$ 1).

131. Pilot Settler Irrigation Scheme (TCP/ZAM/2205 Ma): (Phase I: January - April 1983; Phase II: 1983 - 1986) This project is located in Mazabuka area, 100 to 150 kilometres south of Lusaka, and is being implemented under the general supervision of the Ministry of Agriculture and Water Developmnent in co-operation with FAO. Its objective is to establish well planned and designed pilot schemes, to analyse farmer response to farming under irrigation and to make recommendations for future low-cost development of irrigation in the regions, on the basis of reconnaissance studies of the potential for such development. A pilot study has been completed and Phase II, involving the establishment of a pilot irrigation scheme, has just started. The estimated cost is US$ 1.2 million of which FAO is contributing US$ 60,000.

132. Mpongwe Development Project: (Phase I: 1978 - 1982; Phase II: 1982 - 1995) This project is centred in the Copperbelt Province. Its objectives are to increase the production of wheat and soya in Zambia, to select, train and settle 95 Zambian farmers on a 50 hectare irrigated farm, and to develop the Mpongwe Block as a future centre of the Mpongwe Development Area. By June 1980, an irrigated area of 250 hectares had been developed. Among the objectives of Phase I are the establishment of the Mpongwe Development Authority (MDA), the settlement of 15 farmers on a 50 hectare farm, and the completion of an investigation into the water resources of the eastern aquifer with a view to expanding irrigation. The completion date for Phase I was June 1982. By October 1981, no settlement programme had been initiated because the land area had not been delineated by the Government. The irrigation works were unfinished, but it was expected that they would be completed by the end of the project.

133. Phase II aims to expand irrigated farmland to a total of 5,000 hectares and to settle a further 80 Zambian farmers. The main components of this phase are: a capital works programme, land clearing and irrigation engineering, the cultivation of irrigated wheat and rainfed soya beans in rotation, and the settlement of farmers. Each will be implemented over a three year period on 50 hectares of irrigated farmland.

134. The scheme has all the advantages of a fully integrated strategy and has implications for the overall economic development of the surrounding area. It is a project that emphasizes self-reliance in food production. It is hoped that it will serve as a nucleus of development for the area and act as a model for future integrated development elsewhere in the agriculture sector. The investment cost of the development programme is estimated at K. 47 million, of which the capital works constitute K. 35 million.

135. Training and Extension Services in Agriculture and Renewable Resources: This is a country-wide project, implemented between 1979 and 1983, under the aegis of the Ministry of Lands and Natural Resources in co-operation with the Ministry of Agriculture and Water Development. Its objectives were to strengthen rural information systems and to train extension workers and land-users, in order to improve farming methods and to increase yields per unit area of agricultural crops.

136. The activities involved are: training agricultural extension officers, conducting seminars and short courses for land-users at farm training centres, group discussions on radio and television, and the production of an agricultural magazine. About 970 field agriculture extension workers were trained between 1979 and 1983, and over 500,000 farming families have either participated in a group discussion or attended an agricultural and/or natural resources seminar. The estimated cost was US$ 30,573,000 for the period 1979-1983, provided by the Government.

137. Research in Agriculture and Renewable Natural Resources: (1979 - 1983) This is another country-wide project of the Ministry of Agriculture and Water Development in co-operation with the Ministry of Lands and Natural Resources. Its objective is to carry out research on livestock, crops, forests, wildlife, and soil and water resources, in order to obtain data for the planning of the country's social and economic development. It involves the provision of nucleus breeding herds, the development of new varieties of crops, ecological surveys, and data collection and analysis.

138. Hybrid maize varieties are now being produced as well as improved stocks of breeding pigs and cattle. The afforestation of cleared areas and the rehabilitation of eroded areas have been undertaken. The estimated cost of the project is US$ 12,537,000, provided by the Government.

139. Education Service: (1979 - 1983) This is a general country-wide programme of the Ministry of Agriculture and Water Development, the Ministry of Lands and Natural Resources, the Ministry of General Education and the Ministry of Information and Broadcasting. Its aim has been to train teachers and education broadcasters to assist and promote public awareness in the wise

use of natural resources. The activities involved have included the purchasing of visual aid materials, the introduction of appropriate subjects in the syllabi of trainee teachers, the teaching of appropriate subjects in primary schools, and the daily broadcasting of relevant topics on the radio. Its estimated cost is US$ 14,700,000.

140. Land-use Planning Surveys and Mapping: (1979 - 1983) This is a country-wide project under the Ministry of Lands and Natural Resources in co-operation with the Ministry of Agriculture and Water Development. Its objective has been to assess the land, forest, soil and water resources of the country to obtain data for mapping and for economic development planning for the country as a whole. Actions have involved the production of land use maps, aerial photography and deforestation surveys. Aerial photographs are now available, land use maps will be published during 1984, and reports and maps will also be published soon.

141. Development of Agriculture and Renewable Natural Resources: (1979 - 1983) This project is being implemented under the aegis of the Ministry and Lands Natural Resources in co-operation with Ministry of Agriculture and Water Development. Its objective is to plan and implement a rural development programme that will improve the living standards of the rural population. Actions involved have included the planning of agricultural schemes and crop production on project farms. The cost is estimated at US$ 168,589,000.

C. Records of successes and/or Failures

142. Information is not readily available concerning successes and failures of past anti-desertification projects or programmes. There is, however, one example of a successful project in the recent past.

143. The Chapula Small Scale Irrigation Development and Training Programme (1969-1975): This project was located in the Kalulushi area of the Copperbelt Province and implemented with support from FAO and UNDP. Its aim was to assist the Government of Zambia in establishing training facilities and developing an area for the intensive production of vegetables by local growers, using modern methods and irrigation. Components of the project included the laying out of 61 hectares of land for gravity and sprinkler irrigation plus 48 hectares for rainfed, mainly agricultural cropping. Basic services of mechanical cultivation, supply of inputs and a comprehensive internal marketing scheme were provided by the project. The growers were organised into the Nkana Growers Association.

144. A total of 142 growers were given training and cropping rights on a group basis. One interesting practice applied in this project is a five year crop rotation system that maintains a humus balance. This technology was developed to overcome the important problems of nematodes, soil-borne diseases, and decline in soil fertility. Emphasis was placed on good nursery and field practices as an adjunct to chemical methods of pest control. In 1974 a total of 658 tons of produce valued at K.92,000 was marketed. The major crops produced were cabbage, potatoes, grapes, cob maize, and carrots.

CHAPTER 30: ZIMBABWE

A. Problems of Desertification and Current Status

145. The primary causes of desertification or land degradation in Zimbabwe are related to increasing population pressures on land resources. The result has been soil loss and extensive deforestation, brought about mainly by clearing for cultivation, cultivation too close to river beds, crop production in marginal areas, and poor cultivation methods practised by a rapidly expanding peasant community that has few resources to raise itself above the level of subsistance agriculture. Over-cropping, badly constructed and maintained soil conservation works, overgrazing, with the loss of protective perennial grasses, and the periodic incidence of drought have also contributed to land degradation in Zimbabwe. The areas most affected are certain parts of the communal lands in the west and southern parts of the country, and a small area in the east. They are semi-arid lands with a low mean annual rainfall. Communal lands occupy 16 million hectares (42 per cent of the land), on which the majority of the African population of 3.5 million live.

146. The Natural Resources Board of the Ministry of Natural Resources and Tourism and the Department of Agriculture, Extension and Technical Services (Agritex) of the Ministry of Agriculture, are the principal institutions co-ordinating anti-desertification activities in Zimbabwe. Agritex is responsible for the implementation of good soil conservation and husbandry practices, and the Natural Resources Board is responsible for administering the Natural Resources Act and for fostering public awareness.

147. Reconnaissance surveys and the promotion of environmental awareness are the main focus of the Extension Division of the Ministry of Natural Resources and Tourism. The Division has divided the country into nine regions and stationed personnel in each region. The function of these extension officers is to spread environmental conservation education in their respective regions. The extension staff do this in collaboration with the local people, who have set up their own District Conservation Committees (DCCs). The Forestry Commission is often represented on these committees. Altogether there are 55 districts and 219 District Conservation Committees. In addition to the DCCs, there are also about 165 Intensive Conservation Committees (ICCs). There is also an Inspectorate Division within the Ministry which monitors the use of the natural resources of the land and draws the attention of the Extension Division and other responsible local authorities to any anomalies in land use. The education programme places emphasis on sustainable land use practices.

148. Peasants have unalienable rights to forest produce but under the Natural Resources Act they can be prosecuted for land abuse or misuse. This Act is often used as a last resort. Since 1980 the Ministry of Natural Resources and Tourism and the Forestry Commission, in a joint venture, have launched a National Tree Planting Day for the first Saturday in every December, to signify the start of the tree planting season for everybody.

149 In recent years there has been a move to emphasize multi-purpose wood planting to protect the soil, supply fuel needs and also for aesthetic purposes. In addition, some small programmes of gully reclamation are being carried out by the villagers themselves in collaboration with the Natural Resources Board. The Board also runs annual training courses for all conservation committee members. These courses take the form of a series of lectures delivered by experts from the various ministries on different aspects of environmental conservation.

B. Current Anti-Desertification Programmes and Projects

150. Rural Afforestation Project: (1982 to present) This project focuses on communal lands and is being implemented by the Forestry Commission with support from the World Bank. The project aims to: (a) ameliorate the fuelwood deficit in 42 per cent of the districts in six provinces, by planting fast-growing exotic trees; (b) understand and influence the attitudes of the inhabitants of communal lands to encourage them to participate in tree planting, and develop their awareness of the need for afforestation; (c) initiate action to increase exotic wood supplies, conserve indigenous wood resources, make more efficient use of wood as fuel and building material, and arrest the physical deterioration of communal lands; and, (d) promote tree planting and management in selected areas as an integral part of the on-farm livestock raising activities of the people.

151. The project includes the development of an infrastructure for the production and distribution of seedlings and woodlot planting, and the provision of education information and extension services for the promotion of tree planting and management as an integrated part of farm management. It is also undertaking research into many aspects of rural afforestation and wood as an energy resource. The project involves the establishment of 48 nurseries near rural service centres in 23 districts on 35 areas of communal land.

152. In its first year, 1982, it was planned to establish 12 nurseries in four provinces; 11 of them had been established by mid-1983 and were producing plants: four in Mashonaland, five in Masvingo Province, and one each in Manicaland and Midlands Provinces. A secondary nursery site in Manicaland Province has provisionally been selected. A minimum production of 50,000 seedlings per nursery is envisaged during 1983. Sites have been cleared for block plantations on three forest areas and 110 hectares of plantations have been established at two urban centres, with a further 54 hectares being prepared for planting during the coming season.

153. Although it is too early to assess the impact of this rural afforestation project in arresting desertification, progress in this scheme has generally been satisfactory. Major problems facing the scheme include the availability of and access to land for tree planting, the protection of trees on grazing land, and the willingness of inhabitants to plant. The estimated cost of the project is US$ 9,323,700, most of which has been provided by the World Bank.

154. Agro-forestry project - Mafungabusi: (begun in 1982 - 1983) This is a five year project in Gokwe District, covering an area of 82,000 hectares and affecting 60 families, again under the aegis of the Forestry Commission. The project is aimed at the integration of forestry and agriculture, and the generation of additional employment and income in the drylands of Zimbabwe. Its components include the interplanting of crops and trees on denuded Kalahari sand and soils.

155. Biogas installations: (1982 - 1984) This is a country-wide project supported by the European Economic Community (EEC). It is concerned with the installation of Chinese and Indian biogas units in all districts of Zimbabwe in order to demonstrate their potential usefulness in reducing petroleum imports and in supplementing costly the electricity supply. The project intends to mobilise the people through their district councils to select plant locations and provide labour and local building materials. It also involves the training of local builders for each District Council. So far, 15 units have been completed. The estimated cost is US$ 150 million.

156. Construction and Installation of Woodstoves: (1982 - 1984) This is another country-wide project, supported by EEC. Its objective is to ensure efficient utilization and conservation of fuelwood through improved woodstoves. It involves the installation of two units of woodstoves in each district and the mobilization of the people via their district councils to provide labour and local building materials. It also involves the training of local builders for each district council. Two test stoves have been approved and recommended for construction and distribution to the districts. The estimated cost is US$ 100 million.

157. Reclamation Teams: (begun in 1983) This project aims at combating major soil erosion problems, in particular in the communal areas. Four teams will be established and will carry out major reclamation and soil conservation work in areas where soil erosion has become a major problem and local communities and field extension staff cannot control it.

158. The teams will carry out major conservation work such as filling in and sloping gully sides, diverting run-off water, ripping compacted soils, pasture furrowing, run-off drains, bolsters, silt traps in the form of dams and weirs, diversion dams and other necessary conservation works. Other measures include fencing, re-seeding, re-routing stock corridors and increasing water supplies. An extension programme has been included as an integral component to ensure local involvement and participation. The teams work in close liaison with the principal district staff and other Government departments. The total capital cost of the project is estimated at Z$ 1,050,540, out of which the estimated total running cost is Z$ 886,132.

159. Resettlement Scheme: (begun in 1980) This is an on-going country-wide scheme launched since independence. Its aim is to relieve human pressure in communal lands by resettling thousands of family farmers on formerly white-owned farmlands which the Government has bought at current market values. Some 160,000 families are affected, but estimates indicate that up to 300,000 families need to be resettled if the pressure in the communal areas is to be eased and land degradation brought under control.

160. The technical component of the resettlement programme consists of the implementation of three models. In Model A, entitled 'Intensive Village Settlement with Individual Arable Allocation and Communal Grazing Areas', each of the settler families is allocated a residential plot of 2,500 square metres within a communal village and 5 hectares of crop land within a radius of 3 kilometres of the village. In addition, each settler family is given grazing rights for five livestock units in Natural Region II, eight livestock units in Natural Region III and ten livestock units in Natural Region IV. These allocations, given in the form of a permit to reside, to cultivate land and to graze stock, are designed to curb overstocking and to enable a settler family to produce subsistence grain requirements plus a net income of $ 400 per annum. Communal woodlots are encouraged.

161. In Model B, entitled 'Intensive Settlement with Communal Living and Co-operative Farming', all activity is based on community co-operative structures and management. The system aims to assist people of very limited resources to develop a viable agricultural enterprise. It calls for strong dedication to co-operative action in a tight-knit communal society, a high level of mutual trust and respect, and the ability to put communal interest above personal interest. All land, equipment and property is co-operatively owned, although livestock may be privately owned. The co-operative must be established as a legal entity.

162. Model C, entitled 'Intensive Settlement combined with a Centralised Estate Farm', consists of a central core estate with associated settlers. The estate provides certain services to the settlers who in return contribute labour. Arable land and livestock are individually owned, grazing is communal.

163. It is too early to assess the results of this resettlement programme. Serious problems being encountered in its implementation include a high population increase in the communal lands (estimated annual increase is about 3.7 per cent) and the high cost of land purchase. The estimated procurement of land for resettlement is Z$ 250 million and for the development of infrastructure in the new areas is Z$ 300 million.

C. Records of Successes and/or Failures

164. Information on past experience is not immediately available.

D. Information and Experience in Desertification Control

165. The following are interesting technical research and experimental projects which have been initiated and which are directly relevant to desertification control and resource planning and development in arid areas.

166. The transitional probability matrix method (TPM) of yield analysis for water resource development. In semi-arid regions, one of the main hydrological problems is the unreliability of dry season river flow before the onset of the wet season. The provision of water for irrigation and

domestic purposes throughout the year usually entails the construction of impoundments to store thru-flood flow during the rains for release during the dry season. There is considerable annual variation in rainfall in these drylands, so that the reservoirs need to be of sufficient size to store water during years of above average rainfall to be used in years of low rainfall.

167. The Ministry of Natural Resources and Water Development has pioneered and improved a method to analyse quickly and efficiently the data required in this type of seasonal and annual store-and-release approach, the transitional probability matrix method of yield analysis. Using this method, curves can be presented for estimating the potential yield of a system. The method is reliable, simple and economical in that it uses only those hydrological variables that have a direct bearing on the problem. It therefore overcomes the need for the high density recording stations that are such a common feature in the drylands of Africa.

168. The Soil Loss Estimation System (SLEMSA): The Institute of Agricultural Engineering of the Department of Agriculture, Technical and Extension Services (Agritex) is undertaking a number of projects concerned with the collection of data for a soil loss estimation system (SLEMSA). The system is now being used by AGRITEX to design safe rotational systems in arable lands.

169. SLEMSA makes use of two types of data: fundamental data from which the predictive equations are built up, and user data tables to enable the designer to select the site values of variables to be put into the predictive equations. Fundamental data are collected on field plots and in the laboratory under simulated rainfall. User data is collected on farms countrywide. Data banks are being compiled of the relationships between soil loss, runoff and five control variables: rainfall energy, crop cover, soil erodibility, slope length and slope per cent.

170. Other Interesting Programmes: The Department of National Parks and Wildlife Management has drawn up and is undertaking a drought relief programme to conserve the indigenous flora and fauna of the drylands and improve wildlife management. Loss of perennial grass vigour is often the most important factor leading ultimately to so-called desertification in Zimbabwe (and also Botswana). The sequence of critical thresholds in the sere is variable but may include a direct passage to bare ground with reduced infiltration of precipitation and accelerated wind or water erosion, or it might involve bush encroachment, with a consequent drying out of soils, springs, etc., and increased erosion, with an increasing loss of perennial secondary production as the process proceeds. Recent work in Zimbabwe demonstrates that the proper use and marketing of wildlife provides one of the few opportunities for enhancing sustainable productivity in marginal areas from a very low level, whether or not these are already deteriorating. For example, ranching enterprises in natural region III yield about $ 3,75 profit per hectare from cattle or almost $ 6 from cattle and game. Likewise in natural region V net returns from wildlife are about three times those from livestock, hence less need to "stress" the range using livestock. Thus higher yield and greater profit from wildlife over domestic stock is achieved on commercial ranches and also in communal areas where there is a shift towards a wildlife economy.

Because of two years of drought, the vegetation in some of the national parks is beginning to be affected. To relieve pressures on the land, the Department has proposed and embarked on the following measures:

- a heavy culling programme in Wankie, Conarezhou and Zambezi Valley;
- an increase in the 1983 hunting quota, to remove excess animals;
- the relocation of some animals to areas with light grazing pressure.

The Department is also installing water pumps in the Wankie National Park as a drought relief measure.

171. Another interesting project is an appropriate technology extension service for approximately 90,000 people which is being run by the Technology Forum of the Department of Land Management, Faculty of Agriculture of the University of Zimbabwe. The project is located in Sebungwe, an isolated mountainous district with low agricultural potential due to poor soils, low rainfall, tsetse-fly infestation and limited employment opportunities. The extension service projects include alternative energy technology (solar energy and efficient wood-stoves), home soap making by women, metalwork and carpentry training to produce furniture for new clinics and schools, rug making, carving, basket making and gudza work, toy making, poultry raising, rabbit production and bee-keeping.

172. Research into tree species suitable for the drier areas of Zimbabwe is being assisted by the Australian Development Assistance Bureau and the International Development Research Centre of Canada, and the latter agency is also funding the establishment of a regional tree seed centre in Harare.
