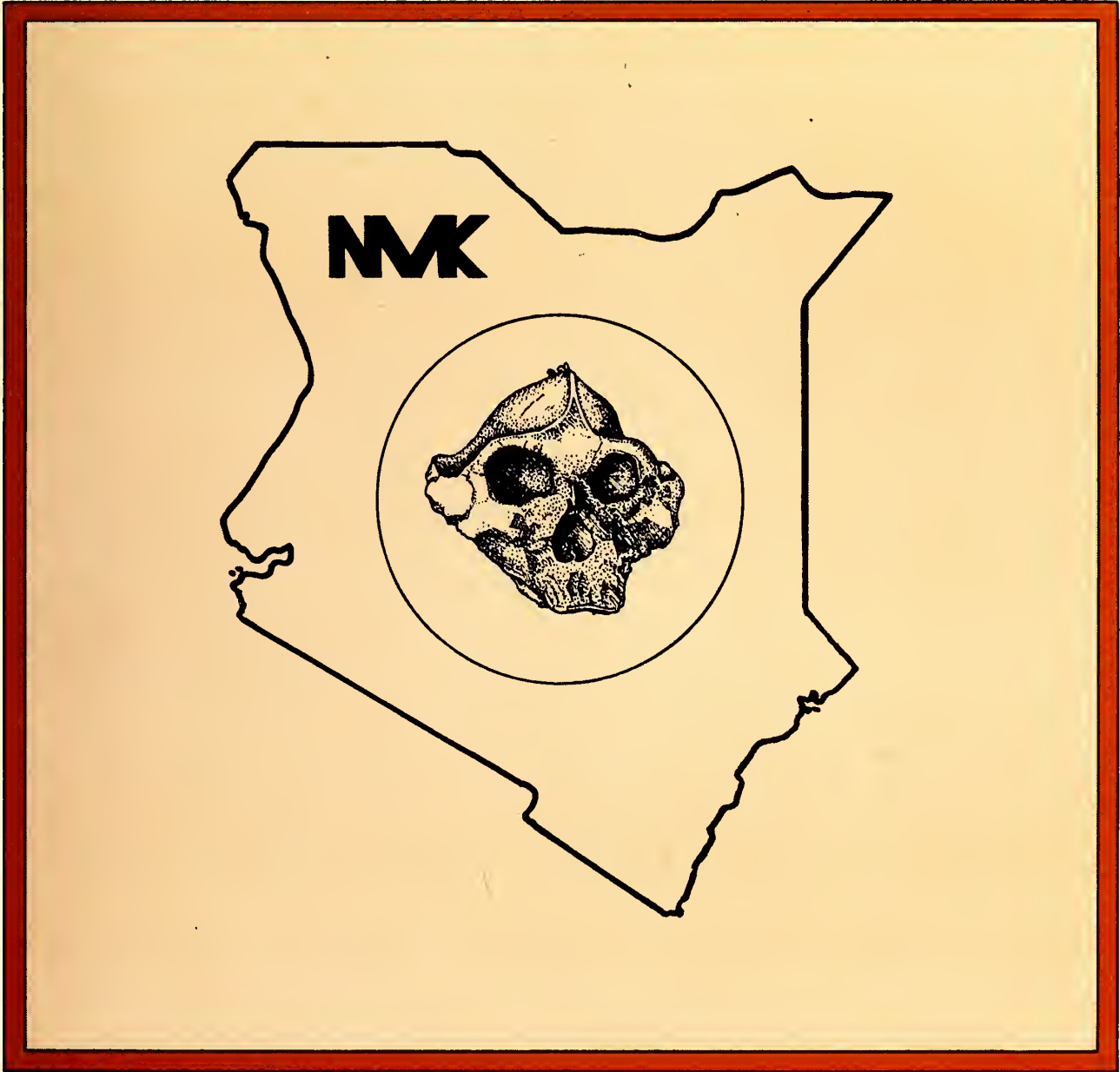


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6-7 JULY 1987

**ORGANIZED BY
C.H.S. KABUYE & A.R.D. TAYLOR**

HOSTED BY THE NATIONAL MUSEUMS OF KENYA

**AND SPONSORED BY
THE INTERNATIONAL BOARD FOR PLANT GENETIC RESOURCES**



Edited by H.J. Beentje & B. Khayota
National Museums of Kenya
Nairobi
1989

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WELCOMING ADDRESS

R.E. Leakey

I would like to start by offering a very warm welcome to all of you, and to say how very grateful I am to the International Board of Plant Genetic Resources for sponsoring this workshop.

An earlier meeting to discuss these topics was held in August 1986, sponsored jointly by the Ministry of Agriculture and ICIPE. I believe the time has come that a second meeting would be useful to keep up the impetus and review progress.

The National Museum has large collections that go beyond the botanical resources of Kenya and East Africa generally. Our biological collections incorporate reference material in entomology, ichtyology, herpetology, mammology, ornithology and our paleo-sections. These collections are of importance not just for East Africa, but for the continent as a whole. We at the Museum are increasingly aware of the need to be more useful to the community than simply be a rather closed taxonomic centre. It was with this in mind that the Board of the Museums met recently to discuss the importance of expanding our activities in the botanical field.

We felt that work in the botanical field should go beyond the collecting of plants and their identification and we are instituting a programme now that will be dealing with more applied areas, such as chemotaxonomy and phytochemistry.

It is against this background that we are getting more involved with other programmes and other institutions, and that is why I welcomed the initiative taken by my staff to hold this workshop.

The National Museums makes no pretensions about being involved in the agricultural field; we are primarily concerned with the area of endemics and the indigenous bio-resources in this part of the world.

In 1984 the Museum hosted a Strategy Conference on plant communities, and we have continued to be active in developing inventories of endangered Kenyan habitats, such as the Taita Hills and the Coastal forests.

The African Ministers meeting in Cairo, held in December 1985, recommended the setting up of technical cooperation networks. A conference in Nairobi in October 1986, under the auspices of UNEP, established guidelines involving Regional and National Networks on different aspects of the environment. As a result of this, in February 1987 the Ministry of Environment and Natural Resources identified various focal points for National networks and the National Museums was selected as the focal point for Genetic Resources.

This workshop provides an excellent opportunity to give us clear guidelines on what we should be doing. There is a great opportunity here for exchange of scientific information, particularly with a view to developing a consensus as to what should happen in the genetic resources area.

There is a lot of competition in this field and a lot of

unnecessary duplication of efforts, a lot of waste of time and of public funds. I hope that as a result of discussions here, we will at least know what we should *not* do, because someone else is doing it already.

I also hope that as a result of this workshop a Committee can be set up to meet regularly and discuss guidelines and implementations on matters concerning genetic resources.

GENETIC RESOURCES IN THE WIDE PERSPECTIVE

Dr. Hamdallah Zedan

Biological diversity and ecosystem conservation is rapidly becoming one of the most important issues of the year 2000. Species and their genetic materials promise to play an expanding role in sustainable development. Their contributions to agriculture, forestry, medicine, industry and environment amount to billions of dollars per year.

Species that are important to human welfare are not just wild relatives of agricultural crops and domesticated animals. Many species are far more important in terms of the role they play in a healthy and productive ecosystem. The natural vegetation cycles nutrients, helps to stabilize the climate, provides a sink for carbon, moderates down-hill flow of water, aids in flood control and prevention of silting of costly water reservoirs, filters pollutants, controls soil erosion and desertification, etc. Yet living natural resources such as plants, animals and microorganisms and the ecosystems of which they are a part and on which they depend, are severely threatened and vast stocks of biological diversity are in danger of disappearing, just as science is learning how to exploit their genetic variability.

A very small fraction of the estimated 10 million species of animals, plants and microbes in existence today already supports our welfare through their contribution to modern agriculture, industry, medicine, energy, biotechnology and the environment and many more benefits could come from wild and underexploited species. Countless plants and animals - the numbers have been estimated at more than 3 million - as well as microorganisms are still undescribed. Most of these occur in the tropics, and many may be of significant value as sources of foods, fibres, drugs, chemicals and other raw materials. To date, scientists have conducted cursory screening of only one in ten, more detailed screening of one in fifty, and intensive screening of only one in a hundred. As for animals, the number screened amounts to only a tiny fraction of the 5-10 million of the earth's species. Thus, an analysis of all plant and animal species would reveal many new materials of benefit to mankind. Moreover, the emergence of techniques such as genetic engineering and tissue culture reinforces the need for maintaining the richest possible pool of wild genes. The projected loss in species diversity could cripple the genetic base for the continued improvement and maintenance of currently utilized species and deprive us of many potentially useful ones.

Irrespective of this fact, the loss of genetic diversity is continuing; we could lose one million out of the earth's 5-10 million species by the end of this century. It is estimated that by the middle of the next century we could lose at least one third of the earth's total species and the genetic material they contain. The ultimate causes are the irreversible alteration or destruction of habitats through the unprecedented expansion of human popula-

tion in the last few decades and the ever-growing demands on living resources through illegal trade, indiscriminate hunting, etc. These factors have led to extensive transformation of ecosystems, either through urban development or the spread of new technologies, sometimes carelessly misapplied in agriculture, industry and transportation. It may be argued that ecosystem destruction and species extinction occur naturally even without human intervention. This is true, but human activities increased the rate of extinction hundreds of times.

Not only species and their ecosystems, but also varieties and races within plant and animal species are being lost, thus reducing the diversity of genetic material. In domesticated plant and animal species thousands of traditional cultivars, breeds, varieties and races with great genetic diversity (variability) and dramatically increased adaptability for long-term survival have accumulated. The broad genetic base of these domesticated races enabled a significant proportion of their populations to survive under various environmental stresses, such as drought, high temperature, pests and disease, salinity, etc. and it is imperative to preserve their wild relatives as the base for continuing genetic selection and improvement.

In the past few decades, however, man has developed, through scientific breeding, high yielding crop and plant varieties, animal breeds and microbial strains, characterized by greater genetic uniformity and a narrower genetic base. At present, man relies on an increasingly limited number of species and varieties for his food, fibre, timber, medicines and other natural products, and this trend is not likely to be reversed in the near future. At the same time traditional varieties were abandoned (causing their permanent loss) in favour of new ones and the chances of obtaining their wild relatives as potential breeding material is increasingly limited by the loss and degradation of their habitat.

The concentration of genetic strains has continued to such an extent that now almost every coffee plant in Brazil descends from a single plant, the entire U.S. soybean industry is derived from 6 plants, all from one site in Asia, and all rubber trees growing outside America descend from a single collection of seeds.

Although the new plant breeds increased productivity dramatically and brought great gains, they also created a number of problems. Recent experiences show that because of their narrow genetic base they are:

- ill-fitted for the needs of small producers with low management inputs;
- vulnerable to adverse conditions and to pests and disease;
- liable to change genetically, losing the specific qualities maximized by breeding;
- too narrowly based genetically for further breeding.

If the valuable gene pools by which this dangerous situation could be corrected continue to disappear, the loss could be irreparable.

The disappearance of traditional animal breeds is advancing at an alarming rate as well, mainly because of the indiscriminate crossing of local breeds with exotics with

a high productivity, and the technical ease with which artificial insemination can be applied.

Microorganisms present a special case. Their presence and activity is essential to the health and the functioning of ecosystems and the whole environment through, among other factors, mineralization and cycling of important elements, photosynthesis, fertility of soil, pest and vector control and detoxification of pollutants. They also play a significant role in bioproductivity, either directly through the synthesis of food, feed, medicines and chemicals, or indirectly through making nutrients available for other primary producers. Although specific microbial strains are not likely to become extinct except under extremely harsh conditions, retrieval of such strains from natural ecosystems is technically almost impossible; the only way to make valuable strains available for exploitation is by their conservation in culture collections, which is relatively simple and inexpensive.

The case for conservation of biological diversity on scientific as well as economic grounds has now been well-established. It is reinforced by growing awareness of the scientific, ethical, cultural, psychological and recreational values attached to the conservation of species, races and varieties within species, as well as ecosystems as a whole, in all parts of the world. The emerging awareness of the need for urgent positive action to conserve and develop the world's biological diversity in terms of genetic resources as man's chief insurance against their destruction has resulted in a number of efforts. But the magnitude of the problem is still far from being fully appreciated by decision-makers and supported by public opinion; all too often only lip service is paid to conservation requirements in development projects, and many of the nations possessing a rich biological diversity have insufficient capacity to manage these living resources.

National efforts for conservation are still ill-organized, and few countries have undertaken the preparation of a national conservation strategy or guidelines to meet conservation requirements; conservation programmes including planning, training, education, research and cooperation on national and international levels are lacking. Assistance and guidance available to developing countries are absent, or have been modest. Most developing countries do not have enough knowledge, and ecosystem conservation in national development policies and programs appear to be neither practiced nor adopted. Policy makers and the general public for whom policy is made must realize the size and urgency of the threat as well as the link between conservation and sustainable development. This may require reforms of tax and tenure systems and changes in trade patterns.

A North-South and South-South collective harmonized action for the conservation and sound management of earth's biological diversity is needed. Everybody bears some responsibility for over-exploitation and degradation of biological diversity. Although two-thirds of all species occur in the tropics (i.e. the developing world) it is the developed nations that possess the technological expertise to exploit the genetic resources of species; a

situation which raises several important issues important to North-South relations, and which highlights the interdependency of these relations. For example, possession of individual species may be limited to one nation, while significant benefits from the use of this species may accrue to all nations. Also, mismanagement of important ecosystems belonging to one country may cause severe damage to other nations. Deforestation in Nepal, for example, has caused great damage in India and Bangladesh.

Thus, nations possessing biological diversity have a duty to safeguard their species on behalf of the international community; the community at large has a duty to enable these nations by providing whatever assistance is required in terms of funds, skills, etc. This justifies the need to develop agreements that satisfy the "rights of possession" of those who have the resources and the "rights of access" to needy ones.

There is however a cost element in conservation of natural resources and their natural ecosystems, and of course a benefit depending on the utility of the genetic resources. Within the available financial resources and to match costs and benefits, indiscriminate conservation of all genotypes would be prohibitively expensive, technically impossible and not fully utilizable. The main issues requiring attention in the national and international efforts in this area are therefore:

1. Conservation of *samples* of selected ecosystems as a whole as reservoirs of species diversity - many of which remain to be discovered - and development of appropriate management plans and detailed inventories;
2. Establishment of mechanisms of generating information on less known and under-exploited genetic resources, and development of criteria for selection of those to be conserved. Information is needed on their geographical distribution, modes of reproduction, breeding potential and diversity, as well as conservation methodology;
3. Continuous updating and review of criteria for conservation priorities. Genetic diversity is a dynamic state, and a species with no known potential may move to one with a broad potential;
4. Gearing genetic resources conservation with rational utilization, as the ultimate objective of conservation is the deployment of the preserved genetic material for sustainable development;
5. Assisting developing countries to improve their own traditional varieties into more productive varieties that can perform better under the prevailing conditions; thus the value of a given genetic resource - be it plant, animal or microorganism - would not be estimated only by its role in intensive production systems but also in sustainable production systems;
6. Improving accessibility to conserved genetic resources.

A number of national and international efforts are already being tried but their combined activities are tiny in the face of the large needs. Less than 4 % of the total land area of the Earth is managed for conservation, and these areas are unevenly distributed and often poorly pro-

tected. This area is quite insufficient, particularly as regards the tropical forest ecosystems, to ensure adequate maintenance of biological diversity. In addition, local people are rarely associated with the planning and management of protected areas, and under mounting short-term economic and social pressures, may use these areas for incompatible purposes such as poaching, unmanaged grazing or woodcutting. The need for integration of conservation and rural development and for local understanding of that need calls for new conservation methods and for the establishment of non-conventional protected areas which are of direct benefit to the local people.

There is an urgent need for increased support to developing countries by providing them with specialized expertise and training for conservation and increasing the awareness of decision-makers and the general public. Governments also need assistance to enable them to become parties to conservation conventions and to fulfill their obligations under such conventions.

As a positive response to the World Conservation Strategy, which reaffirmed living resource conservation and its direct linkage to sustainable development, countries have to embark on the formulation, adoption and implementation of comprehensive National Conservation Strategies and thus to integrate conservation with their socio-economic development plans and programs to ensure that development is sustainable. The National Conservation Strategy process involves the strategic planning of resource use in a wide variety of sectors. World assessment of renewable natural resources should continue on a systematic basis with a phased approach to resource monitoring and data management.

Many international organizations, including UNEP, IBPGR, FAO, UNESCO and IUCN have a history of co-operation in the area of natural resources conservation. They were instrumental in implementing the proposals recommended by the World Conservation Strategy and by a number of relevant expert group consultations and meetings.

One major regional event in this area took place in 1985 at the initiative of UNEP. Recognizing the fact that conservation of genetic resources is an integrated part of sustained management, the African Ministers' Conference on the Environment - which held its first meeting in Cairo in 1985 - decided to establish or strengthen an African Network for Genetic Resources Conservation and Management as one of the eight technical networks that will be established in the region. Another decision which bears relevance to genetic resources is the implementation of 150 village pilot projects and 30 pilot semi-arid stock raising zones aimed at self-sufficiency in food and energy, using local expertise and local genetic resources.

The Network's objective is:

1. To promote the scientific and technical capabilities of the African region by forging links between national scientific research and technological development institutions;
2. To promote inter-country co-operation for conservation and management of genetic resources;

3. To assist countries to integrate conservation with optimum resource utilization for improving agriculture, industry, health and environment in a sustainable way.

The establishment and development of the network would provide answers to at least the basic needs of every country, such as the availability of genetic resources, source locations, source potential, etc. However, it should be emphasized that development and/or strengthening of National Conservation Programmes should precede - or proceed concurrently with - the development of the regional network which should build upon presently existing activities and responsibilities of various national and international agencies in relevant areas to make for a greater degree of co-operation and complementary aid to avoid unnecessary duplication and overlapping.

Initiation of the implementation of a network would entail the following:

1. Identification of national experts and institutions active in genetic resource conservation, management and utilization;
2. Identification of NGO's, networks, associations, panels, committee's, etc. that can help in the implementation of the network;
3. Survey of existing national/regional programmes and activities of genetic resources;
4. Visits to selected promising institutions reported to be most appropriate to linkage via networking and meeting with national experts, professionals, policy and decision makers to make an assessment, taking into account the available natural, financial and manpower resources; equipment, adequacy of communications, willingness to collaborate; problems to be alleviated; legal, economic, political and social issues which may result in non-technical obstacles; etc.
5. Identification of institutes and organizations located in developed countries that are able and willing to co-operate with the network;
6. Identification of UN-organizations and relevant existing or planned networks and expert panels, and examining ways and means of possible cooperation with the network;
7. Setting up of a policy/scientific advisory council (to develop strategies for the network establishment and operation) and operating committees (for the implementation of the council decisions) with one co-ordinating unit in each country;
8. Discussion of the council plans and strategies with scientists, professionals and decision-makers from African countries and internationally prominent experts and representatives of UN organizations, NGO's and potential donors to adopt strategies and priorities and to ensure effective co-ordination;
9. Preparation of packages of activities to implement the adopted strategies and priorities;
10. Approaching potential donors (including UN agencies) for financial support of the network. This would be in addition to the technical and scientific expertise and in cash/kind contribution of member states;
11. Adjusting new technologies to the range of prevalent

farming conditions within various ecosystems.

A national member of this network would ideally be a central institution with access to one or more of the nature reserves, biosphere reserves, germplasm banks, or biological reference collections. This may not be easy at the initial stage because nature reserves may belong to different government departments ranging from forestry to tourism; germplasm banks often belong to ministries of agriculture; reference collections may belong to various natural history museums, etc.

A preparatory phase may need to precede the full establishment of this network. In this phase, countries would be encouraged to establish national commissions, or central government bodies, for the conservation of genetic resources. Such commissions or bodies would be ideal members of this network.

CONSTRAINTS IN GENETIC RESOURCES CONSERVATION

DIVERSITY: ITS IMPORTANCE TO WILD SPECIES

R. Malpas

Worldwide some 25,000 plant species and more than 1000 animal species are presently thought to be threatened with extinction. These figures, however, are underestimates since they do not take into account the extinction of small animal species, e.g. insects, which are lost when their habitats are destroyed. If we do try to take these losses into account, estimates are that 500,000-1,000,000 species will be lost by the end of the century.

The most serious threat to the survival of species and therefore to genetic diversity is the destruction and degradation of natural habitat by man, e.g. the clearance of vast tracts of tropical rain forest is resulting in present day mass extinction of species. Other human interference such as wetland drainage, expansion of human settlements and expanding agriculture are all contributing to this destruction of genetic diversity. Exploitation of wild species, for example for food or commercial trade, is also posing a serious threat to diversity. Modern technological advances, if anything, have increased our dependence on wild species, e.g. wild species represent a source of new crop varieties which are capable of producing high yields, or withstanding harsh conditions and disease. They also represent a source of new medicines for the treatment of human diseases. There is every reason to believe that our dependence on wild species will in fact *increase* in the years to come, and it is therefore a matter of clear common sense that we should make every effort to preserve as large a bank of genetic diversity as possible, not only to support current scientific advances but also as a security for the future.

Even species which seem of little or no value to mankind today, may be of critical use in the future, and the important point here is that once such species are lost, there is no hope of ever retrieving them. They have taken more than a million years to evolve from even their closest relatives.

But the problem is more complex than this. Species are a crucial element in natural ecosystems, and loss or disturbances of these ecosystems as well as loss of these elements, have far-reaching consequences. So loss of species is therefore of importance to a human community for many other reasons, such as for the management of water catchments and the prevention of soil erosion.

One final point is that the loss of genetic diversity may have important consequences on the species themselves. Genetic differences within a species allow the species to adapt to climatic changes, disease outbreaks and many other environmental factors. Any reduction in that diversity, for example in the endangered mountain gorillas in Ruanda (of which the population has been reduced to 120-200 animals) obviously has very serious conse-

quences to that species; this species is very susceptible to certain diseases or other factors which could lead to extinction.

The World Conservation Strategy which was published by IUCN, UNEP and WWF in 1980 phases the preservation of genetic diversity along with the maintenance of essential ecological processes and sustainable utilization of species as one of the three main goals of conservation. A large part of IUCN's worldwide conservation efforts is focused on this aspect and I would like to mention the work of the species survival commission and its many specialist groups which are working to prevent species extinction by developing an understanding of the requirements of the individual species, and by developing specific field conservation activities. On the assumption that actions to prevent extinction of species can only be based on up to date and accurate information, IUCN established a conservation monitoring centre in 1983, with the responsibility for establishing a comprehensive computer database on the status of plant and animal species around the world, and for making this information available in a clear and simple form to decision makers.

At the regional level, the IUCN Eastern Africa Regional Office focuses on practical field activities, and on conserving particular habitats and their constituent species, e.g. our work in the Eastern Usambara mountains in Tanzania, an area with unique species diversity and endemism. In this area we just completed a study which aims to draw up a conservation plan for the forests. The main focus of this study has been to understand the species composition of the forest in terms of its trees, other plants and animals and to establish the individual requirements of the various species. From this understanding, the forest management plan is being compiled which hopefully will ensure the long-term survival of the full diversity of forest fauna and flora. As a follow-up to this management plan, we are now launching a project in the villages surrounding the forest, which will focus on improvement of agricultural practices and the establishment of village woodlots, both activities aimed at relieving pressure on the natural forests.

Our projects in the East Usambaras perhaps illustrate best what we consider as the two main ways of approaching the conservation of natural diversity at the national level.

First, we believe that a research and inventory effort is needed which will identify key genetic resources and provide a proper understanding of the natural areas to which they belong.

Second, we feel there is a need to implement practical projects in the field which will ensure that the representative natural areas and their constituent species are preserved. And in keeping with the latest conservation thinking, we believe that this project should not aim at the strict protection of habitats by excluding all human use, but that it should provide use of resources by the local

communities. These two approaches should perhaps ideally be launched under a National Genetic Resources Conservation Strategy, which in turn would form one element of the broader National Conservation Strategy.

To conclude, I would like to say that IUCN fully supports the goals of this workshop. We very much hope that the structure for launching a national genetic resources strategy will emerge in the next two days, with companion plans for carrying out the national inventory of genetic resources and the representative habitats through establishing a database, and launching field activities to conserve these resources. I would like to say that IUCN stands ready to assist in all of these efforts in every way we can.

DIVERSITY, ITS IMPORTANCE TO CROPS

A.F. Attere

An understanding of the nature and extent of crop plant diversity is fundamental to plant genetic resources. Without this we would be unable to collect, conserve or utilize satisfactorily the vast array of diversity which is found in the majority of crop plants and their wild relatives (Ford Lloyd & Jackson 1986).

Crop plants have evolved from wild species under the influence of humans. Diversity is a result of crop plant evolution under domestication since the origin of agriculture to modern times.

Domestication of plants was a major event in man's cultural evolution. It is an evolutionary process operating under the influence of human activities. This process of domestication has resulted in a number of phenotypic changes, as well as in reproductive biology. Plants lost the ability to survive as wild plants through mutations which enable man to harvest plants more easily, such as the non-brittle rachis mutation in cereals and the loss of dehiscence in the pulses. Crops often show gigantism, especially in parts of plants selected by man such as seeds and fruits.

Crop plants are subjected to the rigours of both natural and artificial selection pressures. Wild plants must be adapted to the environment in which they grow, and plants which diverge significantly may be selected against. In many ways cultivated plants have been released from these selection pressures, and great diversity, particularly morphological diversity, has accumulated in many crops.

During domestication crop plants were brought into contact with many different wild plants, with which they hybridized and exchanged genes, thus increasing the physiological adaptation of the plants. Other features are the suppression of defensive mechanisms, the reduction of sexual fertility in vegetatively propagated crops, and change from the perennial to the annual habit. A change in reproductive biology from outbreeding to inbreeding has enabled crops to exploit fully their new man-made habitats. Several morphological features are associated with this change. Reproductive changes in finger millet have been documented (Ganeshiah & Uma Shaanker 1982) including synchrony of flowering and increase in gynoeceum volume.

The pattern of genetic diversity seen in crop plants results from the interaction of gene mutation and migration, recombination, selection and genetic drift (Ford Lloyd & Jackson 1986). Migration can increase variation in populations by adding allied genetic material. During their wandering humans have taken their crops with them to new sites and geographical variation has been increased through adaptation to different environmental conditions. Hybridization with allied species not found in the original region of domestication has often occurred with stabilization of hybrids through polyploidization.

Harlan (1966) considered that the evolution of crop plants progresses primarily on a differentiation-hybridization cyclic system.

Vasilov was the first to focus attention on the diversity to be found in crop plants and to the fact that it was concentrated in "areas of diversity", centres of origin for many crops. He investigated the distribution of the major crop plants and determined areas where there were concentrations of botanical varieties, using detailed studies of their morphology, cytology, genetics and their resistance to pests and diseases and adaptations to different climatic conditions. Eight of these centres of diversity were identified, and these centres have been the reservoirs from which plant breeders have collected valuable materials for their work. Recognizing some gaps in this classification Harlan (1971) developed the notion of centres and non-centres, suggesting that agriculture began independently in three areas, each one associated with a large and diffuse non-centre. Recently Hawkes (1983) proposed an alternative scheme in which he distinguishes nuclear centres of agricultural origins from the regions of diversity which developed later, when farming had spread out from the nuclear centres in which it had originated.

Primitive cultivation which persisted until very recently in these parts of the world permitted contact among already variable races of crops, and gene flow between these and their related wild species. These were also modified by the local environment in which they were grown, and by the cultural methods adopted by farmers. Thus emerged distinctive local races which we call land races or primitive cultivars, adapted to numerous agroecological situations.

A situation now exists in the world which requires plant breeders and other agricultural scientists to identify efforts towards a solution of the threatening population explosion and the need to alleviate hunger and malnutrition. This requires new genetic inputs to solve the problems associated with expanded production and to improve quality under harsh environmental conditions.

Diverse gene pools are the foundation of an effective crop improvement programme. Not only do genetic resources provide the necessary building blocks for further varietal improvement, but genetic diversity is essential if high levels of productivity are to be sustained. They are a source of inherited diversity and in the past breeders and agronomists found valuable characters which have increased yields, conferred resistance to pests and diseases, and have provided nutritional, aesthetic and technical qualities. They have also made it possible to extend the adaptation of crops to adverse agro-edaphic conditions.

As modern agriculture progressed, more productive varieties and new crops were introduced into production, similar varieties tend to occupy vast areas and uniformity has the hazard of potential vulnerability to diseases. The best known example of genetic vulnerability due to varietal uniformity was the maize disaster in 1970 in the U.S.A., due to an epidemic of southern corn leaf blight on maize hybrids with identical cytoplasm for male sterility, designated Texas (T). In recent decades it was recog-

nized that the areas which had seemed to be inexhaustible sources of breeding material were rapidly being changed under a wave of new varieties with high yield potentials and under conditions of modern agriculture. These genetic reservoirs were thus doomed to extinction.

A world wide concern over the loss of valuable genetic diversity has been widely recognized in the past 25 years. Several international institutions, such as the International Board for Plant Genetic Resources (IBPGR), as well as regional and national institutions are now specialized in collecting and conserving this diversity, which is the basis for sustained and continuous breeding programmes vital for the survival of mankind.

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MAINTENANCE OF DIVERSITY IN EX-SITU CONSERVATION

Dr. A. Abou-Zeid

Concern over the loss of valuable sources of plant germplasm has been widely recognized. Many institutions around the world hold collections of crop germplasm and germplasm of wild crop relatives.

During the last twenty years many collection missions have been made in Kenya. Most of this collected germplasm was lost because of the absence of proper conservation facilities and/or poor data documentation. Fortunately, some of these collections were duplicated to other genebanks abroad and can be brought back to Kenya.

In most cases seeds are the right crop planting material because they are easy and cheap to conserve. In respect of the physiology of seed conservation, two seed groups can be classified. "Orthodox" seeds can be dried and conserved for long periods at low storage temperatures and "recalcitrant" seeds which will be damaged if dried or exposed to low temperatures.

There are three types of seed storage:

1. Short term storage indicates a period up to 2 years in controlled or uncontrolled storage conditions.
2. Medium term indicates a period from 2 to 10 years at a temperature of 0-5 degrees centigrade
3. Long term indicates a period of more than 10 years at temperatures between -10 and -20 degrees centigrade.

It is necessary to dry seeds to a moisture content of 10-4 % and to pack them in sealed containers before storage, particularly for medium and long-term conservation. Vegetatively propagated crops as well as species with recalcitrant seeds are normally preserved in tissue culture or in field collections.

In Kenya about 52,000 germplasm collections are being conserved in cold stores at various breeding and research stations:

Cereals 25,000; pulses 5,000; cash crops 6,900; root and timber 1,000; pasture species 11,000; other crops 3,100 accessions.

Thirteen cold stores for the maintenance of working collections exist at different stations in Kenya, with a total storage capacity of 773 square meters.

The National Crop Plant Genetic Resources Centre in Kenya (National Genebank, Muguga) has developed a standard documentation system for use in Genebank activities, and will soon accommodate facilities for data computerization and for long-term seed conservation with a storage capacity of 150 square meters at a temperature of -18° C.

All efforts should be made to identify previously collected germplasm, and to eliminate duplicates. Special attention should be given to make the optimum use of available documentation facilities and know-how. An information flow between Research Stations and the Genebank should be guaranteed. Systematic germplasm collections must be carried out in order to save endangered crop plant genetic resources and their wild relatives.

DOCUMENTATION AND THE AIMS OF CONSERVATION

Dr. A.R.D. Taylor

Our aim is always to maximize genetic diversity. This explains all the activities we are discussing: running gene banks, establishing or maintaining Reserves or Parks, talking about in-situ or ex-situ conservation. Broadly speaking, crops are best conserved through ex-situ methods, while wild species must be conserved in-situ through necessity. Forest species bridge these categories and both these techniques are used. Documentation is defined as the collection of information about species - their location and diversity, whether talking about wild populations or the population in a gene bank. Ultimately the whole purpose behind documentation is to guide conservation action; the science (some would say the art) of documentation is far better developed for crops than it is for wild species.

My task is to outline some common problems and suggested solutions for documentation applied to conservation.

Taking a holistic view, every plant species should be conserved and thoroughly documented, and in principle in-situ and ex-situ methods apply equally to all plants. We of course compromise in this because some plants are more important to us than others - we eat some and burn others, while attempting to eradicate those classed as 'weeds'. We, however, cannot afford this attitude if we are honest about conservation.

Reflecting our differences in interest in plants we can eat and those we can only look at, there have arisen two rather independent systems of global documentation, one co-ordinated by the International Union for the Conservation of Nature and the other by the International Board for Plant Genetic Resources. Neither are United Nations bodies, but collaborate closely with the UN Environment Programme and the UN Food and Agriculture Organization respectively. In fact the IUCN and the IBPGR collaborate on their common interests - wild plants which are crop relatives. Their documentation systems are very different in operation. The IUCN operates four database units: threatened plants, species conservation, protected areas and wildlife trade monitoring units. The IBPGR, however, has a decentralized system of databases specializing in each major crop at each of the co-operating International Agricultural Research Centres (IARC's) around the world, as well as the participating national gene banks. The main difference between their approaches is a result of IUCN's interest in in-situ conservation and IBPGR's emphasis on ex-situ conservation.

How does one make sense of all this at a national level? In the national interest, plant resources should be conserved for utilization and the information systems in use should serve conservation efficiently whether being used for crops, trees or medicinal plants. Every gene bank in the world seems to have a different system of recording data about its accessions; a process of documentation evolution is still apparent, similarly, in that every national park or reserve has species inventories taken in dif-

ferent ways. How then can a decision be taken about whether ex-situ conservation should be used to support a deteriorating in-situ strategy? One approach which should be tried is to identify key species in each conserved community and use these as 'marker' or 'indicator' species for the state of genetic diversity in each area. Agreed phenotypic markers must be developed for the assessment of diversity (see Simpson & Withers 1986) and used in documentation of wild communities as well as for the contents of the gene banks. Another approach which has been used quite widely already has been to computerise herbarium records for a region and to use this to map species distribution over time. There is no reason, however, why morphotypic characters in duplicates of herbarium specimens should not help in diversity assessment.

The reverse situation is of course the assessment of whether ex-situ conservation collections held in seed banks possess sufficient genetic diversity compared to the parent growing population from which the collection was abstracted. This can be done again using a combination of biochemical and morphotype descriptors and it would be desirable to standardise both the descriptors and the method of documenting these. The situation for crops is quite advanced: the IBPGR publishes recommendations for most stored crops, and these are regularly updated. For wild species, including crop relatives and trees, much remains to be done.

Within Kenya, there are already several documentation systems in use for the various seed stores, some barely adequate to record accessions, others of an incredible complexity. The prime consideration should be to ensure that all accessions of germplasm are documented to a standard enabling sound genetic diversity assessment; with this in mind it is recommended that IBPGR's collection forms be used for field collections - if properly completed they enable decisions to be taken on whether the sample collected was sufficiently diverse. The IBPGR's standards for storage documentation should also be used, for similar reasons. This recommendation applies to *all* plant categories. Genetic diversity indexing should also be applied to gene bank accessions, preferably through isozyme analysis, but also using conventional morphotypic descriptors. As a guide, there are four categories of descriptor recommended by the IBPGR for gene banks: Passport information, Characterisation data, Preliminary evaluation data and Full evaluation data (see Ford-Lloyd & Jackson 1986).

For many crops stored in Kenya's seed storage facilities, the above data is available for internationally recognized breeders lines. The priority should be to evaluate locally bred lines and landraces to the same standard and implement suitable documentation.

Finally, at this stage in Kenya's development, it would be wise to consider a unified system of computer documentation so that records maintained at the various gene banks and seed stores around the country are held to the same high standard, and to enable effective information exchange with the international community.

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Question (Dr. Oggema): Why do you feel that Kenya is the country where the IBPGR system could be adopted? You are aware that we have inherited a lot of systems from our donors, some of which are quite good.

Answer: The emphasis is on unification of the system as we start computerization.

PRESENT ACTIVITIES IN BREEDING STATIONS AND RESEARCH INSTITUTES

KENYA FORESTRY RESEARCH INSTITUTE AND KENYA FORESTRY SEED CENTRE

E. Murugi Kariuki

The Kenya Forestry Research Institute (KEFRI) is responsible for improvement and conservation of forest in Kenya, in collaboration with the Forest Department. With the assistance of the Federal Republic of Germany a Forestry Seed Centre was established. This became operational in November 1986. The Seed Centre collects, processes, stores and distributes seeds. It has five collection centres representing the different regions of the country. Its cold storage facilities are divided in three rooms, two at +3 degrees centigrade and one at -18 degrees.

The research being conducted in the Seed Centre has an emphasis on storage trials, especially of indigenous species, so as to determine the optimum method for storing these seeds. Orthodox seeds are those that can be stored for medium (2-10 years) or long (>10 years) periods at low moisture contents in sealed containers at 3-5 degrees or -18 degrees (Willan 1985). Recalcitrant seeds are those that cannot withstand appreciable drying without injury (Willan 1985). Conservation of species with recalcitrant seeds in-situ is therefore of great importance.

In our collection centres we have a specific form which collectors are supposed to fill in, with details on each species, where it has been collected, and which species it is associated with. In future, all this information will be compiled and documented.

For indigenous species there is a distinct lack of information on their storage requirements and best provenance areas. KEFRI is really starting from scratch to find out these requirements and to collect seeds; collectors are now required to collect voucher herbarium specimens at the same time when they collect the seed, to ascertain the name of the species. We are trying to improve on seed quality, as well as on the number of species collected in Kenya.

There is 2.150.000 ha of indigenous forest, 50.000 ha of nature resources, 22.000 ha of indigenous hard and soft wood plantations and 150.000 ha of exotic species plantations- e.g. pine, cypress, eucalypts, acacia. There are several stands of clonal material and provenances, especially of Central American pines (Odera 1984). In the indigenous forests there is restricted selective felling, geared to promote diversity and quality of the residual crop.

At KEFRI, the different divisions collaborate with one another. The Seed Centre works especially closely with the Tree Breeding Division, on breeding and selection of both exotic and indigenous species.

The genetic resources in Kenya could be better managed and utilized by:

1. Integration of plant germplasm conservation in the National Land use agenda.
2. Introducing a legal requirement for producing Environmental Impact Assessment Statements.
3. Placing a mandatory ban on further alienation of forest land for agriculture, by increasing agricultural productivity in existing areas by adoption of modern farming methods and the green revolution packages.
4. Striking a realistic balance between the conservation and production functions of our forests.
5. Training of more tree breeding staff.

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NATIONAL PLANT BREEDING STATION, NJORO

Dr. M.W. Oggema

The National Plant Breeding Station is one of the oldest research stations in Kenya, started in 1908. In 1926 the Station became the only breeding station in Kenya, and it was handling all crops : coffee, horticultural crops, cereal crops, pasture crops, oil seed crops and all others. This has now changed, and at the moment we are dealing with wheat, barley, all oil seed crops and some triticums. Because of inadequate storage facilities, NPB station can only store germplasm on a short term basis, that is about two years. So after every two years we rejuvenate our material.

We also keep fungal spores in vials in liquid nitrogen or in refrigerators on both long and short term basis. These are classified according to susceptible or resistant reaction on known plant host genes. The collections we have are mainly for rust species and sclerosis.

The Station receives much germplasm from IBPGR groups: CIMMYT, CIAT and ICRISAT. It also receives genetic material through personal contacts and exchange from institutions in foreign countries. The process of importation and exportation is a continuous one. The station introduces, breeds and selects germplasm to improve productivity; we also collect land varieties of species such as castor and sesame from different agro-ecological zones.

The station is very well known all over the world for its breeding of wheat, barley and sunflower; in crops such as rapeseed, triticum, oats and linseed we concentrate on selection from introductions, and then introduce them to the farmers.

We rarely use wild species in our hybridization programs, but our aim is to use them in the future particularly for species such as barley and castor which both have wild relatives in this country.

I would like to suggest that our staff is given more training, as most of them are quite young and lack both experience and training.

I also wish to state that there should be a central gene bank for non-commercial crop species, that is undomesticated crops.

Question (Miss Murugi): How is seed storage effected?

Answer: We store for 2 years, and then grow the same seed lot for seed production to try and keep the gene pool the same.

Question (Dr. Lamprey): Where does the wild barley grow? Is the habitat secure, in case you need to collect more?

Answer: Wild barley occurs on high ground in the Mau area.

Comment (Dr. Lamprey): Security of wild populations through habitat conservation is vital.

Question (Prof. Owino): Are wheat and barley germplasm kept elsewhere as well?

Answer: Yes, in Maryland (USA) and the Netherlands.

DRYLAND FARMING RESEARCH STATION, KATUMANI

P. Kusewa

Katumani is one of the newest research stations in Kenya, started in 1956. But for various activities it is one of the most important in the country. About two years ago, through the assistance of IBPGR and GTZ, we were provided with cold storage facilities, and since then we have been able to initiate and programme our germplasm collection. As a dryland farming research station, we are mainly concerned with food crops, pasture and pasture legume crops, and recently we are getting involved with agroforestry for dryland areas.

Major areas for plant genetic resources at Katumani are collection, maintenance, conservation, characterisation, evaluation, documentation and utilization of the germplasm. The food/pasture species involved are cereals, legumes, root crops and oil crops found in the semi-arid areas of Kenya. In addition to these local materials we receive a lot of germplasm from other countries and organizations such as ICRISAT, CIAT and CIMMYT.

Among our cereal collections there are maize, sorghum, millet, finger-millet, proso millet and foxtail millet. Interesting legumes are cowpeas, pigeon peas, common beans, mung beans, chickpea, black gram, lablab bean, soybean, ground nuts and velvet bean. Among our oil crops there is some jojoba, safflower and castor. As root crops we have sweet potatoes and cassava. As pasture species we have collections of rose grass, napier, gene, magarihari, star grass and sea grass.

As legume fodder crops we have bugina, stylosanthes and a few acacias.

Collection

The objectives of our collection programme is to increase variability, which is a key factor in genetic improvement. We have organized collection missions together with other international research centres such as ICRISAT. We collect in various parts of Kenya, to collect seed and vegetative parts, according to the way species are propagated.

At present our collections number about 10.000, including a good number of exotic material: like pigeon pea from ICRISAT and cowpea from Nigeria.

We recently wrote up a program which is now being discussed by NCST, to collect and utilize wild relatives of our crops, such as cow peas and pigeon peas.

Maintenance

Germplasm is maintained both in-situ and ex-situ. The ex-situ material is stored in the cold room, while in-situ material is in a living collection in the field. We have irrigation facilities at Katumani to maintain vegetatively propagated material like cassava, sweet potato and grasses. Cold storage is at 4° C, after seed has been sundried to a moisture content of 4-11 %.

Characterization

After collecting and maintaining, we have to characterize our material so that we know what we have. The various records are based on IBPGR descriptors of respective crops. At present 1.200 accessions of finger millet, about 900 accessions of pearl millet, 150 accessions of foxtail millet and 2 accessions of barnyard millet are being characterized. This is carried out by growing accessions along checked cultivars of matching maturity, and recording characteristics. In collaboration with ICRISAT a set of 500 accessions of pigeon pea is being characterized at two locations, at Katumani (Maruba farm) and Kiboko. This has resulted in identification of a number of genotypes with desirable traits, which will be utilized in the pigeon pea improvement programme.

Documentation

Relevant data are taken from the different accessions we have collected. The data which is generated during evaluation is compiled and distributed to the interested scientists, and breeders, with copies being kept at the centre. Eventually we hope to have these data on computer for more easy access.

Since 1985 we have a Research Officer working on germplasm at Katumani, but we feel we need more than one person, both in the scientific and technical sector, to assist the Research Officer in all the different activities we are carrying out.

We feel that the establishment of a National Gene Bank in Kenya would play an important role in coordinating all the different activities in germplasm collection and conservation in Kenya.

Question (Mr. Ndegwa): How do you go about collecting and handling indigenous plants in addition to others?

Answer: By mapping the areas and timing the phenological stage to collect seed.

NATIONAL SUGAR RESEARCH CENTRE, KIBOS: STATUS OF SUGARCANE GERMPLASM CONSERVATION AND USE IN KENYA

M.O. Osoro

Introduction

Sugarcane production in Kenya developed out of the jaggery business initiated by the Asian community at the beginning of the century. Hence, before the establishment of a plantation white sugar factory in 1924, all sugarcane was for the production of jaggery. The germplasm for the initiation of the sugar industry was imported from India by the Indian settlers who had experience in the manufacture of jaggery.

From this small beginning sugarcane growing has grown to a major industry. The sugarcane crop now covers an area of over 95.000 ha (Muturi 1986). There are now seven major sugar factories. To cater for sugarcane improvement the government has set up research, supporting the sugarcane development programme.

Responsibilities of the National sugar research centre

The National Sugar research centre comes under the Kenya Agricultural Research Institute. The centre is responsible for the development of an overall programme of research in the sugarcane crop. Its broad objectives are:

1. To develop new high-yielding, disease- and pest-resistant and high quality varieties of sugarcane through a programme of selection and field testing, and to bulk and distribute selected material for planting.
2. To determine factors which limit sugarcane yields in various ecological zones.
3. To study pests and diseases of the sugarcane plant with a view of devising control measures against these.
4. To disseminate the information obtained from field trials to farmers and all others interested in the development of sugar in Kenya.

Production of superior-yielding hybrid canes has been achieved mainly by introducing varieties from other countries. Good commercial varieties are imported through the Plant Quarantine Station at Muguga. After vigorous closed and open quarantine at Muguga the canes are released to the National Sugar Research Centre for open quarantine observations and multiplication before they are subjected to agronomic, pathological and selection trials.

After the collapse of the East African Sugarcane breeding programme in 1977 no more material was received from Kibaha, Tanzania, so in 1982 the government established its own breeding program for Kenya. The breeding programme is based at the Coast Agricultural Research Centre, Mtwapa, where environmental conditions for flowering and seed setting are excellent (Jagathasan 1985). The progenies of the crosses are selected both in Coast Province and Western Kenya. Disease and pest screening is conducted at the National Sugar Research Centre at Kibos.

Sugar germplasm conservation

The Plant Quarantine Station at Muguga maintains a sugarcane clonal collection with 519 varieties (Sankaranarayanan et al. 1968). The majority of these varieties are introductions with only a few varieties which resulted from the former East African Community Sugar Breeding Programme. Of the 200 man-made sugarcane hybrids which are maintained at the world sugarcane collection at Can Point, USA and Coimbatore, India (Sankaranarayanan et al. 1968), 87 hybrids are maintained at Muguga. These hybrids are freely distributed to all who request them.

The National Sugar Research Centre at Kibos maintains a collection of 300 varieties. All the introduced varieties are duplicates of those at Muguga. Some collections are also maintained by the major sugar factories; and there is also a collection of genetic stocks at Mtwapa and Ramisi. These collections contain all elite genotypes used by breeders all over the world as parents in the breeding of new varieties.

Clonal maintenance of two to several years remain the basis at present but potential for maintenance as seed or tissue culture should be considered. The clones are replanted as the ratoons get old.

The germplasm exchange program

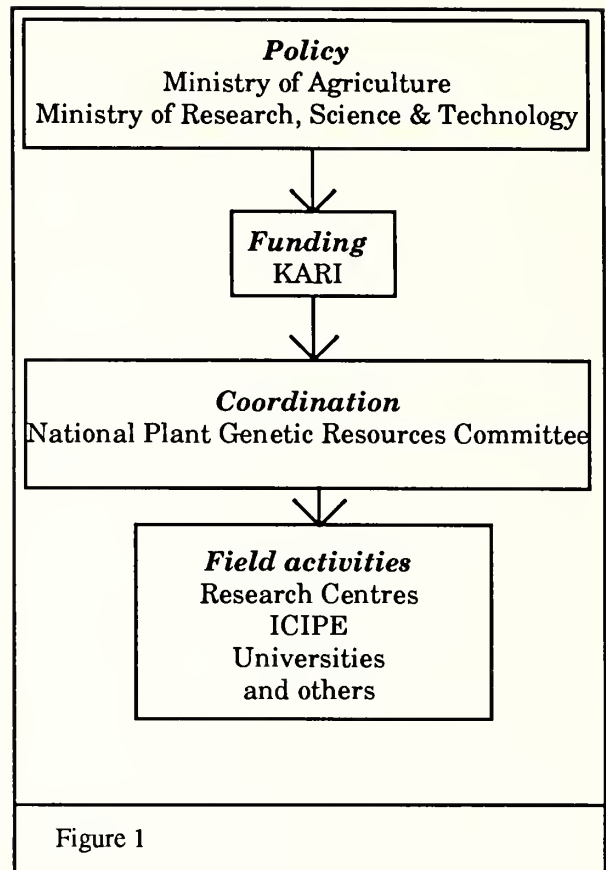
The Kenya programme of sugarcane exchange is coordinated by the Plant Quarantine Section, Muguga. In the past Kenya has imported vegetative material from India, USA, Taiwan, Australia, Mauritius, Brazil, the West Indies and Mexico. Kenya has exported vegetative material to Ethiopia, Somalia, Tanzania, Australia and Zimbabwe. Loss of viability of the vegetative material while in transit is often experienced.

Wild crop relatives in East Africa

The Kenya sugarcane breeding program is still in its infant stages. Hence, no efforts have been made to collect, maintain and evaluate wild species or wild relatives of sugarcane. However, of the sugarcane and related grasses *Saccharum edule* Hassk., *S. officinarum* L., *S. sinense* Roxb., *S. spontaneum* L., *Miscanthidium violaceum* (Schw.) Robyns, *M. erectum* (Steud.) Hubbard, *Miscanthus floridulus* (Labill.) Warb., *Naranga porphyrocoma* (Hense) Bor and *Sclerostya fusca* (Roxb.) A. Camus occurring wild in East Africa only *Miscanthidium violaceum* (from Uganda) and *Saccharum spontaneum* (from Kenya) have been collected (Price 1968).

Proposed management and organization of plant genetic resources

The nature of collecting, conserving and utilization of plant genetic resources requires national and international coordination. Management of national plant genetic resources in Kenya should be effected by setting up a Plant Genetic Resources Centre, as recommended earlier (Proceedings National Seminar on germplasm & Seed technology 1986). The centre would coordinate the network of national and regional research centres, institutions of higher learning and other agencies to collect,



introduce, maintain and catalogue and distribute all types of germplasm. Most of the research centres in Kenya are organized around crop commodities for which the Director of KARI is responsible. The research centres have specialist committees. For the proper management of plant genetic resources, it is suggested that commodity specialist centres are strengthened. These committees should comprise plant breeders, plant pathologists, entomologists, crop physiologists, etc. The responsibilities of the specialist committees in conjunction with the Plant Genetic Resource Centre should include:

1. to prepare reports indicating national progress in collecting, conserving and utilization for each crop of significance to Kenyan Agriculture.
2. to identify strengths and weaknesses, and to recommend actions to be taken.

KARI should provide leadership and funding of plant germplasm conservation and utilization. The Minister of Agriculture or the Ministry of Research, Science and Technology should be responsible for policy formulation.

Personnel requirements

Qualified scientists are needed to strengthen the plant breeding programmes, and these should be leaders in plant genetic conservation, evaluation and use. The sugarcane germplasm collection is hampered by the non-availability of qualified staff. A training programme for local staff on germplasm handling should be mounted.

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NATIONAL AGRICULTURE RESEARCH STATION, KITALE

D.K. Muthoka

The Station is responsible for keeping maize, forages and pasture, fodder shrubs, sorghum and rice germplasm. Germplasm is kept both in cold storage and in the field; the latter is true for fodder and pasture plant species; cold storage is used for maize (3.216 accessions), pasture, forages and fodder shrubs (10.325 accessions), sorghum (5.241 accessions) and rice (200 lines).

Maize

Maize was introduced in Kenya in 1494. Caribbean flint types of maize, still predominant in the East African Coastal strip, were introduced by Portuguese and Arab explorers and traders.

The big and sudden rise in the importance of maize followed the introduction after 1900 of a different type from South Africa. The most successful introductions to Kenya were Hickory King, (Natal) White horsetooth, Ladysmith white, Salisbury white, Champion (Potchefstroom) white pearl and Iowa silver mine. Hickory king had been introduced to Natal from the USA shortly before the Boer war. South Africa had also imported, or derived, the other stocks from the Southern USA, and they can mostly be classified as white southern dents. These have originally come from Mexico, and show particular affinities with the cylindrical dent race Tuxpeno.

The last distinct type of maize to arrive in Kenya prior to modern introductions was the high altitude race Cuzco from Peru.

The local yellow maize, still found in East Africa but now declining in use, is probably derived mainly from early introductions of Caribbean flint, and partly from later introductions via South Africa of yellow dents.

The many different types of famine-relief maize that have often been shipped in, seem to have left little contribution, perhaps because most of them were not suited to Kenyan climate and altitude.

We now have over 3.216 new maize introductions in cold storage. Some of these are being used by breeders in breeding varieties/hybrids with resistance to leaf blight (*Helminthosporium turcicum*), leaf rust (*Puccinia sorghi*) and *Puccinia polysora* and maize streak disease.

Pasture and fodder

Eastern Africa is recognized as the centre of origin of 8-10 of the most economically important tropical and sub-tropical pasture species, contributing 20-25 % of total sown pasture species. It is also a fact that East Africa's indigenous grasses are the most outstanding in yield and quality in the tropical and sub-tropical regions. Since 1951 rapid progress has been made in the forage collection and introduction of pasture grasses and legumes. The richness of grass species (594 species) in Kenya offered an excellent chance of selecting better varieties. Bogdan collected 4.661 entries during 1950-1973. The local collection of ecotypes comprises 1.369 grasses, 908 legumes and 40 shrubs. New introductions

include 974 grasses, 1,227 legumes and 143 shrubs.

Further collection and introduction was carried out by the FAO Trust Fund Forage Collection and Evaluation Project (TF KEN 29 NOR) which was based at Kitale during 1974-1982. The local collection comprises 2,067 grasses, 951 legumes and 254 shrubs. The introductions include 648 grasses, 1,115 legumes and 629 shrubs. The term fodder shrubs and herbs is used in a broad sense, including shrubs and broad-leaved herbs, including the less important legumes.

Further improvements were made by mass collections of further grass ecotypes, which can be partly attributed to the success achieved in the selection programmes of Rhodes grass and Nandi setaria.

Laborious efforts were made by Ibrahim and Muthoka to document the enormous amount of information collected by Bogdan. By relocating his collection on soil, vegetation, ecological and rainfall maps, very valuable and interesting information was extracted.

Imports and exports

Imports of germplasm come from international agricultural research centres such as CIMMYT, IBPGR, ICRI-SAT, CIAT and ILCA.

Germplasm is exported to many African and overseas countries.

Other functions

Plant breeding and selection is carried out at the station, especially on maize, forage plants, fodder legumes, fodder shrubs and pastures.

Constraints

The station is hampered in its task by:

1. lack of trained personnel
2. lack of training facilities
3. lack of storage
4. lack of facilities such as computers, seed driers, packing machines, etc.

Proposed future action by National Gene Bank

1. collection and exploration coordination
2. documentation of germplasm
3. manpower development and training
4. providing facilities

COFFEE RESEARCH FOUNDATION, RUIRU

J.B. Owuor

Coffee forms one of the leading commodities of international trade, and for Kenya it forms one of the major sources of foreign exchange.

Africa has potentially the largest area suitable for coffee production; unfortunately, the continent only accounts for 25 % of the world production of coffee. This could be improved vastly, if we would utilize our vast genetic resources to combat production problems: mainly diseases and pests, and the deterioration of soil fertility.

Contrary to what one would expect, the Coffee Research Foundation does not have a clear mandate to specify that it should take charge of the conservation of coffee genetic resources. This fact is not given the kind of importance which it deserves.

The current inventory of germplasm at our research station is basically arabica coffee. Of the many species of coffee that exist, only two are important: *Coffea arabica* and *Coffea canephora*, which is robusta coffee. Of our ca. 1,000 accessions, over 970 are of *Coffea arabica* and of these most are already exploited. So there is little room in which a plant breeder, faced with future problems, can move to find material to utilize.

It is not often realized that along with Ethiopia and Sudan, Kenya ought to be considered as a centre of origin of *Coffea arabica*. French workers have recently provided evidence that arabica coffee originated in parts of Nandi and Marsabit. Taking this into account, it seems rather a sorry state that we have not made any collection missions in these parts of the country, and that we do not have any material in our collections collected by Kenyans. The missions which have been here to collect were French, such as ORSTOM and FAO missions, and the material from Kenya we have is duplicate material from these missions.

So one of our proposals is that national collecting missions, where CRF collaborates with a national centre, should be undertaken immediately - because agricultural activity, including the growing of introduced coffee, is fast encroaching in these areas.

We also have proposals on how a National Plant Genetic Resource Centre should be set up, and what kind of functions would have to take our centre into account: increasing the genetic pool, ensuring the conservation of bank material, evaluation of bank material, to create an implementation and analysis unit, and to dispatch material and information to the centres as well as training.

AGRICULTURAL DEVELOPMENT CORPORATION

H. D'Souza

The Agricultural Development Corporation is one of the National Statutory Organizations. It is charged with the responsibility of managing state farms in the National interest. Over 30 ADC farms exist; they are located mainly at the coast, in the high altitude areas of Molo (over 2400 m) and at the medium altitudes (1800-2000 m) of Trans Nzoia.

The management of state farms also involves maintenance of perennial crop varieties which were inherited from the previous colonial owners of the farms; this is especially true for citrus. As part of our development strategies, large orchards have been established and fruits of temperate origin such as apples, apricots, pears, peaches and plums have been imported. Some varieties of these trees have not adapted very well but they have been preserved in small numbers, while the productive varieties are planted on a commercial scale.

It may be of interest to note that ADC is also actively involved in the multiplication of all potato varieties and cereal crops for commercial use. This is simply the maintenance of quality seed in the national interest.

Whereas many public or private institutions have the freedom to keep their plant collections, it is suggested that the National Research Centres should take the responsibility for collecting, identifying and maintaining the plant genetic materials that are best adapted to their climatic conditions. This should be done under the guidance of a central committee.

COASTAL AGRICULTURAL RESEARCH STATION

O.C. Njue

While the main station is situated at Mtwapa, there are sub-stations at Matuga, Msabaha, and Mpeketoni in Lamu. We deal with crop plants such as coconut, cashewnut, citrus, mango, sugarcane, pineapple and banana; minor crops are soya, simsim, guava and chiku. Cassava is an important crop on which much research is done. We also have some fodder crops, grasses and pasture legumes, on which we are cooperating closely with Kitale. As Dr. Osoro has mentioned, we do most of the flowering of sugarcane. We also undertake some breeding work and there are about 104 cultivars of sugarcane. Maize breeding is another of our activities, and quite good work is going on.

We also have cold storage facilities, in which we conserve plant germplasm of some legumes, such as cow-pea, pigeon pea, greengram and groundnut. These have to be put in the field at intervals, as we only have short- and medium-term cold storage.

We also cooperate closely with the National Horticultural Research Station at Thika on citrus, mango, banana, pawpaw and grape.

KENYA SEED COMPANY, KITALE

M. Ndambuki

While our headquarters are at Kitale, we have a number of branches handling various crops: maize is basically at Kitale, wheat and barley are at Nakuru, vegetable seed is handled at Nairobi and we have our processing plant there as well.

Our company started in 1956, mainly for sunflower seed production for bird feed in Europe. In 1958 the company took up pasture seed production for grasses developed by the then Grassland Research Station for dairy farmers. In 1963 we started on hybrid maize seed production, now our main activity, and later on wheat and barley. We now grow a lot of wheat and barley on contract for the breweries; recently the Ministry has approached us to bulk-grow soya beans. We already grow sorghum, soya, and vegetables for seeds.

I must say that the custodians for this basic material are the research stations, as they are the source of the elite lines which they pass over to the company for multiplication. At our Elgon Downs Farm at Endeless we do some maintenance in growing basic material, communicating with the breeders to keep the variety true to type. In this we work closely with the National Research Stations; in our control plots we ensure that the material we pass on to the farmers is the same as it was originally developed by the breeders. We also run some research mainly to solve seed production problems, and we also try to develop our own material, working from material from foreign seed companies.

We do have problems, such as the isolation we have to apply to keep lines of crops pure. This does give land problems; a lot of our seed, in maize especially, is grown on ADC farms.

We work closely with the inspection service, the National Seed Quality Control Services. We also fall under the International Seed Trade Association, as we also export some of our seed, so we have to meet their standards as well.

We are working more on the utilization of genetic resources than on conservation, but we do conserve our elite lines. We have a cold store, but not a very reliable one; our plans are to build another one for breeding material and one for storing basic material, as we intend to have at least 25 % carry-over stock, to meet adverse weather conditions.

TEA RESEARCH FOUNDATION OF KENYA

C.K. Njuguna

The foundations' main object is to promote research into, and to investigate all problems relating to tea and such other crops and systems of husbandry as are associated with tea throughout Kenya. One of our responsibilities is the improvement of the tea crop, both in yield and in quality.

Tea germplasm and maintenance

The foundation introduced tea planting material, both seeds and clones, from all parts of Kenya and from Uganda, Tanzania, Malawi, Zaire and Reunion. This tea is maintained at the Foundation's Timbilil Estate, Kericho.

Tea is an open-pollinated crop and in a field of seedling tea every plant in that field is different genetically from any other plant. This means that at the Foundation there are as many genetically different tea plants as there are seedlings, which at Timbilil Estate means tens of thousands. Tea plants are known to live for up to 100 or more years. The oldest plants on Timbilil Estate are about 30 years. As tea seed viability is short the tea germplasm has to be maintained in-situ.

In the late 1960s it was decided that any tea clone which was found to have low yield would be uprooted, and its area used for other experimental material. It was later realised that even low-yielding clones may be useful later in characters other than yield. It was therefore decided that all clones planted in the field would in future be maintained unless a clone failed to survive. Now over 2600 clones are maintained.

A museum of the major Kenyan tea clones has recently been established at the Foundation. To date 62 major and 12 minor clones have been included in the Museum; more will be added as they become available. Also the major tea seedling stocks, commonly known as jats, found in Kenya will be added to the Museum. To date 5 jats have been planted in the museum. Land will be available in the near future for further expansion.

Though there has not been a problem of land availability at the Foundation's Timbilil Estate to date, the Foundation would like to have a substation somewhere East of the Rift Valley where some of the major tea types can be duplicated for preservation. This would also give an opportunity to test planting material more widely.

Import and export of tea germplasm

Before the break-up of the East African Community there was no problem of getting tea planting material from either Uganda or Tanzania. Now it may be difficult to get planting material from these countries. However, Kenya has most of the tea types found in these countries.

If the need arises, the Foundation can import material from other African countries through the Plant Quarantine Station at Muguga. This Station is not well-g geared to grow tea plants but with cooperation from the Foundation it can be done. No live tea material is allowed to be imported from outside Africa.

The Foundation usually does not export tea germplasm apart from small amounts of tea seeds or cuttings for research purposes to other cooperating institutions. The export of tea planting material is generally done by the commercial firms, including the Kenya Tea Development Authority. These firms, however, have to get permission to export tea material from the Ministry of Agriculture.

Tea improvement

Tea breeding and selection is the major research work done at the Foundation. The Foundation also cooperates with the technical departments of two tea companies which are working on the breeding and selection of better tea planting material.

There are no wild relatives of tea indigenous to East Africa.

Manpower availability

The Foundation has found it difficult to recruit qualified scientists such as plant physiologists and cytogeneticists. These are either not there or the remuneration offered by the Foundation is not good enough to attract the right calibre of scientists. At the moment the Foundation is not in a position to sponsor scientists for further studies at the institutions of higher learning.

Management of tea genetic resources

The tea genetic resources are well-managed and utilised in Kenya. There is one tea company uprooting old tea in Kericho and replanting. Before uprooting a few plants in every field are being selected and propagated vegetatively to produce clones for trials. This will preserve the germplasm. The company has allowed the Foundation to join in this programme of selecting better tea material from the fields due for uprooting and replanting.

Woodfuel species

Due to the prevailing world energy crisis, the Foundation has embarked on testing a number of woodfuel species to identify which ones are the best for use in tea factories and for domestic use by smallholders. Currently the genera being tested are *Eucalyptus*, *Acacia*, *Casuarina* and *Leucaena*.

NATIONAL IRRIGATION BOARD

O.E. Baraza

The National Irrigation Board was established in 1966 with the responsibility of managing the large scale irrigation settlement schemes in Kenya. To date it has six such schemes distributed countrywide. These are Tana, Mwea, Ahero, West Kano, Bunyala and Perkerra Irrigation Schemes. In Tana Irrigation Scheme maize and groundnuts are the main crops; Mwea, Ahero, West Kano and Bunyala are rice schemes while Perkerra grows citrus, bananas, onions and chillies.

Since its inception NIB has been involved in research aimed at improving its operation and increasing the yield of crops. To this end two research stations have been established at Ahero and Hola.

Rice

As this is a non-indigenous crop most of the varieties grown in large scale schemes have come from outside. Small-scale producers in the coastal region however have varieties which they have maintained for a long time, with very desirable characters, but low in yield.

Characters considered during selection include yield, resistance to prevalent diseases and pests, stem rot etc., milling qualities, cooking and taste qualities, and adaptability to the growing environment. No single variety combines the optima of all these characters, hence the need to do breeding work. It is necessary to preserve seed of varieties with desirable characters for use in the future.

Cotton

This is also a non-indigenous crop. Current commercial stock-breeding is done elsewhere in East Africa but reselection has been done locally. Variety selection material has come from cotton-growing areas from all over the world. Characters for consideration during selection include quality of fibre, ginning out-turn, resistance to diseases and adaptability to the growing environment. The need to preserve material with desirable characters applies here as well.

Conclusion

Changes in policy on quality characteristics and/or pricing of the material for commercial production also requires that tested material of desirable characters be preserved.

We propose that for short-term storage of genetic material the National Commodity Research Stations could coordinate, but for the long term we think there is a need for a National Gene Bank to undertake this work.

WESTERN AGRICULTURAL RESEARCH STATION, KAKAMEGA

J.K. Rutto & C. Mburu

The centre deals with crops, pastures and fodder, not to mention animals. Mostly these commodities are dealt with in collaboration with other stations. Specifically, the centre deals with sorghum, maize, finger millet, beans, local and exotic vegetables, groundnuts, soybeans, fruits, cassava, sweet potatoes, pasture and fodder. However, the centre's responsibility as far as plant genetic resources is concerned is partial and includes *Sorghum bicolor*, *Eleusine spp.*, *Arachis hypogaea*, *Glycine max*, *Manihot spp.*, *Ipomoea spp.*, local vegetables and fodders. These are both conserved in the cold store and in working collections in the field.

Other germplasm conserved in the field include:

1. Banana, with 23 lines, both local and exotic. Replicates in other locations are necessary.
2. Cassava, with 34 lines, both local and exotic. Promising lines are also maintained in other Government institutions around the centre, where they are in danger of being lost due to poor care and casual stealing. More replicates in different localities are necessary, as well as tissue culture.
3. Sweet potato, 40 lines, both local and exotic. Virus diseases threaten the crop, and more sites are necessary for maintenance.
4. Fodders: 10 lines in the field and some in seed form. Not many problems.
5. Fruits: citrus, 7 lines; mango, 9 lines; avocado, 6 lines.

These are all maintained in a small museum, and some are used in propagation work. The problem facing the museum is that of management, due to limited funds. This brings about a shortage of labour for maintenance, purchase of fertilizer, herbicides, insecticides, etc. With mangoes and to a lesser extent the citrus, the material does not seem adapted to prevailing conditions. Therefore replicates in other localities are necessary.

Cold storage is effected at a temperature of 2-10 °C for 2-10 years. Germplasm is conserved for *Sorghum bicolor* (431 lines), *Eleusine coriacea* (97 lines), local vegetables (6 types of local varieties), *Arachis hypogaea* (15 lines, mostly from Muguga), and *Glycine max* (40 lines, mostly from Muguga).

Breeding and selection

Due to a lack of breeders not much work is done concerning the above species. Considerable breeding in Sorghum is being done at the Centre's substation, Alupe. Selection work has been carried out at Screre and currently at Kakamega (W.A.R.C.) on *Eleusine coriacea*, *Arachis hypogaea*, *Glycine max* and local vegetables, and to a lesser extent on *Manihot esculenta* and *Ipomoea spp.*

Import and export

The Centre exchanges with other local institutes, but international exchange is only effected as far as *Sorghum bicolor* and *Eleusine coriacea* are concerned; imports are done from ICRISAT, India, CIMMYT, Uganda, Ethiopia, Sudan and other countries.

Constraints

Germplasm is usually imported or exported through the Plant Quarantine Station at Muguga for phytosanitary certification and it takes rather too long for the germplasm in question to reach its destination. Lack of knowledge of the available germplasm and where it can be found limits importation of material of particular importance. There is a need, therefore, for a National Gene Bank to document the world as well as the local germplasm and to give the documentation as wide a circulation as possible.

Crop relatives: wild species

As hardly any breeding work is being done, no wild relatives have been put to use for breeding work. However, it should be mentioned that the region (East Africa) is very rich in wild relatives of Sorghum and local vegetables. There is a need for a collection mission throughout Kenya for some of the species and their wild relatives, as soon as possible to avoid the loss of germplasm by deterioration of wild plant habitats.

Manpower and/or training constraints

Manpower is lacking at the Centre as far as plant genetic resources are concerned. The personnel concerned with crops are agronomists and not very conversant with germplasm management other than selection and production. Strictly speaking, no one has been adequately trained on the plant genetic resources management. Therefore collection, documentation, maintenance, conservation and usage is carried out independently by various scientists. Personnel should be trained to deal with genetic resources effectively to avoid loss of the existing germplasm.

Management and utilization of plant genetic resources

Of late, several Agricultural Research Stations have acquired cold rooms from the National Gene Bank, which is a step forward to better management of germplasm. More efforts should be put towards maintenance of these stores. As mentioned earlier the collection of germplasm together with their wild relatives should be a priority, especially for species which are believed to have originated in East Africa. More attention should be given to the already existing germplasm in a bid to conserve, regenerate and document the available material. The documentation should be fed to the National Gene Bank, which in turn can feed all the stations with the national information on germplasm; this would reduce unnecessary duplication of some work by the stations.

Due to lack of trained staff the potential of most of the germplasm has not been exploited. The training of staff is therefore crucial. As plant genetic resources form the basis of all other fields such as agronomy, breeding, pathology etc. it should be given as much attention as these other fields.

UNIVERSITY OF NAIROBI**Prof. D.M. Mukunya**

We have looked at the Research Stations as the main research conservators of germplasm. The Nairobi University Faculty of Agriculture has a department of crop science, concerned with crop development, research and education, and a number of staff members are involved in research and conservation of germplasm. This is in collaboration with national institutes such as the Horticultural Research Station; for example, Dr. Njue is now doing research into characterization of local vegetables. With Kusewa we have a collaboration programme on pigeon pea, and currently there are ca. 800 accessions of pigeon pea collected from Kenya and Uganda. We have also been working on beans, and the Horticultural Research Station at Thika should have over 1,500 duplicates of the University collection of beans. At the department of botany there are quite a number of accessions of wild rice.

There are also small accession numbers of maize and cowpeas; but the most interesting germplasm is that of *Rhizobium*, a collection of the various bacteria used as inoculants for grain legumes, forage and crop varieties. These are maintained in the departments of soil science and botany, and I believe that should be part of our National Germplasm resource.

MOI UNIVERSITY**Prof. F. Owino**

Most of the efforts at the University towards the conservation of forest genetic resources has been directed towards in-situ conservation: trying to get a part of some forest to be a nature reserve. Those areas have been left pretty well intact, although at the moment there are some problems of destruction and disturbance, just as in many other forests. Within these reserves we still have a very broad base of biological diversity, and probably maximum genetic variability with respect to individual tree species.

One point which I would like to raise is whether this strategy of nature reserves is a realistic one for the future. This strategy requires a fairly specific legal framework. I am not convinced that the nature reserves as we have them now are sufficiently protected. Examples such as the very valuable small blocks of forest at the coast, the kayas, are probably better protected under the National Museum. But I will leave this issue for discussion later.

We do have much woody vegetation in the arid and semi-arid zone and this is threatened. From the foresters point of view this area is less known than the closed forest and this is the one area that calls for a close working together between ecologists, foresters and wildlife people. This belt is very important, it covers large tracts of this country, and it is neglected from the point of view of foresters; the ecologists working there are usually not tree people.

The mangrove forests of the coast are also facing destructive pressure at the moment; this is a very valuable forest type which must be maintained and which will require special conservation strategies.

The bamboo forests have also been in the news recently, and there is pressure on the Forest Department to restore these to their former state.

The only other development which I would like to highlight is that there is now increasing interest in indigenous trees, and special emphasis is given to multipurpose trees. A start has been made at the University to survey and collect from individual species.

We have started a small germplasm collection at the University, and I hope that together with KEFRI this will improve.

As one of the basic issues I regard the manpower shortage. We have to create germplasm for future needs, and this is true for both forestry and crops people.

There has also been a suggestion about a national germplasm documentation centre. Should we pool all documentation, for both trees and crops, or should we keep these separate? I hope that we can have an institution large enough to care for both, taking into account the shortage of manpower we have noted.

FOREST DEPARTMENT

J.R. Wawiye

Forestry is currently under pressure from the agricultural people. Everybody wants land that the forest is occupying, and we are trying our best to conserve, and indeed increase, what we have. As you know, there is a lot of work going on in agroforestry. KEFRI is a very important institution and needs a lot of support to do what it can do. We cover ex-situ and in-situ germplasm: in-situ we have about 2.15 million hectares of indigenous forest reserve, and about 50,000 hectares of nature reserve, plus 32,000 ha of indigenous hard and soft wood plantations. We also have 150,000 ha of exotic species, these being mainly used for industrial purposes.

In the indigenous forest we have restricted selection geared to promote diversity and quality of the crop. Implementation is sometimes difficult because sometimes people come in and cut trees without a licence. At the seed centre we are working on selection of indigenous species, starting with high-priority ones; the aim is to have a minimum of 50 trees selected so that we can keep a broad baseline.

We also have clonal banks of pines and cypress; for species such as *Pinus caribbea* var. *hondurensis* and *Pinus oocarpa* selection has been done.

In the centre we also have cold storage facilities: the short term one (+3 °) is mainly for incoming and outgoing seed; the long term storage is at - 18 °. Since there is not enough information on indigenous species we have started storage trials to see at which temperature species should be stored.

We import and export seeds for research or for afforestation programs and for breeding and selection. We work together with the breeding section on this.

As regards manpower, we need more staff. In the seed centre we do not have enough staff, and for the whole institute the position is the same.

I would like to suggest that plant germplasm conservation is integrated in the National land use agenda; that a legal requirement is introduced for environmental impact assessments; that there comes into being a mandatory ban on further alienation of forest lands, and that agriculture productivity in existing agricultural areas is increased, by the adaptation of modern farming methods under the green revolution packages; and that a realistic balance is struck between conservation and the production functions of our forests.

OPPORTUNITIES AND LIMITATIONS OF MULTIPURPOSE TREE AND SHRUB GERMPLASM SUPPLIES

P.G. von Carlowitz

Introduction

During an international workshop on multipurpose tree germplasm held in 1983 in Washington DC the general concern that internationally the availability of germplasm for lesser-known multipurpose tree and shrub species is insufficient and may therefore retard development of agroforestry and other forms of integrated land use was voiced. Consequently, one of the recommendations of the workshop was to carry out a survey of suppliers of such germplasm and to publish a specialized seed directory which would facilitate communication and trade between those who require germplasm of multipurpose tree and shrub species for research and development activities and those who can supply it.

From late 1985 to early 1986, such a worldwide survey of seed suppliers was carried out. Questionnaires were sent to more than 400 government-based seed banks, seed banks operated by research institutes, international organizations, development agencies and commercial seed suppliers. About 100 of them responded and their particulars were published in the first edition of the "multipurpose tree and shrub seed directory".

Critical analysis of the survey results

It came as a surprise, and to some extent made nonsense of the general concern over insufficient germplasm availability, that the 100 suppliers listed stated their ability to supply for close to 700 of those species which by ICRAF's definition qualify as multipurpose tree and shrub species. This surprisingly large number of species may be even bigger considering that a sizeable number of species contained in some of the suppliers' seed lists could not be clearly identified as multipurpose species due to the use of insufficient or unclear taxonomic nomenclature.

Another surprising aspect evident from the data regards the range of prices for seeds of various species. Differences in price of over a thousand per cent per kilogram of seed of a particular species are quite common. This even applies to more commonly known and commonly used species such as *Acacia alba*. The prices quoted by the 19 seed suppliers who can provide this germplasm range from US\$ 4 to US\$ 106 per kilogram. *Azadirachta indica* with 18 suppliers and a price range of 5000 per cent is another example. Even in the case of the widely spread and well known *Leucaena leucocephala*, the prices differ from the cheapest of the 38 suppliers to the most expensive one by 1300 per cent. A lot of other examples could be cited.

A closer look at the location of the different suppliers, the species they trade in and the prices they charge suggest that prices are not necessarily low where the seeds can be collected nearby, or that they are high when the natural seed source was obviously far from the suppliers' location. Equally, the abundance of flowering and fruiting that are characteristic for certain species do not seem to influence the prices distinctly.

Although some allowances have to be made with regard to high prices occasionally and justifiably charged for research quantities from expensive collections abroad, the wide-ranging price scales indicate an obviously rather disorganized and uncoordinated market, particularly for lesser known species.

It is also obvious that high prices are not necessarily related to high quality of seeds or vice versa. This impression was not confirmed but was supported by random purchases of seeds from some suppliers.

Although the survey may have been useful in facilitating communication between seed requesters and seed suppliers, in identifying the large number of species for which seeds are available, and in exposing a price structure which leaves much to desire, it also has its limitations. Within the limits of the number of questions one can ask with a reasonable likelihood of receiving answers, care had been taken to assess the competence of the seed suppliers. However, information received on their institutional status, sources of germplasm, ability to provide proper seed documentation, and methods of and facilities for seed storage methods and facilities may give some indication as to their professionalism but cannot provide conclusive evidence of the level of reliability.

It provided equally difficult - in fact, almost impossible - to assess the quality of the germplasm which is offered by the various suppliers. Even in cases where suppliers stated that seeds are collected by their own staff and from their own seed stands or orchards, there were no reasonable means and ways to find out whether the basic rules for seed collection were being observed.

The selection of healthy, vigorous parent trees which are not overmature and the avoidance of isolated trees of naturally cross-pollinating species is one consideration. The definition of utilization-oriented ideotypes to provide guidelines for the selection of parent trees of the appropriate phenotype is quite another. While it can and should be expected that the basic rules mentioned above are normally observed, it cannot be expected that ideotype-oriented selections of parent trees of multipurpose tree species are being conducted. Researchers concerned with the use of woody perennials in agroforestry systems or other forms of integrated land use have so far failed to provide definitions of utilization-oriented ideotypes although this is an increasingly important aspect of germplasm improvement of multipurpose trees and shrubs. Therefore seed collectors and suppliers cannot be held responsible for the omission of such considerations.

Some reports received from seed suppliers indicated that they keep stocks of, or are able to provide, more than one provenance of seeds for individual species. This is particularly true for better-known species such as *Gliricidia sepium*, *Leucaena leucocephala* and some *Acacia* species. However, it was difficult to accommodate all this detailed information in a seed directory without enlarging it to a bulky publication which would then be difficult to handle as a reference tool on seed sources. Nevertheless, the second edition will take account of such important additional details and will mention, in the remarks column for individual suppliers, the availability of several provenances wherever applicable.

Conclusions and further needs

There can be no doubt that renewed efforts are necessary to inventorize more seed suppliers in order to gauge the full range of multipurpose tree and shrub species covered in terms of seed supply. This would not only provide a better and wider range of facilities for the development of agroforestry and many other forms of mixed land use, but may also contribute to the ex-situ conservation of germplasm. The previous survey carried out by ICRAF, involving only a fraction of all companies, institutes and organizations engaged in collecting, trading and distributing germplasm covered close to 700 species. This indicates that for more species than these germplasm is collected, stored and available for use. No attempt has been made so far to analyze the list of species covered in order to identify those species among them which are rare and probably endangered. However, it is not unlikely that the existing large number of seed collectors and suppliers can make and already are making a positive contribution to the ex-situ conservation of germplasm.

KENGO: KENYA ENERGY NON-GOVERNMENTAL ORGANIZATIONS

L.Kangethe, G. Arum & A. Aworry

Introduction

When we are talking of in-situ conservation, let us not just talk about the habitat, but also on the ecology of that habitat. As scientists, it is very easy to talk of inventories, gene banks and data banks - but is that enough? Are we keeping inventories of things which do not exist anymore? How do we link this process of data collection and documentation to the survival and multiplication of what is already there? We must enact strategies that respects both this scientific process and the social aspect of public awareness, public education and policy action. Without due regard to these issues we will be working on a hollow perspective.

The conservation of genetic resources can only be achieved by local participation at the grassroots level. It is therefore of paramount importance that indigenous knowledge on habitat management be taken into consideration in the development of a national strategy on genetic resources; such as traditional resource utilization and indigenous land use patterns and systems. The dissemination of information on the value of genetic resources must be given priority if such management and observation is to be achieved.

Rural grassroots communities should be involved in the planning, development, management and utilization of nature reserves. This will ensure that the target community hosting the nature reserves benefits directly from the exploitation of these resources. A greater sense of responsibility and the need to conserve natural resources will naturally be instilled in the public if such an approach is used.

KENGO's efforts in creating awareness on the need to conserve and manage genetic resources focus on indigenous trees. Since 1983 KENGO is undertaking research and is disseminating information on indigenous trees; this dissemination takes the shape of forums, seminars and workshops; of public exhibitions with slide shows, displays of plant specimens, seed and tree profiles; and of publication of articles in local dailies on indigenous trees and seed, as well as weekly radio programmes. Educational material on trees and seeds are also produced.

Research on indigenous trees

The principal purpose of KENGO's research is to collect information on the uses and value of local tree species as perceived by the local communities. It is by no means intended as a botanical survey; however, researchers can benefit from the wealth of useful data it has made available.

Data collection field trips generate dried plant specimens with full botanical descriptions; photographs of trees, showing both the whole tree and close-ups of flowers, seeds, leaves and bark; tree seeds for germination trials; and data collection via comprehensive questionnaires, either botanical (data on localities, natural habitat, and phenotypic characteristics) or socio-economic (data on

fruiting and seeding time, seed dispersal, seed treatment; propagation methods; local uses; agroforestry potential; limitations of the tree, such as susceptibility to pests and diseases, known toxicity; and socio-cultural aspects such as taboos). Questionnaires also try to ascertain which tree communities have disappeared from the area and why. This information is sought from older members of the community.

Data compilation is finalized by literature review and consultation of resource persons in relevant organizations such as the Forest Department, the University of Nairobi and the East African Herbarium.

Results

So far 28 articles have appeared in local dailies; the "KENGO news" also publishes articles; 12 district workshops on agroforestry and tree planting have been held; a major workshop has been held during the UN decade for women conference in 1985; a journalist workshop has been held on environment and development; and a workshop has been held for media policy makers on environment and development.

All these promotional activities have contributed to the change in national policy on the planting of indigenous trees for conservation at the grassroots level.

The project has so far been concentrating on the trees of the arid and semi-arid areas of Kenya, and a book on 109 trees is in the process of being published. The next area to be surveyed will be the coastal zones, and finally the high potential areas.

A special survey of the indigenous fruit trees of Kenya will be embarked on in August 1987.

In the pipeline is a project on the indigenous vegetables of Kenya, to be started in August 1987.

Research on seed

As public awareness on the value of indigenous trees has been raised, the problem arises that there is little or no documentation on seed germination, viability, procurement and handling. Systematic knowledge on presowing techniques and on the mass production of seedlings in tree nurseries is scarce or lacking. To fill this gap, KENGO initiated the tree seed project.

The methodology is to carry out, in collaboration with J.K.C.A.T., ground seed germination trials, to do growth performance tests on dryland indigenous trees, to carry out in-situ conservation of selected dryland trees and to do extension work to educate and create awareness in college students and the local community.

In this project KENGO collaborates closely with KEFRI, the University of Nairobi and JKCAT.

Seed stands for 40 dryland indigenous tree species have so far been established, and more will follow. Data on propagation trials for these 40 species are being collected, and will be published.

About 4000 seedlings have been distributed to the local community.

40 extension workers have been trained on the various aspects of seed collection.

Two publications have been produced: "How to collect, handle and store seeds" and "Pocket directory on trees and

seeds of Kenya”.

Slide shows prepared at KENGO include: “seeds for tree planting”/”Mbegu kwa upandishaji wa miti”, a how-to on seed technology, in english and swahili; “the value of indigenous trees” (in english).

Several workshops for media personnel (journalists workshop at Homa Bay, media policy makers workshop at Kabarnet, and a workshop on the value of indigenous vegetation in Nairobi) recommended the research on, and writing of a report on the state of seed and genetic resources in Kenya. This report has now been published by KENGO.

WILD POPULATIONS

THE STATUS OF WILD POPULATIONS

Ndegwa Ndiang'ui

Life support systems are centered on primary productivity as the single most common denominator. And while plants form the resource base in ecosystems, they have not received the attention they deserve as regards their conservation. Wildlife conservation has over the years tended to concentrate activities on the fauna with little emphasis on the flora. And in general the case for plant resource conservation has not been articulate enough to bring them to the forefront along with other competitors for land and financial resource allocation, as well as for public appreciation.

There is a very large and yet unrealised potential value of the indigenous flora in tropical Africa. But with the rise in human population and the rate at which stocks of wild populations of plants are disappearing due to other land uses, it is probable that some species will disappear even before we know that they existed. Thus the potentially beneficial germplasm is largely untapped, whether for its value in agriculture, horticulture, medicine, industry or other purposes. Some of this germplasm is faced with extinction.

The various wild populations of plants in Kenya today range from afroalpine vegetation to rock desert to mangrove forests, displaying an enormous wealth of diversity in genetic resources within the various habitats. Some of these habitats have been botanically explored, while others are little known floristically. The purpose of conducting floristic or vegetation inventories in these habitats is to establish the components comprising these communities. On these basic data conservation strategies of the resource in question are founded.

Vegetation inventories and the mapping of plant communities form essential tools in plant resource conservation. But conducting vegetation inventories for a country with such varied habitats as Kenya is an enormous task which requires qualified personnel and a great deal of funding. Even with these prerequisites (which are lacking anyway) the importance of such an institution as the East African Herbarium cannot be overemphasized. The Herbarium is an active institute which has assumed a positive role in the conservation of plant resources. With a reference collection of about half a million plant specimens from East Africa the herbarium is well-equipped with the primary data necessary to start such inventories.

Among its present activities, the Herbarium is involved in compiling checklists of plants of various habitats in the country and in conducting vegetation inventories, especially of endangered habitats. Already checklists have been completed for no less than 20 habitats. In other areas plant collecting has been done without the compilation of such checklists. From checklists various data can be generated, such as the species composition, the levels of endemism and information about endangered species.

The Herbarium has compiled a list of about 50 habitats in the country that are considered to be critically in need of

a vegetation inventory. The objective is to try and acquire the basic data in order to have a foresight in problems of ecological stability and species interactions within such ecosystems.

Habitats that have been considered endangered contain species that are themselves threatened. In some cases the threat is due to overexploitation of timber, for example *Podocarpus* and *Ocotea* in the Taita Hills, or *Dalbergia melanoxylon*, the African Blackwood, which has been exploited heavily by the woodcarving industry.

Other species may be threatened due to the reduction in size of their original habitat, e.g. the Taita African Violet, *Saintpaulia teitensis*, which is endemic to the Taita forests; the same is true for a wild coffee species, *Coffea fadenii*. Mrima Hill in Kwale District is another example of a habitat with endemics which has been drastically reduced by intensive agriculture and open cast mining.

Species of plants from the semi-arid environment are faced with threat from the imminent increase in wildlife and livestock populations which exceed the land's carrying capacity. Overgrazing and denudation lead to soil erosion and land degradation, and that includes a genetic erosion of plant resources. Some constituents of this semi-arid environment are wild relatives of crops such as *Eleusine*, *Sorghum* and *Gossypium*.

From a plant resource conservation standpoint the setting aside of a plant sanctuary such as Mutomo Hill Plant Sanctuary serves to conserve and protect plants in their natural habitats, especially in the semi-arid areas.

Wild populations of plants today are rather discontinuous in community structure and form rather isolated sites. Most of these sites exist today in a sea of culturally modified environment; some of these are the only gene pools left for species, and species richness decreases with the decreasing amount of space under vegetation cover. There is an imminent danger of depleting the natural stocks of desirable species, while uncontrolled harvesting ecologically destabilises the ecosystems. The cutting down of the largest and most mature trees constitutes a genetic erosion, especially where there is a lack of documentation to indicate how much wood is in stock for exploitation.

The cause for species extinction in wild populations is generally the reduction of geographic range of the species or the decrease of density of the species within a given habitat. These processes are currently taking place all over Kenya, and they threaten species richness as well as the viability and stability of gene pools of wild populations of plants. We are faced with an ecologically complex problem of determining how small an indigenous patch of forest can be made to maintain a viable population; and this pays little attention to the possible genotypic effects on the populations.

In conclusion I would like to say it is not too late to initiate documentation of species through botanical surveys and vegetation inventories. Research should be initiated to establish growth rates, seed availability, germinability, location of selected genotypes in the field, etc. Research should endeavour to achieve genetic improvement once good genotypes have been identified. Biologi-

cal limitation, especially in the area of genetic improvement, constitutes an obstacle to development, which, if overcome, would enable the world to feed and clothe itself on a sustainable basis, where development would not be destructive to the environment but in consonance with the maintenance and improvement of productive habitats.

THE ROLE OF KREMU

F. Msafiri

Introduction

Conservation of genetic resources can only proceed when we know what to conserve, how much of it, where it is and how it is threatened. KREMU is responsible for monitoring of range resources and high potential plant resources, as well as sources of forage for animals and woodfuel in order to detect condition and trend. In 1977 KREMU started establishing ground stations for collecting baseline data on plant species, their density and biomass. These stations were meant to act as permanent monitoring sites, and therefore they are supposed to be representative for large areas.

Inventories

To be able to assess what there is in terms of plant genetic resources, inventories are the most important activities since they tell us how much of these resources we have.

KREMU adopted two sampling methodologies for doing this - viz. Point Centre Quarter for measuring woody species and Quadrats for estimating biomass and species composition. These two methodologies give us density and species frequencies. They also enable us to detect plants which are indicators of different range conditions as well as endangered species. Some of the indicator species include:

- For overutilized rangeland: *Microchloakunthii*, *Oropetium capense*, *Astripomoea* sp.
- Salinity: *Salvadora persica*, *Sporobolus spicatus*
- High water table: *Acacia xanthophloea*
- Black cotton soil: *Acacia drepanolobium*, *Pennisetum mezianum*

From the survey carried out by KREMU in Taita-Taveta and Kwale, some plant species were discovered to be under threat locally and these include *Dalbergia melanoxylon* and *Terminalia spinosa*. Both these species are in high demand for charcoal burning. The felling of *Terminalia spinosa* leads to destruction of other species such as *Acacia* spp. and to a lesser extent *Combretum* spp. As a result of this severe soil erosion has been caused between Samburu and Mariakani.

Some threatened habitats

From some of KREMU's field stations, there are clear indications about some habitats being under threat. Loita plains and the woodlands around Lake Elmentaita are good examples. In 1977, when KREMU station no. 6 was established near Ngore-Ngore in Narok District, wheat farming had not extended south of the Narok - Ngore-Ngore road. Within a span of less than 5 years, the whole of our 10 x 10 km station was taken up by a wheat field (Fig. 1). This is a serious threat to the Loita plains as a buffer zone for wildlife in Masai Mara, apart from the diverse and unique vegetation of the Loita plains themselves.

In the same year, Gilgil Station was established around Lake Elmentaita. Today, the whole station is taken up by settlement. The problem with Gilgil station is the threat to

the *Acacia xanthophloea* woodland around the lake. Although there are probably no people settled within the woodland, there is a likelihood of treepoaching for domestic use, which might cause environmental problems with the lake itself.

Another threatened area is the miombo woodland of Kilifi and Kinango in Coast province. The *Brachystegia* woodland south of Kinango is already being cleared for cultivation and this goes together with charcoal burning of this same species around Mangea Hill in Kilifi district.

Plant species documentation

KREMU is collaborating with the National Museums to document all plant species in all Kenyan herbaria. Presently, there is no comprehensive information system allowing potential users to have easy access to data. This exercise, once completed, will enable individual users to retrieve information on species distribution. This will be made possible by the Geographical Information System computer KREMU is installing. The system will also enable users to identify those species which were collected a long time ago and never since. This enables researchers to check whether the species is extinct, or whether it had been by-passed by collectors due to its rarity. Should the species be identified in the field, arrangements can be made to get the plants conserved, either in-situ or ex-situ.

Conclusion

With KREMU's expertise in Landsat imagery interpretation and vegetation inventories, it is my hope that KREMU will contribute greatly in the inventory of plant genetic resources and in the identifying of areas needed for in-situ conservation.

PRIORITIES FOR ACTION: EX-SITU CONSERVATION

OPERATIONS OF THE NATIONAL GENE BANK

E.N. Seme

There is an awareness now that there is a need for the conservation of our natural heritage. It was the Ministry of Agriculture that initiated the establishment of our National Gene Bank, when it was realized that we are losing germplasm of our natural heritage not only in the field, but also from the research stations. To confirm this, in 1978 some surveys were conducted by GTZ experts, and they revealed that there was a considerable amount of germplasm being lost in the research stations due to the fact that germplasm is kept under adverse storage conditions. GTZ came up with a proposal that a National Gene Bank be established by the Ministry of Agriculture to take care of germplasm. In 1982 this proposal was implemented with technical and financial assistance from the Federal Republic of Germany, and Dr. Abou-Zeid was posted to Kenya to help establish the National Gene Bank.

Since that time quite a lot of work has been done. The establishment of the National Gene Bank is taking place in two phases: phase 1 was to rehabilitate all cold storage facilities in the country, especially in the major research stations. To that effect, 5 cold storage facilities were given to Katumani, Kitale, Njoro, Kakamega and Mtwapa. Also, two workshops were conducted dealing with the documentation of germplasm, as there was no standard of documentation common to all stations. Collection record sheets and data sheets are now standardized, agreeing with IBPGR documentation procedures. We also have a storage file for vegetatively propagated germplasm. Packing materials and sealing machines have also been provided to the stations.

Phase 2 was the actual construction of the central gene-bank building with its cold storage facilities. We managed to overcome problems of bureaucracy, and at the end of this month the contractors will hand over the central gene bank building to us. We will now start equipping the building, the laboratories and installing cold storage facilities, and we hope that at the end of the year the gene bank will be functioning.

Another aspect is the field gene bank. We have sites for the conservation of some species which we cannot keep in cold storage, e.g. bananas. These field sites are situated at Matuga (for the coastal area) and Matuamba (for high altitude crops); Matuga, being prone to drought, is now provided with irrigation facilities, and bananas, avocados, cashew, some citrus and coconuts are already installed. Another of these field stations is planned in Kakamega.

The purpose of the National Gene Bank as we see it is

1. To organise germplasm and collection missions at a National level
2. To introduce new genetic resources in consultation with other research stations and the National Plant Quarantine Station

3. To deal with the international exchange of germplasm and relevant information,
4. To conserve germplasm temporarily in tissue culture
5. To multiply germplasm and to evaluate on a preliminary basis for specific gene bank purposes
6. To coordinate all crop plant genetic resource activities, seed processing and packaging for long-term storage and long-term deep-freeze seed storage
7. To manage documentation work in Kenya for data collection from research stations
8. To organize technical meetings and workshops dealing with gene bank affairs.

We have now identified a gene bank committee; the members are drawn from various institutions that deal with plant genetic resources. We have been delaying the meeting because of the previous uncertainties over the construction of the central genebank.

ESTABLISHMENT OF BOTANIC GARDENS AND PROPAGATION UNITS FOR ENDANGERED SPECIES

Christine H.S. Kabuye

Plant resources in the wild are regarded as a free source for our requirements, be it for food, medicine, timber, industrial purposes, fuel or forage. But there has been a tendency to over-utilize these sources and often destroying them for other development. As a result a number of species are becoming rare or are near to extinction, warranting conservation measures.

Although conservation of species in their natural habitats is the best way of ensuring their continued genetic diversity, this is not always possible, as the habitats themselves may be threatened. Alternatives must then be found to save at least the ones known to be of potential value. Establishing botanic gardens, preferably with conditions similar to the threatened habitats would help to establish them elsewhere. Propagation units would handle research on the best methods of propagating the various species.

The Workshop on the status and options for the management of plant communities in Kenya, held here at the Museum in March 1984, recommended establishing two major gardens: one in Nairobi and one in Mombasa, as well as smaller ones in each province. This was endorsed by the Strategy conference for the management and protection of Kenya's plant communities, held in August 1984.

Although little has been done to implement this, a few regional Museums have land to develop a botanical garden. In Nairobi there are plans to develop a part of Ololua forest for this purpose. At the coast a small site next to Gedi National Monument can be developed for species adapted to coral.

Elsewhere there are facilities, public or private, which could be improved or developed, such as the botanic gardens at Mazeras (Coast); in Nairobi the Arboretum and City Park could serve as an ex-situ refuge for dry upland species. Suggestions have been made on the possibility of developing botanic gardens at main entrances to National Parks and Reserves, and I would like to learn of any comments on this possibility. With this idea in mind a botanical garden for coastal hinterland species could be sited in the Shimba Hills, while one for the dry interior could be sited at Tsavo National Park. Such gardens will not only be for conservation purposes but will also act as public awareness centres, focusing attention on our plant genetic resources.

In all this, species within threatened habitats will have to be identified, information about their possible use will have to be obtained, and their distribution elsewhere will have to be worked out. This information will determine whether conservation of a particular species in a botanical garden is a priority. Once this need has been established, it will become necessary to obtain propagation material. The propagation units will be advised to collect, grow and multiply material for the appropriate gardens.

Plans are underway to establish a propagation unit under the Museum, specifically to deal with threatened species of economic importance, with medicinal or horticultural po-

tential; an example of the last kind is *Gigasiphon macrosiphon*, a threatened species only known from Mrima Hill. As KEFRI is looking for forest tree seed for future improvement of stocks, so KEMRI should be encouraged to grow plants for medicinal purposes, and KARI is encouraged to consider plants of agricultural importance such as crop relatives or potential new crops.

As planning and managing botanic gardens is a relatively new development, a lot of input will be needed. We will require horticulturalists, nurserymen, landscape planners and technicians, both to man the garden and the propagation units, as well as funds to run the facilities.

The first priority is to organize the Nairobi and Mombasa Gardens while negotiations are started to acquire land for other gardens.

To work through the threatened habitats and to identify the species under threat we need a good number of ecologists and taxonomists, together with transport. The information records at the Herbarium, which are our database on endangered species, need to be put on computer to make retrieval easier and faster.

Baseline knowledge of wild plants and priorities for action

H.J. Beentje

The main priority for action is definitely the protection of example vegetation types. In this, we can define three phases:

1. Inventory of selected sites
2. Formulation of priority sites to be protected, and proposing these
3. Political implementation of scientific proposals

Inventories

I should first of all emphasize that, although not many good inventories have been made, it is already quite clear which sites are priority sites to be protected, as they are examples of vegetation types, and contain rare species as well. These sites can, and should be, protected now, and information about these sites can be obtained from articles in "Endangered Resources For Development" (Anonymous, 1984).

There are not many organizations in Kenya that are able to carry out good, integrated inventories. I use the word integrated as not only consisting of a list of plants, but also providing information about the vegetation type(s), about local names and uses of the plants, about the occurrence of rare species, and about the status of, and threats to, the site. KREMU and the East African Herbarium are probably the only two organizations able to carry out such inventories, and of these two the Herbarium is hampered by a lack of transport facilities.

Good fieldguides are another prerequisite for good inventories: at the moment I am working on a new edition of "Kenya trees and shrubs", to encompass all woody plants of Kenya over 1.5 m high; Dr. Agnew is working on a second edition of his "Upland Kenya wild flowers". What is lacking, therefore, is a guide to the herbs of the Coast, and a guide to the herbs of Northern Kenya.

Figure 1 shows inventories undertaken so far. It is clear that some areas, richest in species, suffer from a lack of botanical knowledge; examples are the forest belt of Mount Kenya and the coastal forests. Due to threats on the vegetation, priority in inventories should be given to forests, the limestone areas of the northeast, and woodlands.

Figure 2 was prepared from over a thousand distribution maps of woody species. It shows which areas have been under-collected. Each dot represents at least two plant collections: whether this means just 2 collections or many more was impossible to indicate.

Priority sites

The formulation of priority sites to be protected should be based on a cross-section of representative vegetation types, influenced by species-richness and the occurrence of rare species. The knowledge of vegetation types at this moment enables us to draw up a list of representative vegetation types. Species-richness and the occurrence of rare species often go together in Kenya, and this rarity of species can be inferred from distribution maps, the fre-

quency with which a species occurs, and the distribution of its habitat; status of, and threats to, this habitat also play a role.

For Kenya, not much has been published about rare species, but I am preparing an Atlas of the rare trees of Kenya (Beentje 1988), and there is a preliminary list of rare and endangered woody species (Beentje, 1986). Out of a total number of 1800 woody plants of Kenya, 270 are rare (i.e. 16%); extrapolating to the total number of Kenyan higher plant species, estimated at 7000, over 1100 species are rare, and rare in a world sense, not just for Kenya.

Concentration areas of rare species are, according to these two publications:

1. coastal Kenya, with 50% of all rare species, of which most occur in moist forests.
2. central Kenya: 15%
3. Taita Hills forests: 15%
4. northeast Kenya: 10%

Kakamega forest, although without rare species in a world sense, is extremely rich in species and should be conserved for that reason alone; it is a gene pool of exceptional richness, now sadly being depleted at a furious rate.

Political implementation of scientific proposals

Let me repeat: the necessary knowledge for proposing priority sites to be protected in-situ is already there. Although the data are scanty, enough is known to say which sites are richest in species, where most of the rare species occur, and which areas need quick protection to save them from encroachment and destruction: see Table 1. It only needs a consensus, a concerted proposal from the scientific community in Kenya to give the necessary weight to a scientific proposal to the politicians at both national and local level. If such a concerted proposal can be made quickly, and if the local communities are also involved in such a proposal, then scientists, I think, have done their duty.

TABLE 1 Priority sites to be protected
<p>COAST: <i>Mangia Hill forest</i> (< 5 square kilometer) <i>Tana River forests</i> (selected blocks, ca. 10 sq. km.) <i>Pangani Rocks</i> (< 1 sq. km.)</p>
<p>TAITA-TAVETA: <i>Taita Hills forests</i> (<3 sq. km.)</p>
<p>KITUI: <i>Mutha and Endau forest</i> (ca. 5 sq. km.)</p>
<p>MERU: parts of <i>Imenti forest</i> (selected blocks to ca. 10 sq. km.)</p>
<p>NANDI: part of N and S <i>Nandi forest</i> (selected blocks to ca. 25 sq. km.)</p>

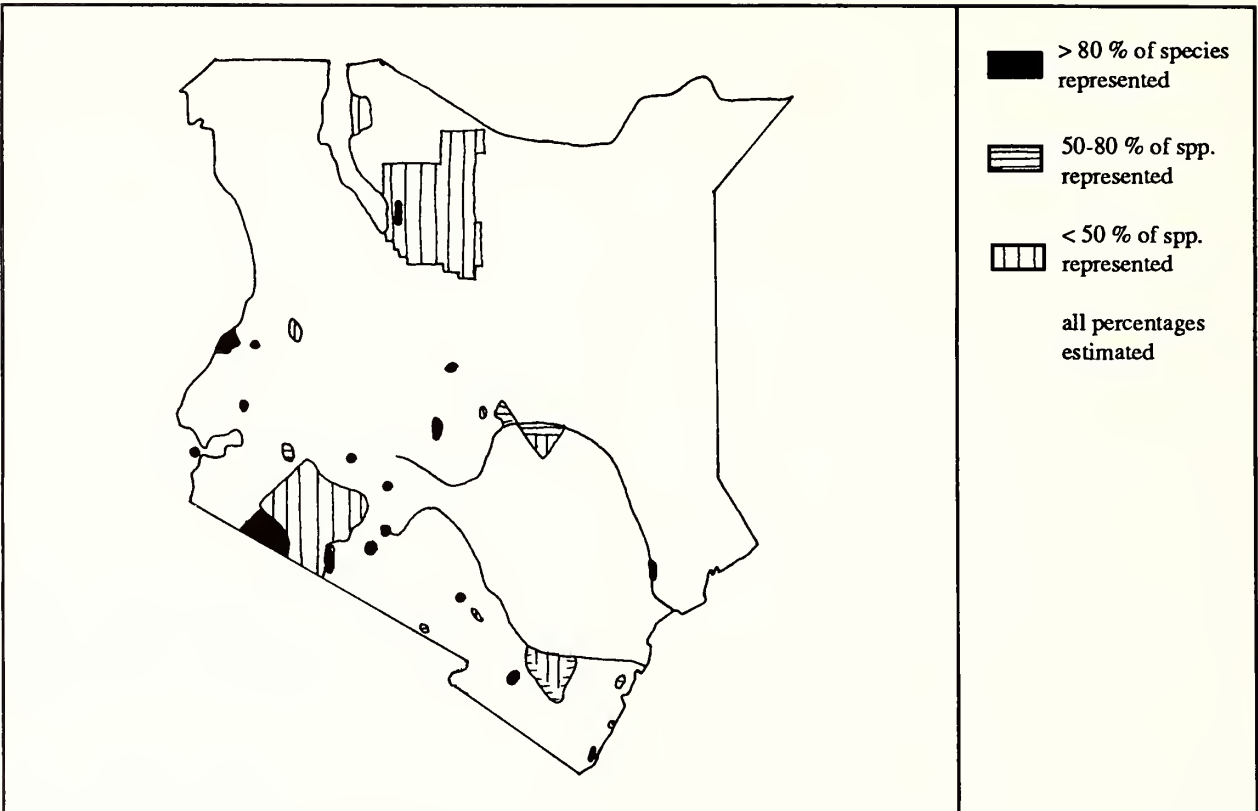


Figure 1. Status of inventarization of areas

See reference list for literature

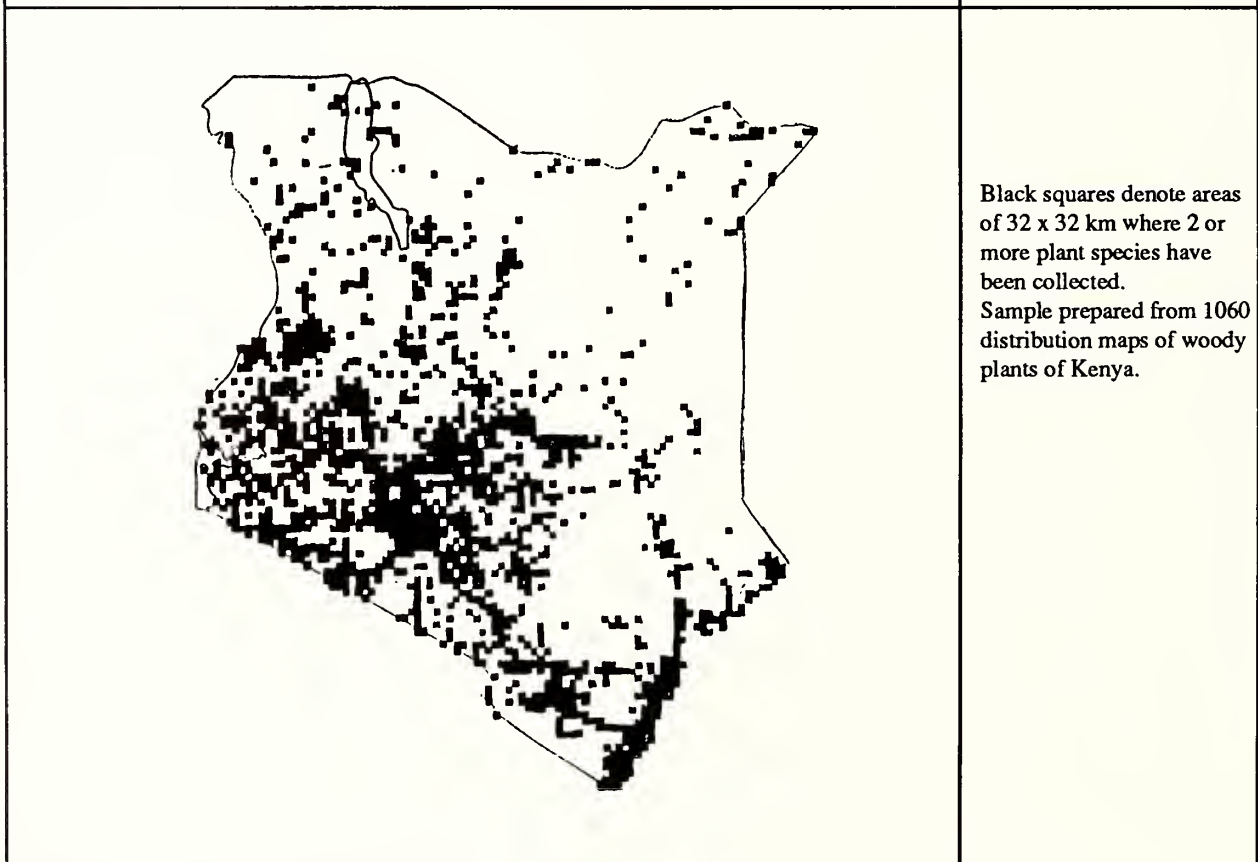


Figure 2. Collected and under-collected areas

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NOTE: when several inventories exist for the same area usually the most recent one, or the best one, is the only one to be taken into account. Vegetation maps have not been mentioned except where they are accompanied by a checklist; a list of vegetation maps of Kenya has been compiled by Mr. F. Bulski for UNEP.

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THE ROLE OF NATIONAL PARKS AND RESERVES IN CONSERVING GENETIC RESOURCES

D.M. Mbuvi

Introduction

Genetic resources conservation is a relatively new concept. However, from the historical point of view the collection and utilization of useful plants and animals is as old as the history of man. It must have originated when man moved from a hunting/gathering society into a more agricultural society.

We must record with appreciation the foresight of early pioneers in the establishing of the network of Parks and Reserves, started during the colonial era. Today Kenya can claim to be in the forefront of the countries of the world with fairly representative samples of all the biotic communities, including the marine ones, protected in 20 National Parks and 27 National Reserves, preserved, at least in theory, in perpetuity.

Ecological basis for conservation

Kenya is a country with an extreme richness of habitats. Due to the richness of species in terms of diversity and abundance, as well as the scenic attractions of our landscapes, we can consider ourselves as a wildlife tourist paradise. Kenya enjoys an enormous numbers of climates, from the tropical, via the temperate to the alpine zone:

1. Afro-alpine zone (moorlands)
2. Equatorial zone (forest, derived grassland or bushland)
3. Sub-humid zone (moist woodlands or *Combretum* savanna)
4. Semi-arid zone (*Acacia-Themeda*)
5. Arid zone (*Acacia-Commiphora*)
6. Very arid or desert zone (Dwarf shrub or bushed grassland)

The biotic communities and natural regions of Kenya

These were formulated by the Wildlife Conservation and Management department (Wildlife planning unit) as a precursor for the evaluation of the National Parks and Reserves system. The main objectives were:

1. to ensure that the Parks and Reserve system represents the Kenyan natural resources in a comprehensive manner.
2. to provide a rational basis for assessing and evaluating the existing system of Parks and Reserves.
3. to provide a rational basis for the identification and establishment of new Parks and Reserves.
4. to provide an analysis of local and natural factors that will influence the future management and development of the Parks/Reserves system.

In this regard, a guide was produced which will be of considerable interest and value to planners and managers of natural resources. It depicts 19 biotic communities which were defined and mapped, incorporating all major plant and animal species found in Kenya. Also recognized were 13 Natural Regions, some of which have been divided in sub-regions. They represent virtually every landform type ranging from the glaciated mountains and

permanent snow of Mount Kenya to recent volcanic areas and desert landscapes.

Current Parks and Reserves

It is gratifying to note that overlays for the major biotic communities against the existing Parks and Reserves reflect a fair representation except for one or two areas. This is also true of the Natural Regions versus Parks and Reserves.

The Wildlife Act defines National Parks and National Reserves in the same way: in practice National Reserves are managed by local authorities, which are inevitably influenced by social-economical or political factors.

The long-term survival of National Parks is threatened by two factors:

1. peripheral influences from human activities: settlement, cultivation, grazing etc.
2. tourism activities within the Parks/Reserves, which sometimes becomes a destructive activity, especially in relation to the plant cover in Amboseli, the Mara and Samburu.

It has been said that tourism activity can be more destructive than any other human activity, including grazing under the patrol system.

Management plans are now being drawn up to steer activities for the long-term survival of Parks and Reserves.

Question (Mr. Ndambuki): Do you in any way regulate the relative numbers of animal species in wildlife conservation?

Answer: No, not in any way; in fact we have noted what looks like a new species, e.g. the waterbuck now present at Lake Nakuru is different from the past one, presumably due to competition as a result of increased numbers.

Question (Dr. Odera): What is being done to control destruction of forest by game animals?

Answer: Large mammals are not being manipulated as far as destruction of forest is concerned. A joint programme is needed to be drawn up by the two parties.

SETTING UP A NATIONAL PLANT GENETIC RESOURCES COMMITTEE

INTRODUCTION

C. Gitau

I would like to begin by giving some background information. At the 11th session of the UNEP governing council, the governments of Africa were invited to convene an African environmental conference to discuss national environmental priorities and to identify common problems worthy of a regional programme of action to deal with serious environmental problems. Two years later, in its decision 13/6 of the 13th session of the UNEP governing council, the council approved the executive directors proposal to convene the African Environmental Conference, and an expert group meeting proceeding in December 1985; as a result of this the first African Ministerial Conference on the Environment was held in Cairo.

Kenya sent a strong delegation, headed by the Hon. Jeremiah Nyagah, Minister of Environment and Natural Resources, who was elected as one of the vice-presidents of the conference. One of the resolutions adopted during the conference was to establish or strengthen 8 specialized regional networks, one being in the field of genetic resources.

The purpose of this network is

1. to promote co-operation between the technical and research institutions of African states,
2. to promote information exchange,
3. to conduct basic studies and
4. to develop links between national departments in specific areas.

Accordingly the National Environmental Secretariat, one of the departments of the Ministry of Environment and Natural Resources, identified the National Museums of Kenya as the focal point for matters related to genetic resources.

This workshop has therefore been organized to work out a strategy to co-ordinate the activities specifically connected with plant genetic resources. For this to be done it is necessary to set up a committee which should meet at regular intervals, to review progress of recommendations which will come out of this workshop, and to guide future activities.

May I propose that this committee be composed of the following:

National Museums of Kenya: 2 representatives

K.A.R.I.: 3 (1 from Plant Quarantine, 1 from the Gene Bank, 1 from the crop section)

KEFRI: 1

N.C.S.T.: 1

Nairobi University: 2 (1 from Chiromo, 1 from Kabete)

Kenyatta University: 1

Moi University: 1

Egerton University: 1

KREMU: 1

N.E.S.: 1

KEMRI: 1.

Question (Mr. Osoro): What are going to be the roles of the two National Committees - one which was first formed at the Serena Hotel in 1986 and the one formed now?

Answer: The committee formed at the Serena Hotel was composed of Permanent Secretaries; the committee just formed is a scientific one.

Question (?): Would it be a good idea to have a decentralized system with subcommittees, e.g. KEFRI, Gene Bank, crops (KARI), KEMRI, etc. This committee (NPGR comm.) should then be the overall coordinator which should report to the policy committee.

Answer: Yes, this is accepted as a useful proposal.

Question (Miss Murugi): are the in-situ and ex-situ working groups formed here part of the steering committee?

Answer: No - they are just part of this workshop.

Question (Mr. Ndegwa): Relating to the media coverage of the NPGR committee, would it be practicable to co-opt the Director of Broadcasting or his representative?

Answer: These were invited to this workshop, but did not turn up.

Question (Mr. Ndambuki): Since there already exists a National Plant Genetic Resource committee, established in 1986, and also a Gene Bank committee, how does this present PGR committee fit in? There seems to be a conflict of interests.

Answer: The Gene Bank Committee could be answerable to, or fit under the umbrella of, the NPGR committee, which advises the committee of Permanent Secretaries.

RECOMMENDATIONS OF THE "IN-SITU" WORKING GROUP

Chairman: D.M. Mbuvi

Reference was made to the 1984 Strategy conference for the Management of Kenya's plant communities. It was agreed that the broad recommendations adopted at that workshop be used as terms of reference in drawing out the working groups recommendations, as follows:

1. Evaluation of the 1984 and 1986 workshops' recommendations to assess their current implementation, and to find out the bottlenecks in those that were not implemented.
2. Among the priority species to be conserved are the wild relatives of crop species, and endangered/threatened plants.
3. A major priority is the conducting of vegetation inventories in areas where this has not yet been done.
 - 3b. Funds should be sought to enable the concerned institutions to conduct these surveys as a matter of urgency; these institutions are the National Museums, WCMD, KREMU and KEFRI.
4. Access to germplasm resources in Kenya should be regulated, especially to foreigners, and this should be monitored by the National Plant Genetic Resources Committee.
5. Manpower development and training: career prospects for plant geneticists and people working in related fields should be made more attractive in order to attract and retain professionals.
 - 5b. Donor agencies and institutions such as the Tea and Coffee Boards should support training in these areas; especially short-term professional courses should be developed.
6. Funding: the new Ministry of Research, Science and Technology should be involved in seeking for funds to support the field of in-situ conservation.
7. Public education. DDC's should be informed of the importance of Environmental Impact Assessments. The National Plant Resource Committee should publicise, and seek for support in such institutions to include development authorities (TDA, LBA, development authorities etc.)
8. Those areas identified for in-situ conservation should be continuously monitored by the NES department of environmental impact assessment.
9. On small sites of conservation value: a new category was proposed to include coastal Kayas, their western equivalents, and the small Taita Hills forests. This category should comprise Sites of Special Scientific and Cultural Interest, possibly to be conserved under National Monuments.
10. Conservation objectives: - *short term*: endangered species should be identified along with their habitats. Identification of endangered species to be done by the National Museums. - *long term*: conservation measures should be instituted within these habitats, even within already protected areas, to control destructive human activities.

11. Collection missions should be organized and coordinated by the national Gene Bank, to include food crop and cash crop relatives, horticultural, medicinal, pasture/forage and forest species.

12. In addition to the National Committee on Plant Genetic Resources this in-situ working group recommends to hold regular meetings to address itself to in-situ conservation measures.

Question (Dr. Gaudet): Who will carry out the evaluation of the 1984 and 1986 workshop recommendations?

Answer: The organizers of these workshops should be approached about such an evaluation.

Question: (Dr. Gaudet): Some bilateral agencies have a requirement to carry out environmental impact assessments on overseas projects. In Kenya NES is responsible for E.I.A. for projects. Should they expand their mandate?

Answer: NES should be approached about expanding their mandate to require E.I.A. for agriculture projects, and require collection and conservation of genetic material.

RECOMMENDATIONS

by Professor F. Owino

That the National Herbarium be the focal institution for plant germplasm collection and -documentation. The National Herbarium should have a mandate to obtain funds internally and externally in support of vegetation inventories, germplasm collection and the documentation of wild species.

That the National Herbarium should work closely with the National Gene Bank and relevant institutions such as KARI, KEFRI and the Universities to ensure that both domesticated and wild plant genetic resources are sufficiently surveyed, collected and documented.

RECOMMENDATIONS OF THE "EX-SITU" WORKING GROUP

Chairman: H. Kamau

1. Priorities should be
 - exploration
 - survey and inventory
 - collection
 - characterization
 - evaluation and germplasm exchange
 in that order.
2. Documentation will be carried out by the National Plant Genetic Resources Centre and will be a continuous process.
3. Storage of germplasm will involve maintenance, multiplication and regeneration.
4. Priority crops for collection are listed below:
 - Cereals:** maize, wheat, rice, sorghum and endangered species.
 - Legumes:** beans, cowpea, pigeon pea, green grams, mung bean, chickpea, endangered species.
 - Horticultural crops:** vegetables, fruits, root crops, ornamentals, spices, endangered species.
 - Oil crops:** sunflowers, castor oil, soya bean, coconut, groundnuts, rape seed, endangered species.
 - Cash crops:** coffee, tea, pyrethrum, cotton, sisal, sugar, others.
 - Tree species:** industrial, fuelwood, agroforestry, soil trees & environmental conservation, food/browse/fodder, shade/social/medicinal, endangered species.
 - Tubers/roots**
 - Pasture species**
 - Forage species**
5. Responsibilities:
 - 5.1 the National Crop Plants Genetics Resources Centre will carry out the following activities:
 - 5.1.1 long term conservation
 - 5.1.2 central documentation
 - 5.1.3 exchange of germplasm, internal and external
 - 5.1.4 training
 - 5.1.5 ensure germplasm security
 - 5.1.6 collection of un-mandated crops
 - 5.1.7 dissemination of information to research institutes
 - 5.2 Research institutions will carry out the following activities:
 - 5.2.1 collection
 - 5.2.2 characterization
 - 5.2.3 evaluation
 - 5.2.4 utilization
 - 5.2.5 short/medium term storage
 - 5.2.6 documentaion
 - 5.2.7 feed-back to the National Crop Plant Genetic Resources Centre of material and information
 - 5.3 the Universities will be responsible for the following activities:
 - 5.3.1 training
 - 5.3.2 manpower development
 - 5.3.3 further evaluation
 - 5.3.4 basic research and development of wild species
 - 5.3.5 collection

5.3.6 characterization

5.3.7 evaluation

5.3.8 utilization

5.3.9 feed-back to the Gene Bank for central documentation and long-term storage

6. There will be common activities applicable to all institutions such as in-vitro conservation.

Question (Prof. Mukunya): Do we need to duplicate the base genetic material at the Central Gene Bank and Research Centres within the country?

Answer: The Central Gene Bank should conserve all materials, both active and inactive. The National Research Stations should keep active collections.

RECOMMENDATION TO THE NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY by Dr. R.E. Leakey

It has been noted that in spite of the important progress in achieving research co-ordination by the National Council for Science and Technology, there remains a problem with respect to export of biological material from Kenya, especially by foreign scientists.

It is therefore recommended that the National Council for Science and Technology be requested to consider ways of strengthening the national reference collections by requiring all foreign visiting workers to deposit any unique material and duplicates of all other material with an appropriate Kenyan institution.

SUMMARY OF RECOMMENDATIONS

by Dr. J.A. Odera

The whole aspect of the conservation of plant germplasm requires a national approach because we have crops and trees both in the wild and domesticated. The responsibility of conserving this resource cannot be left with any one agency. We are therefore recommending that a holistic approach is taken, i.e. we look at this from a national point of view, and we are proposing that there should be a National Plant Genetic Resources Committee, constituted of an ex-situ group (with the National Gene Bank with its network of outstations, KEFRI and the Herbarium) and an in-situ group (Wildlife Conservation and Management Department, Forest Department, National Environmental Secretariat, KREMU).

Then we have the National Council for Science and Technology, a Government institution with the task of overseeing all aspects of research and development in Kenya.

I do not know how the new Ministry is going to fit in here, that is outside my mandate for this presentation.

The National Museums of Kenya will have the function of holding the Committee meetings and be the central point for bringing all these people together.

Foreign collectors, as in the past, are to apply to the Office of the President for a Research Permit. The applications go to the National Council for Science and Technology for evaluation and recommendation. The applications then go back to the Office of the President for issue or denial of a permit. It is recommended that the Herbarium be involved in the evaluation of the research projects. It is recommended that the Herbarium be the main depository of any plant collections. All collectors should affiliate with the Herbarium.

We see the ex-situ and in-situ groups coming together under the umbrella of the National Committee, and then deciding on policies.

Question (Mr. von Carlowitz): Has the National PGR Council an official advisory function?

Answer: Yes, to the Government bodies concerned on priorities and conservation policy, and other topics.

CONSERVATION POLICY

MANPOWER DEVELOPMENT ISSUES

Prof. D.M. Mukunya & Prof. S.K. Imbamba

The kind of training we need among the people who are going to steer this important national effort should supply a good background in the basic sciences e.g. biology, mathematics, chemistry, logic, computer sciences, statistics.

The people heading the institutions that will be conserving germplasm should have university degrees, e.g. BSc..

Then we need specialists i.e. plant physiologists, plant ecologists, taxonomists, environmentalists, etcetera.

Do the Universities (Moi, Egerton, Nairobi, Kenyatta and Baraton) have the capability to produce such people? Do we have enough lecturers around that we can give basic BSc. degrees and also go further and train plant breeders and physiologists to higher levels?

The answer must be yes, and no. We have had to ask money from undergraduates in order to train them to postgraduate level, as there were not enough funds. If there are international organizations which can come to our aid in this area, we shall be very pleased. We also lack facilities; there is a certain amount of research in our institutions but not as much as we should like, we need people with MSc. and PhD degrees conducting research in these areas.

In the last 10 years we have trained about 20 plant breeders; these are in great demand, both locally and internationally, and they cannot be retained in any post for a long time; high salaries elsewhere lure them away. This has contributed significantly to the stagnation of our own development.

DISCUSSION

Dr. Taylor: The National Gene Bank would essentially become self-sufficient in the next 2 or 3 years through German involvement. In the meantime the Universities should offer some higher training, if necessary an informal diploma course, to fill the gap; we have specialists working with the gene banks now, but their time is taken up with their responsibilities. A training strategy should be developed for gene banks making use of the expertise that is already there.

Dr. Abou-Zeid: We do have in mind to train more people according to our needs, and we have scientists receiving training abroad. We are losing some scientists because they are attracted elsewhere; we would like to recommend that we are given facilities to enable our scientists to remain in one place.

Prof. Owino: I wanted to raise two issues with respect to manpower development. There may be a case here for some crash programme to train in the Herbarium and in the University. This could be done at two levels, a specific course for those that are already on the job, to make them more suitable, and a masters level training in one of the Universities.

Dr. Odera: There is something wrong somewhere in the training in specialized areas e.g. breeders, physiologists, taxonomists; we need to come up with a strong recommendation to institute a crash training programme. Has the problem been that young scientists were discouraged from taking breeding studies?

Prof. Mukunya: Around 1979/80 there was great concern because we were getting very few postgraduate students applying for breeding, and a committee set up to investigate this discovered that there was a feeling among students that breeders did not have enough avenues of possibilities. Right now we are getting more applications in this field than in any other, since people have discovered that there are more openings and green pastures.

We also now have about six plant breeding lecturers and 20 other academic staff in the department of crop science. I do not know about the forestry area.

Prof. Owino: We have not really started a tree breeding programme at MSc. level and this is something that could be discussed. There are certain aspects of germplasm collection that link directly with the botanists in the Herbarium and this is one area which has received relatively little professional prominence.

(Unknown): Would it be possible to have the postgraduate programmes continuous instead of taking breeders this year, and pathologists next year? And would it be possible to shorten the civil stint of two years, which a BSc now has to do before he can do further training, to 6 months?

Prof. Mukunya: The postgraduate programmes have a capacity to take a minimum of 10 students, but we prefer to have 20 students, and so we have alternate year courses. We are also overhauling the postgraduate programmes, and there is to be no more extension beyond two years for postgraduate years.

Prof. Owino: For the purposes of gene bank and germplasm exploration, we need to make recommenda-

tions here at this workshop. We recommend that a crash training programme be proposed in the department of Botany, since the collection and documentation of germplasm seems to have to come out of the department of Science.

Dr. Odera: A number of organizations, such as the Herbarium, KEFRI, WCMD are faced with a shortage of trained manpower in these areas. We will be doing a service to germplasm conservation if we can come out with a specific recommendation that refers to crash training of resource persons on germplasm management, to cover ecology, taxonomy, physiology and breeding.

Dr. Oggema: We have always sponsored students to the University of Nairobi, but when they are given a thesis, they are given something irrelevant to the Gene Bank. This has accounted for loss of staff in our stations. Can't we have a forum where we discuss the thesis projects of these students?

Prof. Imbamba: We try as much as possible to let students carry out research in areas of their own interest. Occasionally the lack of facilities makes this impossible. The other issue is the question of taking students for the same course every year, because the supervisor has to finish with one lot before registering another.

Dr. Abou-Zeid: How much would be the training costs for one student for one year?

Prof. Mukunya: Right now the cost of training a postgraduate student is about 45.000/- to 48.000/-. As long as someone is taking care of the bills, it is possible to have short-term training courses at the University of Nairobi, which can be arranged between the concerned institution and the staff of the University.

NCST representative: We have been receiving quite a number of applications for funding projects for MSc students from other departments, and the feeling is that the 9.000/- which was mentioned for research work is not enough.

Prof. Mukunya: The 9.000/- is actually a laboratory field fee. If a student has a good research proposal we sometimes ask the dean committee to fund this, and also NCST, DAAD, IDRC etc., in order to accelerate the completion of the thesis.

Prof. Imbamba: The figures given are the amounts needed to pay the university to do a masters, but the student also has to eat and live, there is money necessary to do research, and that brings the total to 45.000/-

Dr. Odera: The problem at the university now is the lack of funds for training at the postgraduate level, and also a lack of teaching or supervisory staff. Why can't we come up with a figure and go to a donor so as to train students under relevant environment, and get value for the money? This workshop recognises the urgency of undertaking supportive studies on the management of plant genetic resources, gene banks and allied activities, seeing the existing paucity of trained manpower, and recommends that the National Germplasm Committee should prepare a crash programme focusing on postgraduate training, with possible donor support.

Prof. Mukunya: Within the last 3 years the University of Nairobi came up with a document for accelerated postgraduate training and updating of facilities in the Univer-

sity, particularly in preparation for the work that is going to be done by national institutes such as KARI, KEFRI etc. and so far USAID has a package for training people in research, which will have to be given to local institutions that will be training the research workers. There was a feeling that the University of Nairobi postgraduate programmes in the Department of Science could take up the bulk of training of MSc programmes, and it was found out that in terms of expenditure, training someone in Kenya is much less than sending them out.

P. von Carlowitz (ICRAF): There is also a shortage of training and teaching staff. In the initial case of such a programme which may be funded from outside, wouldn't there be too big a workload and gaps e.g. in taxonomy. Eventually such a program may generate an own institution capability, but initially it would be very difficult to put an extra load on your regular programmes, given the fact that you are still very few to act as trainers in such a programme.

Prof. Mukunya: It was considered that whichever donor would accept to fund this would also think about the local capability in terms of staffing. For example the University of Nairobi has established over 48 linkages with universities all over the world, so we can have exchanges of staff as well as student exchange. In areas where we have no lecturers we can get them from our sister universities.

Dr. Attere: We have to capitalize on these linkages. There are universities in U.K. which have been involved in training people for plant genetic resources activities; we could try and link with that university so that they start training for the first 2-3 years, while lecturers start a genetic resources course here.

Dr. Abou-Zeid: According to our rule we should train people locally.

Prof. Owino: I support the proposal from Dr. Odera that a crash programme be recommended to be undertaken by a local institution, but this should not be left to the National Germplasm Committee. A proposal for such training should come from a training institution. All the workshop can do is give the go-ahead to such an institution to come up with a proposal, and then the Committee can bless it. Could we be more specific and have a local University come up with a proposal for support of funding.

The Faculty of Science here in Nairobi has a reasonable strength in botany and could be strengthened to move into genetics, and I would recommend that this be the proposing institution.

Dr. Taylor: I come from the botany department here at Chiromo. I think it is the duty of this workshop to outline in general terms how many people need to be trained, and over what period, so we can relate funds to be asked for to those factors. This is needed by the faculty to make decisions about funding and staff.

Mr. Mbuvi: Is the issue of numbers that has been raised based on the capability of the university, or demand?

Prof. Mukunya: On demand, in the germplasm sector.

Dr. Odera: Interested institutions will demand and work out the number that they would require and then a number can emerge. But I am not sure how this would work out. Prof. Owino says that we should mandate one university to prepare a package but I do not know how this will work out

effectively.

Miss Kabuye: We see in this workshop that there is a lot to be done but we have very few people to do it. We were talking about surveying, collecting, monitoring, and working out which habitats are endangered, which species are endangered in the wild. All this needs people to go out and find out what is happening in the field, and it must be done now. We do not need a programme for the next ten years - we need one now. What we need to work out is how many people we need to have for this crash training programme, how much funding is needed, and then ask a University to take care of such a crash training programme.

Dr. Taylor: I agree the manpower desire should be specified very closely, and that this should be done on a national basis. The financial implications should be worked out very soon. The National Germplasm Committee should be mandated to ask donors, specifically for this crash training programme.

Dr. Odera: So the National Germplasm Committee should prepare a crash program proposal and then call donors.

Mr. von Carlowitz: This Committee couldn't act in starting discussions with the donors directly. This would have to go through government institutions. The way I see it is that the National Germplasm Committee would prepare the whole thing and pass it on to a respective Ministry suitable to call on the donors.

Dr. Attere: If the Universities and the National Museums come up with a programme proposal for a crash course, IBPGR will be able to cost most of that course, I can say that right now.

Prof. Mukunya: The Germplasm Committee is preceded by a powerful committee of 5 Permanent Secretaries, who were mandated at the Serena Hotel workshop.

Prof. Imbamba: I will provide the necessary information together with Prof. Mukunya. We have the figures, we know how much it costs, and we can tell how long the training will take. We can provide this information to Miss Kabuye.

Prof. Mukunya: We have already identified the Herbarium as the clearing house of whatever activities we have. We will have to give them the opportunity to define the proposal.

Dr. Odera: No! Not the Herbarium, but the National Germplasm Committee.

Prof. Imbamba: We will have to move fast; in October this year the new course is starting, if we are assured of enough students coming in we can get prepared.

Prof. Owino: If this is going to be a training proposal we better leave these to a training institution. If we can make a recommendation which is specific to a training institution, the whole thing will move faster.

Dr. Taylor: This crash course should not necessarily be an MSc course, but an interdisciplinary course; it takes 2 years to get every MSc course on the books, and we have no chance to meet this year's MSc deadline, so this course should be an ad hoc course. The university is mandated to set up ad hoc courses, and then we are free to move outside deadlines.

Mr. Awori: It would be useful at this stage to name 3 people to act on behalf of this Committee to develop such a proposal; this can then be presented as a draft to the

Committee to review.

Prof. Mukunya: I propose as the in-situ group KEFRI, the Herbarium, the dept. of Botany and WCMD, and I propose Dr. Odera to be the chairman.

Mr. Mugo: I propose representatives from the Herbarium, as well as Seme (ex-situ), Odera (in-situ) to be the chairman, Mbuvi, Mukunya and Kokwaro from the botany department.

Mr. Ndegwa: We should have a time limit for this subcommittee to convene.

Miss Kabuye: I suggest we have the National Committee meet as soon as possible, in the 2nd week of August.

Mr. Mugo: As a result of this discussion, we have now come up with a proposal for a crash training course programme. We have agreed that the Germplasm Committee should write up a programme, through a small working group composed of Dr. Odera (chairman), the Herbarium, Mr. Seme, Mr. Mbuvi, Prof. Mukunya and Prof. Kokwaro. This group will start sitting this Friday, so they can come up with a proposal for the main National Germplasm Committee, not later than the second week of August.

INTERNATIONAL NETWORK ASSISTANCE STATEMENTS

INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE

Dr. R. Benstead-Smith

The International Union for the conservation of nature recognises the importance of conserving natural resources, both ex-situ and in-situ, and this is in fact one of its main goals.

We are better able to help in-situ conservation. We would certainly like an opportunity to work with the national institutions in helping them to set up practical projects, to help set up funding for these, and then work with these institutions in implementing these projects. Two particular areas of what has been talked about these last two days seem most appropriate for us: one is the inventory of plant genetic resources, i.e. studies of particular areas which have not yet received special study; and more generally, to set up a national data base.

IUCN headquarters in Switzerland stores data on a global level, and the Conservation Monitoring Centre is very interested in helping set up national databases of biological resources in a number of countries.

The combined forces of the regional office here and the Conservation Monitoring Centre in U.K. would be able to help set up some sort of national database here, if that is what is wanted. I am thinking particularly of things like Dr. Beentje's presentation where he gave maps of the distribution of species; for all that sort of information IUCN has some sort of storage system with a possibility of putting it in a more accessible, and more expandable, basis so that it won't become cumbersome as more and more information is gathered.

In connection with that, I would like to comment that a lot has been talked about identifying endangered species to be conserved; I think it is important that species are not seen in isolation, particularly in complex ecosystems like tropical forests.

There has to be a pilot programme of research into the life history of these species. Globally very little is known about the dynamics of tropical forest, and how particular species survive. There is no reason to suppose that just because you identify the species, you know how to conserve it. You have to do research on how that species is surviving within the natural ecosystem, and make sure that you keep those conditions there to enable it to survive. Without that sort of research, the kind of questions that were raised yesterday about minimum area, minimum viable populations etc. do not mean anything until you understand how the species is reproducing.

At the same time, I feel there is plenty of room for action already. There is already quite a lot of information available which has led to certain areas to be identified as being very important for the conservation of genetic resources, e.g. the Taita Hills, Coastal forests etc. These are small areas rich in biological resources, and they do need some kind of protection.

Another way in which IUCN would like to help is in setting up projects to protect those specific areas. A few points arise: one is which would be the appropriate institution to work with in that case. Yesterday there was some talk of designating some of these smaller areas as National Monuments or something like that. But until you identify who is responsible for a particular area, then nobody can set up anything to help protect the area. I think it is maybe worthwhile for the Committee to review the question of what the legal status of such areas is going to be.

Another point is that in protecting those areas we also want to look at the interests of the local communities. In what way do they depend on those areas or would they like to use them. How can these areas be protected without detriment to the local communities. The kind of public awareness work that the KENGO representative was talking about is important, especially where genetic resources are concerned, because when you are protecting say important catchment areas or forests important to timber production, you can demonstrate some immediate rewards in that locality.

When one is talking about the benefits of genetic resources, very often these are not local benefits but national benefits, and often they are not immediate benefits, but long-term ones. It is not an easy idea to sell to local communities; maybe it is easiest to pick on an area which is known to have species of particular value e.g. rare coffee species or indigenous tree species; these are demonstratable values.

INTERNATIONAL CENTRE FOR RESEARCH IN AGROFORESTRY (ICRAF) P. von Carlowitz

The International Centre for Research in Agroforestry is an International Research Council, not an institute, with a worldwide mandate of Agroforestry research in the tropics and sub-tropics. It is made up of quite a unique combination of representatives and scientists of practically all disciplines which in one way or another are relevant to agroforestry. At present and compared to other big institutes it is still rather a small organization, but more recently it has been growing quite fast and we hope that by the end of next year, we will have reached the strength and staff level we require considering the enormous practical research task and our wide spread geographical mandate area, our limited financial and professional staff resources do not commit the implementation of the many required research projects by ourselves. Furthermore, such an attempt would ignore one of the more important mandate areas of the institution i.e. institution to promote the capability and capacity of national research institutes and research organizations which are related to this rather new scientific discipline as agroforestry happens to be. Contrary to agriculture and forestry which can look back on a history of about 200 and 300 thousand years, we are looking back on no history whatsoever unless you call 15 years history.

By status, mandate and structure as well as funding ICRAF is naturally set to work and operate through networks and collaboration with other institutions of various kinds e.g. donor institutions, research institutions and Universities in the tropics and sub-tropics as our actual mandate. We are not dealing with the temperate zone. Our conceptual approaches and research designs require operational research networks and various technologies which have been developed. This kind of network approach has also been acknowledged by our 14 or so donors who directly or indirectly support these activities. Several networks in a number of years have been set up or initiated. I should mention that collaboration with other institutions is very pronounced in ICRAF. It takes various forms. Either formal approaches like here in Kenya, e.g. with Dr. Odera and his institute, and more informal although quite intensive collaboration with Moi University; and many other in the 3 continents i.e. Latin America, Africa and Asia.

Examples of active networks we have are in the field of information, active field research and experimentation, in particular in Africa under the broad heading of what we call Agroforestry Research Network Africa within our collaboration programme. There is also a network which is just in the beginning of multipurpose tree related data bases. In every field we cannot do the whole thing ourselves, and interaction with other institutions and those people who do similar work is necessary to avoid unnecessary and expensive overlapping, to establish common grounds, to identify research steps etc.

There is also a network through which we establish an agroforestry systems network or inventory which we thought necessary to base further improvement on. In all of these activities, one which we should not forget is the regional germplasm development centres with particular emphasis on woody perennials within this group, with emphasis on multipurpose trees for integrated land use i.e. agroforestry.

Preliminary discussions have been held on this. We believe that there are certain activities in germplasm development which could be done efficiently and economically in a regional approach rather than a national approach, not ignoring the necessity of national germplasm banks and gene banks. But when it comes to training for example, or with regard to active germplasm banks which include dissemination of germplasm, e.g. for rare species or lesser used species, a regional approach may be more economical.

What is very often difficult is to get staff, in particular computer programmers. The last thing to mention which has something to do with collaboration and networking is our education and training facilities. We have an ever-increasing and rather strong training and education programme geared towards the promotion of agroforestry research; where they operate on various levels we have short courses, in Latin America, Africa and Asia. They are set up to serve researchers and semi-level government decision makers of the concerned ministries. Another programme is internship training where for 3 months to 6 months someone is working on a small but self contained research project. Then we have the senior fellowship research programme where a scientist from tropical and sub tropical countries are with us for a year and tackle the complete research programme.

This has been so successful that we have increased this opportunities considerably. The idea from our point of view behind that is to set up a promotion network. In agroforestry we still need promotion. We have to sell the idea and to define what we mean with that. The best way of doing this is to draw more people in and let them go back satisfied with what we do and what we think, and if they are convinced of the whole approach, the wider the idea of which we are convinced will spread.

INTERNATIONAL BOARD FOR PLANT GENETIC RESOURCES (IBPGR)

Dr. A.F. Attere

First of all I should thank the National Museum for associating IBPGR with the organisation of this workshop; once again, it has given us the opportunity to be associated with scientists working on the field of genetic resources in Kenya.

The IBPGR is one of the 13 centres of CGIAR in FAO, Rome. We are charged with the mandate of promoting plant genetic resources conservation globally. This means mainly to ensure that the natural crops are properly collected, conserved, evaluated, documented and freely available to all scientists all over the world. In Kenya, since 1978, we have been associated in various types of activities. We have given some equipment, scientific material, funds etc to various institutions in Kenya towards the conservation of plant genetic resources. We are pleased to be associated with this workshop which has recognised the need for a multidisciplinary approach when it comes to genetic conservation in Kenya; there is a need to develop and encourage manpower and we agreed that we will recommend that a multidisciplinary course for plant genetic resources be initiated at the University level, and serve the needs of Kenya as well as the needs of the region.

I would like to say again that one of the things IBPGR will look forward to is try and fund this course if it happens to be here in Kenya for Kenya and the region.

Right now we have trained a number of Kenya research staff in terms of Plant Genetic Resources activities and while we wait for the proposal to be submitted we are still ready to train more people in the university of Birmingham where we have the only course on plant genetic conservation right now operating in the world.

Right now we have already made money available to the National Gene Bank to start some of these activities as far as collecting is concerned and we are waiting for a proposal for characterization and multiplication of some of the resources existing in Kenya, right now. We look forward to repatriate any material which is of Kenya origin but which is now being duplicated or conserved in other gene banks in the networks, back to the national gene bank to Kenya.

We also look forward to seeing the national committee for genetic resources solve the problem of publicity or support i.e. if this committee can be a presidential committee for plant genetic resources in Kenya, I think we will have the right backing, publicity and support that is needed.

We look forward to seeing this committee operational during the second workshop on plant Genetic resources for Africa which IBPGR and UNEP hopefully will be organising in Kenya next year.

GTZ

Dr. Abou-Zeid

GTZ started in 1972 to establish national and International Gene banks in several countries. We started with Ethiopia, Costa Rica and now Kenya. We give support to other gene banks directly or indirectly through other organizations by giving technical support.

The National Gene Bank Programme in Kenya was started in 1983. We started all activities with GTZ institutions in the country. We came up with a number of a new cold stores for medium and short term cold storage. We have now 773 cubic m storage capacity for medium and short term cold storage in different institutions in Kenya. All the institutions were provided with proper packing material, and technical guidelines for management of germplasm. Generally we trained a number of scientists in different aspects.

Our National Gene Bank here will accommodate all facilities for seed processing, seed testing and for long term conservation. We will have 2 cold stores with total storage capacity of 150 cubic m and will be running at -18°C. We will have also facilities for seed drying.

We hope to have everything in action by January 1988.

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (U S A I D)

J.J. Gaudet

Over the years, U S A I D has funded a lot of activities related directly to the conservation of the natural material or in some cases conservation as relating to germ material etc, e.g. U S A I D has funded agricultural research programmes. U S A I D has also to a certain degree funded organisations like I C R A F, N E S and more recently in 1986, a certain amount of money from U S A I D was used for preparation of the materials for the proceedings of 1986 conference on the Strategy of Conservation of Plant Genetic materials.

Most of these activities, projects etc. were initiated in Washington. Recently at this workshop I have been in contact with some people here relating to some potential for funding activities in germplasm and biological diversity.

There is a new project that is beginning shortly, entitled Natural Resource Management in Africa which can be used towards this end.

BRITISH DEVELOPMENT DIVISION IN EAST AFRICA (O D A)

J.R.F. Hansell

We are the regional office of the ODA's development administration in London and our remit is the whole of East Africa, Somalia and Sudan. We are responsible for identifying projects there, to monitor them, ensure that the finances are available and evaluating the projects.

Unfortunately there are only 2 of us in the natural resources sector covering all five countries. So as a result of this we wait for people like you to come to us with projects. Unfortunately we don't have the manpower to go forward to look for projects for funding. In this respect therefore, I am pleased to say that in Kenya you have been active in putting forward programmes of this nature to us. The effective conservation and use of Kenya's Natural Resources is a high priority both for the government of Kenya and the donor. As a donor, we are delighted that the government of Kenya has designated the National Museums of Kenya as the coordinator of the national plant germplasm resource activities.

We have received in O D A a request to assist in the establishment of a plant conservation and propagation unit with a focus on developing propagation methods for wild plant species, including the crop relatives and indigenous species. As we have heard in this meeting much emphasis in agriculture is placed on use of exotic crops. Similarly forests of exotic trees cover much of the landscape. As a result, indigenous species for local land races have been overlooked as a resource. The museum has set up sites in which in-situ conservation is currently being practised e.g. Gedi and Ololua.

Ex-situ conservation of germplasm in the field of agricultural crops is being carried out by the ministry of agriculture with assistance from G T Z . For forestry species this is complimented by the tree seed bank at Muguga, KEFRI. We in O D A recognise the importance of the genetic resource species and the interest it arouses in both the scientific and layman circles around the world. We in U K have for many years had traditional links with the East African countries, through the Herbarium at Kew and the University of Edinburgh etc. We are hoping to develop and continue these links and I would like to say that we are very close to signing an agreement with Moi University for assistance through the forestry department in terms of manpower training and research in forestry.

I am delighted to say that we have been discussing at ODA the area that you are discussing and look forward to be able to cooperate and assist in this.

CLOSING SPEECH

R.E. Leakey

I have not had the advantage of listening to the last sessions, but I think I have picked up enough to make a modest attempt at summarising and bringing out some points which I believe are important. Before I do so, I would like to put the discussion into the context of the past perspective, the archaeological context, and I would like to state that many people forget that the use of plants in the domesticated sense, by man on this planet is at the most 10,000 years. The ability of man to exploit his environment as a hunter-gatherer goes back at least 2 million years and the domestication of most of the crops we now utilise, has taken place in the last 5000 years. One of the most interesting points that has arisen recently, is the understanding that hunter-gatherers communities living in the semi-arid and parts of the planet earth today, utilise plant resources that make up 75-80% of plant resources that are growing below ground, tubers and rhizomes; a very small part of the plant world being exploited above ground, yet much of our discussion in the last two days has related to the conservation of species that are above ground rather than the resources that are at present, totally unexploited, by man in the broad sense. This is an important point to remember.

The other point that I would like to bring out is also one of perspective; we are not here purely as academics discussing academic issues, we are here considering matters that concern the future of our country, our region and our planet; the future in terms of survival of our species. We are naturally selfish, and our preoccupation is the welfare of humanity within the confines of the discussion, and it is worth pointing out that many of our leaders around the world have a very short term perspective.

Over the last 10 years we have read and worried a great deal about the increasing drought conditions that are prevailing in many parts of Africa; the Sahara zone is of particular significance. Lake Turkana in northern Kenya receives 98% of its water from the Ethiopians highlands and the level of Lake Turkana is a very good measure of the rainfall received by Ethiopia. During the last 15 years, the water level on Turkana has dropped 41 feet. This was measured in front of my camp. And that drop of 41 feet has I think, been reflected in the drought and the famine that we have read about and been concerned about. Carbon dating and Potassium Argon - isotope work done in the last 2 years has established that as recently as 3000 years ago, Lake Turkana was 60 meters lower than it is today. This given you some indication of the possibilities of further drastic climatic change affecting this region and much of this discussion about the conservation of species/genetic resources should be seen in the context of a changing world and a world, that historically, has changed very little but pre-historically has changed very dramatically. I think this should be remembered in terms of the background to some of our deliberations.

Let me now turn to some more specific issues and say straight away that I think this workshop has demonstrated that in Kenya, there are Kenyans trained and ready and

positioned to help Kenya, and what these Kenyans need is help from their friends. This country has reached the stage in its development where we should be able to hold the initiative, and use that initiative to get help and I think the time has passed when we looked for external initiatives; and I think that the onus is on us as Kenyans heading and working in Kenyan institutions to use that initiative, and the goodwill that is so abundant from our friends, to solve some of our national problems.

Another point I should like to make that has come through very clearly, is that this workshop was designed to discuss the strengthening of national institutions and not the building of new national institutions. A great many conferences, workshops and symposiums over the last decade, have been called with a view to creating new empires, new structures, new edifices; this particular Workshop has identified areas of weakness in existing structures and the need to strengthen those through coordination and communication rather than to try to push them aside and say well lets start again with a new white elephant; that an important point for us to remember in the course of this discussion.

Of course we are a young, developing country; particularly at the current moment, we in Kenya face quite severe financial constraints and all of us, who work for Kenyan institutions are aware of the directives that have been received from the Treasury in the last few weeks, about cutting the budget; and many of us have to face very very severe financial cutbacks in our programmes and these cutbacks will affect training, our ability to produce better documentation programmes - it will affect our ability to exploit the institutional potential and the collection of new material in all sorts of different ways and I think we must be realistic and recognise that we are proposing new advances at possibly one of the worst times. Nevertheless, I would like to bring out the fact that at least in Kenya, and this is true of some of our neighbours as well, we are very fortunate to have very strong political support for the concept of the conservation of the genetic resources, particularly in the botanical field and I don't think one could ask for greater political awareness than is given by President Moi in his support for forest conservation, soil conservation and the whole genetic resources area.

I think that we have identified that our main weakness is an institutional weakness in terms of the lack of ability to communicate and co-ordinate rather than a weakness from the area of political support; and much more could be done as has been suggested to capitalise on that potential and political support that has been given and is given constantly by the President.

The other thing that has become very clear, as a result of our discussions in the last 2 days, is that there is a lot of professional goodwill in Kenya - there are a number of Kenyan experts in different institutions and different fields who, when they actually get together are prepared to work together and talk together. It is important to remark on the fact that a large number of international agencies have indicated, not just today, but previously, their willingness to help and I dare say as the director of this institution, that there is a lot of money looking for good

projects in Kenya. We are not short of money in Kenya from international agencies, we are short of good projects and that comes down to our ability as Kenyans in Kenyan institutions to formulate workable programmes to attract the funding, in the national interest. I can not over-emphasise my complete conviction that money is there if we ask for it. The initiative must be ours - if we are going to move forwards.

I would like to touch on two or three brief points that I think are worth mentioning. Kenya does need a more cohesive programme, both in ex-situ and in-situ programmes of conservation. There is a need to recognise that the Forest Department, the Dept. of Wildlife, the National Museums with its ability to legislate under the Monument Act, can do far more than has been done - and this is an area that we have identified and where perhaps in the next six months we will see some progress - this certainly will be my hope. In terms of the ex situ conservation again a lot has been identified in terms of need and areas where much can be done. The National Gene bank and the effort that is going on in that area is very important. Both in terms of ex-situ and in-situ programmes, there is a potential to attract support because of the regional implication for what is being done in Kenya. We have to remember there is, as Kissinger put it, a domino effect to progress in a single country, and I think there is much to be said for the support of programmes in Kenya in terms of what they will do for our region because of this ripple effect.

The question of training is one which we as Kenyans are constantly facing - its an area that is difficult and its compounded by many issues. I do not think it is necessary to go into, and our training institutions are stressed to say the least; they have many problems and we should be realistic in terms of what can be done over night. Nevertheless the idea of a crash training programme in the area of genetic resources conservation is tremendously important, and I am very enthusiastic about the possibility that something can be done in the near future to improve the level of manpower that is available to deal with some of the issues discussed over the last two days. Although we have high level political support for the concept, there is much more that could be done in terms of public support - public at two levels; public in terms of civil service level. There is a great deal of apathy on the part of administration in the government system (and this is surely coming from ignorance) and there is a great deal of apathy from the public at large, considering often that the problem is not theirs, but somebody else's. I think that public awareness is something that could be dealt with in part though this crash training programme that is being discussed.

An area that is very dear to my heart and one where I believe a great deal of progress could be made quickly if we get our act together nationally, is in the data retrieval area. It is quite clear we could jump a decade if we started the right way and that is to get our information into a system where it would be at national level. It is pertinent to this discussion that in the developing countries we are still talking about the technological revolution and appropriate technology for development, whereas in the developed countries they are now in the communication revolu-

tion, they are dealing with computers at a level that we often have not thought of. I think the database/data retrieval/computerisation is an area where enormous quantum leap could be anticipated, relatively easily if we discuss it in the right terms. I was particularly pleased to hear the representative of IUCN indicate a willingness to assist - there are a number of areas in which we could get help, but it should be a national endeavour rather than a source of little bits that don't communicate with each other and perpetuation of a problem which we are sadly too familiar with.

The final point I should like to make is that around the room we have already had sincere offers of help from external agencies; I would like to pay tribute to the IBPGR's help in getting this meeting off the ground in the first place and in the hope that it is giving in so many different areas, and I think that it is a very important part of the endeavor for the future. I would like to pay tribute to that assistance which has been given and will be given in the future.

I recognise that IBPGR gets help from UNEP itself and having UNEP so close gives me an opportunity to pay tribute to UNEP's role in this; but when you have a giant so close, you often think that the giant will do the work for you and I do not think we should forget in fact that we are a slight disadvantage in having UNEP here because it makes us lazy. We think UNEP will deal with our problem for us and I think you must remember that UNEP is there for the the world, not just for Kenya. Many of us Kenyans think that Gigiri is there just for us but it deals with everyone's problem. The offer from UNEP to continue with some of the initiatives taken as a result of this meeting is very much appreciated.

I would also like to say that the offer from USAID is significant; as a result of the rather peculiar way that the United States works, the Congress has unwillingly thrown something towards us that if we are clear, we can take; and that is a lot of help in this genetic diversity programme - as Kenyans we should be able to take advantage of and some initiatives have been and will be taken.

The representative from Great Britain speaking for the ODA, spoke very clearly and I am slightly embarrassed because he mentioned mostly things that he's hoping to do for the National Museums, but I would stress that what he is doing for the National Museum is in the area of botanic/genetic resources/conservation/propagation, and is very much in line with the recommendation that I believe has come from the workshop.

It would be wrong to conclude without recognising ICRAF and its networking which will prove very useful particularly respect to germplasm banking; similarly the GTZ input in the national gene bank and the support that you are giving in this whole area is recognised. There is much that you are doing and from what I have heard much you could still do; and now we would ask you as a representative of the GTZ to keep in close touch with some of the initiatives that will follow this.

It is very exciting to have that sort of support so easily offered. Finally I would like to say that all of this will come to nothing if we forget that the meeting was called to try

and establish a way in which we could communicate better as Kenyans and Kenyan institutions. The workshop was designed to try and establish a forum in which follow-up action and initiatives can be taken for the benefit of our country. The idea of national genetic resources committee is important, I take it as a great honour that so many of you have so willingly agreed to support the initiatives that has been taken, but we shouldn't underestimate or minimize the initiatives that have been taken before upon which this initiative has been built; I believe that in the National Museums through the National Herbarium, a great deal can be achieved and will be achieved and I would like to place the total support of the National Museums of Kenya towards this initiative. Thank you all.

LIST OF PARTICIPANTS

- Dr. A. ABOU-ZEID
National Genebank, Box 47051, Nairobi
- J. ADUNGAH
East African Herbarium, National Museums of
Kenya, Box 45166, Nairobi
- G. ARUM
Kenya Energy non-Governmental Organization,
Box 48197, Nairobi
- A.F. ATTERE
International Board for Plant Genetic Resources,
Box 30709, Nairobi
- A. AWORI
Kenya Energy non-Governmental Organization,
Box 48197, Nairobi
- O.E. BARAZA
National Irrigation Board, Box 30372, Nairobi
- Dr. H.J. BEENTJE
East African Herbarium, National Museums of
Kenya, Box 45166, Nairobi
- Dr. R. BENSTEAD-SMITH
International Union for the Conservation of
Nature, Box 68200, Nairobi
- P.G. von CARLOWITZ
International Council for Agroforestry, Box
30677, Nairobi
- Dr. J.A. CHWEYA
Dept. of Crop Science, Univ. of Nairobi, Box
29053, Nairobi
- Dr. S. DOSSAJI
Phytochemistry Dept., National Museums of
Kenya, Box 40658, Nairobi
- H. D'SOUZA
Agricultural Development Corporation, Box
47101, Nairobi
- Mrs. V.N. GATHAARA
National Plant Breeding Station, Box 26, Njoro
- Dr. J. GAUDET
US Agency for International Development, Box
30261, Nairobi Regional Office
- Miss C.M. GETAO
National Environmental Secretariat, Box 67839,
Nairobi
- J.R.F. HANSELL
Natural Resources Adviser, c/o British High
Commission, Box 30465, Nairobi
- Prof. S.K. IMBAMBA
Dept. of Botany, Univ. of Nairobi, Box 30197,
Nairobi
- Miss C.H.S. KABUYE
Botanist-in-charge, East African Herbarium,
National Museums of Kenya, Box 45166, Nairobi
- H.N. KAMAU
Plant Quarantine Station, Box 30148, Nairobi
- L. KANGETHE
Kenya Energy non-Governmental Organization,
Box 48197, Nairobi
- Miss E. M. KARIUKI
KEFRI, Kenya Seed Centre, Box 74, Kikuyu
- Miss B.N. KHAYOTA
East African Herbarium, National Museums of
Kenya, Box 45166, Nairobi
- Prof. J.O. KOKWARO
Chairman, Dept. of Botany, Univ. of Nairobi, Box
30197, Nairobi
- P.K. KUSEWA
Director, National Dryland Farming Research
Station, Box 340, Machakos
- Dr. H. LAMPREY
World Wildlife Fund, Box 48177, Nairobi
- Dr. R.E. LEAKEY
Director/Chief Executive, National Museums of
Kenya, Box 40658, Nairobi
- Dr. R. MALPAS
International Union for the Conservation of
Nature, Box 68200, Nairobi
- D.M. MBUVI
Wildlife Conservation and Management Depart-
ment, Box 40241, Nairobi
- F. MSAFIRI
Kenya Rangeland Ecological Monitoring Unit,
Box 47146, Nairobi
- R.V. MUGO
Deputy Director, National Environmental Secre-
tariat, Box 62839, Nairobi
- Prof. D.M. MUKUNYA
Chairman, Dept. of Crop Science, Univ. of Nai-
robi, Box 30197, Nairobi
- G.M. MUNGAI
East African Herbarium, National Museums of
Kenya, Box 45166, Nairobi
- K. MUSIA
Kenya Seed Company, Box 553, Kitale
- D.K. MUTHOKA
Director, National Agricultural Research Station,
Box 450, Kitale
- Mr. MUTINGA
International Centre for Insect Physiology and
Ecology, Box 30772, Nairobi
- F.M. NDAMBUKI
Kenya Seed Co. Ltd., Box 553, Kitale
- J.N. NDEGWA
East African Herbarium, National Museums of
Kenya, Box 45166, Nairobi
- P.M. NDONYE
National Environmental Secretariat, Box 67839,
Nairobi
- O.M. NJUE
Coast Agricultural Research Station (Mtwapa),
Box 16, Kikambala
- C.K. NJUGUNA
Tea Research Foundation of Kenya, Box 820,
Kericho
- O. OCHIAGO
Institute of Primate Research, National Museums
of Kenya, Box 40658, Nairobi

- Dr. J.A. ODERA
Director, Kenya Forestry Research Institute, Box
20412, Nairobi
- Dr. M.W. OGGEMA
Director, National Plant Breeding Station, Box 26,
Njoro
- Dr. M.O. OSORO
Director, National Sugar Research Centre, Box
1221, Kisumu
- Prof. F. OWINO
Head, Forestry Dept., Moi University, Box 3900,
Eldoret
- J.B.O. OWUOR
Coffee Research Foundation, Box 4, Ruiru
- J.K. RUTTO
Western Agricultural Research Station, Box 169,
Kakamega
- E.N. SEME
National Genebank, Box 14733, Nairobi
- Dr. A.R.D. TAYLOR
Dept. of Botany, Univ. of Nairobi, Box 30197,
Nairobi
- Mrs. G.N.W. TITHAI
National Council for Science and Technology,
Box 30623, Nairobi
- F. WALIAULA
Kenya Rangeland Ecological Monitoring Unit,
Box 47146, Nairobi
- Miss S. WATTIMAH
East African Herbarium, National Museums of
Kenya, Box 45166, Nairobi
- Dr. H. ZEDAN
United Nations Environmental Program, Box
47047, Nairobi

INDEX TO ABBREVIATIONS

- ADC-Agricultural Development Corporation
CGIAR-Consultative Group on International Agricultural
Research
- CIAT-Centro Internacional de Agricultura tropical
CIMMYT-International Wheat and Maize Centre
CRF-Coffee Research Foundation
DDC-District development Committee
EIA-Environmental Impact Assessment
FAO-Food and Agriculture Organization of the United
Nations
- GTZ-German Technical Assistance
IARC-International Agricultural Research Centre
IBPGR-International Board for Plant Genetic Resources
ICRAF-International Council for Research in Agro-
forestry
- ILCA-International Livestock Centre for Africa
ICRISAT-International Crop Research Institute for
Semi-arid Tropics
- IUCN-International Union for the Conservation of
Nature and Natural Resources
- JKCAT-Jomo Kenyatta College of Agriculture &
Technology
- KARI-Kenya Agricultural Research Institute
KEFRI-Kenya Forestry Research Institute
KEMRI-Kenya Medical Research Institute
KENGO- Kenya Energy Non-Governmental Organiza-
tion
- KREMU-Kenya Rangeland Ecological Monitoring Unit
LBDA-Lake Basin Development Authority
NCST-National Council for Science and Technology
NES-National Environment Secretariat
NGO-Non-Governmental Organization
NIB-National Irrigation Board
NMK-National Museums of Kenya
ODA-Overseas Development Agency (British)
ORSTOM-Organisation de Recherches Scientifiques et
Technologiques d'Outre-Mer (French)
- TDA-Tea Development Authority
UN-United Nations
UNEP-United Nations Environmental Programme
USAID-United States Agency for International Devel-
opment
WCMD-Wildlife Conservation and Management
Department
WWF-World wide Fund for Nature/World Wildlife
Fund



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Editorial Committee	Dr. H. Adan
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