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Report on Investigations

on

THE STATE OF SEED IN KENYA

by

Kamoji Kang'aru Wachiira
Consultant

for

KENGO
Mutiso Consultants
Mennonite Central Committee

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Introduction

Kenyans today are well aware of the problems they face to feed themselves and to produce sufficient fuel wood for domestic needs. With population growing at the fastest rate anywhere in the world in a country with only 20% arable land, there is recognition of the fact that, in addition to hard socio-economic choices, important decisions must be urgently taken with regard to land use, choice of crops, and rehabilitation of degraded land which has been lost to overgrazing, deforestation, soil erosion, and desertification.

Some progress has been made in Kenya raising awareness of people, particularly opinion makers, to the crisis they face. Concern about environmental degradation and the urgent need to conserve soil cover while at the same time creating sustainable sources of woodfuels, has spurred interest in planting trees throughout the country. This development has increased the demand for tree seed, especially seeds of efficient arid-area species and multipurpose agroforestry species. One consequence of this growing interest in "new forestry" is an unprecedented competition for the limited quantities of tree seeds available today and a concern among those involved in tree planting schemes and projects that new and reliable seed sources and supplies must be developed in order to ensure continued growth in this important sector.

KENGO, an NGO committed to productive conservation, is interested in seeking ways of making adequate seed of the appropriate types available to interested farmers and community groups. Together with other organizations and agencies, KENGO is proposing an intensive study of all issues related to availability of appropriate seeds in Kenya--both tree seed and food crop seed. While the immediate issue is on developing programmes and policies in support of availability of tree seeds for all purposes, KENGO is of the opinion that this issue must be understood in its fullest context, which includes the impact of foreign-based agribusiness/petrochemical industries on choices taken in countries such as Kenya.

Because Kenya is no longer self-sufficient in food, outside forces are playing an increasingly important role in

influencing how and for whom Kenya uses its land and resources. As Kenya leans on international sources for grain purchases and relief food in times of famine and for long-term development inputs, we become more dependent on solutions which are designed for foreign environments and economies. KENGO is concerned about the appropriateness of many of the solutions currently being tried or encouraged in Kenya. A brief look follows of some trends and related issues.

Current Trend: Increasing use of hybrid seed as a means to increase productivity.

Related Problems:

1. dependence of small-scale farmers on purchase of total package of input including new seed each season, as well as pesticides, and fertilizers. This effect of the "Green Revolution" mode of rural development has driven many farmers into debt in other parts of the world as they resort to loans to finance the expensive package of inputs.

2. vulnerability of farmers to massive crop failure due to monoculture planting which increases risk to environmental stresses (e.g., pesticide resistance and drought)

Current Trend: Increasing shift to cash crops

Related Problems:

1. increasing percentage of the precious arable land being devoted to commercial cultivation of luxury items (flowers, vegetables and beverages) for export overseas, leaving more and more Kenyans to eke out bare subsistence on increasingly marginal lands.

2. Land degradation due to decreased fallowing and/or "soil mining," and loss of traditional germplasm due to replacement by cash crops and improved cultivars.

KENGO believes that it is time for Kenyans to take a close look at what is happening to the ordinary farmer and citizen in countries where the Green Revolution has had an impact. Additionally, it behoves all of us who are interested in the issue of seeds, particularly crop seeds, to be keenly aware of breakthroughs in biotechnology that threaten to have a profound even revolutionary impact on seed technology and agriculture in general. It is not too late for Kenya to avoid the pitfalls and to learn from the experiences of

other peoples. In a country that is largely dependent on small-scale agriculture, it is paramount that Kenya plan for constructive policies and programmes that will enable the bulk of its population in the absence of better alternatives, to derive their livelihood from the land as productive small-scale farmers.

This report is an initial effort to enquire into the international scientific and commercial agricultural forces which have an impact both practically and attitudinally in Kenya, as well as the policies, infrastructure and practices in Kenya with regard to seeds. This is viewed as a working paper to be used in planning for a much more thoroughgoing examination of the issues at the proposed Symposium. Out of the proceedings of that Symposium, KENGO would hope that a major report on the current state of seeds in Kenya, the international factors influencing availability of seeds, related policies, serious gaps in Kenya's capacity to fulfill its current and future seed requirements and recommendations for future policy and programmes will emerge.

Chapter I

CURRENT SITUATION REGARDING CROP AND TREE SEED IN KENYA

Both symbolically and literally, seeds are unquestionably the essence, the very basis of the renewal of life. It is difficult to overstate the crucial role played by seeds in an agricultural economy. The quality, the quantity as well las the whole range of activities associated with seed availability and procurement are all fundamental issues in ensuring a successful food policy. In Kenya as elsewhere in Africa, as food needs rise and production declines, as prices of inputs rise and general incomes decline, so too will requirements rise for more seeds--both better types and more appropriate (even unorthodox) crops.

The seed issue, epecially future projections of seed demand/supply and advances in seed technology, is a rather vast topic. It becomes even more so in our case since we are interested not just in improved, high-productivity crop seed but also in seed of old varieties with special qualities; we are also interested in reviving some traditional crops in order to help insulate rural systems from fluctuations caused by uncontrollable external events. Finally we are interested in agroforestry and other tree seeds.

The state of seed is further complicated by the fact that both seed science and seed marketing are at a historic turning point. Previously plant breeding and seed production were carried out in a relatively stable, predictable environment mostly comprised of government agricultural research establishments, many small seed companies and fierce competition. With the arrival of new technologies in genetic engineering and fast high-tech breeding techniques, large multinational firms have moved into seed business and research. With this change the marketing picture is bound to alter dramatically. The MNCs include such giant chemical concerns as Shell and Sandoz which are now beginning to tie certain seeds to specific chemicals in their control.

Agroforestry and Tree Seeds

There has been a massive increase in demand for tree seed and other tree planting material in Kenya in the last ten

years, especially in the last five. Starting roughly about the time of the 1977 National Seminar on Desertification, with the subsequent UN Conference on Desertification held in Nairobi the same year, a great deal of enthusiasm in tree planting and soil-cover maintenance was generated. This enthusiasm was translated into organized movements of various sizes and different orientations which started small rural tree planting projects in many parts of Kenya. By 1982 there were at least 15 national organizations involved in planting operations of various sizes. This was in addition to the usual Forest Department industrial plantation and afforestation schemes. With such high levels of demand a shortage of tree seed was bound to occur sooner or later. A special aspect of this new demand was that seeds of unconventional, even obscure, species were sought. Whereas earlier demand was of fairly predictable species, largely confined to the traditional Forest Department list of mainly exotic species, prospective planters now turned their attention to, among others, efficient arid-area species, or to previously untried indigenous species and often to multipurpose agroforestry species.

This innovation was spurred by the following developments:

1. The National Seminar on Desertification, mentioned above helped to clarify to a larger audience the growing seriousness of environmental degradation in Kenya and the urgent need to conserve soil cover and to use where possible local flora in rehabilitation exercises. Kenyan acacias were specifically mentioned and recommended.

2. The publications of the U.S. National Academy of Science on underexploited and potentially useful multipurpose plant species from all over the tropics.

3. Finally, by the subsequent growth of an agroforestry outlook in rural agriculture and the "local woodlot" approach to rural energy self-sufficiency and farm practices.

The upshot of this "new forestry' was an unprecedented competition for the small quantities of tree seeds then available and a growing perception by those involved in planting schemes of an approaching bottleneck or seed supply constraint to planting schemes. It was felt that many projected schemes would be impeded unless new and reliable seed sources were procured and future sources and supplies institutionalized. This sentiment was repeated time and time again by participants and contributors at the special Training Workshop on Seed Collection and Handling held at Moi University in July 1985 (1,28). Earlier a consultant for ICRAF raised similar concerns and went on to highlight some possible solutions here and elsewhere (19).

Food Crop Seed

While tree planting organizations were encountering seed shortages, those in the farming and food sector were in the midst of a growing cropseed crisis whose severity was not to be fully recognized until the 1984 drought and famine. The widespread failure of the 1984 long rains and the ensuing crop losses meant disastrous shortfalls in commercial improved seed (primarily maize and bean) just when most subsistence seeds had either been consumed or were lost in the drought. Practically every farmer, large and small, was therefore in the market for commercial supplies. For the first time in memory, Kenyan commercial seed producers could meet only a fraction of the demand in maize and bean seeds. What some had feared for a decade, specifically since the 1971/74 drought, had occurred. The 1984 short rains season found many farmers unable to sow for want of seed. Kenyan farmers had to resort to imported commercial and "aid" seed, to unsuitable seed or to non-crop alternative land uses.

This 1984 drought brought many more actors into the seed question. Most notable were NGOs, particularly church related ones, UNICEF, FAO, and WFP, who heretofore had left seed questions to the MOA research stations and the commercial/ parastatal seed companies. The latter's planning, distribution, even programme capacities were so swamped that the Office of the President and the Ministry of Finance and Planning became the major actors. Perhaps this obeyed the logic of disaster control, but it is not a useful state of affairs for the long run in solving seed shortages.

The seed shortfall clearly would affect the size of the subsequent harvest just at the time when depleted national grain reserves needed massive replenishing. Clearly in crop farming, the seed issue had suddenly become a crisis and a whole new set of questions became apparent. Can Kenya's current cropseed infrastructure provide in the future adequate seed, certified or otherwise, to the rapidly growing crop sector? What technical and commercial adjustments are necessary? What institutions, public or private, local or foreign, influence seed production and marketing in Kenya? What institutional adjustments are necessary? How do subsistence farmers view the modern hybrid cultivars--the so-called High Yield, High Response varieties (H.Y.V.)?

Impact of Green Revolution

Hitherto increases in Kenyan food production and rural income have been based upon introduction of new improved or hybrid cultivars in food and cash crops a fact stressed repeatedly in the National Food Policy Paper (84), quoted below:

> The objective of food crop research will be to continue the search for more productive crop varieties, while increased emphasis will be placed on breeding programmes aimed at continuous increases in the yields of already established strains. (Section 3:13)

In crops, particularly, absolute food yields may rise, initially anyway, when hybrids and other "miracle" grains are cropped. However, the so-called "Green Revolution" model of the sixties and seventies brought with it a package of inseparable elements--high yield hybrids which require higher levels of costly chemical inputs such as fertilizer and pesticides plus purchases of new seeds every season. Kenya subscribes, in large measure, to this model of rural development as the food policy referred to above makes clear. As a result, other technologies like composting, local variety selections and utilisation of traditional crops were ignored and are being lost.

In summarizing the experiences of the last 20 years of the Green Revolution, very serious doubts have been expressed as to whether benefits ever did accrue to the rural peasants concerned (52 to 57). Evidence from Asia, (India, Sri Lanka, Pakistan, and the Philippines) where high-input, high-response hybrid rice cultivars were first introduced to previously stable and self-sufficient rural systems, shows that the shift resulted in economic disruption and social dislocation in the form of farmer indebtedness, resulting in repossession of their land, marginalization of small producers, and concentration of production by the larger producers. The outcome was the creation of a large dispossessed population of ex-farmers who migrated to cities in search of employment but who became instead unemployed shanty-dwellers. Evidence seems to suggest that beyond such structural disruptions the Green Revolution package in many cases benefitted the urban dwellers of the countries concerned (in that among other things consumer prices decreased) and the multinational corporations of the industrial countries who supplied the inputs, more than the rural societies which were ostensibly targetted (57).

More importantly for our purposes here, is the fact that this seed-chemical package spelt disaster for the rich crop-mixes that had existed since ancient times and that were part and parcel of the local cultures, folklore, and production systems. Older crop varieties, grown for ages and adapted to local conditions and environmental stresses, were rapidly replaced and often wiped out by hybrids planted in monocultural tracts which, being genetically uniform, are extremely vulnerable to environmental stress. A sneering attitude to these old races of crops became the order of the day among agricultural research and extension officials. In some circles here in Kenya and abroad this attitude still

persists. However, officials in many countries are now discovering, in many cases belatedly, the exact toll of decades of "Green Revolution;" Sri Lanka has lost many ancient varieties and landraces of rice. So have India and Malaysia.

This is the process called gene erosion where the rich diversity of genes, summarized and carried over from year to year as "genetic packages" in the different varieties of seed and sustained for eons as a cultural heritage of peoples, is extinguished rapidly or slowly, and replaced by highly vulnerable, genetically uniform cultivars. This reduced diversity in crops or reduced mix of crop species does not make for very much reliability or suitability in the long run. It reduces the in-built natural buffers against environmental stress and sets the stage for crop disasters when hybrids may fail en masse, e.g., as a result of a new pest or disease or sudden environmental changes.

In terms of gene erosion, Kenya's experience with high response cultivars is not very different from the Asian model. Old crops and old varieties have been and are being displaced. Luckily not quite as much destruction of germplasm seems to have taken place, although no proper inventory really exists here. But the danger is present and it is growing. Cash cropping for export may sometimes seem the larger danger in eliminating traditional crops and causing gene erosion. There are no figures but it is clear that horticultural crops and perennial cash crops are expanding rapidly at the price of food crop production (87). It is of dubious advantage in a situation where hunger and malnutrition exist to grow coffee and french beans for export at low and relatively falling international prices in order to import expensive staple foods and luxuries. These basic questions of food policy are large but they clearly have a bearing on the seed question in general and in any case must soon be addressed.

The Case for Traditional Crops

It is now realized that a wide and abundantly varied genetic base is crucial to stress-resistance in crops as in any community of living organisms; that those "lowly," previously derided, primitive varieties and landraces carry genomes of inestimable value for future farming and breeding; and that already much genetic information has been lost due to the "Green Revolution" attitudes and development model and that some back-tracking may be of great advantage especially to preserve and rejuvenate what is left of the old crop land races (41,42,43,44).

There is also growing evidence that rural development is not a simple question of biological/chemical efficiency in crop productivity. Neither is it a phenomenon dependent on high

technical expertise emanating from outside the farm system as the "Green Revolution" package assumed. There is a basic need for rural people to acquire greater control of their systems, to participate and to build their community and their institutions. If some productivity is lost in the short-run, the gains are inevitable in the long-run in that less "energy" will seep out to external systems. This is a form of slow de-linking from predatory, uncontrollable larger systems while slowly creating new, albeit initially weak, forms of self-sufficiency in food, in income generation and to some degree in political power, making it possible for farmers to control more of their own destiny.

No point is more appropriate to start from than self-sufficiency in seeds, that is, removing the dependence on commercial suppliers of unpredictable, expensive, sometimes unsuitable and unreliable seed. Hybrid seed, for example, does not reproduce itself. One must always purchase next season's seed from seed agents. Traditional crop seed, by contrast is made and harvested on the farm as a basic part of rural renewal. Except for times of disasters, it is always there. It is ecologically suitable to the area and makes up for its supposedly lower productivity by eminently higher stress tolerance and at much lower external energy (chemical, etc.) inputs. It is hence reliable.

A related problem as regards rural self-sufficiency is the growing threat of food as a political and economic weapon and the risks of international price wars as "grain mountains" increase in the industrial north and as these stock piles are off-loaded into the international market. One can imagine the possibility, difficult but there all the same, where a return to small-scale, traditional crop systems, in addition to the greater economies and ecological suitability, would also provide some buffering, if not total insulation from the ill effects of such international eventualities. If national diets change, say to non-grain staples, and as long as no natural disasters intervene, one is already partly de-linked from international grain movements, partly self-sufficient, and less likely to become a permanent ward of relief agencies.

Some may argue that this view is retrogressive, anti-progress, etc. In the short run it might seem so. In the long-run it could help create a new reality in rural life and shift the thrust from the "Green Revolution" model with its attendant dislocations to new community-directed production. It need not be a rapid change. It need not immediately oust or even challenge cash crops from their dominant role in many areas, but it slowly begins to create alternative forms and "vision."

Since the next 15 years are a critical watershed period in genetics, germplasm conservation and seeds in general, our examination of the state of seeds must have a strong future-projection component--something akin to looking into Kenya's seed requirements and policies into the 21st Century. This will release us from the narrow confines of merely investigating today's immediate needs, practical and urgent as they are, and help us to make a larger contribution to the wider seed debate and hopefully to Kenya's food preparedness in the future.

Chapter II

KENYA'S GERMPLASM HERITAGE

East Africa is geographically and ecologically somewhat abnormal. For one, it is the only equatorial eastern seaboard of a major continental landmass that is arid. By all counts ours should be a hot, humid, equatorial forest environment with nary a moisture-deficient month. Similarly-located regions on the Asian and South American landmasses are tropical rain forest ecosystems. Because of the monsoon effects, among other reasons, Eastern African lowland environments are principally semi-desert with scrubby vegetation of the dry Acacia/Commiphora type. The highlands form "ecological islands" of humid environments in this generally arid setting. East Africa is an area of unusually rich biotic endemism and it is no wonder that, with ecozones ranging from desert to alpine, this land provided an excellent setting for hominid and human evolution.

According to the Russian crop scientist N. I. Vavilov, there are seven centres of crop diversity in the world. Of these only the Ethiopian centre falls in sub-saharan Africa. Northern Kenyan uplands and wetlands are included in the Ethiopian centre in the strict sense of Vavilov's classification. But in a wider sense, much of Kenya and many of her traditional crops could be considered to belong to Vavilov's Ethiopian centre. The following crops or their wild relatives are, according to Vavilov, endemic in Ethiopia and Kenya, especially in the highlands:

Bananas	Onion
Barley	Sesame
Castorbean	Sorghum
Coffee	Wheat
Flax	Millet
Lab Lab (Dolichos)	Vigna

This is, however, an incomplete list. N. I. Vavilov, a Russian, and A. de Candolle, a Swiss, brought to early crop studies a bias of their European training and cultural values. They could not be expected to pay much heed to localized ethnic food tastes in Africa or to even be aware of them. In fact, for one reason or another, they both

missed the West African centre of origin which, though recognized as vital, does not feature in Vavilov's crop genetic diversity map. They understandably emphasized crops then known to European scholarship and culinary science and ignored important but obscure local ones.

There are literally thousands of crops in East Africa that were part of folk culture. They include root crops like the Kakamega yam (Liruku), pulses like Lab Lab (Bonavist beans or dolichos), Vigna sp, and pigeon pea, about a dozen species of grasses which yield grain in times of famine (and might be hardier in some cases than some millets), fruits and vegetables. The latter two were often collected wild and for that reason may have been ignored as a crop, but there is evidence to suggest that wild vegetables (Amaranthaceae, Solanacea and Cruciferae to name a few families) contributed a considerable portion of the dietary intake. Many are still used today, e.g., Thabai or Hatha (nettle) in the Central Highland forest zone, and Saga/akeyo (Cleome), so treasured in Nyanza/Western Provinces and now entering fresh vegetable commerce, etc. In addition, perennial tree/shrub foliage of diverse species was an important vegetable source for many cultures. Baobab and some Malvaceae relatives as well as cassava leaves are still used as potherbs.

Unfortunately, it is difficult to get a fuller documentation or inventory of Kenya's traditional food-crops. This is a very serious gap that needs filling.

The Ministry of Agriculture has this year started a special project to study traditional crops and revive interest in them. Under the Home Economics (Nutrition/Food Technology) section, the Intensive Food Production and Utilization project (IFPUP) will soon start two pilot projects in Kakamega and Kiambu Districts with SIDA assistance. Although their primary bias is nutrition, experiences here will illuminate future needs and directions. Initial goals include cataloguing folk crops and food types, documentation of cultivation, preparation and storage methods; and collection of germplasm and seed multiplication with a view towards introducing them as crops more widely. Eventually, it is hoped new crops from other Kenyan areas can be induced as dietary elements in all project districts and the country as a whole as the project expands.

This is a commendable effort that needs support and follow-up. One hopes it has not come too late. Some MOA officials, however, apparently still maintain that Kenyan crop landraces are virtually worthless in terms of food production. Improved varieties are encouraged as a matter of policy which aims for "higher productivity" as the only goal. Simple economics and changed tastes also mitigate

against traditional crops. Take sorghum and millets for example.

For centuries many societies in today's Kenya depended on sorghum and three main millet species: Bulrush (Pennisetum sp), foxtail (Setaria sp), and finger millet (Eleusine sp) for most grain requirements. Millets (especially bulrush) are particularly useful because of drought resistance and ease of pest-free storage--no insect bores into them because the grain size is so small. Unfortunately, the sowing-to-harvesting labour input is so high and the calorie productivity so low that other crops, despite being much less nutritious, are more attractive alternatives on a simple cost/benefit or calorie for calorie basis. Cash crops and maize have slowly replaced sorghum and millets in most areas in the last half century.

As for other traditional crops, e.g., beans, new improved varieties bred and selected to improve yield and disease resistance have swamped old varieties. According to MOA officials, changes in pathogenicity are an ever present danger as disease-causing microbes mutate and overwhelm new varieties. MOA officials state, however, that all traditional crop germplasm is in safe, secret storage for breeding purposes, and that much of the current improved bean cultivars are genetically composed of old bean landraces of Kenya. Such cultivars are Mwenzi mmoja, Mwitemamia, Wairimu, and Rose coco.

Other than the IFPUP concession mentioned above, the MOA is apparently fully in the Green Revolution school of thought as regards cash crops, hybrids and traditional crops. This is in keeping with the National Food Policy guidelines mentioned above. No other fact illustrates this as well as the apparent absence of a guideline on seed sources for millets or traditional grain legumes. In fairness, some millet and sorghum work is being done and improved varieties are sometimes available. Millets are now being selected and improved at Katumani Station. But generally traditional crops are left to their own dynamics and farmers must save and perpetuate their own seed. In a situation of frequest famines and fierce competition from improved varieties it is altogether likely that not only is the acreage decreasing fast but also that some crops and germplasm are disappearing. It is necessary to know the types, the trends and magnitudes of such losses. IFPUP will, most likely, not be able to provide this information soon enough in their area of work. The proposed Symposium should.

Another illustration of the Green Revolution attitudes on policy is the tendency to ignore the farmers that for want of land and subsistence are forced to cultivate marginal areas. Maai Mahiu and Rumuruti, Ithanga and lowland Kitui come to mind. Everybody deplores this form of agriculture,

but it is there and increasing. MOA attitude seems to be that such lands are for grazing, ranching, or other non-sedentary uses. Farmers seem to ignore this and to plant ecologically unsuitable crops. There must be crops other than maize that can be grown by such farmers in at least some marginal areas. Durum wheat (as in Ethiopia) and Triticale and millets come to mind, yet no work seems to be afoot to address this problem.

It has been reported that two researchers at the University of Nairobi, Crop Science Department, at Kabete, Drs. B. I. Muruli and D. M. Mukunya have collected some Kenyan traditional grain legumes (cowpeas and beans respectively). This is precious germplasm and should prove quite useful in the future if stored properly. Plant Quarantine Services may store the collection as part of their accessions. Lawrence Ragwa, at Katumani, is working with millets and may have a wide collection of living germplasm of traditional varieties in addition to hybrids.

Localized Crops and Wild Food Plants

Virtually all Kenyan communities have foods and tastes unique to their individual cultures and environments. If a list were to be assembled of all the edible plants and local crops of all the ethnic groupings of Kenya, it would doubtlessly go into the thousands. There would be wild fruit, annuals and perennials, potherbs, wild roots and tubers, edible fungi and aquatic weeds and semi-domesticated to fully-domesticated crops of all kinds. It would be a formidable list, indeed. No such list has been compiled for the entire country, although regional ones might exist. This is an area of possible research in the future. The IFPUP of MOA will hopefully soon have complete lists for Kakamega and Kiambu Districts. The former District falls in a particularly rich forest environment and has a rich tradition of using wild and semi-domesticated plant materials as food. The following is a brief and tentative list of some folk crops and foods from some localities in Kakamega:

Some Traditional Foods of Kakamega
(note: spellings not exact)

Kabras (and/or Maragoli)	Tiriki	Comments
Greens		
Emiro	Miro	(Legume)
Omurere	Omurere	
Lisutsa*	Lisutsa	Solanun, sp.
Libokwe	Libokwe	
Tsisaka	Tsisaka	Akeyo in Luo (Cleome, sp.)
Maranyolo*	Tsimboga	Amaranthus, sp.
Eshivetso*	Enderema	Riverside tree leaves eaten during drought
Eshingayangaya* (Linyororo)	Shingayangaya	Commelina
Sirietso*	Shiriezo	Tree leaf vegetable from the forest
Marande*		Perennial Vigna
Legume pods		
Tsibande		Pigeon pea-like wild legume not now found
	Tsimbalakaiya	Perennial forest tree, pods collected from ground and shelled
Liruku		Dioscorea
Fruits		
Elisalia	Tsikulumuru	Underground "fruit" reportedly annual monocotyledon
Mukhyyu		Juiced and fed to children in times of famine

* denotes self-sown annuals or perennials. All the rest are sown by farmers from seed, except the tree species which are wild.

Other regions have similar traditional food sources and it seems a very important area to which scientific and popular attention should be directed in order to revive where possible such crops and improve on their productivity and consumer acceptance as foods. See Appendix I for some of Turkana's food plants.

Virtually no work has been undertaken to domesticate, improve or study indigenous Kenyan wild fruit trees. KENGO has a plan to start collecting and doing trials of some of these plants at the Jomo Kenyatta College of Agriculture at Juja in the near future. There are at least two Kenyan wild relatives of fruit trees that can, at least, provide worthwhile rootstock to exotic scions and perhaps impart some stress resistance. These are Garcinia sp, a mangosteen relative and Diospyros sp, a relative of the Japanese persimmon. These merit experimentation.

Medicinal Plants

Kenya has a wealth of traditional herbal medicine which is slowly being recognized as an important part of medical treatment (89). Important treatises have been published on medicinal plants, their curative principles and their pharmacology (e.g., 40).

What may not yet be well known is that Kenya and the East African region in general are unique in medicinal flora because of several biogeographical factors. One is related to the climatic forces referred to earlier that make the Eastern African Coast and hinterland relatively dry, unlike other similarly located equatorial areas. The other is the presence of medium-altitude coastal uplands, e.g., Shimba, Usambara, Uluguru, and Teita, which by being moister and cooler are essentially islands of lowland rainforest environments, ecologically isolated for long enough geologic time to produce a high degree of endemicity or, in other words, to evolve many plants species found nowhere else in the world. Many of these plants have qualities yet to be discovered. Many are medicinal. This was dramatically illustrated by the discovery that Maytenus sp, a shrub from Shimba Hills, has cancer-curing qualities. American researchers have taken out at least 50 tons for analysis, as well as the germplasm to grow the plant there.

On the East African Highlands proper, i.e., land over 2,000 metres altitude and especially mountains rising above 3,000 metres, there exists interesting ecosystems in terms of plant endemicity. In contrast to the warmer, humid coastal uplands mentioned above, these high mountains are cool, moist, and in many respects temperate. They often have alpine flora on the higher reaches whose closer relatives are found in the mid-latitude mountains and arctic regions.

Montane rain forests are distinct from tropical rainforest formations. Mt. Kenya, Aberdares, Kilimanjaro, Elgon and Ruwenzoris fall in this category. Elsewhere they have been referred to as "ecological islands" in an expanse of dryness.

The flora here has evolved in total isolation for millions of years resulting in unique species, genera and even families. It is perhaps right to say that the genetic treasure in this flora is virtually unexplored. A few endemic species have, however, been identified as promising sources of medicine. Among these are the following Mt. Kenya species:

Guzotia sp, which yields a high-value oil currently under investigation as an anti-cancer drug in Europe and America. Indications are that germplasm has already been shipped out.

Valeriana sp, a potent natural sedative and asprin substitute, again under experimentation and germplasm also most likely already taken out.

Dr. Gopalan of the University of Nairobi, Department of Botany is doing some work with these plants.

Other Food Plants

If one includes lowland, lake basin forest formations and especially the unique Kakamega forest, the list of potentially useful plant materials lengthens. One need only mention wild crops and crop relatives as examples. Two categories will illustrate: legumes and tubers. Vigna, a relative of cowpea, is commonly found in the Uganda-Western Kenya areas while a wild, winged bean relative (Phosphocarpus) is now known to be endemic in Kakamega/ Uganda lowland forests and farther east, in spots. Edible tubers and roots abound in the montane and lowland forest. Dioscorea sp (yams) are largely an African food crop of the West African centre of crop evolution. Uganda and Kakamega have endemic species of these and other tubers used as food, but perhaps not investigated in any detail.

Arid and Semi-arid Plant Resources

Most of Kenya's surface area consists of hot, semi-arid lowlands with a rich and varied flora, albeit of less uniqueness than the "islands" referred to above. Pastoral or nomadic cultures have evolved in this environment and collectively have a vast store of folk knowledge on plant uses. These cultures and people are Somali, Borana, Gabra, Rendille, Turkana, Samburu/Maasai, Kamba, and Pokot to name a few. Their vast environmental knowledge is barely tapped and possibly disappearing as young people spurn older ways

and "modernization" eats up their territory and culture. This knowledge loss is as serious as germplasm loss and steps should be taken to retrieve what is possible before it is too late.

Dry-area "Economic Botany"

Most commercial uses of plants in the semi-arid lowlands have been based on tapping wild acacia trees for gum arabic, collecting myrrh essence or resins from aloes often organized by individual merchants for export. No firm data exist. It seems though that a more organized and possibly less destructive commerce can be built around some of these resources with more benefits accruing to local populations than before. Better yet, actual plantations can be established. One for aloe resin, which is an important commodity in pharmaceuticals, is already functioning at Marsabit under the management of a Catholic priest. This is an excellent idea that needs more enquiry. It seems that some NGOs are already planning to study and encourage such plantations and possible non-destructive collection from wild stands.

Comment on Conservation of Flora

This chapter set out to survey the less well-known wealth of Kenya's flora heritage--the totality of Kenya's plant germplasm. Conservation of these plant communities that may have such important meaning on Kenya's future welfare is, strictly speaking, not in the realm of seed investigations, but the point must be made that germplasm, wild and domestic, is the building block of seeds and the source of many plant products.

The International Union for the Conservation of Nature and Natural Resources (IUCN), and the National Environment and Human Settlement (NEHSS) are doing some work towards a conservation strategy (31).

Chapter III

CURRENT BREEDING ACTIVITIES IN KENYA

As a means of increasing yields in a situation of extreme land constraint and capital shortage, breeding and research are heavily emphasized by Government in the National Food Policy of 1981. The following quotations illustrate this commitment:

> The main aim of policy for seeds will be to ensure a steady increase in the supply of improved varieties. . . . . (Section 3.9)
>
> The objective of food crop research will be to continue the search for more productive crop varieties while increased emphasis will be placed on breeding programmes aimed at continuous increases in the yields of already established strains. (Section 3.13)

Through the Ministry of Agriculture, the Government of Kenya has a comparatively well established crop breeding and seed production infrastructure. There are currently five major National Agricultural Research Stations (NARS), each with a specific crop mandate. Breeding, varietal selection and seed release in such crops are done solely by that station. Following is a list of the main food crop stations with their mandates:

Station	Crop
NARS, Kitale	Maize Pasture
NARS, Njoro	Wheat Barley Triticale, Oats
NARS, Thika	Beans Cowpeas Horticultural

NARS, Katumani	Dryland Crops, Sorghum, Millet, Pigeon peas, sweet potatoes
NARS, Mtwapa	Cassava Fruits All coastal crops

In addition, the MOA has a network of sub-stations which are usually linked with one of the above main ones in terms of crop mandates. Thus, for example, Embu Agricultural Research Station is a major substation for maize breeding and trials.

Potato breeding and seed production are done at the Potato Research Station Tigoni. Other stations handle industrial crops, e.g., sugar cane and cotton at Kibos, but these do not concern us here.

Kenya Seed Company and some other semi-private and private companies are also active in some breeding activities, but they depend on government breeding work for their main lines which they obtain for free to multiply and bulk for sale as seed. In addition, East African Industries is now active in oilseed (sunflower and rape) breeding.

Improved Cultivars: Seed Quality Control and Release

The general trend in the last four decades in Kenya has been towards increasing the acreage under improved cultivars, especially in maize, barley, wheat, beans. See table below:

Crop	Total Crop Area 000 ha.	% Area Planted with Improved Cultivars
Maize	1.200	95
Barley	70	100
Wheat	100	70
Beans	400	25

All seed and new cultivars are released after careful testing, certification, and registration by the The National Seed Quality Control Service (NSQCS). Situated at Lanet, NSQCS is charged with ensuring that all seed released to farmers conforms to the International Seed Traders Association (ISTA) rules and standards. The Specialist Cultivar Release Committee (SCRC), composed of experts in each crop, after three years field testing recommends to the National Cultivar Release Committee (NCRC) to include a new cultivar in the national "Index." To be included in the

Index, a new cultivar must be different from others, pure, uniform and superior.

Kenya subscribes to the principles and procedures for seed certification contained in the schemes published by the OECD, in which Kenya is a member country for Cultivar Certification Schemes.

Seed and Plant Cultivars Act, 1972

All seed activities and releases, summarized above, are governed by the Seed and Plant Cultivars Act, 1972 (see Appendix II).

Seed Production in Kenya
1979/1980

Crop	National Crop Area (ha)	Seed Crop Area (ha)	Seed (tons)
Wheat	100,000	2,925	4,945
Barley	70,000	2,852	2,707
Triticale	-	14	21
Oats	-	1	.5
Maize	1,200,000	2,850	15,796
Potato	-	88	200
Beans	400,000	106	53

Examples of Breeding Work in Kenya

The following are examples of breeding work in Kenya done either by Government or companies and other institutions.

a) Maize Seed

Kenya uses about 15,000 to 20,000 tons of improved commercial maize seed a year. A fair estimate of subsistence non-commercial maize seed would be in the region of 10,000 tons.

As in all major commercial crops, basic breeding work in maize is done by Government and then the bred lines are passed on free of charge to Kenya Seed Co. to multiply, to bulk and sell as commercial seed. The National Agricultural Research Station at Kitale is the major government maize breeding station in Kenya since long before independence. Katumani, Mtwapa and Embu are important maize breeding sub-stations. While Kenya Seed Co. can, in theory, multiply and bulk seed anywhere that conditions and facilities permit, most highland varieties (500 - 600 series and the new 832) are done in the Endebess/Kitale and Uasin Gishu areas in both private and ADC farms. Kenya Seed Co. have now their own in-house supplementary breeding programme for maize--National Breeding Programme--which will ensure maize

seed availability and improvement for all climatic zones and for possible export. Already some export is undertaken to Tanzania and Uganda.

Contract farmers produce the final seed under the supervision of Kenya Seed Co. and the NSQCS. Retailing is largely done through KGGCU, Co-operative Unions, Cereals and Produce Board and other agents.

Kenya Seed Co. have modern drying and testing facilities at Endebess where capacity exists to dry up to 25,000 tons a year but usually average 15,000 tons during good harvest years.

As a response to government policy, seed storage facilities will be built within the next three years by the company in conjunction with governmemt to ensure that at all times there is enough buffer seed for two years planting in case of seed-crop failure or other emergencies. This would mean a storage network capacity of not less than 40,000 tons. Proposed sites are Kisii, Kakamega, Kitale and perhaps Sagana.

There is an upward trend in improved maize seed demand. In 1983 farmers used 13,000 tons of Kenya Seed Company's maize seed, 14,000 tons in 1984, and about 16,000 tons in 1985. One reason for this increase is the sub-division of previous large scale wheat-land into small-holder plots under maize and stock. There is also a growing trend all over the country to plant maize in drier areas as land shortage forces populations to marginal areas. For this reason it would seem that the demand for dryland seed is rising proportionately faster than for wetter area varieties. Another reason for the increase in maize seed demand is that due to drought and poor rain distribution farmers often have to plant twice or even more in one season to ensure a full crop. This would explain part of the large increases in seed demand in the last two years.

As more small-scale farmers turn from traditional varieties to improved ones, Kenya Seed officials expect that by 1990 demand for maize seed of all cultivars should be between 25,000 and 30,000 tons.

They emphasize one important point: that their seed production capacity is immense; if, for example, demand for 50,000 tons of seed a year suddenly rose it could easily be met with only one or two years advance warning as the limiting factor is mainly time and not the physical infrastructure. This implies that for most improved cultivars there should be no shortage of seed for any length of time. Seed-growers or contract farmers, who obviously enjoy the favourable financial and marketing agreement can be readily recruited as the need arises. Being a

parastatal, Government can also provide emergency facilities when necessary.

This was proved in 1984 when rains failed and little seed was harvested. Since farmers' own seed sources had dried up or had been consumed, everybody turned to commercial sources. Due to frequent post-emergence drying up and the need to re-plant, demand also catapulted. It is estimated that during the failed 1984 short-rains, more than twice the normal amount of seed was planted out. This situation of inadequate supply and excessive demand meant that 1984/1985 seasons found the country without enough seed especially the Katumani and the 500 hybrid series.

To rectify this the company along with the Ministry of Agriculture mounted an emergency rescue operation to produce seed under irrigation at Bura. The plan reportedly worked and seed supply recovered fully by 1985.

Maize Breeding and Germplasm

A brief account of the major genetic constituents of the current Kenyan hybrids is of some interest (45). There does not exist an all purpose, universal hybrid maize cultivar. Each cultivar is carefully bred to produce specific growth and yield characteristics in a given environment. Breeding in Kenya started in 1955 at Kitale using local traditional strains which after many generations had adapted to the various zones and diseases and could be considered as distinct (i.e., in-bred, therefore pure) varieties. These varieties can be divided into four general types:

1. Coastal maize - originally introduced by the Portuguese in the 1500s from the West Indies

2. Local Yellow - originally from USA via South Africa

3. East African Flat White - local names: muratha, kingi, katumbili, the complex called the Kenya Flat white, grown in the moist highlands and some dry highlands, by far the most popular variety in Kenya. Introduced in 1900 from USA and/or via South Africa.

4. Cuzco - local name: githigu, introduced in the early 1900s by missionaries from South America, highest altitude, tea zone up to 3,000 m.. Grains have purple, red and brown colour.

These four basic types form the main breeding material although foreign germplasm from CIMMYT and elsewhere have been used in some cases. All the original germplasm is reportedly in storage at the various germplasm banks in the country and internationally at CIMMYT and elsewhere. Kenya

Seed Co. also has a large in-house germplasm bank at Kitale. In addition, many small farmers still grow these traditional varieties. Their numbers are perhaps declining rapidly due to wider and increasing use of hybrid seed. There is need to know the exact status of these traditional varieties although scientists and officials seem sure that should need ever arise to grow these varieties adequate seed could be multiplied within a year or so from existing germplasm here and elsewhere.

Improved and Hybrid Maize Cultivars →

Four main cultivars have been bred for Kenya's zones:

1) 500 series (511, 512, 513) for the medium altitude or the coffee zone
2) 600 series 611, 612, 613, 625) for the tea zone
3) 823 for high altitude, high rainfall variety, soon to be released
4) Coastal-Pwani hybrids 1,2, developed from Mexican-American and local germplasm
5) Coastal composite
6) Dryland or Katumani series.

b) Wheat Seed

All wheat breeding is done at the Agricultural Research Station, Njoro. Although there are many varieties, disease vulnerability, etc., makes it imperative to continually breed new varieties as resistance and pathogenicity of rust change. Material lines are then passed on the Kenya Seed Co. for multiplication at their Nakuru Station before contract farmers produce the final seed for distribution to farmers. Wheat varieties are bred specifically for capital intensive, large scale, high-productivity farming areas.

Little or no attempt has been made to breed wheat for small-holder (say non-mechanized harvester) producers nor for dry land growing despite obvious demand or potential for both. Durum wheat is kept as renewable germplasm for breeding purposes and one assumes that the resources are there for such dryland wheat breeding if policy should change to emphasize small-scale wheat production on marginal land.

Due to growing fragmentation of large farms previously under wheat in the Rift Valley and changes from wheat growing to barley and rapeseed, etc., demand for wheat seed has been declining for a decade.

c) Barley

Again the bred material is obtained from Government breeders at Njoro, but lately the Kenya Breweries Ltd. have entered the local barley industry in a big way in order to satisfy

all their previously imported malt requirements. Kenya Seed Co. have started contract breeding and multiplication for Kenya Breweries with germplasm supplied from CIMMYT to supplement Government breeders and to help find the best malting variety for various growing zones, Narok being the major one at the moment. By this agreement, Kenya Seed Co. will do the seed maintenance, multiplication and trials. All indications are that barley is rapidly becoming a major grain in Kenyan farming, geared wholly to the brewing industry.

d) Other Cereals

A small demand exists for oats for animal feed. Small quantities of seed are produced for this market. A most important new grain whose seed is available but at low demand is the new cross-genera grain, Triticale--a cross between wheat (Triticum) and rye (Secale), and which has practically all the advantages of the two parents and greater productivity than either.

It would seem that with proper further varietal breeding of Triticale a strain suitable for zones drier than the driest wheat zones is easily possible and this needs much more concerted attention by all concerned. At the moment, for reasons not wholly clear but worth researching further, Triticale has not caught on. There is a possibility that the brown colour of rye contributes to the "not white enough" complaint by consumers, so millers and bakers prefer wheat, polished at that, in deference to consumer preferences. It has been verified that 20%, if not 30% of bread dough could be Triticale without colour or taste variation whatsoever. It is worth enquiring from the authorities concerned what official policy might be as it seems that Triticale would lower costs to both producer and consumer while utilizing poorer land and less rainfall in some cases. Research and further breeding are continuing at Njoro.

c) Pasture

Kenya Seed Co. are fully responsible for grass seed production. While most breeding is done by the National Agricultural Research Station, Kitale, the company has also recently started some breeding especially of Boma Rhodes (Chloris guyana) with material from U.S. firms, especially Pioneer Hy-bred International. An extensive collection of grass germplasm exists and is continually increasing. Kenya is a net exporter of pasture seed and no shortage of conventional pasture species has occurred to any serious extent. With FAO assistance, MOA has just completed a major Kenyan pasture germplasm documentation project (32).

d) Sunflower and other Oilseeds

Kenya Seed Co. jointly with East African Industry (EAI) and the Kenya Government have just completed a successful 5-year breeding programme from 1978 to 1983 at Wanguru, Mwea. The aim was to produce varieties higher in oil content (40% as compared to 20% before) and suited to various zones. Five varieties were developed and released. Germplasm was imported from Holland and USA. EAI have, however, pulled out after the end of the agreement claiming to have started a local subsidiary Oil-Crops Development (OCD) to deal with all aspects of oil seed (88).

Kenya Seed are, however, still continuing with sunflower breeding to improve on the five varieties above in the hope that NSQCS will select their better varieties at future sunflower trials.

Rapeseed and sunflower are new oil crops of increasing importance in which OCD have interests. Future breeding research and extension are part of OCD's plan aimed at total self-sufficiency in edible oil for the East African market.

Grain Legumes

Thika is the mandated bean research station. Under the Kenya/Dutch Government Grain Legume Project (GLP) some important new bean varieties have been developed (GLP 2, GLP 92, GLP 1004) with local germplasm. Mwezi Mmoja and Mwitemania varieties are some of the older, improved varieties. Dr. D. M. Mukunya of the Crop Sciences Department of the University of Nairobi specializes in bean research and has bread new varieties of Rose Coco. All germplasm is stored at Thika Horticultural station.

Soy beans are considered a potential field crop and Kenya Seed Company is accordingly carrying out trials of various strains with a view to breeding and multiplication. For some reason, the crop is not important in Kenya's agriculture at the moment.

Cow peas have not been bred in Kenya although Dr. B. I. Muruli has made extensive collections. Vita-3 a strain originally from Uganda has proved very productive after IITA provided the germplasm.

Other Related Activities

Although not involved in direct breeding or seed work, Plant Quarantine Services (PQS) of Kenya Agricultural Research Institute (Muguga) is an important adjunct to the NARS system. Described below are some of PQS's activities relevant to our enquiry.

Plant Quarantine Services

Over the last 10 years, Plant Quarantine Services (PQS) has become one of the very few institutions to make practical and routine use of tissue culture in Kenya. In all virus screening and cleaning work, as well as in general propagation of clones, meritematic tissue culture is now a standard operation at PQS. There is, therefore, already a fund of knowledge of this modern technique, as well as fairly adequate laboratory facilities. It is now PQS policy to import all tuberous plant materials in the remarkably efficient tissue culture form rather than in the old-fashioned, bulky rooted-plants method. This way the risks of introducing new dangerous soil-borne (especially nematodes and fungi) pests has been totally eliminated.

The major importance of this facility for us is that already in the country there exists a rudimentary centre for some modern bio-tech work on to which more advanced work can be added, e.g., protoplast fusion for breeding, direct cell culturing work for greater speeds in propagation of clones and research facilities in other such molecular and cellular level of plant work (see Chapter IV). For a long time to come, however, the officer in charge sees propagation as the dominant use of tissue culture in fulfilling their quarantine, plant pathology, cloning and dissemination work because of lack of facilities, funds and trained personnel.

Germ Plasm Collection

PQS is the official entry point for all plant materials imported into Kenya. Official PQS policy is that 10% of all material imported must be retained at the centre for propagation and distribution to other interested parties in Kenya. The importer gets the remaining 90%. PQS also actively seeks to introduce many new or important strains and varieties of major crops. This has resulted in a sizeable collection of crop varieties from all over the world. Unfortunately, due to previous oversight, many crop varieties were wholly given out leaving PQS without specimen or mother plants. This situation would not have happened were it not for the fact that PQS was then seen more as a quarantine station than an incipient gene bank.

It is now policy to plant out and establish, where practicable, all perennial accessions with documentation of relevant technical data. PQS is now therefore an active germplasm collection centre with much scope in the future. Vegetatively reproducing plants, e.g., banana, sugar cane, and sweet potatoes are especially easy to maintain. Fruit mother trees are now happily established and easily supplied on demand as budwood, e.g., mangoes, avocado, plum, pear and grapes as cuttings.

PQS has recently started two interesting functions as a germplasm centre.

a) The International Board for Plant Genetic Resources (IBPGR) in their most recent grass collecting visit to East Africa last year collected practially all Bracharia (grass) species endemic in this region and took the material to genebanks abroad. PQS, which used as a temporary depository and to screen the material, retained living specimens of each species/race in the PQS plots--the largest such collection in this area.

b) PQS staff have just organized germplasm rescue mission. Before the East African Community was dissolved in 1977, EAFFRO had a network of sorghum research station in East Africa. Kenya's was at the Provincial Agricultural Research Station in Busia. Much earlier, (perhaps in the early sixties) this station had received, as had all the sister stations, a collection of improved cultivars and primitive races of sorghum from all over Africa and elsewhere for purposes of disseminating to farmers and for research. Most of the Busia collection came from Serere and Kilombero, the counterpart stations in Uganda and Tanzania, respectively. After the collapse of the Community, the sorghum work at the Kenya and Uganda stations ground to a halt (civil chaos in the latter country may have contributed further to this). Sorghum seed which had been collected and poorly stored in unsealed, unfumigated packets since 1974 were left unattended until PQS staff got wind of it. They were brought to Muguga, weevils and all, and immediately planted out in plots. Of the 80 varieties it seems a good 50% or more might produce at least several plants each as some germination has already taken place.

It is perhaps overstating it to say that some of these would have been extinguished were it not for this mission. Kilombero still may have a wide collection of similar sorghum germplasm. But in terms of Kenya, it is a unique effort by what seems like a highly motivated staff. Results of this rescue mission may be published in the KARI bulletin.

Proposed Base Gene Bank and the Current Network

Of interest, too, is the proposed base germplasm (gene) bank currently under study by GTZ experts. It will be located on PQS grounds, but it will have different terms of reference and jurisdiction. A base gene bank is one where seeds are stored over periods of many decades at temperatures of -20 degrees C., or lower and kept dormant and undisturbed. This contrasts with active seed banks where seeds are kept about 4 C. over shorter periods and are constantly exchanged,

disseminated and even grown out to renew the material for seed or for further storage. When completed, this bank will join the network of such banks in Africa and elsewhere. While it will not necessarily alter the Kenyan seed situation immediately, it augurs well for future preservation of precious material, e.g., threatened crop and wild relatives whose habitats are now irreparably damaged.

As an adjunct to this project there is a research proposal under way at PQS to establish an active seed bank to hold some of the future base bank accessions in active form and permit easy access. (NB: Access to a base bank is very infrequent, measured in years, as disturbances to the storage cubicles must be minimized.)

PQS already has a small refrigerated seed bank of about 60 cubic metres. It is here that all imported seed materials are stored during the period of analysis and dissemination to research stations, organizations, and individuals. For many years the station was administered by USAID technical assistance staff, but it is now fully Kenyan-run.

Due to lack of funds and some organizational problems the cooling machinery broke down in 1980 and was not repaired until 1983. In those years of non-refrigerated storage 98% of all accessions were destroyed. In soybeans alone, of 213 accessions, 183 were lost--a great loss by all accounts. These were mainly modern, improved cultivars and would easily be replenished from the original sources and progeny lines. So while the losses are regrettable, they are not as catastrophic as would be the case if a collection of rare seeds of endangered material got lost by such a breakdown. This incident does serve, nevertheless, to illustrate the dangers facing gene banks and the need for network collections and duplications as insurance against any losses, inadvertent or otherwise.

At the moment there are 20,000 accessions of 200 seed species and varieties in storage, mainly graminae and pulses. An active regeneration programme, albeit hampered by budgetary constraints, has been instituted.

It seems that, with a little more official or political commitment to the germplasm collection/bank principle, this country already has a rudimentary infrastructure which would come in most handily should, as seems likely, policy be altered to more aggressive conservation/acquisition of seed/germplasm.

PQS works closely with other Government Agricultural/Horticultural Research stations all over the country. These stations can be termed a form of germplasm network, each with its own specialty. Ideally they should have active germplasm collections in addition to their other

seed/clone producing functions. It is, however, not clear how well maintained the germplasm accessions are at some stations. While there is no evidence to cause excessive alarm, some concern about the level of documentation and standards of storage has been voiced. In many cases the concern seems justified as the example on machine breakdown at PQS several years ago indicates.

Commercial Seed Importation

According to the Seed and Plant Varieties Act mentioned earlier, National Agricultural Laboratories (NAL) handles/ all issues related with quality, fitness, etc., of all seeds imported to Kenya.

Chapter IV

IMPACT OF BIOTECHNOLOGY ON AGRICULTURE

In 1973 two scientists in California achieved a major scientific breakthrough; they were able to transfer the gene of one organism to the DNA of a second organism. This inserted gene then went on to "express" itself along with the second organism's DNA just as if it had been part of its genetic code all along. They had spliced genes and they had transferred them between organisms. This is the newest, the most revolutionary process in genetics and the entire biological sciences and is called Recombinant DNA (rDNA) or, more popularly, genetic engineering. The manipulation and alteration of the genetic or cellular integrity of an organism in order to create novel forms engineered for specific functions promises to revolutionize, in a way difficult to exaggerate, all the sciences and the economies of many societies. It is part of that cluster of new scientific techniques and discoveries that is called "biotechnology" or biotech for short, a term that encompasses various processes--rDNA, cell fusion, micro-injection, tissue culture, etc.

Genetic engineering was first applied in medical and animal sciences, not in botanical or agricultural sciences. It was only after 1980 that researchers in these latter disciplines attempted the first serious efforts of rDNA work. This new instrument has suddenly changed the possibilities of plant and crop breeding by many orders of magnitude within a brief period of only five years. With scientific work still going on and new biotech discoveries being announced regularly, it seems the agricultural potential of this new tool is simply astronomical (65,69,71,76).

Effort is now under way to apply these cellular and molecular technologies commercially, as well as to specific agricultural problems. To illustrate the new vistas opened up by biotechnology, listed below are some potential uses already being tested in various research establishments abroad:

a. herbicide resistance in crops

b. environmental stress resistance in crops
c. direct nitrogen fixation by crops and micro-organisms
d. biosynthesis or the direct production of plant bio-chemicals in factories
e. breeding and propagation of novel crops

a) Herbicide Resistance

Herbicides are part and parcel of the agribusiness production process. One constraint of herbicide use is the danger of killing off the desired crop while spraying weeds. If a crop were developed that could resist, i.e., be indifferent to, the effects of a potent chemical weed killer, it would make it possible and much cheaper to douse the entire field with that chemical, scorch all the weeds and leave that crop unharmed. Bioengineering has already shown promise to deliver this. Already two Brassica (rape) varieties have been bred that are resistant to the herbicide atrazine by splicing and transferring mutated genes from herbicide resistant weeds that are relatives of rape. There is hope that atrazine-resistant tomato/potato varieties will soon be engineered by a similar weed-to-crop gene transfer using recombinant DNA technology.

b) Environmental Stress

Recombinant DNA allows scientists and breeders to identify a gene for a desired plant property, locate it and splice it, then by means of a vector organism, usually a specific bacterium, implant it into a second organism's genome. Thus it is possible to literally create new plant types almost with made-to-order characteristics. Such characteristics could be drought resistance, less vulnerability to vast climatic fluctuations, disease resistance and salinity tolerance, therefore permitting sea-water irrigation, and a host of other such possibilities. This would immediately set the stage for spatial expansion of crop production into areas where it was previously impossible. A particularly promising use, especially for a country like Kenya where soil erosion and sloping land limit farming area, is the potential for making minimum or no-till farming possible on a larger scale by engineering beneficial micro-organisms and using them to combat soil-borne plant diseases. Normally, no-till soil conditions harbour too many soil diseases and necessitate expensive fumigation, making this practice uneconomic.

c) Direct Nitrogen-fixation

Nitrogen is a vital nutrient in crop productivity. Legumes can, if provided with proper Rhizobium bacteria, make their own nitrogen from the air. Why can't other plants be

engineered to do likewise? This is already being attempted although it is still too early. More efficient Rhizobium/Legume varieties combinations have already been experimentally produced. At the University of Wisconsin researchers have engineered Azobacter, another nitrogen-fixing micro-organism, to make it supply nitrogen to maize, not by a symbiotic root-nodule relationship as in legumes, but by direct leakage of nitrogen near the maize roots. Direct transfer of the nitrogen-fixing facility to a crop is so far unthinkable as too many genes are involved. Still, there is hope of further research breakthroughs.

d) Biosysthesis or the Direct Production of Plant Bio-chemicals

In the medical and zoological sciences, many advances in synthesizing enzymes, hormones and other animal physiological chemicals have already become commonplace. For instance, insulin, interferon, vaccines, etc., can now be produced by bio-engineered micro-organisms growing in methanol vats in factories. Bio-synthesis, as this process is called, is most advanced in animal/medical sciences. Plant and crop sciences are somewhat behind but are fast catching up. By 1984 laboratories were capable of producing some 50 natural products with yields equal to or greater then those of the crops they would replace. High fructose corn syrup (HFCS) now biosynthesized from maize is undermining the traditional farm sources of sugar. The sugar beet industry in Europe and North America is undergoing serious dislocation as a result of more and more such non-farm sweeteners (Aspertame is the latest) being manufactured in biotech labs. Up to 15 percent of Japan's and 40% America's sugar demand is now being satisfied through biosynthesis. This will have drastic and immediate repercussions on sugar growing economies and societies (60,72). In the Philippines, for example, export incomes from cane-based sugar dropped from U.S.$657 million to $316 million between 1980 and 1983 and are still dropping. The social cost of this type of product-displacement is colossal and rising. It is definitely with us as all those who farm, sell and make policy on sugar know. Its impact will grow in the future and much of Western Kenya's economy, increasingly sugar dependent, will face great difficulties, if not collapse.

Another new process is the production of protein animal-feed by biotechnology. Single Cell Protein (SCP) is a basic amino-acid manufactured by micro-organisms in large quantities. It will replace soy-bean (the most important protein feed crop) when fully developed. Conceivably it could be seen as a process which would save grain and protein foods now used as animal feeds and help Kenya's quest for protein self-sufficiency production. However, the economics of these activities are not yet known.

However, not all plant products can be easily produced thus. For example, cellulose fibre or coffee/tea products are too complex to permit easy bio-manufacture, but it is now just a question of time and research. The list of biochemicals that can be biotechnically manufactured is growing and many economies, including Kenya's, face considerable disruption (61,66). See Appendix XI for a list of other plant product tissue culture. NB. Pyrethrum is now an almost obsolete crop as pyrethrins can be biosynthesized.

e) Plant Breeding and Propagation

Most of the above-mentioned processes are possible because scientists can now work at the cellular or molecular level of life in contrast to the whole-organism level of the past. Cell and molecular biology allows for direct manipulation of living forms and compresses time and space so that what used to take thousands of years and hectares and tens/hundreds of technicians many years or even decades, can now be done in several petri-dishes by one individual in months.

This has permitted rapid breeding and propagation of new varieties as well as culturing cells and regenerating them. An important spinoff of this technology is the recent discovery of genetic variation spontaneously occurring in tissue cultures or cell-clones which should, by all expectations, be identical. This has provided a potentially rich new source of genetic diversity which seems, if proven to be persistent, to redeem this new scientific tool.

Limitations

Biotechnology is a formidable new tool. Much of it is still in its infancy. Many problems have yet to be overcome especially in basic science. For example some crop species have failed to respond to any genetic manipulations while knowledge on gene-vector micro-organisms is still limited. But research is progressing rapidly as the list in the following section demonstrates.

New Bio-engineered Crops

The following wholly bio-engineered new crop varieties are scheduled to be released from biotech laboratories or field trials into commercial growing as per timetable shown:

Bioengineered Crop	Release of Altered Plants to Breeders	Release of Seed to Farmers
Maize	1984	1990
Wheat	1986	mid-1990s
Sorghum	1990	mid-1990s
Sunflower	1985	1987

Tomatoes	1984	1986-88
Potato	1985	1986-88
Beans	1986	early 1990s
Sugarcane	1985	mid-1990s

Biotechnology, Patents and Multinationals

Biotech is the new growth area. Multinationals have sensed the great financial possibilities that lie in wait for investors--"Biobucks" as one scientist called them. This new technology needs the legal protection afforded by patenting in order to recoup the immense start-up research investments needed. Patents provide the holder with exclusive legal rights to an invention for 17 years during which time, if a patent is infringed, the holder has legal recourse. Genetic engineering is a suit tailor-made for the plant patenting process.

Take, for example, pesticide-tying. Agro-chemical corporations which possess patented proprietary pesticides in their manufacture would love to force farmers to only use their brand chemicals. Producing patented seed of varieties which are bio-engineered to resist (or depend on as the case might be) that given proprietary chemical provides an excellent sales strategy and assured high returns to investments for a long time with little competition. This is exactly what Ciba-Geigy has done with their herbicide "Dual" and what others are fast aiming for. Ciba-Geigy pellets seed with Dual resisting chemicals so that seedlings can be unaffected by the herbicide when fields are doused. They call this pelleting "Herbishield" and, of course, it is patented.

The powerful synergy which biotechnology confers on the chemical-seed linkage and the revolutionary potentials inherent in genetic engineering make possible a dangerously high degree of control of the entire agricultural production process.

In the USA, for example, many of the leading MNCs already have activities related to biotechnology (including at least 83 of the largest Fortune 500, while at least 62 of the 500 largest non-US-based MNCs have now entered biotech activities (74).

Some of the MNCs in biotech are: Allied, American Cyanamide, ARCO, Chevron, Ciba-Geigy, Dow, DuPont, FMC Corp, Hoechst, Monsanto, Occidental Petroleum, Pfizer, Rohm and Haas, Sandoz, Shell, Stauffer and Upjohn. Many of these same companies have also merged with or purchased seed companies (68). Such well-known companies as Northrup King, Asgrow, Trojan and Funk have been absorbed into the network of petrochemical and pharmaceutical giant MNCs (see

Appendices III, VIII, IX, and X for lists of recent seed company acquisitions by MNCs).

Clearly seeds, agriculture, food and commodity export will never be the same again.

Possible Impact and Implications of Biotech in Kenya

Unlike the Green Revolution whose main impact was in the country concerned, Bio-revolution will have an all-pervasive impact in developed and developing economies, but as always in new technologies greater impacts will occur in the Third World (see Appendix IV for comparisons of Green Revolution and Biotechnology). Although the majority of the biotechnologies are still embryonic, potential economic and particularly agricultural implications are so dramatic and possibly disruptive that we need to know them early enough so that proper protective steps can be undertaken on an emergency basis if need be. By the same token, many opportunities for exploiting biotech exist and these too should be explored. Following are some areas that need investigation:

a) What agricultural products on which Kenyans depend are likely to be displaced in the near future? We have seen that sugar is one of them. What are the implications of such displacements.

b) How will multinational seed-agrichemical giants affect seed availability here? Are there ways to combat or ameliorate the effects of that form of seed marketing? More specifically, are there threats to Kenya's current seed infrastructure from MNC acquisition?

c) Many biotech processes and innovations can be of immense help in solving some of Kenya's farming problems. For example, new bio-engineered crop varieties that can grow in semi-arid sandy, clay or saline soils would boost Kenya's production immensely and remove the land-constraint that now exists. Another example is biosynthesis of some products. Are there any possibilities of comparative advantage if Kenya undertook some biosynthesis? For example, if sugarcane farming is unprofitable because of biosynthetic sweeteners then could gasohol be biosynthesized from Kenya's sugar crop and thus help save on foreign petroleum bills? What are the income redistribution effects of such a move? Further, can Kenya benefit in livestock disease eradication by use of medical biotech?

d) What are the secondary effects to Kenya as a

result of economic dislocations caused by biotech abroad?

"common human heritage" rich countries collect and hoard germplasm from the South, then use this precious material for breeding and crop improvement. Resultant high yields are then sold to the South at high prices as food or used as political weapons in some cases. Worse yet, the seed of improved varieties are patented and made not a common heritage, but private property by multinational firms. Such seeds are only available at exorbitant royalties while the germplasm is sometimes used as a political weapon denied some nations and begrudged others.

Mooney has documented many cased of unfairness in germplasm access. He highlights the case of the International Board of Plant Genetic Resources (IBPGR) as the concentration of the rich countries resolve to siphon off the genetic abundance of the South and store it in the North. IBPGR is the creation of the Consultative Group of International Agricultural Research (CGIAR), a consortium of large foundations, the World Bank, multinationals, and western governments that also founded and oversees the global network of the International Agricultural Research Centres (IARC) listed below with their research or service speciality:

International Food Policy Research Institute
(IFPRI), Washington, D.C., policy studies

International Maize and Wheat Improvement Centre
(CIMMYT), Mexico, maize, wheat, barley

International Rice Research Institute
(IRRI), Phillipines, rice

International Crops Research Institute for the Semi-Arid Tropics
(ICRISAT), India, arid area crops, sorghum millets

International Centre for Agricultural Research in Dry Areas
(ICARDA), Syria

International Centre for Tropical Agriculture
(CIAT), Colombia, general tropical crops

International Crop Centre
(CIP), Peru, potatoes

International Institute for Tropical Agriculture
(IITA), Nigeria, grain legumes

International Laboratories for Research for Animal Diseases
(ILRAD), Kenya, animal health

International Livestock Centre for Africa
(ILCA), Ethiopia, livestock and pasture

International Board for Plant Genetic Resources (IBPGR), Rome, germplasm collection

International Services for National Agricultural Research (ISNAR), Holland, research development and management

This CGIAR network has done much crop improvement, germplasm collection and storage. CIMMYT and IRRI are notable in having provided the so-called hybrid miracle grains (wheat, maize, rice) that sparked off the USAID-proclaimed "Green Revolution" in the sixties. Serious questions have recently been expressed about the benefits of IRRI in the Phillipines and India and rebellion against IRRI rice hybrids expressed (see ICDA Seedling, October, 1985, pages 4 and 6 respectively). Of greater importance, according to the activists though, seems to be IARC's role as siphons or funnels for germplasm from the South to Northern seed banks. All accessions collected by International Board for Plant Genetic Resources (IBPGR) go to these centres and to developed countries' storage systems.

IBPGR, in self-defence, claims that delay in collections until all nations are ready for storage and use might result in serious losses of threatened material. They point out the requests of Kampuchea, Ethiopia and Sudan for germplasm of their traditional crops after their own germplasm was destroyed in war or drought or both. Had these not been collected and stored earlier by CGIAR centres they would have been lost for good. A strong case is argued by IBPGR that the issue is how South countries can use germplasm, that is already freely available internationally, while also taking steps to store the rest of their own gene heritage properly. It must be remembered that IBPGR's mandate is in only 50 crops, up from the original list of nine. Other non-crop plant germplasm falls under the mandate of International Union for the Conservation of Nature (IUCN).

On balance, it seems the IBPGR has a crucial role to play in crop germplasm collection and storage given the rate of loss, human caused (e.g., destruction of habitats, war, "Green Revolution" cultivars, etc.) or catastrophic, e.g., drought. There is evidence, for example, that the 1974 Sahelian drought wiped out many grain landraces which would now be replaceable had there been IBPGR-like collection/storage programmes before that disaster.

It seems possible that while CGIAR and its wealthy western sponsors may have had ulterior political/economic motives, IBPGR itself was a naive (politically innocent) grouping of scientists going about business unquestioningly, as technocrats are often wont to do while fitting into a mold that clearly keeps old colonial forms unchallenged. One cannot assume that science acts in a socio-economic vacuum

or that it is value-free or immune from political machinations.

Mooney, RAFI, ICAD, and others have, however, highlighted the "conspiratorial" aspect of germplasm and seed business and the vested interests of large business firms and shown how IBPGR may reinforce past unfairness in seed and food relations. UNFAO, the shield used by CGIAR for ten years to cover some of their activities, has been forced by these indefatiguable activists and the Group of 77, to take more control of IBPGR and to bring it under the UN General Assembly.

This is the culmination of the Third World anti-IBPGR and anti-CGIAR thrust that started in 1981 at the FAO 21st biennial conference in Rome with Mexico kicking off the debate. The debate was continued at the 22nd conference in 1983 and resolved at the 23rd conference this last November in favour of more democratization of access to germplasm. On the surface this seems like a major victory for the Third World.

However, evidence is already developing that the CGIAR (under the insistance of Western interests, especially the U.S. Government) is refusing to accept democratization of access to germplasm or to bring IBPGR's operations directly under the UNFAO and the General Assembly's control. CGIAR has threatened to oppose the decision made in November 1985 by pulling out of FAO entirely and forming an independent germplasm bank, leaving the FAO to begin from scratch to establish a new network of genebanks. This, after having used FAO staff and facilities and Third World genetic resources for ten years to establish the IBPGR banks. If this comes about, it will be grossly unjust and lends credence to Pat Mooney's and others' observations as expressed in issues of ICDA Seedling and IGRP Report from late 1985 onwards (96, 97 respectively).

Patents

The question of access is much larger than can be solved by an FAO or UN resolution, however. A more sinister development regarding access, in fact the real problem, is the increasing tendency for seed firms to apply patent laws to seeds bred from freely obtained germplasm and to charge userous royalties for such seed. Patent laws in industry have been widely exposed as a vicious form of imperialist control and a hindrance to transfer of technology in favour of industrial nations. In addition to this legalistic blocking of access to seeds and germplasm, multinationals like Shell Oil, Pioneer Hi-bred International, Sandoz, Ciba-Geigy, Atlantic Richfield, Basf, Pfizer, etc., are moving into the seed business by buying out smaller firms, forming conglomerates and monopolies, and concentrating on

seed marketing. This risks to alter permanently the seed industry to the great detriment of poor countries' food production.

This has interestingly raised an outcry in the American and international media, as well as genuine concern over the future of seed marketing. The following sampling of recent articles gives some idea of this.

"Mystical Thinking and the Patentability of Higher Organisms," Geoffrey Karny, Genetic Engineering News, 7-8/84.
"Protection of Plant Varieties and Parts as Intellectual Property," Sidney Williams, Science, 7/6, 84.
"Multinationals Move In: Firms See Growth Potential in Seeds," Ken Conner, San Francisco Chronicle, 6/9/84.
"Patents Are Biotech's Battlefront," Gail Schares, San Francisco Chronicle, 6/7/84.
"Seed Growers Concerned About Industry Trends," Dick Yost, Oregon Farmer-Stockman, 5/17/84.
"Genetic Engineering Patent Law Trends Affecting Development of Plant Patents," C. Weagley, D. Jeffrey, and A. Kiepenbrock, Genetic Engineering News, 4/84.
"Do We Need a Special Patent Law for Biological Inventions? Iver Cooper, BioTechnology, 2/84.
"Preserving Plant Genetic Resources: Open Letter to World NGOs and Others," Upendra Baxi and Clarence Dias, Mainstream, 11/19/83.
"Budapest Treaty Makes Biotechnology Patenting Simpler," Stanley Schlosser, BioTechnology, 11/83.
"Agricultural Biotechnology Needs Strong Patents," Nicholas Reding, BioTechnology, 9/83.
"Conglomerates Have Big Plans for Nation's Seed Companies," Thomas Porter, Jr., Greenhouse Manager, 7/83.
"Seeds of Disaster," Mark Schapiro, Mother Jones, 12/82.
"The Legal and Legislative Background," Donna Smith and Jonathan King, Environment, 7-8,82.
"The International Breeders' Rights System and Crop Plant Innovation," John Barton, Science, 6/4 82.
"Patenting Life Forms: Issues Surrounding the Plant Variety Protection Act," Barbara Claffey, Southern Journal of Agricultural Economics, 12/81.
"Seed Patenting Considered a Threat to the World's Food Supply," Cary Fowler, COOP News, 8 17 81.
"A Rhubarb Over Patenting Vegetables," Ann Crittenden, New York Times, 6/13/80.
"Seed Patents: Fears Sprout at Grass Roots," Eleanor Randolph, Los Angeles Times, 6/2/80.
"Patent Protection for Plants," Carolyn Jabs, New York Times, 5/7/80.

"The Real Scoop on the Plant Patent Controversy,"
Anthony DeCrosta, Organic Gardening, 5/80.

At the root of the problem is the Plant Breeders Rights (PBR) movement, a well-organized, generously-funded lobby of large seed multinationals and rich nations that seek to protect seed monopolies by lobbying for legislation in all countries so that patent legislation can be passed more widely. The International Union for the Protection of new Varieties of Plant (UPOV) negotiated the "Convention of Paris" in 1964 which sought to militantly lobby enactment of uniform legislation and enforcement of PBR laws throughout the world. Mooney, IGRP, ICSA, RAFI and a host of other activists have thoroughly documented the sordid aspects of this movement. Thanks to their work and the events at FAO since 1981, it seems UPOV and PBR are losing some of their steam. Some countries that had the legislation in their books are reconsidering or stalling. For Kenya, which has pro-PBR laws on the books, we believe this issue is so critical for the nation's future that it needs much more open discussion by farmers, scientists, civil servants, and politicians, new policy instruments, and clear national positions in favour of repeal of such laws (see Appendix II, part V, 17 (2)).

Biotech and Privatization

Much credit goes to the Rural Advancement Fund International (RAFI) of Pittsboro, North Carolina, and their International Genetic Resources Program (IGRP) for their indefatigable efforts in exposing the international going-on in germplasm, especially monopolization. In recognition of this, the co-founders of RAFI, Pat Roy Mooney and Gery Fowler were awarded this year the Right Livelihood Award, the alternative Nobel Prize in Sweden and commended thus:

> . . . .(they have) drawn attention to the dangers of replacing a wide variety of locally adapted plants by a few high-yielding but disease prone varieties with a narrow genetic base. . . .(and their) efforts to promote the free exchange of genetic resources and block legislative moves towards their monopolization.

Multinationals, Biotechnology and Monopolization

Third World victories at FAO and IBPGR may be hollow if multinational agribusiness firms have their way. They are already moving in a big way to corner the international seed market. Starting with the "natural patent" that hybrid seed offers (farmers must return to the store every season for hybrid seed) big business recognized the potential of such a market and bought rights to specific hybrids while emphasizing hybrid breeds and cross-pollinating varieties

only. Legal patents and plant breeders rights and UPOV also present further protection for their investments.

But by far the greatest new growth area in seed commercial monopolization is the emerging biotechnology and MNCs will be quick to corner this too. At a MNC conference held in Geneva in May 1985, called "Biotech '85," a highly candid background paper entitled, "The New Plant Genetics: Restructuring the Global Seed Industry," analysed the influence of biotech on the seeds industry and multinationals. I quote from that paper as reported in the ICDA Seedling bulletin of October, 1985, page 8:

> the value of all seed planted by farmers worldwide is currently in excess of US$ 50 billion. The problem for the industry is however that "only" 63% of that value is supplied by companies and organizations because too many farmers still use their own seed. But anyhow, the total retail value of all seed incorporating biotech improvements is forcasted to increase from US$ 8 million in 1985 to US$ 6.8 billion by the year 2000, which represents a 57% annual growth rate. The paper also states that shortly after the year 2000, no more than a dozen global companies will dominate the seed market.
>
> One of the reasons, mentioned in the paper, why multinationals are now so interested in acquiring seed companies is the fact that seed is "Ecology plus." "Unlike many pesticides which are under attack by environmentalists, seed and the plant sciences are considered ecologically positive. The threat of withdrawal and/or recall because of politically inspired pressures is unlikely with seed."

Clearly these trends will have a great impact in Kenya if we are caught unawares. While Kenya did not legislate UPOV guidelines, PBR protection currently provided in the Seed and Plant Varieties Act, although inactive, offers a potentially disastrous entry point to seed control by MNCs.

Chapter 6 describes the current seed marketing and distribution in Kenya. Multinationals are known to be interested in acquiring major local seed operations in all countries, including Kenya, and the gravity of such an eventuality should be clear from above.

Appendices III, VIII, IX, and X give lists of some of the recent merger/acquisitions of petrochemical or pharmaceutical multinationals with/of biotech and seed firms.

Chapter 6

SEED MARKETING AND DISTRIBUTION IN KENYA

There are two major categories of crop seed sources in Kenya: non-commercial seed produced on the farm and set aside for subsequent season and the commercial suppliers. The former is undoubtedly responsible for a large bulk of total seed used. It would not be incorrect to infer that in relative terms and for a variety of reasons more and more small-scale farmers who were previously self-sufficient in seed have had to look to commercial sources for some if not all their seed requirements. Figures to support these trends are lacking and we need to examine this farther for the symposium.

The commercial seed sector, ideally could be quantified, were it not for the extreme levels of suspicion and secrecy that are an integral part of the seed industry. No company seems, as a matter of policy, to publish annual reports. Neither of course are there figures for the "informal commercial sector," the market-sellers who handle produce, a large quantity of which ends up as seed material. This sector too needs some investigation and quantification.

There are, however, 13 registered firms who deal wholly with seeds. These 13 form the Seed Traders Association of Kenya (STAK) (see Appendix V for a list of some member companies) which is affiliated to the International Seed Traders Association (ISTA). STAK is a recently established organization and may not yet have the lobbying power or experience of its counterparts elsewhere. In fact, all indications are that it is rather tentative in its existence due to perhaps some market rivalries. It is, nevertheless, an important organ to keep in mind when discussing the seed issue in Kenya. The commercial seed market is dominated by one giant seed company--the Kenya Seed Company based at Kitale. So all-embracing are the activities of this firm that it merits some detailed discussion.

Kenya Seed Company Ltd. was formed privately after the Second World War. It is now owned by the Kenya Government, the KGGCU and private individuals--51%, 30%, and 19% respectively. Since the Government also has some interest in KGGCU, one can surmise that the combined influence of the

Government in the company's policy is considerably higher than the 51% figure would at first indicate. In fact, Kenya Seed Co. now consider themselves as a parastatal trader-producer organization. They, therefore, enjoy official protection and must necessarily follow government policy in addition to commercial good-sense (95).

The National Food Policy makes several references to this company, viz.,

> Section 4:6. The Kenya Seed Company has already been directed to ensure that adequate supplies of seed, particularly maize and wheat, are available at the beginning of each crop season. . . .
>
> . . . . target rates of growth of sales (will be) 10% a year for improved maize and wheat. . . .

The Government will use its majority shareholding in Kenya Seed Company to ensure that these goals are met.

Kenya Seed are mainly concerned with the production and marketing of the following seeds:

- Maize
- Wheat
- Barley
- Other cereals (Oats, Triticale)
- Pasture
- Sun flower
- Horticultural (vegetables and flowers)
- Grain Legumes

For details on cereals and other field crops, see Chapter III, Current Breeding Activities in Kenya.

Horticultural Seeds

For the production of all horticultural crops, Kenya Seed Company has recently acquired a subsidiary company Simpson and Whitelaw (of Simlaw Seeds fame). This was previously owned by Mitchell Cotts, then by Kirchoffs, of UK and Germany respectively, but had reverted to local private interests prior to acquisition by Kenya Seeds Co. This acquisition made Kenya Seed the seed giant that it is, in addition to the official influence that a parastatal can command. Simpson and Whitelaw were already a force to reckon with in terms of horticultural seed production. Another subsidiary of Kenya Seed Co. is Hortiseed Ltd., wholly charged with horticultural seed production, making Simpson and Whitelaw mostly a marketing firm.

A good 75% or more of all vegetable seed for the Kenya market is produced by Hortiseed from breeding material in their own local collection or material acquired externally. Following is a summary of the major horticultural seeds from Hortiseed.

a) Beans

There seems to be some overlap with the parent company in bean seed production. All bean lines are obtained from Agricultural Research Station, Thika, and multiplied. Some importation was done before, but this is gradually coming to a stop. Hortiseed Ltd. have experienced the only known case of patented horticultural seed with the french variety Moneil. Rather than pay royalties, company policy is to discontinue or ignore such a variety, while breeding a variety closely related to the patented one. Moneil is an excellent variety bred specifically for European green bean requirements. Simlaw are marketing a "near-enough" variety and claiming it has Moneil-like qualities without infringing on patents.

b) Vegetables

Previously all vegetable seed was imported from Europe, North America, Australia and New Zealand. Since acquisition by Kenya Seed Co., an aggressive programme of local production has been instituted and the following vegetable seeds are locally produced and in some cases exported:

- Capsicum (sweet and hot)
- Okra
- Melons (water and sweet)
- Eggplant
- Cucumber
- Coriander
- Collards (a variety of sukuma-wiki or kale)
- Peas
- Pumpkin
- Radish

Some other crop seeds are imported in bulk as ready-seed because local production is limited by either or both of two problems:

a) Being of temperate/sub-tropical origin, many vegetable species, especially the cruciferae (mustard/cabbage) family have highly specific photoperiodicity and do not flower or fruit in our short-day conditions, perferring at least 13 to 14 hours of daylight. New short-day varieties are, however, being bred and this may soon permit seed production of a wider range of species here in Kenya.

Already an American variety of kale (sukuma wiki) called collard green, popular in Southern U.S.A. is seeding here in sufficient commercial amounts and no more kale seed is imported as has been the case heretofore. Another technical reason is failure by some crops to keep to type, e.g., tomatoes, needing new lines all the time to ensure and preserve fidelity of varietal characteristics as these tend to drift in successive progeny.

b) The second problem is simple economies of scale. To be economic, seed production must be in large quantities--hundreds of tons or more. Kenyan demand is often in tens of tons in many varieties and is not worth the overheads necessary. For the same reason, local breeding or "line maintenance" of most low demand crops would be far too expensive in comparison with direct imports of ready-seed. (NB. All local seed multiplication is done in rain-fed farming as irrigation overheads would price it out of the market.) In most large-scale seed production systems abroad (especially industrial countries) agri-business efficiency is applied to massive seed production systems resulting in very low prices per unit.

For these two reasons, the following seeds are imported:

Lettuce (most)	Beets
Courgettes	Spinach
Tomato	Kale (non-Collard)
Cabbage	Celery, etc.
Carrot	Asian Cucurbits
Onions	(bitter gourd, etc.)
Chards	Turnips and Swedes

Kenya is a net horticultural seed importer, but is gradually breaking into the export market in some varieties when surpluses are realized, depending on weather conditions and local demand levels. Being able to export is an indication of the high standard of Hortiseed Ltd. Exports have been undertaken to Denmark, England, Holland, and East/Central Africa.

Other Firms

As stated earlier there are at least 12 other seed firms registered in the country. The other best known of these is the East African Seed Company, a local Asian-owned concern of smaller size than Simpson and Whitelaw/Hortiseed complex of Kenya Seed Company. They seem to carry the same general lines as the latter, but also carry some traditional crops and spice seed. They are, however, perhaps dealing in uncertified seed, but, in fairness, they may sometimes warn buyers of this fact. One case is known where a buyer of soya bean seed had been warned that it was not certified. None germinated. Again, in fairness, they are the only large company who seem to handle local crops, e.g., njahe (Lab Lab or bonavist beans), other than the "Nyamakima-type" of informal food-cum-seed sellers. None of such seed could possibly be certified by the National Seed Quality Control Service and some policy and even legal questions could therefore arise here.

Another seed company of interest which may represent a different and intriguing genre is Jardinage Ltd. More needs to be known about the company and others like it. According to allegations in seed circles (unverified and largely unverifiable due to typical trade secrecy, and in all fairness allegations must be anticipated in a trade of such fierce competition) this firm represents the local thrust of multinational seed interests. They allegedly import through neighbouring countries and then dump various varieties in Kenya (no evidence that these varieties are patented which would raise interesting questions of patent-busting). In the seed industry, dumping implies low-quality seed and not necessarily low price. But seed business is, even more than other commercial enterprise, highly dependent on consumer satisfaction for entrepreneurs to survive. One suspects that Jardinage and other such companies would not take such risks in such a small market as Kenya and that their merchandise is perhaps of threateningly high standards, backed by an organization that could bear early losses in order to break into the market for specific (if not calculated) objectives. It is suspected that multinational backing is not unlikely and these companies represent what maybe coming in Kenya's seed future if market entry remains free and competitive and not dominated by parastatal-like monopolies. As Kenya Seed Co. would presumably and understandably not like to see. There have been frequent outcries against "unfit" imported seed lately, uttered by senior officials. This gives the impression that there are dealers who do not follow the laid-down rules and regulations (90,91,92).

Flower Seed

Kenya Seed Company's horticultural seed subsidiaries engage extensively in flower and ornamental seed multiplication on contractual basis with European and North American seed companies, many of them multinationals. The practice is for the breeders to send in "line-material" from which multiplication and bulking can be done in Kenya's year round growing conditions. The following flower species are grown thus and exported:

Cosmos
Zinnia
Impatiens
Marigolds
Convolvulus
Nasturtiums
Vinca

Seed Multiplication Sites

Kenya Seed Company has a wide-ranging network of farms, mostly leased and/or contracted, in which seed growing and multiplication are done; for maize, wheat and barley, the Trans-Nzoia, Uasin Gishu, Nakuru Districts are the most important Districts, but recently, the ideally hot and wet

Malakisi region of Busia has gained in importance as a multiplying area. Narok and Naivasha areas are also used for some species. For a long time now, it has been recognized that East Africa is ideal for seed multiplication work. Thus Arusha is a major site for European seed houses, while Kenya's importance has increased rapidly as her role as a seed supplier for Eastern and Central Africa has been expanded. Currently most of the multiplication is done for European and North American companies.

Chapter 7

EXISTING AGROFORESTRY/SEED PROGRAMMES

a) In this section the structure and objectives of several new agroforestry projects are discussed. They represent attempts by individuals, NGOs, and the Government to solve the seed bottleneck while at the same time to reach out to more individual farmers and community groups than has been the case heretofore. They are thus models worthy of study with a view to assisting prospective project planners to gain a picture of what has been tried, how, and with what results. The projects are divided into two broad categories:

A) NGO/Community Group projects
B) Government of Kenya programmes

A) NGO/Community Group Projects

Undoubtedly there are many local small-scale tree planting projects in the country. They range from individual enthusiasts of the "Men of the Trees" type to church missionaries who try all types of species in their area or on their land. Of more interest are the new, more formally instituted projects with clear sets of objectives, including extension/training and diffusion strategies. These projects are not very many, but they are increasing and should have more impact in the future, judging by their current momentum. They have been founded by church groups, primary/secondary schools, wildlife clubs, and NGOs and range in size from local projects to larger regional projects like Care-Kenya in Nyanza to KENGO's far-ranging role on national scale.

The recent increase in rural afforestation and agroforestry stems from the increasing acceptance of "tree planting as part of farming" idea which in turn can be traced to the initiative of the local community non-government organizations such as those mentioned above.

From a seed production point of view, however, few of the community projects seem to have devised reliable seed-production or acquisition methods. They rely heavily on donations from other organizations. By relying on external seed most have suffered from the "seed bottleneck"

and were forced to delay or curtail their planting schemes as well as resort to whatever seed was available which, in many cases, was unsuitable for their areas. Participants at the Moi University Training Workshop held in July 1985 on seed collection and seed handling stressed the importance of seed self-sufficiency constantly in their deliberations.

KENGO has in the last two years contributed immensely in seeking solutions to the tree (especially indigenous species) seed problems (see below for details). Another well-known project which has attempted to resolve this seed problem has been the CARE-Kenya project in Siaya and South Nyanza. Financed by CIDA through CARE-Canada and headed by a Canadian volunteer, this project has in the two years of its existence created an effective seed and seedling distribution network. Local groups with well-trained extension personnel are recruited from local communities. Seed trees and stands have been identified and collection on a predictable basis has been started. Plans are at hand to expand their seed distribution network in the two Districts which is based entirely on locally-produced seed.

This project, like many others still in their infancy, seems to have incorporated "self-perpetuating" mechanisms, e.g., counterpart or understudy staff so the project will outlast the expatriate input, training of junior staff, systems to create local self-sufficiency in seed, and elimination of expensive centralized seed storage structures.

To the extent that NGO-initiated projects take appropriate steps to continue innovatively on their own, independent of outside initiators, much will have been gained. One hopes that the understudy method of skill-transfer works, but one fears that where it fails, as commonly happens, the projects become stagnant and/or collapse. Without careful attention paid to this important question, we cannot count on continued success of planting projects or seed supply.

This discussion concludes with descriptions of some NGO programmes, with information provided by representatives of the organizations.

1) CARE-Kenya, Nyanza Project

In 1983, CARE-Kenya instituted an agroforestry project in Siaya, financed by CARE-Canada. The basic aim is to encourage community groups (primary schools, women's groups, etc.) to start small-scale nurseries which can supply seedlings for various plantings.

There are currently over 200 such group nurseries with a capacity of at least 5,000 seedlings each, making for a total of one million seedlings. There is a potential for 90

more groups being developed before the long rains of 1987. There is also hope that a figure of 500 group-nurseries is ultimately possible. The goal is to produce 3 million seedlings in all of Siaya District annually. In addition, similar groups and nurseries have been started in South Nyanza with similar objectives.

In Siaya where the project has been underway for a longer period of time, a rudimentary ecological division of the District has been done; each of the three regions is organized with its own recommended species, based on rainfall and broad soil types. The general agroforestry species of the warm seasonally dry lowlands are available in the nurseries. These include: Leuceana, Markhamia, Cassia, Siamea, C. spectabilis, Terminalia, Erythrina, papaya, guava, mango, and citrus. In all, seed for at least 24 species are available.

The project is organized hierachically with two administrative heads with field officers under them, three in Siaya and four in South Nyanza. Under these field officers are the extension officers--32 in Siaya and 60 in South Nyanza. These are in close touch with local farmers and community groups responsible for the nurseries. The farmers assist them to identify good stands of suitable agroforestry species and they pay the farmers to collect the seed. CARE-Kenya purchases this seed from the farmers. Surplus seed is available for sale to non-CARE buyers.

At the moment, only crude pretreatment is undertaken, but plans are afoot to set up better drying and storage facilities, though the preferred course is to harvest and use fresh seed every season.

Three extension officers of superior practical aptitude in seed and forestry work have been identified and will be trained in order to upgrade extension services and help make the project self-sustaining. In fact, CARE-Kenya is eager to do everything possible to ensure that the programme outlasts their presence of three and one half years.

2) KENGO

KENGO is an association of Kenyan NGOs in the field of energy. Since its formation in 1982, KENGO has been very active in agroforestry and general energy information and extension services all over Kenya. KENGO's major activities have been in the following areas:

a) seed collection, exchange and distribution
b) extensions and training
c) publications and general information
d) research and trials.

Seed Collection

KENGO has established a seed collection network based mainly in Eastern Province. The strategy is to liaise with MOERD officials and Divisional Forest Officers (DFO) who identify possible collectors. KREDP Centre managers also assist especially by providing forwarding facilities for collected seed. Average price is Shs. 10-15/- a kilo for Acacia tortilis. So far there has been no shortage of collectors at such a price, but perhaps this is subsidized since the collectors may be salaried elsewhere.

In 1985 about 500 kg. of seed was collected this way mainly from Kitui and distributed all over the country for free. KENGO ranks as one of the foremost sources of indigenous dryland species.

Extension and Training

This constitutes KENGO's major work. Objectives are to upgrade technical competence at all levels in agroforestry practices and seed collection. In October 1985 a training workshop was held at Kitui for individuals and organizations from all over Kenya--nursery workers from EMI, primary school teachers from many districts, NGO leader, CARE-Kenya extension staff, KWDP nursery staff and even GK prison warders in charge of agroforestry and church groups.

A sub-objective of such training is to encourage local seed collections and improve seed quality. This strengthens and widens the national seed network. So far one major Kenyan-wide travelling workshop has been completed and others are planned. A workshop for media people was organized recently in Homa Bay to acquaint them with energy and environment issues and their role in it.

Publications and General Information

KENGO's other main function is as a clearing house for agroforestry news and activities. KENGO publishes a periodical KENGO NEWS as well as other material on agroforestry and energy issues including seeds (25). Of great signifiance was the booklet Pocket Directory of Trees and Seeds in Kenya by Wayne Teel and KENGO. This excellent book has helped make tree taxonomy and seed identification more accessible to non-botonists as well as assisting create a national network for seed-exchange. A major seed manual, How to Collect, Handle, and Store Seeds, is in press.

Research and Field Trials

According to KENGO, the next phase of their work consists of follow-up field work to collect data on germination and performance of seeds supplied, survivorship and growth rates

in various areas. Already data collection forms have been sent for some of this information. In addition plants are reportedly under way to establish a "drought management agroforestry system based on indigenous trees" at the Jomo Kenyatta College of Agriculture and Technology. There will be seed orchards and demonstration trials in addition to research on germination performance, etc. Eventually it is hoped to start investigations in Kenyan wild fruit trees as crops.

3) Turkana Afforestation

With aid from Norad, Kenya Government has started afforestation projects in Turkana District under the supervision of Ed Barrows. This is a very important model project for the driest areas of Kenya with nomadic populations and it merits some study. We were, however, unable to include it here in any detail due to travelling constraints. Reports indicate that it is extremely successful and has, in some areas, a food-for-work component tied to tree planting and maintenance.

b) Goverment of Kenya/Donor Programmes

The overall agroforestry seed situation in Kenya is currently uncoordinated and fragmented. There is no doubt there are serious weaknesses, especially in supply of traditional crop seeds and tree seeds. One example of a current attempt to rationalize the situation is the proposed Forest Seed Centre at Muguga which provides a first step toward rationalizing the supply of tree seed in Kenya. It is expected to begin operations in 1987. It will assist the Government tree system to deliver agroforestry seed for community projects and will raise standards of seed collection, processing and storage to international standards. This, in general, is a good thing.

Another is the Rural Afforestation Extension Service (R.A.E.S.). Started in the mid-seventies, the RAES is a Government programme to promote small-scale rural planting. RAES's objective has been met to some extent in some areas by establishing nurseries in rural areas close to farmers and making inexpensive seedlings available, although the choice of species was limited to the old exotic trio of cypress, pine, and eucalyptus, even in areas where these were manifestly unsuitable, e.g., Kitui District. RAES has recently shifted its emphasis to include indigenous trees and new multipurpose agroforestry species but a shortage of this type of seed has persisted. To rectify this, extension officers are encouraged to seek local seed sources and arrange for collection at appropriate times. But apparently this is still in its incipient stages and RAES still depends on the Forest Seed Centre at Muguga (part of the Ministry of Agriculture) for the majority of seed supply.

An interesting example of the catalytic role of individual resourcefulness is the effect that the British Government Overseas Development Assistance (ODA) staff have had on RAES activities in the Embu, Meru, Isiolo (EMI) Forestry Project. In 1982, Kenya Government entered an agreement with ODA to provide extension advisory services in rural afforestation in the three districts with special emphasis on their more arid lowlands.

Within three years the extension service there has been injected with new life that has galvanized many groups and individuals to start nurseries and planting schemes. The key to this seems to be the identification of methods to motivate junior extention officers, who were selected from among nursery attendants then promoted and encouraged. One in Meru is reputed to have helped plant out more seedlings than the Department in his area last year, according to EMI staffers. RAES could quite profitably pay heed to such intiatives and introduce them to other areas, thereby altering the pace and intensity of rural afforestation.

It is in seed procurement and self sufficiency that EMI has excelled. Initially it was totally dependent on Muguga for all seed and experienced great difficulties getting appropriate, leave alone, adequate seed. Now they are totally self-sufficient in basic seed requirement. This was achieved thus:

a) starting a well structured collecting programme with each area responsible for only one or two species. This specialization by stations has resulted in production of good, reliable seed and a surplus for exchange. RAES even gets some seeds from EMI now.

b) Eucalyptus camaldulensis seed of different provenance was imported from Commonwealth Science and Industrial Research Organization (CSIRO)-Australia and is undergoing field test to judge which provenances are most suitable for EMI regions. Other importations have been undertaken from Setropa in Holland. After establishment, these seedling will form future seed stands.

c) Emphasizing simple pretreatment storage methods and establishing three simple seed stores in the EMI area.

An excellent manual on nursery practice has been published by ODA staff, A Forest Nursery Manual for Kenya (18).

This is certainly one of the more successful RAES-donor projects, and all its aspects, not the least of which the seed work, need to be emulated by RAES in other Districts.

Concluding this section, these three Government afforestation projects will be described in some detail.

Information was provided by representatives of the organizations.

1. Forest Seed Centre

The Forest Seed Centre (FSC) was established at KARI, Muguga, in 1984, to take over all tree seed functions previously under the Forest Department. Although currently under the KARI umbrella, and therefore falling within the jurisdiction of the Ministry of Agriculture, it is hoped that the Centre's position will soon be rationalized so that it falls under the Forest Department of the Ministry of Environment and Natural Resources.

GTZ, the donor agency, has assigned two German seed experts to start the Centre along with Kenya Government forestry officers from KARI. GTZ proposed to build and commission a fully equipped, international-standard seed processing and storage plant with all the newest seed technology. The cold rooms will have a capacity of 100 cubic metres, divided into several chambers of variable temperatures as necessary. They have also received permission to have a seed quarantine facility on site, thus bypassing the PQS for pest screening and cleaning of import/export seeds. The policy, economic and practical implications of this need constant monitoring.

It was pointed out that forest seed storage is normally for the short-term, with the long-term storage being best done by means of a seed orchard, due to the extremely long rotation period for tree species. With this in mind, the FSC is designed with the following objectives:

a) a practical approach to storage of seed to ensure continuous supply even during years of poor seed harvest. In this case, the bank is to act as a buffer against wide fluctuations of supply.

b) to emphasize short-term active storage of mostly 1 to 5 years with some allowance for some medium term storage of 5 to 10 years. No provision will be made for long term base collections.

c) to aim to eventually have in stock seed of all important Kenyan and exotic tree and shrub seeds--especially agro-forestry, afforestation (including arid area species, industrial) and ornamentals. No provision for fruit tree seed will be made in the initial stages.

d) to conduct research into optimum methods of seed processing, testing, and optimum storage temperatures for tropical species, e.g., Meru oak and neem, which are problem storage

species whose behaviour in prolonged cold storage is not well known, as indeed is the case with many other tropical forest seeds.

e) to train Kenyan staff in all aspects of forest tree seed work and gene bank technology.

f) to establish or strengthen seed stand units (natural or orchards) with six sub-centres in different ecozones. These are Elburgon, Daraja, Sokoro, Londiani, Gedi and two in semi-arid areas. Already an eight hectare seed orchard exists at Muguga from EAFFRO clones and another at Londiani.

2) Rural Afforestation Extension Services (R.A.E.S.)

The R.A.E.S. is charged with all non-industrial afforestation schemes and extension services with special emphasis on small-scale rural tree planting. A brief historial summary will perhaps help put the current work of R.A.E.S. in perspective and also show the evolution of seed activities at the Forest Department.

When the Forest Department was set up early this century a bias towards industrial plantation was inevitable, since part of the terms of reference for the fledgling department were to introduce exotic fast growing fuel-woods for railway locomotion. British foresters, drawing on their training and experience in South Africa and India, naturally decided on eucalyptus and black wattle. These were among the first species to be grown before 1910. Although they were later abandoned by the railway authorities as inefficient fuel sources, the bias continued. Again, due to their experience in temperate forestry, the same foresters also introduced exotic conifers, especially pines, cypress, and auracarias, as well as an assortment of Australian acacias and grevillea. These were eventually to permanently alter the humanized landscape of Kenya. The Pine/Cypress dominance in Kenya's industrial plantation has persisted to this day. With the new papermills creating such a high demand of soft-wood pulp, this bias seems permanent and will probably become stronger.

When R.A.E.S. was formed in the seventies they fitted into this scheme. Their officers and foresters were former Forest Department employees and they tended to carry on those same practices with which they were familiar. Again, like their British predecessors by force of "training and experience," the pine/cypress dominance was carried over to rural afforestation. Up to now, these species along with the ubiquitous eucalyptus are what one encounters most frequently at their nurseries.

During the early days of the Forest Department, seed stands were established at various sites around East Africa, but mostly within Kenya. These still remain the main sources of Forest Department's approved seed. Apparently no questions were asked about the suitability of those original provenances to Kenya's different environments or needs, and it is possible that here is an area for future research work in genetic variability or drift and perhaps in tree breeding. However good or bad, adequate seed of limited species has been supplied through the years from these sources to practically all prospective planters and public institutions, up to the explosion in seed demand these last five years.

The seed unit was formerly a part of the Forest Department. In 1982 it was incorporated in KARI at Muguga and upgraded to full division status with a silvi-culturalist in charge. Now, however, new changes have taken place and it seems that, with the assistance of the German Agency for Technical Co-operation (GTZ), the proposed Forest Seed Centre at KARI will take over all forest seed work (see Forest Seed Centre).

From a seed point of view, this was easy; simply requisition for seed supply directly from the Forest Seed Centre and wait for the certified seed. But by late seventies, as R.A.E.S. operations expanded, it became clear that Muguga could no longer handle the increasing demand for seed in addition to their traditional plantation seed commitments.

R.A.E.S., therefore, recently started the policy of actively encouraging their own District Extension Officers to collect species (exotic and indigenous) that were already growing in their areas. This has had many results. Most immediately it has boosted seed supplies and created tendencies towards self-reliance in seed at local levels and greater freedom in planting schedules without the previous delays and uncertainties. Also there has been a widening of species available to include more indigenous ones. There exists the possibility, though, of lowering seed quality and giving less emphasis on mother tree properties. R.A.E.S. has become, nevertheless, partly a seed collecting organization in addition to their other activities. They still depend on Muguga for much of their seed needs, however, a position likely to persist well into the future.

There are now plans to improve on the quality and quantities of seed collected in the next development phase by stressing provenance and stricter source-selection, as well as increasing training of foresters and their collectors on basic seed technology.

Towards such improvements, R.A.E.S. has in progress the following:

a) a major national guide by district showing rates of viability and suitable times of harvest for for given species. It is hoped this will help Districts in need of a given species to order it directly from where it is available fresh, thus minimizing storage problems.

b) compilation of a national catalogue of all institutional seed sources in order to co-ordinate national supply and demand.

c) creating a new system for re-educating R.A.E.S. foresters aiming at raising their awareness of the importance of their own personal input in improving local seed procurement.

3) Kenya Renewable Energy Development Project

Kenya Renewable Energy Development Project (KREDP) was started in 1980/81. It is funded by USAID (under the Ministry of Energy and Regional Development MOERD) with Energy Development International (EDI) of Washington, D.C., as project consultants. Its objectives are as follows:

a) Woodfuel use efficiency (ceramic jiko, kiln design)
b) Industrial or burner efficiency to decrease waste
c) Woodfuel production through agroforestry/ afforestation projects

We shall take a look at only the third objective in this summary.

KREDP has established six Regional Centres, one each in the main ecological zones. Each centre is situated in a Farmers Training Centre (FTC) where they established a nursery, seed orchard and trial plots, etc. Relevant agroforestry research is undertaken at each of these Centres. Nursery management, species choice and simple seed collection/storage techniques are taught to farmers and FTC staff as well as KREDP extension staff.

Seed Collection

Originally the KREDP agro-forestry/afforestation schemes were to obtain seeds from other organizations, local and foreign, including commercial firms. It was hoped that the Forest Department could supply most of the requirements, but it soon became quite clear that alternative, more reliable sources must very soon be set up.

In 1981-82 seed supply from Ministry of Natural Resources (Forest Dept.) was very limited both in quantity and in species range. Therefore, KREDP redesigned their project to include a substantial seed acquisition element so that in a short while complete self-sufficiency in seeds would be achieved. The quickest way was deemed to be through contractor-collection. In the last two years seed has largely been acquired from such contractors--individuals on contract to deliver seed directly to regional centres for processing, planting and forwarding of surplus. By mid-1985 this method had proved so successful that KREDP had been able to supply all their needs in all the regional centres and to leave a substantial surplus from which other NGOs have benefitted freely for most agro-forestry species. (See Appendix VI for list of quantities, species and beneficiaries for 2nd quarter 1985.) In crude figures KREDP estimates that a gross total of about 8,000 kg. of seed has been collected between 1982 and 1985.

It has now been realized that this system has inadequacies and shortfalls and that, while quantity is assured, there is need for greater emphasis on quality; i.e., the whole question of provenance and harvesting seed from known marked and superior mother trees for given needs; quality control, especially at processing and storage stages to ensure greater viability. To cater for these new needs there is now an ambitious five year programme on the drawing boards which, if approved and if "external funding is forthcoming," KREDP would be one of the larger suppliers in Kenya.

A high-level seed expert and consultant may soon be engaged to set this rolling in the preparatory stages. In the meantime, beginning last year a Central Seed Services unit (CSS) has been created "in association with KARI at Muguga where a sizeable cold storage unit has been installed." KREDP's tree seed cold storage is the core of the planned future seed bank. Pre-storage processing is done at the KREDP Jamhuri site from where country-wide seed collection is also coordinated.

In storage currently are 111 seed species, both exotic and indigenous, agroforestry and regular in amounts ranging from 0.1 kg. to 100 kg. by species. In the next few years KREDP hopes to be able to supply all their needs of all species, and to cater to most local buyers as well as possibly enter the competitive seed export market for some seed varieties. A tentative price list has been put out as a guide for local and export sales (see Appendix VII). It is not unlikely that a local company will be encouraged to undertake tree seed sales if such a venture is proved competitive and profitable. The idea has been mooted for the long term.

In addition to the processing and storage facilities, training in seed technology will be undertaken in

association with International Council for Research in Agroforestry (ICRAF). This forms the other important part of decentralizing and upgrading seed supply. Quality-training of seed technicians at all levels is seen as a necessary first step.

Kenya Woodfuel Development Project

The Kenya Woodfuel Development Project is a joint undertaking between the Government of Kenya and the Dutch Government with the Beijer Institute (of the Royal Swedish Academy of Science) providing the major consultancy.

This project is guided by a deliberately limited objective: to prove and popularize the idea that firewood trees can be grown like any other perennial crop both for household fuel needs and if necessary for commercial purposes. To arrive at their choice of species that best fulfill these objectives, KWDP has developed quite a simple set of criteria for species selection: a) fast growth rate; b) compatibility with food crops in order to permit tree/food intercropping; c) "coppiceability' to save on reestablishment time and costs after each wood harvest; d) forage or fodder value; and e) preference for nitrogen fixing properties.

By a process of elimination, based mainly on above criteria, it was decided that for Kakamega, their initial zone of rural woodfuel planting, four species are suitable. These are Calliandra calothyrsus, Mimosa scabrella, Leuceana leucocephala K-28, and Gliricidia sepium. A fifth species, Sesbania sesbans, has been included, but it is a biennial and locally self-generating. It is not included in the seed scheme.

So far all the seed for the Mimosa, Gliricidia, and Calliandra species has been imported from Satropa, a Dutch firm. It is estimated about 30 kg. of Mimosa and Calliandra were imported at approximately Ksh 1,500 per kilo. The firm claims as provenances Brazil, Costa Rica, and Indonesia. Although trial plantings are still too young to go by, there are already visible phenotypic and perhaps even performance differences between seeds of the same species but of different provenances. Leuceana K-28 seed is entirely from the KREDP seed bank.

In Kakamega KWDP initially selected seven sublocations for their project. Each sublocation has an average of 3 farmer-groups, each with an average of 20 households. There are a total of 420 farms in the entire project. Soon these will be increased and further plantings are therefore

envisaged by mid-next year within the same seven sublocations.

So far all the seed of the four exotic species has been imported. A second important objective of the project is to work towards total self-sufficiency in seed at the local or farm level. In fact, the project designers see their role as one of making themselves dispensable as soon as possible, leaving the project idea to diffuse through the rural economy at its own pace after this initial awareness-raising and planting programme. This will only be possible if the "woodfuel cropping" idea is seen to work to advantage and seeds are available locally on demand. KWDP foresee an ideal situation where seed is picked directly from the mother tree to the nursery without need for processing or storage facilities or (hopefully) commercial middlemen. So keen are the organizers of the project about this that they intend to test the possibility of sowing seed directly to the sites thus also doing away with the nursery stage altogether.

There are plans to expand into several other districts if funding is forthcoming. In Kisii some groundwork has been done and planting with at least the same four species should start before 1987. Another district on the list is Murang'a where perhaps an additional set of species may have to be included to cater for the higher, cooler zones. But in all cases seed procurement will be based on the local self-sufficiency principle outlined above.

For the longterm, the idea has been broached at KWDP that the feasibility of peri-urban woodlots to supply domestic and commercial woodfuels for urban dwellers should be investigated and, if proved viable, implemented in some areas. Nairobi and Nyeri have been mentioned as possible test towns. This of course is still in the early discussion stages and is again dependent on funding availability. If carried through, it would naturally increase demand for seed. However, depending on species chosen for various peri-urban sites, KWDP's approach of seed self-sufficiency in the shortest time for each project should accommodate much of the demand.

On provenance and seed quality improvement, KWDP feel it is now essential to set about choosing the best performers among the four species and limiting seed collection from such stands. The assumption seems to be that the imported germplasm represents the whole range of genetic possibilities in each species and that selection can now begin for the best strains per site or per district and encouraging those as future seed sources. One can argue with this, but given the stated objectives of the project, it seems adequately workable. Besides the material is still

available for future researchers and breeders to work with if need be in developing better varieties.

KWDP have also started Seed Production Units (SPU) at several sites in order to complement and supplement farmers' seed production and ensure adequate supply at farm level. Already such units are in production as are some 28 of the original farms. The SPU will also serve as a centre for seed collector-training as well as being a permanent seed orchard.

An elementary seed manual on general seed collection practices, handling, etc. was published earlier on and will soon be updated as the experience on the four main species accumulates.

One can surmise that KWDP, an interesting model for a limited (woodlot agro-forestry) goal, will soon be in a position to produce enough seed for their own purposes and that in the future a surplus for exchange or sale will be available especially if proper incentives are given to farmers. In such an eventuality, quality control and proper storage/packaging procedures will have to be worked out more strictly since, by their admission, KWDP does not intend to emphasize this aspect initially. Such a uniform or standardized procedure should present no great difficulties as it will hopefully be necessary wverywhere in the country where seeds are being handled anyway.

Other Agroforestry Seed Developments

The Ministry of Agriculture has plans to establish an agroforestry section in order to integrate multipurpose tree cropping in farm systems. This is an excellent idea and one hopes MOA will liaise with other ministries and organizations, especially in seed supply matters to avoid duplication and waste.

A private firm at Bamburi, Baobab Farms Ltd., has for several years been selling agroforestry seed commercially., Appendix VIII shows their price list. It is not clear to what extent their seed activities are economically self-sustaining, but according to R. D. Haller, the manager, there is good commercial potential in tree seed in Kenya.

Chapter 8

CONCLUSIONS AND RECOMMENDATIONS

Kenya has had a reasonable seed industry able to supply much of the domestic needs in both the improved crop sector and the forestry sector. In the last few years, however, it has become evident that drastic changes need to be carried out to ensure that Kenya's seed industry can continue to serve its critical role in farming and agroforestry. One reason for this is that there is an ever-increasing demand for seeds of all categories, while at the same time it will be necessary to encourage novel (ecologically-friendly) species in crops and agroforestry, which have hitherto played a minor role both in MOA/MENR activities and the seed industry. Evidence here and elsewhere shows that while high yield cultivars are seemingly the answer to increased food production, they are not so useful in small-scale farming or in marginal areas, and there are extremely high hidden costs. Among them are loss of traditional crop germplasm, the so-called gene-erosion, and ever-increasing farmer dependence on the market as a source of inputs, including seeds. By contrast, traditional crops are security-plus in many respects, although lower in productivity, than H.Y.V.

Given the preceding information and analysis, it is evident that there are several critical areas with regard to seeds, food self- sufficiency, and fuel wood which Kenyans need to address themselves to urgently. Public airing of issues by means of a symposium would certainly help to popularize them and thus set the stage for incorporating the issues into both local and national planning, as well as NGO strategies.

Following, is a discussion of several critical issues which must be address.

ISSUE No. 1: Germplasm Conservation and Storage

Of prime importance in building a solid seed infrastructure is the creation of a comprehensive germplasm conservation and storage system. The existing storage system in Kenya is limited to physical storage of accessions alone and needs expansion to other activities, as well as rationalization

and legal guidelines. The following areas need to be addressed:

1) While Kenya has an existing network for germplasm storage, it is not clear to what extent the stored material is being properly preserved. A case in point is the loss of germplasm due to machine break doen at PQS between 1981 and 1983.

2) Due to lack of documentation, it is not known how useful the material is, e.g., the redundancy vs. the comprehensiveness of the collection.

3) There is no concerted, nation-wide collection of germplasm programme in effect. Given the rate of distruction of habitat and the conversion to cash cropping and improved hybrids and cultivars, the rate of gene erosion must be high.

4) There is a lack of local awareness of the crucial importance of maintaining landraces and traditional varieties in local farmer-curator living collections, which authorities should recognize and promote as another important form of germplasm storage.

5) The National Parks and Forest Reserves form natural germplasm stores of utmost importance and must be protected against all incursions. Kakamega Forest and other forests, for example, are being excised for cash cropping and settlements at tremendous risk to genetic loss.

6) There is little evidenced that research is being conducted on germplasm of traditional crops to improve productivity, even by simple varietal selection methods.

7) A coordinated, but decentralized expansion of storage facilities would ensure that germplasm remain in the hands of local farmers, rather than under the control of highly centralized, potentially more bureaucratic and less responsive administrative systems.

8) Kenya lacks a strict legal framework to protect Kenyan germplasm from being collected and expatriated secretly or in an uncontrolled manner, where duplicates are not deposited in Kenyan banks with supporting field data supplied by the collectors.

ISSUE NO. 2: <u>National Coordination of Biotechnology and all Seed-Related Issues</u>

There is a glaring lack of national coordination of seed-related issues. The technical side of breeding for some crops and the legal-regulatory side of seed inspection, certification and release are, in theory at least, well catered for. However, this is true to the extent that seed science remained simple and straightforward. New techniques in biotech, MNC privatization, and marketing, however, call for a thorough re-evaluation of the law and policies. There is a strong need for a body to oversee all issues and activities that impinge on seed--a kind of seed information clearing house and alert-system. The following example should make this need evident.

Biotechnology threatens to introduce revolutionary techniques and products into national economies. This will affect all societies, industrialized and non-industrialized alike, especially the latter which like Kenya depend on a few crops for foreign earnings. Product displacement is now a growing and terrifying reality. In Kenya's case, sugarcane and pyrethrum are cases in point. In addition to the threat, however, there are many far-reaching benefits that Kenya can reap by intelligently harnessing certain aspects of biotech. Yet nowhere in Kenya is there any concentrated effort to understand, to evaluate, and to prepare for the effects and opportunities of biotechnology in our future. This is a major shortcoming.

Related to this is the internationalization of the seed industry and of germplasm. Multinational petrochemical and agribusiness concerns are moving into biotechnology, breeding and seed business. By use of patents and variety protection statues they are establishing new and potentially unjust ways of distributing agri-inputs especially seeds. The impact of this on self-sufficiency of food in Kenya and other Third World countries is worrisome.

There is no evidence that patenting in any form benefits society. There is much evidence that in fact patents raise prices to consumers and retard research and market competition. In a non-industrialized country like Kenya, patents retard technological transfer and help maintain past unfair division of international labour. These and more questions were addressed at the 1981 UNCTAD conference where the Group of 77 stood for the abolition of patenting. They were joined later by some industrial nations like Canada, Australia, Turkey and New Zealand. In plant materials, patenting comes under Plant Breeders Rights (PBR) which claim to protect research and proprietary rights.

In view of this it is most surprising that Kenya has in its books a plant patenting law--Plant Varieties and Seeds Act copied almost word for word from British Legislation. In this Act, PBR are recognized and supported. This can seriously undermine Kenya's interests in seeds and food

production by rendering support to and playing into the hands of the international corporate interests. It seems, however, that the Act is inactive, but the danger of activation is there although it is highly unlikely that Kenya would join UPOV given the current state of knowledge of that organization's unethical ulterior motives and PBR in general.

Kenya is important in international seed circles because of her potential as a seed supplier for Eastern Africa. Kenya is already operative in the production structure of European seed companies as a multiplication and bulking area for various types of seeds. This role may grow. It would not be surprising if some multinational agri-chemical concerns have merger designs for the local seed firms. These concerns lead to the following recommendations:

1) A high-powered agency should be constituted to pave the way for national preparedness and to act as:

   a) an information clearing house on new technology and possible effects;

   b) advance alert system to warn of impending economic changes and opportunities that may affect Kenya's agricultural interests e.g., crop displacement;

   c) coordinator on all germplasm work--collection, conservation, exportation, storage;

   d) study center for state-of-the-art issues in biotech, and seeds and advise authorities on what are necessary steps and actions towards preparedness.

   e) India and Cuba have already started embryonic biotech programmes which we should study intensively in designing ours.

   Biotechnological research is potentially dangerous in that it can produce lethal organisms unknown to nature and humanity. Therefore, extreme caution, coordination, and control in all biotech activities must be a basic ground-rule.

2) It is encouraging that an international infra-sturcture already exists geared towards issues related to transfer of biotechnology, exploring its applicability in the Third World as well as building a global alert system. These provide a beginning point. Some of these organizations

are:

-International Centre for Law in Development (ICLD)
-Council on International and Public Affairs (CIPA)
-United Nations Centre on Transnational Corporations (UNCTC)
-United Nations Centre for Science and Technology for Development (UNCSTAD), especially UNCSTAD's Advance Technology Alert System (ATAS) which publishes the periodical ATAS Bulletin.

Kenya must support these international efforts and side with them at international fora when big-power politics and interests threaten to undermine Third World interests in technology, food, seeds, and germplasm. For example, the United Nations has now moved to create a centre whose primary mandate is to diffuse and disseminate biotech information and R & D in the Third World. The International Centre for Genetic Engineering and Biotechnology (ICGEB) has been formed under the auspices of the United Nation's Industrial Development Organization (UNIDO), although western nations oppose ICGEB (especially the U.S. and Japan) because it is a threat to their biotech monopoly. ICGEB should provide useful countervailing influence against privatization of biotech and seed technology and Kenya must liaise intimately with them while supporting them and others forcefully at international fora.

3) NGOs be sensitized as to the extremely grave nature of bio-revolution and of germplasm loss. This would be as a first step towards galvanizing them and eventually grassroots organizations and people to understand the issues and take what defensive (and where necessary offensive i.e., constructive) actions are necessary for national and local preparedness.

4) Keen NGOs and individuals could profitably be encouraged to carry out direct tasks, symbolic or otherwise, that help build momentum or provide models, e.g., small-scale collections of some threatened germplasm, growing of rare landraces in simple living-collections, pending the building of gene banks.

5) Small projects in biotech can be identified and encouraged. The beauty of biotech is that in some respects it is easy to enter inexpensively. It also allows for seemingly quixotic possibilities to be tried out. A few

that come to mind are:

a) Echinocloa haploclada is a grass species of Kenya's lower altitude's swampy or seasonally-swampy grasslands. It also thrives in riverine ecosystems. It grows rapidly after rains, seeds, and dies back when rains are over. The whole cycle can take less than two months. Most important it has large nutritious grains higher in food content than rice. It seems that by intergeneric breeding as in Triticale (e.g., between Oryza and Echinocloa or any other combination thereof) a novel Kenyan grain can be produced that can grow literally in the wild with minimal cultivation using marginal land. Intrageneric breeding with domesticated Asian Echinocloa millets has also some potential. With bioengineering techniques, the sky is the limit. Although esoteric basic research should be avoided, investigations into possibilities of producing new grains from our graminae by various rDNA methods should be undertaken. Other possibilities are:

b) Wild Setaria can be combined (or bred with) Setaria italica (fox-tail millet). If the resulting grain takes after the wild one even by half the growth properties, most of Kenya's grasslands can grow it. Similarly Nandi Setaria a pasture grass bred or bioengineered into Setaria italica might produce simultaneously rich pasture and copious grain.

c) Wild Eleusine genes can likewise be spliced into Eleusine coracana (wimbi) genomes.

d) Similarly wild sorghum, Panicum and Eragrostis (of Teff fame) should be manipulated.

e) Most interesting is the Pennisetum typhoides (bulrush millet) the most drought resistant of millets. Crossed with, or gene-spliced into, other wild graminoids or Pennisetum species a wide array of possibilities would open up in grain production in marginal lands.

One only needs to observe the prolific productivity (absolute biomass and grain) of wild Kenyan grasslands in the Ecological Zone III to V during the brief period of wetness to grasp the possibilities and the potential benefits of wild grass genes in cereal breeding.

Kenya can pioneer in such research inexpensively. Why not?

ISSUE No. 3: Agroforestry and Rural Afforestation

As concerns agroforestry and rural afforestation a great deal of experience has been accumulated in a brief period and already many projects are under way. These provide good models to learn from and to modify where necessary, especially as concerns seed production, storage, and distribution, as well as training and extension. The localized, decentralized nature of these projects is some insurance for longer survival although questions of continuity after expatriates in charge depart remain a concern and must be addressed now.

It must be recognized that agroforestry is a form of farm production of wood products. It is therefore an economic activity. While ecological parameters or suitability and crop-tree compatibility must be considered, the primary goal is productivity (biomass) at minimal cost. Care must therefore be taken not to over-romanticize indigenous species without reference to economic considerations, e.g., rate of growth and biomass production. By the same token, some recent exotic introductions may prove weedy in some ecosystems. Algaroba (essentially a mesquite) in lower Tana shows such tendencies where bovines browse the pods and disseminate seed far and wide.

Finally, it has become evident while carrying out this enquiry that it is often the individual plant enthusiast who galvanizes or catalyzes planting and seed-collecting activities and makes the difference between success or failure in a project. KENGO's and others' experience corroborate this. Such individuals are retired forest nursery keepers, school teachers and headmasters and church leaders. Given encouragement and initial guidance, it seems there is a fund of unexploited initiative that could be harnessed, especially now that retirement at an early age is releasing such talent and experience.

Following are examples of such individually catalyzed projects:

Simenya Primary School (Siaya) - Headmaster
Khayega project near Kakamega - Late Mr. Shitaka
a retired forest worker
Tigithi Primary School (Muranga) - Mr. Marura
Kariaini Nursery (Laikipia) - Mrs. Naomi Wambui
Fudumi Farm - Chavakali - Dr. Wanje
Maseno Diocese project - Church leaders

In other crop and food experimentation and development this individual catalyst method seems to recommend itself

eminently in creating models and centres of innovation and diffusion.

It is important to keep in mind while planning for the symposium that a primary objective is to harness and enhance Kenya's strengths and resources to create self-sufficiency in all spheres and at all levels.

There exists here a tremendous amount of traditional knowledge on plants and seed which is at risk of getting lost if not recorded and used. Further, there is much scientific talent in Kenya. With appropriate leadership, and a climate of free exchange of ideas, this talent can be moulded into a dedicated and creative cadre of indigenous professionals. Ultimately, achievement of goals discussed in this paper is dependent on active cooperation between professionals and local people at the community level.

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Appendix i.

Wild plant resources - Wild berries, fruits and nuts play a very large part in Turkana diet, while other parts of plants may also be used: leaves boiled or chewed, roots eaten fresh or cooked, stems and gum chewed, bark infused to make tea, flowers sucked or eaten, pods of Acacia tortilis eaten fresh or dried. Morgan (1980) lists 47 species that are used more or less regularly in these ways and Gulliver gives 14 fruits, nuts or seeds which he regards as 'main food', apart from those casually consumed on the spot, some of which, such as esekon, (Salvadora persica), may be used in large quantities. The significance of wild products is emphasized by the preparation required to make some of them edible - for at least six species the fruits need to be boiled several times. Major contributors to diet in various areas are edome, (Cordia sinensis), egoli, (Doum palm), erdung, (Boscia coriaceae), edapa, (Dobera glabra) and erpat, (Terminalia spinosa).

Products may be eaten immediately, fresh or cooked, or pounded up into a kind of meal, sometimes mixed with blood, for storage. Many of the wild plant resources are available in the dry seasons when other food is at a minimum.

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CHAPTER 326

1 of 1972.

THE SEEDS AND PLANT VARIETIES ACT

Commencement: 1st January, 1975

An Act of Parliament to confer power to regulate transactions in seeds, including provision for the testing and certification of seeds; for the establishment of an index of names of plant varieties; to empower the imposition of restriction on the introduction of new varieties; to control the importation of seeds; to authorize measures to prevent injurious cross-pollination; to provide for the grant of proprietary rights to persons breeding or discovering new varieties; to establish a Tribunal to hear appeals and other proceedings; and for purposes connected with and incidental to the foregoing

PART I—PRELIMINARY

Short title.

1. This Act may be cited as the Seeds and Plant Varieties Act.

Interpretation.

2. In this Act, unless the context otherwise requires—

"authorized officer" in connexion with any provision of this Act, means a public officer authorized by the Minister by notice in the Gazette to exercise the functions specified in such provision;

"compulsory licence" means a licence granted by the Minister under section 23 of this Act;

"the Index" means the index of names of plant varieties prepared under section 7 of this Act;

"Minister" means the Minister for the time being responsible for matters relating to agriculture;

"plant breeder's rights" means rights granted under section 17 of this Act;

"plant variety" means an assemblage of cultivated individuals which are distinguished by any character (morphological, physiological, cytological, chemical or others) significant for

additional kinds of crop or plants, whether grown or self-sown and whether of those or any other types or varieties, as may be specified in such order for the purposes of this definition;

"the occupier", in the case of unoccupied land, means the person entitled to the occupation of the land;

"protected crop" means a crop of a type or variety of plant which is protected by an order in the area concerned, being a crop grown for the purpose of producing seeds.

PART V—PLANT BREEDER'S RIGHTS

Grant of plant breeder's rights.

17. (1) Rights may be granted in accordance with this Part in respect of plant varieties of such species or groups as may be specified by a scheme made by the Minister under this Part.

(2) Subject to this Part, plant breeder's rights shall be granted by the authorized officer if he is satisfied that the conditions laid down in section 18 of this Act are fulfilled.

(3) The Third Schedule to this Act shall have effect for the protection of an applicant for plant breeder's rights pending a decision on his application.

(4) Before making a scheme, the Minister shall consult representatives of such organizations as he deems to have a substantial interest in the matter to be regulated and of such other interests as appear to the Minister to be concerned, and any scheme—

(*a*) may make different provision for different species or groups of plant varieties;

(*b*) may contain such supplemental, incidental and transitional provisions as appear to the Minister to be appropriate;

(*c*) may be varied or revoked by a subsequent scheme,

so, however, that the variation or revocation of a scheme shall not prejudice a grant of plant breeder's rights made before the variation or revocation takes effect.

Conditions for grant of rights.

18. (1) The conditions laid down in this section must be fulfilled as respect both the applicant for plant breeder's rights and the plant variety to which the application relates.

Appendix iii.

BIOTECHNOLOGY

TABLE 1: Some Recent Seed Company Acquisitions and Characteristics of Acquiring Firms

Acquiring Company:	Seed Subsidiaries	In-house Biotech:	Biotech Venture Firm Interests:
ARCO	Dessert Seed Co	X	IPRI Ingene Bioengineering Center
Celanese	Celpril, Inc Moran Seeds Joseph Harris Seed Co.	X	
Ciba-Geigy	Ciba Geigy Seeds Funk Seeds Louisiana Seeds Hybridex	X	
FMC Corporation	Seed Research Associates	X	Centocor Immunorex
Monsanto	Farmers Hybrid Co.	X	Genex Biogen Genentech Collagen
Occidental Petroleum	Ring Around Products Excel Hybrid Missouri Seeds Moss Seeds	X	
Pfizer	Trojan Seed Co. Jordan Wholesale Co. Clemens Seed Farms Warwick Seeds	X	
Sandoz	Northrup King National N-K McNair Seeds Gallatin Valley Rogers Brothers Ladner Beta	X	Zoecon
Shell	North American Plant Breeders Nickerson Seed Co. Agripro, Inc. Tekseed Hybrid	X	Cetus
Stauffer	Stauffer Seeds Blaney Farms Prairie Valley	X	
Upjohn	Asgrow Seeds Associated Seeds	X	

Appendix iv.

Table 2. *A Comparison of the Institutional Structures of the Green Revolution and Biorevolution*

Characteristics	Green Revolution	Biorevolution
Crops affected	Wheat, Rice, Maize	Potentially all crops, including vegetables, fruits, agroexport crops (e.g. oil palms, cocoa), and specialty crops (e.g. spices, scents)
Other products affected	None	Animal products Pharmaceuticals Processed food products Energy
Areas affected	Some LDCs; some locations (i.e. if accompanied by irrigation, high quality land, transport availability, etc.)	All areas; all nations all locations, including marginal lands (characterized by drought, salinity, Al toxicity, etc.)
Technology development and dissemination	Largely public or quasi-public sector	Largely private sector (multinational corporations and start-up firms, with the former predominating in terms of commercialization)
Proprietary considerations	Patents and plant variety protection generally not relevant	Processes and products patentable and protectable
Capital costs of research	Relatively low	Relatively high
Research skills required	Conventional plant breeding and parallel agricultural sciences	Molecular and cell biology expertise plus conventional plant breeding skills
Crops displaced	None (except the germplasm resources represented in traditional varieties and land races)	Potentially any

Appendix V.

There are ten private or cooperative seed production organisations. Their addresses and the crops they handle are given below:

MAJOR SEED-PRODUCING ORGANIZATIONS IN KENYA, 1980

Organization	Species
Kenya Seed Co. Ltd. P.O. Box 553 Kitale	Maize, small cereals, sunflower, rapeseed, grasses, sorghum
Njoro Seed Co. Ltd. P.O. Box Molo	Wheat, barley
Agricultural Development Corporation P.O. Box 556 Nakuru	Potato
Hortiseed Kenya Co. Ltd. P.O. Box 30472 Nairobi	Beans, horticultural crops
East African Seed Co. Ltd P.O. Box 45125 Nairobi	Beans, horticultural crops
Simpson and Whitelaw P.O. Box 40042 Nairobi	Horticultural crops
Ideal Seed Company Ltd. P.O. Box 43374 Nairobi	Beans, horticultural crops
Mount Kenya Agro-Industries P.O. Box 161 Kiganjo	Potato, beans
Jardinage P.O. Box 59317 Nairobi	Horticultural crops, beans
Kenya Highland Seed Co. P.O. Box 322 Nanyuki	Beans

Appendix vi.

Genetic research timetable for key crops – Predictions

	Identification, duplication and modification of agriculturally important genes	Routine growth of plant tissue in laboratory culture conditions	Growth of first genetically transformed whole plant	First plants altered by new technology available to breeder for commercial production	Growth of transformed plants on a routine basis
Major cereals					
Corn	now (zein, early maturity genes)	now	early 1990s	now	mid-1990s
Wheat	1985 – 1987	now	early 1990s	1984 – 1986	mid-1990s
Rice	1985 – 1987	now	lat 1980s	now	early 1990s
Barley	now (hordein, powdery mildew resistance genes)	now	1986 – 1988	1985 – 1987	early 1990s
Sorghum	1987 – 1989	1984 – 1986	early 1990s	1988 – 1990	mid-1990s
Oil seeds					
Soybean	now (nitrogen fixation genes)	now	early 1990s	1988 – 1990	mid-1990s
Oil palm	1988 – 1990	now	late 1990s	now	after 2000
Sunflower	1985 – 1987	1984 – 1986	now	1984 – 1986	1986 – 1988
Oilseed rape	1984 – 1986	now	late 1980s	now	early 1990s
Forages					
Alfalfa	1986 – 1988	now	1985 – 1987	now	early 1990s
Red clover	now (nitrogen fixation genes)	now	early 1990s	now	mid-1990s
Vegetables					
Tomatoes	1984 – 1986	now	1983 – 1985	now	1986 – 1988
Lettuce	1985 – 1987	now	late 1980s	1983 – 1985	early 1990s
Cucumer	1986 – 1988	1983 – 1985	mid-1990s	1985 – 1987	late 1990s
Onion	1986 – 1988	1984 – 1986	early 1990s	1984 – 1986	mid-1990s
Potato	now	now	1983 – 1985	now	1986 – 1988
Carrot	1983 – 1985	now	1983 – 1985	now	1986 – 1988
Beans	now (phaseolin)	1984 – 1986	1986 – 1988	1985 – 1987	early 1990s
Peas	now (vicilin, legumin)	1984 – 1986	mid-1990s	1985 – 1987	late 1990s
Brassicas	1983 – 1985	now	late 1980s	now	early 1990s
Grasses					
Kentucky Bluegrass	late 1980s	1985 – 1987	mid-1990s	1986 – 1988	late 1990s
Orchard-grass	late 1980s	1985 – 1987	mid-1990s	1986 – 1988	late 1990s
Woody plants					
Fruit, nut and ornamental trees	mid-1990s	1986 – 1988	late 1990s	early 1990s	after 2000
Forest trees	mid-1990s	now	lat 1990s	early 1990s	after 2000
Specialty crops					
Sugarbeets	1985 – 1987	now	early 1990s	1987 – 1989	mid-1990s
Sugarcane	1987 – 1989	now	early 1990s	now	mid-1990s
Cotton	1985 – 1987	now	early 1990s	1983 – 1985	mid-1990s
Tobacco	now	now	1983 – 1985	now	1986 – 1988

BAOBAB FARM LIMITED

Appendix VII.

TREE SEED : PRICE LIST

Name of Tree	Price/100g	No of seeds/100g
Prosopis juliflora F^1	Kshs 150.==	3,000
Prosopis juliflora F^2	Kshs 200.==	3,000
Prosopis pallida	Kshs 300.==	3,000
Leucaena leucocephala K^8	Kshs 75.==	2,000
Leucaena leucocephala K^{28}	Kshs 75.==	2,000
Azadirachta indica	Kshs 20.==	400
Casuarina equisetifolia	Kshs 300.==	50,000
Conocarpus lancifolius	Kshs 250.==	60,000
Winged Beans	Kshs 60.==	280
Prosopis pods	Kshs 300.==	1 bag
Algaroba seedlings	Kshs 3.==	per plant

19/9/84

Appendix viii.

The major producers of agricultural chemicals in the world (1978)
(1978)

Company	country of origen	turnover of agricultural-chemicals (x 10^6 US$)	fertilizer producer	new seed producers (x10^6 SF)
Bayer	W-G.	1480	x	x
Ciba-Geigy	Swi	1090	-	241(1977)
Shell	Neth/UK	655	-	xx
Monsanto	USA	605	x	xx
ICI	UK	515	xx	x
Rhône-Poulenc	Fr	465	xx	xx
BASF	W-G	450	xx	x
Dupont	USA	400	?	?
Stauffer	USA	380	x	x
Eli Lilly	USA	336	?	?
Dow American	USA	335	-	?
Cyanamid	USA	325	x	?
Union Carbide	USA	320	x	xx
Kumiai	JAP	279	?	?
FMC	USA	260	-	xx
Schering	USA	213	-	?
Hoechst	W-G	210	x	x
Rohm & Haas	USA	204	-	xx
Sandoz	Swi	162	-	464(1977)
Roussel-Uclaf*	Fr	161	-	?
Diamond Shamrock	USA	145	x	xx
Sumitomo	JAP	120	x	?
Velsicol	?	110	-	?
Montedison	IT	97	xx	?

* = 50,2% Hoechst
x = prominent producer
xx = extremely prominent producer
- = no producer
? = unknown.

Appendix ix.

Major producers of seed not of chemical inputsector origin

	principal activity	country of origin
Anderson Clayton*	cereals and oilcrops (trade and processing) fodder producer	USA
Central Soya*	cereals, oilseeds, cattle-fodder, poultry, etc.	USA
Cargill*	cereals, oilseeds largest grain trader in the world	USA
Celanese	chemical fibres	USA
Upjohn	pharmaceuticals	USA
Dekalb Agresearch	hybrid seeds and initial stockraising material	USA
ITT	telecommunication etc. food	USA
Occidental Petroleum	oil, chemicals fertilizers	USA
Olin	chemical products (breeding in cooperation with Shell)	USA
Pfizer	pharmaceuticals	USA
Pioneer Hi-Bred	seeds, poultry, computer services	USA
Purex	seeds	USA
Rank Howis McDougall	flour, bakeries other foods	UK
Tate and Lyle	sugar	UK

* These 3 companies control the world grain trade together with Continental Grain and Bunge.

Appendix x.

Multinational Corporations, Product Lines, and Seed Company Subsidiaries*

Multinational Parent	Primary Products	Seed Subsidiaries
Sandoz (Switzerland)	pharmaceuticals	Ladner Beta Seed (Canada) Zaadunie (Netherlands) Northrup King (USA) Rogers Brothers (USA) National-NK (USA) Sluis en Groot (Netherlands)
Shell (UK/Netherlands)	oil, chemicals	International Plant Breeders (UK) Comanie General de Semillas (Spain) Rothwell Group (UK) Interseeds (Netherlands) IPB Japan (Japan) Nickerson P. Cmbh (West Germany) Zwaan (Netherlands & Belgium) North American Plant Breeders (USA; with Olin Chemical)
CIBA-Geigy (Switzerland)	pharmaceuticals, chemicals	Funk Seeds International (USA) Stewart (Canada) Louisiana Seeds (USA) CIBA-Geigy Mexicana (Mexico)
Celanese (USA)	textiles, chemicals	Celpril (USA) Horan (USA) Joseph Harris (USA) Nugrain
Cargill (USA)	grain marketer	ACCO (USA) Dorman (USA) Kroeker (Canada) PAG (USA)
Occidental Petroleum (USA)	oil, petrochemicals	Ring Around Products (USA) Excel Hybrid (USA) Missouri (USA) Moss (USA)

*These data are presented for illustrative purposes only.

Appendix xi.

Plant Product Tissue Culture: Performing Corporation and Country of Origin.*

Product	Company	Country of Origin or Cultivation
Opium	Plant Science (UK)	Turkey, Thailand
Cinchona	Plant Science (UK)	South America, Indonesia
Digitalis	Plant Science (UK)	
Ginseng	Plant Science (UK)	United States, Korea
Catharanthine	Institute for Biotechnology Research (Ger)	
Pyrethrum	Biotec (Bel)	Kenya, Tanzania, Uganda
Tobacco	Japanese Salt and Tobacco Monopoly	United States
Murasaki	Mitsui Petrochemical (Jap)	Japan, Korea, China

*These data are presented for illustrative purposes only.

THEN GOD SAID, " I GIVE YOU EVERY SEED-BEARING PLANT ON THE FACE OF THE WHOLE EARTHAND EVERY TREE THAT HAS FRUIT WITH SEED IN IT. THEY WILL BE YOURS FOR FOOD..."

Genesis 1:29

Not for Publication

or Reference.

Introduction

Kenyans today are well aware of the problems they face to feed themselves and to produce sufficient fuel wood for domestic needs. With population growing at the fastest rate anywhere in the world in a country with only 20% arable land, there is recognition of the fact that, in addition to hard socio-economic choices, important decisions must be urgently taken with regard to land use, choice of crops, and rehabilitation of degraded land which has been lost to overgrazing, deforestation, soil erosion, and desertification.

Some progress has been made in Kenya raising awareness of people, particularly opinion makers, to the crisis they face. Concern about environmental degradation and the urgent need to conserve soil cover while at the same time creating sustainable sources of woodfuels, has spurred interest in planting trees throughout the country. This development has increased the demand for tree seed, especially seeds of efficient arid-area species and multipurpose agroforestry species. One consequence of this growing interest in "new forestry" is an unprecedented competition for the limited quantities of tree seeds available today and a concern among those involved in tree planting schemes and projects that new and reliable seed sources and supplies must be developed in order to ensure continued growth in this important sector.

KENGO, an NGO committed to productive conservation, is interested in seeking ways of making adequate seed of the appropriate types available to interested farmers and community groups. Together with other organizations and agencies, KENGO is proposing an intensive study of all issues related to availability of appropriate seeds in Kenya--both tree seed and food crop seed. While the immediate issue is on developing programmes and policies in support of availability of tree seeds for all purposes, KENGO is of the opinion that this issue must be understood in its fullest context, which includes the impact of foreign-based agribusiness/petrochemical industries on choices taken in countries such as Kenya.

Because Kenya is no longer self-sufficient in food, outside forces are playing an increasingly important role in

influencing how and for whom Kenya uses its land and resources. As Kenya leans on international sources for grain purchases and relief food in times of famine and for long-term development inputs, we become more dependent on solutions which are designed for foreign environments and economies. KENGO is concerned about the appropriateness of many of the solutions currently being tried or encouraged in Kenya. A brief look follows of some trends and related issues.

Current Trend: Increasing use of hybrid seed as a means to increase productivity.

Related Problems:

1. dependence of small-scale farmers on purchase of total package of input including new seed each season, as well as pesticides, and fertilizers. This effect of the "Green Revolution" mode of rural development has driven many farmers into debt in other parts of the world as they resort to loans to finance the expensive package of inputs.

2. vulnerability of farmers to massive crop failure due to monoculture planting which increases risk to environmental stresses (e.g., pesticide resistance and drought)

Current Trend: Increasing shift to cash crops

Related Problems:

1. increasing percentage of the precious arable land being devoted to commercial cultivation of luxury items (flowers, vegetables and beverages) for export overseas, leaving more and more Kenyans to eko out bare subsistence on increasingly marginal lands.

2. Land degradation due to decreased fallowing and/or "soil mining," and loss of traditional germplasm due to replacement by cash crops and improved cultivars.

KENGO believes that it is time for Kenyans to take a close look at what is happening to the ordinary farmer and citizen in countries where the Green Revolution has had an impact. Additionally, it behoves all of us who are interested in the issue of seeds, particularly crop seeds, to be keenly aware of breakthroughs in biotechnology that threaten to have a profound even revolutionary impact on seed technology and agriculture in general. It is not too late for Kenya to avoid the pitfalls and to learn from the experiences of

other peoples. In a country that is largely dependent on small-scale agriculture, it is paramount that Kenya plan for constructive policies and programmes that will enable the bulk of its population in the absence of better alternatives, to derive their livelihood from the land as productive small-scale farmers.

This report is an initial effort to enquire into the international scientific and commercial agricultural forces which have an impact both practically and attitudinally in Kenya, as well as the policies, infrastructure and practices in Kenya with regard to seeds. This is viewed as a working paper to be used in planning for a much more thoroughgoing examination of the issues at the proposed Symposium. Out of the proceedings of that Symposium, KENGO would hope that a major report on the current state of seeds in Kenya, the international factors influencing availability of seeds, related policies, serious gaps in Kenya's capacity to fulfill its current and future seed requirements and recommendations for future policy and programmes will emerge.

Chapter I

CURRENT SITUATION REGARDING CROP AND TREE SEED IN KENYA

Both symbolically and literally, seeds are unquestionably the essence, the very basis of the renewal of life. It is difficult to overstate the crucial role played by seeds in an agricultural economy. The quality, the quantity as well las the whole range of activities associated with seed availability and procurement are all fundamental issues in ensuring a successful food policy. In Kenya as elsewhere in Africa, as food needs rise and production declines, as prices of inputs rise and general incomes decline, so too will requirements rise for more seeds--both better types and more appropriate (even unorthodox) crops.

The seed issue, epecially future projections of seed demand/supply and advances in seed technology, is a rather vast topic. It becomes even more so in our case since we are interested not just in improved, high-productivity crop seed but also in seed of old varieties with special qualities; we are also interested in reviving some traditional crops in order to help insulate rural systems from fluctuations caused by uncontrollable external events. Finally we are interested in agroforestry and other tree seeds.

The state of seed is further complicated by the fact that both seed science and seed marketing are at a historic turning point. Previously plant breeding and seed production were carried out in a relatively stable, predictable environment mostly comprised of government agricultural research establishments, many small seed companies and fierce competition. With the arrival of new technologies in genetic engineering and fast high-tech breeding techniques, large multinational firms have moved into seed business and research. With this change the marketing picture is bound to alter dramatically. The MNCs include such giant chemical concerns as Shell and Sandoz which are now beginning to tie certain seeds to specific chemicals in their control.

Agroforestry and Tree Seeds

There has been a massive increase in demand for tree seed and other tree planting material in Kenya in the last ten

years, especially in the last five. Starting roughly about the time of the 1977 National Seminar on Desertification, with the subsequent UN Conference on Desertification held in Nairobi the same year, a great deal of enthusiasm in tree planting and soil-cover maintenance was generated. This enthusiasm was translated into organized movements of various sizes and different orientations which started small rural tree planting projects in many parts of Kenya. By 1982 there were at least 15 national organizations involved in planting operations of various sizes. This was in addition to the usual Forest Department industrial plantation and afforestation schemes. With such high levels of demand a shortage of tree seed was bound to occur sooner or later. A special aspect of this new demand was that seeds of unconventional, even obscure, species were sought. Whereas earlier demand was of fairly predictable species, largely confined to the traditional Forest Department list of mainly exotic species, prospective planters now turned their attention to, among others, efficient arid-area species, or to previously untried indigenous species and often to multipurpose agroforestry species.

This innovation was spurred by the following developments:

1. The National Seminar on Desertification, mentioned above helped to clarify to a larger audience the growing seriousness of environmental degradation in Kenya and the urgent need to conserve soil cover and to use where possible local flora in rehabilitation exercises. Kenyan acacias were specifically mentioned and recommended.

2. The publications of the U.S. National Academy of Science on underexploited and potentially useful multipurpose plant species from all over the tropics.

3. Finally, by the subsequent growth of an agroforestry outlook in rural agriculture and the "local woodlot" approach to rural energy self-sufficiency and farm practices.

The upshot of this "new forestry' was an unprecedented competition for the small quantities of tree seeds then available and a growing perception by those involved in planting schemes of an approaching bottleneck or seed supply constraint to planting schemes. It was felt that many projected schemes would be impeded unless new and reliable seed sources were procured and future sources and supplies institutionalized. This sentiment was repeated time and time again by participants and contributors at the special Training Workshop on Seed Collection and Handling held at Moi University in July 1985 (1,28). Earlier a consultant for ICRAF raised similar concerns and went on to highlight some possible solutions here and elsewhere (19).

Food Crop Seed

While tree planting organizations were encountering seed shortages, those in the farming and food sector were in the midst of a growing cropseed crisis whose severity was not to be fully recognized until the 1984 drought and famine. The widespread failure of the 1984 long rains and the ensuing crop losses meant disastrous shortfalls in commercial improved seed (primarily maize and bean) just when most subsistence seeds had either been consumed or were lost in the drought. Practically every farmer, large and small, was therefore in the market for commercial supplies. For the first time in memory, Kenyan commercial seed producers could meet only a fraction of the demand in maize and bean seeds. What some had feared for a decade, specifically since the 1971/74 drought, had occurred. The 1984 short rains season found many farmers unable to sow for want of seed. Kenyan farmers had to resort to imported commercial and "aid" seed, to unsuitable seed or to non-crop alternative land uses.

This 1984 drought brought many more actors into the seed question. Most notable were NGOs, particularly church related ones, UNICEF, FAO, and WFP, who heretofore had left seed questions to the MOA research stations and the commercial/ parastatal seed companies. The latter's planning, distribution, even programme capacities were so swamped that the Office of the President and the Ministry of Finance and Planning became the major actors. Perhaps this obeyed the logic of disaster control, but it is not a useful state of affairs for the long run in solving seed shortages.

The seed shortfall clearly would affect the size of the subsequent harvest just at the time when depleted national grain reserves needed massive replenishing. Clearly in crop farming, the seed issue had suddenly become a crisis and a whole new set of questions became apparent. Can Kenya's current cropseed infrastructure provide in the future adequate seed, certified or otherwise, to the rapidly growing crop sector? What technical and commercial adjustments are necessary? What institutions, public or private, local or foreign, influence seed production and marketing in Kenya? What institutional adjustments are necessary? How do subsistence farmers view the modern hybrid cultivars--the so-called High Yield, High Response varieties (H.Y.V.)?

Impact of Green Revolution

Hitherto increases in Kenyan food production and rural income have been based upon introduction of new improved or hybrid cultivars in food and cash crops a fact stressed repeatedly in the National Food Policy Paper (84), quoted below:

> The objective of food crop research will be to continue the search for more productive crop varieties, while increased emphasis will be placed on breeding programmes aimed at continuous increases in the yields of already established strains. (Section 3:13)

In crops, particularly, absolute food yields may rise, initially anyway, when hybrids and other "miracle" grains are cropped. However, the so-called "Green Revolution" model of the sixties and seventies brought with it a package of inseparable elements--high yield hybrids which require higher levels of costly chemical inputs such as fertilizer and pesticides plus purchases of new seeds every season. Kenya subscribes, in large measure, to this model of rural development as the food policy referred to above makes clear. As a result, other technologies like composting, local variety selections and utilisation of traditional crops were ignored and are being lost.

In summarizing the experiences of the last 20 years of the Green Revolution, very serious doubts have been expressed as to whether benefits ever did accrue to the rural peasants concerned (52 to 57). Evidence from Asia, (India, Sri Lanka, Pakistan, and the Philippines) where high-input, high-response hybrid rice cultivars were first introduced to previously stable and self-sufficient rural systems, shows that the shift resulted in economic disruption and social dislocation in the form of farmer indebtedness, resulting in repossession of their land, marginalization of small producers, and concentration of production by the larger producers. The outcome was the creation of a large dispossessed population of ex-farmers who migrated to cities in search of employment but who became instead unemployed shanty-dwellers. Evidence seems to suggest that beyond such structural disruptions the Green Revolution package in many cases benefitted the urban dwellers of the countries concerned (in that among other things consumer prices decreased) and the multinational corporations of the industrial countries who supplied the inputs, more than the rural societies which were ostensibly targetted (57).

More importantly for our purposes here, is the fact that this seed-chemical package spelt disaster for the rich crop-mixes that had existed since ancient times and that were part and parcel of the local cultures, folklore, and production systems. Older crop varieties, grown for ages and adapted to local conditions and environmental stresses, were rapidly replaced and often wiped out by hybrids planted in monocultural tracts which, being genetically uniform, are extremely vulnerable to environmental stress. A sneering attitude to these old races of crops became the order of the day among agricultural research and extension officials. In some circles here in Kenya and abroad this attitude still

persists. However, officials in many countries are now discovering, in many cases belatedly, the exact toll of decades of "Green Revolution;" Sri Lanka has lost many ancient varieties and landraces of rice. So have India and Malaysia.

This is the process called gene erosion where the rich diversity of genes, summarized and carried over from year to year as "genetic packages" in the different varieties of seed and sustained for eons as a cultural heritage of peoples, is extinguished rapidly or slowly, and replaced by highly vulnerable, genetically uniform cultivars. This reduced diversity in crops or reduced mix of crop species does not make for very much reliability or suitability in the long run. It reduces the in-built natural buffers against environmental stress and sets the stage for crop disasters when hybrids may fail en masse, e.g., as a result of a new pest or disease or sudden environmental changes.

In terms of gene erosion, Kenya's experience with high response cultivars is not very different from the Asian model. Old crops and old varieties have been and are being displaced. Luckily not quite as much destruction of germplasm seems to have taken place, although no proper inventory really exists here. But the danger is present and it is growing. Cash cropping for export may sometimes seem the larger danger in eliminating traditional crops and causing gene erosion. There are no figures but it is clear that horticultural crops and perennial cash crops are expanding rapidly at the price of food crop production (87). It is of dubious advantage in a situation where hunger and malnutrition exist to grow coffee and french beans for export at low and relatively falling international prices in order to import expensive staple foods and luxuries. These basic questions of food policy are large but they clearly have a bearing on the seed question in general and in any case must soon be addressed.

The Case for Traditional Crops

It is now realized that a wide and abundantly varied genetic base is crucial to stress-resistance in crops as in any community of living organisms; that those "lowly," previously derided, primitive varieties and landraces carry genomes of inestimable value for future farming and breeding; and that already much genetic information has been lost due to the "Green Revolution" attitudes and development model and that some back-tracking may be of great advantage especially to preserve and rejuvenate what is left of the old crop land races (41,42,43,44).

There is also growing evidence that rural development is not a simple question of biological/chemical efficiency in crop productivity. Neither is it a phenomenon dependent on high

technical expertise emanating from outside the farm system as the "Green Revolution" package assumed. There is a basic need for rural people to acquire greater control of their systems, to participate and to build their community and their institutions. If some productivity is lost in the short-run, the gains are inevitable in the long-run in that less "energy" will seep out to external systems. This is a form of slow de-linking from predatory, uncontrollable larger systems while slowly creating new, albeit initially weak, forms of self-sufficiency in food, in income generation and to some degree in political power, making it possible for farmers to control more of their own destiny.

No point is more appropriate to start from than self-sufficiency in seeds, that is, removing the dependence on commercial suppliers of unpredictable, expensive, sometimes unsuitable and unreliable seed. Hybrid seed, for example, does not reproduce itself. One must always purchase next season's seed from seed agents. Traditional crop seed, by contrast is made and harvested on the farm as a basic part of rural renewal. Except for times of disasters, it is always there. It is ecologically suitable to the area and makes up for its supposedly lower productivity by eminently higher stress tolerance and at much lower external energy (chemical, etc.) inputs. It is hence reliable.

A related problem as regards rural self-sufficiency is the growing threat of food as a political and economic weapon and the risks of international price wars as "grain mountains" increase in the industrial north and as these stock piles are off-loaded into the international market. One can imagine the possibility, difficult but there all the same, where a return to small-scale, traditional crop systems, in addition to the greater economies and ecological suitability, would also provide some buffering, if not total insulation from the ill effects of such international eventualities. If national diets change, say to non-grain staples, and as long as no natural disasters intervene, one is already partly de-linked from international grain movements, partly self-sufficient, and less likely to become a permanent ward of relief agencies.

Some may argue that this view is retrogressive, anti-progress, etc. In the short run it might seem so. In the long-run it could help create a new reality in rural life and shift the thrust from the "Green Revolution" model with its attendant dislocations to new community-directed production. It need not be a rapid change. It need not immediately oust or even challenge cash crops from their dominant role in many areas, but it slowly begins to create alternative forms and "vision."

Since the next 15 years are a critical watershed period in genetics, germplasm conservation and seeds in general, our examination of the state of seeds must have a strong future-projection component--something akin to looking into Kenya's seed requirements and policies into the 21st Century. This will release us from the narrow confines of merely investigating today's immediate needs, practical and urgent as they are, and help us to make a larger contribution to the wider seed debate and hopefully to Kenya's food preparedness in the future.

Chapter II

KENYA'S GERMPLASM HERITAGE

East Africa is geographically and ecologically somewhat abnormal. For one, it is the only equatorial eastern seaboard of a major continental landmass that is arid. By all counts ours should be a hot, humid, equatorial forest environment with nary a moisture-deficient month. Similarly-located regions on the Asian and South American landmasses are tropical rain forest ecosystems. Because of the monsoon effects, among other reasons, Eastern African lowland environments are principally semi-desert with scrubby vegetation of the dry Acacia/Commiphora type. The highlands form "ecological islands" of humid environments in this generally arid setting. East Africa is an area of unusually rich biotic endemism and it is no wonder that, with ecozones ranging from desert to alpine, this land provided an excellent setting for hominid and human evolution.

According to the Russian crop scientist N. I. Vavilov, there are seven centres of crop diversity in the world. Of these only the Ethiopian centre falls in sub-saharan Africa. Northern Kenyan uplands and wetlands are included in the Ethiopian centre in the strict sense of Vavilov's classification. But in a wider sense, much of Kenya and many of her traditional crops could be considered to belong to Vavilov's Ethiopian centre. The following crops or their wild relatives are, according to Vavilov, endemic in Ethiopia and Kenya, especially in the highlands:

Bananas
Barley
Castorbean
Coffee
Flax
Lab Lab (Dolichos)
Onion
Sesame
Sorghum
Wheat
Millet
Vigna

This is, however, an incomplete list. N. I. Vavilov, a Russian, and A. de Candolle, a Swiss, brought to early crop studies a bias of their European training and cultural values. They could not be expected to pay much heed to localized ethnic food tastes in Africa or to even be aware of them. In fact, for one reason or another, they both

missed the West African centre of origin which, though recognized as vital, does not feature in Vavilov's crop genetic diversity map. They understandably emphasized crops then known to European scholarship and culinary science and ignored important but obscure local ones.

There are literally thousands of crops in East Africa that were part of folk culture. They include root crops like the Kakamega yam (Liruku), pulses like Lab Lab (Bonavist beans or dolichos), Vigna sp, and pigeon pea, about a dozen species of grasses which yield grain in times of famine (and might be hardier in some cases than some millets), fruits and vegetables. The latter two were often collected wild and for that reason may have been ignored as a crop, but there is evidence to suggest that wild vegetables (Amaranthaceae, Solanacea and Cruciferae to name a few families) contributed a considerable portion of the dietary intake. Many are still used today, e.g., Thabai or Hatha (nettle) in the Central Highland forest zone, and Saga/akeyo (Cleome), so treasured in Nyanza/Western Provinces and now entering fresh vegetable commerce, etc. In addition, perennial tree/shrub foliage of diverse species was an important vegetable source for many cultures. Baobab and some Malvaceae relatives as well as cassava leaves are still used as potherbs.

Unfortunately, it is difficult to get a fuller documentation or inventory of Kenya's traditional food-crops. This is a very serious gap that needs filling.

The Ministry of Agriculture has this year started a special project to study traditional crops and revive interest in them. Under the Home Economics (Nutrition/Food Technology) section, the Intensive Food Production and Utilization project (IFPUP) will soon start two pilot projects in Kakamega and Kiambu Districts with SIDA assistance. Although their primary bias is nutrition, experiences here will illuminate future needs and directions. Initial goals include cataloguing folk crops and food types, documentation of cultivation, preparation and storage methods; and collection of germplasm and seed multiplication with a view towards introducing them as crops more widely. Eventually, it is hoped new crops from other Kenyan areas can be induced as dietary elements in all project districts and the country as a whole as the project expands.

This is a commendable effort that needs support and follow-up. One hopes it has not come too late. Some MOA officials, however, apparently still maintain that Kenyan crop landraces are virtually worthless in terms of food production. Improved varieties are encouraged as a matter of policy which aims for "higher productivity" as the only goal. Simple economics and changed tastes also mitigate

against traditional crops. Take sorghum and millets for example.

For centuries many societies in today's Kenya depended on sorghum and three main millet species: Bulrush (Pennisetum sp), foxtail (Setaria sp), and finger millet (Eleusine sp) for most grain requirements. Millets (especially bulrush) are particularly useful because of drought resistance and ease of pest-free storage--no insect bores into them because the grain size is so small. Unfortunately, the sowing-to-harvesting labour input is so high and the calorie productivity so low that other crops, despite being much less nutritious, are more attractive alternatives on a simple cost/benefit or calorie for calorie basis. Cash crops and maize have slowly replaced sorghum and millets in most areas in the last half century.

As for other traditional crops, e.g., beans, new improved varieties bred and selected to improve yield and disease resistance have swamped old varieties. According to MOA officials, changes in pathogenicity are an ever present danger as disease-causing microbes mutate and overwhelm new varieties. MOA officials state, however, that all traditional crop germplasm is in safe, secret storage for breeding purposes, and that much of the current improved bean cultivars are genetically composed of old bean landraces of Kenya. Such cultivars are Mwenzi mmoja, Mwitemamia, Wairimu, and Rose coco.

Other than the IFPUP concession mentioned above, the MOA is apparently fully in the Green Revolution school of thought as regards cash crops, hybrids and traditional crops. This is in keeping with the National Food Policy guidelines mentioned above. No other fact illustrates this as well as the apparent absence of a guideline on seed sources for millets or traditional grain legumes. In fairness, some millet and sorghum work is being done and improved varieties are sometimes available. Millets are now being selected and improved at Katumani Station. But generally traditional crops are left to their own dynamics and farmers must save and perpetuate their own seed. In a situation of frequest famines and fierce competition from improved varieties it is altogether likely that not only is the acreage decreasing fast but also that some crops and germplasm are disappearing. It is necessary to know the types, the trends and magnitudes of such losses. IFPUP will, most likely, not be able to provide this information soon enough in their area of work. The proposed Symposium should.

Another illustration of the Green Revolution attitudes on policy is the tendency to ignore the farmers that for want of land and subsistence are forced to cultivate marginal areas. Maai Mahiu and Rumuruti, Ithanga and lowland Kitui come to mind. Everybody deplores this form of agriculture,

but it is there and increasing. MOA attitude seems to be that such lands are for grazing, ranching, or other non-sedentary uses. Farmers seem to ignore this and to plant ecologically unsuitable crops. There must be crops other than maize that can be grown by such farmers in at least some marginal areas. Durum wheat (as in Ethiopia) and Triticale and millets come to mind, yet no work seems to be afoot to address this problem.

It has been reported that two researchers at the University of Nairobi, Crop Science Department, at Kabete, Drs. B. I. Muruli and D. M. Mukunya have collected some Kenyan traditional grain legumes (cowpeas and beans respectively). This is precious germplasm and should prove quite useful in the future if stored properly. Plant Quarantine Services may store the collection as part of their accessions. Lawrence Ragwa, at Katumani, is working with millets and may have a wide collection of living germplasm of traditional varieties in addition to hybrids.

Localized Crops and Wild Food Plants

Virtually all Kenyan communities have foods and tastes unique to their individual cultures and environments. If a list were to be assembled of all the edible plants and local crops of all the ethnic groupings of Kenya, it would doubtlessly go into the thousands. There would be wild fruit, annuals and perennials, potherbs, wild roots and tubers, edible fungi and aquatic weeds and semi-domesticated to fully-domesticated crops of all kinds. It would be a formidable list, indeed. No such list has been compiled for the entire country, although regional ones might exist. This is an area of possible research in the future. The IFPUP of MOA will hopefully soon have complete lists for Kakamega and Kiambu Districts. The former District falls in a particularly rich forest environment and has a rich tradition of using wild and semi-domesticated plant materials as food. The following is a brief and tentative list of some folk crops and foods from some localities in Kakamega:

Some Traditional Foods of Kakamega
(note: spellings not exact)

Kabras (and/or Maragoli)	Tiriki	Comments
Greens		
Emiro	Miro	(Legume)
Omurere	Omurere	
Lisutsa*	Lisutsa	Solanun, sp.
Libokwe	Libokwe	
Tsisaka	Tsisaka	Akeyo in Luo (Cleome, sp.)
Maranyolo*	Tsimboga	Amaranthus, sp.
Eshivetso*	Enderema	Riverside tree leaves eaten during drought
Eshingayangaya* (Linyororo)	Shingayangaya	Commelina
Sirietso*	Shiriezo	Tree leaf vegetable from the forest
Marande*		Perennial Vigna
Legume pods		
Tsibande		Pigeon pea-like wild legume not now found
	Tsimbalakaiya	Perennial forest tree, pods collected from ground and shelled
Liruku		Dioscorea
Fruits		
Elisalia	Tsikulumuru	Underground "fruit" reportedly annual monocotyledon
Mukhyyu		Juiced and fed to children in times of famine

* denotes self-sown annuals or perennials. All the rest are sown by farmers from seed, except the tree species which are wild.

Other regions have similar traditional food sources and it seems a very important area to which scientific and popular attention should be directed in order to revive where possible such crops and improve on their productivity and consumer acceptance as foods. See Appendix I for some of Turkana's food plants.

Virtually no work has been undertaken to domesticate, improve or study indigenous Kenyan wild fruit trees. KENGO has a plan to start collecting and doing trials of some of these plants at the Jomo Kenyatta College of Agriculture at Juja in the near future. There are at least two Kenyan wild relatives of fruit trees that can, at least, provide worthwhile rootstock to exotic scions and perhaps impart some stress resistance. These are Garcinia sp, a mangosteen relative and Diospyros sp, a relative of the Japanese persimmon. These merit experimentation.

Medicinal Plants

Kenya has a wealth of traditional herbal medicine which is slowly being recognized as an important part of medical treatment (89). Important treatises have been published on medicinal plants, their curative principles and their pharmacology (e.g., 40).

What may not yet be well known is that Kenya and the East African region in general are unique in medicinal flora because of several biogeographical factors. One is related to the climatic forces referred to earlier that make the Eastern African Coast and hinterland relatively dry, unlike other similarly located equatorial areas. The other is the presence of medium-altitude coastal uplands, e.g., Shimba, Usambara, Uluguru, and Teita, which by being moister and cooler are essentially islands of lowland rainforest environments, ecologically isolated for long enough geologic time to produce a high degree of endemicity or, in other words, to evolve many plants species found nowhere else in the world. Many of these plants have qualities yet to be discovered. Many are medicinal. This was dramatically illustrated by the discovery that Maytenus sp, a shrub from Shimba Hills, has cancer-curing qualities. American researchers have taken out at least 50 tons for analysis, as well as the germplasm to grow the plant there.

On the East African Highlands proper, i.e., land over 2,000 metres altitude and especially mountains rising above 3,000 metres, there exists interesting ecosystems in terms of plant endemicity. In contrast to the warmer, humid coastal uplands mentioned above, these high mountains are cool, moist, and in many respects temperate. They often have alpine flora on the higher reaches whose closer relatives are found in the mid-latitude mountains and arctic regions.

Montane rain forests are distinct from tropical rainforest formations. Mt. Kenya, Aberdares, Kilimanjaro, Elgon and Ruwenzoris fall in this category. Elsewhere they have been referred to as "ecological islands" in an expanse of dryness.

The flora here has evolved in total isolation for millions of years resulting in unique species, genera and even families. It is perhaps right to say that the genetic treasure in this flora is virtually unexplored. A few endemic species have, however, been identified as promising sources of medicine. Among these are the following Mt. Kenya species:

> Guzotia sp, which yields a high-value oil currently under investigation as an anti-cancer drug in Europe and America. Indications are that germplasm has already been shipped out.
>
> Valeriana sp, a potent natural sedative and asprin substitute, again under experimentation and germplasm also most likely already taken out.

Dr. Gopalan of the University of Nairobi, Department of Botany is doing some work with these plants.

Other Food Plants

If one includes lowland, lake basin forest formations and especially the unique Kakamega forest, the list of potentially useful plant materials lengthens. One need only mention wild crops and crop relatives as examples. Two categories will illustrate: legumes and tubers. Vigna, a relative of cowpea, is commonly found in the Uganda-Western Kenya areas while a wild, winged bean relative (Phosphocarpus) is now known to be endemic in Kakamega/ Uganda lowland forests and farther east, in spots. Edible tubers and roots abound in the montane and lowland forest. Dioscorea sp (yams) are largely an African food crop of the West African centre of crop evolution. Uganda and Kakamega have endemic species of these and other tubers used as food, but perhaps not investigated in any detail.

Arid and Semi-arid Plant Resources

Most of Kenya's surface area consists of hot, semi-arid lowlands with a rich and varied flora, albeit of less uniqueness than the "islands" referred to above. Pastoral or nomadic cultures have evolved in this environment and collectively have a vast store of folk knowledge on plant uses. These cultures and people are Somali, Borana, Gabra, Rendille, Turkana, Samburu/Maasai, Kamba, and Pokot to name a few. Their vast environmental knowledge is barely tapped and possibly disappearing as young people spurn older ways

and "modernization" eats up their territory and culture. This knowledge loss is as serious as germplasm loss and steps should be taken to retrieve what is possible before it is too late.

Dry-area "Economic Botany"

Most commercial uses of plants in the semi-arid lowlands have been based on tapping wild acacia trees for gum arabic, collecting myrrh essence or resins from aloes often organized by individual merchants for export. No firm data exist. It seems though that a more organized and possibly less destructive commerce can be built around some of these resources with more benefits accruing to local populations than before. Better yet, actual plantations can be established. One for aloe resin, which is an important commodity in pharmaceuticals, is already functioning at Marsabit under the management of a Catholic priest. This is an excellent idea that needs more enquiry. It seems that some NGOs are already planning to study and encourage such plantations and possible non-destructive collection from wild stands.

Comment on Conservation of Flora

This chapter set out to survey the less well-known wealth of Kenya's flora heritage--the totality of Kenya's plant germplasm. Conservation of these plant communities that may have such important meaning on Kenya's future welfare is, strictly speaking, not in the realm of seed investigations, but the point must be made that germplasm, wild and domestic, is the building block of seeds and the source of many plant products.

The International Union for the Conservation of Nature and Natural Resources (IUCN), and the National Environment and Human Settlement (NEHSS) are doing some work towards a conservation strategy (31).

Move to beginning

Chapter III

CURRENT BREEDING ACTIVITIES IN KENYA

As a means of increasing yields in a situation of extreme land constraint and capital shortage, breeding and research are heavily emphasized by Government in the National Food Policy of 1981. The following quotations illustrate this commitment:

> The main aim of policy for seeds will be to ensure a steady increase in the supply of improved varieties. . . . . (Section 3.9)
>
> The objective of food crop research will be to continue the search for more productive crop varieties while increased emphasis will be placed on breeding programmes aimed at continuous increases in the yields of already established strains. (Section 3.13)

Through the Ministry of Agriculture, the Government of Kenya has a comparatively well established crop breeding and seed production infrastructure. There are currently five major National Agricultural Research Stations (NARS), each with a specific crop mandate. Breeding, varietal selection and seed release in such crops are done solely by that station. Following is a list of the main food crop stations with their mandates:

Station	Crop
NARS, Kitale	Maize Pasture
NARS, Njoro	Wheat Barley Triticale, Oats
NARS, Thika	Beans Cowpeas Horticultural

NARS, Katumani	Dryland Crops, Sorghum, Millet, Pigeon peas, sweet potatoes
NARS, Mtwapa	Cassava Fruits All coastal crops

In addition, the MOA has a network of sub-stations which are usually linked with one of the above main ones in terms of crop mandates. Thus, for example, Embu Agricultural Research Station is a major substation for maize breeding and trials.

Potato breeding and seed production are done at the Potato Research Station Tigoni. Other stations handle industrial crops, e.g., sugar cane and cotton at Kibos, but these do not concern us here.

Kenya Seed Company and some other semi-private and private companies are also active in some breeding activities, but they depend on government breeding work for their main lines which they obtain for free to multiply and bulk for sale as seed. In addition, East African Industries is now active in oilseed (sunflower and rape) breeding.

Improved Cultivars: Seed Quality Control and Release

The general trend in the last four decades in Kenya has been towards increasing the acreage under improved cultivars, especially in maize, barley, wheat, beans. See table below:

Crop	Total Crop Area '000 ha.	% Area Planted with Improved Cultivars
Maize	1.200	95
Barley	70	100
Wheat	100	70
Beans	400	25

All seed and new cultivars are released after careful testing, certification, and registration by the The National Seed Quality Control Service (NSQCS). Situated at Lanet, NSQCS is charged with ensuring that all seed released to farmers conforms to the International Seed Traders Association (ISTA) rules and standards. The Specialist Cultivar Release Committee (SCRC), composed of experts in each crop, after three years field testing recommends to the National Cultivar Release Committee (NCRC) to include a new cultivar in the national "Index." To be included in the

Index, a new cultivar must be different from others, pure, uniform and superior.

Kenya subscribes to the principles and procedures for seed certification contained in the schemes published by the OECD, in which Kenya is a member country for Cultivar Certification Schemes.

Seed and Plant Cultivars Act, 1972

All seed activities and releases, summarized above, are governed by the Seed and Plant Cultivars Act, 1972 (see Appendix II).

Seed Production in Kenya
1979/1980

Crop	National Crop Area (ha)	Seed Crop Area (ha)	Seed (tons)
Wheat	100,000	2,925	4,945
Barley	70,000	2,852	2,707
Triticale	-	14	21
Oats	-	1	.5
Maize	1,200,000	2,850	15,796
Potato	-	88	200
Beans	400,000	106	53

Examples of Breeding Work in Kenya

The following are examples of breeding work in Kenya done either by Government or companies and other institutions.

a) Maize Seed

Kenya uses about 15,000 to 20,000 tons of improved commercial maize seed a year. A fair estimate of subsistence non-commercial maize seed would be in the region of 10,000 tons.

As in all major commercial crops, basic breeding work in maize is done by Government and then the bred lines are passed on free of charge to Kenya Seed Co. to multiply, to bulk and sell as commercial seed. The National Agricultural Research Station at Kitale is the major government maize breeding station in Kenya since long before independence. Katumani, Mtwapa and Embu are important maize breeding sub-stations. While Kenya Seed Co. can, in theory, multiply and bulk seed anywhere that conditions and facilities permit, most highland varieties (500 - 600 series and the new 832) are done in the Endebess/Kitale and Uasin Gishu areas in both private and ADC farms. Kenya Seed Co. have now their own in-house supplementary breeding programme for maize--National Breeding Programme--which will ensure maize

seed availability and improvement for all climatic zones and for possible export. Already some export is undertaken to Tanzania and Uganda.

Contract farmers produce the final seed under the supervision of Kenya Seed Co. and the NSQCS. Retailing is largely done through KGGCU, Co-operative Unions, Cereals and Produce Board and other agents.

Kenya Seed Co. have modern drying and testing facilities at Endebess where capacity exists to dry up to 25,000 tons a year but usually average 15,000 tons during good harvest years.

As a response to government policy, seed storage facilities will be built within the next three years by the company in conjunction with governmemt to ensure that at all times there is enough buffer seed for two years planting in case of seed-crop failure or other emergencies. This would mean a storage network capacity of not less than 40,000 tons. Proposed sites are Kisii, Kakamega, Kitale and perhaps Sagana.

There is an upward trend in improved maize seed demand. In 1983 farmers used 13,000 tons of Kenya Seed Company's maize seed, 14,000 tons in 1984, and about 16,000 tons in 1985. One reason for this increase is the sub-division of previous large scale wheat-land into small-holder plots under maize and stock. There is also a growing trend all over the country to plant maize in drier areas as land shortage forces populations to marginal areas. For this reason it would seem that the demand for dryland seed is rising proportionately faster than for wetter area varieties. Another reason for the increase in maize seed demand is that due to drought and poor rain distribution farmers often have to plant twice or even more in one season to ensure a full crop. This would explain part of the large increases in seed demand in the last two years.

As more small-scale farmers turn from traditional varieties to improved ones, Kenya Seed officials expect that by 1990 demand for maize seed of all cultivars should be between 25,000 and 30,000 tons.

They emphasize one important point: that their seed production capacity is immense; if, for example, demand for 50,000 tons of seed a year suddenly rose it could easily be met with only one or two years advance warning as the limiting factor is mainly time and not the physical infrastructure. This implies that for most improved cultivars there should be no shortage of seed for any length of time. Seed-growers or contract farmers, who obviously enjoy the favourable financial and marketing agreement can be readily recruited as the need arises. Being a

parastatal, Government can also provide emergency facilities when necessary.

This was proved in 1984 when rains failed and little seed was harvested. Since farmers' own seed sources had dried up or had been consumed, everybody turned to commercial sources. Due to frequent post-emergence drying up and the need to re-plant, demand also catapulted. It is estimated that during the failed 1984 short-rains, more than twice the normal amount of seed was planted out. This situation of inadequate supply and excessive demand meant that 1984/1985 seasons found the country without enough seed especially the Katumani and the 500 hybrid series.

To rectify this the company along with the Ministry of Agriculture mounted an emergency rescue operation to produce seed under irrigation at Bura. The plan reportedly worked and seed supply recovered fully by 1985.

Maize Breeding and Germplasm

A brief account of the major genetic constituents of the current Kenyan hybrids is of some interest (45). There does not exist an all purpose, universal hybrid maize cultivar. Each cultivar is carefully bred to produce specific growth and yield characteristics in a given environment. Breeding in Kenya started in 1955 at Kitale using local traditional strains which after many generations had adapted to the various zones and diseases and could be considered as distinct (i.e., in-bred, therefore pure) varieties. These varieties can be divided into four general types:

1. Coastal maize - originally introduced by the Portuguese in the 1500s from the West Indies
2. Local Yellow - originally from USA via South Africa
3. East African Flat White - local names: muratha, kingi, katumbili, the complex called the Kenya Flat white, grown in the moist highlands and some dry highlands, by far the most popular variety in Kenya. Introduced in 1900 from USA and/or via South Africa.
4. Cuzco - local name: githigu, introduced in the early 1900s by missionaries from South America, highest altitude, tea zone up to 3,000 m.. Grains have purple, red and brown colour.

These four basic types form the main breeding material although foreign germplasm from CIMMYT and elsewhere have been used in some cases. All the original germplasm is reportedly in storage at the various germplasm banks in the country and internationally at CIMMYT and elsewhere. Kenya

Seed Co. also has a large in-house germplasm bank at Kitale. In addition, many small farmers still grow these traditional varieties. Their numbers are perhaps declining rapidly due to wider and increasing use of hybrid seed. There is need to know the exact status of these traditional varieties although scientists and officials seem sure that should need ever arise to grow these varieties adequate seed could be multiplied within a year or so from existing germplasm here and elsewhere.

Improved and Hybrid Maize Cultivars →

Four main cultivars have been bred for Kenya's zones:

1) 500 series (511, 512, 513) for the medium altitude or the coffee zone
2) 600 series 611, 612, 613, 625) for the tea zone
3) 823 for high altitude, high rainfall variety, soon to be released
4) Coastal-Pwani hybrids 1,2, developed from Mexican-American and local germplasm
5) Coastal composite
6) Dryland or Katumani series.

b) Wheat Seed

All wheat breeding is done at the Agricultural Research Station, Njoro. Although there are many varieties, disease vulnerability, etc., makes it imperative to continually breed new varieties as resistance and pathogenicity of rust change. Material lines are then passed on the Kenya Seed Co. for multiplication at their Nakuru Station before contract farmers produce the final seed for distribution to farmers. Wheat varieties are bred specifically for capital intensive, large scale, high-productivity farming areas.

Little or no attempt has been made to breed wheat for small-holder (say non-mechanized harvester) producers nor for dry land growing despite obvious demand or potential for both. Durum wheat is kept as renewable germplasm for breeding purposes and one assumes that the resources are there for such dryland wheat breeding if policy should change to emphasize small-scale wheat production on marginal land.

Due to growing fragmentation of large farms previously under wheat in the Rift Valley and changes from wheat growing to barley and rapeseed, etc., demand for wheat seed has been declining for a decade.

c) Barley

Again the bred material is obtained from Government breeders at Njoro, but lately the Kenya Breweries Ltd. have entered the local barley industry in a big way in order to satisfy

all their previously imported malt requirements. Kenya Seed Co. have started contract breeding and multiplication for Kenya Breweries with germplasm supplied from CIMMYT to supplement Government breeders and to help find the best malting variety for various growing zones, Narok being the major one at the moment. By this agreement, Kenya Seed Co. will do the seed maintenance, multiplication and trials. All indications are that barley is rapidly becoming a major grain in Kenyan farming, geared wholly to the brewing industry.

d) Other Cereals

A small demand exists for oats for animal feed. Small quantities of seed are produced for this market. A most important new grain whose seed is available but at low demand is the new cross-genera grain, Triticale--a cross between wheat (Tritiicum) and rye (Secale), and which has practically all the advantages of the two parents and greater productivity than either.

It would seem that with proper further varietal breeding of Triticale a strain suitable for zones drier than the driest wheat zones is easily possible and this needs much more concerted attention by all concerned. At the moment, for reasons not wholly clear but worth researching further, Triticale has not caught on. There is a possibility that the brown colour of rye contributes to the "not white enough" complaint by consumers, so millers and bakers prefer wheat, polished at that, in deference to consumer preferences. It has been verified that 20%, if not 30% of bread dough could be Triticale without colour or taste variation whatsoever. It is worth enquiring from the authorities concerned what official policy might be as it seems that Triticale would lower costs to both producer and consumer while utilizing poorer land and less rainfall in some cases. Research and further breeding are continuing at Njoro.

c) Pasture

Kenya Seed Co. are fully responsible for grass seed production. While most breeding is done by the National Agricultural Research Station, Kitale, the company has also recently started some breeding especially of Boma Rhodes (Chloris guyana) with material from U.S. firms, especially Pioneer Hy-bred International. An extensive collection of grass germplasm exists and is continually increasing. Kenya is a net exporter of pasture seed and no shortage of conventional pasture species has occurred to any serious extent. With FAO assistance, MOA has just completed a major Kenyan pasture germplasm documentation project (32).

d) Sunflower and other Oilseeds

Kenya Seed Co. jointly with East African Industry (EAI) and the Kenya Government have just completed a successful 5-year breeding programme from 1978 to 1983 at Wanguru, Mwea. The aim was to produce varieties higher in oil content (40% as compared to 20% before) and suited to various zones. Five varieties were developed and released. Germplasm was imported from Holland and USA. EAI have, however, pulled out after the end of the agreement claiming to have started a local subsidiary Oil-Crops Development (OCD) to deal with all aspects of oil seed (88).

Kenya Seed are, however, still continuing with sunflower breeding to improve on the five varieties above in the hope that NSQCS will select their better varieties at future sunflower trials.

Rapeseed and sunflower are new oil crops of increasing importance in which OCD have interests. Future breeding research and extension are part of OCD's plan aimed at total self-sufficiency in edible oil for the East African market.

Grain Legumes

Thika is the mandated bean research station. Under the Kenya/Dutch Government Grain Legume Project (GLP) some important new bean varieties have been developed (GLP 2, GLP 92, GLP 1004) with local germplasm. Mwezi Mmoja and Mwitemania varieties are some of the older, improved varieties. Dr. D. M. Mukunya of the Crop Sciences Department of the University of Nairobi specializes in bean research and has bread new varieties of Rose Coco. All germplasm is stored at Thika Horticultural station.

Soy beans are considered a potential field crop and Kenya Seed Company is accordingly carrying out trials of various strains with a view to breeding and multiplication. For some reason, the crop is not important in Kenya's agriculture at the moment.

Cow peas have not been bred in Kenya although Dr. B. I. Muruli has made extensive collections. Vita-3 a strain originally from Uganda has proved very productive after IITA provided the germplasm.

Other Related Activities

Although not involved in direct breeding or seed work, Plant Quarantine Services (PQS) of Kenya Agricultural Research Institute (Muguga) is an important adjunct to the NARS system. Described below are some of PQS's activities relevant to our enquiry.

Plant Quarantine Services

Over the last 10 years, Plant Quarantine Services (PQS) has become one of the very few institutions to make practical and routine use of tissue culture in Kenya. In all virus screening and cleaning work, as well as in general propagation of clones, meritematic tissue culture is now a standard operation at PQS. There is, therefore, already a fund of knowledge of this modern technique, as well as fairly adequate laboratory facilities. It is now PQS policy to import all tuberous plant materials in the remarkably efficient tissue culture form rather than in the old-fashioned, bulky rooted-plants method. This way the risks of introducing new dangerous soil-borne (especially nematodes and fungi) pests has been totally eliminated.

The major importance of this facility for us is that already in the country there exists a rudimentary centre for some modern bio-tech work on to which more advanced work can be added, e.g., protoplast fusion for breeding, direct cell culturing work for greater speeds in propagation of clones and research facilities in other such molecular and cellular level of plant work (see Chapter IV). For a long time to come, however, the officer in charge sees propagation as the dominant use of tissue culture in fulfilling their quarantine, plant pathology, cloning and dissemination work because of lack of facilities, funds and trained personnel.

Germ Plasm Collection

PQS is the official entry point for all plant materials imported into Kenya. Official PQS policy is that 10% of all material imported must be retained at the centre for propagation and distribution to other interested parties in Kenya. The importer gets the remaining 90%. PQS also actively seeks to introduce many new or important strains and varieties of major crops. This has resulted in a sizeable collection of crop varieties from all over the world. Unfortunately, due to previous oversight, many crop varieties were wholly given out leaving PQS without specimen or mother plants. This situation would not have happened were it not for the fact that PQS was then seen more as a quarantine station than an incipient gene bank.

It is now policy to plant out and establish, where practicable, all perennial accessions with documentation of relevant technical data. PQS is now therefore an active germplasm collection centre with much scope in the future. Vegetatively reproducing plants, e.g., banana, sugar cane, and sweet potatoes are especially easy to maintain. Fruit mother trees are now happily established and easily supplied on demand as budwood, e.g., mangoes, avocado, plum, pear and grapes as cuttings.

PQS has recently started two interesting functions as a germplasm centre.

a) The International Board for Plant Genetic Resources (IBPGR) in their most recent grass collecting visit to East Africa last year collected practially all Bracharia (grass) species endemic in this region and took the material to genebanks abroad. PQS, which used as a temporary depository and to screen the material, retained living specimens of each species/race in the PQS plots--the largest such collection in this area.

b) PQS staff have just organized germplasm rescue mission. Before the East African Community was dissolved in 1977, EAFFRO had a network of sorghum research station in East Africa. Kenya's was at the Provincial Agricultural Research Station in Busia. Much earlier, (perhaps in the early sixties) this station had received, as had all the sister stations, a collection of improved cultivars and primitive races of sorghum from all over Africa and elsewhere for purposes of disseminating to farmers and for research. Most of the Busia collection came from Serere and Kilombero, the counterpart stations in Uganda and Tanzania, respectively. After the collapse of the Community, the sorghum work at the Kenya and Uganda stations ground to a halt (civil chaos in the latter country may have contributed further to this). Sorghum seed which had been collected and poorly stored in unsealed, unfumigated packets since 1974 were left unattended until PQS staff got wind of it. They were brought to Muguga, weevils and all, and immediately planted out in plots. Of the 80 varieties it seems a good 50% or more might produce at least several plants each as some germination has already taken place.

It is perhaps overstating it to say that some of these would have been extinguished were it not for this mission. Kilombero still may have a wide collection of similar sorghum germplasm. But in terms of Kenya, it is a unique effort by what seems like a highly motivated staff. Results of this rescue mission may be published in the KARI bulletin.

Proposed Base Gene Bank and the Current Network

Of interest, too, is the proposed base germplasm (gene) bank currently under study by GTZ experts. It will be located on PQS grounds, but it will have different terms of reference and jurisdiction. A base gene bank is one where seeds are stored over periods of many decades at temperatures of -20 degrees C., or lower and kept dormant and undisturbed. This contrasts with active seed banks where seeds are kept about 4 C. over shorter periods and are constantly exchanged,

disseminated and even grown out to renew the material for seed or for further storage. When completed, this bank will join the network of such banks in Africa and elsewhere. While it will not necessarily alter the Kenyan seed situation immediately, it augurs well for future preservation of precious material, e.g., threatened crop and wild relatives whose habitats are now irreparably damaged.

As an adjunct to this project there is a research proposal under way at PQS to establish an active seed bank to hold some of the future base bank accessions in active form and permit easy access. (NB: Access to a base bank is very infrequent, measured in years, as disturbances to the storage cubicles must be minimized.)

PQS already has a small refrigerated seed bank of about 60 cubic metres. It is here that all imported seed materials are stored during the period of analysis and dissemination to research stations, organizations, and individuals. For many years the station was administered by USAID technical assistance staff, but it is now fully Kenyan-run.

Due to lack of funds and some organizational problems the cooling machinery broke down in 1980 and was not repaired until 1983. In those years of non-refrigerated storage 98% of all accessions were destroyed. In soybeans alone, of 213 accessions, 183 were lost--a great loss by all accounts. These were mainly modern, improved cultivars and would easily be replenished from the original sources and progeny lines. So while the losses are regrettable, they are not as catastrophic as would be the case if a collection of rare seeds of endangered material got lost by such a breakdown. This incident does serve, nevertheless, to illustrate the dangers facing gene banks and the need for network collections and duplications as insurance against any losses, inadvertent or otherwise.

At the moment there are 20,000 accessions of 200 seed species and varieties in storage, mainly graminae and pulses. An active regeneration programme, albeit hampered by budgetary constraints, has been instituted.

It seems that, with a little more official or political commitment to the germplasm collection/bank principle, this country already has a rudimentary infrastructure which would come in most handily should, as seems likely, policy be altered to more aggressive conservation/acquisition of seed/germplasm.

PQS works closely with other Government Agricultural/Horticultural Research stations all over the country. These stations can be termed a form of germplasm network, each with its own specialty. Ideally they should have active germplasm collections in addition to their other

seed/clone producing functions. It is, however, not clear how well maintained the germplasm accessions are at some stations. While there is no evidence to cause excessive alarm, some concern about the level of documentation and standards of storage has been voiced. In many cases the concern seems justified as the example on machine breakdown at PQS several years ago indicates.

Commercial Seed Importation

According to the Seed and Plant Varieties Act mentioned earlier, National Agricultural Laboratories (NAL) handles/ all issues related with quality, fitness, etc., of all seeds imported to Kenya.

Chapter IV

IMPACT OF BIOTECHNOLOGY ON AGRICULTURE

In 1973 two scientists in California achieved a major scientific breakthrough; they were able to transfer the gene of one organism to the DNA of a second organism. This inserted gene then went on to "express" itself along with the second organism's DNA just as if it had been part of its genetic code all along. They had spliced genes and they had transferred them between organisms. This is the newest, the most revolutionary process in genetics and the entire biological sciences and is called Recombinant DNA (rDNA) or, more popularly, genetic engineering. The manipulation and alteration of the genetic or cellular integrity of an organism in order to create novel forms engineered for specific functions promises to revolutionize, in a way difficult to exaggerate, all the sciences and the economies of many societies. It is part of that cluster of new scientific techniques and discoveries that is called "biotechnology" or biotech for short, a term that encompasses various processes--rDNA, cell fusion, micro-injection, tissue culture, etc.

Genetic engineering was first applied in medical and animal sciences, not in botanical or agricultural sciences. It was only after 1980 that researchers in these latter disciplines attempted the first serious efforts of rDNA work. This new instrument has suddenly changed the possibilities of plant and crop breeding by many orders of magnitude within a brief period of only five years. With scientific work still going on and new biotech discoveries being announced regularly, it seems the agricultural potential of this new tool is simply astronomical (65,69,71,76).

Effort is now under way to apply these cellular and molecular technologies commercially, as well as to specific agricultural problems. To illustrate the new vistas opened up by biotechnology, listed below are <u>some</u> potential uses already being tested in various research establishments abroad:

a. herbicide resistance in crops

b. environmental stress resistance in crops
c. direct nitrogen fixation by crops and micro-organisms
d. biosynthesis or the direct production of plant bio-chemicals in factories
e. breeding and propagation of novel crops

a) Herbicide Resistance

Herbicides are part and parcel of the agribusiness production process. One constraint of herbicide use is the danger of killing off the desired crop while spraying weeds. If a crop were developed that could resist, i.e., be indifferent to, the effects of a potent chemical weed killer, it would make it possible and much cheaper to douse the entire field with that chemical, scorch all the weeds and leave that crop unharmed. Bioengineering has already shown promise to deliver this. Already two Brassica (rape) varieties have been bred that are resistant to the herbicide atrazine by splicing and transferring mutated genes from herbicide resistant weeds that are relatives of rape. There is hope that atrazine-resistant tomato/potato varieties will soon be engineered by a similar weed-to-crop gene transfer using recombinant DNA technology.

b) Environmental Stress

Recombinant DNA allows scientists and breeders to identify a gene for a desired plant property, locate it and splice it, then by means of a vector organism, usually a specific bacterium, implant it into a second organism's genome. Thus it is possible to literally create new plant types almost with made-to-order characteristics. Such characteristics could be drought resistance, less vulnerability to vast climatic fluctuations, disease resistance and salinity tolerance, therefore permitting sea-water irrigation, and a host of other such possibilities. This would immediately set the stage for spatial expansion of crop production into areas where it was previously impossible. A particularly promising use, especially for a country like Kenya where soil erosion and sloping land limit farming area, is the potential for making minimum or no-till farming possible on a larger scale by engineering beneficial micro-organisms and using them to combat soil-borne plant diseases. Normally, no-till soil conditions harbour too many soil diseases and necessitate expensive fumigation, making this practice uneconomic.

c) Direct Nitrogen-fixation

Nitrogen is a vital nutrient in crop productivity. Legumes can, if provided with proper Rhizobium bacteria, make their own nitrogen from the air. Why can't other plants be

engineered to do likewise? This is already being attempted although it is still too early. More efficient Rhizobium/Legume varieties combinations have already been experimentally produced. At the University of Wisconsin researchers have engineered Azobacter, another nitrogen-fixing micro-organism, to make it supply nitrogen to maize, not by a symbiotic root-nodule relationship as in legumes, but by direct leakage of nitrogen near the maize roots. Direct transfer of the nitrogen-fixing facility to a crop is so far unthinkable as too many genes are involved. Still, there is hope of further research breakthroughs.

d) Biosysthesis or the Direct Production of Plant Bio-chemicals

In the medical and zoological sciences, many advances in synthesizing enzymes, hormones and other animal physiological chemicals have already become commonplace. For instance, insulin, interferon, vaccines, etc., can now be produced by bio-engineered micro-organisms growing in methanol vats in factories. Bio-synthesis, as this process is called, is most advanced in animal/medical sciences. Plant and crop sciences are somewhat behind but are fast catching up. By 1984 laboratories were capable of producing some 50 natural products with yields equal to or greater then those of the crops they would replace. High fructose corn syrup (HFCS) now biosynthesized from maize is undermining the traditional farm sources of sugar. The sugar beet industry in Europe and North America is undergoing serious dislocation as a result of more and more such non-farm sweeteners (Aspertame is the latest) being manufactured in biotech labs. Up to 15 percent of Japan's and 40% America's sugar demand is now being satisfied through biosynthesis. This will have drastic and immediate repercussions on sugar growing economies and societies (60,72). In the Philippines, for example, export incomes from cane-based sugar dropped from U.S.$657 million to $316 million between 1980 and 1983 and are still dropping. The social cost of this type of product-displacement is colossal and rising. It is definitely with us as all those who farm, sell and make policy on sugar know. Its impact will grow in the future and much of Western Kenya's economy, increasingly sugar dependent, will face great difficulties, if not collapse.

Another new process is the production of protein animal-feed by biotechnology. Single Cell Protein (SCP) is a basic amino-acid manufactured by micro-organisms in large quantities. It will replace soy-bean (the most important protein feed crop) when fully developed. Conceivably it could be seen as a process which would save grain and protein foods now used as animal feeds and help Kenya's quest for protein self-sufficiency production. However, the economics of these activities are not yet known.

However, not all plant products can be easily produced thus. For example, cellulose fibre or coffee/tea products are too complex to permit easy bio-manufacture, but it is now just a question of time and research. The list of biochemicals that can be biotechnically manufactured is growing and many economies, including Kenya's, face considerable disruption (61,66). See Appendix XI for a list of other plant product tissue culture. NB. Pyrethrum is now an almost obsolete crop as pyrethrins can be biosynthesized.

e) Plant Breeding and Propagation

Most of the above-mentioned processes are possible because scientists can now work at the cellular or molecular level of life in contrast to the whole-organism level of the past. Cell and molecular biology allows for direct manipulation of living forms and compresses time and space so that what used to take thousands of years and hectares and tens/hundreds of technicians many years or even decades, can now be done in several petri-dishes by one individual in months.

This has permitted rapid breeding and propagation of new varieties as well as culturing cells and regenerating them. An important spinoff of this technology is the recent discovery of genetic variation spontaneously occurring in tissue cultures or cell-clones which should, by all expectations, be identical. This has provided a potentially rich new source of genetic diversity which seems, if proven to be persistent, to redeem this new scientific tool.

Limitations

Biotechnology is a formidable new tool. Much of it is still in its infancy. Many problems have yet to be overcome especially in basic science. For example some crop species have failed to respond to any genetic manipulations while knowledge on gene-vector micro-organisms is still limited. But research is progressing rapidly as the list in the following section demonstrates.

New Bio-engineered Crops

The following wholly bio-engineered new crop varieties are scheduled to be released from biotech laboratories or field trials into commercial growing as per timetable shown:

Bioengineered Crop	Release of Altered Plants to Breeders	Release of Seed to Farmers
Maize	1984	1990
Wheat	1986	mid-1990s
Sorghum	1990	mid-1990s
Sunflower	1985	1987

Tomatoes	1984	1986-88
Potato	1985	1986-88
Beans	1986	early 1990s
Sugarcane	1985	mid-1990s

Biotechnology, Patents and Multinationals

Biotech is the new growth area. Multinationals have sensed the great financial possibilities that lie in wait for investors--"Biobucks" as one scientist called them. This new technology needs the legal protection afforded by patenting in order to recoup the immense start-up research investments needed. Patents provide the holder with exclusive legal rights to an invention for 17 years during which time, if a patent is infringed, the holder has legal recourse. Genetic engineering is a suit tailor-made for the plant patenting process.

Take, for example, pesticide-tying. Agro-chemical corporations which possess patented proprietary pesticides in their manufacture would love to force farmers to only use their brand chemicals. Producing patented seed of varieties which are bio-engineered to resist (or depend on as the case might be) that given proprietary chemical provides an excellent sales strategy and assured high returns to investments for a long time with little competition. This is exactly what Ciba-Geigy has done with their herbicide "Dual" and what others are fast aiming for. Ciba-Geigy pellets seed with Dual resisting chemicals so that seedlings can be unaffected by the herbicide when fields are doused. They call this pelleting "Herbishield" and, of course, it is patented.

The powerful synergy which biotechnology confers on the chemical-seed linkage and the revolutionary potentials inherent in genetic engineering make possible a dangerously high degree of control of the entire agricultural production process.

In the USA, for example, many of the leading MNCs already have activities related to biotechnology (including at least 83 of the largest Fortune 500, while at least 62 of the 500 largest non-US-based MNCs have now entered biotech activities (74).

Some of the MNCs in biotech are: Allied, American Cyanamide, ARCO, Chevron, Ciba-Geigy, Dow, DuPont, FMC Corp, Hoechst, Monsanto, Occidental Petroleum, Pfizer, Rohm and Haas, Sandoz, Shell, Stauffer and Upjohn. Many of these same companies have also merged with or purchased seed companies (68). Such well-known companies as Northrup King, Asgrow, Trojan and Funk have been absorbed into the network of petrochemical and pharmaceutical giant MNCs (see

Appendices III, VIII, IX, and X for lists of recent seed company acquisitions by MNCs).

Clearly seeds, agriculture, food and commodity export will never be the same again.

Possible Impact and Implications of Biotech in Kenya

Unlike the Green Revolution whose main impact was in the country concerned, Bio-revolution will have an all-pervasive impact in developed and developing economies, but as always in new technologies greater impacts will occur in the Third World (see Appendix IV for comparisons of Green Revolution and Biotechnology). Although the majority of the biotechnologies are still embryonic, potential economic and particularly agricultural implications are so dramatic and possibly disruptive that we need to know them early enough so that proper protective steps can be undertaken on an emergency basis if need be. By the same token, many opportunities for exploiting biotech exist and these too should be explored. Following are some areas that need investigation:

a) What agricultural products on which Kenyans depend are likely to be displaced in the near future? We have seen that sugar is one of them. What are the implications of such displacements.

b) How will multinational seed-agrichemical giants affect seed availability here? Are there ways to combat or ameliorate the effects of that form of seed marketing? More specifically, are there threats to Kenya's current seed infrastructure from MNC acquisition?

c) Many biotech processes and innovations can be of immense help in solving some of Kenya's farming problems. For example, new bio-engineered crop varieties that can grow in semi-arid sandy, clay or saline soils would boost Kenya's production immensely and remove the land-constraint that now exists. Another example is biosynthesis of some products. Are there any possibilities of comparative advantage if Kenya undertook some biosynthesis? For example, if sugarcane farming is unprofitable because of biosynthetic sweeteners then could gasohol be biosynthesized from Kenya's sugar crop and thus help save on foreign petroleum bills? What are the income redistribution effects of such a move? Further, can Kenya benefit in livestock disease eradication by use of medical biotech?

d) What are the secondary effects to Kenya as a

result of economic dislocations caused by biotech abroad?

Chapter 5

GERMPLASM, PRIVATIZATION AND MULTINATIONS: NEW STRATEGIES IN SEED MARKETING

In 1970, fifteen percent of the U.S. maize crop was destroyed by the Southern corn leaf blight. Suddenly the extreme danger of genetic uniformity in crops was brought into sharp international focus. Loss of genetic diversity and the ever narrowing genetic base of major crops and the need to preserve the worlds genetic heritage became a major issue in the media and for scientists. The latter intensified their search-and-collect missions for old and dying varieties, old landraces, wild relatives of major crops with full realization that it was now a race against time to save this precious breeding material. Most of these collections came from the third world countries, the greatest sources of plant diversity, and practically all went to the industrialized countries for breeding and storage. The former are the planet's repository of plant (indeed biotic) diversity, the latter store the collected germplasm. This is the process that has been called "gene drain" whereby the "food-poor gene-rich" nations of the South "contribute" genetic resources termed as a common heritage of mankind to the "gene-poor grain-rich" industrialized nations of the North who have the scientific facilities to use and store the genetic material (43). One conservative estimate, for example, is that the Third World contribution to American agriculture alone is several billion dollars a year of which over US$500 million is added to the value of the wheat crop alone (43 page 3).

It is this allegedly unequal advantage that spurred many individual scientists and activists to question the state of germplasm ownership. The International Coalition for Development Action (ICDA) and the Rural Advancement Fund International (RAFI) have been at the forefront of this movement. RAFI published Pat Mooney's first book entitled Seeds of the Earth in 1979 in which he encapsulated the debate. In 1983 he raised the debate to another level with the publication of The Law of the Seed.

Basically, Mooney's argument is that under the cover of

"common human heritage" rich countries collect and hoard germplasm from the South, then use this precious material for breeding and crop improvement. Resultant high yields are then sold to the South at high prices as food or used as political weapons in some cases. Worse yet, the seed of improved varieties are patented and made not a common heritage, but private property by multinational firms. Such seeds are only available at exorbitant royalties while the germplasm is sometimes used as a political weapon denied some nations and begrudged others.

Mooney has documented many cased of unfairness in germplasm access. He highlights the case of the International Board of Plant Genetic Resources (IBPGR) as the concentration of the rich countries resolve to siphon off the genetic abundance of the South and store it in the North. IBPGR is the creation of the Consultative Group of International Agricultural Research (CGIAR), a consortium of large foundations, the World Bank, multinationals, and western governments that also founded and oversees the global network of the International Agricultural Research Centres (IARC) listed below with their research or service speciality:

International Food Policy Research Institute
(IFPRI), Washington, D.C., policy studies

International Maize and Wheat Improvement Centre
(CIMMYT), Mexico, maize, wheat, barley

International Rice Research Institute
(IRRI), Phillipines, rice

International Crops Research Institute for the Semi-Arid Tropics
(ICRISAT), India, arid area crops, sorghum millets

International Centre for Agricultural Research in Dry Areas
(ICARDA), Syria

International Centre for Tropical Agriculture
(CIAT), Colombia, general tropical crops

International Crop Centre
(CIP), Peru, potatoes

International Institute for Tropical Agriculture
(IITA), Nigeria, grain legumes

International Laboratories for Research for Animal Diseases
(ILRAD), Kenya, animal health

International Livestock Centre for Africa
(ILCA), Ethiopia, livestock and pasture

International Board for Plant Genetic Resources (IBPGR), Rome, germplasm collection

International Services for National Agricultural Research (ISNAR), Holland, research development and management

This CGIAR network has done much crop improvement, germplasm collection and storage. CIMMYT and IRRI are notable in having provided the so-called hybrid miracle grains (wheat, maize, rice) that sparked off the USAID-proclaimed "Green Revolution" in the sixties. Serious questions have recently been expressed about the benefits of IRRI in the Phillipines and India and rebellion against IRRI rice hybrids expressed (see ICDA Seedling, October, 1985, pages 4 and 6 respectively). Of greater importance, according to the activists though, seems to be IARC's role as siphons or funnels for germplasm from the South to Northern seed banks. All accessions collected by International Board for Plant Genetic Resources (IBPGR) go to these centres and to developed countries' storage systems.

IBPGR, in self-defence, claims that delay in collections until all nations are ready for storage and use might result in serious losses of threatened material. They point out the requests of Kampuchea, Ethiopia and Sudan for germplasm of their traditional crops after their own germplasm was destroyed in war or drought or both. Had these not been collected and stored earlier by CGIAR centres they would have been lost for good. A strong case is argued by IBPGR that the issue is how South countries can use germplasm, that is already freely available internationally, while also taking steps to store the rest of their own gene heritage properly. It must be remembered that IBPGR's mandate is in only 50 crops, up from the original list of nine. Other non-crop plant germplasm falls under the mandate of International Union for the Conservation of Nature (IUCN).

On balance, it seems the IBPGR has a crucial role to play in crop germplasm collection and storage given the rate of loss, human caused (e.g., destruction of habitats, war, "Green Revolution" cultivars, etc.) or catastrophic, e.g., drought. There is evidence, for example, that the 1974 Sahelian drought wiped out many grain landraces which would now be replaceable had there been IBPGR-like collection/storage programmes before that disaster.

It seems possible that while CGIAR and its wealthy western sponsors may have had ulterior political/economic motives, IBPGR itself was a naive (politically innocent) grouping of scientists going about business unquestioningly, as technocrats are often wont to do while fitting into a mold that clearly keeps old colonial forms unchallenged. One cannot assume that science acts in a socio-economic vacuum

or that it is value-free or immune from political machinations.

Mooney, RAFI, ICAD, and others have, however, highlighted the "conspiratorial" aspect of germplasm and seed business and the vested interests of large business firms and shown how IBPGR may reinforce past unfairness in seed and food relations. UNFAO, the shield used by CGIAR for ten years to cover some of their activities, has been forced by these indefatiguable activists and the Group of 77, to take more control of IBPGR and to bring it under the UN General Assembly.

This is the culmination of the Third World anti-IBPGR and anti-CGIAR thrust that started in 1981 at the FAO 21st biennial conference in Rome with Mexico kicking off the debate. The debate was continued at the 22nd conference in 1983 and resolved at the 23rd conference this last November in favour of more democratization of access to germplasm. On the surface this seems like a major victory for the Third World.

However, evidence is already developing that the CGIAR (under the insistance of Western interests, especially the U.S. Government) is refusing to accept democratization of access to germplasm or to bring IBPGR's operations directly under the UNFAO and the General Assembly's control. CGIAR has threatened to oppose the decision made in November 1985 by pulling out of FAO entirely and forming an independent germplasm bank, leaving the FAO to begin from scratch to establish a new network of genebanks. This, after having used FAO staff and facilities and Third World genetic resources for ten years to establish the IBPGR banks. If this comes about, it will be grossly unjust and lends credence to Pat Mooney's and others' observations as expressed in issues of ICDA Seedling and IGRP Report from late 1985 onwards (96, 97 respectively).

Patents

The question of access is much larger than can be solved by an FAO or UN resolution, however. A more sinister development regarding access, in fact the real problem, is the increasing tendency for seed firms to apply patent laws to seeds bred from freely obtained germplasm and to charge userous royalties for such seed. Patent laws in industry have been widely exposed as a vicious form of imperialist control and a hindrance to transfer of technology in favour of industrial nations. In addition to this legalistic blocking of access to seeds and germplasm, multinationals like Shell Oil, Pioneer Hi-bred International, Sandoz, Ciba-Geigy, Atlantic Richfield, Basf, Pfizer, etc., are moving into the seed business by buying out smaller firms, forming conglomerates and monopolies, and concentrating on

seed marketing. This risks to alter permanently the seed industry to the great detriment of poor countries' food production.

This has interestingly raised an outcry in the American and international media, as well as genuine concern over the future of seed marketing. The following sampling of recent articles gives some idea of this.

"Mystical Thinking and the Patentability of Higher Organisms," Geoffrey Karny, Genetic Engineering News, 7-8/84.
"Protection of Plant Varieties and Parts as Intellectual Property," Sidney Williams, Science, 7/6, 84.
"Multinationals Move In: Firms See Growth Potential in Seeds," Ken Conner, San Francisco Chronicle, 6/9/84.
"Patents Are Biotech's Battlefront," Gail Schares, San Francisco Chronicle, 6/7/84.
"Seed Growers Concerned About Industry Trends," Dick Yost, Oregon Farmer-Stockman, 5/17/84.
"Genetic Engineering Patent Law Trends Affecting Development of Plant Patents," C. Weagley, D. Jeffrey, and A. Kiepenbrock, Genetic Engineering News, 4/84.
"Do We Need a Special Patent Law for Biological Inventions? Iver Cooper, BioTechnology, 2/84.
"Preserving Plant Genetic Resources: Open Letter to World NGOs and Others," Upendra Baxi and Clarence Dias, Mainstream, 11/19/83.
"Budapest Treaty Makes Biotechnology Patenting Simpler," Stanley Schlosser, BioTechnology, 11/83.
"Agricultural Biotechnology Needs Strong Patents," Nicholas Reding, BioTechnology, 9/83.
"Conglomerates Have Big Plans for Nation's Seed Companies," Thomas Porter, Jr., Greenhouse Manager, 7/83.
"Seeds of Disaster," Mark Schapiro, Mother Jones, 12/82.
"The Legal and Legislative Background," Donna Smith and Jonathan King, Environment, 7-8,82.
"The International Breeders' Rights System and Crop Plant Innovation," John Barton, Science, 6/4 82.
"Patenting Life Forms: Issues Surrounding the Plant Variety Protection Act," Barbara Claffey, Southern Journal of Agricultural Economics, 12/81.
"Seed Patenting Considered a Threat to the World's Food Supply," Cary Fowler, COOP News, 8 17 81.
"A Rhubarb Over Patenting Vegetables," Ann Crittenden, New York Times, 6/13/80.
"Seed Patents: Fears Sprout at Grass Roots," Eleanor Randolph, Los Angeles Times, 6/2/80.
"Patent Protection for Plants," Carolyn Jabs, New York Times, 5/7/80.

"The Real Scoop on the Plant Patent Controversy,"
Anthony DeCrosta, Organic Gardening, 5/80.

At the root of the problem is the Plant Breeders Rights (PBR) movement, a well-organized, generously-funded lobby of large seed multinationals and rich nations that seek to protect seed monopolies by lobbying for legislation in all countries so that patent legislation can be passed more widely. The International Union for the Protection of new Varieties of Plant (UPOV) negotiated the "Convention of Paris" in 1964 which sought to militantly lobby enactment of uniform legislation and enforcement of PBR laws throughout the world. Mooney, IGRP, ICSA, RAFI and a host of other activists have thoroughly documented the sordid aspects of this movement. Thanks to their work and the events at FAO since 1981, it seems UPOV and PBR are losing some of their steam. Some countries that had the legislation in their books are reconsidering or stalling. For Kenya, which has pro-PBR laws on the books, we believe this issue is so critical for the nation's future that it needs much more open discussion by farmers, scientists, civil servants, and politicians, new policy instruments, and clear national positions in favour of repeal of such laws (see Appendix II, part V, 17 (2)).

Biotech and Privatization

Much credit goes to the Rural Advancement Fund International (RAFI) of Pittsboro, North Carolina, and their International Genetic Resources Program (IGRP) for their indefatigable efforts in exposing the international going-on in germplasm, especially monopolization. In recognition of this, the co-founders of RAFI, Pat Roy Mooney and Gery Fowler were awarded this year the Right Livelihood Award, the alternative Nobel Prize in Sweden and commended thus:

> . . . .(they have) drawn attention to the dangers of replacing a wide variety of locally adapted plants by a few high-yielding but disease prone varieties with a narrow genetic base. . . .(and their) efforts to promote the free exchange of genetic resources and block legislative moves towards their monopolization.

Multinationals, Biotechnology and Monopolization

Third World victories at FAO and IBPGR may be hollow if multinational agribusiness firms have their way. They are already moving in a big way to corner the international seed market. Starting with the "natural patent" that hybrid seed offers (farmers must return to the store every season for hybrid seed) big business recognized the potential of such a market and bought rights to specific hybrids while emphasizing hybrid breeds and cross-pollinating varieties

only. Legal patents and plant breeders rights and UPOV also present further protection for their investments.

But by far the greatest new growth area in seed commercial monopolization is the emerging biotechnology and MNCs will be quick to corner this too. At a MNC conference held in Geneva in May 1985, called "Biotech '85," a highly candid background paper entitled, "The New Plant Genetics: Restructuring the Global Seed Industry," analysed the influence of biotech on the seeds industry and multinationals. I quote from that paper as reported in the ICDA Seedling bulletin of October, 1985, page 8:

> the value of all seed planted by farmers worldwide is currently in excess of US$ 50 billion. The problem for the industry is however that "only" 63% of that value is supplied by companies and organizations because too many farmers still use their own seed. But anyhow, the total retail value of all seed incorporating biotech improvements is forcasted to increase from US$ 8 million in 1985 to US$ 6.8 billion by the year 2000, which represents a 57% annual growth rate. The paper also states that shortly after the year 2000, no more than a dozen global companies will dominate the seed market.
>
> One of the reasons, mentioned in the paper, why multinationals are now so interested in acquiring seed companies is the fact that seed is "Ecology plus." "Unlike many pesticides which are under attack by environmentalists, seed and the plant sciences are considered ecologically positive. The threat of withdrawal and/or recall because of politically inspired pressures is unlikely with seed."

Clearly these trends will have a great impact in Kenya if we are caught unawares. While Kenya did not legislate UPOV guidelines, PBR protection currently provided in the Seed and Plant Varieties Act, although inactive, offers a potentially disastrous entry point to seed control by MNCs.

Chapter 6 describes the current seed marketing and distribution in Kenya. Multinationals are known to be interested in acquiring major local seed operations in all countries, including Kenya, and the gravity of such an eventuality should be clear from above.

Appendices III, VIII, IX, and X give lists of some of the recent merger/acquisitions of petrochemical or pharmaceutical multinationals with/of biotech and seed firms.

Chapter 6

SEED MARKETING AND DISTRIBUTION IN KENYA

There are two major categories of crop seed sources in Kenya: non-commercial seed produced on the farm and set aside for subsequent season and the commercial suppliers. The former is undoubtedly responsible for a large bulk of total seed used. It would not be incorrect to infer that in relative terms and for a variety of reasons more and more small-scale farmers who were previously self-sufficient in seed have had to look to commercial sources for some if not all their seed requirements. Figures to support these trends are lacking and we need to examine this farther for the symposium.

The commercial seed sector, ideally could be quantified, were it not for the extreme levels of suspicion and secrecy that are an integral part of the seed industry. No company seems, as a matter of policy, to publish annual reports. Neither of course are there figures for the "informal commercial sector," the market-sellers who handle produce, a large quantity of which ends up as seed material. This sector too needs some investigation and quantification.

There are, however, 13 registered firms who deal wholly with seeds. These 13 form the Seed Traders Association of Kenya (STAK) (see Appendix V for a list of some member companies) which is affiliated to the International Seed Traders Association (ISTA). STAK is a recently established organization and may not yet have the lobbying power or experience of its counterparts elsewhere. In fact, all indications are that it is rather tentative in its existence due to perhaps some market rivalries. It is, nevertheless, an important organ to keep in mind when discussing the seed issue in Kenya. The commercial seed market is dominated by one giant seed company--the Kenya Seed Company based at Kitale. So all-embracing are the activities of this firm that it merits some detailed discussion.

Kenya Seed Company Ltd. was formed privately after the Second World War. It is now owned by the Kenya Government, the KGGCU and private individuals--51%, 30%, and 19% respectively. Since the Government also has some interest in KGGCU, one can surmise that the combined influence of the

Government in the company's policy is considerably higher than the 51% figure would at first indicate. In fact, Kenya Seed Co. now consider themselves as a parastatal trader-producer organization. They, therefore, enjoy official protection and must necessarily follow government policy in addition to commercial good-sense (95).

The National Food Policy makes several references to this company, viz.,

> Section 4:6. The Kenya Seed Company has already been directed to ensure that adequate supplies of seed, particularly maize and wheat, are available at the beginning of each crop season. . . .
>
> . . . . target rates of growth of sales (will be) 10% a year for improved maize and wheat. . . .

The Government will use its majority shareholding in Kenya Seed Company to ensure that these goals are met.

Kenya Seed are mainly concerned with the production and marketing of the following seeds:

Maize	Pasture
Wheat	Sun flower
Barley	Horticultural (vegetables and flowers)
Other cereals (Oats, Triticale)	Grain Legumes

For details on cereals and other field crops, see Chapter III, Current Breeding Activities in Kenya.

Horticultural Seeds

For the production of all horticultural crops, Kenya Seed Company has recently acquired a subsidiary company Simpson and Whitelaw (of Simlaw Seeds fame). This was previously owned by Mitchell Cotts, then by Kirchoffs, of UK and Germany respectively, but had reverted to local private interests prior to acquisition by Kenya Seeds Co. This acquisition made Kenya Seed the seed giant that it is, in addition to the official influence that a parastatal can command. Simpson and Whitelaw were already a force to reckon with in terms of horticultural seed production. Another subsidiary of Kenya Seed Co. is Hortiseed Ltd., wholly charged with horticultural seed production, making Simpson and Whitelaw mostly a marketing firm.

A good 75% or more of all vegetable seed for the Kenya market is produced by Hortiseed from breeding material in their own local collection or material acquired externally. Following is a summary of the major horticultural seeds from Hortiseed.

a) Beans

There seems to be some overlap with the parent company in bean seed production. All bean lines are obtained from Agricultural Research Station, Thika, and multiplied. Some importation was done before, but this is gradually coming to a stop. Hortiseed Ltd. have experienced the only known case of patented horticultural seed with the french variety Moneil. Rather than pay royalties, company policy is to discontinue or ignore such a variety, while breeding a variety closely related to the patented one. Moneil is an excellent variety bred specifically for European green bean requirements. Simlaw are marketing a "near-enough" variety and claiming it has Moneil-like qualities without infringing on patents.

b) Vegetables

Previously all vegetable seed was imported from Europe, North America, Australia and New Zealand. Since acquisition by Kenya Seed Co., an aggressive programme of local production has been instituted and the following vegetable seeds are locally produced and in some cases exported:

Capsicum (sweet and hot)
Okra
Melons (water and sweet)
Eggplant
Cucumber
Coriander
Collards (a variety of sukuma-wiki or kale)
Peas
Pumpkin
Radish

Some other crop seeds are imported in bulk as ready-seed because local production is limited by either or both of two problems:

a) Being of temperate/sub-tropical origin, many vegetable species, especially the cruciferae (mustard/cabbage) family have highly specific photoperiodicity and do not flower or fruit in our short-day conditions, perferring at least 13 to 14 hours of daylight. New short-day varieties are, however, being bred and this may soon permit seed production of a wider range of species here in Kenya.

Already an American variety of kale (sukuma wiki) called collard green, popular in Southern U.S.A. is seeding here in sufficient commercial amounts and no more kale seed is imported as has been the case heretofore. Another technical reason is failure by some crops to keep to type, e.g., tomatoes, needing new lines all the time to ensure and preserve fidelity of varietal characteristics as these tend to drift in successive progeny.

b) The second problem is simple economies of scale. To be economic, seed production must be in large quantities--hundreds of tons or more. Kenyan demand is often in tens of tons in many varieties and is not worth the overheads necessary. For the same reason, local breeding or "line maintenance" of most low demand crops would be far too expensive in comparison with direct imports of ready-seed. (NB. All local seed multiplication is done in rain-fed farming as irrigation overheads would price it out of the market.) In most large-scale seed production systems abroad (especially industrial countries) agri-business efficiency is applied to massive seed production systems resulting in very low prices per unit.

For these two reasons, the following seeds are imported:

Lettuce (most)	Beets
Courgettes	Spinach
Tomato	Kale (non-Collard)
Cabbage	Celery, etc.
Carrot	Asian Cucurbits
Onions	(bitter gourd, etc.)
Chards	Turnips and Swedes

Kenya is a net horticultural seed importer, but is gradually breaking into the export market in some varieties when surpluses are realized, depending on weather conditions and local demand levels. Being able to export is an indication of the high standard of Hortiseed Ltd. Exports have been undertaken to Denmark, England, Holland, and East/Central Africa.

Other Firms

As stated earlier there are at least 12 other seed firms registered in the country. The other best known of these is the East African Seed Company, a local Asian-owned concern of smaller size than Simpson and Whitelaw/Hortiseed complex of Kenya Seed Company. They seem to carry the same general lines as the latter, but also carry some traditional crops and spice seed. They are, however, perhaps dealing in uncertified seed, but, in fairness, they may sometimes warn buyers of this fact. One case is known where a buyer of soya bean seed had been warned that it was not certified. None germinated. Again, in fairness, they are the only large company who seem to handle local crops, e.g., njahe (Lab Lab or bonavist beans), other than the "Nyamakima-type" of informal food-cum-seed sellers. None of such seed could possibly be certified by the National Seed Quality Control Service and some policy and even legal questions could therefore arise here.

Another seed company of interest which may represent a different and intriguing genre is Jardinage Ltd. More needs to be known about the company and others like it. According to allegations in seed circles (unverified and largely unverifiable due to typical trade secrecy, and in all fairness allegations must be anticipated in a trade of such fierce competition) this firm represents the local thrust of multinational seed interests. They allegedly import through neighbouring countries and then dump various varieties in Kenya (no evidence that these varieties are patented which would raise interesting questions of patent-busting). In the seed industry, dumping implies low-quality seed and not necessarily low price. But seed business is, even more than other commercial enterprise, highly dependent on consumer satisfaction for entrepreneurs to survive. One suspects that Jardinage and other such companies would not take such risks in such a small market as Kenya and that their merchandise is perhaps of threateningly high standards, backed by an organization that could bear early losses in order to break into the market for specific (if not calculated) objectives. It is suspected that multinational backing is not unlikely and these companies represent what maybe coming in Kenya's seed future if market entry remains free and competitive and not dominated by parastatal-like monopolies. As Kenya Seed Co. would presumably and understandably not like to see. There have been frequent outcries against "unfit" imported seed lately, uttered by senior officials. This gives the impression that there are dealers who do not follow the laid-down rules and regulations (90,91,92).

Flower Seed

Kenya Seed Company's horticultural seed subsidiaries engage extensively in flower and ornamental seed multiplication on contractual basis with European and North American seed companies, many of them multinationals. The practice is for the breeders to send in "line-material" from which multiplication and bulking can be done in Kenya's year round growing conditions. The following flower species are grown thus and exported:

Cosmos
Zinnia
Impatiens
Marigolds
Convolvulus
Nasturtiums
Vinca

Seed Multiplication Sites

Kenya Seed Company has a wide-ranging network of farms, mostly leased and/or contracted, in which seed growing and multiplication are done; for maize, wheat and barley, the Trans-Nzoia, Uasin Gishu, Nakuru Districts are the most important Districts, but recently, the ideally hot and wet

Malakisi region of Busia has gained in importance as a multiplying area. Narok and Naivasha areas are also used for some species. For a long time now, it has been recognized that East Africa is ideal for seed multiplication work. Thus Arusha is a major site for European seed houses, while Kenya's importance has increased rapidly as her role as a seed supplier for Eastern and Central Africa has been expanded. Currently most of the multiplication is done for European and North American companies.

Chapter 7

EXISTING AGROFORESTRY/SEED PROGRAMMES

a) In this section the structure and objectives of several new agroforestry projects are discussed. They represent attempts by individuals, NGOs, and the Government to solve the seed bottleneck while at the same time to reach out to more individual farmers and community groups than has been the case heretofore. They are thus models worthy of study with a view to assisting prospective project planners to gain a picture of what has been tried, how, and with what results. The projects are divided into two broad categories:

A) NGO/Community Group projects
B) Government of Kenya programmes

A) NGO/Community Group Projects

Undoubtedly there are many local small-scale tree planting projects in the country. They range from individual enthusiasts of the "Men of the Trees" type to church missionaries who try all types of species in their area or on their land. Of more interest are the new, more formally instituted projects with clear sets of objectives, including extension/training and diffusion strategies. These projects are not very many, but they are increasing and should have more impact in the future, judging by their current momentum. They have been founded by church groups, primary/secondary schools, wildlife clubs, and NGOs and range in size from local projects to larger regional projects like Care-Kenya in Nyanza to KENGO's far-ranging role on national scale.

The recent increase in rural afforestation and agroforestry stems from the increasing acceptance of "tree planting as part of farming" idea which in turn can be traced to the initiative of the local community non-government organizations such as those mentioned above.

From a seed production point of view, however, few of the community projects seem to have devised reliable seed-production or acquisition methods. They rely heavily on donations from other organizations. By relying on external seed most have suffered from the "seed bottleneck"

and were forced to delay or curtail their planting schemes as well as resort to whatever seed was available which, in many cases, was unsuitable for their areas. Participants at the Moi University Training Workshop held in July 1985 on seed collection and seed handling stressed the importance of seed self-sufficiency constantly in their deliberations.

KENGO has in the last two years contributed immensely in seeking solutions to the tree (especially indigenous species) seed problems (see below for details). Another well-known project which has attempted to resolve this seed problem has been the CARE-Kenya project in Siaya and South Nyanza. Financed by CIDA through CARE-Canada and headed by a Canadian volunteer, this project has in the two years of its existence created an effective seed and seedling distribution network. Local groups with well-trained extension personnel are recruited from local communities. Seed trees and stands have been identified and collection on a predictable basis has been started. Plans are at hand to expand their seed distribution network in the two Districts which is based entirely on locally-produced seed.

This project, like many others still in their infancy, seems to have incorporated "self-perpetuating" mechanisms, e.g., counterpart or understudy staff so the project will outlast the expatriate input, training of junior staff, systems to create local self-sufficiency in seed, and elimination of expensive centralized seed storage structures.

To the extent that NGO-initiated projects take appropriate steps to continue innovatively on their own, independent of outside initiators, much will have been gained. One hopes that the understudy method of skill-transfer works, but one fears that where it fails, as commonly happens, the projects become stagnant and/or collapse. Without careful attention paid to this important question, we cannot count on continued success of planting projects or seed supply.

This discussion concludes with descriptions of some NGO programmes, with information provided by representatives of the organizations.

1) <u>CARE-Kenya, Nyanza Project</u>

In 1983, CARE-Kenya instituted an agroforestry project in Siaya, financed by CARE-Canada. The basic aim is to encourage community groups (primary schools, women's groups, etc.) to start small-scale nurseries which can supply seedlings for various plantings.

There are currently over 200 such group nurseries with a capacity of at least 5,000 seedlings each, making for a total of one million seedlings. There is a potential for 90

more groups being developed before the long rains of 1987. There is also hope that a figure of 500 group-nurseries is ultimately possible. The goal is to produce 3 million seedlings in all of Siaya District annually. In addition, similar groups and nurseries have been started in South Nyanza with similar objectives.

In Siaya where the project has been underway for a longer period of time, a rudimentary ecological division of the District has been done; each of the three regions is organized with its own recommended species, based on rainfall and broad soil types. The general agroforestry species of the warm seasonally dry lowlands are available in the nurseries. These include: Leuceana, Markhamia, Cassia, Siamea, C. spectabilis, Terminalia, Erythrina, papaya, guava, mango, and citrus. In all, seed for at least 24 species are available.

The project is organized hierachically with two administrative heads with field officers under them, three in Siaya and four in South Nyanza. Under these field officers are the extension officers--32 in Siaya and 60 in South Nyanza. These are in close touch with local farmers and community groups responsible for the nurseries. The farmers assist them to identify good stands of suitable agroforestry species and they pay the farmers to collect the seed. CARE-Kenya purchases this seed from the farmers. Surplus seed is available for sale to non-CARE buyers.

At the moment, only crude pretreatment is undertaken, but plans are afoot to set up better drying and storage facilities, though the preferred course is to harvest and use fresh seed every season.

Three extension officers of superior practical aptitude in seed and forestry work have been identified and will be trained in order to upgrade extension services and help make the project self-sustaining. In fact, CARE-Kenya is eager to do everything possible to ensure that the programme outlasts their presence of three and one half years.

2) KENGO

KENGO is an association of Kenyan NGOs in the field of energy. Since its formation in 1982, KENGO has been very active in agroforestry and general energy information and extension services all over Kenya. KENGO's major activities have been in the following areas:

a) seed collection, exchange and distribution
b) extensions and training
c) publications and general information
d) research and trials.

Seed Collection

KENGO has established a seed collection network based mainly in Eastern Province. The strategy is to liaise with MOERD officials and Divisional Forest Officers (DFO) who identify possible collectors. KREDP Centre managers also assist especially by providing forwarding facilities for collected seed. Average price is Shs. 10-15/- a kilo for Acacia tortilis. So far there has been no shortage of collectors at such a price, but perhaps this is subsidized since the collectors may be salaried elsewhere.

In 1985 about 500 kg. of seed was collected this way mainly from Kitui and distributed all over the country for free. KENGO ranks as one of the foremost sources of indigenous dryland species.

Extension and Training

This constitutes KENGO's major work. Objectives are to upgrade technical competence at all levels in agroforestry practices and seed collection. In October 1985 a training workshop was held at Kitui for individuals and organizations from all over Kenya--nursery workers from EMI, primary school teachers from many districts, NGO leader, CARE-Kenya extension staff, KWDP nursery staff and even GK prison warders in charge of agroforestry and church groups.

A sub-objective of such training is to encourage local seed collections and improve seed quality. This strengthens and widens the national seed network. So far one major Kenyan-wide travelling workshop has been completed and others are planned. A workshop for media people was organized recently in Homa Bay to acquaint them with energy and environment issues and their role in it.

Publications and General Information

KENGO's other main function is as a clearing house for agroforestry news and activities. KENGO publishes a periodical KENGO NEWS as well as other material on agroforestry and energy issues including seeds (25). Of great signifiance was the booklet Pocket Directory of Trees and Seeds in Kenya by Wayne Teel and KENGO. This excellent book has helped make tree taxonomy and seed identification more accessible to non-botonists as well as assisting create a national network for seed-exchange. A major seed manual, How to Collect, Handle, and Store Seeds, is in press.

Research and Field Trials

According to KENGO, the next phase of their work consists of follow-up field work to collect data on germination and performance of seeds supplied, survivorship and growth rates

in various areas. Already data collection forms have been sent for some of this information. In addition plants are reportedly under way to establish a "drought management agroforestry system based on indigenous trees" at the Jomo Kenyatta College of Agriculture and Technology. There will be seed orchards and demonstration trials in addition to research on germination performance, etc. Eventually it is hoped to start investigations in Kenyan wild fruit trees as crops.

3) Turkana Afforestation

With aid from Norad, Kenya Government has started afforestation projects in Turkana District under the supervision of Ed Barrows. This is a very important model project for the driest areas of Kenya with nomadic populations and it merits some study. We were, however, unable to include it here in any detail due to travelling constraints. Reports indicate that it is extremely successful and has, in some areas, a food-for-work component tied to tree planting and maintenance.

b) Goverment of Kenya/Donor Programmes

The overall agroforestry seed situation in Kenya is currently uncoordinated and fragmented. There is no doubt there are serious weaknesses, especially in supply of traditional crop seeds and tree seeds. One example of a current attempt to rationalize the situation is the proposed Forest Seed Centre at Muguga which provides a first step toward rationalizing the supply of tree seed in Kenya. It is expected to begin operations in 1987. It will assist the Government tree system to deliver agroforestry seed for community projects and will raise standards of seed collection, processing and storage to international standards. This, in general, is a good thing.

Another is the Rural Afforestation Extension Service (R.A.E.S.). Started in the mid-seventies, the RAES is a Government programme to promote small-scale rural planting. RAES's objective has been met to some extent in some areas by establishing nurseries in rural areas close to farmers and making inexpensive seedlings available, although the choice of species was limited to the old exotic trio of cypress, pine, and eucalyptus, even in areas where these were manifestly unsuitable, e.g., Kitui District. RAES has recently shifted its emphasis to include indigenous trees and new multipurpose agroforestry species but a shortage of this type of seed has persisted. To rectify this, extension officers are encouraged to seek local seed sources and arrange for collection at appropriate times. But apparently this is still in its incipient stages and RAES still depends on the Forest Seed Centre at Muguga (part of the Ministry of Agriculture) for the majority of seed supply.

An interesting example of the catalytic role of individual resourcefulness is the effect that the British Government Overseas Development Assistance (ODA) staff have had on RAES activities in the Embu, Meru, Isiolo (EMI) Forestry Project. In 1982, Kenya Government entered an agreement with ODA to provide extension advisory services in rural afforestation in the three districts with special emphasis on their more arid lowlands.

Within three years the extension service there has been injected with new life that has galvanized many groups and individuals to start nurseries and planting schemes. The key to this seems to be the identification of methods to motivate junior extention officers, who were selected from among nursery attendants then promoted and encouraged. One in Meru is reputed to have helped plant out more seedlings than the Department in his area last year, according to EMI staffers. RAES could quite profitably pay heed to such intiatives and introduce them to other areas, thereby altering the pace and intensity of rural afforestation.

It is in seed procurement and self sufficiency that EMI has excelled. Initially it was totally dependent on Muguga for all seed and experienced great difficulties getting appropriate, leave alone, adequate seed. Now they are totally self-sufficient in basic seed requirement. This was achieved thus:

a) starting a well structured collecting programme with each area responsible for only one or two species. This specialization by stations has resulted in production of good, reliable seed and a surplus for exchange. RAES even gets some seeds from EMI now.

b) Eucalyptus camaldulensis seed of different provenance was imported from Commonwealth Science and Industrial Research Organization (CSIRO)-Australia and is undergoing field test to judge which provenances are most suitable for EMI regions. Other importations have been undertaken from Setropa in Holland. After establishment, these seedling will form future seed stands.

c) Emphasizing simple pretreatment storage methods and establishing three simple seed stores in the EMI area.

An excellent manual on nursery practice has been published by ODA staff, A Forest Nursery Manual for Kenya (18).

This is certainly one of the more successful RAES-donor projects, and all its aspects, not the least of which the seed work, need to be emulated by RAES in other Districts.

Concluding this section, these three Government afforestation projects will be described in some detail.

Information was provided by representatives of the organizations.

1. Forest Seed Centre

The Forest Seed Centre (FSC) was established at KARI, Muguga, in 1984, to take over all tree seed functions previously under the Forest Department. Although currently under the KARI umbrella, and therefore falling within the jurisdiction of the Ministry of Agriculture, it is hoped that the Centre's position will soon be rationalized so that it falls under the Forest Department of the Ministry of Environment and Natural Resources.

GTZ, the donor agency, has assigned two German seed experts to start the Centre along with Kenya Government forestry officers from KARI. GTZ proposed to build and commission a fully equipped, international-standard seed processing and storage plant with all the newest seed technology. The cold rooms will have a capacity of 100 cubic metres, divided into several chambers of variable temperatures as necessary. They have also received permission to have a seed quarantine facility on site, thus bypassing the PQS for pest screening and cleaning of import/export seeds. The policy, economic and practical implications of this need constant monitoring.

It was pointed out that forest seed storage is normally for the short-term, with the long-term storage being best done by means of a seed orchard, due to the extremely long rotation period for tree species. With this in mind, the FSC is designed with the following objectives:

a) a practical approach to storage of seed to ensure continuous supply even during years of poor seed harvest. In this case, the bank is to act as a buffer against wide fluctuations of supply.

b) to emphasize short-term active storage of mostly 1 to 5 years with some allowance for some medium term storage of 5 to 10 years. No provision will be made for long term base collections.

c) to aim to eventually have in stock seed of all important Kenyan and exotic tree and shrub seeds--especially agro-forestry, afforestation (including arid area species, industrial) and ornamentals. No provision for fruit tree seed will be made in the initial stages.

d) to conduct research into optimum methods of seed processing, testing, and optimum storage temperatures for tropical species, e.g., Meru oak and neem, which are problem storage

species whose behaviour in prolonged cold storage is not well known, as indeed is the case with many other tropical forest seeds.

e) to train Kenyan staff in all aspects of forest tree seed work and gene bank technology.

f) to establish or strengthen seed stand units (natural or orchards) with six sub-centres in different ecozones. These are Elburgon, Daraja, Sokoro, Londiani, Gedi and two in semi-arid areas. Already an eight hectare seed orchard exists at Muguga from EAFFRO clones and another at Londiani.

2) Rural Afforestation Extension Services (R.A.E.S.)

The R.A.E.S. is charged with all non-industrial afforestation schemes and extension services with special emphasis on small-scale rural tree planting. A brief historial summary will perhaps help put the current work of R.A.E.S. in perspective and also show the evolution of seed activities at the Forest Department.

When the Forest Department was set up early this century a bias towards industrial plantation was inevitable, since part of the terms of reference for the fledgling department were to introduce exotic fast growing fuel-woods for railway locomotion. British foresters, drawing on their training and experience in South Africa and India, naturally decided on eucalyptus and black wattle. These were among the first species to be grown before 1910. Although they were later abandoned by the railway authorities as inefficient fuel sources, the bias continued. Again, due to their experience in temperate forestry, the same foresters also introduced exotic conifers, especially pines, cypress, and auracarias, as well as an assortment of Australian acacias and grevillea. These were eventually to permanently alter the humanized landscape of Kenya. The Pine/Cypress dominance in Kenya's industrial plantation has persisted to this day. With the new papermills creating such a high demand of soft-wood pulp, this bias seems permanent and will probably become stronger.

When R.A.E.S. was formed in the seventies they fitted into this scheme. Their officers and foresters were former Forest Department employees and they tended to carry on those same practices with which they were familiar. Again, like their British predecessors by force of "training and experience," the pine/cypress dominance was carried over to rural afforestation. Up to now, these species along with the ubiquitous eucalyptus are what one encounters most frequently at their nurseries.

During the early days of the Forest Department, seed stands were established at various sites around East Africa, but mostly within Kenya. These still remain the main sources of Forest Department's approved seed. Apparently no questions were asked about the suitability of those original provenances to Kenya's different environments or needs, and it is possible that here is an area for future research work in genetic variability or drift and perhaps in tree breeding. However good or bad, adequate seed of limited species has been supplied through the years from these sources to practically all prospective planters and public institutions, up to the explosion in seed demand these last five years.

The seed unit was formerly a part of the Forest Department. In 1982 it was incorporated in KARI at Muguga and upgraded to full division status with a silvi-culturalist in charge. Now, however, new changes have taken place and it seems that, with the assistance of the German Agency for Technical Co-operation (GTZ), the proposed Forest Seed Centre at KARI will take over all forest seed work (see Forest Seed Centre).

From a seed point of view, this was easy; simply requisition for seed supply directly from the Forest Seed Centre and wait for the certified seed. But by late seventies, as R.A.E.S. operations expanded, it became clear that Muguga could no longer handle the increasing demand for seed in addition to their traditional plantation seed commitments.

R.A.E.S., therefore, recently started the policy of actively encouraging their own District Extension Officers to collect species (exotic and indigenous) that were already growing in their areas. This has had many results. Most immediately it has boosted seed supplies and created tendencies towards self-reliance in seed at local levels and greater freedom in planting schedules without the previous delays and uncertainties. Also there has been a widening of species available to include more indigenous ones. There exists the possibility, though, of lowering seed quality and giving less emphasis on mother tree properties. R.A.E.S. has become, nevertheless, partly a seed collecting organization in addition to their other activities. They still depend on Muguga for much of their seed needs, however, a position likely to persist well into the future.

There are now plans to improve on the quality and quantities of seed collected in the next development phase by stressing provenance and stricter source-selection, as well as increasing training of foresters and their collectors on basic seed technology.

Towards such improvements, R.A.E.S. has in progress the following:

a) a major national guide by district showing rates of viability and suitable times of harvest for for given species. It is hoped this will help Districts in need of a given species to order it directly from where it is available fresh, thus minimizing storage problems.

b) compilation of a national catalogue of all institutional seed sources in order to co-ordinate national supply and demand.

c) creating a new system for re-educating R.A.E.S. foresters aiming at raising their awareness of the importance of their own personal input in improving local seed procurement.

3) Kenya Renewable Energy Development Project

Kenya Renewable Energy Development Project (KREDP) was started in 1980/81. It is funded by USAID (under the Ministry of Energy and Regional Development MOERD) with Energy Development International (EDI) of Washington, D.C., as project consultants. Its objectives are as follows:

a) Woodfuel use efficiency (ceramic jiko, kiln design)
b) Industrial or burner efficiency to decrease waste
c) Woodfuel production through agroforestry/ afforestation projects

We shall take a look at only the third objective in this summary.

KREDP has established six Regional Centres, one each in the main ecological zones. Each centre is situated in a Farmers Training Centre (FTC) where they established a nursery, seed orchard and trial plots, etc. Relevant agroforestry research is undertaken at each of these Centres. Nursery management, species choice and simple seed collection/storage techniques are taught to farmers and FTC staff as well as KREDP extension staff.

Seed Collection

Originally the KREDP agro-forestry/afforestation schemes were to obtain seeds from other organizations, local and foreign, including commercial firms. It was hoped that the Forest Department could supply most of the requirements, but it soon became quite clear that alternative, more reliable sources must very soon be set up.

In 1981-82 seed supply from Ministry of Natural Resources (Forest Dept.) was very limited both in quantity and in species range. Therefore, KREDP redesigned their project to include a substantial seed acquisition element so that in a short while complete self-sufficiency in seeds would be achieved. The quickest way was deemed to be through contractor-collection. In the last two years seed has largely been acquired from such contractors--individuals on contract to deliver seed directly to regional centres for processing, planting and forwarding of surplus. By mid-1985 this method had proved so successful that KREDP had been able to supply all their needs in all the regional centres and to leave a substantial surplus from which other NGOs have benefitted freely for most agro-forestry species. (See Appendix VI for list of quantities, species and beneficiaries for 2nd quarter 1985.) In crude figures KREDP estimates that a gross total of about 8,000 kg. of seed has been collected between 1982 and 1985.

It has now been realized that this system has inadequacies and shortfalls and that, while quantity is assured, there is need for greater emphasis on quality; i.e., the whole question of provenance and harvesting seed from known marked and superior mother trees for given needs; quality control, especially at processing and storage stages to ensure greater viability. To cater for these new needs there is now an ambitious five year programme on the drawing boards which, if approved and if "external funding is forthcoming," KREDP would be one of the larger suppliers in Kenya.

A high-level seed expert and consultant may soon be engaged to set this rolling in the preparatory stages. In the meantime, beginning last year a Central Seed Services unit (CSS) has been created "in association with KARI at Muguga where a sizeable cold storage unit has been installed." KREDP's tree seed cold storage is the core of the planned future seed bank. Pre-storage processing is done at the KREDP Jamhuri site from where country-wide seed collection is also coordinated.

In storage currently are 111 seed species, both exotic and indigenous, agroforestry and regular in amounts ranging from 0.1 kg. to 100 kg. by species. In the next few years KREDP hopes to be able to supply all their needs of all species, and to cater to most local buyers as well as possibly enter the competitive seed export market for some seed varieties. A tentative price list has been put out as a guide for local and export sales (see Appendix VII). It is not unlikely that a local company will be encouraged to undertake tree seed sales if such a venture is proved competitive and profitable. The idea has been mooted for the long term.

In addition to the processing and storage facilities, training in seed technology will be undertaken in

association with International Council for Research in Agroforestry (ICRAF). This forms the other important part of decentralizing and upgrading seed supply. Quality-training of seed technicians at all levels is seen as a necessary first step.

Kenya Woodfuel Development Project

The Kenya Woodfuel Development Project is a joint undertaking between the Government of Kenya and the Dutch Government with the Beijer Institute (of the Royal Swedish Academy of Science) providing the major consultancy.

This project is guided by a deliberately limited objective: to prove and popularize the idea that firewood trees can be grown like any other perennial crop both for household fuel needs and if necessary for commercial purposes. To arrive at their choice of species that best fulfill these objectives, KWDP has developed quite a simple set of criteria for species selection: a) fast growth rate; b) compatibility with food crops in order to permit tree/food intercropping; c) "coppiceability' to save on reestablishment time and costs after each wood harvest; d) forage or fodder value; and e) preference for nitrogen fixing properties.

By a process of elimination, based mainly on above criteria, it was decided that for Kakamega, their initial zone of rural woodfuel planting, four species are suitable. These are Calliandra calothyrsus, Mimosa scabrella, Leuceana leucocephala K-28, and Gliricidia sepium. A fifth species, Sesbania sesbans, has been included, but it is a biennial and locally self-generating. It is not included in the seed scheme.

So far all the seed for the Mimosa, Gliricidia, and Calliandra species has been imported from Satropa, a Dutch firm. It is estimated about 30 kg. of Mimosa and Calliandra were imported at approximately Ksh 1,500 per kilo. The firm claims as provenances Brazil, Costa Rica, and Indonesia. Although trial plantings are still too young to go by, there are already visible phenotypic and perhaps even performance differences between seeds of the same species but of different provenances. Leuceana K-28 seed is entirely from the KREDP seed bank.

In Kakamega KWDP initially selected seven sublocations for their project. Each sublocation has an average of 3 farmer-groups, each with an average of 20 households. There are a total of 420 farms in the entire project. Soon these will be increased and further plantings are therefore

envisaged by mid-next year within the same seven sublocations.

So far all the seed of the four exotic species has been imported. A second important objective of the project is to work towards total self-sufficiency in seed at the local or farm level. In fact, the project designers see their role as one of making themselves dispensable as soon as possible, leaving the project idea to diffuse through the rural economy at its own pace after this initial awareness-raising and planting programme. This will only be possible if the "woodfuel cropping" idea is seen to work to advantage and seeds are available locally on demand. KWDP foresee an ideal situation where seed is picked directly from the mother tree to the nursery without need for processing or storage facilities or (hopefully) commercial middlemen. So keen are the organizers of the project about this that they intend to test the possibility of sowing seed directly to the sites thus also doing away with the nursery stage altogether.

There are plans to expand into several other districts if funding is forthcoming. In Kisii some groundwork has been done and planting with at least the same four species should start before 1987. Another district on the list is Murang'a where perhaps an additional set of species may have to be included to cater for the higher, cooler zones. But in all cases seed procurement will be based on the local self-sufficiency principle outlined above.

For the longterm, the idea has been broached at KWDP that the feasibility of peri-urban woodlots to supply domestic and commercial woodfuels for urban dwellers should be investigated and, if proved viable, implemented in some areas. Nairobi and Nyeri have been mentioned as possible test towns. This of course is still in the early discussion stages and is again dependent on funding availability. If carried through, it would naturally increase demand for seed. However, depending on species chosen for various peri-urban sites, KWDP's approach of seed self-sufficiency in the shortest time for each project should accommodate much of the demand.

On provenance and seed quality improvement, KWDP feel it is now essential to set about choosing the best performers among the four species and limiting seed collection from such stands. The assumption seems to be that the imported germplasm represents the whole range of genetic possibilities in each species and that selection can now begin for the best strains per site or per district and encouraging those as future seed sources. One can argue with this, but given the stated objectives of the project, it seems adequately workable. Besides the material is still

available for future researchers and breeders to work with if need be in developing better varieties.

KWDP have also started Seed Production Units (SPU) at several sites in order to complement and supplement farmers' seed production and ensure adequate supply at farm level. Already such units are in production as are some 28 of the original farms. The SPU will also serve as a centre for seed collector-training as well as being a permanent seed orchard.

An elementary seed manual on general seed collection practices, handling, etc. was published earlier on and will soon be updated as the experience on the four main species accumulates.

One can surmise that KWDP, an interesting model for a limited (woodlot agro-forestry) goal, will soon be in a position to produce enough seed for their own purposes and that in the future a surplus for exchange or sale will be available especially if proper incentives are given to farmers. In such an eventuality, quality control and proper storage/packaging procedures will have to be worked out more strictly since, by their admission, KWDP does not intend to emphasize this aspect initially. Such a uniform or standardized procedure should present no great difficulties as it will hopefully be necessary wverywhere in the country where seeds are being handled anyway.

Other Agroforestry Seed Developments

The Ministry of Agriculture has plans to establish an agroforestry section in order to integrate multipurpose tree cropping in farm systems. This is an excellent idea and one hopes MOA will liaise with other ministries and organizations, especially in seed supply matters to avoid duplication and waste.

A private firm at Bamburi, Baobab Farms Ltd., has for several years been selling agroforestry seed commercially. Appendix VIII shows their price list. It is not clear to what extent their seed activities are economically self-sustaining, but according to R. D. Haller, the manager, there is good commercial potential in tree seed in Kenya.

Chapter 8

CONCLUSIONS AND RECOMMENDATIONS

Kenya has had a reasonable seed industry able to supply much of the domestic needs in both the improved crop sector and the forestry sector. In the last few years, however, it has become evident that drastic changes need to be carried out to ensure that Kenya's seed industry can continue to serve its critical role in farming and agroforestry. One reason for this is that there is an ever-increasing demand for seeds of all categories, while at the same time it will be necessary to encourage novel (ecologically-friendly) species in crops and agroforestry, which have hitherto played a minor role both in MOA/MENR activities and the seed industry. Evidence here and elsewhere shows that while high yield cultivars are seemingly the answer to increased food production, they are not so useful in small-scale farming or in marginal areas, and there are extremely high hidden costs. Among them are loss of traditional crop germplasm, the so-called gene-erosion, and ever-increasing farmer dependence on the market as a source of inputs, including seeds. By contrast, traditional crops are security-plus in many respects, although lower in productivity, than H.Y.V.

Given the preceding information and analysis, it is evident that there are several critical areas with regard to seeds, food self- sufficiency, and fuel wood which Kenyans need to address themselves to urgently. Public airing of issues by means of a symposium would certainly help to popularize them and thus set the stage for incorporating the issues into both local and national planning, as well as NGO strategies.

Following, is a discussion of several critical issues which must be address.

ISSUE No. 1: Germplasm Conservation and Storage

Of prime importance in building a solid seed infrastructure is the creation of a comprehensive germplasm conservation and storage system. The existing storage system in Kenya is limited to physical storage of accessions alone and needs expansion to other activities, as well as rationalization

and legal guidelines. The following areas need to be addressed:

1) While Kenya has an existing network for germplasm storage, it is not clear to what extent the stored material is being properly preserved. A case in point is the loss of germplasm due to machine break doen at PQS between 1981 and 1983.

2) Due to lack of documentation, it is not known how useful the material is, e.g., the redundancy vs. the comprehensiveness of the collection.

3) There is no concerted, nation-wide collection of germplasm programme in effect. Given the rate of distruction of habitat and the conversion to cash cropping and improved hybrids and cultivars, the rate of gene erosion must be high.

4) There is a lack of local awareness of the crucial importance of maintaining landraces and traditional varieties in local farmer-curator living collections, which authorities should recognize and promote as another important form of germplasm storage.

5) The National Parks and Forest Reserves form natural germplasm stores of utmost importance and must be protected against all incursions. Kakamega Forest and other forests, for example, are being excised for cash cropping and settlements at tremendous risk to genetic loss.

6) There is little evidenced that research is being conducted on germplasm of traditional crops to improve productivity, even by simple varietal selection methods.

7) A coordinated, but decentralized expansion of storage facilities would ensure that germplasm remain in the hands of local farmers, rather than under the control of highly centralized, potentially more bureaucratic and less responsive administrative systems.

8) Kenya lacks a strict legal framework to protect Kenyan germplasm from being collected and expatriated secretly or in an uncontrolled manner, where duplicates are not deposited in Kenyan banks with supporting field data supplied by the collectors.

ISSUE NO. 2: <u>National Coordination of Biotechnology and all Seed-Related Issues</u>

There is a glaring lack of national coordination of seed-related issues. The technical side of breeding for some crops and the legal-regulatory side of seed inspection, certification and release are, in theory at least, well catered for. However, this is true to the extent that seed science remained simple and straightforward. New techniques in biotech, MNC privatization, and marketing, however, call for a thorough re-evaluation of the law and policies. There is a strong need for a body to oversee all issues and activities that impinge on seed--a kind of seed information clearing house and alert-system. The following example should make this need evident.

Biotechnology threatens to introduce revolutionary techniques and products into national economies. This will affect all societies, industrialized and non-industrialized alike, especially the latter which like Kenya depend on a few crops for foreign earnings. Product displacement is now a growing and terrifying reality. In Kenya's case, sugarcane and pyrethrum are cases in point. In addition to the threat, however, there are many far-reaching benefits that Kenya can reap by intelligently harnessing certain aspects of biotech. Yet nowhere in Kenya is there any concentrated effort to understand, to evaluate, and to prepare for the effects and opportunities of biotechnology in our future. This is a major shortcoming.

Related to this is the internationalization of the seed industry and of germplasm. Multinational petrochemical and agribusiness concerns are moving into biotechnology, breeding and seed business. By use of patents and variety protection statues they are establishing new and potentially unjust ways of distributing agri-inputs especially seeds. The impact of this on self-sufficiency of food in Kenya and other Third World countries is worrisome.

There is no evidence that patenting in any form benefits society. There is much evidence that in fact patents raise prices to consumers and retard research and market competition. In a non-industrialized country like Kenya, patents retard technological transfer and help maintain past unfair division of international labour. These and more questions were addressed at the 1981 UNCTAD conference where the Group of 77 stood for the abolition of patenting. They were joined later by some industrial nations like Canada, Australia, Turkey and New Zealand. In plant materials, patenting comes under Plant Breeders Rights (PBR) which claim to protect research and proprietary rights.

In view of this it is most surprising that Kenya has in its books a plant patenting law--Plant Varieties and Seeds Act copied almost word for word from British Legislation. In this Act, PBR are recognized and supported. This can seriously undermine Kenya's interests in seeds and food

production by rendering support to and playing into the hands of the international corporate interests. It seems, however, that the Act is inactive, but the danger of activation is there although it is highly unlikely that Kenya would join UPOV given the current state of knowledge of that organization's unethical ulterior motives and PBR in general.

Kenya is important in international seed circles because of her potential as a seed supplier for Eastern Africa. Kenya is already operative in the production structure of European seed companies as a multiplication and bulking area for various types of seeds. This role may grow. It would not be surprising if some multinational agri-chemical concerns have merger designs for the local seed firms. These concerns lead to the following recommendations:

1) A high-powered agency should be constituted to pave the way for national preparedness and to act as:

   a) an information clearing house on new technology and possible effects;

   b) advance alert system to warn of impending economic changes and opportunities that may affect Kenya's agricultural interests e.g., crop displacement;

   c) coordinator on all germplasm work--collection, conservation, exportation, storage;

   d) study center for state-of-the-art issues in biotech, and seeds and advise authorities on what are necessary steps and actions towards preparedness.

   e) India and Cuba have already started embryonic biotech programmes which we should study intensively in designing ours.

   Biotechnological research is potentially dangerous in that it can produce lethal organisms unknown to nature and humanity. Therefore, extreme caution, coordination, and control in all biotech activities must be a basic ground-rule.

2) It is encouraging that an international infra-sturcture already exists geared towards issues related to transfer of biotechnology, exploring its applicability in the Third World as well as building a global alert system. These provide a beginning point. Some of these organizations

are:

-International Centre for Law in Development (ICLD)
-Council on International and Public Affairs (CIPA)
-United Nations Centre on Transnational Corporations (UNCTC)
-United Nations Centre for Science and Technology for Development (UNCSTAD), especially UNCSTAD's Advance Technology Alert System (ATAS) which publishes the periodical ATAS Bulletin.

Kenya must support these international efforts and side with them at international fora when big-power politics and interests threaten to undermine Third World interests in technology, food, seeds, and germplasm. For example, the United Nations has now moved to create a centre whose primary mandate is to diffuse and disseminate biotech information and R & D in the Third World. The International Centre for Genetic Engineering and Biotechnology (ICGEB) has been formed under the auspices of the United Nation's Industrial Development Organization (UNIDO), although western nations oppose ICGEB (especially the U.S. and Japan) because it is a threat to their biotech monopoly. ICGEB should provide useful countervailing influence against privatization of biotech and seed technology and Kenya must liaise intimately with them while supporting them and others forcefully at international fora.

3) NGOs be sensitized as to the extremely grave nature of bio-revolution and of germplasm loss. This would be as a first step towards galvanizing them and eventually grassroots organizations and people to understand the issues and take what defensive (and where necessary offensive i.e., constructive) actions are necessary for national and local preparedness.

4) Keen NGOs and individuals could profitably be encouraged to carry out direct tasks, symbolic or otherwise, that help build momentum or provide models, e.g., small-scale collections of some threatened germplasm, growing of rare landraces in simple living-collections, pending the building of gene banks.

5) Small projects in biotech can be identified and encouraged. The beauty of biotech is that in some respects it is easy to enter inexpensively. It also allows for seemingly quixotic possibilities to be tried out. A few

that come to mind are:

a) Echinocloa haploclada is a grass species of Kenya's lower altitude's swampy or seasonally-swampy grasslands. It also thrives in riverine ecosystems. It grows rapidly after rains, seeds, and dies back when rains are over. The whole cycle can take less than two months. Most important it has large nutritious grains higher in food content than rice. It seems that by intergeneric breeding as in Triticale (e.g., between Oryza and Echinocloa or any other combination thereof) a novel Kenyan grain can be produced that can grow literally in the wild with minimal cultivation using marginal land. Intrageneric breeding with domesticated Asian Echinocloa millets has also some potential. With bioengineering techniques, the sky is the limit. Although esoteric basic research should be avoided, investigations into possibilities of producing new grains from our graminae by various rDNA methods should be undertaken. Other possibilities are:

b) Wild Setaria can be combined (or bred with) Setaria italica (fox-tail millet). If the resulting grain takes after the wild one even by half the growth properties, most of Kenya's grasslands can grow it. Similarly Nandi Setaria a pasture grass bred or bioengineered into Setaria italica might produce simultaneously rich pasture and copious grain.

c) Wild Eleusine genes can likewise be spliced into Eleusine coracana (wimbi) genomes.

d) Similarly wild sorghum, Panicum and Eragrostis (of Teff fame) should be manipulated.

e) Most interesting is the Pennisetum typhoides (bulrush millet) the most drought resistant of millets. Crossed with, or gene-spliced into, other wild graminoids or Pennisetum species a wide array of possibilities would open up in grain production in marginal lands.

One only needs to observe the prolific productivity (absolute biomass and grain) of wild Kenyan grasslands in the Ecological Zone III to V during the brief period of wetness to grasp the possibilities and the potential benefits of wild grass genes in cereal breeding.

Kenya can pioneer in such research inexpensively. Why not?

ISSUE No. 3: Agroforestry and Rural Afforestation

As concerns agroforestry and rural afforestation a great deal of experience has been accumulated in a brief period and already many projects are under way. These provide good models to learn from and to modify where necessary, especially as concerns seed production, storage, and distribution, as well as training and extension. The localized, decentralized nature of these projects is some insurance for longer survival although questions of continuity after expatriates in charge depart remain a concern and must be addressed now.

It must be recognized that agroforestry is a form of farm production of wood products. It is therefore an economic activity. While ecological parameters or suitability and crop-tree compatibility must be considered, the primary goal is productivity (biomass) at minimal cost. Care must therefore be taken not to over-romanticize indigenous species without reference to economic considerations, e.g., rate of growth and biomass production. By the same token, some recent exotic introductions may prove weedy in some ecosystems. Algaroba (essentially a mesquite) in lower Tana shows such tendencies where bovines browse the pods and disseminate seed far and wide.

Finally, it has become evident while carrying out this enquiry that it is often the individual plant enthusiast who galvanizes or catalyzes planting and seed-collecting activities and makes the difference between success or failure in a project. KENGO's and others' experience corroborate this. Such individuals are retired forest nursery keepers, school teachers and headmasters and church leaders. Given encouragement and initial guidance, it seems there is a fund of unexploited initiative that could be harnessed, especially now that retirement at an early age is releasing such talent and experience.

Following are examples of such individually catalyzed projects:

Simenya Primary School (Siaya) - Headmaster
Khayega project near Kakamega - Late Mr. Shitaka
a retired forest worker
Tigithi Primary School (Muranga) - Mr. Marura
Kariaini Nursery (Laikipia) - Mrs. Naomi Wambui
Fudumi Farm - Chavakali - Dr. Wanje
Maseno Diocese project - Church leaders,

In other crop and food experimentation and development this individual catalyst method seems to recommend itself

eminently in creating models and centres of innovation and diffusion.

It is important to keep in mind while planning for the symposium that a primary objective is to harness and enhance Kenya's strengths and resources to create self-sufficiency in all spheres and at all levels.

There exists here a tremendous amount of traditional knowledge on plants and seed which is at risk of getting lost if not recorded and used. Further, there is much scientific talent in Kenya. With appropriate leadership, and a climate of free exchange of ideas, this talent can be moulded into a dedicated and creative cadre of indigenous professionals. Ultimately, achievement of goals discussed in this paper is dependent on active cooperation between professionals and local people at the community level.

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Appendix i.

Wild plant resources - Wild berries, fruits and nuts play a very large part in Turkana diet, while other parts of plants may also be used: leaves boiled or chewed, roots eaten fresh or cooked, stems and gum chewed, bark infused to make tea, flowers sucked or eaten, pods of Acacia tortilis eaten fresh or dried. Morgan (1980) lists 47 species that are used more or less regularly in these ways and Gulliver gives 14 fruits, nuts or seeds which he regards as 'main food', apart from those casually consumed on the spot, some of which, such as esekon, (Salvadora persica), may be used in large quantities. The significance of wild products is emphasized by the preparation required to make some of them edible - for at least six species the fruits need to be boiled several times. Major contributors to diet in various areas are edome, (Cordia sinensis), egoli, (Doum palm), erdung, (Boscia coriaceae), edapa, (Dobera glabra) and erpat, (Terminalia spinosa).

Products may be eaten immediately, fresh or cooked, or pounded up into a kind of meal, sometimes mixed with blood, for storage. Many of the wild plant resources are available in the dry seasons when other food is at a minimum.

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CHAPTER 326

1 of 1972.

THE SEEDS AND PLANT VARIETIES ACT

Commencement: 1st January, 1975

An Act of Parliament to confer power to regulate transactions in seeds, including provision for the testing and certification of seeds; for the establishment of an index of names of plant varieties; to empower the imposition of restriction on the introduction of new varieties; to control the importation of seeds; to authorize measures to prevent injurious cross-pollination; to provide for the grant of proprietary rights to persons breeding or discovering new varieties; to establish a Tribunal to hear appeals and other proceedings; and for purposes connected with and incidental to the foregoing

PART I—PRELIMINARY

Short title.

1. This Act may be cited as the Seeds and Plant Varieties Act.

Interpretation.

2. In this Act, unless the context otherwise requires—

"authorized officer" in connexion with any provision of this Act, means a public officer authorized by the Minister by notice in the Gazette to exercise the functions specified in such provision;

"compulsory licence" means a licence granted by the Minister under section 23 of this Act;

"the Index" means the index of names of plant varieties prepared under section 7 of this Act;

"Minister" means the Minister for the time being responsible for matters relating to agriculture;

"plant breeder's rights" means rights granted under section 17 of this Act;

"plant variety" means an assemblage of cultivated individuals which are distinguished by any character (morphological, physiological, cytological, chemical or others) significant for

additional kinds of crop or plants, whether grown or self-sown and whether of those or any other types or varieties, as may be specified in such order for the purposes of this definition;

"the occupier", in the case of unoccupied land, means the person entitled to the occupation of the land;

"protected crop" means a crop of a type or variety of plant which is protected by an order in the area concerned, being a crop grown for the purpose of producing seeds.

PART V—PLANT BREEDER'S RIGHTS

Grant of plant breeder's rights.

17. (1) Rights may be granted in accordance with this Part in respect of plant varieties of such species or groups as may be specified by a scheme made by the Minister under this Part.

(2) Subject to this Part, plant breeder's rights shall be granted by the authorized officer if he is satisfied that the conditions laid down in section 18 of this Act are fulfilled.

(3) The Third Schedule to this Act shall have effect for the protection of an applicant for plant breeder's rights pending a decision on his application.

(4) Before making a scheme, the Minister shall consult representatives of such organizations as he deems to have a substantial interest in the matter to be regulated and of such other interests as appear to the Minister to be concerned, and any scheme—

(*a*) may make different provision for different species or groups of plant varieties;

(*b*) may contain such supplemental, incidental and transitional provisions as appear to the Minister to be appropriate;

(*c*) may be varied or revoked by a subsequent scheme,

so, however, that the variation or revocation of a scheme shall not prejudice a grant of plant breeder's rights made before the variation or revocation takes effect.

Conditions for grant of rights.

18. (1) The conditions laid down in this section must be fulfilled as respect both the applicant for plant breeder's rights and the plant variety to which the application relates.

Appendix iii.

BIOTECHNOLOGY

TABLE 1: Some Recent Seed Company Acquisitions and Characteristics of Acquiring Firms

Acquiring Company:	Seed Subsidiaries	In-house Biotech:	Biotech Venture Firm Interests:
ARCO	Dessert Seed Co	X	IPRI Ingene Bioengineering Center
Celanese	Celpril, Inc Moran Seeds Joseph Harris Seed Co.	X	
Ciba-Geigy	Ciba Geigy Seeds Funk Seeds Louisiana Seeds Hybridex	X	
FMC Corporation	Seed Research Associates	X	Centocor Immunorex
Monsanto	Farmers Hybrid Co.	X	Genex Biogen Genentech Collagen
Occidental Petroleum	Ring Around Products Excel Hybrid Missouri Seeds Moss Seeds	X	
Pfizer	Trojan Seed Co. Jordan Wholesale Co. Clemens Seed Farms Warwick Seeds	X	
Sandoz	Northrup King National N-K McNair Seeds Gallatin Valley Rogers Brothers Ladner Beta	X	Zoecon
Shell	North American Plant Breeders Nickerson Seed Co. Agripro, Inc. Tekseed Hybrid	X	Cetus
Stauffer	Stauffer Seeds Blaney Farms Prairie Valley	X	
Upjohn	Asgrow Seeds Associated Seeds	X	

Appendix iv.

Table 2. *A Comparison of the Institutional Structures of the Green Revolution and Biorevolution*

Characteristics	Green Revolution	Biorevolution
Crops affected	Wheat, Rice, Maize	Potentially all crops, including vegetables, fruits, agroexport crops (e.g. oil palms, cocoa), and specialty crops (e.g. spices, scents)
Other products affected	None	Animal products Pharmaceuticals Processed food products Energy
Areas affected	Some LDCs; some locations (i.e. if accompanied by irrigation, high quality land, transport availability, etc.)	All areas; all nations all locations, including marginal lands (characterized by drought, salinity, Al toxicity, etc.)
Technology development and dissemination	Largely public or quasi-public sector	Largely private sector (multinational corporations and start-up firms, with the former predominating in terms of commercialization)
Proprietary considerations	Patents and plant variety protection generally not relevant	Processes and products patentable and protectable
Capital costs of research	Relatively low	Relatively high
Research skills required	Conventional plant breeding and parallel agricultural sciences	Molecular and cell biology expertise plus conventional plant breeding skills
Crops displaced	None (except the germplasm resources represented in traditional varieties and land races)	Potentially any

Appendix V.

There are ten private or cooperative seed production organisations. Their addresses and the crops they handle are given below:

MAJOR SEED-PRODUCING ORGANIZATIONS IN KENYA, 1980

Organisation	Species
Kenya Seed Co. Ltd. P.O. Box 553 Kitale	Maize, small cereals, sunflower, rapeseed, grasses, sorghum
Njoro Seed Co. Ltd. P.O. Box Molo	Wheat, barley
Agricultural Development Corporation P.O. Box 556 Nakuru	Potato
Hortiseed Kenya Co. Ltd. P.O. Box 30472 Nairobi	Beans, horticultural crops
East African Seed Co. Ltd P.O. Box 45125 Nairobi	Beans, horticultural crops
Simpson and Whitelaw P.O. Box 40042 Nairobi	Horticultural crops
Ideal Seed Company Ltd. P.O. Box 43374 Nairobi	Beans, horticultural crops
Mount Kenya Agro-Industries P.O. Box 161 Kiganjo	Potato, beans
Jardinage P.O. Box 59317 Nairobi	Horticultural crops, beans
Kenya Highland Seed Co. P.O. Box 322 Naryuki	Beans

Appendix vi.

Genetic research timetable for key crops – Predictions

	Identification, duplication and modification of agriculturally important genes	Routine growth of plant tissue in laboratory culture conditions	Growth of first genetically transformed whole plant	First plants altered by new technology available to breeder for commercial production	Growth of transformed plants on a routine basis
Major cereals					
Corn	now (zein, early maturity genes)	now	early 1990s	now	mid-1990s
Wheat	1985 – 1987	now	early 1990s	1984 – 1986	mid-1990s
Rice	1985 – 1987	now	lat 1980s	now	early 1990s
Barley	now (hordein. powdery mildew resistance genes)	now	1986 – 1988	1985 – 1987	early 1990s
Sorghum	1987 – 1989	1984 – 1986	early 1990s	1988 – 1990	mid-1990s
Oil seeds					
Soybean	now (nitrogen fixation genes)	now	early 1990s	1988 – 1990	mid-1990s
Oil palm	1988 – 1990	now	late 1990s	now	after 2000
Sunflower	1985 – 1987	1984 – 1986	now	1984 – 1986	1986 – 1988
Oilseed rape	1984 – 1986	now	late 1980s	now	early 1990s
Forages					
Alfalfa	1986 – 1988	now	1985 – 1987	now	early 1990s
Red clover	now (nitrogen fixation genes)	now	early 1990s	now	mid-1990s
Vegetables					
Tomatoes	1984 – 1986	now	1983 – 1985	now	1986 – 1988
Lettuce	1985 – 1987	now	late 1980s	1983 – 1985	early 1990s
Cucumer	1986 – 1988	1983 – 1985	mid-1990s	1985 – 1987	late 1990s
Onion	1986 – 1988	1984 – 1986	early 1990s	1984 – 1986	mid-1990s
Potato	now	now	1983 – 1985	now	1986 – 1988
Carrot	1983 – 1985	now	1983 – 1985	now	1986 – 1988
Beans	now (phaseolin)	1984 – 1986	1986 – 1988	1985 – 1987	early 1990s
Peas	now (vicilin, legumin)	1984 – 1986	mid-1990s	1985 – 1987	late 1990s
Brassicas	1983 – 1985	now	late 1980s	now	early 1990s
Grasses					
Kentucky Bluegrass	late 1980s	1985 – 1987	mid-1990s	1986 – 1988	late 1990s
Orchard-grass	late 1980s	1985 – 1987	mid-1990s	1986 – 1988	late 1990s
Woody plants					
Fruit, nut and ornamental trees	mid-1990s	1986 – 1988	late 1990s	early 1990s	after 2000
Forest trees	mid-1990s	now	lat 1990s	early 1990s	after 2000
Specialty crops					
Sugarbeets	1985 – 1987	now	early 1990s	1987 – 1989	mid-1990s
Sugarcane	1987 – 1989	now	early 1990s	now	mid-1990s
Cotton	1985 – 1987	now	early 1990s	1983 – 1985	mid-1990s
Tobacco	now	now	1983 – 1985	now	1986 – 1988

BAOBAB FARM LIMITED Appendix VII.

TREE SEED : PRICE LIST

Name of Tree	Price/100g	No of seeds/100g
Prosopis juliflora F^1	Kshs 150.==	3,000
Prosopis juliflora F^2	Kshs 200.==	3,000
Prosopis pallida	Kshs 300.==	3,000
Leucaena leucocephala K^8	Kshs 75.==	2,000
Leucaena leucocephala K^{28}	Kshs 75.==	2,000
Azadirachta indica	Kshs 20.==	400
Casuarina equisetifolia	Kshs 300.==	50,000
Conocarpus lancifolius	Kshs 250.==	60,000
Winged Beans	Kshs 60.==	280
Prosopis pods	Kshs 300.==	1 bag
Algaroba seedlings	Kshs 3.==	per plant

19/9/84

Appendix viii.

The major producers of agricultural chemicals in the world (1978)
(1978)

Company	country of origen	turnover of agricultural-chemicals (x 10^6 US$)	fertilizer producer	new seed producers (x10^6 SF)
Bayer	W-G.	1480	x	x
Ciba-Geigy	Swi	1090	-	241 (1977)
Shell	Neth/UK	655	-	xx
Monsanto	USA	605	x	xx
ICI	UK	515	xx	x
Rhône-Poulenc	Fr	465	xx	xx
BASF	W-G	450	xx	x
Dupont	USA	400	?	?
Stauffer	USA	380	x	x
Eli Lilly	USA	336	?	?
Dow American	USA	335	-	?
Cyanamid	USA	325	x	?
Union Carbide	USA	320	x	xx
Kumiai	JAP	279	?	?
FMC	USA	260	-	xx
Schering	USA	213	-	?
Hoechst	W-G	210	x	x
Rohm & Haas	USA	204	-	xx
Sandoz	Swi	162	-	464 (1977)
Roussel-Uclaf*	Fr	161	-	?
Diamond Shamrock	USA	145	x	xx
Sumitomo	JAP	120	x	?
Velsicol	?	110	-	?
Montedison	IT	97	xx	?

* = 50,2% Hoechst
x = prominent producer
xx = extremely prominent producer
- = no producer
? = unknown.