

AFFORESTATION OF ARID AND SEMI-ARID LANDS

FINAL REPORT OF THE LAND PRODUCTIVITY GROUP

SECTION ARID & SEMI-ARID LANDS

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FOREWORD

Summery

This is the final report of the ASAL afforestation work group. It is a compilation of the former reports and additional findings.

The working group «Afforestation of Arid and Semi-Arid Lands» is geographically restricted to lower altitude and low available moisture zones of Kenya, which can also be described as the agricultural lowpotential areas of the country. The definition of Arid and Semi-Arid follows the Agro-Ecological Zones classification of FAO, 1987 and elaborated by Jätzhold et al in the Farm Management Handbook of Kenya. In its simplified form it combines temperature and available moisture. Temperature in the map units directly relate to altitude, which makes the system less reliable because moisture availability is also related to elevation above sea level. For planning purposes the system is usable.

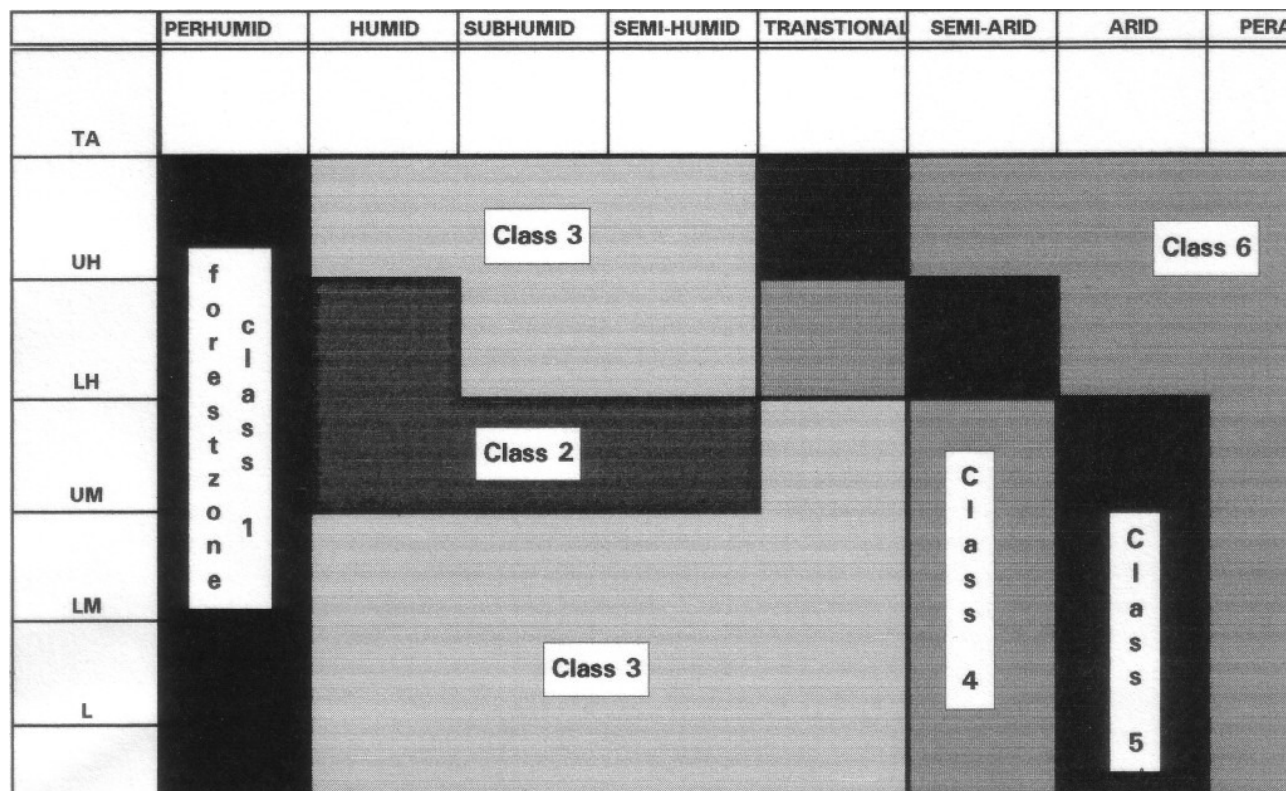


Figure 1. Agro-Ecological Zones

The report describes the general climatic properties, its restrictions, the main land use and utilization systems, the possibilities for development and the constraints.

Predictions of economic trends and growth of population are accordingly to the general accepted scenarios by the KFMP. Distinction in development is made for different target groups and accordingly project profiles given. Special emphasize has been given to cottage industry development for the village level and larger scale plantation forestry for energy production. On national level a proposal for a rotational afforestation credit fund for farmers and farmers' associations has been worked out in more detail.

Additional information is given in annexes. Annex 1 gives species profiles of trees mentioned in the text and important drought-resistant and multipurpose trees, suitable to plant in ASAL. The descriptions are mainly drawn from the ICRAF **MULTIPURPOSE TREE & SHRUB DATA-BASE**.

Annex 2 gives a summary of the status of the twenty-seven most important ASAL districts as distilled from the District Master Plans, the Districts Development Plans and the visits to the Districts' Forest Service Headquarters.

MAIN REPORT

BACKGROUND INFORMATION

General information

The Arid and Semi-Arid zones cover about 85 % of Kenya. Their main characteristics can be summarized in the following table:

CRITERIA	AEZ: VII	AEZ: VI	AEZ: V	AEZ: IV
A. CLIMATE				
1. Rainfall (annual average [mm])	200-300	300-500	500-700	700-850
2. Rainfall (50% probability 1st season [mm])	-	100-200	150-200	250-350
3. Rainfall (50% probability 2nd season [mm])	-	50-150	150-200	250-350
4. Rainfall/evapo-transpiration [%]	15	15-25	25-40	40-50
B. POPULATION				
1. Permanent immigration	Negligibly	negligibly	Low	High
2. Seasonal migration	Very low	Low	Moderate	Very high
3. Return migration	Very low	Low	Moderate	Very high
4. Growth	Very low	Low	Moderate	Very high
5. Density	Low	Medium	High	Very high
C. LAND USE TRENDS				
1. Sedentarization of pastoralists	Moderate	Moderate	Prominent	Prominent
2. Conversion of dry season grazing to cultivation	Prominent	Prominent	Prominent	Completed
3. Land privatisation	Beginning	Beginning	Increasing	Completed
4. Displacement of pastoralists	Prominent	Prominent	Moderate	Moderate
5. Effects from land use changes in highland areas	Very Low	Low	Moderate	High
D. CONFLICTS				
1. Land use conflicts in key areas	Very severe	Severe	Moderate	Low to moderate
2. Wildlife/agriculture	Moderate	Moderate	Severe	Severe
3. Wildlife/livestock	Moderate	Moderate	Serious	Serious
E. RENEWABLE RESOURCES				
1. Water resources	Very poor	Very poor	Poor	Ample
2. Vegetation	Shrubland	Bush & shrubland	Bushland	Dry wood- & bushland
3. Wildlife	Abundant	Abundant	Reasonable	Moderate
F. PRODUCTION POTENTIAL				
1. Livestock production	Very high	Very high	High	Moderate
2. Tourism	Moderate	High	High	Moderate
3. Annual Crop production	Very low	low	moderate	High
4. Perennial crop production	low	low	moderate	high
5. Plantation forestry	low	moderate	high	high
6. Key production areas	very few	few	few	Abundant
G. NEGATIVE ECOLOGICAL IMPACT				
1. Overgrazing in key areas	Moderate	Moderate	high	very high
2. Over use wood resources	Moderate	Moderate	High	High
3. Degradation in key areas	Very high	Moderate	Moderate	High
4. Over use water resources	Very high	High	Moderate	Moderate
5. Pollution by chemicals	Very low	low	Moderate	High

Table 1. Summary of characteristics and socio-economic Status of ASAL.

Traditional landuse

Traditionally there are 3 important landuse systems, namely: gathering-hunting, animal husbandry (livestock and wildlife) and farming. The way of using the natural environment and its resources has always been a result of the climatic and edaphic conditions and the capacity of man to overcome those handicaps.

Livestock husbandry

The second landuse system: animal husbandry is nowadays the most important for the natural semi-arid and arid rangelands as far as number of people involved. Pastoralists copied the seasonal migration pat terns of the large herbivores in search of green grass and water. During wet periods the animals disperse over the range, while during the dry periods they concentrate around permanent waterholes, rivers, lakes or in sub-humid to humid zones on higher elevations.

As the pastoralists were depended on their restricted resources, they had a very well balanced management system. Not only for the rangelands but also for their shambas and woodlots. The Turkana for example have a grazing control system, in which the rangeland is geographically divided in sections or ekitela. Those sections are subdivided in grazing associations or adakars. Usufruct is linked to users of the same adakar but in practice are held by families who use the same ere or wet season grazing area. In the ere the Tainted shambus are situated and the ekwar or woodlots in floodplains and riverine forests. Those woodlots provide the necessary fodder during the dry season. Within the wet season grazing area or ere a herd owner has the right to use the ekwar. The produce of this woodlot belongs to only the owner, and he will protect the trees against damages. Land tenure is a reflection of the management of the natural resources. Although there must be many more example of traditional well balanced utilization and management of trees and forests, this example serves its purposes to call attention to the fact that the traditional land-user is not ignorant in his own environment. Only drastic socio-economic changes can bring him out of balance.

Wildlife utilization

In terms of economic return, a derivation of the gathering-hunting landuse system: wildlife utilization takes the first position. The type of utilization is non-destructive, because hunting has been banned and the large game animals are now only watched within their natural habitat. As the majority of wildlife consists of large grazers, they are the main competitors for natural resources to domestic ruminants. For this reason the highest densities are within protected areas (national parks, game reserves, etc.), not only because man wanted to protect them against encroaching farmers and pastoralists, illegal hunting, but also because the animals are hardly tolerated outside those areas. In semi-arid land, closer to the larger human settlements, wildlife utilization in the form of cropping or culling is practiced on a small scale. Although the idea behind the utilization of wildlife for commercial meat production is sound, the problems are with the harvesting of the meat and the marketing of the product.

Rainfed farming

In the semi-arid zone, rainfed farming of annual crops has been practiced on a small scale and mostly in a nomadic way, where before the rainy season the land was cleared of the natural vegetation by cutting and burning, the land was used a few seasons and then left to restore its natural vegetation cover and with it the fertility of the soil.

PRESENT STATUS

The actual socio-economic and ecological status of the arid and semi-arid land is in its generality assumed to be bad. This assumption is mainly based on spot observations of degradation along motorable roads and around settlements.

District	year	Nr plots	Trees m ³ /ha	Shrubs m ³ /ha	Year	Nr plots	Trees m ³ /ha	Shrubs m ³ /ha	Change m ³ /ha	timespan
Narok	1991	731	7.60	2.39	1978	677	1.66	0.32	0.63	13
Lamu	1989	287	6.46	2.87	1978	308	2.16	0.67	0.69	11
Kitui	1990	1316	6.40	2.09	1978	1159	1.69	0.80	0.61	12
Gerissa	1988	1836	4.24	3.40	1978	1161	0.84	1.92	0.48	10
Kilifi	1989	632	3.88	3.24	1978	466	2.47	1.66	0.27	11
Tone	1990	1683	1.67	3.31	1978	1684	0.92	0.74	0.27	12
Machakoa	1990	646	4.46	1.39	1986	688	2.36	2.26	0.26	6
Kajiado	1991	816	2.14	1.77	1978	903	0.82	0.26	0.22	13
Mendera	1990	1033	7.28	2.86	1978	842	0.47	1.31	0.20	12
Pokot	1990	341	4.60	2.83	1987	376	4.41	2.64	0.19	3
Wejir	1990	2922	0.62	2.77	1978	2186	0.42	0.81	0.17	12
Teita-Taveta	1991	702	1.70	2.17	1978	711	1.44	0.66	0.14	13
Maraebit	1990	1877	0.18	1.79	1978	3444	0.12	0.44	0.12	12
Isiclo	1990	1106	0.66	2.38	1978	1118	0.64	0.98	0.12	12
Kwele	1989	321	2.09	3.24	1978	266	2.89	1.29	0.11	11
Laikipa	1990	417	3.99	1.73	1987	392	3.32	2.16	0.08	3
Turkana	1990	2430	0.99	1.80	1987	1942	1.17	1.99	-0.13	3
Baringo	1990	461	6.40	2.67	1987	479	6.24	2.37	-0.18	3
Samburu	1990	1003	2.10	2.61	1987	933	6.02	2.17	-1.16	3
Total/AVG		20368	2.39	2.48		19620	1.40	1.14	0.16	

Table 2. Biomass changes of woody vegetation in ASAL Districts.

Those observation are with certainty biased. Rainfall indeed is low and also erratic, and this has been the case for a long time. Degradation of soil and vegetation is directly related with concentration of human and animal population, therefore highly related to existing infrastructure as roads and water points. To extrapolate those findings and conclude that the arid zones are degraded might not be true.

The woody component of the vegetation.

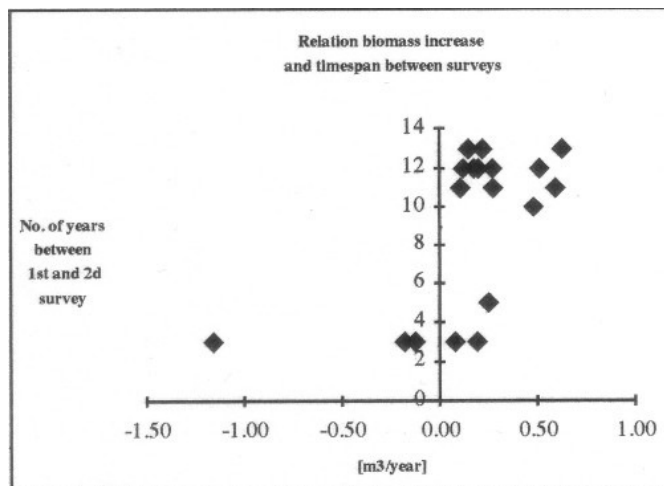


Figure 2. Relation between biomass change & time span between surveys.

According to the aerial surveys, done by DRSRS in 1978, 1985, 1987, 1988 and 1990/91 no significant degradation has been observed, except in Baringo, Samburu and Isiolo. The result of the analysis of the surveys might be insignificant, because a rather strong relation exists between change of woody biomass and the time lapse between the surveys as is shown in Figure 2. The high decrease of Baringo, Isiolo and Samburu might have occurred during the last three years, but this implies that in the seven-odd years before that the woody biomass was in fact increasing a lot, because the average change is practical negligible (See Table 2). The most important user of the vegetation are domestic and wild herbivores. The range of domesticated grazers is not very wide but they cover almost the whole spectrum of available food resources: cattle and sheep use the ground cover of mainly grasses and herbs, camels are high browsers and goats eat everything at all levels. Therefore livestock is a direct competitor with wild grazers for available vegetation and drinking water, which means that increase in livestock density result in a proportional decrease in wild grazers. The total biomass of wild grazers shows however hardly any fluctuation during the period 1920 - 1989 which might be cause by unreliable counts.

Population trend for 1990 - 2015

Although the total population of Kenya will continue to increase in a progressive way, the prediction is that towards the end of the century the rate will slightly decrease. Following the by the KFMP accepted JICA National Water Master Plan projection procedure based on the provisional 1989 Census Data, the population growth trend shows a slow increase of rural population and high urbanization of mainly Mombasa and Nairobi.

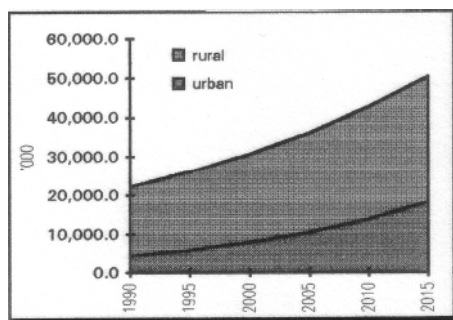


Figure 3. Population trend 1990-2015

Fuelwood demand and supply

Availability of fuel-wood will become a major problem if we assume that the main energy source in Kenya will not switch to fossil energy resources. Assuming an increase in energy needs, proportional to the expected increase in population, the total demand for wood fuel will almost increase 2,5 times in the next 25 years. Considering a steady supply of 20,4 million m³, the national deficit is estimated to reach 10 million m³ in 2015. However, 2/3 of the

demand is rural and the national policy is to increase on-farm wood fuel production for self subsistence, and the local market.

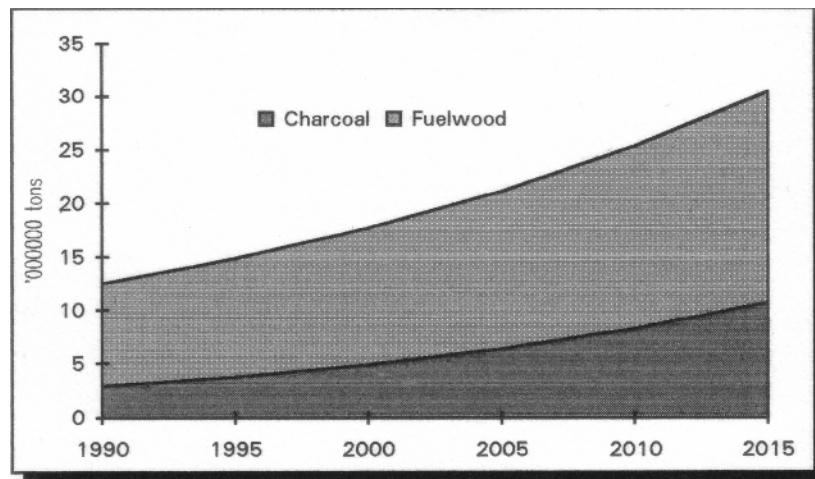


Figure 4. Future wood-fuel consumption trend.

Urban areas will have a deficit of 3,3 million. Even if the production of firewood can be optimized to 60 m³/yr/ha Kenya will need an additional area of 550 km² of efficiently managed plantations. The largest urban markets are situated in the high potential and coastal zones of Kenya, where restrictions for production are mostly economic. In perspective of pollution of the urban environment firewood and charcoal are not appropriate fuels. Therefore a change towards cleaner fuels have to be taken in consideration. The Coastal zone has less possibilities for intensive production of wood fuel.

Constraints for development

Apart from climatic and edaphic constraints as shortage of water, high temperatures and low fertility, restrictions for development are mainly socio-economical. Non-institutional constraints relate to lack of awareness of the population, land tenure system, lack of interest in tree planting by pastoralists, bad roads, fire hazard, lack of labor and adverse climate. In Figure 6 constraints mentioned by DFO's are visualized in a graph and ordered according to their rank of importance, expressed in percentages.

Climatic and edaphic constraints

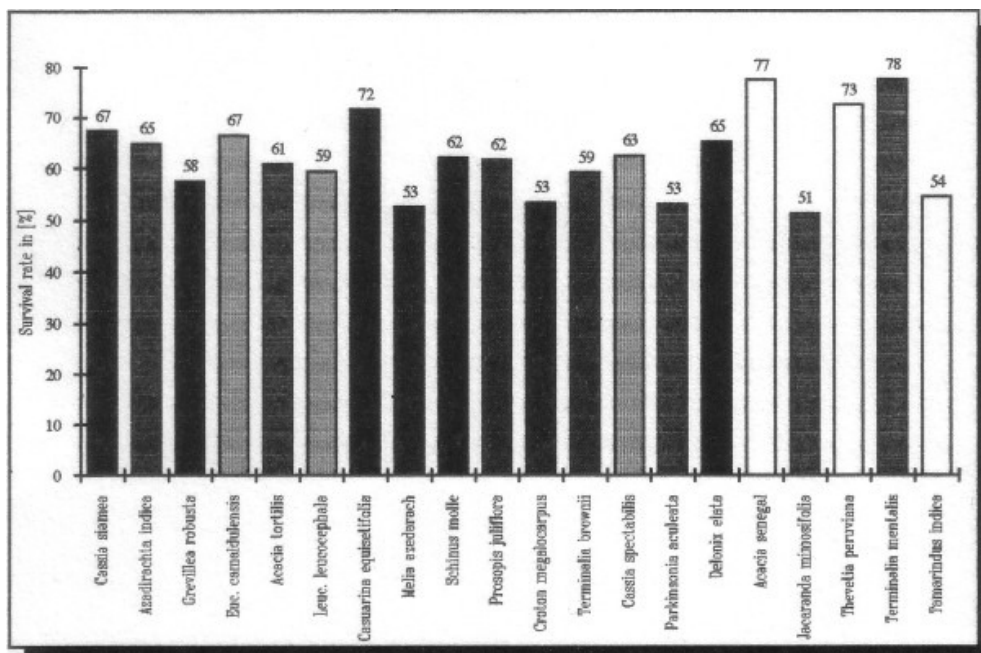


Figure 5. 20 most preferred tree species in digressive order (X-axis) and their survival rate (Y-axis).

ASAL, per definition, offer difficulties to grow high yielding trees under short rotation cycles. Only in key areas, where open or artesian water is available such tree crops can be grown. Water, however, is a scarce resource and will always compete with other uses: drinking water and water to irrigate annual crops. Growing trees under those conditions needs a significant initial investment in terrain preparation and if gravity irrigation is used in irrigation equipment. Depending on the local market and the expected price for the product (wood, by-products, secondary products) the farmer has to decide how much he wants to invest. Low input plantation forestry, however, is possible where under natural conditions trees grow. Proper terrain preparation to improve water infiltration, correct choice of species, proper nursery and planting techniques and management of the plantation (woodlots, wind belt, etc.) can avoid excessive costs for watering during the whole rotation cycle. Unfortunately the farmers' preference for tree species is often based on site conditions of sub-humid and humid zones.

Figure 5 visualizes the survival-rate expressed in percentages of the 20 most referred tree-species in ASAL Districts. It shows that the most preferred trees don't have the highest survival rate.

Operational weakness of the FDO's.

Institutionally the Districts' Forest Offices are very weak if no exploitation is carried out in the District or no international funded projects are present. There exists a categorical lack of operational funds and material to carry out the planned activities. Also the offices are understaffed or the staff is not sufficiently schooled. The Districts' Forest Offices suffer mainly from lack of operational means and schooled personnel to carry out their planting program.

Land tenure

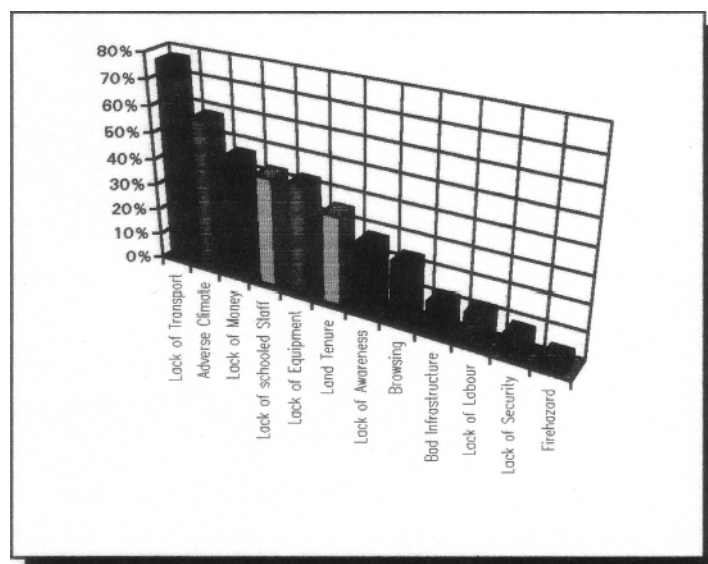


Figure 6. Restrictions for planting activities of Forest Department Offices in ASAL Districts.

The traditional land tenure system reflected a well adapted farming system, while the people were totally dependent on their environment. This is no longer the case. With help from outside they managed to free themselves from the population regulating dynamics of Nature. Therefore and also for the needs of modern society the old system is no longer desired and will have to change into a system of sedentary husbandry and agriculture. Such a process, because of the resistance met, will take time. Eventually it will come with accelerating pace, not in the least because of the temptations of the western consumer's society. The Forestry Master Plan will deal with the next 25 years, i.e., with one generation. The process of sedentarization has already started and at the end of that period of 25 years might be halfway.

It is however unthinkable that total sedentarization will be completed, unless by force and therefore the Master Plan should deal with the fact that the extensive rangelands will be the longest under communal ownership and should be treated as such.

The arrival of a cash economy has of course a dramatic influence. Resistance, however, to total acceptance has been great up to now. The pastoralist makes use of it in an opportunistic way and mostly only in time of dire needs, but as soon as possible he will return to his traditional way of life. Slowly but surely, however, they become dependent on the benefits of a cash economy and this implies a trend towards sedentarization and together with that a change in land-use: more farming and sedentary cattle ranching.

The traditional land tenure system didn't include activities as replanting or enrichment planting but had rules for exploitation of the vegetation. As population pressure increased and new boundaries impeded movement of the herds, over-utilisation resulted and rules guaranteeing rational utilization grew slack.

Today the traditional land tenure system is hampering the tree planting program, because farmers don't feel secure enough to invest much in the land, from which they feel they might be expelled anytime. Also they don't feel that the trees they plant are theirs and might be cut down or browsed by others. In Semi-Arid Zones, with the presence of modern large-scale farming, settlement schemes, irrigation projects and increasing population, land adjudication is more advanced. In most Semi-Arid districts 50 to 75 % of the land is adjudicated and the process is still continuing. From the districts in Sub-Humid zones, most of land is freehold.

Livestock husbandry and overstocking problem.

For the ASAL areas the two most important landuses are wildlife utilization (mostly in the form of tourism) in side protected areas and livestock utilization in the rest. Most of the ASAL Zones in the 27 districts are inhabited by pastoralists. The increasing competition between farmers, pastoralists and wildlife has increased pressure on the existing vegetation. Overstocking in relation to the grazing capacity is the major danger for deterioration of the rangelands, as explained by IPAL:

..The human population is increasing both in total numbers and in localized densities due to settlement or sedentarization. Pastoralists who become sedentarized usually move some of their livestock into the settlements with them, since they often have no alternative source of subsistence. While nomadic use of the desert pastures allows for rest and recovery between periods, this is not possible in a settled situation and the vegetation suffers and becomes depleted. Continuous grazing and trampling lead to a change in plant composition and the reduction of palatable species to flourish. Eventually even these are reduced and the soil surface is exposed to accelerated erosion. In areas where the depth of soil is shallow, permanent changes occur which prevent the recovery of the original forage plants...

While the densities of cattle has been increasing progressively of the last 60 years it seems that the rate is slowing down in the last decade. As stocking capacity of the rangelands is in direct relation to the amount of digestible biomass, which in its turn is direct related to the available moisture, one could conclude that the stocking rate is equal to the capacity. However, no data are available on status of the wild herbivores, who are the main competitors for the same resources.

Most studies, thus, point out that overgrazing and degradation of the soil occurs not on all of the rangeland, but specifically around settlements. Those are also the best place to concentrate on with forestry projects, either concerned with restoration of the vegetation, improving the fodder or fuel wood situation, or soil and water conservation.

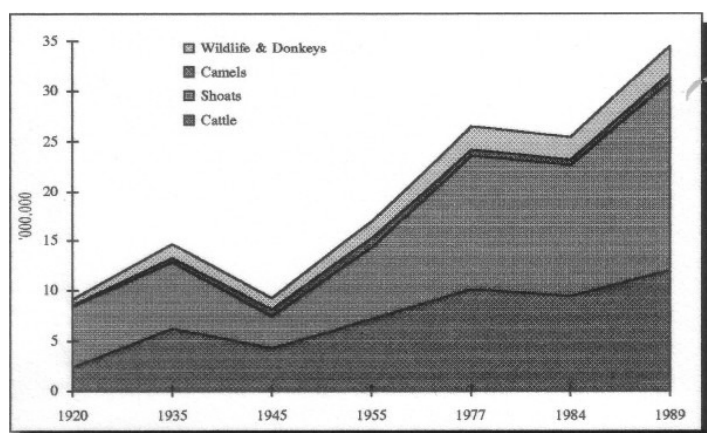


Figure 7. Trend of livestock density from 1920 - 1989.

As the highest pressure on the environment will occur during the dry seasons, when herds are concentrated around the permanent watering holes, such as the Loima Hills and rivers, it is only logical that symptoms of degradation are most significant at those places. Efforts to reverse degradation will also be more effective at these places. Not only because of the permanent presence of people, but also because of the presence of water or better ecological conditions (mist forest on Loima Hills). People seeking relief from famine in the larger settlement such as *Lodwar* are approached and employed in the Food-ForWork (FFW) planting programs. In total there have been over 3000 ha planted during 15 years.

Remedies for constraints

If Kenya will comply with the global strategy of rational utilization of natural renewable resources, conservation of biodiversity, and at the other hand wants to provide land for the landless and be self sufficient in feeding its population, the only way will be to increase productivity in areas with a high potential, and at the other hand diminish pressure on the low potential areas.

Conservation of bio-diversity should include all living beings and not only genotypic but also phenotypic aspects. This means that peoples, living in, and depending on natural ecosystems should have the chance to continue to do so, especially because they still know how to utilize their environment in a rational way. Proper land use planning can avoid competition for space. Such planning should be based on the land use classifications existing.

The legislative framework is of the utmost importance. Policies and laws, concerned with the marketing, growing and protection of trees, are setting the boundaries for «playroom» of the individual farmer and rural communities. Policies concerning land-use management, agricultural development, forestry, conservation of nature should be complementary in time and space. Laws should be in line with the policies.

Tree planting practices and nursery techniques

For arid and semi-arid zones the main restrictive factor is the availability of moisture. Survival of trees in those harsh environments depends on various production factors. They mainly concern terrain preparation, nursery techniques, planting practices and proper choice of tree species. In arid and semiarid zones available moisture is the main constraint. Even very drought hardy trees-species need water. Especially during the juvenile stage the young plants are dependent on hang-water and direct precipitation. Initial above-soil growth is mostly very limited, because all energy goes into the development of the root-system.

It is not always acknowledged that the visual part of the tree represents only one-half of its total biomass. Trees growing in arid zones have probably more invisible (underground root-system) than visible (stem and crown) biomass. The growth of hair-roots is a continuous process, and they can penetrate depths of over 30 meters searching for water and minerals.

Proper development of the root-system during the nursery period, terrain preparation and correct planting methods are crucial for the survival of young trees in the field. Water infiltration improving techniques as building of structures as micro-catchments, terraces etc., have widely been used in Africa and the techniques are well-known, but are not everywhere practiced in Kenya. Too much emphasis is given to put continuous hand watering during the juvenile stage. Under ASAL condition this might lead to under-development of the root system, as it prevents the roots from growing downwards to subsoil water, either phreatic or in hang-water profile. Better large quantities of water once a month, than small quantities each day.

Propagation techniques have to be chosen with keeping the best root-system development in mind. Natural regeneration, either from seed or vegetative, guarantees the best root-system. The second best option is to dig up wildlings or use cuttings. Modern nursery techniques using plastic containers should be the last option.

PAST TRENDS

Rehabilitation of rangelands.

During the last decades several attempts have been made to improve the quality of the ASAL rangelands by rotational ranching, block grazing and enrichment planting. Most of these efforts have failed because the measures were imposed on the local population and didn't include their participation. The traditional division of the rangeland by pastoral tribes has proved to be best adapted to the natural circumstances in the long run.

Crisis relief.

Drought has forced pastoralists to seek relief from hunger and has resulted in concentrations of sedentarized nomadic people around settlements as Lodwar, Mandera, Garissa, Isiolo. Rapid deterioration of the environment has been caused by those impromptu gatherings of people. Some efforts of rehabilitation of the environment and production of fuel-wood and fodder have been carried out by Food-for-Work programs. Those efforts, however, have not been sustainable as they didn't carry the interest of the people.

POLICIES

If the National policy concerning the ASAL includes sustainable use of natural resources, renewable or non-renewable, it should be understood that rational use becomes an important issue. The ecosystems in ASAL don't tolerate high rates of overturn without leading to degradation and diminishing of the ecoscope. Policies should therefore focus on protection and conservation, rather than exploitation. Protection and conservation are of course included in the policy of the Wildlife Service and it might well be that vocation of the majority of the Arid lands will be mainly Wildlife Reserves and National Parks, but should give more emphasis to the human population.

RELATED SECTORS

The «Afforestation in ASAL» Work Group, is mainly geographically defined. Overlap with the other work groups in the Land-Productivity Division, who are more land-use oriented, is large. No proposal for development can be made without including the other groups.

The World bank ASAL Team is currently designing an Environmental Profile and Action Plan for the Arid and Semi-Arid Lands in Kenya. The action far development proposed will include the review of existing policies concerning conservation, protection and development of the environment and intervention in various sectors: Livestock, Agriculture, Wildlife, Water, Energy, Roads, Human Resource Development, Drought Contingency Planning, Reclamation of Wastelands and Training, Demonstration and Adaptive Research. Forestry has been included in a later stage. This undertaking has the same scale as the KFMP and overlaps it in many aspects. The responsibility for the program will lie with the MRDASW and implementation will fall within the framework of the National Environment Secretariat of the MENR.

ONGOING DEVELOPMENT PROGRAMS

In forestry most ongoing development projects are concerned with Farm-Forestry and Soil & Water Conservation. In Figure 10 the percentages of projects dealing with 4 main sectors are depicted. The largest number is involved in Soil & Water Conservation (48 %), Projects concerned with protection (36 %) and with Fuel wood production (36 %) are equally present, while 32 % of the project are involved in extension of farm forestry. At the moment 25 international funded projects are going on.

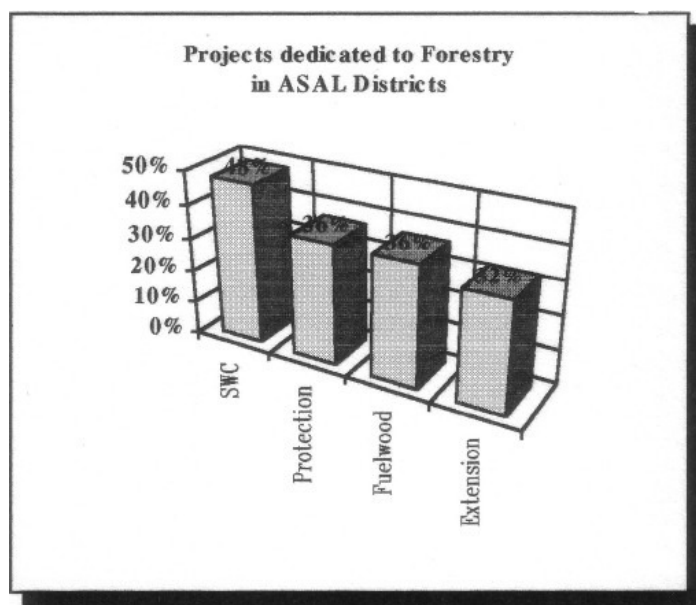


Figure 8. Ongoing International Funded Project in ASAL Districts.

Terminated and abandoned Project.

Many project have been terminated or abandoned because the aid agency gave the project over to the government or stopped the activities because of political or economical reasons. They all have left cars, build infrastructure and established nurseries and plantation or trial plots. The Kenya government often doesn't have the extra money to

continue maintenance and the results are graveyards with rusty material and neglected trees. A fund should be set up to continue at least the management of plantations, woodlots and trial plots.

DEVELOPMENT POTENTIAL AND OPPORTUNITIES

Development implies economic growth and higher average incomes with increasing demands for renewable and non-renewable forest resources. The value of natural resources is normally expressed in commodity prices. After the acceptance of the second law of thermodynamics and the difficulties of including added-values in Cost/Benefits analysis it is increasingly accepted to take the energy-flow as base for efficiency calculation and analysis of management systems of natural resources.

Low level input systems might seem inefficient in terms of costs; energy-wise they rank high in efficiency. Especially for the Arid Zones rational utilization of renewable natural resources seems feasible. At the moment the main products of the bush land and tree savannahs are beef and forest products: charcoal, fuelwood, honey, pharmaceuticals, gums, etc., which are all harvested in an increasingly «un-rational* way. Opportunities for sustainable production of forest by-product are certainly present, but mostly on a small-scale level (cottage industry).

Arid Zones

Development opportunities in Arid Zones are in general limited. Low turnover and rational utilization are key-words for any activity that concern the natural renewable resources of the Arid Zones. For economic reasons passive methods for restoration of degraded vegetation and soils are more preferable than active methods as replanting or protection against over utilization by fencing off.

Planting (afforestation and reforestation) should be limited to Key-Areas around existing settlement. More attention should be given to direct seeding, planting with cuttings, proper terrain preparation and water infiltration improvement techniques.

The same rationality is valid for tourism and other forms of wildlife utilization, where over-exploitation (high densities of tourist and cars) lead to deterioration of the environment and habitat of wildlife. Wildlife utilization for meat or milk production has been studied in the past. Some farmers still are operational on a small scale in wildlife culling and ranching. It might be sensible to give continual attention to developments in this field, especially the economic aspects (market) and harvesting techniques.

Historically the main forestry by-products from the arid lands were Gum-Arabic, tapped from the *Acacia senegal*, Myrrh, tapped from the *Commiphora* and Honey (nectar) gathered by hanging beehives in any flowering tree but mainly *Acacia* spp. Also the palm nuts of the *Borassus aethiopum* and leaves from the Doum Palm (*Hyphaene thebaica*), both growing in riverine forests and seasonal flooded plains are non-wood products used for food and basket-weaving. Attention must be given to this traditional use and management of existing practices encouraged. Rational utilization of the limited resources can be more efficient. Harvesting of quality products such as myrrh's, gums, and pharmacopoeia can be a possibility, however commerce (middle man etc.) must be controlled to avoid over-exploitation.

Semi-Arid Zones

The semi-arid zones, lying in between the high potential area and low potential rangelands are for both an area of overflow of population. For the rangelands in times of drought the pastoralists tend to go there and for the population of the high-potential zone the land-hungry tend to expand their agricultural activities in the less desirable and more risky semi-arid lands. This makes the semi-arid zone a paramount zone in terms of conflict between actual land use and land use capacity. Land-degradation is most likely to occur in this zone, as well as the over-cutting of trees for fuelwood and charcoal. Semi-arid zones, however, offer also better opportunities for development because of the presence of a better infrastructure and sufficient human resources. Many localities in semi-arid zones have been subject to soil and water conservation activities. In the past most projects were applying mechanical methods such as terracing, while forgetting to combine this with biological methods. This omission has been corrected during the last few years, but still a lot of restoration work has to be done. To speed up this process, it could be worthwhile to set up a credit system, based on a

Forestry Development Fund, from which farmers can loan cash to plant trees, however, with the restriction that they are organized in a association or co-operative. The fund should be an incentive not only to plant trees, but also to organize the farmers. Credit can be given for the duration of the commercial rotation period of the species planted: say 15 years, without interest, but from the product the farmers has to pay at least the money necessary to replant his original acreage of plantation, whether as woodlot, windbreaks, live fences or shade-trees. Part of the fund, e.g. the interest of the main capital, should be used for the institutional strengthening of the farmers organizations.

Coastal Zones

The coastal zone of Kenya, with its high relative humidity is different from other areas and landuse is typified by a high percentage of tree crops. Dominant in the landscape are Cocos Palm plantations and wood lots. Also Cashew Nut is omnipresent as well as Mango and Citrus trees. The semi-arid transitional zone between the sub-humid coastal plains (< 50 masl) and the arid hinterland is characterized by slash and burn agriculture and has caused in many places erosion of the top soil. Most of the land is trustland, but some large resettlement scheme have been realized. Dependence on artificial water supply from deep wells, pumped up by motorized pumps makes those schemes vulnerable when money lacks for maintenance and to salinization of the groundwater. In general the coastal zone has a relative high potential for tree crops and it could be worthwhile to look into the possibilities of producing construction and fuel wood and vegetable oils and fats for energy and consumptive uses. Special forest formation in the coastal zone are the holy Khaya forests and woodlots, which had and sometimes still have an important religious meaning for the local population. By means of the influence of modern Kenyan society, the impact of tourism, and the hunger for arable land, the future of the Khayas has been endangered.

The mangrove forests, although with limited variety in tree species, offer a very special habitat for numerous non-woody plants and animals. Estuaries are most important for the marine fauna, as they serve as hatchery and nursery for many scale- and crayfish species. Both forest formation deserve attention from the KFMP.

Sub-Humid zones

In the transition zones of sub-humid to semi-arid zones exist the so-called marginal lands. Also around Lake Victoria and South of Mnt. Elgon in the Districts of Bungoma, Busia, Kisumu and South Nyanza the «Marginal Cotton Zones» represent a-zonal areas with drainage problems and lesser or more erratic rainfall. In those areas, under traditional farming systems the flat land was dedicated to farming or grazing, while the hill tops were set aside as grazing reserve for the dry periods. As in other areas of Africa with a predominance of perennial grasses, burning is practices to get rid of the unpalatable dead material and unwanted shrub vegetation, to kill parasites and to force the tussocks to sprout green leaves before their time. This practice, combined with overgrazing has virtually bared the hills and caused erosion or lack of fuelwood and fodder.

Moreover, because of the pressure for agricultural land the farmers have slowly encroached further uphill, endangering the stability of the slopes. Those hills are at the moment either community possessed County Council Land (sometimes legalized sometimes not) or Gazetted Forest Reserves. Mostly the County Council has given the management to the Forestry Department, who's main task is to restore the vegetation in order to halt erosion, protect springs, encourage water infiltration and ensure a stock of fuelwood and fodder.

Because of the edaphic conditions on the hills, natural vegetation has the best chance of survival. Enrichment reforestation with exotics but preferable local species could be considered in case of lack of genetic material. Planting of trees is an expensive activity, especially when terrain preparation for water infiltration is required. Therefore rehabilitation of the natural vegetation should always be considered in the first place. Only there, where certain species have disappeared, reintroduction can be of use. Also, when edaphic and climatic conditions are more favorable and markets for the required wood products are available, forest plantations can be profitable and can compete with agriculture.

ENVIRONMENT AND ECOSCOPE

The Ecoscope

The Ecoscope includes all economic functions of the environment. In a certain stage of its evolution an ecosystem can provide a limited amount of resources and can absorb a limited amount of polluting substances, without degradation. Over-exploitation of resources does not only affect the productive capacity of the environment but also its regulation and information function. Every use of non-renewable resources, over-exploitation of renewable resources and pollution of both reduces the Ecoscope.

Sustainable use of natural resources means that the ecosystem will not essentially be affected and that mitigating measures will be taken into account to prevent or to compensate damage.

The Environment

The environment is defined as the living and working area of individuals and groups of human beings. Characteristics of the environment are defined by nature (soil, climate, vegetation and fauna or in general the bio-diversity) and by the material infrastructure, that is acquired through human activities (roads, houses, dams and industries). In this sense it is the combination of the natural environment and the manmade environment.

Environmental Impact Assessment (EIA)

To avoid that the Ecoscope is reduced, it is essential to integrate environmental assessment in the development policy of a country. Projects and program concerned with rural development or Institutional strengthening of Governmental and Non-Governmental Organizations are more and more feeling the need for EIA. The increase of non-appropriate techniques and materials in the rural environment, without an (infra)structure to deal with the adverse impact of its waste, leads to degradation of the environment. Therefore it becomes increasingly necessary to predict the possible effect of development activities, not only on the man-made environment but also on the natural. During the initial phase of launching a development program, project profiles should contain predictions concerning their impact on the environment (both positive and negative). The results should be written down in an Environmental Assessment Statement (EAS), encompassing all aspects of the ecoscope.

During the phases of project appraisal and project evaluation the EIA should be an obligatory part. If Environmental Assessment Statements already are made, the EIA should relate to them and, if necessary, set new short term directions in order to meet the long term objectives envisaged in the EAS.

EIA in relation to KFMP.

For Kenya, negative impact on the environment can be mostly expected from tourism, primary industries (charcoal plants, sawmills, paper and pulp mills, sugar-cane refineries, etc.), modern farming systems and from badly planned infrastructure and chaotic urbanization. The FD can help to avoid the diminishing of the Ecoscope by, e.g., promulgation of appropriate technology, rational exploitation of resources, avoiding erratic designing of roads and boundaries, taking into account the natural territories of wildlife and domestic grazers in rangelands, improving the urban environment by tree-planting.

CONCLUSIONS AND RECOMMENLATIONS

One of the most important tasks of the KFMP is for the Manpower Section. Reorganization of the FD, allocation of tasks to the various Ministries, more GK funded long-term projects and programs is highly desired. Protection against degradation of Arid Lands goes hand in hand with increasing the agricultural and forestry output of the High and Medium Potential zones of Kenya.

Planting (afforestation and reforestation) should be limited to Key-Areas around existing settlement. More attention should be given to direct seeding, planting with cuttings, proper terrain preparation and water infiltration improvement techniques.

Extension to farmers and Pastoralists should be left to the Ministries of Agriculture and Livestock. However, those Ministries could employ Foresters specifically for silvicultural tasks.

More emphasis should be given to commercial small scale enterprises for the rational utilization of forest (by)products, including exploitation of plantations. Depletion of renewable resources by Kmining» praetises should be discouraged at the source: control of commerce.

All projects should have a percentage of their budget dedicated to research, which should be executed by KEFRI, while more attention should be given to native species research. Also more attention should be given to terrain preparation for water harvesting in the ASAL zones.

Extension and training of farmers should be linked to farmers' organizations. The extension officer or has to be available, but the farmer should come with his problems to him. Operational costs should be partly paid by the farmers' organization.

Distinction between private and public tree planting activities should also be made in financial and organizational aspect. In the private sector tree planting is well developed and organized. The public sector, especially in the rural areas, need more stimulation to improve the urban environment.

As has been quoted many times now in the KFMP papers:

... "The Plan is nothing, planning is everything".... this is true if the planners are planning, or the future planners are learning to plan, but not if the planning is left to the advisors.

PROPOSED PROJECT PROFILES

PROJECT PROFILES TO CONSIDER:

WITH THE PRINCIPAL OBJECTIVE TO ASSURE:

-PERMANENCY AND PROGRESSION IN THE PROPOSED FORESTRY DEVELOPMENT PROJECTS AND PROGRAMMES,

-POSITIVE INVOLVEMENT OF THE FOREST DEPARTMENT, INCLUDING ITS FORESTRY RESEARCH INSTITUTE AND EXTENSION SERVICE DIVISION, BY:

Considering financial aid to long-term forestry development programs or projects, minimizing technical aid and, at the same time including and guarantying the involvement of MENR-staff, notably forestry department, KEFRI , FESD formerly called RAES by dedicating parts of each budget to local staff, extension and research,

Including financial aid to existing NGO's involved in forestry development, or by promoting the establishment of rural associations of individuals interested in forestry development, by financial aid, preferable in the form of creating a rotating forestry development fund,

Proposing to the government to review the legislation and revoke existing legal constraints on government policies and correcting contradictions between existing policies concerning land-uses,

Proposing to the government to modify the institutional organization structure of the MENR and specially the FD, in order to make the department more efficient and to avoid overlap in interests of the various ministries involved in rural development MRDASAW, MOA, MWT, MLD.

Creating financial and technical possibilities for further professional education and research of the FD's executive Staff,

TAKING INTO ACCOUNT THAT:

The conservation and protection of the extensive rangelands of the semi-arid and arid zones can only effectively be accomplished by improving the range management in critical areas such as locations of concentration of man and livestock during the dry season,

Increasing population pressure is no justification for increasing the present area under cultivation at the cost of the natural vegetation, but the more for increasing the productivity of the existing area under cultivation, and in doing so not endangering the further existence of natural vegetation reserves and so ensuring the abundance and diversity of the indigenous Flora and Fauna,

BUT ALSO:

To Give Kenya a competitive place on the world and regional market for agricultural products of high quality, and:

To make room for forest plantations in areas under cultivation in the high potential areas, for alleviating the demand for fuel and construction wood,

PROJECT PROFILE 1

Development Fund for Afforestation and Reforestation.

Target groups

Small and medium-sized farmland owners in rural areas, organized in NGO's, normally not having access to credit for forestry related activities.

Background

Many farmers in Kenya are interested in planting trees as a cash generation crop. They lack mostly funds for initial investments and the technical knowledge of establishing and managing a plantation in a sound way. On a National level the Credit Fund can provide in both. Loans will not be given to private farmers, but to organized farmers in Cooperations or Associations. The NGO gives loans to their associates for the acquisition of seedling, c.q. seeds, and necessary materials. All labor must be provided by the farmer. Interest on the loan will be paid to the farmers associating, to pay for the administration of the local fund and for the hiring of expertise. After the first rotation the farmer will pay back 10% of the profits with a minimum of the money borrowed to the NGO, who will use this money for replanting or expanding its afforestation activities. At least one forester with BSc degree will be attached to the NGO to safeguard proper silvicultural management of the planted trees.

Program Objective

The long term objective of the program will be the Nation-wide promotion of tree planting in rural areas on an economic sound and profitable base; to provide the local and regional market with primary tree products and generate additional income for the population. By ensuring proper silvicultural management the program will guarantee sustainable production, at the same time endeavoring the upkeep of environmental quality and its ecoscope. It provides additional job opportunities for national educated foresters in the private sector and aims at strengthening of NGO's in aspects of administration and organization.

Goals to be reached in the short term

The existing NGO's in Kenya, local or nation-wide organized will have the opportunity to strengthen themselves in organization and administration. The original goal of planting nation-wide 5,000,000 seedlings per district ($43 \times 5,000,000/1600 = 13,437.5$ ha/yr.), has been proved unrealistic under the present conditions. It will have a better chance with proper attention after the giving out of the seedlings if the farmers have invested in them.

PROJECT PROFILE 2

Plantation forestry for forest (by)products

Target groups

Medium and small sized farm owners. Cottage level industry, small industry.

Background

Fossil fuel has to be bought with foreign currency and is therefore relatively expensive for Kenya. The progressive use of fossil fuel will surely continue during the next 10-20 years. Fossil energy, however is not unlimited. The harder it is to mine, the more expensive it gets. The long-term trend can therefore not continue as it is. New technologies to produce nuclear-fusion-based energy might succeed, but at the moment the results are still doubtful. Better alternatives are energy sources like geo-thermal, wind and sunlight induced electric energy. Also new technologies for the production of organic fuels, extracted from fast growing plants are getting more advanced. The automobile industry, having a high interest in future energy sources, are already heavily investing in the development of engines running on electricity and vegetable fuels.

Program Objective

The production of oil and fat from trees on (small-scale) plantation base, for (small-scale) manufacture of oils and fats for consumption, cooking or fuel.

Intervention level

District Development, mainly Coastal Province. Assumed market: Mombasa.

Input

Improved seed-stock, knowledge on management, harvesting and transformation of product.

Species to consider

Species that might be used in a first try-out include: *Prosopis africana*, *Hyphaene petersiana*, *Cocos nucifera*, *Butyrospermum paradoxum*, *Borassus aethiopum*, *Balanites aegyptiaca* and *Anacardium occidentale*.

Goals to be reached in the short term

The establishment of tree plantations for the production of an energy alternative for wood fuel, charcoal, and paraffin.

PROJECT PROFILE 3

Rehabilitation of riverine forests

Target groups

Farmers and settled pastoralists in a-zonal riverine forests in Arid Lands.

Background

The seasonal rivers, cutting through Arid Lands always have served as refuges for pastoral tribes. They contained (semi)permanent settlement where the children and elderly were stationed during the dry season. The riverine forest provided most of their building material, fodder and shelter. Usufruct rights were usually well developed. During the last decades more and more farmers have settled in those key areas, either through resettlement programs or on private initiative. As the attitude towards tree planting and maintenance is better developed amongst those people the chance of success for rehabilitation of degraded riverine forests and river flats will be better. Also the survival chance of trees is far higher because of the presence of phreatic water.

Program Objective

The long term objective is to rehabilitate riverine forests, enrich them with multipurpose tree species and integrate them in the land use system of both farmers and pastoralists.

Intervention level

The projects intervene on community level. It encompasses cottage industry development use of forest product for subsistence and local or regional commerce.

Input

Expertise on planting techniques, water harvesting techniques, silvicultural techniques for plantation management, harvesting techniques of forest (by) products.

Species to consider

Species to consider are mostly already present, but need more protection against browsing, fire and over-utilization. The natural regeneration capacity of riverine forest species is most high, but impeded by trampling, browsing and fires. Multipurpose tree species include members of the Palmae family such as *Borassus aethiopum*, *Hyphaene thaebaica*, as well as *Acacia* spp, *Khaya senegalensis*, *Prosopis juliflora*, *Parkinsonia aculeata*, *Eucalyptus camaldulensis*, etc.

Goals to be reached in the short term

Sensitizing of the target group towards tree management and propagation by protection of natural regeneration (wildlings). Improving harvesting techniques of forest (by)products as palm fronds, poles, resins, gums, etc., keeping in mind a sustainable production.

PROJECT PROFILE 4

Improvement of environment in arid zone settlements

Target groups

Communities and villages in Key-Areas of the Arid Zones.

Background

Degradation in and around settlements in arid zones is mostly severe. Many villages are new and set up in haste or with a temporary character. Not much attention is given to the well-being of the inhabitants. Many settlements have already such programs, either through Schools, NGO, Chiefs' Offices, KANU or the local administration. Such programs need stimulation and the active involvement of the administration and local FDO.

Intervention level

Village level.

Input

Seed stock, operational funds, tools.

Species to consider

The well known drought resistant ornamental trees.

Goals to be reached in the short term

Tree planting program initiation through schools, volunteers.

PROJECT PROFILE 5

Enrichment Planting of Water Catchment areas

Target groups

Communities in key areas of semi-arid and arid zones (key-areas defined as site with better climate because of higher elevation, mist influence, or the presence of open water).

Background

Especially the watersheds in the ASAL are very vulnerable to over utilization. The MRDASAW's and the Office of the President execute SWC program in water catchments. Rehabilitation of eroded gullies and riverbanks by fencing of and enrichment planting with fast growing exotic tree species and grasses is widespread. The need however is felt to plant also indigenous trees, not only for aesthetical and ethical reason, but also because fast growing exotics are mainly light demanding pioneer species with a short life cycle. As the catchments allow extensive utilization only, one should consider the planting of slow growing indigenous trees with a long life cycle. In order to combine soil conservation with future profitable use, tree species with excellent wood properties might first be considered.

Program Objective

Extension of life cycle of catchment forest plantations in combination with production of high quality wood to ensure local communities or private a future income.

Intervention level

Local, District.

Input

Seed stock, nursery material, expertise.

Species to consider

Well known woodcarving species are *Brachylaena huillensis*, *Terminalia brownii*, *Dalbergia melanoxylon*, *Melia volkensii* and also *Tamarindus indica*. Other quality wood producing tree species are *Olea welwitschii*, *Olea hochstetteri*, *Azelia quanzensis*, *Trichilia emetica*, *Milicia excelsa*, etc.

Goals to be reached in the short term

Establishment of (private) nurseries of indigenous valuable tree species near watersheds. Involvement of public institutions (schools, volunteers groups, scouts, NGO's, etc.) in planting and maintenance of seedlings in watershed plantations.

PROJECT PROFILE 6

Monitoring of existing tree plots

Target groups

FD, KEFRI, KARI personnel in rural research stations.

Background

Many of the elimination and growth trial established by external funded project have been abandoned or neglected after the project activities were terminated. Those plots are often still existing and have grown into mature or nearly mature stands which should have been utilized. The lack of clearing and thinning practices have reduced the quality of the trees while utilization by the local population for collection of firewood and fodder often is prohibited. Forest Department Staff involved in research are complaining that they lack instrument for monitoring height and diameter growth. With very simple means, however, such instrument can be made or cheaply bought: one notepad, one pencil, one rolling tape measure and a pole of two or three meter length, divided in 10 cm partitions is in most cases sufficient to monitor the growth of young trees. Research staff should be informed and made enthusiastic by, e.g., university staff.

Program Objective

Initiate the continuation or beginning of a nationwide monitoring of biomass growth, guided by the proper research and teaching institutions. Integrate or extend research into forest management and exploitation by local population in a rational way and with low-input level.

Intervention level

Rural communities, district-level, nation-wide.

Input

Funds for additional training courses, material and maintaining communication between national institutions and the field. All project concerned with tree growing should devote 10 % of their budget to research and extension. The proper national institutions should be involved to execute the planned activities in those fields.

Goals to be reached in the short term

Start up of simple biomass growth measuring and revival of protocols of existing elimination and growth rate trial-plots.