ICRAF Consultancy Report

to IDRC sponsored

Dryland Agroforestry Research Project

in Machakos District Kenya

Kenya 83 - 0036

Period 16 September 1986 - 15 September 1987
Introduction

During the final year of the Dryland Agroforestry Research Project, ICRAF together with project staff focussed on the analysis of the project results and the preparation of a set of research proposals for the second phase of the project.

It should be noted that the results of the last two seasons of on-station research have not yet been processed by project staff and hence, so far, no assistance could be provided in the analysis and write-up of the research reports/notes.

Research result and research proposals : second phase

A copy of the report written for the second phase containing the research results and proposed second phase is attached.

ICRAF support

The ICRAF staff members who were involved in advisory work during the reporting period were D.A. Hoekstra, P.J. Wood and S. Minae. Also secretarial, programming and photocopying backstopping has been provided.
Proposed Second Phase Dryland Agroforestry Research Project

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1. Background

The first phase of the Dryland Agroforestry Research Project in Machakos started on the 18th August 1983 and finishes in August 1987. The Project's principal donor is I.D.R.C. and the implementing institutions are KARI/1, NDFRS/2 Katumani and M.I.D.P./3, with ICRAF/4 assisting in a consultancy capacity.

Based on ICRAF's diagnosis and design methodology the following research objectives were formulated:

- To examine the possibilities for maintaining/increasing the productivity of the cropping system by establishing an alley cropping system;

- To examine the possibilities for improving the quality, quantity and seasonal distribution of forage on the farm by planting fodder tree/shrub species in the grazing areas and by developing cut-and-carry forage systems;

- To examine the possibilities for reducing the labour input requirements of the free-grazing system and fuelwood collection by establishing live fences around the grazing land, and on-farm fuelwood tree planting;

- To examine the possibilities for increasing the cash income of the farmers by the introduction of fruit trees, pole and timber species.

To formulate the second phase of the Project, a summary of the actual research programme during the first phase will be given, followed by an assessment of the results, and a reassessment of the research needs. The final section contains a detailed proposal for a research programme for the second phase.

1/ Kenya Agricultural Research Institute.

2/ National Dryland Farming System Research Station.

3/ Machakos Integrated Development Project.

2. Description of the Research Program

2.1 Introduction

The implementation of the project was effected from two angles; on station research based at Katumani (N.D.F.R.S) and ICRAF Field station and on farm research conducted in the Kakuyuni catchment in Yatta plateau, which is in the Eastern part of the Machakos District about 140 km from Nairobi. Both research stations are at an altitude of approximately 1600 m. and receive an average annual rainfall of 600-700 mm. The Kakuyuni catchment is about 1200 m. and receives an annual rainfall of 600 mm.

2.2 On-station research

2.2.1 Alley cropping

2.2.1.1 Green manure trials

The objective of these trials was to screen the effect of different tree leaves and rates of application on plant growth once incorporated into the soil. In the initial screening, it was decided to adopt a design with very small plot sizes (micro) exposing relative differences between treatments rather than absolute differences. Two independent, completely randomised lay outs were used, one to test the effect of different treatments on beans, the other on maize. The species tested were: *Leucaena leucocephala*, *Cassia siamea* and *Terminalia brownii*. Later on *Sesbania sesban* and *Lonchocarpus eriocalyx* were added. The rates of application were respectively 1 and 2 kg of fresh leaves per m².

A similar layout using larger plot sizes aimed at evaluating yield difference were adopted for the best performing species, using maize as a test crop.

These experiments were all established on the N.D.F.R.S. respectively in November 1983 (micro plots), March 1985 (macro plots) and November 1985 (micro plots).

2.2.1.2 Hedgerow trial

The objectives of this trial are subdivided into 2 phases i.e:

Phase 1, Development (before lopping of hedges)

i) the effect of the introduction of hedgerows on the yield of maize.

ii) the effect of different in-row spacings of the trees on the yield of maize in the alleys.

iii) the effect on maize yield in relation to the proximity to the hedgerows on the yield of maize.

iv) the "side of hedge" effect on maize yield.
Phase 2, Operational (once lopping commences).

i) the combined effect of hedgerow intercropping and green manuring on the yield of maize in alleys;

ii) the combined effect of different in-hedgerow spacings and green manuring on the yield of maize in alleys;

iii) the effect of proximity to hedgerows on the yield of maize under green manuring conditions;

iv) the "side of hedge" effect on yields of maize under green manuring conditions; and

v) the effect of different hedgerow spacings on the yield of leafy and woody material from trees.

To study objectives i) and ii), a randomised design with 3 different treatments (including the control) with 4 replicates was used. The other objectives were studied within each of the treatments.

*Cassia siamea* was selected as the tree species for the hedgerow. Within each plot (except the control plots) 4 hedges were established from seedlings at a between-row spacing of 3.6 metres. The in-row spacing of the *Cassia* was respectively 0.25m and 1.0 m (hereafter referred to as C 0.25 and C 1.0).

In between 2 hedges, 3 rows of maize were sown parallel to the hedges at a spacing of 0.9 m (between rows) and 0.3 m (in row). In the control plots, each tree row (hedge) is replaced by a row of maize. Maize was planted twice a year following the rainfall pattern in the area.

This trial was established on NDFRS in November, 1983.

### 2.2.2 Species selection

The objectives of the trial were:

i) To assess initial survival and early growth and suitability of promising Central American species several of which are already widely grown in Kenya;

ii) To obtain some early information on tree/crop competition, specifically on maize;

iii) To provide a demonstration of experimental layout and to retain specimen trees;

iv) To identify promising germplasm introductions for follow-up research and development.
The trial was set for 5 years (up to November, 1989) at which stage it is to be removed except for the specimen trees. The location of the trial is the ICRAF Machakos Field Station.

All species were supplied by the Central American collections from the Oxford Forestry Institute. The full list is given in Annex 1, but the species successfully raised for planting are marked with an asterisk on the table. All species are known to be grown successfully on farms in Central America for fuelwood and other purposes, and some are already widely planted in Kenya. Some of the species in the trial can be used quickly in an extension programme after initial screening.

The 18 species were planted in a randomised block design, six trees per plot at 1.3 m spacing, in 3 blocks, one plot wide and aligned along the contour. The trial was established in October/November 1984.

Along one edge of block 1, six lines of maize, at normal spacing, starting 90 cm from the trees, were planted in the three growing seasons up to the end of 1986, to assess competition effects.

2.3 On-farm research

2.3.1 Rehabilitation of existing species in the grazing land

A survey of the existing vegetation in the grazing land revealed a wealth of browsed, naturally regenerated tree seedlings/stumps (hereafter referred to as trees). Although several years old, most trees never grow to maturity because they are constantly browsed by domestic and wild animals. Another factor impeding the growth of these trees is the low water infiltration rate into the soil caused by high run-off due to lack of vegetation and compaction of the topsoil.

To enable these trees to get out of reach of browsers a small V-shaped catchment was dug up-slope from the trees; a protective ring of thorny bushes was applied around the tree and the number of branches was reduced to one main shoot.

Twenty three farmers were selected to participate in the experiments. An inventory of the 3 selected species was made on each of these farms and, based on this information, it was decided for each farm to experiment with either 1, 2 or 3 species (normally 2 per farm).

Twenty trees of each selected species were randomly chosen per farm. Ten of these were monitored for control purposes (exposed to browsing) while the remaining ten were treated and monitored.

This trial which was research managed, was initiated on-farm in the Kakuyuni catchment in October 1983.
2.3.2 Tree species for the grazing lands

The main objective of this trial was to screen tree and shrub species which could be planted in the grazing land for the production of fodder (leafy material, pods) and fuelwood. Both management and implementation were handled by the researcher.

Seedlings were planted in a square 10 x 10 m protected by a dead thorny fence. Within each square different species were planted at a spacing of 1 x 1 m. Such squares were established on 23 farms in the Kakuyuni catchment in April 1984 on either black cotton soils or red ferrasols-cambisols.

The species used were:

i) Acacia nilotica
ii) Acacia tortilis
iii) Cassia sturtii Australian
iv) Leucaena Leucocephala
v) Prosopis alba
vi) Prosopis juliflora

Seed source:
local
local
Australia
local/adapted
local/adapted
local/adapted

After screening for survival some management aspects were introduced in collaboration with the farmer altering the scope of the research to farmer management.

2.3.3 Grazing land treatment package

Initially this package was meant to be a demonstration of a combination of "best bet" component technologies including fencing, enrichment planting of trees, shrubs and grasses and soil and water conservation structures. Such packages were to be established by self help groups. However the package turned out to be optimistic with regard to some of the components, especially fence species and grasses. The objectives of the trial was therefore reconsidered and emphasis was put on observation rather than demonstration.

Observations were made on the following aspects:

i). performance of tree species for fencing, enrichment planting along the fence and on terraces.
ii) performance of grass species
iii) rehabilitation of existing vegetation as a result of fencing and soil and water conservation.

The species used for fencing were Acacia mellifera, Caesalpinea spinosa, Parkinsonia aculeata, Ziziphus mauritania, Prosopis juliflora and Commiphora africana.
Enrichment planting within the fenced areas included *Cassia siamea*, *Sesbania sesban*, *Eucalyptus camoldulensis* and *Leucaena leucucephala*.

Planted grasses included *Panicum maximum*, *Chloris guyana*, *Cynodon dactilon*, *Bhaira* grasses and star grass.

To avoid animals entering the plots during the first years when the live fences were not yet developed, a fence of dead thorny branches was laid out around the plot.

To resolve soil and water run off, enrichment planting of trees and grasses took place along the contour. These plantings were complemented with infiltration pits, micro catchments and ploughed furrows.

This experiment was laid out on 2 farms in April 1985.

### 2.3.4 Fruit trees

The introduction of fruit trees had been identified as one way to increase the supply of food and cash to the household.

Towards the end of the short rains of 1983 a total of 356 fruit trees - rough Lemon, Passion fruit, Pawpaw, Guava and Mango - were issued to farmers for farm planting. The long rains which followed were unusually poor.

### 2.3.5 Alley cropping

Based on the encouraging on-station results of the alley cropping experimentation, on-farm trials on the system commenced in November 1985.

The main objective of this on-farm research was to study the farmers' acceptance/modification of the system. Initially the tree component was managed by the researcher and the crops by the farmer. Alley cropping plots were laid out on 3 farms, species used were *Leucaena leucacephala*, *Gliricidia sepium*, *Cassia siamea* and *Sesbania sesban*.

### 2.3.6 Nursery/dissemination aspects

Although not originally part of the research objectives, the general lack of infrastructure to raise and distribute seedlings and to disseminate technologies, were later on identified as problems. Self help groups were involved in the production of seedlings in the Project nursery at the dam site.

The same groups were also involved in the establishment of the grazing land package treatment (fencing, soil and water conservation treatment, planting of grasses and trees) on 2 farms. (see also 2.3.3)
Around the nursery site, a selection of trees (see 3.3.2 for species) were planted partly to protect the area from a serious erosion hazard, and partly to demonstrate the different species to the local farms. Also, the project engaged in the distribution of seedlings to be planted by the farmers themselves (see 3.3.4 for species).

3. Research results

3.1 Alley cropping

The results of the green manure trials using micro plots were rather encouraging although not always consistent. No results were obtained for the first and second season.

As shown in Figure 1, Leucaena gave the best results in all seasons although the 1-kg per sq.m treatment was, unexplainably, better in season 5 than the 2-kg treatment. More than doubling of yields took place in season 4 and 6 per sq.m as a result of the grain manuring.

Cassia siamea gave particularly good results in the 4th and 6th season. It was furthermore consistent in its expected performance i.e. the 2-kg treatment was better than the 1-kg treatment in all seasons. It should be noted however that the 1-kg treatment gave rather small improvements except in season 4.

Terminalia brownii behaved inconsistently in that in 2 out of four seasons the 1-kg treatment did better than the 2-kg treatment. The results of the two more recent experiments with Sesbania and Lonchocarpus were encouraging. Already in the second year a significant increase in the moist performance could be observed.

Figure 1. Grain yield increases - green manure trial as percentage of the control (micro plots)
The results from the macro plots are still inconclusive with the exception of the *Leucaena* 2 kg treatment.

The results of the hedgerow trials using *Cassia siamea* were encouraging during the development phase since the positive interactions between the hedges and the maize apparently more than balanced out the negative interactions (see Fig. 2). Drought caused the development period to be much longer than expected. Based on observation of on-farm experiments, 2 seasons are normally sufficient to establish the plants so that lopping can be started.

![Figure 2. Maize yield per row - hedgerow trial as percentage of control - Development Phase.](image)

Grain weight per row %

<table>
<thead>
<tr>
<th>Season 1</th>
<th>Season 2</th>
<th>Season 3</th>
<th>Season 4</th>
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<tbody>
<tr>
<td>Control</td>
<td>Co</td>
<td>C-</td>
<td>Co</td>
</tr>
<tr>
<td></td>
<td>0.25</td>
<td>1.0</td>
<td>0.25</td>
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<tr>
<td></td>
<td>No yield</td>
<td></td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td></td>
<td>1.0</td>
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</table>

The operational phase of the trial (after lopping) has not yet shown any dramatic increase in maize yields production, although an upward trend can be observed (see Fig. 3).

![Figure 3. Maize yield per row - hedgerow trial as percentage of control 0 Operational Phase](image)

Grain weight per row %

<table>
<thead>
<tr>
<th>Season 5</th>
<th>Season 6</th>
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<tbody>
<tr>
<td>Control</td>
<td>Co</td>
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<tr>
<td></td>
<td>0.25</td>
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<td></td>
<td>C-</td>
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<td></td>
<td>1.0</td>
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It was also observed that during this operational phase, the maize row upslope from the hedge performed best, indicating the hedge's potential as a soil and water conservation structure.

The on-farm alley cropping experimentation is still young and hence no major conclusion can be drawn. However, the following observations are worth noting:

i) labour input for establishing the hedge was much lower than expected i.e. 40-45 hours/ha for transplanting bare rooted seedlings (between row spacing 4 meters, in row 0.5 m).

ii) labour input for lopping hedges was about 55 hours/ha per cutting (Kathama data).

iii) survival rate of directly sown seedlings was low. This was aggravated by the fact that several seedlings were removed by hired labourers during weeding.

iv) none of the 3 farmers altered the maize population, and all planted a row of maize together with the hedge.

v) one farmer used part of the *Leucaena* loppings to feed his animals.

vi) several members of the self help group have requested to be included in this trial.

3.2 Rehabilitation of existing vegetation on grazing land

The experiments aimed at increasing the growth of the existing vegetation gave varying results with different tree species.

*Balanites aegyptiaca* responded favourably to the treatments, especially on the shallow red soils. Over the 18-month period, height increment was over 55 cm, while mean root collar diameter increment was over 6 mm. While most trees are still too small to be left them unprotected, there seems to be little doubt that the apical shoots are steady enough to continue their growth into mature trees.

Although the total height and root collar increment of the *Acacia tortilis* was almost the same as *Balanites*, i.e., 62 cm and 9 mm respectively, the die back of the apical shoots during the last measuring period raises serious questions as to the appropriateness of this treatment. Furthermore the stiffness of the apical shoots leaves much to be desired. It is therefore suggested that the treatments for the *Acacia tortilis* trees should be modified by leaving a single shoot to develop instead of just one so as to avoid too fast a growth of a single apical shoot.
Commiphora africana's response to the treatments was somewhat in between those of Balanites and Acacia. Height increment was 48 cm while root collar growth was 9 mm. The stiffness of the apical shoots, especially those which had developed quickly on the deep red soils and those which initially had a below-average root collar diameter, was insufficient to keep them upright. It is therefore also recommended to modify the treatment in the same way as for Acacia tortilis.

3.3 Species screening

3.3.1 On-station

The on-station experiments for the Central American germplasm showed excellent survival, despite the virtual failure of the rains in the season in which they were planted. The excellent standard of weeding no doubt contributed to this. On the basis of results at 2.3 years (see Figure 4) it was decided to obtain more seed of some of the most promising species, as follows:

- Gliricidia sepium
- Leucaena diversifolia
- Leucaena shannoni
- Senna atomeria

All of these can now be put into farming systems on a provisional basis, and blocks of trees will be planted to enable selection of desirable ideotypes to be made for further propagation. The elementary testing of maize grown along one edge of one block of the trial was too crude to enable major decisions to be made, although it did appear that Parkinsonia aculeata had a much less suppressive effect than the other species. The species is already well known in Kenya for live fencing, but more seed of the Oxford provenance will be sought for comparison with the locally adapted variety, and for use on-farm for live fencing.

3.3.2 Species screening on denuded soils at Kakuyuni dam site

The conditions in which these trees were planted were severe, as most of the topsoil had been removed. Some useful results have nevertheless been found at ages of one, two and three years. Of the 15 species planted only three showed less than 60% survival at 3 years old. These were Gliricidia sepium, Grevillea robusta and Casuarina equisetifolia, and the deaths were attributed to termites. Most of the other species were also reported to have been attacked by termites. The most vigorous were Acacia saligna, Cassia siamea, Prosopis juliflora, Eucalyptus camaldulensis, Melia azaderach, Azadirachta indica, and the indigenous Croton megalocarpus.

3.3.3 Tree species for the grazing lands

The results from the on-farm trials of planted trees on grazing lands indicated from the start that there is always a likelihood of farmers dropping out of the programme. Of 23 farms in the initial programme,
only 10 were left at the end of the first year. Survival was good, and at the end of the first year the indigenous Acacias were showing close to 100%, with *A.nilotica* doing better that *A.tortilis* on black soils, as expected. *Leucaena leucocephala* did better than expected in the poor rains of 1984, and so did *Prosopis juliflora*. Acacia *saligna* showed poor survival, but is still worth including in a fodder lot. *Cassia sturtii* was not impressive in growth or survival but might be worth re-trying as a fodder lot.

The conclusions are that survival of the Acacias, *Leucaena* and *Prosopis juliflora* is good if protected from grazing. On the worst of the eroding red soils it was evident that any planting should go hand in hand with soil conservation measures. The spacing of planted trees should depend on the species, but for the Acacias need not be less than 3 to 4 metres, and about 2 metres for *Leucaena* or *Prosopis* if these are intended to be lopped and thinned for fodder and fuelwood.

3.3.4 On-farm species distributed to farmers

Some of the same species as were used on the denuded lands were also distributed to farmers, who planted them over a period of three years on farmland. In general the survival was worse than on the denuded lands. One species in particular survived very badly, *Casuarina equisetifolia*, although its height growth was good; it was stated to be "very termite prone". As on the denuded lands, termite control, which is well understood in Kenya, is important if trees are to fulfil the function farmers require of them. This also applies to the difficulties reported over growing fruit trees (see below), and in the future nursery stock should be treated with Aldrex in accordance with normal practice to avoid farmers having to apply this toxic chemical in the field. The Neem (*Azadirachta indica*) was very popular with farmers, with 67% survival but slow growth; the related *Melia azaderach* also showed similar survival and good growth at 3 years, and its insecticidal properties were observed. Both deserve to be made more widely available to farmers. Other species to show good height increment were *Cassia siamea* (78%) survival *Croton megalocarpus* (67%), *Grevillea robusta* (25%), *Leucaena leucocephala* and *Prosopis juliflora* (85%).

The survival of all the species in the above two trials could be expected to be improved using simple anti-termite measures, and the satisfactory height growth means that most of them could be offered to farmers now without further testing, with suitable instructions for their care after planting.

3.3.5 On-farm live fencing and hedge trials.

Six species were used for on-farm trials, mostly planted along contours, but in some places on slopes where erosion proved a problem. The most successful species for the point of view of height and survival were:
Acacia mellifera
Caesalpinia spinosa
Parkinsonia aculeata
Zizyphus mauretania

Commiphora africana was disappointing, attributed to poor maintenance and termite damage. A thorny variety of Prosopis juliflora showed moderate survival but good growth. There was some browsing damage from domestic and wild animals, but there is now a package of species which can be confidently recommended to farmers for live fencing, provided that reasonable standards of management are applied.

<table>
<thead>
<tr>
<th>Species</th>
<th>Survival</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>Parkinsonia aculeata</td>
<td>58-100%</td>
<td>Important live fence</td>
</tr>
<tr>
<td>Zizyphus mauretania</td>
<td>82%</td>
<td>Potential for fruit</td>
</tr>
<tr>
<td>Caesalpinia spinosa</td>
<td>69%</td>
<td>Live fencing potential</td>
</tr>
</tbody>
</table>

Prosopis juliflora, Leucaena leucocephala, Eucalyptus camaldulensis, Azadirachta indica, Acacia nilotica and A. mellifera all gave about 30% survival. Commiphora, Calliandra calothyrsus and Cassia siamea were all very poor. The results are sufficiently encouraging in view of the severe conditions to indicate that some further field trials in which special attention is paid to ground preparation, mulching, water harvesting and termite control, should be made.

3.3.6

Of the grasses introduced, the survival was 50% for the Lemon, and well below this for the others. Termite damage was reported to be one reason for the Mango and Guava deaths, and lack of maintenance for the Passion fruit. Survival would have been improved by the addition of manure or other organic matter in the planting hole, and for such valuable plants arrangements should be made for hand watering if the rains fail in future, and for termite control with insecticides.

3.4 Nursery/dissemination

The participation of the self-help groups in the nursery activities was relatively short lived and were in fact discontinued after one year.

The main reasons seem to have been:
  i) no proper follow-up from Project and ICRAF staff
  ii) lack of water in the nursery and
  iii) insufficient internal group organization for the maintenance activities.

The participation of groups in establishing the grazing land trials was more encouraging since several group members contributed to this activity. There was also a clear desire by the groups to continue with these activities.
The distribution of seedlings was also appreciated by farmers. However, to improve survival rates, more information should be provided to the farmers.

3.3.6 Fruit trees

The trees that were planted in the short rains of 1983, which were poor, as noted above were, Panicum maximum performed poorly, Bhaira and Cynodon sp. tended to dry following prolonged draught while Chloris gryana, Cynodon dactilon and star grasses performed well.

4. Reassessment of research needs/organisation

The basis for the reassessment of research needs are the results of the experiments conducted during the first phase as well as a re-diagnosis of the problems to be addressed.

It is proposed that research during the second phase of the project should be subdivided into 3 main categories:

i) organizational research for the dissemination of trees/technologies, which is by definition on-farm;
ii) biological research to identify appropriate species, arrangements and management practices; on-farm and on-station;
iii) adaptive research to identify farmers' reactions/modifications of biologically tested technologies; on-farm only.

A socio-economic survey is proposed to be undertaken at Kuinet green revolution centre; a location in Agro-climatic zone 3 in Uasin Gishu District selected by KEFRI as one of the seven green revolution or extension nuclei anticipated to be developed in the very near future. A soil survey and characterization has already been undertaken by KEFRI. The survey is to be undertaken jointly by KEFRI; Institute of Development - studies - University of Nairobi and Centre of Evangelism Development Trust (a local Evangelistic NGO), and Moi University.

4.1 Organisational research

As the first phase of the Project has produced some technologies which can be extended to a larger group of farmers, the problem of the lack of infrastructure for such dissemination needs to be addressed.

First of all there is the problem of transferring technologies to the villagers in a cost-effective way.

Secondly, there is the problem of the production and distribution of seedlings.
The spreading of technologies could be tried through various agents using different methods e.g. the existing agricultural extension services using the T and V system, the RAES of the forest Department self-help groups and school children using leaflets and/or lectures.

The production and distribution of seedlings has so far been handled by the Forest Department (...nurseries in Machakos District) and MIDP (...nurseries). It is not surprising to see that at present only a few farmers are reached through these outlets. The creation of many more smaller, decentralised nurseries seems therefore essential. However, due to the semi-arid conditions in most of the District, water needs to be made available at each nursery site. Research will be needed to find the most cost efficient way of obtaining water (outside the scope of the project). Also the involvement of farmers in the production and distribution of seedlings needs to be examined to reduce the cost of production.

The technologies to be considered for the organisational research are the grazing land package and the rehabilitation of existing species. Alley cropping may be considered towards the third year of the project, if proven to be acceptable to farmers (biological and adaptive research).

4.2 Biological research

In the second phase of the project the on-station biological research on the alley cropping system will be continued to monitor the long term effects of mulching and hedgerow intercropping. Support for more detailed monitoring of soil aspects (i.e. nutrient release and uptake) as well as microclimatic effects (soil moisture, temperature, radiation) will be provided through the participation of three University of Nairobi graduates under a project entitled "Traditional Techniques for Microclimatic Improvements" (TTMI). An MSc student from Moi University will monitor long term effects of mulching and hedgerow intercropping using vegetables under irrigation at Kuinet green revolution centre.

Background

Although many species are currently suitable for immediate use on farm, further research is desirable to find more species that meet the specifications for inclusion in the agroforestry interventions identified for the project area as well as Kuinet green revolution centre in agroclimatic zone 3. The interventions are:

Alley cropping for mulch, fodder and fuel
Fodder banks on grazing land
Mixed intercropping on grazing land for fodder, shade and fuel
Live fences and hedges
Some further species testing especially fruit trees will be undertaken since many farmers expressed a keen interest in fruit for either cash or home consumption. Such testing can take place on-farm as well as on-station.

Although the survival of many of the trees planted in the past has been acceptable, many have suffered from termites, cutworm and browsing damage. This is particularly troublesome with expensive fruit trees. The technology for the control of termites has been well-known in Kenya for over 30 years, but the traditional chemicals may not continue to be available in the future.

Part of the research should therefore be dedicated to finding cost effective methods to reduce termite damage. It is envisaged that part of the biological research required would be conducted by ICRAF staff (not funded by the project).

4.3 Adaptive research

The alley cropping technology is probably the most in need of adaptation to farmers' conditions since it is a completely new concept within the dryland areas. A start was made with this research during the Project's first phase. However, it is felt that clearer directions are required to obtain the maximum information from this type of research. Also monitoring of these trials should be better defined. As has been mentioned already, gradually the management of the hedges should be left to the farmers themselves.

The grazing land package also requires further development especially with regard to the management of the plots after rehabilitation. It is suggested that such research could be conducted on those farms which already had part of their grazing land treated during the first phase of the Project.

4.4 Organisation of the proposed research

During the first phase of the Project, KARI was the main implementing body while the contributions of Katumani NDFRS Station and MIDP were limited. This has in fact affected the quality of implementation especially when agronomic, pastoral and extension expertise and supervision were required. It seems therefore appropriate that during the second phase of the Project some changes are made in the organisational set up so as best to accommodate the three major lines of research mentioned earlier.
KEFRI /1, which was set up independently of KARI in July 1986 seems best suited to deal with biological research dealing with species selection, establishment and management as well as providing the technical assistance in the nursery activities. They would also serve as advisors for the tree component in the other trials.

Katumani Station (KARI) seems best suited to deal with the biological research involving establishment of crops and grasses as well as the interactions between trees, crops and grasses. They should therefore, be considered to take responsibility for alley cropping experimentation as well as adaptive research. They would also serve as an advisor for the organisation oriented research.

MIDP (Ministry of Agriculture) should take responsibility for the organisational/dissemination research.

ICRAF could provide consultancy services in each of the lines of research. This support would include actual participation in field activities on a more continuous basis than in the first phase. The consultancy will be paid in part and be covered under ICRAF’s own programme COLLPRO.

IDS - UNIVERSITY OF NAIROBI will be collaborating with KEFRI; Moi University and Centre of Evangelism Development trust in the socio-economic survey at Kuinet green revolution centre. Moi University will supervise the alley cropping/mulching trials at Kuinet. An Msc student to be attached to the project.


5.1 Organizational/dissemination research

5.1.1 Rehabilitation of existing trees by schoolchildren and self help groups.

Objective: to test the potential role of schoolchildren and self help groups in the dissemination of the tree rehabilitation technology.

Manpower: Silviculturist Extension Specialist

1/ Kenya Forest Research Institute, Muguga.
Methodology: The extension specialist will prepare a leaflet in collaboration with the silviculturist in which is explained: i) the objective of the technology ii) the identification of species to be used in the treatments, notably *Acacia tortilis* and *Balanites aegyptiaca*. iii) the layout of the micro catchment (drawing), iv) the establishment and maintenance of the protective circle of thorny bushes.

The treatment will be explained to the schoolchildren of the three primary schools in Katangi market as well as to the members of the three self help groups in the area.

Monitoring: the number of children/self help group members who have taken up this technology as well as the number of treated trees per participant will be recorded once every season. For those not adopting the technology, reasons for non-adoption will be recorded.

The monitoring will be based on a sample of the population (adopters as well as non-adopters).

Adjustments will be made if necessary.

Duration: September 1987 - August 1990

Expected output

- leaflet explaining the technology to be used by future disseminators.
- method for dissemination of the technology through schoolchildren and self-help groups.
- rehabilitation of useful tree species in the grazing land area in the project location.

5.1.2 Production and distribution of seedlings through self help groups.

Objective: to test the potential role of self help groups in the production and distribution of seedlings for their own use.

Manpower: Extension Specialist
Silviculturist
Nursery Supervisor (full time)

Material inputs: Seeds
Nursery materials

Methodology: The silviculturist in collaboration with the extension specialist will prepare a leaflet summarising the nursery activities to be handled by the farmers under the guidance of a nursery supervisor.

The nursery is located at the dam site where water is available cheaply. The three self help groups in the area have been approached for this trial.
The amount and type of seedlings to be raised will be determined by the individual’s and group’s requirements. Each group will be involved in short, labour demanding activities such as filling the containers and pricking out seedlings. Less labour intensive activities such as watering, may be carried out by only a few group members. Groups can make their own arrangements for rewarding such members. The possibilities for raising cash by means of raising saleable seedlings (fruits!) for non-members would be considered in this context.

The distribution of the seedlings to the different plots will be arranged through local transport.

**Monitoring:** labour inputs, the group’s organizational development, and the number and type of seedlings produced. Survival rates of planted seedlings other than the ones used in experiment 5.1.3 will also be monitored.

Adjustments will be made if necessary.

**Duration of the experiment:** May 1987 – August 1990

**Expected outputs**

- leaflet on nursery management
- method for raising and distributing seedlings through local farmers (including costing and survival rates).
- indication of potential production and distribution capacities of self help groups.

**5.1.3 Dissemination grazing land package through self help groups**

**Objectives:** to test the capabilities and capacities of self help groups and individuals to introduce the grazing land treatment.

**Manpower:** Extension Specialist
Soil and Water Conservation Specialist
Silviculturist
Pasture Specialist

**Material inputs:** Tools
Grasses and tree seedlings

**Methodology:** A leaflet will be produced by the specialists describing the package including fencing, enrichment planting of trees and grasses, improvement and management of existing vegetation and soil and water erosion controls. In principle 2 designs should be used, one for a grazing fodder bank and one for a cut and carry fodderbank. Seedlings required for these experiments will be raised by the groups in experiment 5.1.2. Groups will organise themselves to provide the labour for establishing these plots. Maintenance of fences and vegetation within grazing land may be left to the individuals on whose land the package is put.
Selection of the farmers will be left to the groups; however, selection of sites will be made by Project staff using the maps of the Kakuyuni landscape plan. Project personnel will also assist in the layout of the soil and water conservation work.

Details on the management of the plots will be provided at a later stage (based on the findings of the adaptive research). It is expected that the tested plots will be out of use for approximately 2 years.

**Monitoring**: labour input for the different activities i.e fencing, enrichment planting and soil and water conservation works. Groups' organisational developments and number and type of seedlings planted as well as their survival rates.

**Duration**: September 1987 - 1990.

**Expected outputs**:
- leaflet on grazing land package treatment
- method for improving grazing land through self help groups and individuals (including costing)
- indication of potential capacities of self help groups to spread this technology
- assessment of the establishment costs.

### 5.2 Biological research

#### 5.2.1 Alley cropping - on-station.

**Objectives:**

(a) To screen the effect of different leaves and rates of application on plant growth once incorporated in the soil.

(b) To study the mineralization rates of loppings of Cassia Siamea as well as leaves that have the potential to be used for alley cropping.

(c) To study the soil physical changes as a result of mulch/green manure application from the following perspectives

- Soil nutrients
- pH
- Carbon content
- Moisture gradient
- Physical aggregate stability
- Water characteristics
- pF curves
- Soil microorganisms.
(d) to study the mineralization rate of leaves and loppings of agroforestry species which have potential to be used for alley cropping under agro-climatic zone 3 as well as the soil physical changes as a result of mulch green manure application to vegetables under irrigation from the perspectives outlined at (c) above.

(e) To continue with the operational phase of Hedgerow trials as described in 2.2.1.2.

(f) To study the microclimatic aspects i.e. shrubs, soil moisture, during the operational phase of the alley cropping trials.

Manpower:
Agronomist for overall direction
MSc. Student: Agroforester from KEFRI attached to the project to be registered at the University of Nairobi. (specifically for objective b)
MSc. Student: From Soil Science Dept. University Of Nairobi. (for objective c)
PhD Student: Lecturer - Dept of Geography, University of Nairobi (for objective f)
MSc. student from Moi University (for objective d)

Material Inputs: Monitoring equipment (TTMI)
Laboratory equipment

Methodology:

The objectives (a) and (e) will be implemented as described in 2.2.1.1 and 2.2.1.2. Apart from the three species tested in 2.2.1.1., which included Sesbania sesban and Lonchocarpus eriocalyx, Gliricidia sepium will be included in the green mulch trials.

The mineralization trials will be carried out by undertaking laboratory analysis to determine the composition of the green manure leafy material before application. Regular samples will be taken for analysis after application for residual nutrients as well as foliar analysis of the crop.

5.2.2 Species and Provenance Trials

Routine soil analysis for the factors outlined in (c) and (d) will be undertaken by the MSc. students.

Comprehensive methodology on radiation, shading effects as well as through determination other micro climatic factors have been documented in detail in the PhD project proposal already accepted by the School of Graduate Studies University of Nairobi, Objective (f). The experiment will be undertaken in the 0.25m Cassia siamea hedgerow trials described under 2.2.1.2.


- 20 -
Expected Output:
- i) list of species for potential use in alley cropping
- ii) assessment of long term effects.
- iii) assessment of biological alley cropping system.
- iv) Four Agroforestry Specialists, one at PhD and three at MSc level will be contributed to the local experts pool.

Objectives:
To evaluate for appropriate interventions, different provenances of indigenous trees already known.

To identify and introduce exotic species which appear to be promising for appropriate interventions.

Both of these would be tested on-station or on-farm as suitable.

Personnel needed:
Silviculturist
Extension specialist

Material inputs
Seed from Kenyan and other sources; planting stock; approximately 1 ha of land for planting.

Methodology
Seed will be obtained from other tropical countries with similar conditions to those in the project area, notably Australia for fodder, browse and fuelwood species, and the Oxford Forestry Institute for provenances of Central American species which have already been shown suitable for use. Indigenous and adapted local strains of exotic species will be obtained in Kenya. The seedlings for planting will be raised in the ICRAF nursery at Katumani. The experiments will be planted at the NDFRS maruba field station, and on farm at Katangi. The farms will be those of interested farmers who are already active in innovation, and the trees to be planted will be the most promising improved varieties.

At least 10 farmers will be sought to participate in the trial which will include alley cropping trials of Gliricidia sepium.
Assessments:
- Survival and growth at annual intervals after planting.
- Suitability of foliage for fodder and browse.
- Fuelwood acceptability.

Duration
October 1987 - August 1990

Outputs:
Yield and performance data for new and improved germplasm.
Indications of acceptability to farmers.

5.2.3 Control of pests of planted trees, especially termites

Objectives
To evaluate the use of "Aldrex" and other locally-manufactured insecticides to treat nursery planting stock.

To investigate the availability of alternative insecticides against termites in particular, both for field and nursery use.

These trials would be on-farm and in the nurseries.

Personnel needed:
Silviculturist
Extension specialist
Nurserymen

Methodology
Standard locally-available chemicals will be obtained from the main farmers' outlets and applied both according to the makers' instructions and in accordance with the published methodologies for tree protection. In particular, the treatment of plant pots in the nursery by well-trained and protected nurserymen, without the need for further field treatment, will be investigated. The applications will be made to normal planting stock in the ICRAF and project nurseries, and the field planting will be on-farm in areas indicated by farmers to be termite-prone. Alternative chemicals to the "Aldin" and "Dieldrin" formulations will be sought from the manufacturers for trial. Simple trials of locally grown natural insecticides such as those obtainable from Neem and Persian Lilac will be tried also, on-farm. Only trees known to be susceptible to termites will be used for these trials.
Assessments:
- Survival of planted trees annually.
- Identification of main causes of death in casualties.

Duration:
August 1987 - August 1990

Outputs:
Detailed instructions for extension workers, farmers, nurserymen and others on the use of insecticidal chemicals for the control of field pests.

5.2.4 Introduction and Improvement of Fruit Trees

The enthusiasm of farmers for fruit trees for improving nutrition and farm income was noted several times in the past. The main varieties of Citrus do well, and Mangoes, Papaya and Guava are all well-known. There is, however, a need to improve on the traditional varieties if possible, and to investigate new fruiting trees previously not known in the area.

Objectives:

To identify and introduce improved varieties of fruit trees, especially Mango (from the Kenya coast and India) and Guava (mainly from India). In addition, improved Citrus varieties would be sought. In all cases, the advice of the Agriculture Department would be sought on suitable sources.

To raise rootstocks of *Zizyphus* species for grafting improved fruiting material of the famous "Ber" from the semi-arid zones of India, to graft suitable material, and to evaluate the resulting orchard trees on-farm and on station.

Personnel needed:

Silviculturist
Extension specialist
Agricultural/horticultural specialists

Methodology:

Rootstocks of *Zizyphus mauretania* to be raised in the nursery at Kakuyuni; some of these to be supplied to the Plant Quarantine authorities for testing vegetative imported material, some to be planted by farmers for subsequent grafting of improved material in the field, and some to be planted at the Kakuyuni dam site for on-station trials.
Total number of rootstocks to be about 200 over the period of the project. The scions of improved "Ber" will be sought from the Central Arid Zone Research Institute at Jodpur in India, and will be sent by air to Nairobi for screening by quarantine before grafting on-station for multiplication for issue to farmers. The other improved fruit varieties will be sought through the Agricultural Department or overseas as appropriate, raised to farmers for evaluation. Protection against termites will be practised in all cases.

**Assessment:**

- Survival of planted trees and rootstocks.
- Success of grafting; assistance from qualified horticultural specialists would be sought.
- Long term yield and quality assessments, using farmer's evaluations as far as possible.

**Duration:**

August 1987 - August 1990. However, few valid long term results are expected in this time, and the trials would need to be monitored for at least 15 years.

5.3 Adaptive research

5.3.1 Alley cropping

**Objective:** to test the viability of alley cropping on-farm

**Manpower:** Agronomist
              Silviculturist
              Extension Specialist

**Material inputs:** seedlings

**Methodology:** Experiments on 3 farms will continue and an additional 5 to 10 plots will be added to increase the validity of the observation.

The project staff will supervise the layout and establishment of the hedgerows and initially provide some advice on the crop establishment in the alleys. Guidelines will also be provided on the management of the hedges once they are ready for lopping. Over time the researchers should distance themselves from the management aspects of the system and observe the farmer's management of the trial.

**Monitoring:** labour inputs in establishing and maintaining the hedges; observation on labour and material inputs as compared to normal cropping; development of crop yields over time; specific practices, introduced by the farmer; farmers' acceptance of the technology.
Duration: September 1987 - August 1990

Outputs

i) assessment of labour inputs for establishing and monitoring the alley cropping system
ii) assessment of yield development
iii) assessment of the adoptability of this technology.

5.3.2 Management of improved grazing land

Objective: To develop an appropriate management system for the use of the improved grazing land for grazing and harvesting of poles and fuelwood.

Manpower:
- Pasture Specialist
- Extension Specialist
- Silviculturist

Methodology: A system of rotational grazing and cut and carry fodder collection will be discussed with the 2 farmers who already have an improved grazing area.

Also the harvesting of newly planted tree for fuelwood and/or poles will be discussed.

Monitoring: Labour inputs for maintaining the plots, especially the fence, vegetative growth, stocking rates and pd and grass production for cut and carry and off take of poles and fuelwood.

Outputs: i) management plan for improved grazing area
ii) assessment of potential production capacity
iii) assessment of economic viability of the package in combination with research described in 5.1.3

Duration: September 1987 - August 1990

5.3.2.1 Melia Volkensii browse project.

Objective: - To investigate potentials of fruits, leaves and bask as supplement for ruminant animals.
- To investigate the potentials of establishing Melia volkensii fodder banks for use at peak demand times.

Manpower: - Tree breeder - KEFRI
- Silviculturist - KEFRI
- Animal production expert
Methodology: - Field and laboratory investigations will be jointly run by KEFRI and KARI (animal production staff).

Monitoring: - Laboratory analysis for Animal feed values from bark, leaves and fruit will be undertaken.
  - Field sampling based on survey results from RTDS project to ascertain provenance differences will be undertaken.

Outputs: - Information on feed values of *Melia Volkensii* as well as its potential as a forage supplement for dry periods in the semi-arid areas.


5.3.3 Hydrological studies

Objective: To examine the hydrological implications of the Katangi over-grazed land currently under rehabilitation.

Manpower: MSC. student from KEFRI to be registered in a Canadian University.

Methodology: The following measurements will be conducted on both rehabilitated and control plots at Katangi.

- bulk density
- profile moisture content
- infiltration rates
- total run-off and sediment production
- time to run-off

Conventional methodology will be adopted for each aspect.

Output: A comprehensive hydrological report that would form a basis of preparation of management plans for deteriorated sites in agro-climatic zone 5.

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<thead>
<tr>
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<th>1988/89</th>
<th>1989/90</th>
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<td>Q1  Q2  Q3  Q4</td>
<td>Q1  Q2  Q3  Q4</td>
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<td>- preparation of leaflet</td>
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<td>- selection of children and groups</td>
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<td>2. Objective 5.1.2 Production of seedlings and distribution through self help groups</td>
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<tr>
<td></td>
<td>3. Objective 5.1.3 Dissemination of grazing land package through self help groups</td>
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<td>Quarter</td>
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<td>2</td>
<td>3</td>
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<tr>
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### Time Table for Activities (cont.)

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<tr>
<td>C. Biological Research</td>
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</tr>
<tr>
<td>D. Control of Pests of Planned Trees, especially Termites</td>
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<tr>
<td>E. Introduction &amp; Improvement of Trees</td>
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<tr>
<td>F. Species and Provinces Trials</td>
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<tr>
<td>G. Logistical Research</td>
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- Adaptive Research
- Biological Research
- Control of Pests of Planned Trees, especially Termites
- Introduction & Improvement of Trees
- Species and Provinces Trials
- Logistical Research

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## To Be Administered by Recipient

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<th>Year 3</th>
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<td>18,150</td>
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<td>14,520</td>
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<tr>
<td>Agro-horticultrist</td>
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<td>436,548</td>
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<td>- Total Recipient Contribution</td>
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</tbody>
</table>
1. **SALARIES AND ALLOWANCES**

**Project Manager and Agroforester**

It is assumed that the current occupants of the posts will continue occupying the posts. The salary of the Project Manager will therefore be the current salary with an owner/occupier house allowance of 4,500/= pm, which will remain constant for the duration of the project. The agroforester will start at the beginning of the project and the current salary with an owner/occupier house allowance of 2,500/= pm. It is assumed that the current occupants of the posts will continue occupying the posts. The salary of the Clerical Officer is in lien of the current Administrative assistant post. House allowance will be as per the current KEFRI terms for the rest of the staff.

2. **Research Expenses**

- Casual Labour: From the experience of the current project it has been found that a minimum of eight workers are required full time both on station trials and nursery site.
- Fuel and maintenance: The current Suzuki pickups are getting old and need frequent maintenance. The rates have risen from 19/= p.d at the beginning of the project to 29/= p.d at present an increase of 48%.
- Field supplies and equipment: This vote will be used for buying tools for women's groups as well as chemicals and seeds.
- Project Manager and Agroforester: In addition to the salary, 10% fixed house allowance of 2,500/= pm, 4,500/= pm which will remain constant for the duration of the project. The agroforester will start at the beginning of the project and the current salary with an owner/occupier house allowance of 2,500/= pm. It is assumed that the current occupants of the posts will continue occupying the posts. The salary of the Project Manager and Agroforester.

3. **Socio-economic Survey**

To be done at Uasin Gishu in 3 sites.
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<td>KEFRI Research Officers</td>
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<tr>
<td>IDS Research Scientist</td>
<td>600/= each</td>
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<td>Vehicle Hire (6 100/= p.d.)</td>
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<td>2 Research Assistants (Students from Moi University)</td>
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<tr>
<td>Total Contingency</td>
<td>10,500</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>RECIPIENT CONTRIBUTION</td>
<td></td>
</tr>
<tr>
<td>The contribution will be in form of salaries to seconded staff as well.</td>
<td></td>
</tr>
<tr>
<td>5. RECIPIENT CONTRIBUTION</td>
<td></td>
</tr>
<tr>
<td>For on station trials, this will be used to buy an electronic weighing balance &amp; a KG capacity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL COST</td>
<td>130,500</td>
</tr>
</tbody>
</table>
### Item 1: Salaries & Allowances

<table>
<thead>
<tr>
<th>Item</th>
<th>Year 1 (K. Shillings)</th>
<th>Year 2 (K. Shillings)</th>
<th>Total Administered (K. Shillings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>120,000</td>
<td>120,000</td>
<td>240,000</td>
</tr>
<tr>
<td>Agroforester</td>
<td>45,000</td>
<td>45,000</td>
<td>90,000</td>
</tr>
<tr>
<td>Clerical Officer</td>
<td>25,000</td>
<td>25,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Field technicians</td>
<td>30,000</td>
<td>30,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Driver</td>
<td>12,000</td>
<td>12,000</td>
<td>24,000</td>
</tr>
</tbody>
</table>

### Item 2: Research Expenses

- Casual labour
- Field supplies
- Fuel and maintenance of vehicles
- Office supplies
- Telephone
- Postage
- Documentation
- Medical supplies
- Field supplies
- Casual labour

### Item 3: Publications

- Field equipment
- Field research
- Field survey
- Socio-economic survey
- Field technical
- Field work

### Item 4: Training (In Service)

- In-service training for technicians at Kenya Polytechnic Centre

### Item 5: Field Equipment

- Small equipment
- Fuel and maintenance of vehicles
- Small equipment
- Fuel and maintenance of vehicles

### Item 6: Total Field Equipment

<table>
<thead>
<tr>
<th>Item</th>
<th>Year 1 (K. Shillings)</th>
<th>Year 2 (K. Shillings)</th>
<th>Total Administered (K. Shillings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Equipment</td>
<td>120,000</td>
<td>120,000</td>
<td>240,000</td>
</tr>
<tr>
<td>Training (In Service)</td>
<td>45,000</td>
<td>45,000</td>
<td>90,000</td>
</tr>
<tr>
<td>Publications</td>
<td>25,000</td>
<td>25,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Research Expenses</td>
<td>30,000</td>
<td>30,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Training (In Service)</td>
<td>12,000</td>
<td>12,000</td>
<td>24,000</td>
</tr>
</tbody>
</table>

### Item 7: Total Recipient Administered

<table>
<thead>
<tr>
<th>Item</th>
<th>Year 1 (K. Shillings)</th>
<th>Year 2 (K. Shillings)</th>
<th>Total Administered (K. Shillings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>250,000</td>
<td>250,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Year</td>
<td>IDRC Contribution in CAD (10%)</td>
<td>IDRC Administered (10%)</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------</td>
<td>--------------------------</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>12,584</td>
<td>22,167</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7,167</td>
<td>7,254</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7,254</td>
<td>27,005</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>53,584</strong></td>
<td><strong>82,424</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Comments**

- To be administered by IDRC.

- Revolution Centre for use by
  - Revolution Centre. 
  - to be allocated to Hunter Green
  - double cab 4x4 - Katherine.

- University of Cape Town
  - to be awarded to Massachusetts Institute of Technology.

- University.
  - fellowships (1).
  - conferences and seminars.

- Training.
  - course and seminars.

- Consultancies.

- Equipment.
  - motor cycles (1).
  - vehicles (1).

- Year 1:
  - 15,000
  - 5,000

- Year 2:
  - 5,000
  - 2,500

- Year 3:
  - 10,000
  - 2,500

- Total:
  - 27,000
  - 7,254
Dryland Agroforestry Research Project
Assessment of Local Farmer Participation

The Phase II on-farm scheme of the Dryland Agroforestry Research Program (DARP), sited in Machakos District, Kenya, was designed to incorporate farmer participation in an effort to:

- examine the possibilities for maintaining, or increasing, the productivity of the cropping systems by establishing alley cropping;

- examine the possibilities for the improving the quality, quantity and seasonal distribution of forage on the farm by planting fodder tree/shrub species in the grazing areas and by developing cut-and-carry forage systems;

- examine the possibilities for reducing the labour input requirements of the free-grazing system and fuelwood collection by establishing living fences around the grazing land, and by on-farm fuelwood tree planting;

- examine the possibilitites for increasing the cash income of the farmers by the introduction of fruit trees (Mwendandu, 1986:1).

This report entails an assessment and evaluation of the nature and degree of local participation in the on-farm trials, in Phase II of the DARP, whose objective was to introduce and incorporate the use of multipurpose trees into local farming practice. While any attempt to incorporate local people into the development process is an achievement, it will be shown that, with respect to the DARP, farmer participation was generally limited to employing farmers as the implementors of technology as opposed to local farm experts. Effective and fair local farmer participation must establish a mutual and egalitarian collaboration between farmer and researcher which validates and incorporates local knowledge and experience as a fundamental part of the project design and goals. For local participation to be mutually
beneficial, a give and take relationship, local expertise regarding agro-ecological environments should be investigated and incorporated. With respect to DARP, this does not appear to be the case. Suggestions regarding possible amendments to the project design which would encourage a more synergistic co-operation between development groups and local farmers will be included where applicable. A number of factors will be considered in this evaluation:

(i) how were farmers chosen for participation in the on-farm project (i.e. on what criteria),
   - to what extent, if any, were household and community politics taken into consideration when making these kinds of decisions (i.e. who does, and who does not, participate with respect to gender and wealth)

(ii) on farms which did participate, to what extend did the farmers have control, and decision-making power, over the project design and implementation;

(iii) to what extent were the suggestions (positive or negative) of the participating farmers incorporated into the project design or documented for future work.

The following analysis is limited in scope to the Phase II portion of the DARP. The primary reason for this is that Phase I of DARP was conducted on station without any formal farmer participation. Moreover, the following discussion is based solely on DARP research reports; opinions and conclusions therefore, are formulated based upon the available literature and not actual field experience with the agroforestry project. A discourse analysis of what is and is not documented regarding the on-farm portion of DARP is however considered to be equally valuable.
Farmer Selection for On-Farm Trials - DARP

The objective of this section is to call into question the criteria upon which farmers were selected to participate in the on-farm trials of Phase II in the DARP. While much of the selection criteria no doubt appeared practical and logistical to the development facilitators, it will be shown that the criteria upon which farmers and their plots were chosen to participate had the effect of marginalizing a number of local people who may have wished to participate. By selecting only a particular type of farmer, considerable insights and forms of knowledge are lost from the project. Moreover, as particular groups of people are excluded from the development scheme, the agro-ecological and economic conditions under which they farm are effectively overlooked by researchers and consequently do not fall within the parameters of the study. In this way, the results of the project may only be applicable of feasible for the target group of farmers, and not the greater part of the community. Thus, the degree to which the selected farmers represent a reliable cross-section of the local farming community (i.e. with respect to wealth, age, gender etc.) is directly related to the overall applicability of the projects results and development suggestions.

The selection of farmers and plots for the Dryland Agroforestry Research Project were those which had the following characteristics:

(i) relatively large farmers with bullocks, who can afford to experiment on part of their cropland;
(ii) plots which have been under cropping for an extended period of time and which are not usually manured;
(iii) plots which have a terrace structure in place and have either Ferralsols and Cambisols (Nyamai, 1990:4).
The project insisted upon choosing farmers with a large amount of land because it was suggested that to obtain realistic farm data, plot sizes should be fairly large. Also large plot sizes, according to the project facilitators, would increase variability and in turn increase the amount of observational information to be fed back to on-station research (ibid:4).

Limiting farmer participation in on-farm trials to those who have large plots of land, while having some logistical benefits (as mentioned above), have had some serious deleterious effects. First of all, limiting farmer participation to those with large plots of land effectively, however unintentionally, favours wealthier farmers over those who are comparatively poorer. Since wealthy and poor farms do not necessarily share the same problems with respect to agriculture (although this is often assumed), the needs of the poorer farmers are effectively marginalized from the scope of the DARP. For example, often a major impediment to sustained agricultural production on poorer farms is a lack of cash to purchase seeds and other fertilizers. In fact, many of the problems faced by farmers in African communities have less to do with biophysical shortcomings, and more to do with socio-economic and political inequalities at the household and community level - something which is not addressed by the project facilitators.

In the same way the project neglected to decipher the needs of different gender groups. The project blindly assumed that male and female headed households suffer the same constraints to farm-level production (which is rarely the case), and consequently did not require equal representation between men and women in the on-farm trials. As female-headed households often experience a comparatively greater difficulty in sustaining farm production (for example, as a result of impaired access to productive resources), the needs of women farmers specifically are marginalized.

The problems caused by this criteria scheme therefore jeopardized not only the needs of
those who were unable to participate but also the project objectives themselves. The primary goal of the Dryland Agroforestry Research Project was to examine the possibilities for improving the quality of life of the inhabitants of the semi-arid lands of Kenya by developing agroforestry technologies geared to solving farm constraints to agricultural production. Incorporating local participation into the project design is intended, generally speaking, to create an environment in which the needs of local people may be articulated by the people themselves. The DARP project however, by neglecting existing socio-economic and gender differentiation at the community level, failed to create agricultural/technological options which were applicable and feasible to all members of the farming community. In the case of the Dryland Agroforestry Research Project the question must be posed - a better quality of life for whom?

In order for the needs of all farmers (of different wealth and gender status) to be realized by an agricultural development project, the selection of farmers to participate must be representative of different socio-economic and gender groups. If however, the need for large plots of land remains important to the integrity of the project objectives, other strategies may be employed which may allow the concerns of all local farmers to be articulated. Simply because a farmer is unable to participate in farm-level experimentation does not necessarily dictate that his ideas and experience cannot be incorporated into the project. Individual and group interviews and community meetings, for example, may serve a consultative function, allowing for local knowledge, experience, and experimentation of all farmers to be validated and incorporated into the project design.

**Participation and Farmer Control/Decision-Making Power**

An important, if not critical, component of local participation in a development project is the belief that the farmer is an equal partner in the project's design and implementation. Since
the local community generally, and the farmer specifically is the beneficiary of a given agricultural development scheme, it seems only fitting that he/she/they have a measure of control over the project design, implementation, and monitoring. In the case of the Dryland Agroforestry Research Project, the results are mixed. In many, if not most, areas the local farmer was no more than the implementor of a prescribed agroforestry technology designed by the development group. Is this really participation?
OBJECTIVES

The Dryland Agroforestry Research Project sited in Machakos District aims at developing agroforestry technologies for the semi-arid areas of Kenya focusing on related land use systems with a view to improve the quality of life of the inhabitants.

The specific objectives were as follows:

- to examine the possibilities for maintaining/increasing the productivity of the cropping systems by establishing alley cropping system.

- to examine the possibilities for improving the quality, quantity and seasonal distribution of forage on the farm by planting fodder trees/shrubs species in the grazing areas and by developing cut and carry forage systems.

- to examine the possibilities for reducing the labour input requirements of the free-grazing system and fuelwood collection by establishing living fences around the grazing land, and by on-farm fuelwood tree planting.

- to examine the possibilities for increasing the cash income of the farmers by the introduction of fruit trees.

AGROFORESTRY TECHNOLOGIES

In order to solve farm constraints, agroforestry technologies (AFT's) were formulated and tested on station. Although agroforestry is an old art, the technologies had to be tested to establish whether the practices were compatible with the semi-arid conditions and local cultural norms. Appropriate technologies for testing were identified as follows:-

- An alley cropping system using Leucaena leucocephalla, Cassia siamea and Gliricidia sepium intercropped with maize/beans at varying espacements.

- Fodder banks in the farms using Leucaena leucocephalla to be used in a "cut and carry" system.

- Fruit trees orchards of Carica papaya (Pawpaw), Citrus, Mangoes and guavas intercropped with maize/beans at different espacements.

- Home gardens and amenity planting using various multipurpose trees (MPTs) such as Grevillea robusta, Cassia siamea, Eucalyptus spp. etc.

- Live fences using species such as Caesalpinia spinosa, Parkinsonia aculeata, Zizyphus mauritania, etc.
The parameters of interest in the on-station research at Maruba were those considered to be beneficial to the farmers. This included biomass production of woody perennials, grain yield in cereal crops and the survival rates of all components. Based on these results of the on-station trials, the AF technologies were tested on farmers' land. Up to now the project has developed a good understanding of the bio-economic potentials and constraints of Agroforestry technologies tested. The use of Alley cropping technology to boost crop yield was realised in the last two cropping seasons. This, however, needs to be confirmed in more farmers' fields. The project has however managed to popularize and validate the AFT's to farmers.

NURSERIES

Currently the project operates one nursery at Katangi to raise seedlings to be supplied to the contact and non contact farmers. DRAP also encourage groups and individual farmers to initiate and manage prototype nurseries to raise their own seedlings. This is achieved by providing the basic materials such as watering cans, good forest soils and poly-tubes. The project staff also do organise training courses on basic nursery methods of seedling tending. This facility is also extended to schools within project area. By doing so, seedlings and information of AFTs can be disseminated to farmer clients not accessible to the project area through their children.

ACHIEVEMENTS OF PROJECT

Phase 1 - The project identified several promising tree species and low input agroforestry technologies such as alley cropping, grazing land rehabilitation, fodder banks, woodlots, and fruit trees establishment. This were all achieved through a combination of on-station and on-farm activities.

Phase 2 - Several other tree species were screened, management options prioritized and on-farm trials refined. During this phase it was identified that fruit trees were highly valued because they generate cash income. Collaborative work with schools was further strengthened because it had the multiple advantage of training young potential farmers as well as reaching more farmers especially those outside the project area.
BACKGROUND

In 1983 ICRAF scientists in collaboration with scientists from the National Dryland Farming Research Station (NDFRS - Katumani) and the Machakos Integrated Development Programme (MIDP) carried out a Diagnosis and Design (D and D) study for the semi-arid land use systems in Machakos District. Based on this study, the Dryland Agroforestry Research Project (DARP) was initiated by the Kenya Forestry Research Institute (KARI) - in collaboration with NDFRS and MIDP with ICRAF in advisory capacity. The DARP Project, with funding from the International Development Research Centre (IDRC) is in the third phase which is better referred to as technology transfer phase.

Since the beginning of this project, a number of research activities focusing on specific agroforestry interventions have been tested collaboratively with the farmers on their fields. Most of these interventions are still continuing as well as new ones that have been initiated. Results and/or observations have been reported in various research reports and notes covering the period from November, 1983 to December 1991.

On-farm research activities are carried out at Kakuyuni catchment area of Yatta Division while the on-station research is conducted at Maruha farm at Katumani (near ICRAF field station). Kakuyuni area lies in the agro-ecological zone 5 on the Yatta plateau and 60kms East of Machakos town on the Kitui road. The area realises an annual bimodal rainfall of about 700mm; soils are predominantly ferralsol-cambisol association with lithic phases and vertisols are found in poorly drained depressions. The dominant trees and shrubs comprise of Combretum molle, Acacia tortilis, Acacia nilotica, Terminalia brownii and Balanites aegyptiaca. Acacia dreponolobium are common on the black cotton soils.

The common farming system at Kakuyuni is sedantary agriculture with livestock as a major component of the landuse. Pressure of increasing livestock and human populations is threatening both the medium and long term sustainability of land resource. Some of the major constraints in the farming community were identified and prioritised as follows:-

1. Low levels of crop production due to insufficient levels on nitrogen in the soil.
2. Low soil fertility due to soil degradation.
3. Lack of fodder (especially during the lean periods i.e May - September and January - February.
4. Lack of cash income.
5. Lack of labour for the off-farm activities.
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