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ICRAF
INTERNATIONAL COUNCIL FOR RESEARCH IN AGROFORESTRY
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REPORT ON THE FIFTH ICRAF/USAID AGROFORESTRY COURSE 4—22 NOVEMBER 1985 NAIROBI, KENYA

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MARCH 1986

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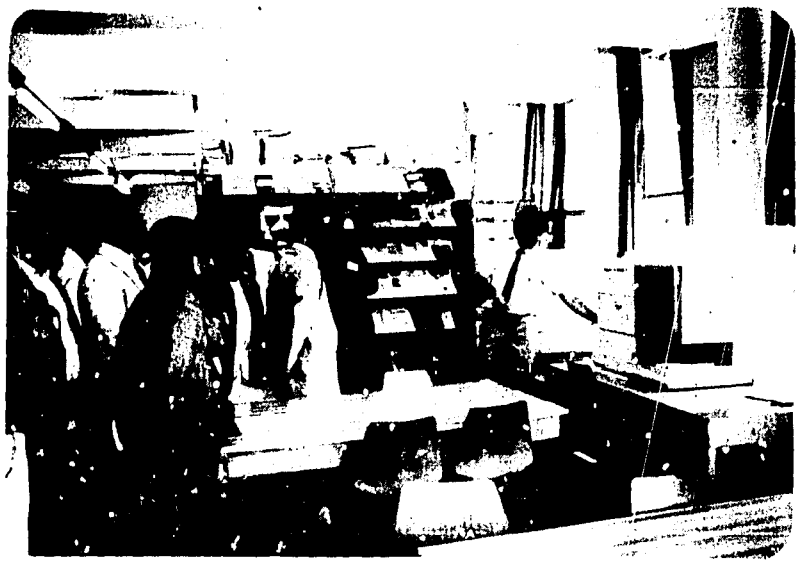
AGROFORESTRY COURSE IN PICTURES

OPENING SESSION

Dr. Bjorn Lundgren, ICRAF's Director welcomed the course participants and gave the opening address.



An introduction to ICRAF's information and documentation services by Richard Labeile.

Agroforestry experience in Kenya by Amare Getahun*

*Energy Development International (Ministry of Energy & Regional Development).

FIELD TRIPS

At ICRAF Field Station, Machakos participants are introduced to the Agrometerological facilities by Dr. Till Darnhofer.

At Mtwapa Agroforestry Centre, Mombasa, Dr. Jonathan Okafor, on behalf of the course participants, planted a commemorative tree outside the centre's offices.

At Baobab Farm Ltd, Mombasa, the role of agroforestry in the reclamation of a quarry site is explained by Mr. Rene Haller*

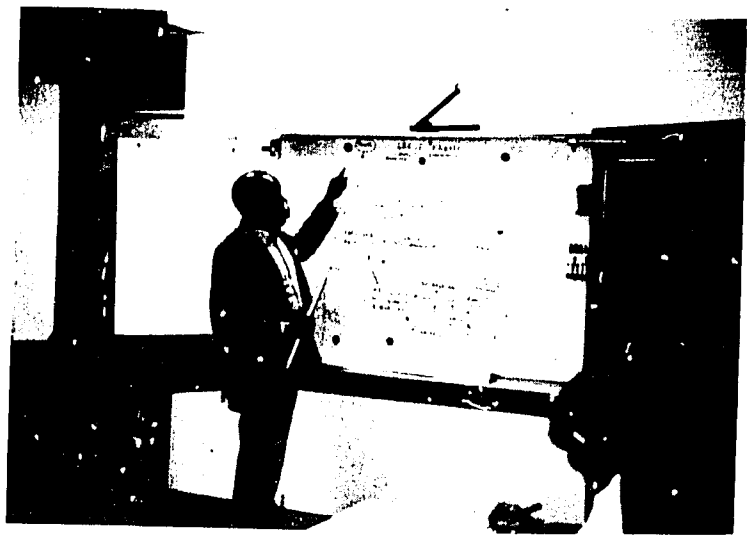
*Farm Manager, Baobab Farm Ltd.

Interviewing farmers around the Kakuyuni project site in Machakos

The farmer (second infront) takes the participants round the farm during interviews.

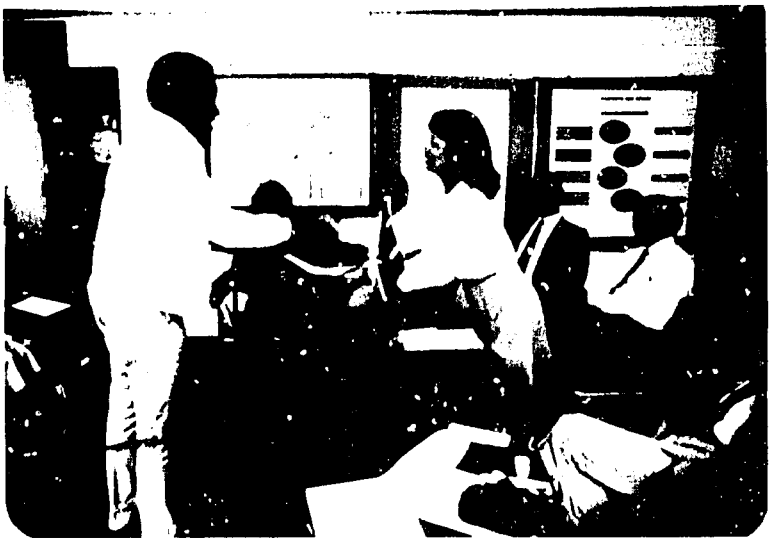
Participants relax at a tented camp site in Katangi Machakos, at the end of the first day of interviewing farmers.

Groups met to discuss land use problems diagnosed in the field and discussed possible interventions to solve the diagnosed problems.



Participants presented diagnosed problems and potential interventions to improve the land use system.

Participants got involved in the economic appraisal of selected agroforestry interventions with ..ULBUD.



Certificates of attendance were issued to course participants.

Final evaluation of the course and vote of thanks by participants.

INTRODUCTION

Background

1. By its unique multidisciplinary nature, agroforestry approach to land use dictates the need for a combination of resources available from institutions involved in agriculture, livestock production, forestry and other related sectors. While this is a pragmatic approach, its implementation in most developing countries faces two major constraints: the very rigid disciplinary boundaries between existing institutions and lack of trained manpower. As an in intiative in starting to face the challenge of the above mentioned constraints, ICRAF, under a cooperative agreement with the USAID, has been developing the model of a three-week training course and a package of training materials on Agroforestry Research for Development: Concepts, Practices, and Methods. This is a short term training aimed at multidisciplinary and inter-institutional teams of research scientists and development planners in LDCs.

2. The format and training materials have so far been tested in a series of five training courses (this being the last) sponsored by United States Agency for International Development (USAID). The first and second courses held in Nairobi, Kenya, in November 1983 and June 1984 respectively, were mainly for participants from the Africa region. The third course took place in October 1984 at the Universiti Pertenian Malaysia and was attended by participants from the ASEAN region. The fourth course was held in Peru in June 1985 and was attended by participants from the Amazon region.

3. The fifth and last course, under the ICRAF/USAID Cooperative Agreement, which is discussed in this report, was held in Nairobi, Kenya, from 4 to 22 November 1985.

Participants

4. Twenty nine participants from twelve (mainly African) countries attended the course distributed as follows: Burundi (2), Ethiopia (2), Kenya (7) Madagascar (3) Malawi (1), Mali (1), Nigeria (1), Philippines (1)Rwanda (2) Sudan (5), Uganda (3) and Zimbabwe (1). Most of the participants came from national institutions engaged in some form of agroforestry research, development and/or teaching. The disciplines represented were forestry (11), agronomy (6), ecology (4), animal science (2) soil science (2), economics (2) , extension education (1) and political science (1). See Annex I for list of participants.

5. A list of invited speakers/guests and ICRAF staff who participated in the development of the programme is in Annex II.

Dr. Ester Zulberti was the course coordinator assisted by Mr. James Wahome.

Objectives

6. The overall objective of the course was "to enhance the professional capabilities of research scientists and development planners from developing countries, for initiating and implementing agroforestry research, leading to the development of systems and technologies that are both suited to local conditions and adoptable by farmers." This objective was accomplished by exposing the participants to:

.the concepts and practices of agroforestry as a land-use system;
.ICRAF's methodolcgy to diagnose agroforestry related land-use problems and potentials and to design appropriate interventions to overcome the constraints so diagnised (the D&D Methodolcgy);
.descriptions of predominant agroforestry systems and practices in African countries: and, appropriate experimental approaches to generate agroforestry technology.

*The Philippino participant is at present a Research Fellow at ICRAF

PROGRAMME

7. Registration and opening session - Registration took place at ICRAF headquarters on 4 November where the participants were issued with a package of training materials for the first week and general information about the course. Financial and administrative matters were also settled with the course coordinator. Most of the participants were accommodated at the Sixeighty Hotel across the street from ICRAF.

8. The Director of ICRAF, Dr. Bjorn Lundgren, gave a welcome address to the participants during the opening session in the presence of ICRAF staff.

9. A reception was held on November 4 at Dr. Ester Zulberti's residence, for the participants and attended by ICRAF staff and invited guests from international and national institutions in Kenya.

10. Programme structure and content - The focus of the course was on ICRAF's multidisciplinary approach to land use problems and specification of priorities for research in order to develop and test sound agroforestry technologies to fill in identified gaps.

11. The course programme was structured in two modules aimed at covering the following:

    I- the conceptual and technical background of agroforestry, and

    II- the diagnosis and design methodology and appropriate experimental approaches to generate agroforestry technology. The scope, sequence and approximate duration of each module is indicated in Table 1.

12. Prior to the course, participants had been requested to prepare reports with descriptions of agroforestry systems and practices prevalent in their respective countries. Guidelines had been previously provided by ICRAF for this purpose.

Table 1. SCOPE, SEQUENCE AND DURATION OF TRAINING MODULES

MODULE	MAIN TOPIC	PROVIDED ANSWERS TO	DURATION
1	The Conceptual and Technical Background of Agroforestry	. What is agroforestry? . What are some of the existing . systems and practices? What is the role of tree-crop associations, animals, economics, the human factor, etc. in agroforestry?	5 days
11	a) The Diagnosis and Design Methodology	What is the conceptual framework? What are the steps and stages? What examples are there of D&D applications and with what results? (Case study) How does it work in practice? What do we know that can be of immediate use?	8 days
	b) appropriate Experimental Designs	What appropriate experimental designs are there to generate agroforestry technology?	2 days

With the help of Prof. Anthony Young, who acted as the moderator, participant report groups were established on the basis of subject matter and/or country of origin. Nineteen reports were discussed. Summaries of reports/papers prepared by participants can be be seen in Annex III.

13. Below is a brief summarized account of the main activities undertaken in each module.

Module 1

Presentations: Through lectures, slide presentations and discussion sessions, ICRAF staff and invited speakers presented the concepts and practices of agroforestry. Papers presented invited speakers are in Annex IV while the course time table and daily programme of activities can be seen in Annex V

Field observations: Two guided trips for field observations were organized. The first one was to the fertile uplands of Kiambu District which provided an opportunity to see a wide range of land use systems. The second one was to the ICRAF Field Station in Machakos District mainly for participants to observe demonstration trials on

(a) multipurpose trees and shrubs,
(b) soil conservetion techniques
(c) tree establishment
(d) tree crop interface
(e) systematic tree arrangement
(f) windbreak
(g) alley cropping
(h) germsplasm
(i) intercropping and
(j) living fences

Module II.

The purpose of this module was to provide the participants with first-hand experience on the benefits and difficulties of a multidisciplinary approach to land use. As outlined below, ICRAF's rapid appraisal diagnostic and design methodology was sequentially introduced and applied.

.A presentation of CIMMYT's conceptual and methodological approach to On-Farm Research and their experiences to-date in Africa (lecture and slides).

.Introduction to ICRAF's Diagnostic and Design Methodology

.An overview of the D and D applications under different ecological and socio-economic conditions.

.Pre-diagnostic information on the Kakuyuni Project area(site of Kenya Care Study) was presented and discussed in preparation for the field survey

.Field survey was carried out in small multidisciplinary groups in households around the Kakuyuni Catchment. Two days were set aside for farmer interviews. Two of the four groups interviewed small scale farmers (with less than 10 acres while the other two interviewed large scale (with more than 10 acres) farmers.

.Diagnostic analysis took place at ICRAF headquarters. One day was allocated to analyse the information gathered on land use problems and potentials while a second day was spent on deriving and refining technical specifications for appropriate land use systems.

. Design Stage

Based on the diagnostic analysis above, agroforestry models - derived from the information obtained during farmer interviews- were developed. Possible interventions that fitted the specified systems design were listed. The participants then regrouped and prioritized management practices established. At the close of the day, a demonstration of a computer programme to predict productivity/sustainability of tree/crop mixture was held.

•Research Stage The participants split into their respective groups and worked on technology specifications aimed at alleviating diagnosed land use problems and exploiting identified potentials in the project area.

The broad functional specifications arrived at were:

a) Diversification and increase of the cash income
b) Improvement of crop production per unit area
c) Ensuring future supply of adequate quality of woodfuel (firewood and charcoal).
d) Provide for shelter needs

Furthermore, components and management for each of the technologies were specified and elaborated on. A meeting of farmers selected from those that had been interviewed during the field exercise, and the respective participant groups and group leaders was held at he ICRAF Field Station with a twofold purpose. Firstly, to consult with farmers on the agroforestry models designed by the groups. Secondly, to let farmers observe agroforestry practices on demonstration plots.

•Technology Design Evaluation

The bio-physical environmental, and social/environmental and economic aspects and their role in the design of agroforestry technology/research were presented and discussed. The economic appraisal of agroforestry interventions came next. The participants were given an opportunity to try their hand on ex-ante economic analysis and MULBUD* applications. A short session was held to enlighten participants on sources of agroforestry information including the availability and types of specialized data bases. This was followed by presentations on agroforestry research planning, experimental bases for computer selected agroforestry interventions and a demonstration on a computer programme for calculating systematic spacing designs.

*MULBUD is an interactive package designed to assist in the economic appraisal of land use system involving trees, either as ' sole' enterprises or in combination with other enterprises.

On the morning of the last day, a final presentation on on-farm experimentation was given. This generated lively discussions between ICRAF staff and the participants.

14 Special Activities.

Three films, i.e. Monitoring the Environment, Trees of Hope and Choices, from the United Nations Environmental Programme (UNEP) and the International Development Research Centre (IDRC) were screened each once at lunch breaks during the first and second weeks. A farewell party was organized by the participants at the Carnivore, a popular local restaurant in Nairobi, on the evening of the last day of the course.

A visit to the Kenya Coast was organized by ICRAF as part of the programme. For two days, the participants visited two sites of the Kenyan Renewable Energy Development Project (KREDP) at Mtwapa and Matuga and the Baobab Farm both situated at the Kenya Coast. Participants were able to see the following at each of the projects.

i) Mtwapa and Matuga Agroforestry Centres

nursery for multipurpose trees
seed orchards
agroforestry research/demonstration on browse/fodder multi-purpose tree species such as leucaena leucocephala, Gliricidia sepium, Prosopis spp. and Sesbania grandiflora.
biogas and stoves programmes which are mainly used for training extension staff.

ii) Baobab Farm is a subsidiary company of Bamburi Portland Cement which is charged with the responsibility of reclaiming and rehabilitating quarry sites after the cement making material has been removed from the top layers. Over its 30 years existence, the Boabab Farm has developed the following major activities on the reclaimed sites:

- woodlots of Casuarina and Eucalyptus spp.
- growing of bananas, grapes, pineapples, cashewnuts and, citrus etc.
- rearing of crocodiles
- rearing of tilapia - e.g. with an annual output of 30 tonnes of fish. Incorporation of wildlife; e.g. over 85 species of birds, hippotamus,buffalo, monkeys and blueback, into the ecosystem and, of course, the giant millipedes to breakdown the coral and replenish the soil fertility into the ecosystem. A truly integrated system of animal husbandry icluding sheep, goats, oryx and eland to make use of the forage from the undergrowth and the high quality browse/fodder from species such as Prosopis and Leucaena that have been successfully grown on the dry and rough portions of the farm.

15 Monitoring

Monitoring procedures were applied throughout the development of the course with the aim of identifying programme weaknesses and applying corrective measures in time. Review and formative evaluation sessions were organized at the end of the first, second and third weeks.

16 Evaluation

A final summative evaluation session took place on the last day of the course. An evaluation form designed for this purpose was handed out to participants. Twenty eight evaluation forms were filled out and returned. The results of this evaluation and the participants main comments are in Annex VI. A summary of the main observations is presented below.

.Pre-course information was received by the participants in good time prior to the start of the course.

.The daily working sessions and field exercises were considered adequate while the total length of the course/work sessions were felt to be too short.

.The course objectives were found to be relevant to the participants professional needs.

.More examples with statistical analysis of agroforestry experiments should be included

.The computers should to be made available after office hours for economic analysis i.e. MULBUD exercises.

.The training package and presentations by speakers were very satisfactory.

17 Follow-up

On the morning of Friday 22 November, course organizers and participants discussed possible alternatives for follow-up actions.

Communications among participants and between participants and ICRAF staff was identified as highly desirable. Agreement was reached on the following specific actions.

.ICRAF will include all participants in the Council's mailing list to receive the regular publications e.g. newsletter.

.ICRAF will send - 4 to 6 months after the course - a follow-up questionnaire aimed at identifying the extent to which the course material information is being put into use and the agroforestry activities and the involvement of the participants.

.Participants will send to ICRAF a copy of the reports presented to their respective institutions with detailed recommendations on possible agroforestry research alternatives and potentials at national/regional levels.

.Participants will collaborate with ICRAF in the identification of qualified colleagues who would benefit most from ICRAF'S organized activities.

18 Closing session

The official closing address was given by Dr. Bjorn Lundgren. Present at the ceremony were Dr. Amare Ge ahun, Team Leader of Energy Development Internal (E/DI), ICRAF staf. and course participants.

19 Training Materials

Since agroforestry training and the development of appropriate training materials are new involvements, a systematic method is being followed by ICRAF - under the ICRAF/USAID Cooperative Agreement - to develop such training materials. The procedure followed is essentially the same as in the development of research methods, namely collation and evaluation of relevant information from cognate disciplines, integration of such information into a new format, and the testing of the same during the training courses.

An "agroforestry training package" was compiled from existing knowledge and selected information about agroforestry principles, practices and methods gathered from different sources and arranged to follow the course programme of activities. A preliminary version of this package was developed and tested during the previous ICRAF/USAID agroforestry courses. Training materials were placed into three different folders for easy up-dating. For each week, the training materials included main notes, key articles, practical exercises and case studies. It also contained a list of recommended, references which were made available to the participants, upon request.

A slide set on "Agroforestry Practices and Systems in Developing Countries" was made available to participants from the on-going ICRAF global Agroforestry Systems Inventory Project (Also sponsored under the ICRAF/USAID Cooperative Agreement, the list of the main articles, documents, working papers etc, presented week by week can be found in Annex VII.

The concurrent running of the training courses and the development of the training package has provided ICRAF with an opportunity to progressively test, refine and modify each of them. The final version will be available on request, by mid 1986.

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14 Dr. Till Darnhoffer
15 Dr. P. K. Nair
16 Dr. Anthony Young
17 Dr. Ester Zulberti
18 Mr. Peter Wood
19 Mr. Dirk Hoeckstra
20 Mr. Richard Labelle

ANNEX III

SUMMARIES OF PRESENTATIONS

BY

COURSE PARTICIPANTS

THE POTENTIAL ROLE OF AGROFORESTRY IN ACP STATES

by

Irene Kamau

ABSTRACT

All but 3 states out of the 66 which comprise Africa, Caribbean and Pacific (ACP) lie in the international belt. This does not, however, suggest that there is uniformity of climate. On the contrary, climate was one of the factors used in classifying the countries for the purpose of discussing their agroforestry potentials. Other criteria used in the classification were based on the physical characteristic and socio-economic and historical factors.

Based on the above criteria, the ACP states were grouped into 6: humid West and Central Africa; the Sahel, Eastern and Southern Africa, the Caribbean; the Pacific and the tropical highlands.

The humid west and central Africa zone has high rainfall and the soils are highly weathered and have low inherent fertility. The farming systems include shifting cultivation compound farms and plantation systems. The potential role of agroforestry in this zone would be to improve soil fertility, combat soil erosion and improve crop production. Possible agroforestry interventions include alley cropping, improved fallow and multistorey cropping.

In the Sahel, water is the most important constraint to crop and animal production. There are two broad agricultural systems, one based on nomadic pastoralism and the second one based on sedentary rainfed agriculture. There is an urgent need to reverse environmental degradation. Agroforestry could alleviate this problem as well as provide fuelwood and fodder, improve crop production, and protect the soil from wind and water erosion. Shelterbelts, intercropping trees with crops and planting trees in grazing lands some of the possible agroforestry interventions.

The Eastern and Southern Africa has an unfavourable moisture balance. The farming systems are a mixture of traditional and western systems. Livestock production and wildlife are important landuse systems in the zone. Agroforestry systems which alleviate environmental degradation provide fuelwood and fodder and promote water infiltration would be the most appropriate for the region.

The Caribbean is composed of small island states which are far from external markets. The farming systems are dominated by plantation agriculture of sugar-cane and fruits like banana. Small farms and backyard gardens are used for local food production. The agroforestry potential in the Caribbean is linked with the general policy of the region which promotes tree-crops. Agroforestry can also be used in soil conservation and in Shelterbelts. Agricultural labour is, however, a constraint to the development of agroforestry.

The Pacific is similar to the Caribbean in that it is made up of small island states. However, the farmer has well established agroforestry systems. The potential role of agroforestry lies in the improvement of the existing systems in order to improve soil fertility, control soil erosion, provide shelterbelt and diversify agriculture.

The Tropical Highlands form a distinct group which has high population, high agricultural potential and vulnerable slopes. Mixed farming is generally practised although plantation farming is significant. The role of agroforestry would be to control soil erosion, provide fuelwood and fodder project water catchment areas and improve fertility.

III - 3

Agroforestry Research in Uganda

by

Jane Kisakye

ABSTRACT

The environmental problems to Agroforestry were discussed. These included: drought hazard due to over-population and deforestation; food and fodder shortages especially during the dry season; forest clearance and degradation; soil erosion; declining soil fertility; salinization; pasture degradation due to overgrazing; timber and fuelwood shortage; weeds, pests and diseases.

Land use and agricultural systems in the eleven agroecological zones of Uganda were presented. The agricultural zones may be summarised as follows: perennial crop zone; highlands or mountain zone; Central Uganda/Ankole Buganda reigon; and the Northern annual crop zone.

Although the 'taungya' system has been practised in Namanve, Mafuga and Mabira forests and most of the small farmers are practising agroforestry, there is still very little agroforestry research going on in Uganda. There are few trails of Maesopsis and cocoa and other crops at Mutai Forest Reserve in Busoga and another agroforestry research project is carried out at Kasese by CARE. Agroforestry trials to be located at Nakawa Forest Station were proposed in 1984. There is a potential for groforestry research in Uganda to relieve pressure on natural forests; and ensure self - sufficiency in wood supply; increase soil fertility and to solve the problems mentioned above

Landuse and Agroforestry Activities in Sudan

by

Talaat Dafalla Al Magid

ABSTRACT

Landuse - Main landuse practices are farming and livestock husbandry, whereby the system of shifting cultivation is the main feeture in farming. The components of the cropping systems are the farming, sequence of crop and the rotation of land. The location of most settlements is determined by the occurence of water supplies and cultivable land surrounding villages (Bildat), but the traditional agricultural system (as the most dominant type of shifting cultivation), commonly known as Gum Cultivation Cycle which is 15-20 years.

Table 1. shows the Dominant Landuse in Arid/Semi arid regions of Sudan.

Agroforestry - The introduction of taungya started very early in Sudan, In the forest reserves people were allowed to cultivate under taungya system when the system is used during establishment or regeneration. Acacia senegal on good clay with rainfall (400/600) is mechanically sown in combination with taungya system. The seed is sown in parallel lines 6m apart and the plantation is intercropped

Type	Precipitation in mm	Dominant landuse
1 - Hyper Arid to Arid	50 200	Nomadic and semi-nomadic grazing
2 - Arid	200-400	Grazing combined with subsistence millet cultivation
3 - Semi-arid	400-600	Cultivation of millet and sorghum combined with groundnuts/sesame and animal husbandary
4 - Semi-arid	600-900	Intensive cultivation of millet, sorghum, maize/groundnuts/animal husbandary

On sandy soils with rainfall (300-500) pitplanting at spacing of 4x4 metre plants 4-5 months old is practiced, the land is firstly disc-harrowed and intercropped using taungya system.

Taungya	Benefit	Location	Source of water
1 - Vegetable, alfalfa, henna grown between citrus and date palm, spacing 3m	fruit	North	Nilewater
2 - Bullrush millets/sorghum grown under Acacia albida	pods/fodder fuelwood	'Zalengi' Western Sudan	Rainfall
3 - Lablab, sorghum/maize between Eucalyptus microtheca	Gezera Scheme	Central Sudan	Nilewater

Agroforestry practices are dominant in Sudan, where trees are incorporated into farming systems as shelterbelts to provide protection to agricultural crops from the damaging affects of wind, provide production of fodder, fuelwood and poles, but most of these belts are not properly managed, no specific design and therefore research is needed. The project GCP/SUP/NET is now preparing consultancies in range management and socio-economics for managing natural savanna forests in Eastern region of Sudan and hopefully this study will establish the basis for future research in this subject.

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Abstract of the report on landuse systems and Agroforestry in Rwanda

by

A. Kamanzi & S. Masabo

ABSTRACT

Rwanda is a small country in the heart of Central Africa; it covers an area of 26,338 km^2 with a population of 5,000,000 inhabitants. The average density is 220 inhabitants per square kilometre; however it exceeds 500 inhabitants in some areas. The annual rate of population growth is 3.7 percent.

The climate is an equatorial one, moderated by the altitude (970 to 20°C. The annual precipitation and temperature means are respectively 1200 mm and 20°C

The soil is principally made of Kaolisols; in the eastern plateau, it is made of lateritic clay originated from schists, while in the north it is made of a fertile volcaninc material. The pH is mainly acid and the slopes are steep, and this increases the susceptibility to rain erosion.

Rwandese agriculture is widely a subsistence one, with low yields of main crops within a multiple cropping system: a large variety of plants associated on the same piece of land (banana, beans, potatoes, maize, etc.). The monoculture is therefore for cash crops.

For the time being, the arable soils are entirely occupied. Therefore, no fallows or shifting cultivation exists and this leads to the ploughing of marginal lands.

The grazing lands are becoming so scarce that the actual policy pays only partial attention to smaller livestock, to non-ruminants and to permanent stabilization.

In order to meet the highly increasing wood needs, afforestation programs are being undertaken, but they are far from reaching self-sufficiency in wood supply.

Relating to agroforestry, is a system which has been applied traditionally for a long time. In fact some multipurpose trees are found in association with food crops only in hedges (Ficsu spp., Eucalyptus spp., Markhamia spp., Polyscias spp., etc.). But as a scientific system or approach optimising production, agroforestry was very recently introduced (since 1975 by the Project Agroforestoral de Nyabisindu). It is an option actually supported by the national agricultural policy because of its potential in solving most of present agronomic problems: fighting erosion, improving soil fertility, providing fodder and fuelwood etc...)

Despite few years of research experience, the Project Agroforestoral de Nyabisindu (P.A.P) has enough knowledge which it has started to popularise slowly in rural areas. However most of the results are not yet published.

Recently, ISAR (Institute des Science Agronomiques du Rwanda) reinforced its department of forestry for a better apprehension of the system and trials are being conducted. In the same way, the Faculty of Agronomy of the National University of Rwanda (UNR), in collaboration with the University of Johannes Gutennberg of Mayence (Rhenamie Palatinat - Germany) is conducting trials at Ruhande-Butere.

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Agroforestry Research in Malawi

Chitedze Agricultural Research Station,
P.O. Box 158, Lilongwe
by
Alex R. Saka

ABSTRACT

Four farming systems that might be considered to constitute an agroforestry system were identified. These farming systems consist of mixtures of crops and some trees grown on the same piece of land.

Agroforestry, however, is a new phenomenon, and research on its various aspects have up to now been carried out by the Tobacco Research Authority. Since these experiments are still in their infancy (less than five years old), only limited data is available to date.

Owing to recent upsurge interest in the study of agroforestry, efforts are underway to establish an agroforestry section in the Department of Agriculture Research under the Engineering and Land Husbandry Commodity Group. As a first step towards this initiative, a multidisciplinary task force has been formed.

It has also been suggested that research in agroforestry should start with an appraisal of existing agroforestry systems to evaluate their merits and demerits before a coordinated system of management of the various systems can be integrated into a unified agroforestry system can be initiated.

An agroforestry demonstration (observation) plot at the Natural Resources College conducted by the Wood Energy Studies Unit was cited as an example of an "agroforestry research experiment" in Malawi. The experimental units consisted of the following crops and trees: maize, groundnuts, rhodes grass, leucaena, *Acacia albida*, *Cajanus cajan*, *Cassia siamea*, bananas, oranges pawpaw and sisal.

Landuse and Agroforestry Activities in Ethiopia

by

Genemew G. Selassie

ABSTRACT

Ethiopia is a land of diverse climatic conditions. This has in turn given rise to landuse practices ranging from pastoralism in the lowlands to settled farming in the highlands. On the other hand traditional land use practices have left bare large areas of the country, particularly in the northern parts. The natural vegetation was cleared to give room to crop cultivation, which continued for generations without any soil and water consevation activities. This led to the disturbance of the eco-system in northern Ethiopia the seriousness of which can be explained by the persistent drought touate. Although other parts of the country have not experienced very serious disturbance in the eco-system as in the north, the problem is by no mean less severe.

Existing landuse practices have adversely affected the eco-system and consequently resulted in declining production is well known. This raises the question, what will be the role of agroforestry in ameliorating the deteriorating situation?

The answer to the above question could among other things be seen in terms of the demand and supply for forestry products. The demand for forest products in the form of woodfuel, construction materials, etc., has been on the increase. But existing resources have been depleted, ways and means should be designed to overcome the problem. The demand cannot be met through the establishment of extensive population in the conventional way particularly in the densely populated areas of the country for the simple reason that, land is a scarce resource. Under such circumstances agroforestry could be considered.

Although agroforestry is believed to have a long tradition in Ethiopia,

its deliberate application as a system of land use has been not yet introduced to the farmer. Moreover research on agroforestry in Ethiopia is just beginning. Initial field reports on research seem to be promising. Hence given its three-fold advantages: productivity, sustainability and adoptability (although the technology is at a preliminary stage of development) the potential for agroforestry practice in Ethiopia appears to be high.

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Agroforestry Interventions In Jebel Marra Area (Sudan)

by

Abdel Hamied Adam

Mohd. A. El Hadi

&

Abdel Gadir Hassan

ABSTRACT

In Sudan AF has been a traditional land use system for a long period where farmers in central Sudan grow Acacia Senegal in rotation with their crop for sustaining soil fertility and production of gum and fuelwood. In western Sudan cropping along the valleys under the Acacia albida (which are deliberately left by farmers also a common practice. Considering all these facts the Jebel Marra Rural Development project - A project geared towards the development of subsistence agriculture. - is collaborating with ICRAF for the establishment of some AF interventions in the area. These AF intervention include the collection of woody plants for possible AF intervention, establishment of AF hedges, investigating the suitabililty of Acacia albida /cerial system, protection of river banks, improvement of traditional honey bee production and the mountain slope re-instalment programme. Implementation of some of these interventions had been started. This includes the collection of some seeds and the choice of suitable sides for provenance of management trials. Some AF hedges of Acacia mellifera were also raised under different spacing to protect cropland against animals and provide fuelwood, fodder and shelter due to the fact that nearly all Acacia albida trees on the areas are aged (above 50 years). Therefore, their impact on the cereal crops and the factors preventing the tree regeneration are under investigation. Appropriate methods of regeneration and the management rules that give optionel and sustainable returns from its combination with animals/crops will also be investigated. The removal of arable lands along the valleys and the damages often caused to crops necessitate the protection of these river banks by planting trees along them.

Attempts are now being made for the involvement of the local authority in the implementation of this program on a large scale. Studies are now being undertaken to find out the problems facing the honey-bee and how to improve the productivity.

Development of Indigenous Fruit and Multipurpose Trees and Shrubs in Nigeria

by

J. C. Okafor

ABSTRACT

Fruit producing and multipurpose trees shrubs originating from and growing between latitude 40[15' and 8[00 N of the the Equator, corresponding approximately to the Forest zone of Nigeria, including the northern edge of the Derived Savanna, are important because of their nutritional value as major sources of vitamins, minerals, cheap proteins, carbohydrates and fats as well as their agroforestry potentials. As important traditional sources of fruits, nuts, spices, condiments, leafy vegetables, edible oil, beverages, cereal miscellaneous useful products and services, these naturally occurring trees and shrubs play a significant role in ameliorating the food problems of the tropics, in general, and Nigeria in particular. They also contribute to the socio-economic welfare of the rural people.

An account is presented of the work done in Nigeria during the past 15 years on indigenous Nigerian fruit and multipurposes trees and shrubs, aimed at their identification,classification,distribution,genecology, clarification of their nutritional importance,uses,and role in the traditional farming systems of the area.

The methods adopted in the multi-phased studies are outlined including surveys (literature, market, questionnaire and field inventory), phenological observations, green house and nursery work on germination and vegetative propagation, and economic and nutritional assessments, including proximate analysis of food and fodder samples.

Arising from the above studies, the following results which attest to the great potential of these woody perennials for further selection, improvement and enhanced utilization are as follows:

a) A total of 171 woody species have been identified in the area, comprising 53 families and 119 genera, including 95 fruit tree species of which over 50 percent are classified as economic.

b) A great deal of variability is detected within some of the species.

c) Description of intraspecific taxa and "forms" or cultivars" within principal species, such as Irvingia gabonensis, Treculia africana, Dacryodes edulis, Pentaclethra macrophylla.

d) Significant differences in the phenology of flowering, fruiting and leafing also dectected in some principal species.

e) Possibility of utilizing early flowering and fruiting through simple vegetative propagation techniques was indicated: About 26 species of fruit trees were found to be buddable some of which have produced viable fruits in two to four instead of the usual 10 or more years. Also, about 17 species were successfully propagated by stem cuttings. Vegetatively propagated trees also produced at low heights which are more convenient and safe for harvesting.

f) Incidence of precocity in terms of early flowering and fruiting was also found in a number of important species.

g) Suitability of tree management methods such as coppicing and prunning was confirmed in several species.

h) Suitability, in some instances, for a great range of products and uses, was also indicated.

i) Several of the species therefore have great potential in agroforestry systems icluding productive (planted stations, browse plants, multipurpose trees, farm trees, fruit orchard etc.

Constraints and problems encountered in the development programme are enumerated including pests, unviable and difficult seed supply, inadequate funding, land tenure, incompatibility of grafted material in some species, slow growth rate,difficulty in budding of some species.

Research priorities are suggested covering field establishment techniques, more germination and propagation studies, growth phenomena of cyclophysis and topophysis, taxonomy, phenology, provenance and breeding research including germplasm conservation, and investigations, into enhanced utilization of indigenous fruits and vegetables.

Interdisciplinary approach and international cooperation in development of tropical fruit and multipurpose trees and shrubs are necessary. The Nigerian experience has shown that it is indeed profitable to engage in large scale production of such woody perennials.

"Agricultural and Soil Erosion Problem in the Highlands of the Central Part of Malagasy"

by

Gervais Andrianirina

ABSTRACT

The central part of Madagascar where uncontrolled burning to renew the pasture and to clear the fields is still practised, is highly affected by soil erosion and decreasing soil fertility.

1 Diagnosis (Analysis of the problem)

.Rainfall: 1200-1800 mm per year
.Two seasons; a hot one (Sept-April) and a cold one (May-August)
.p^H: 5.0 (average) - Altitude: 1200 m-1400 m
.Ferralitic soils in slopy lands and hydromorphic soil in low lowland used generally for riceculture

The main problems are:

.soil erosion and decreasing fertility
.lack of equipment which provoke problem of labour
.usual cultural and social beliefs which lead to expenditure (mourning ceremony for example)
.lack of fertilizers and firewood

Some advantages are;
.available climate making it possible to diversify the production (e.g. cropping of temperate country)
.labouriousness and selfishness of the population
.development of integrated policy of government

2. <u>Design</u> (Possible solution)

The agroforestry system appears as the most viable solution to:

- optimize labour and land use
- enhance erosion control (terracing etc.)
- avoid lack of fertilizer (Nitrogen fixing, live fences, green manure, etc..)
- increase production

increase farmers cash income(firewood)

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Project "Mise En Valeur Des Savoka"
PNUD/FAO/MAG 82.015
MADAGASCAR

by

Pierre Randrianarison

ABSTRACT

Agricultural trade, the tradition and the physiographic appearance of the soil are the technical and economical constraints for the farmers in the East Coast of Madagascar. These problems make the countrymen practice the shifting-cultivation to the forest.

1. The Project Objectives

a) in the short term (until the end of 1987)
Testing about ten forest lands; a new approach based on the following strategies:
rural development with contributions of the concerned communities;
rural space development by the agroforestry system
intensive land development on slopes which can be adapted as irrigated rice-field;

b) In the long term:
It consists of Setting up a balance between the extension of cultures caused by the economical constraints and the forest.

The farmers are to be integrated in the economical development of their soil.

2. The Project's Process

a) Winning the adhesion of the forestry - communities

- allowing them satisfy their need,
- agreeing with them and give them the best help in diversifying their monetary shifts.

b) Teaching them the suitable technical productions and framing them during the practice.

c) Developing the irrigated culture of rice wherever possible

d) Framing the forestry countrymen in the land development

e) Reforesting the top of slope.

3. Species

Reforestation: Euc. grandis, Euc. camaldulensis, Euc. robusta, Euc. Citriodera, Euc. maculata, Euc. cloejiana, Pinus caribea, Terminalia superbas.

Woody fallow: Grevillea banksii

Coffeeculture: C. robusta with Flamingia congesta

Arboriculture: Orange, papaya, nakooba, l..tchis

fishes: Tilapia nilotica, Tilapia mossambica, carpio.

Agroforestry Activities at Ngong/Jamhuri Agroforestry Energy Centre (Kenya)

by

Alice Kaudia

ABSTRACT

The Ngong/Jamhuri Agroforestry Energy Centre is hereby used as a case in point to highlight in brief terms, the agroforestry activities that are being carried out by the Kenya Renewable Energy Development project in its six ecologically sited regional centres. This centre covers the Upland Savanna ecological climatic region characterised by a vegetation cover that varies from woodland to grassland depending on the amount of precipitation. The average annual rainfall is variable and ranges from about 750 mm-1000mm. the undulating terrain flattens out in the drier marginal areas. Common land use systems are mixed crop farming in the wetter parts and nomadic pastoralism in the dry parts. The demonstration plots are made up of five different tree species namely, Eucalyptus saligna, Calliandra calothyrsus, Persia americana, Grevillea roubsta and Sesbaina grandiflora. These are intercropped with either maize or beans depending on the season. Each plot about 0.2 ha and have eight different planting arrangements.

Various parameters are monitored including tree-crop interactions, effect of this land use system the soils and the necessary management practices on the tree.

Tree seed collection and handling is another sub-programme that is now being given priority in planning.

The ultimate aim is to establish an institution that will address itself to the problem of tree seed availability in Kenya.

AF Problems in Taita/Taveta District (Kenya)

by

E. M. Mwangi

ABSTRACT

Several deforestation of hilltops has resulted into severe soil erosion causing negative impact on water retention resulting into surface runoff, seasonality of flow of streams, rivers, silting of dams of water intakes and a decrease in soil fertility.

In the flat lowlands the soil is of poor quality high percentage of sand with low mineral content and poor water holding capacity at the top and hard rock at a depth of one metre hence hindering growth of AF valuable species.

The occupants of these lower places are nomads having a lot of goats, cows, and the land is not yet adjudicated and is usually burned implying its difficulty to establish tree crops. The other areas are cattle ranches, mines or national parks and therefore are difficult to develop AF on.

In the Productive areas the land holding is mostly less than 1 ha. and people will slowly agree to combine crops with trees or livestock.

The Forest Department Produces around 0.5 million seedlings in seven nurseries and thirteen chief nurseries but only about 10% survive when given or sold to the farmers. Although we try to tell them the need of AF the department requires more funds for establishment of woodlots, training of staff, development of cook-stoves, which are more economical in fuel consumption, establishment of micronurseries nearer to farmers and research on the best species for AF which will benefit livestock and crops as well as improving the soil conditions. These may be met by the DANIDA Project next year.

FOOD PRODUCTION FROM FOREST AREAS IN KENYA: THE TAUNGYA SYSTEM

by

Peter Allan Oduol

INTRODUCTION

Shamba or Taungya is a modification of the traditional farming system-shifting cultivation. It orginated in Burma during the last century, as a means of replanting teak forest plantations on badly degraded lands.

The first cultivations in Kenya's forests started way back in 1910. Since then the number has been increasing tremendously. The aim was to establish exotic forest plantations, with minimum financial input.

SYSTEM ORGANIZATON

Each family is allocated 1 ha annually to clear and plant with crops. In one year a family has at least 3-4 plots with food crops. The family plants crops in each plot for a period of 2-3 years, after which the Forest Department, in the 3rd year, plants trees in the plot. The family can continue to plant crops and weed the trees until the canopy closes, after which they (family) move to a different area.

PARTICIPANTS

Forest workers, retired forest workers, landless peasants and those who live within the immediate vicinity of the forest area.

SYSTEM SUCCESS

System success can be attributed to the following factors:

1. The availability of sufficient cultivable land
2. The presence of willing farming (land hungry) population
3. Availability of market
4. Security - protection against game.

CROPS INVOLVED

These vary from place to place, but mainly:

Beans	Pyrethrum	
Potatoes	Wheat	
Maize	Carrots	
Peas	Kale	etc.

SYSTEM CONSTRAINTS

1. Until 1976, the system was very successful, but when the resident workmen status was changed to that of (paid) civil servants, in some areas the number of willing participants dropped.

2. About 40% of the fires originate in these forest shambas, at the time of clearing.

3. Damage by wild animals - e.g. buffaloes, elephants, etc. discourages some participants in remote areas.

4. The cultivation of glades in forest areas has reduced grazing land for both livestock and wild animals.

5. The system requires high level supervision, otherwise the laid down regulations are not followed thus leading to failure in tree establishment.

6. In some areas the number of participants far exceeds the available land, thus leading to illegal clearings.

ADVANTAGES

1. The system provides a more or less full time employment to those without any source of income.

2. To the Forest Department - this is a cost effective method for tree establishment.

3. The system provides a weed free area for tree planting, and a guaranteed weeding period (of trees) for 2 to 3 years, this increases the survival of trees.

4. The system provides cash and food to the participants.

5. The participants benefit from free housing, medical facilities, schools, welfare and infrastructural development.

6. The system makes a significant contribution to national food supplies.

7. Through this system the forests have demonstrated that it is possible to provide food crops on forest land, which otherwise would have not been available for agriculture, as well as increase wood production.

FEATURE OF SYSTEM

With high population growth rate, unemployment, food shortages and landless people, the system will continue to play a leading role in the economy.

RESEARCH NEEDS

Look into the possibility of Forest Department credit facilities for fertilizer to the participants. This will increase the production from the shamba and the trees will also benefit from fertilization, since most areas at least supported one tree (plantation) crop.

The Feasibility of Tree Planting on Farms in Semi-arid Areas of Machakos District, Kenya: A Socio-economic Approach

by

Abdu Lubega

ABSTRACT

Tree planting on farms in an important aspect of agroforestry. Some of the beneficial attributes of tree planting are supply of woodfuel, poles, construction materials, animal fodder and protection against wind damage and soil erosion. However, this activity is relatively new on the farm, especially in arid and sem-arid regions of the developing countries. It requires consideration effort and commitment on the side of the farmer since it will affect some or all of the farm activities. Therefore to analyze the feasibility of tree planting on farms, let alone prescribe the most appropriate methods of tree planting, it is important to understand the farmer's environment.

The first objective pertaining to this research is to describe and analyze the major factors which influence the farmer's activities. The second one will involve formulating a production set of the farm which incorparates tree planting. The research is confined to small-scale farmers who are engaged in subsistence agriculture in semi-arid areas of Machakos District of Kenya. A household is the basic unit and focus of the research.

The approach in the whole research is multidisciplinary. The field research, which involves a survey of households, is currently being undertaken. In addition, technical assistance is being sought from professional and scientific staff of ICRAF and other specialized research institutions. To supplement field data, literature search is also being done at ICRAF.

Based on the gathered data, input, coefficients will be estimated and the resource bases available to the small farmer will be identified and quantified. This information will be combined in a linear programming model where different farm activities will e carried out to produce certain levels of good income, volume of wood and fodder given certain constraints.

An approach to identification of land use systems, problems and Agroforestry potentials

by

ICRAF'S DATA APPRAISAL TEAM FOR AFRICA (DATA*)

The Data Team which is multidisciplinary, composes of a socio-economist, livestock scientist, forester and an environmentalist involved in the study of four Agro-ecological zones in Africa South of Sahara. The four zones comprise the lowland Humid Tropics of West Africa, the Sahel, the Unimodal Highlands of East and Southern Africa (commonly known as the miombo) and the bimodal Highlands of East Africa. Presently, the team is involved in collecting data on the miombo zone of Tanzania, Malawi, Zambia and Zimbabwe - working together with National Task Forces from these countries to identify the existing land use systems and their problems. This zone is to be used as a prototype in developing a methodology which will then be applied to the other three zones with modifications suited to each zone.

Methodological strategy

It was decided that the problems of land use system and their agroforestry potentials be studied on a ecological zone basis because these problems and their agroforestry interventions are expected to be similar. Secondly, it is hoped that there will be networking between countries within a zone to try and avoid duplication in research efforts.

Objectives

The objective of the Data Team would be to complete the ground work being carried out by the National Task Forces in each country in identifying the major or broad land use systems. The team hopes to achieve this objective by extracting and analysing published information from libraries in Nairobi and from libraries

*DATA Team members are: Drs Mamadou Djimde, Freddie Kwesiga, Susan Minae, James Odra and Henry Sibanda.

in various countries. Secondly, it will try and assess the nature and severity of the problems of the land use systems. After identifying the problems the team will then outline agroforestry potentials and possible interventions on zonal basis.

The Approach

The first task that the team embarked on was the delineation of the miombo zone. Four criteria were used: the FAO growing period, vegetation, altitude and rainfall patterns. For example, the growing period of 90 and 270 days were taken as the lower and upper limits respectively, while altitude of 300 m above sea level was taken as the lower altitude limit with no upper limit so long as the dominant vegetation remained a complex of Brachystegia, julbernardia and soberlinia species. Areas with bimodal rainfall pattern were excluded.

Now, with a well defined area of study, general information about the area concerning bio-physical characteristics, socio-economics, and sectoral information on crops, livestock and forestry were collected on country basis. Then the land use systems were identified with their problems and agroforestry potentials. For example, in Tanzania 10 broad land use systems have been identified.

These land use systems were identified using the following criteria: main agricultural products, population density, level of mechanization, socio-cultural aspects as well as bio-physical characteristics. It is the interaction of these factors that give a complete picture of a land use system.

Landuse Pattern and Problems of Management in Burundi

by

Astere Gaboryaheze

ABSTRACT

Firstly, the paper describes the bio-physical conditions prevailing in Burundi and points out the rolling topography as the major factor causing soil erosion in the country.

Then, the landuse activities are analyzed. Emphasis is particularly put on the following problems.

the land fragmentation
the land scarcity in localities under high population densities and heavily depending on agriculture and consequent pressure on marginal lands.

the problem of the rationalization of the systems.
the low yields characterizing the traditional agriculture due to the lack of adequate investments and the low educational level of labour forces in the rural areas.
the difficulty to generate incomes.
the problem of overstocking since cattle breeding remains as social status, and consequent pastures degradation.
the problem of fuelwood shortage and expected resource on crop residues utilization for meeting domestic purposes.

Lastly, the paper stresses the fact that agroforestry research is still at its embryonic stage (test on adaptability and provenances of species) and the need for researchers and agroforesters to given much attention to some viable traditional crop associations.

But, although some agroforestry technologies may be relevant to help solve ecological and socio-economic conditions in Burundi, the feasibility and the adoptability are likely to remain the two major constraints the new researchers will face while introducing new systems.

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Field Experimentation in Agroforestry at ICRAF Field Station
(a progress report)

by

A Repollo Jr.

Introduction

The following progress report deals on the field experimentation part of the Research Fellowship programme at ICRAF.

The nature of the experiments were identified, formulated and implemented at ICRAF Field Station with the guidance and close collaboration for Dr. P. A. Huxley, a senior scientist of ICRAF. The identified studies are designed to resolve some problem areas in tree establishment and management, trees being the major component in an agroforestry system.

Studies being undertaken:

1. Direct planting technique
   Germination of MPTs seeds
   Depth of sowing
   Encapsulation techniques

2. Sub-irrigation technique
3. Phenology studies on MPTs

Materials, Procedures and Preliminary Findings

Seed pre-germination studies. Seeds of MPTs were secured from CARE - Siaya KARI, KREDP and Baobab Farm (Mombasa). They were categorized into spp., size and hardness of seedcoats. Treatments used are: "bubbling" and filter paper.

In the bubbling technique, a fish tank, bubbler, thermometer and thermostat heater were procured. The principle is to soak the seeds in water at constant temperature and continuously provide air from a bubbler. The three important factors for seed germination are thus provided; air, water, and heat.

So far, the species germinated are: Sesbania sesban, Acacia albida, Pinus patula, Caesalpinia sepiaria and Acacia nilotica. Each lot consists of 100 seeds per species replicated three times. Germinated seeds are counted and separated daily. Findings show that bubbling technique enhanced germination of the seeds more than the filter paper method. With Sesbania sesban, results showed that it takes only 12 days to obtain 100% germination while 17 days for the filter paper. The advantage of the bubbling technique is, more uniform germination over a short period of time.

Depth of sowing. This experiment aims at determining the effect of the depth of sowing on the emergence and growth of pre-germinated seeds of MPTs. The different depths being used in this study are: 4, 6, 8, and 10 cms. Polythene tubes filled with forest soil are used. With Sesbania sesban, sown at 4 cm depth. At 6 and 8 cm depths, seeds take about 8 and 11 days to emerge. No emergence was observed at 10 cm depth.

On height increment one month after sowing, the height of seedlings at 4 and 6 cm sowing depth averaged heights of 4.55 and 4.50 cm respectively while seeds sown at 8 cm depth attained a mean height of 3.25 cm. Similar experiments on the other MPTs seeds are being implemented to ascertain the optimum depth of sowing in relation to the size of seeds.

Encapsulation technique. The soil media being used for this experiment are forest soil and cattle manure. The first objective of the experiment is to determine the proportion of the soil media which will encourage early emergence, growth and survival of seedlings. The second objective is to determine the optimum size and shape of the encapsulated material for ease of handling and better grwoth.

Preliminary studies are being conducted to get some insights on how to implement a well replicated experiment.

Sub-irrigation technique. The preliminary study has been completed involving depth, frequency and duration of watering. Results show that only depth has significantly affected the growth of casuarina seedlings. The information was then used to design a bigger and replicated experiment.

The factors which are to be evaluated are:

- .Species - Casuarina, Mango and Grevillea
- .Irrigation - surface and sub-surface
- .Amount of watering 1 1/2 , 2 and 2 1/2 litres for every 2 weeks. The experiment was laid out using a 3 x 2 x 4 factoral in a split-plot design with three replications. It will be implemented just after the short rains.

Phenology studies. Nine MPTs at ICRAF Field Station were properly labelled for a phenology experiment. These are: *Psidium guajava*, *Leuceana leucocephala*, *Acacia albida*, *Prosopis juliflora*, *Parkinsonia aculata*, *Acacia saligna*, *Acacia seyal*, *Grevillea robusta*, and *Sesbania grandiflora*.

The objective of the study is to determine the growth habits of MPTs with regards to the changes of environmental factors and management. Records being collected are; length of branch, number of leaves, existence of lateral shoots, flower buds, flowers, green and mature fruits as well as dropping of leaves.

Observations so far indicated varying responses of different tree species to season and cutting of the branches. While some species continuously show active growth, others seem to be dormant. The information from this study will certainly be useful in the management of MPTs in an agroforestry system.

Conclusion

While results of the studies are still not complete, preliminary assessments point out some useful indications that will hopefully provide workable techniques in seed handling, tree establishment and management.

The direct planting experiments can provide a more reliable technique on pre-germination of MPTs seeds as well as inexpensive handling of seedlings. Preliminary results on sub-irrigation studies point out the efficiency of watering planted seedlings below their root systems compared to the traditional surface irrigation. On the phenology studies, records show significant differences on the growth habits of the MPTs at varying seasons. It is expected therefore, that the information from these studies will be very meaningful in terms of manipulating the trees in an agroforestry system.

The Teaching of Agroforestry at Egerton College (Kenya)

by

T. C. Aloo

ABSTRACT

In 1982, Kenyan forestry educators met and recommended that Agroforestry be taught at Egerton College. This was due to a recognition of the fact that Egerton graduates influence farmers more than university graduates. The physical facilities and manpower were also adequate to enable the course to be started with minimum cost.

At present the AF course is taught to forestry students only, but it might be extended to other students in future. The forestry programme is very broad-based and aims at producing good land resource managers. Some of the courses taught with relevance to agroforestry are introductory agriculture, rural sociology, community forestry, watershed management etc. A multidisciplinary Agroforestry Committee was formed to aid in AF teaching and evaluation of demonstration plots.

The biggest constraint in teaching AF was lack of textbooks. ICRAF was most helpful in providing various publications and the Agroforestry Slide Set which was highly appreciated. More help came from Ministry of Energy and Regional Development/Energy Development International who helped us develop an agroforestry nursery and demonstration plots. The students are already using these facilities to gain practical experience in nursery management and tree/crop farming.

The nursery and demonstration plots will also serve the surrounding community. As part of their learning, students are taken to several parts of Kenya to observe and describe traditional AF systems.

Our graduates are practical-oriented. The D&D methodology as used by ICRAF helps them to assess the farmers needs and prescribe agroforestry interventions.

Finally since Agroforestry is situation \specific, we are developing our own slides peculiar to Kenya to be used in teaching.

PIGEONPEA: A Woody legume for Agroforestry Systems

by

P. M. Kimani

ABSTRACT

Agroforestry land use system involves growing woody perennials on the same area as crops and /or animals such that there is significant economic and ecological interactions between woody and no-woody components. Multipurpose woody perennials are ideal for such systems. Pigeonpea (Cajanus cajan L. Mills) is a woody legume that is suitable for intercropping with annuals in an agroforestry system. It is easily established from seeds, has good coppicing ability, effective in nutrient recycling abilities (fixes atmospheric nitrogen) and is capable of producing high yields of forage for animals. Pigeonpea has multiple uses: it is a rich source of dietary protein, its stems provide fuelwood; seed, pods and foliage provide livestock feed. It is also used aa a wind-break and as hedge plant, and for green manure.

Pigeonpea is a drought tolerant legume that is widely grown in the semi-arid areas of Kenya. It thrives well in soils low in fertility. Because of its deep rooting system and slow initial growth, it causes minimal competition with shallowly rooted annual crops and recycles nutrients from deeper soil profiles. Therefore, it can be intercropped with both cereals or legumes. However, Cajanus may not provide adequate wood for construction and fuel in an agroforestry system. There is need to identify, collect, and study trees species that can be intercropped with Cajanus and other annuals especially in the semi-arid regions. The possibility of using Cajanus as a forage crop needs further investigation.

ANNEXE IV

PAPERS PRESENTED BY INVITED SPEAKERS

AGROFORESTRY FIELD TRIP TO KIAMBU DISTRICT

by

Jeff Odera and Francis Arap Sang

This short tour takes us through some of the most fertile areas in Kenya and traverses a wide range of land-use systems. We go from Nairobi (altitude 1660m, rainfall 1200m p.a.) to above Limuru (Uplands) reaching an altitude of 2240m rainfall 2100mm p.a.).

Below Nairobi to the South and East (see Machakos District Tour) there is less rainfall and, for example on the Thika Road, are some old sisal estates, many now turned into cooperative ranches. Above this zone the coffee starts, reaching its most productive around Kiambu (altitude 1750m). The soils in this part are Kikuyu Red Loams derived from weathered phonolite (a massive lava flow) and in most parts, they are very deep and fertile (see Coffee soils in Kenya and Their Characteristics etc "by A. Mehlich, Coff. Res. Found. A.R. 1966/67 1963). In some parts of this area, particularly in sheltered valleys, intensive banana/maize cultivation is prevalent, also with maize/beans and "sukuma wiki", a collard-type brassica which stands repeated leaf harvesting.

Further up the altitude range (and consequently with higher rainfall and more acid soils) one comes across dairy enterprises followed by tea. At the top of this altitude range there is forestry (including plantations of, mostly, Pinus radiata and Cupressus lusitanica) with sheep grazing on the grassy areas between (a typical grass here is Pennisetum clandestinum "Kikuyu grass" which is very deep rooted and provides good grazing).

The Tour

We start by leaving Nairobi City along the Limuru (Uplands) road, joining

it at Muthaiga where we pass through a segment of the Karura Forest. The indigenous species here include:-
Croton megalocarpus, Brachyleana hutchinsii, Albizzia gummifera, Teclea trichocarpa among the dominant forest species while the undergrowth is composed predominantly of Clausena anistum and the refuge Lantara camara.

Of particular interest are the remnants of the montane sclerophyllous forest which covered the whole of this area prior to farm settlement. Further on, we will see remnant signs of the original montane rain forest in the scattered single trees of Podocarpus gracilior, Olea africana and Polyscias kikuyueusia. Some areas here also been set down to Plantations of:- Juniperus procera (an indigenous gymnosperm which yields to plantation management) Cupressus lusitanica and Eucalyptus saligna.

STOP 1 Crossing the bridge after passing through indigenous forest, we can pull off the road a little higher up and view the plantation of Cupressus lusitanica (LH). We then continue uphill very soon reaching a coffee estate (RH) with large

STOP 2 mature trees of Acrocarpus fraxinifolius on the right side of the road, and Jacaranda mimosaefolia on the left. This is well-kept, unshaded coffee typical of the carefully-managed crop which produces some of the highest quality product in the world.

STOP 3 Further up the road we have an opportunity to stop to view the general landscape (to the right). Trees form an integral part of the land surface. Population per Km^2 will be around 300-400 persons (note the many dwellings). Trees are being used in hedgerows, for shade and environmental benefits, in fuelwood lots, and there are also some timber trees, including a few indigenous species remaining from the forest. In general, farm size is smaller here (about 3-5 hectares?) than on the return route we shall take,

where large tea estates, dairy farms and coffee estates will be seen.

Apart from introduced species, mainly used for fuelwood or timber (e.g. Cupressus, Pinus, Grevillea etc.) Two of the 9 species of indigenous Croton are common here. Croton macrostachys (from 650 - 2200m) and C. megalocarpus a large tree, similarly widespread, which can be dominant in the upper-storey in places.

Leaving this place we continue up. Occasional fruit trees to be seen in farms are mangoes and guavas, but it is too high to grow papaya successfully here. Further up we shall see pears, peaches and plums. Note various types of hedgerows. Several species are used, always ones easily propagated. Cupressus lusitanica again (frequently some plants are allowed to grow tall and all the lower branches are lopped for fuel). Kai apple (Aberia caffra), Croton spp, Buddleia polystachya, Crassocephalum mannii (this is commonly used as "toilet paper"). Cassia siamea is sometimes grown in hedges and cut for poles.

You will see maize (usually maize/beans intercropped) right up to the highest altitude, even though it grows very short and takes a long time to mature.

STOP 4 (Above Rosslyn School) At this altitude the landuse is beginning to change to dairying and fuelwood lots. Note the large number of trees of different species left among the grazing land (RH) But further up these good pastures are being turned-in for cultivating crops (LH). Black Wattle (Acacia mearnsii) can be seen planted in wood-lots (also grown for its bark), but in many places it has seeded and spread to waste patches. Note relatively large plantation of pears to the left (middle distance).

To the right hand side of the road we pass a large tea plantation (looking rather patchy), unshaded but with Hakea saligna used as a windbreak.

We then proceed right along a road into Limuru town. Immediately on the left after the turn is a wattle plantation.

We proceed through Limuru and take a new tarmac road past Uplands. On this route we shall see various examples of plantation forestry on the Lari Escarpment. The original land-use in this region up to the early '60s involved clearcutting the indigenous montane forest and replacement with fast-growing exotic tree species (mainly Cupressus lusitanica, Pinus patula, P. radiata and Eucalyptus saligna) in large plantations as government-owned land. Since the mid '60s much of this forest has been excised for human settlements either on an individual basis or as co-operatives.

You will see on your way a 15-year old Cupressus lusitanica plantation marked for thinning. You will also see the performance of Eucalyptus paniculata on a flat water-logged site.

STOP 5 We stop at the "Look-out-point" to discuss the plantations. Also there is a fine view over the Rift Valley and the sharp gradation in rainfall to the semi-arid plains is obvious - with consequent changes in vegetation. What prospects are there for agroforestry in the drier parts below us?

Trees obviously play an important role in most areas that we have seen on this route. Are they always the most productive and/or the best suited species however? In many cases the land-user seems to have given some thought to tree/shrub arrangement - but are these optimal?

STOP 6 Proceed to Kinale to observe forest plantation establishment by the "Shamba - Taungya" Method. Crops are grown in association with forestry species for 3 to 4 years before the farmers move to another plot of land.

AGROFORESTRY RESEARCH PROGRAMMES IN KENYA

BY

J. A. ODERA

A PAPER PRESENTED TO ICRAF/USAID
AGROFORESTRY COURSE - NAIROBI
4 - 22 NOVEMBER 1985

Kenya has a small area of reserved forest estate (about 3 per cent). The bulk of the forest estate, 2.35 m ha supports the indigenous forests and provides the red wood of high commercial value and conservation functions. Plantation forests (about 0.15 m ha) provides the bulk of wood demand for domestic and commercial needs.

Our forests have quickly disappeared during the decad mainly due to expanding inappropriate and unplanned settlemen and agriculture and over-exploitation of forests particularly for fuelwood, and desertification is threatening many areas. In many areas particularly in the ASALs this has been exacerbated by demographic expansion coupled with the concomittan increase in the number of livestock.

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Biomass-based energy is our main source of renewable energy and is derived almost entirely from combustion of woodfuel, crop and livestock residues. Woodfuel alone accounts for over 60 per cent of total energy consumption. It is estimated that around 20 m cubic metres in 1984 was consumed as woodfuel, about 90 per cent of total consumption. Domestic consumption amounts to over 95 per cent of the total woodfuel consumption.

About 80 per cent of this comes from private farms, woodlots or trustlands, 13 per cent from the natural forest reserve while only 7 per cent originates from County Council forests. It is estimated that the country's total wood requirement would double up by the turn of the century.

It is evident that even based on the current figures, woodfuel supply of about 14 m tons per year is below the total demand of about 20.5 m tons per year. In this scanario some provinces such as Central Nyanza and Eastern are deficient hence net importers while other provinces such as Coast, Eastern, North Eastern and Rift Valley have substantial yields and are potential exporters of woodfuel. Thus the distance of the supply from surplus areas to the major consumption areas is vast. Consquently the net demand cannot be met without adversely affecting prices.

Traditionally in the drier arid and semi-arid land areas pastoralism has predominated with a carefully controlled period of return to a given area. But during the last fifteen years the rapidly increasing population (annual rate about 3.8 per cent) has spread into the drier zone and in some cases

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socio-economically agroforestry systems provide relevant interventions in tackling rural development problems, including the supply of woodfuel for cooking. Agroforestry systems provide avenues for reducing loss of forest, soil and water while enabling the farmer to realize self sufficiency in firewood, minor forest products including some timber, fodder and browse. Revenue from extra supplies of forest products provide useful farm income.

Agroforestry systems have been used traditionally by rural populations and systematically by the Forest Department to establish tree crops (shamba system).

The Shamba System

The shamba system is a form of "Taungya" which is traced to mid 1880s in Burma and is the first modern agroforestry practice (= shifting cultivation). The system has evolved in Kenya through the implementation of the compensatory plantation programme as a low cost governmental approach to reforestation following world war 2. Cultivators are temporarily alloted government land and contracted to cultivate, weed and tend trees species planted by the forest service. The allocated area is normally cleared, fenced where this is necessary for protecting food crops from game damage, and the debris burnt and then planted with agricultural crops. During the second year of cropping, at the onset of the rains, the forest service plants the area with about 6-month-old tree seedlings. The cultivator continues to grow food crops between the trees and

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into the forest reserve. This is causing depletion of forests through clearing for agriculture and the relentless search for fuel and forage. Although expanded cultivation may result in an initial increase in food production, there is no guarantee of sustainability, despite the loss of forests, soil and water.

It is evident that wood resources required for domestic and commercial needs cannot be realized from the forest reserve. Given the small land base under forests management the forest service has adapted the following options as a strategy for meeting the rapidly rocketing rate of consumption of wood.

(a) Tree improvement geared to generate increased yield per unit land, and better forest protection.

(b) Development of social forestry

(c) Afforestation of arid and semi-arid land areas.

SOCIAL FORESTRY

Social Forestry conceptually refers to forestry in scattered land outside the forest reserve, wherever tree growing is possible. Its main components are agroforestry, rural forestry (farm forestry) and urban forestry.

Agroforestry has been accepted as a collective term for land use system and practices based on the integration of woody perennials with crops and or animals. Ecologically and

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tends the latter, for two to three years at no direct cost to the department. The yields of the food crops belong to the farmer.

Traditionally the men folk clear, fence the area and burn all the debris, leaving cultivation for their women. Each year a cultivator is issued with a new shamba of about 1 ha, so that after a few years he has one shamba of newly cleared forest, one which has been cultivated for two years and is planted with young trees and one or two others in which he is cultivating between the rows of trees.

Following the regularization of the resident workmen in the civil service the plots in areas earmarked for replanting are rented out to forest workers at a nominal fee of Shs. 15.00 per ha.

Large quantities of food crops including maize, potatoes, various vegetables and cash crops such as pyrethrum, are produced in the forest reserve annually through the shamba system (Transparency 1). About 8 and 12 per cent of maize and potatoes grown in the country respectively come from the forest reserve; while over 80 per cent of cabbages and carrots, and 60 per cent of kales sold in Nairobi come from the neighbouring forests. In an agricultural country where food production picture is unstable (due to ecological conditions) a system of land use that enhances sustained agricultural productic must be promoted.

The shamba system has clearly evolved a symbiotic relationship in which the interest of the cultivator and those of the forest service are equally realized. Financial and economic

returns accruing to the farmer are real and significant, while the department realizes a low cost establishment of large plantation area.

(a) On going research effort examines the benefits and gains to the cultivators (i.e. an attempt to quantification of their compensation for tree establishment) and their contribution to the economy.

(b) With the diminished area of virgin forests, the yield of food crops from the shamba system is bound to drop as cultivation spreads to second rotation plantation areas. Research is examining this and possible remedial measures.

WOODY PERENNIALS IN ANIMAL AGROFORESTRY

Combined production of livestock and industrial forest management is practiced in the forest estate where sheep and cattle are allowed to graze within the glades in the forest and surrounds of plantation at a nominal fee. (slide)

Although joint livestock and forest management has not reached the sophisticated level such as in Newzealand, the number of cattle supported through this arrangement country wide is quite substantial.

Livestock farmers on their part traditionally leave trees such as *Acacia*, *Makhamia* scattered within the pastures, thus providing shelter from solar radiation and wind. (slide)

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Slide demonstrates a woody plants ability to improve the physical status of the soil -- and hence an enhancement of the biological activities due to improved seepage of rain water, aeration and protection against excessive heat and erosion. Being N_2 fixing in this instance the Cassuarina trees have undoubtedly contributed to a high N_2 status of the soil and hence the luxuriant grass growth.

FARM FORESTRY

Farm forestry focusses on the activities of the extension unit of the forest service and some non-government organisations. It encompasses forestry activities in individual farms or community and village land areas, degraded sites, waste lands such as swamps, river banks, ravines etc. road side and canal bank planting for the benefit of the local people. It also touches on the restoration of derelict areas such as those bearing the scars of quarrying earth excavations etc. Compounds of schools, colleges, hospital and various government institutions and militarry barracks also constitute suitable areas for promoting rural forestry.

The majority of small-holders and peasants traditionally grow mixed crops including some trees, a practice that provides them with some insurance against crop failures, and an intermittent supply of wood for cooking and building. A good example can be seen in the highland where often one sees a gradation from the ridges down to the flood plains beginning with trees, moving down through a series of food and cash crops, including maize

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and pyrethrum. Bananas, arrow roots, sugar cane, and various vegetables are often planted in the plains. In areas of high population concentration, such as Western Kenya and parts of Central Province, farmers avoid direct competition with food production by planting trees in unused areas along roadsides, bounderies of fields, backyards, river banks, fence lines, and around dwellings and villages (slides).

Border Tree Planting

The planting of live fences around homesteads and individual plots is a common tradition throughout the republic. Farmers are increasingly realizing their wood need for poles, wood fuel and fodder by thinning or brush cutting of the rows of trees or pollarding periodically.

In many homesteads mixed planting of various tree species to meet home needs is being practiced. In such holdings indiscriminate and unscientific planting has resulted in over-crowded stands. The research effort examines fast-growing multi-purpose trees for planting along property borders and management option open for periodical harvesting of fuelwood and their foliage for use as fodder, or green manure. Another frequent reason for border planting is the need for live fences and shelter belts around the farms and homesteads.

On going work focusses on the search for and studies of species which do not compete with neighbouring crops. Trees with deep root systems and few shallow lateral roots if any, and a relatively light crown and shade are generally preferred by farmers.

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Many trees such as Grévillea robusta, Makhamia platycalyx, Calliandra callythyrsus and Leucaena leucocephala respond favourably to top pollarding, branch-pollarding and selective pollarding.

It is advocated that by choosing the tree species judiciously and planting them within certain patterns, as well as applying specific management practices, tree planting may be brought to enhance food production, while at the same time supplying substantial amounts of wood products and, most important of all, ensuring longterm ecological stability. It is also advanced that the adoption of such land-use systems will make it possible to sustain productivity, with a more favourable relationship between inputs and produced benefits than typical present-day small-holder practices.

You will be hearing more about our on farm and on-station research and development effort that are examining possible avenues for scientific integration between crops and trees and grazing land improvement.

We shall now very quickly look at experiences of various institutions that are involved in different degrees in rural development projects funded externally that include components of agroforestry *per se* or multipurpose trees in farms or community planting, with agroforestry potential. These include:

(a) Tree planting activities in Turkana district.

(b) EMI afforestation research experience.

(c) CARE Kenya agroforestry project - Siaya

(d) The Kenya woodfuel development programme

(e) Fuelwood afforestation/extension in Baringo.

TREE PLANTING ACTIVITIES IN TURKANA DISTRICT

A number of trials and demonstrations have been established in Turkana District at Lodwar, Kalakol, and Katilu area from 1981. Most of Turkana district is arid to very arid falling in ecological zones 5 to 6. (Mean annual rainfall between 350 to 500 mm, moisture index -42 to -51 and 200 to 350 mm and -51 and -57 respectively). Tree planting in Turkana District focusses on provision of vegetative cover, woodfuel, poles, fodder and browse etc. A total of 40 different species have been tried. Although the species have not been tried under agroforestry situations many have agroforestry potential.

Survival rates vary greatly both between species and within species between plots. The results though not conclusive give reasonable indications as to the species suited for Turkana and on which future trials can be based. It is noted from these results that *A. albida*, *Tamarindus indica*, *Fieus sycamorus* and *Diopyros* sp. can be cultivated in the riparian belts. *A. eliator*, *Delonix alata*, *Cordia sinensis* *Zizyphus mauritiana* and *Dobera glabra* can be planted along the riverines. *Eucalyptus camaldulensis* and *Leucaena leucocephala* have performed well under temporary water logged conditions at Katilu. Date palm (*Phoenix dactylon*) has given very favourable results on certain riverine sites where there are free draining soils and a water table not lower than 4 m.

Salvadora persica, Tamarix spp. and Balanites orbicularis appear to be suited to salty hard pan conditions. By contrast A. cyanophylla, Cassia siamea, Delonix regia and Simmondsia chinensis do not appear to be suited to Kalokol but may still be worth trying along other riverine areas under fresh water conditions. Of the indigenous species tried, A. reficiaens, A. nubica, A. tortilis, A. paolii, A. senegal, A. mellifera, B. orbicularis, Combretum spp. and S. persica showed high drought resistance, but normally grow better when given adequate availability of moisture during establishment. They all show slow initial growth if raised from seedlings and are quite sensitive to drought during the establishment phase. Among the introduced species A. aneura, A. victoriae and A. farnesiana appear promising in the driest sites at Kalokol, Prosopis chilensis and P. juliflora and Parkinsonia aculeata appear to be well adapted to Turkana conditions and have been outplanted widely.

Current investigation focusses on browse species trials. A total of 16 species have been prepared for planting in a combination of microcatchment of different sizes and water harvesting conditions. As a general policy, where soil conditions are right, microcatchments are used for tree establishment. The microcatchments are 10m x 10m with a silt pit at the lowest corner. These microcatchments are designed to

cope with a 60mm rainfall event. Though the initial work input is high in terms of labour, microcatchment if used properly do not require any expensive supplemental watering after planting. They are now proving themselves very successful in many parts of Turkana District as a viable means of tree establishment, with over 300,000 trees currently planted (over 300 ha).

In other areas, where water is easily available, trees can be established through watering. Here a watering schedule for tree watering has been established which depends on watering fewer times but with a greater quantity of water per time. This reduces evapotranspiration loss, and increases the depth for moisture infilteration which helps in speeding up establishment.

Work has been carried out on restoring a date palm orchard at Turkwell Irrigation Scheme. These palms, now producing dates, are trees of great potential in Turkana along the main riverine areas where soil and water conditions are suitable. A number of people have already planted small orchards of this tree which if successful will yield a lot of highly nutritious fruits for local consumption and sale.

E.M.I. FORESTRY PROJECT

Forestry research programme within the Embu, Meru, Isiolo Integrated Development Project was structured to provide information backstopping to the afforestation activities particularly on the dry parts of Embu and in Isiolo district.

Species/Ground Preparation Trials:

Trials have been planted at Gangara, Gategi in Meru and two areas in Isiolo (with different types of soils - red soil and black soil.) These sites lie between altitudes 700 m - 1650 m above sea level, and vary in soil types, from sandy, black cotton, loam and red condition. Average annual rainfall ranges from 400 mm - 1000 mm with Isiolo having the lowest average of 400 mm and Embu highest average of 1000 mm. A big number of species/provenances were planted at each site.

Various methods of ground preparation were incorporated such as pitting, pitting with micro-catchments, cultivation by buldozer and terracing to investigate the effectiveness of these methods of site preparation in factilitating establishment. These trials have been protected and maintained and survival and height growth measurements taken twice per year. Seedlings of 20 species are currently being raised at Merti, Isiolo (alt. 350m) for an irrigated trial to be planted in April 1986.

Tentative results show that the following species are suited for red soil sites: Acacia tortilis, Balanites aegyptiaca, Tamarindus indica and Ziziphus mauritiana. These are all indigenous species whose values for rural tree planting are often overlooked. But they are very drought tolerant, easy to grow and provide a number of products like fuelwood, fodder, poles and edible fruits (Balanites and Tamarindus)

Other species worth drawing attention to are: Leucaena leucocephala (three varieties - ENA, K67 and K8). This species apparently does not do well in very acid soils; Prosopis juliflora, Parkinsonia aculeata, Acacia victoriae and Cassia sturtii (Australian trees); Eucalyptus camaldulensis and E. tereticornis. For E. camaldulensis Katherine and Petford provenances are recommended for better sites and Ord River provenances for drier sites. For E. tereticornis Morehead River provenances appears to be a good provenance. Other 'new' Australian eucalypts and acacias are being tried such as E. argillacea, E. intertexta, E. melanophloia and A. aneura.

For black cotton soils, attention should be drawn to : A. nilotica and A. polycantha (indigenous species). Atriplex semi-baccata and A. nummulora (Australian fodder bushes) are tolerant to saline clay soils. Atriplex semi-baccata was the only species to survive from the first planting at the Isiolo black cotton soil site. A. semi-baccata apprears to have a

potential for providing ground cover and erosion control (trials will be undertaken this season on black cotton soil gullies in the Mwea area).

Albizia lebbek, E. camaldulensis, L. leucocephala, and Ziziphus mauritiana are also doing well in these soils.

For higher potential sites such as Maronga, it is worth mentioning two 'new' species. These are: eucalyptus hubrid - a cross between E. tereticornis and E. saligna from Zambia and A. auriculifornis.

Of the ground preparation techniques used in these trials, deep cultivation by bulldozer has proved to be the best. This technique is obviously not suitable for extension forestry and the method of pitting with micro-catchments has been satisfactory on suitable sites. A partially mechanized variation of this has been very successful on trial fodder blocks at Marimenti. In this method furrows are ploughed along the contour and catchments created by 'tying' the furrows at intervals. The terracing at Njuguini is beginning to show better growth than the standard pits although with higher costs. One other lesson which has come out of these species trials is the critical importance in arid areas, of planting quickly as soon as the soil is wet enough, particularly when the long rains fail to continue. This was convincingly demonstrated at the Gategi, Maronga, Kuami and Isiolo trials where the first

blocks to be planted had a far better survival rate than those planted just one or two days later.

Nursery Techniques:

A series of trials have been carried out to ascertain the optimum size of tube for raising seedlings in the nursery. Seedlings were raised in seven different sizes of tubes and planted out in replicated plots in different sites with different amounts of rainfall. Preliminary indications are that, even in a drought year, tube size seems to have very little effect on establishment rate. Only the very smallest tube (50.8 x 152.4 mm layflat) at the driest site had appreciably poorer survival rates than larger tubes. It seems therefore that we should be able to use smaller tubes than the current standard size (254 x 381 mm layflat) especially in higher rainfall areas, with all the consequent savings in work, materials, space and transport.

Seed Collection, Storage and Treatment:

Much information has been accummulated about seed viability and methods of collection, storage and treatments required to obtain good germination for most of the species used in the EMI area. Success is being obtained in germinating 'difficult to germinate species' like Melia volkensii, Terminalia Brownii, T. pruniodes and T. spinosa.

New district seed collection plans are being introduced in Embu and Meru. The new seed stores at Kinoru and Irongi are nearly complete.

Other Investigations:

Two small trials have been planted at Isiolo to test the effectiveness of the water absorbant chemical 'Agrosoke' - polymer capable of increasing water holding capacity of soil around the tree. Both trials planted in 1983 failed due to drought. They were repeated last October. The trial on black cotton soil has again failed indicating that Agrosoke is of no use on saline clay soils. But trials on red soil has good survival up to now, although it is still not clear whether the Agrosoke has assisted.

Trial fodder blocks were planted last October at Marimenti using mainly P. juliflora, L. leucocephala, Cassia sturtii and Parkinsonia aculeata. These have shown very good establishment and may be used for rehabilitating degraded grazing lands. In general the research programme is planned to move more on to the farm by taking the results from the established trials and attempting to find systems and species that can be used by farmers. The only further 'conventional' species trial planned is an irrigated trial hopefully to be planted at Merti, isiolo in April.

SUMMARY OF RESULTS

(Gangara Species Trial - Planted April, 1983
Survival March 1985)

1. Highest Survival (Over 40%)

   Callitris robusta

   Eucalyptus camaldulensis (Kimberly)

   E. camaldulensis (Katherine)

   Tamarindus indica

   E. camaldulensis (Petford)

2. Moderate Survival (Over 20%)

   Acacia albida

   Cassia siamea

   Eucalyptus microtheca

   Melia azedarach

   Cassia spectabilis

3. Poor Survival (less than 20%)

   All other 17 species tried. Species directly sown had no survival at all. Common ones include Casuarina *equisetifolia*, *Acacia albida*, *E. tereticornis*, *E. sideroxylon*, *E. camaldulensis* (Albacutya) *Prosopis juliflora*, *P. cineraria* *Acacia cyanophylla* etc.

*NB Brackets after species name indicate seed source, provenance, variety or area where the species is planted.

Gategi Species Trial - Planted December, 1983
Survival as at February, 1985

1. Highest survival (Over 40%)

Acacia nilotica (India)

Atriplex semi-baccata (Setropa)

Ziziphus mauritiana (Kositei)

Eucalyptus microtheca (Charleville, QLD)

Acacia polyacantha (Siakago)

Eucalyptus largiflorens (Wileanmia, NSW)

Eucalyptus camaldulensis (Petford, QLD)

Albizzia lebbek (Timmers + Leyer)

Eucalyptus salmonophloia (Martin mine, WA)

E. microtheca (DeGrey, WA)

E. microtheca (Kinunurra , W.A)

2. Moderate Survival (Over 20 %)

Eucalyptus camaldulensis (Gilbert QLD)

E. microtheca (Laura WA)

Leuceana leucocephala (K8)

E. camaldulensis (Njukiini)

E. camaldulensis (L. Ablacatya VIC)

E. microtheca (Coober, SA)

3. Poor survival (Less than 20%)

All other 18 species triad including E. occidentalis (Kataning), E. citriodora (Hughenden QLD), E.maculata (Monto QLD), Grevillea robusta (Riakanau), Prosopis juliflora, P. cineraria, Azadirachta indica, Cassia liamea, Casuarina torulosa, C. glanca etc

2. Moderate Survival (over 20%)

Albizzia lebbek

Acacia arabica

L. leucocephala (K28 and Ena)

E. camaldulensis

Prosopis chilensis

3. Poor survival (less than 20%)

All other 19 species tried. Atriplex semi-baccata. E. hybrid, E. camaldulensis and Acacia cyclops had no survival at all. Among the 19 species with poor survival include: E. tereticornis, E. hybrid, E. camaldulensis, Leucaena leucocephala, (K29 and K8), Prosopis juliflora, P. cineraria Atriplex semi-baccata, etc.

Kuani Species Trial
Survival as at October, 1984

Most species tried had good survival percentages above 40%. Species which had less than 40% survival are:

E. paniculata (Kirinyaga)

E. globulus (Meru)

E. tereticornis (Gede)

E. saligna (Muthara)

E. gomphocephala (Mylap, WA)

Acrocarpus praxinifolius (Embu)

E. cloeziana (Monto, QLD)

Gategi - Repeat Species Trial - Planted October, 1984
Survival as at February, 1985

All species tried which include various provenances of Eucalyptus spp, Acacia spp, etc had high survival rates ranging from 59% to 100%. Acacia senegal, Azadirachta indica, Atriplex nummularia, Leucaena leucocephala, Parkinsonia eculeata, Acacia nilotica, Ziziphus mauritiana Z. mucronata etc. had 100% survival.

Maranga Species Trial - Planted April and May, 1984
Survival as at February, 1985

All species tried had survival rates greater than 40%. Species which had survival percentages less than 40% include: Cordia abyssinica, Eucalyptus saligna and Cupressus lusitanica. Albizzia jakataria and Ginelina arborea had no survival at all. Some common species which had above 40% survival are: Leucaena leucocephala (Ena) Cassia spectabilis, Acacia mollissima, Cassia siamea, E. parniculata, E. hybrid, Croton megalocarpus, Grevillea robusta, E. maculata, E. globulus, E. saligna among others.

Marimanti Species Trial
Survival as at October, 1984

Highest Survival (Over 40%)

Acacia tortilis

Ziziphus mauritiana

Acacia victoria

Cassia sturtii

Prosopir juliflora

Leucaena leucocephala (K341 and K67)

Gategi - Repeat Species Trial - Planted October, 1984
Survival as at February, 1985

All species tried which include various provenances of Eucalyptus spp, Acacia spp, etc had high survival rates ranging from 59% to 100%. Acacia senegal, Azadirachta indica, Atriplex nummularia, Leucaena leucocephala, Parkinsonia eculeata, Acacia nilotica, Ziziphus mauritiana Z. mucronata etc. had 100% survival.

Maranga Species Trial - Planted April and May, 1984
Survival as at February, 1985

All species tried had survival rates greater than 40%. Species which had survival percentages less than 40% include: Cordia abyssinica, Eucalyptus saligna and Cupressus lusitanica. Albizzia jakataria and Gineline arborea had no survival at all. Some common species which had above 40% survival are: Leucaena leucocephala (Ena) Cassia spectabilis, Acacia mollissima, Cassia siamea, E. parniculata, E. hybrid, Croton megalocarpus, Grevillea robusta, E. maculata, E. globulus, E. saligna among others.

Marimanti Species Trial
Survival as at October, 1984

Highest Survival (Over 40%)

Acacia tortilis

Ziziphus mauritiana

Acacia victoria

Cassia sturtii

Prosopis juliflora

Leucaena leucocephala (K341 and K67)

Some species which had above 40% survival are: E. camaldulensis, E. alba, E. crebra, E. terminalis E. tesseloris, E. citriodera, E. maculara, Albizzia lebbek, Cassia siamea, Casuarina cunninghamiana, C. litteralis and Grevillea robusta.

ISIOLO SPECIES TRIAL - RED SOIL
Survival as at May, 1984

Only one species i.e E. tereticornis (N. Cardwell, QLD) had a survival percentage greater than 40% that is 53%. Species with survival greater than 20% include: E. melanophloia (Charleville QLD), 34%; E. argillocea (Learnmonth, WA) 23%; E. tereticornis (Morehead QLD)25%; and Cassia sturtii (Israel) 23%.

The rest of the species tried (68) had percentages lower than 20% with 21 species having no survival at all. Among them are: Parkinsonia aculeata, Balanites eagyptiaca, E. tereticornis (Gladstone), E. camaldulensis (L.Albacatya), Leucaena leucocephala (K8), Tamarindus indica, Prosopis cineraris, P. chilensis, Schinus molle, Cassia siamea, Casuarina equisetifolia, Acacia albida, Azadirachta indica, etc.

tree species such as Sesbania sesban deliberately grown in agricultural land. S. sesban is generally not regarded as a tree, but rather as a plant that enhances soil fertility through nitrogen fixations, and so is tolerated by farmers. This species has been effectively adopted as a source of fuelwood by the women in these areas.

Although the men plant large numbers of trees on their farms, those trees are not used to supply fuelwood to the household. The provision of fuelwood is regarded as being of very low priority in relation to other, seemingly more pressing, needs of the house-hold. Nevertheless, both men and women admit that there are shortages of fuelwood, and these appear to be occurring regardless of the size of the landholding or the amount of woody biomass that is growing on the farms.

Trees normally planted by men on the farms are exotic species such as eucalyptus, which have many uses, but take many years to mature. One avenue that is being explored is based on the observation that some species, particularly S. sesban, are not considered to be trees by either men or women. Sesbania is already intercropped with food crops by women in a few parts of the district to improve soil fertility. Since it is not regarded as a tree, and so women cannot claim ownership of land through it, then the men do not see it as a threat to their standing in the community. The KWDP is developing this line of approach, by introducing

similar tree species that can serve the same purpose, but which bypass the cultural taboos.

Both men and women agree that to plant trees that will be used sorely for fuelwood would be impracticable, for several reasons. Men will not tolerate a situation in which their wives have sole access to the trees, and in any case many farms are far too small to support a woodlot of women's fuelwood trees in addition to the trees the men already raise for other purposes. The problem is therefore being approached from several angles simultaneously. The suitable species identified by the KWDP agroforesters (Sesbania, Leucaena, Calliandra, Mimosa) have many advantages: they have no traditional connotations, they grow very quickly, allow for close planting, they can provide animal fodder, act as windbreaks, improve soil fertility and help prevent erosion, in addition to providing a continuous source of high-quality fuelwood. One potential drawback of Mimosa, however, is that its stems are tall and straight, making them ideal building poles so that they might be monopolized by the men, but even this could be turned to advantage if all four species are marketed as a package that can within a very short period of time provide a significant contribution to the total needs of the household in relation to wood.

The Kenya Wood Development Programme is involved in the production of tree seedlings in (de)centralized nurseries for planting in individual farms. The programme includes the following:

(a) Establishment of seed stands:

Plots of 10 x 10m *Leucaena leucocephala* of K28, *Calliandra calothyrsus*, *Mimosa scabrella*, *Sesbania sesban* and *Gliricidia sepium* have been established in 30 sites in the district.

(b) Espacement trials:

The four species have been established at $\frac{1}{2}m^2$, $1m^2$ and $1.5m^2$ and their production of biomass for fuelwood are being monitored.

(c) Management of small farm nurseries:

The size of nurseries vary from a broken pot to a strip of land between bananas or tree crops. This work looks at prospects of producing healthy and robust seedlings. Stocking of seedlings and root pruning are particularly stressed.

(d) Follow up of planted stock:

A follow up service monitors the performance of planted stock in selected farms per sub-location. Extension services are also provided.

FUELWOOD AFFORESTATION/EXTENSION IN BARINGO

This project is financed largely through FAO. The area is semi-arid, eco-zone IV.

Rainfall of about 600 mm in the year with two peaks on the average in April/may and July/August when 24% and 23% (respectively) of the rains occur. However, the rain is very irregular in both time and place and great variations occur.

Temperature:

The temperature is normally high and the mean annual temperature is 23°C.

Evaporation:

The potential evaporation is high at 2100 mm and the ratio of the average annual rainfall to the average annual potential evaporation is between 0.25 and 0.40. In 1984 when the actual rainfall was only 188.5 mm the ratio of r/Eo dropped to 0.09. in general terms the moisture availability dropped from the semi-arid class to the very arid class for that particular year.

In growing trees in the district, consideration was given to the following:

(a) selection of the most-suited species and production of healthy seedlings

(b) development of appropriate establishment techniques including micro-catchment systems

(c) timely planting out to enable the young trees to benefit from most of the season's rain and hence to face the following dry period.

1. Species Elimination:

Species elimination trials were conducted between 1983 to March 1985 to find species that are suited to the ecozone. The following species have given favourable results:

Parkinsonia eculeata

Prosopis sp. (? juliflora)

Cordia sinensis

Delonix elata

Acacia aneura (from Vaughan springs Northern Territory, Australia)

Albizia lebbek (from India)

Eucalyptus camaldulensis (from Fitzroy River Crossing, W. Australia, and from Wrotham Park Queensland, and Katherine Northern Territory, Australia)

In the hills and minor scarps the most suitable species are:

E. camaldulensis (Fitzroy River Crossing and Katherine)

E. microtheca (from Victoria River, N.T. Australia)

Cassia spectabilis

Azadirachta indica

Melia azedarach

Croton megalocarpus

E. citriodora (from ESE Mr. Molly, Queensland)

Parkinsonia aculeata

A. lebbek

Ziziphus mauritania

C siamea

2. Water Harvesting and Water Concentration:

Some kind of physical structure is absolutely necessary to arrest the flow of rainwater off the site. Otherwise the water flows to the lowest geographic level and most of it is not available for use by artificially planted trees. On the Njemps Flats there is a general slope of 1% upwards Lake Baringo. The soils are very compact and the rate of run-off is very high. Penetration of water is low.

Where the surface is generally smooth and unbroken by erosion channels, the standard physical structure for trapping run-off water is a contour ditch 20 cm deep and a bund of 30 cm height. The long contour ditches are sub-divided by cross-ties at 5 metre intervals and the earth to make each cross-tie is dug from the ditch itself thus making a low point where water concentrates from within the ditch. These low points of water concentration are used as planting spots where planting holes of some 20-30 cm are dug prior to the rains.

A test was made on at Njemps Flat site for water penetration. On 10/11 December, 1984, 40 mm rain fell between midnight and 0500 hours. At a sample point, on the middle of the almost flat catchment the rainwater had penetrated to 70 mm. At a second sample point within the contour ditch, half way between the low points where tree planting had been done, the water had penetrated to 130 mm. But at sample point 3

at one lowest point (where water was still lying at 0800 hours on 11 Dec.) the rain water had penetrated to a depth of 320 mm and was still incomplete.

These contour ditches and bunds have been tried at spaces of 5, 7 and 10 metres. The bigger the spacing the bigger the water catchment is required to service the ditch. It is still uncertain what size of catchment is best. In years of good average rain of 600 mm the 5 metre spacing will work, but in drier years, the wider espacement is more suitable. It is likely that somewhere between 7 and 10 metres will prove to be the best. A density of planting between 400 and 600 trees per hectare seems desirable. In order to maximize on agroforestry pursuits, the less dense planting of 500-400 trees per hectare may be desirable; thus an espacement of about 8 to 10 metres between ditches may be the optimum. In the hills and minor scarps, site preparations are done to harvest and concentrate water to the planting spots. On very stoney ground stone walls or mounds are built by hand along a contour line. These walls are about 25 cm high and they are built at a normal 2 metre vertical interval. Wherever there is any soil it is dug or scrapped down the slope to form a reverse slope against the general line of the land. The soil helps to seal the stone wall gaps and hence helps to retain the water. Planting holes are dug where the water is held by the stone wall.

3. Correct Planting Out Time:

All things being equal, the best time for planting is with the April/May rains, but rainy seasons tend to be irregular and in 1985 planting was started on 26 March whenever the catchments had been filled with water. Planting in April/May is advisable so as to take advantage of the August rains for establishment and growth, when the tree roots begin to develop rapidly downward. After September little or no rain can be expected until April, and it is in this period of drought that trees without developed root systems will die.

It is perfectly advisable to risk planting within the period April to September if sufficient rain has fallen on a particular day, and in the hope that normal rains will follow, according to the average pattern. But it is not advisable to risk such planting after September when the period ahead is expected to be dry.

CARE - KENYA

AGROFORESTRY EXTENSION PROJECT

he CARE Agroforestry Extension Proj Canadian Government funded project, operating in Siaya and South Nyanza Districts. It works in close collaboration with the Kenya Government through the Forest Department and KARI. The Project works with women groups and primary schools, where it assists small scale nursery efforts. So far the Project has assisted 80 women groups nurseries and 25 school nurseries in which 850 women and 12,000 school children actively participated on a self help basis. Considering the enthusiasm in the districts up to 300 nurseries may be covered by the long rains in 1986, in which up to 2,500,000 seedlings will be raised. The species used are depending on what the participating members of the groups define as the species they need. In total 30 different species are used. The Project's strength lies in the fact that we are able to do follow ups on the farms where the trees are planted. Advice is given on both planting site, planting method and tree management. The Project employs 48 local level extension workers for this purpose. They are employed and trained on the Project.

In collaboration with KARI, the Project is working on a research and evaluation component. Agroforestry is new and there are no blue prints for a large scale dissemination as in Siaya and South Nyanza. The

research and evaluation component ensures that all the interventions are researched and quantified. In total 6 research plots have been established to investigate the suitability of agroforestry trees in sustaining soil fertility and possible increased food production. Cropping interventions are researched upon. Mostly alley. Alley widths of 4.25 m x 15 m are used while the spacing for the maize crop is 0.75 m x 0.3 m. Tree seedlings are spaced at 0.5 m along the row. Species used are Markhamia platycalyx, Leucaena leucocephala, Calliandra callothursus and Gliricidia sepium. There is one split plot intercropping trial at Nyasanda where alley widths are varried between 2.75m x 15m; 3.5m x 15m and 4.25m x 15m. S.glandiflora and M. platycalyx are used in this case.

Fuelwood trials were established in Bondo, Abayo and Nyasanga using Cassia siamea, Grevellia robusta Casuarina equisetifolia and Eucalyptus camaldulengis. G. robusta, C. siamea, C. equetifolia and M. platycalyx were used for the surrounds and wind break planting around the research plots.

Biomass productivity of the maize and tree crops are measured regularly. Maize yield at harvest was determined by weight for such treatment. Also growing rates in experimental fuel woodlots are measured. The research has also looked into non-chemical measures for termite control in the nurseries and into the traditional Markhamia platycalyx agroforestry

complex. The findings on the termite research are hopeful and will be published soon.

OTHER PROGRAMMES

The Ministry of Agriculture has an agroforestry and soil conservation section at the headquarters and maintains separate tree nurseries for distributing tree seedlings to farmers. The forest department has a Rural Afforestation Extension Scheme with foresters stationed in 40 out of 41 districts of Kenya. These provide trees and advice to farmers on what trees to plant in given situation and how to plant and tend them. Particular attention is paid to multipurpose trees.

The Ministry of Energy, with support from USAID has established six agroforestry centres with some research component and demonstration.

The Forestry Department of MOI University conducts research on indigenous and exotic multipurpose trees, mainly supported by a grant from the US National Academy of Sciences (NAS) in its fast growing nitrogen fixing trees research network.

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AGROFORESTRY/AFFORESTATION IN KENYA: THE EXPERIENCE OF THE KENYA RENEWABLE ENERGY DEVELOPMENT PROJECT[1]

AMARE GETAHUN

NOV. 1985

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The Views and opinions expressed in this paper however, do not necessarily reflect the official views of USAID or the Government of Kenya.

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[1] Largely adapted from: Amare Getahun 1985: Agroforestry/Afforestation in Kenya (in press)

AGROFORESTRY/AFFORESTATION IN KENYA

1. TREE PLANTING IN KENYA: AN INTRODUCTION

1.1. AWARENESS

In Kenya, the level of awareness and the importance attached to planting trees and their protection by both the Government and the general public is high as reflected by the many GOK agencies and NGOs concerned on, and active in agroforestry, tree planting and conservation (ELC, 1981, and Mathu, 1985); the most important GOK and International agencies being, MOERD, MENR (RAES, FD), NIB, KARI, KWDP, KVDA and NGOs include, KENGO, CARE-Kenya, Action Aid, BAT, ELC, NCWK (Green Belt Movement) ICRAF, Maendeleo Ya Wanawake, MAZINGIRA, UNEP, NCCK, PFP, etc. The recently established Presidential Committee on Soil Conservation and Afforestation and the personal committment of His Excellency, Daniel Arap Moi, President of Kenya, represents the ultimate effort by the Government to effect tree planting throughout the country to restore Kenya's forests, protect watersheds and catchments and the agricultural environment in general. Additionally, the more recently established Presidential Tree Fund and the Presidential Directives to include tree planting education and nursery programs in all formal schools are additional new chapters in the national efforts to:

- Reduce defforestation and environmental degradation by increased tree planting and woodfuel conservation
- Reduce demands on the present woodfuel reserves through end-use efficiency measures
- Develop and improve institutional infrastructure in both GOK and NGOs to effectively excute agroforestry/ afforestation and tree and tree products demand management programs.

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1.2 TREE PLANTING TRADITION AND EXPERIENCE IN KENYA

a) Tree Planting Tradition

Kenya is one of the few Tropical African countries that have relatively good tradition of tree planting both by individual farmers and NGO agencies (World Bank 1978) and Government. The practice of retaining and/or planting trees in ones shamba (farm) and in homesteads as a traditional agroforestry system of land use is common especially in the highlands and coastal region. There has been a liberal tradition of introduction of exotic tropical and sub-tropical trees especially horticultural.

b) Forest Reserves and National Parks

Kenya has also a strong program of reserve forests (gazetted) and national parks, partly supporting the tourist industry and which serve and act as important water catchments and wild life sanctuaries and the Government's ban on timber export also positively contributes to the reduced exploitation of economically important native trees such as Albizia spp., Olea spp., Podocarpus gracilior, Brachylaena hutchinsii, Cordia africana, Hagenia abyssinica, Juniperus procera, Maesopsis eminii, Markhamia spp., Vitex keniensis, etc.; Most of which are also in the national tree planting programs of the Government.

Despite Government efforts of protecting forest reserves and national parks, active defforestation has not been effectively prevented; much of the pressure coming from woodfuel exploitation and expansion of agriculture, and in some extreme cases de-gazettment has been made necessary there-by shrinking the physical size of the reserves or parks. The expansion of agriculture is a direct result of declining food production per unit of land and increasing population. Agricultural yield declines are in turn directly caused by defforestation. This senario is illustrated by Table 1 from Central Kitui. The area is currently not effectively feeding its population without destroying its environment, that is eating its captial in terms of land productivity decline but is even more difficult to see how the area could sustain 4 million people after the year 2035 at which time the environment would have degenerated even more.

c) Forest Plantations

There has been an acitve Government effort of establishing forest plantation for timber, pulp and fuelwood purposes, largely by replacing existing native forest vegetation. Most of these efforts have largely concentrated in the highlands and to some extent in Coast. Such Government efforts are being complemented by efforts of private commercial companies such B.A.T., Tea Estates, Panafrican Paper Mills, E.A. Tanning Extract Co. Ltd., and Baobab Farms (Bamburi Cement Co.). These efforts however tend to lock trees in and keep agriculture and people out, thus intensifying land use conflict in areas where rural population densities are very high and demand for food, energy and wood products high.

More recent efforts include new efforts to reforest degraded hills and valley bottoms both for environmental improvement and enhanced wood supply, with financial and technical participation of several donner agencies (i.e., USAID, Dutch, German, DANIDA, FINIDA, SIDA, etc.) as development assistance projects. These efforts are new incentives but the initial signs of success of plantation on denuded hills appear to be questionable.

1.3 WHY PLANT TREES?

a) Afforestation

Trees can be planted by parishioners around churches, by children around schools, by individual families around homesteads and on farms by cooperatives around entire village (Hoagland, 1985) or around cities, on slopes and river banks and on road reserves by Government and organized groups. But is there an effective tree planting that will conserve and re-build the environment and prevent any environmental destruction in the name of development? The answer is, unfortunately, not enough tree planting is being done to match the zeal and number of tree planting programs and activities.

Kenya has many enviroments that need environmental repair through afforestation programs such as the new DANIDA/MENR

project is S. Nyanza and Taita/Taveta. Such programs include a management plan which includes a utilization (harvest) plan such as fuelwood, charcoal and poles harvest after environmental repair has been attained. Certainly, every available and affordable land should be afforested now, in the face of the acute national fuelwood scarcity as Kenya is listed as one of the 57 nations facing fuelwood scarcity (Hoagland, 1985). Kenya is projected to have 15 million tons of fuelwood shortage by year 2000 thus causing a massive depletion of the standing woody biomass and World Resources Institute estimates that Kenya will need U.S.$83 million over the next 5 years to support necessary agroforestry, fuelwood and watershed establishment and management projects (Hoagland, 1985).

b) Agroforestry[1/]

Current population densities especially in the high and medium potential areas such as the highlands and their associated valleys, and the projected population increases place heavy burden on land use and will lead to more land use conflict between agriculture, livestock, forestry and energy production.

Land allocation on commodity lines like these, will be more difficult. This condition dictates the widespread adoption and use of multiple land use systems that enable one to produce agricultural crops, tree products, and/or livestock from the same unit of land without the risk of environemntal degradation. Such multiple or integrated land use systems are collectively known as agroforestry, representing a diverse array of tropical land use systems and associated technologies where woody perennials (trees, shrubs, palms, etc.) are deliberately used on some form of spatial (space), arrangment or temporal (time) sequence, which, when properly designed and managed, improves the overall farm economy and thus gives the best return to land, labour and capital used.

[1/] Largely adapted from Agroforestry KREDP Brochure (1985)

The major type of agroforestry systems of land use, based on components combination are:

- o Agri-Silviculture - involving the spatial and/or temporal relationship of food crop farming and forestry.
- o Silvo-Pastoral - where tree farming (forestry) and animal production are combined in the land use and management.
- o Agro-Silvo-Pastoral - where arable crop, tree and animal production make up the combination both in time and space.

The biological effectiveness of these types of agroforestry is based on the tree component. Trees and shrubs, particularly under an agroforestry system, provide the following benefits:

- o Protect the soil against burning sun and battering tropical rains,
- o Prevent soil and water erosion and retain soil moisture,
- o Enrich soil by adding organic matter and/or fixing atmospheric nitrogen, thus benefiting the crop,
- o Provide good source of woodfuel (firewood and charcoal), and
- o Provide other products for home use or to be sold, such as fodder, fruits and poles.

Not all tree species are good for agroforestry. But as a general guide, a good species should have one or more of the following characteristics:

- o Fast growing (high biomass production),
- o Nitrogen fixing,
- o Deep rooted,
- o Palatable, high protein leaves (livestock feed), and
- o Produce economic products and by-products (fruits, poles etc.).

In general, such characteristics provide positive interaction between the trees and their associated crops and livestock. Some of the good agroforestry tree species for Kenya that meet some of the above criteria include the following:

For the Coastal and Lake Basin Zones (Fig.1, Zones 1, and 4D

Acacia albida

Casuarina equisetifolia

Flamingia congesta

Gliricidia sepium

Gmelina arborea

Leucaena leucocephala

Prosopis spp.

Sesbania grandiflora

For the Dry Lands (ASAL) (Fig.1, Zones 2A, 2B and 2C)

Acacia spp.

Anacardium occidentalis

Cassia siamea

Casuarina equisetifolia

Prosopis spp.

Psidium guajava

Sesbania grandiflora

Sesbania sesban

Tamarindus indica

For the Highlands (Fig.1, Zones 4A, 4B, 4C and 4E)

Calliandra calothyrsus

Cordia abyssinica

Erythrina spp.

Grevillea robusta

Markhamia spp.

Mimosa scabrella

Persea americana

Sesbania sesban

All of the above species and many others (over 125) are currently being tested in Kenya.

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3. SOME LESSONS LEARNED FROM AGROFORESTRY RESEARCH, DEMONSTRATION, AND EXTENSION IN KENYA

3.1 Brief Description of the Agroforestry Program of KREDP. (See Bulletin for more details)

The biggest network of agroforestry research-demonstration, training, extension and technical services is that of the Kenya Renewable Energy Development Project, a collaborative Program between MOERD, MOALD, MENR and KENGO and complemented by field programs of ICRAF, CARE-Kenya and the Beijer Institute, and others. This project, in addition to Headquarters activities such as Central Seed Services, Library/Documentation, etc., operates regionally-based field programs (Fig. 1), the largest component being the agroforestry research and demonstration farms to generate biotechnical data on agroforestry systems of land use for the major Kenyan Environments (Fig.2) and uses these research farms and seed orchards for teaching and extension. Preliminary data from these research activities is now being made available through technical reports and extension notes. The recommended agroforestry/woodfuel models are now being established as on-farm demonstrations on contact farmers' fields of which there are already 200 such farms which are facilitating agroforestry dissemination in 29 Districts.

The field programs of agroforestry research and extension is greatly being facilitated by a strong seed production and distribution covering more than 125 species is being operated by each centre. These seeds are being provided free, or sold at subsidized prices. Paralleling the seed service program is the seedling production and distribution by the centres and through the 120 decentralized private, group and/or school nurseries.

Closely related to the research and extension and technical services is the training program. The project operates, Headquarters and centre-based training activities on agroforestry and woodfuel conservation. The training is comprised of workshops/seminars, short courses, observation tours, A.S.K. Shows and field days.

3.2 Major Benefits of Agroforestry Systems Compared to Forestry and Agriculture

The project advocates planting trees individually or as clumps (groups) in homesteads, trees around the shamba as live fence/ fuelwood and on-farm. The following general conclusions/ recommendation are based on the Kenya Coast using Leucaena, Casuarina, etc. as the multi-purpose nitrogen fixing agroforestry species using the desing and modules shown in in Figures 3 and 4.

a) Establishment of the Tree Component

A typically highly leached sandy (92%) coastal land was prepared and planted to cassava and Leucaena seedlings were interplanted in rows running east-west and the Leucaena was planted at several density groups ranging from 416 to 10,000 trees/ha. The following results were observed:

(1) Seedling survival rates were high for all species and for Leucaena, ranged from 72% (in the low density group) to 96% (in the high density group). This is much higher compared to forestry (afforestation) national averages (10-40%).

(2) Leucaena normally grows slow during the first 6 to 10 months but in our case (under cassava) growth rates were good and ranged, for 8 months from 1.4m (in the low density bracket to 2.5m in high density group. Thus the high density groups such as the 5,000 and 10,000 trees/ha. on average grow faster significantly. These initial growth rates such as that of Leucaena and Casuarina were 2 to 3 times better than forestry systems of similar densities (1,600 trees/ha.).

(3) The cost of establishing the tree component such as Leucaena or Casuarina is insignificant (only planting labour and cost of seedling) and all benefits to the tree growth resulted from the food crop husbandry. It is generally estimated that agroforestry systems of tree farming cost only 10% of that plantation costs.

Thus, efficiency on land, labour and capital use by the tree component during the initial establishment phase (12-18 months) is significant.

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b) Food Crop and Tree Interraction During the First 2-3 years

(1) Initially (first year) there is very little interraction between the tree component and the agricultural food crop. If there is, it is that the crop (cassava) acts as a nurse crop to the tree system forcing it to grow fast, straight and single stemmed thereby positively affecting its survival and market value of the wood (pole, posts, timber, etc.). The high density range (5,000 to 10,000 range) begun to close canopy after 18 months, thus significantly affecting the maize and bean crops yields while the wider rows (lower density groups) had the least effect on the food crop. At the same time the high density groups models controlled more than 75% of the weed problem.

(2) The mean annual increments (MAI), on per hectare basis, of Leucaena or Casuarina remained high for the high density groups and economical harvestable age was reached after 30 months and at which time shading effect on the crop was significant and partial or fuelwood harvest to reduce shade was necessary. Thus, high density groups (5,000 to 10,000 trees/ha. or more) result in highly productive (biologically effective) short cutting cycles (24 to 30 months) as illustrated in Fig.2).

(3) Wood yield from a partial harvest of Leucaena after 30 months was 62.8 tons/ha. for the highest density (10,000 trees/ha.) and only 8.54 tons/ha. for the low density (416 trees/ha.) with a correspondingly high nitrogen fertilizer contribution from the Leucaena tops to the food crop.

c) Fodder/Browse Values

(1) Feeding trials on dairy cattle and small ruminants carried out indicated that Leucaena generated increases of 35% in commercial milk production when added to the traditional feed. Palatability tests of

browse/fodder and other species on small ruminants (goats and sheep) showed that Leucaena was popular but that Gliricidia and even Casuarina were acceptable.

(2) In the case of Leucaena, seedling undergrowth for grazing was significant in the 4 meter block with partial light penetration but canopy closure in the 2 meter block suppressed seedling regrowth.

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TABLE 1 : POPULATION AND RESOURCE-BASE FOR KITUI CENTRAL SENARIO FOR 1980-2035, WITHOUT MAJOR INTERVENTION

Year	Human Population (mil.)		Land Use Ratio		Productivity intensity (s) $\frac{C \times 100}{C + F}$
	National	Kitui Central	Cropping (C) Years	Fallow (F) Years	
1980	16.0	0.5	3	5	40
2000	37.0	1.0	3	7	30
2020	81.0	2.0	1	9	10
2035	120.0	4.0	1	14	7

TABLE 2. CASUARINA AGOROFRESTRY PLOTS - MTWAPA

3 YEAR GROSS ECONOMIC YIELDS (KSHS. PER HA.)
(BASED ON BAOBAB FARM PRICE)

LINE DENSITY \ ROW WIDTH	2M	4M	8M
1M	34,310	37,590	41,906
2M	33,890	37,475	30,431
3M	35,504	30,335	31,985

Agricultural Control: 24,985

Forestry Control (Gede): 9,748

TABLE 3. CASUARINA AGROFORESTRY PLOTS - MTWAPA

3 YEAR GROSS COSTS (KSHS. PER HECTARE)
(BASED ON BAOBAB FARM PRICE)

LINE DENSITY \ ROW WIDTH	2M	4M	8M
1M	11,310	9,810	9,060
2M	9,810	9,060	8,685
3M	9,309	8,809	8,559

Agricultural controls: 8,310

Forestry control (Gede): 3,850

TABLE 4. CASUARINA AGROFORESTRY PLOTS - MTWAPA

3 YEAR NET ECONOMIC YIELDS (KSH. PER HA.)
BASEON BAOBAB FARM PRICE).

Line Density m. \ Row Width m.	2m	4m	8m
1.0	23,000	27,780	32,846
2.0	24,080	28,415	21,746
3.0	26,195	21,526	23,426

Agricultural Control: 16,675

Forestry Control (Gede) = 5,898

FIGURE 1

Present Regional and District Programmes of KREDP

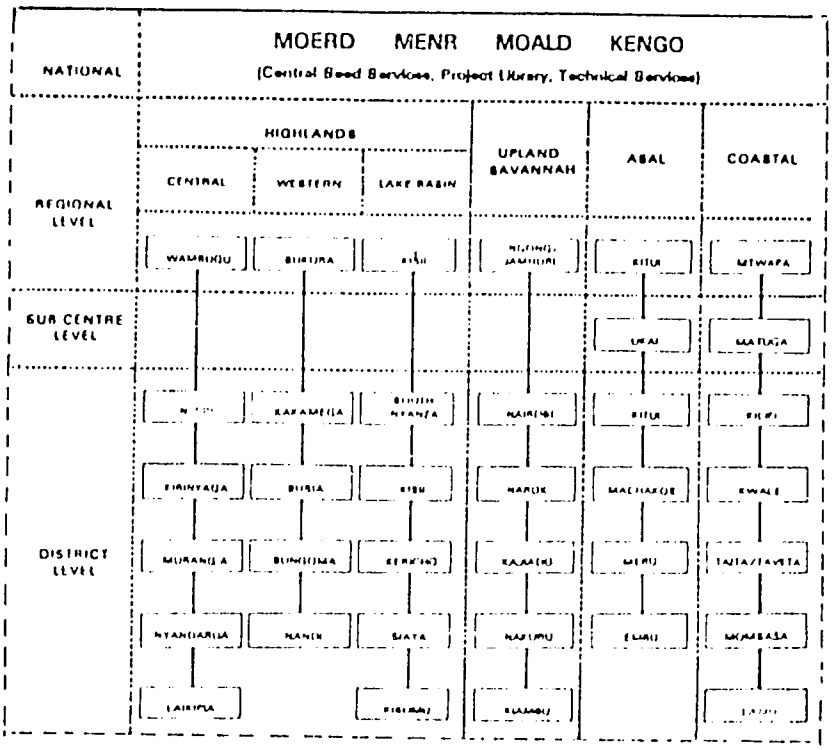
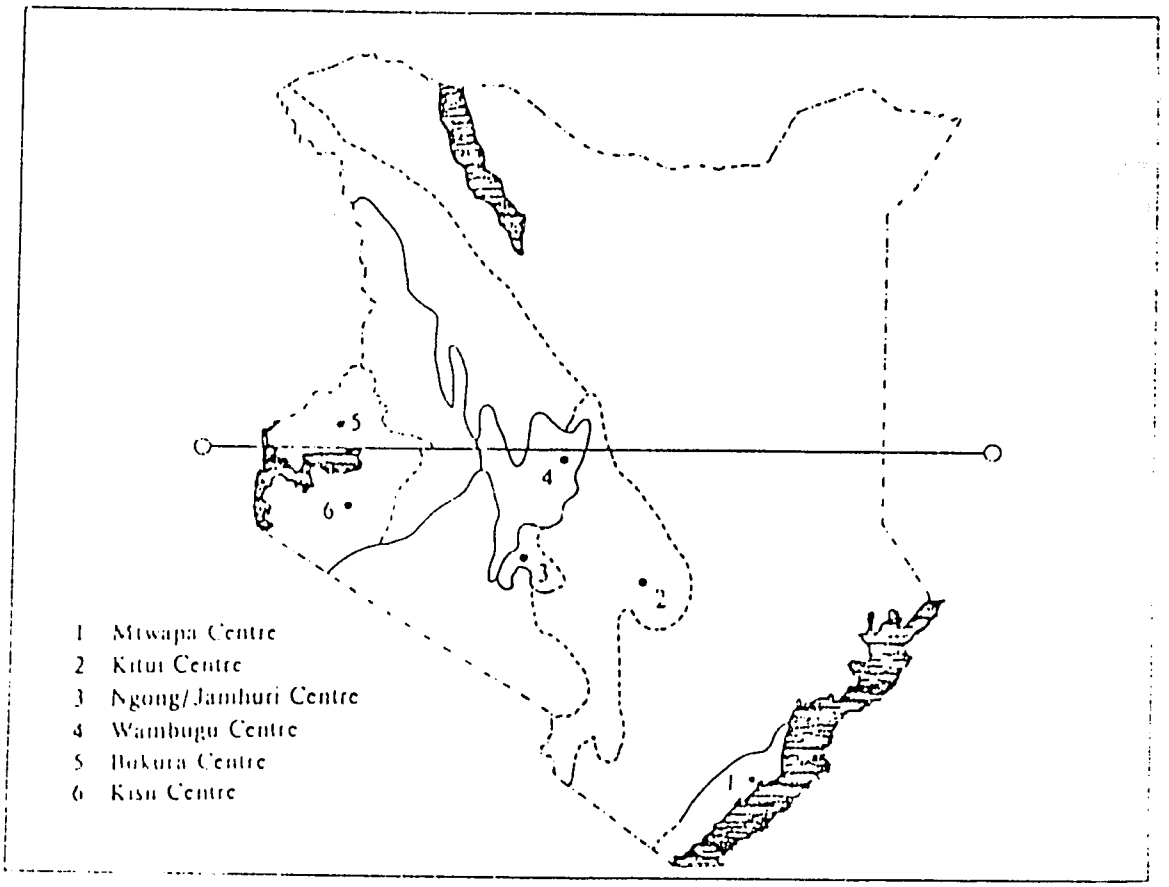


FIGURE 2

Locations of the Agroforestry/Energy Centres



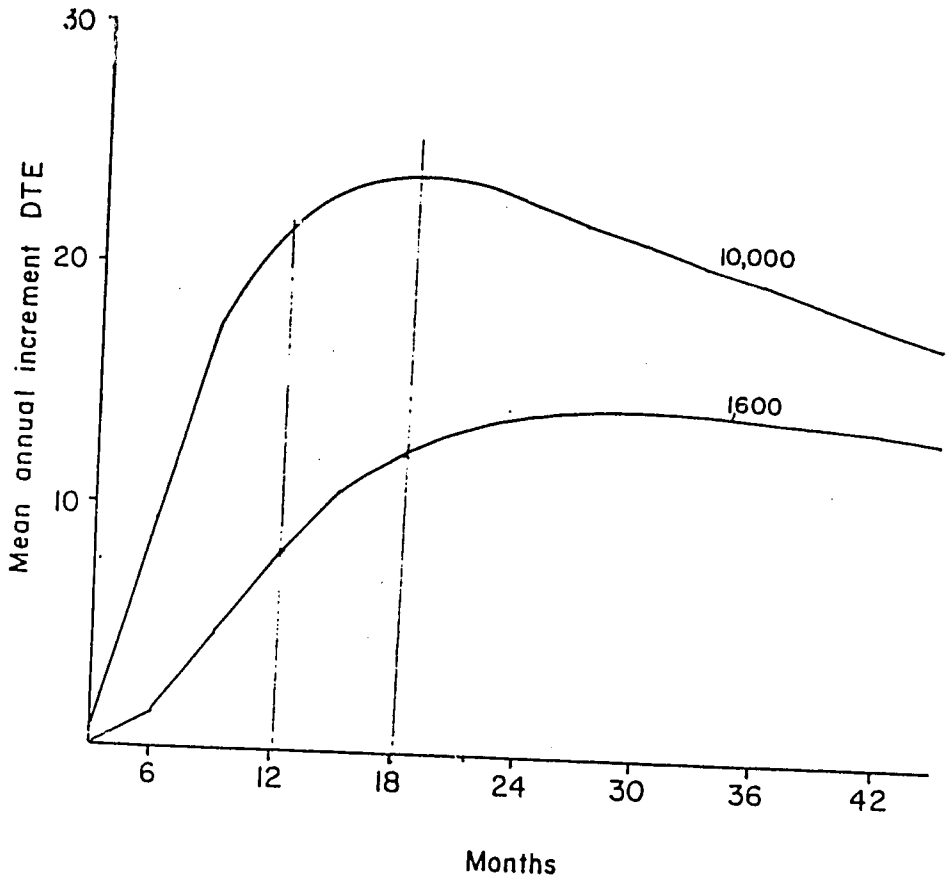


Figure 3 . Mean annual increments (MAI) of Eucalyptus grandis at 1,600 and 10,000 trees per hectare.

Source: Rockwood 1983

CIMMYTS APROACH TO A SYSTEMS BASED RESEARCH

Presented by

Dr. Michael Collinson
and
Dr. P. Anadajayasekeram

The past decade has seen a rapid growth in the development of farming systems, or systems-based, agricultural research. This expansion has been so broad that it is at times difficult to recognize commonalities among the various research approaches grouped under this rubric. A meeting of the IARCs to discuss activities in systems-based research is therefore most opportune. This paper attempts to outline CIMMYT's approach to systems-based research, which we call on-farm research (OFR).

OFR can be considered a class of systems-based research because it takes into account the biological and economic interactions that determine the appropriateness of new technologies for particular groups of farmers. CIMMYT's work in OFR differs in some respects, however, from other types of systems-based research. OFR takes a restricted view of systems and focuses research on one or two enterprises at a time. As well, CIMMYT sees its role in OFR as one of providing research procedures and training, not in developing technologies themselves. Finally, CIMMYT's clients in this work are the national agricultural research services (NARS). It is the purpose of this paper to make explicit these characteristics of CIMMYT's approach to systems-based research, and to describe the activities of CIMMYT agronomists and economists that are related to this approach.

The paper is divided into four parts. The first part describes CIMMYT's rationale for a systems approach. The second part outlines the elements that are taken into consideration in developing the research procedures of OFR. The third part summarizes this set of procedures. The fourth part points to some issues in the institutionalization of on-farm research.

The treatment is best seen in the context of CIMMYT's

sense of its role in the process of technology generation. For historical and other reasons, CIMMYT's role is to provide germplasm, training, and research procedures--along with information and counseling--to its clients, the NARS. NARS are responsible for developing technologies for farmers which raise the productivity of resources committed to maize and wheat. The work of CIMMYT agronomists and economists in OFR is consistent with this role.

While CIMMYT staff recognize the importance of extension services, improved infrastructure, and more congenial policies in increasing resource productivity, our energies in OFR are concentrated on strengthening the research process which generates improved technologies. For the purposes of encouraging a discussion among IARCs regarding alternative approaches to systems-based research, this paper focuses on the contribution of OFR to near-term technology generation. This does not imply, however, that CIMMYT scientists are concerned only with the near-term in their work with NARS. Indeed, OFR often serves as a valuable base for CIMMYT's collaboration with NARS on longer term research issues. In addition, it should be emphasized that the activities of CIMMYT's agronomists and economists are in no way confined to OFR-related activities.

A. The Rationale for a Systems Approach

CIMMYT's work in OFR can be traced to the early 1970's, when it became obvious that the adoption of higher yielding wheat and maize varieties, and improved management practices, was proceeding at an uneven pace. In many areas new technologies were being taken up and used by farmers, but in other cases they were not. CIMMYT sponsored a series of studies to examine these differences in adoption patterns. The results showed quite clearly that new technologies are adopted only when they are consistent with

the agroecological and socioeconomic circumstances of farmers. Although other factors, such as the efficiency of the extension system, may at times be important, the overwhelming conclusion was that adoption of new technology is mostly a question of assuring that recommendations fit farmers' conditions.

Given this evidence, CIMMYT staff reviewed the then conventional process of technology generation with the hope that it could be made more cost-effective, more efficient at developing recommendations which would be widely used by farmers. Through experience with NARS colleagues it became apparent that four elements were critical to an efficient research strategy.

The first was careful identification of the farmer clients for whom recommendations were to be derived. The concept of recommendation domain has proven to be useful in this regard. A recommendation domain is a group of farmers whose circumstances are similar enough that they will be eligible for the same recommendation. The concept of recommendation domain enables researchers to efficiently direct their programs towards specific groups of farmers and well-defined research goals.

A second element was the critical importance of recognizing how interactions -- concurrent and over time, biological and economic -- shape farmer response to alternative technologies. The majority of farmers in developing countries make decisions about technology for a very complex environment. Some of the sources of that complexity are: i) long growing seasons, often permitting more than one crop per year and at times encouraging dependence on a wide variety of crops ii) the importance of risk, due to low farm incomes, uncertain climate and unreliable markets iii) the multiple objectives of farm

families, who often consume a considerable proportion of their own production iv) high dependence on family labor, characterized by competing opportunities and seasonal bottlenecks, and v) heterogeneity of resources employed (e.g. various types of land, labor). These considerations heighten the importance of interactions for developing country farms.

A third element, related to system complexity, is the importance of involving both biological and social scientists in the research process. Their collaboration from the early stages of the research is the most efficient way of addressing system interactions.

Finally, there is the advantage of carrying out much of the research on the farms of representative clients and under their circumstances. These elements have become the hallmarks of the approach which CIMMYT calls on-farm research.

B. A Strategy for On-Farm Research

In framing an approach to on-farm research, several considerations were critical. First, because the development of technologies is seen to be the responsibility of NARS, procedures for implementation must be consistent with NARS resources--staff, physical, and financial. Second, because of the high discount rates on investment in agricultural research characteristic of developing countries, early improvements in technologies are strongly preferred to later improvements, often even when the latter promise relatively large increases in resource productivity. Third, evidence from adoption studies shows that farmers tend to make few changes at one time as they adopt improved technologies.

These considerations convinced CIMMYT to concentrate on a class of systems-based research which treats one, sometimes two, enterprises (e.g. wheat, or a maize-bean intercrop) as variable, but recognizes competitive and complementary relationships with other activities, ensuring that these are integrated into the design of technology for the enterprise under investigation. This contrasts with work on the entire system, which treats many enterprises as variable. As well, in pursuing improved enterprise technology, CIMMYT staff advocate consideration of only a few high priority components. This contrasts with a strategy in which many components of a given enterprise are reviewed for simultaneous change. These characteristics of OFR address, in a cost effective manner, the considerations of the preceeding paragraph: they provide procedures within the reach of NARS resources, they encourage emphasis on near -term results, and they are compatible with farmer adoption behavior.

If research is to proceed efficiently, researchers need to be able to eliminate irrelevant solutions from consideration early in the process. A distinguishing feature of CIMMYT's procedures for planning an on-farm experimental program is the screening of possible solutions for compatibility with the circumstances of representative farmers. This characteristic is a consequence of a research approach that insists on careful identification of client groups, an awareness of system interactions which affect farmer reactions to new technologies, and collaboration between biological and social scientists. These attributes of well-focused diagnosis and planning are additional sources of cost-efficiency, facilitating the early elimination of less relevant potential solutions to priority problems.

The experience gained through this type of work with national programs provides the material for continuing refinement of the procedures. National programs, in turn, modify the procedures to better fit their own needs. Experiences in the NARS also provide the basis for the development of materials used in training.

C. Procedures of On-Farm Research

The OFR procedures that CIMMYT staff develop and teach are based on a decade of experience with national research programs. They are designed to be used with the limited resources that characterize national program research. They are flexible enough to encourage adjustment and refinements as local situations dictate, but formulated so that researchers with little experience have firm guidelines that they can follow. While CIMMYT's staff work with NARS staff on issues related to maize and wheat, the procedures can be applied to a wide variety of crops.

The procedures promote a sequential approach to data collection, in which a rapid overview of the farming system guides further data collection on a smaller number of variables. This information is in turn translated to research priorities which form the basis of an on-farm experimental program. The collaboration of biological and social scientists is emphasized throughout the process. Although the iterative nature of the data collection process is emphasized, it is helpful to describe OFR in five stages: diagnosis, planning, experimentation, assessment, and recommendation (Fig. 1).

1. Diagnosis is both the initial stage of OFR and a continuing activity throughout the research process. Initial diagnostic work should be sufficient to develop a set of priority problems and potentially appropriate solutions that

On-farm research is closely linked to other research activities of NARS which CIMMYT staff endeavor to strengthen. Training in crop agronomy, for instance, emphasizes a practical, problem-oriented approach. Collaboration with NARS disciplinary scientists encourages participation in OFR, not only in order to bring the expertise of such researchers to bear on near-term solutions to farmer problems, but also to help set priorities for longer-term research programs. Similarly, CIMMYT collaboration with NARS economists on agricultural policy issues stresses the role of on-farm research as a basis for relevant policy studies. Moreover, effective on-farm research by NARS requires strong connections to extension services, and CIMMYT encourages the participation of extension personnel throughout the OFR process.

As with all such choices, our strategy has advantages and disadvantages. We believe that, as compared with other strategies, it raises the probability of formulating useful improvements which will be widely utilized by farmers in the near term. Its major disadvantage is that its narrow focus might miss significant, complex improvements, resting on changes in several dimensions of the system and so profitable in the context of existing infrastructure and policy as to be widely accepted by representative farmers.

It was said earlier that CIMMYT itself does not develop technologies for farmers. CIMMYT staff always participate in on-farm research with national program scientists. The work is always part of a conscious strategy of national program development. It consists of gaining experience with OFR techniques by working alongside colleagues in national programs; synthesizing these experiences in procedures; and training national program personnel in their use. CIMMYT is assisting a growing number of NARS scientists to use these on-farm research procedures in approximately 20 countries.

form the basis of the first year's experimentation. During experimentation there are additional opportunities for various types of diagnostic activities. Diagnosis serves to make the experimental stage more efficient, and is not an end in itself.

For the diagnosis that forms the initial stage of OFR, the procedures advocated by CIMMYT include a review of secondary data (including relevant experimental data), an informal survey, and (often) a formal survey. The review of secondary data is fairly straightforward. The informal survey is the keystone of the diagnostic stage, and is absolutely essential. Biological and social scientists visit target areas, observe farmers' fields and talk with farmers, merchants, and others about practices and problems. Each succeeding day of the survey finds researchers focusing more closely on problems of key enterprises. Depending on the situation, the informal survey may be carried out at more than one time during the crop cycle.

The timing and extent of more formal survey activities is determined by the resources available to the national program and the nature of the research area. Choice of survey methods should be determined by the most efficient way of providing: a description of key elements of the system; an identification of problems that limit productivity; an explanation of these problems in the context of the system; and an exploration of the compatibility of proposed solutions with the system.

2. The planning stage of OFR takes place each year, before the cycle's on-farm experiments. It involves translating the information from diagnosis and from previous cycles' experimentation to a set of on-farm experiments. Researchers review the problems which limit the productivity of resources committed to major enterprises. For the most

important problems, researchers must decide if the problem is well enough defined so that possible solutions can be proposed for testing, or if the problem requires better definition. In the case of possible solutions, these are screened e.g. for likely profitability, risk considerations, compatibility with the farming system, and research time and cost. Those possible solutions that clear the screening process, and those factors required to better define priority problems, form the experimental variables from which a set of on-farm experiments are designed. The planning stage specifies the types of experiments, the experimental design, the number and characteristics of the fields where experiments will be planted, and the type of data to be taken.

The concept of recommendation domain is useful throughout the planning process. Specification of the number and type of farmers that share a particular problem, and that are eligible for the same solution, helps set research priorities. Specification of the characteristics of the farmers' fields where experiments should be planted contributes to an efficient use of research resources.

3. Experimentation is, of course, the central part of the on-farm research process. Not only are the experiments themselves the source of the information that will be used in formulating recommendations, but the observations and insights on the farming system gained by the scientists conducting the experiments provide additional information, characteristic of the interative nature of data management in on-farm research. The on-farm experiments look at a small number of experimental variables (generally 4 or less) and usually leave all non-experimental variables at the farmers' level. This underlines the importance of ascertaining the management practices of representative farmers before beginning experimentation.

Although there are a variety of experimental designs appropriate for on-farm research, the experiments can be grouped into three broad categories: i) there are experiments of an exploratory nature which attempt to characterize and further define problems (e.g., is there a response to phosphorus? Is poor plant stand caused by inadequate seedbed or by soil insects?); ii) there are experiments which test solutions to well defined problems (e.g. given that weed control is a problem, which of the potentially relevant solutions is the most appropriate control in this situation?); iii) and there are experiments which verify particular solutions and may be used as demonstrations. In the progression from exploratory to verification experiments, the degree of farmer involvement and management, the number of sites, and the size of individual plots all tend to increase. Other design characteristics will depend on the type of intervention being tested.

4. The assessment of on-farm experiments involves a review of the agronomic responses observed throughout the cycle, a statistical analysis of the results, and an economic analysis. The most important task is to ensure that the trial results can be interpreted agronomically. A statistical analysis gives researchers an idea of the degree of confidence they might place in the differences observed. Finally, when researchers have some assurance that the results of the experiments are reliable and understandable, an economic analysis of the pooled results for one recommendation domain is carried out. CIMMYT staff teach a method of economic analysis which involves partial budgets and marginal analysis. Risk associated with any treatment is estimated by looking at the variability of results across sites and across years and doing a minimum returns analysis. Formal assessment is complemented by continual review of the compatibility of proposed solutions with the farming system,

in particular by seeking farmers' opinions and observations throughout experimentation.

5. The principal goal of on-farm research is to develop recommendations that farmers will want to adopt. The recommendation may be quite specific (e.g. a new variety) or more general (e.g. advice on storing the crop). In any case, it is realized that farmers, being experimenters themselves, will make adjustments and adaptations to most recommendations in the light on their own particular circumstances. The objective is to provide them with the most useful information possible in the context of scarce research resources.

Follow-up on farmers' experiences with new recommendations is an essential part of on-farm research. As was mentioned earlier, the information generated by on-farm research is also useful to scientists involved in station-based agricultural research, and to policy-makers. And the relevance for diffusion is apparent, as extension workers cooperate with researchers through the entire process, contributing insights and coming to know the characteristics of the technology as it develops.

D. The Institutionalization of On-Farm Research

The major thrust of CIMMYT's work in on-farm research is the development and diffusion of a set of research procedures, with the aim of strengthening national program capacity to do this type of work. The procedures serve as guides only, and CIMMYT staff encourage each national program to elaborate its own research models, vocabulary, etc. as local circumstances dictate. CIMMYT staff utilize national program experience in refining the procedures, and encourage the formation of formal or informal networks among national programs so that they can contribute more

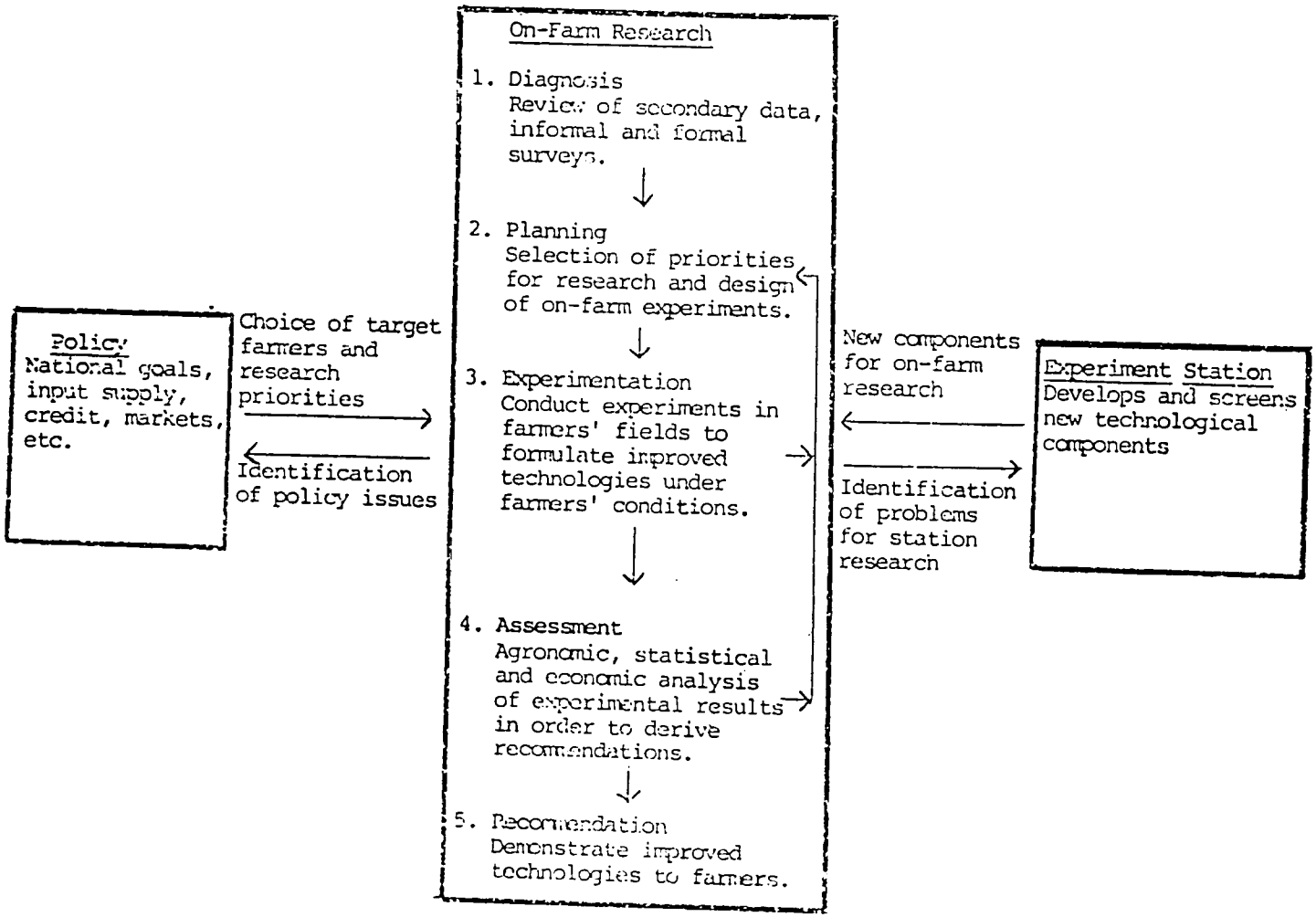
directly to each other's progress.

Although CIMMYT sees its role as the provision of OFR procedures for strengthening national programs, it is aware that there are several other important types of systems-based research activities in which other IARCs participate. In order to ensure that the IARCs and national programs understand the purpose of these activities it would be helpful if each IARC identified the principal clients of its systems-based research (the IARC itself, the NARS, or farmers) and the type of output expected (technology, farmer recommendations, information, procedures, or training).

The IARCs that are participating in systems-based research activities primarily for developing procedures and training national personnel have a particular responsibility to coordinate their efforts. If they do not, contradictory and confusing messages will be brought to the very national programs we seek to strenghten.

In addition, it is evident that such research cannot be carried out in an institutional vacuum. Research philosophies and procedures have implications for the organization and management of research institutions. Whether systems-based research should be organized on a commodity basis or on a regional basis; whether it should be carried out by a separate program or a liason mechanism among existing programs and departments; whether it demands full-time practitioners or can be integrated into current research activities; what mechanisms will ensure interdisciplinary cooperation; and what way to involve extension institutions in the work, are all issues crucial to the success of a systems-based approach in a national setting. No one of the IARCs has the expertise to completely resolve these questions, but discussions must be opened which involve IARCs and, most importantly, NARS in

Figure 1
Stages of On-Farm Research



ANNEX V

COURSE TIME TABLE AND DAILY PROGRAMME
OF ACTIVITIES

ICRAF/USAID AGROFORESTRY COURSE Nairobi, 4-22 November 1985

T I M E T A B L E

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
(4) * WHAT IS ICRAF * COURSE OBJECTIVES AND PROGRAMME * INFODOC	(5) * AF EXPERIENCE IN KENYA	(6) * AF TECHNOLOGY: a) tree-crop associations	(7) (AF Tech. continues) b) the environmental c) animal aspects	(8) (AF Tech. continues) d) human aspects e) economic aspects	(9) VISIT TO ICRAF FIELD STATION IN MACHAKOS	(10)
* CONCEPT OF AF * DISCUSSION OF PARTICIPANTS' AF REPORTS	FIELD TRIP	F I L M * PARTICIPANTS' REPORTS	* PARTICIPANTS' AF REPORTS	F I L M * AF REPORTS SYNTHESIS AND DISCUSSION	AND NAIROBI GAME PARK	FREE
RECEPTION	REPORTS PREPARATIONS	REPORTS PREPARATIONS	FREE			
(11) * CIMMYT'S FSR APPROACH * ICRAF's D & D	(12) * FIELD SURVEY IN MACHAKOS DISTRICT	(13) * FIELD SURVEY IN MACHAKOS DISTRICT	(14) * DIAGNOSTIC ANALYSIS (all day)	(15) * SYSTEM DESIGN SPECIFICATIONS (all day)	(16) VISIT TO BAOBAB FARM AND MIWAPA AF	(17) OPTIONAL PROGRAMME
* PRE-DIAGNOSITC STAGE	(all day)	(all day)	F I L M			
FIELD PREPARATIONS	OVERNIGHT KATANGI	RETURN TO NAIROBI	WORKING GROUPS	TRAVEL TO MOMBASA	TRIALS	FREE RETURN NBI
(18) FREE	(19) (Tech. Design continues)	(20) * TECHNOLOGY DESIGN EVALUATION - environment and economic	(21) (economic evaluation continues)	(22) (AF research continues	(23)	(24)
* TECHNOLOGY DESIGN PLANNING	* CONSULTATION WITH FARMERS	(all day)	* AF INFORMATION * AF RESEARCH/PLANNING AND EXPERIMENTAL BASIS	* COURSE EVALUATION AND CERTIFICATES FARE WELL TO	PARTICIPANTS	LEAVE
COMPUTER EXERCISES	COMPUTER EXERCISES	COMPUTER EXERCISES	PARTICIPANTS			

FIFTH ICRAF/USAID INTERNATIONAL TRAINING COURSE ON AGROFORESTRY RESEARCH FOR DEVELOPMENT

Nairobi, 4-22 November 1985

PROGRAMME OF ACTIVITIES

DATE: MONDAY 4

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	Participants welcome by the Director of ICRAF What is ICRAF	Bjorn Lundgren
	break	
9.45	Course objectives, programme and procedures	Ester Zulberti james Wahome
10.30	Coffee/tea (continued)	
11.30	ICRAF Information and Documentation Programme (INFODOC). Introduction to the library and computer catalog.	Richard Labelle Stephen Okemo
12.30	Lunch break	
14.00	Concept of Agroforestry	Erick Fernandes
15.30	Coffee/tea Discussion on the agroforestry report presentation by participants	Anthony Young (moderators)
19.00	Reception at Dr. Zulberti's residence	

FIFTH ICRAF/USAID INTERNATIONAL TRAINING COURSE ON
AGROFORESTRY RESEARCH FOR DEVELOPMENT

Nairobi, 4-22 November 1985
PROGRAMME OF ACTIVITIES

DATE: TUESDAY 5

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	AF Experiences in Kenya	Jeffrey Odera *
		(moderator)
10.30	Coffee/tea	Amare Getahun**
12.30	Lunch break	
14.00	Field trip to Kiambu District	

*Director Forestry Research, Kenya Agricultural Research Institute (KARI)
** Energy Development International (MIN. ENERGY AND REGIONAL DEVELOPMENT)

FIFTH ICRAF/USAID INTERNATIONAL TRAINING COURSE ON AGROFORESTRY RESEARCH FOR DEVELOPMENT

Nairobi, 4-22 November 1985

PROGRAMME OF ACTIVITIES

DATE: WEDNESDAY 6

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	Agroforestry Technology: Some Principles a) the associations of trees and crops	Peter Huxley Erick Fernandes
10.00	Coffee/tea (continued)	
12.30	Lunch	
14.00	Participants' Agroforestry Reports	Anthony Young (moderator)
15.00	Coffee/tea (continued)	

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FIFTH ICRAF/USAID INTERNATIONAL TRAINING COURSE ON AGROFORESTRY RESEARCH FOR DEVELOPMENT

Nairobi, 4-22 1985

PROGRAMME OF ACTIVITIES

DATE: THURSDAY 7

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	(Agroforestry Technology continues)	
	b) the environmental basis	Anthony Young
10.30	Coffee/tea	
10.45	c) animal aspects	Michel Baumer
12.30	Lunch break	
01.30	Film	
14.00	Participants' Agroforestry Reports	Anthony Young
15.00	Coffee/tea (continued)	(moderator)

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FIFTH ICRAF/USAID INTERNATIONAL TRAINING COURSE ON
AGROFORESTRY RESEARCH FOR DEVELOPMENT

Nairobi, 4-22 November 1985

PROGRAMME OF ACTIVITIES

DATE: FRIDAY 8

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	d) human aspects	John Raintree Dianne Rocheleau
10.00	Coffee/tea	
11.00	e) economic aspects	Dirk Hoekstra
12.30	Lunch - Film	
14.00	Participants' AF reports	Anthony Young Peter Huxley (moderators)
	Coffee/tea	
	AF reports - synthesis & discussion	Peter Huxley
	First week review	Ester Zulberti

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Nairobi, 4-22 November

PROGRAMME ACTIVITIES

DATE: SATURDAY 9

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.00	Depart from Nairobi	
9.30	A visit to ICRAF Field Station in Machakos to observe demonstrations/ trials on:	P.K.R. Nair (Coordinator
	a) MPT'S and shrubs for AF	Peter Wood Till Darnhofer
	b) soil conservation technologies	Michel Baumer
	c) tree establishment	Bjorn Lundgren
	d) windbreak	Peter Huxley
	e) tree-crop interface	Ester Zulberti
	f) systematic tree arrangements	James Wahome
	g) alley cropping	
	h) germplasm	
	i) intercropping	
	j) living fences	
13.00	Lunch at the Field Station	
14.00	Return to Nairobi through the Nairobi National Park	

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PROGRAMME OF ACTIVITIES

DATE: MONDAY 11

TIME	TOPIC/ACTIVITY	RESPONSIBLE
		1/
8.30	CIMMYT's Conceptual and Methodological Approach to On-Farm Research CIMMYT's Experience to date in Africa	Michael Collinson F. Ananda 2/
10.00	Coffee/tea	
10.30	Introduction to ICRAF's Diagnostic and Design Methodology	John Raintree
11.00	An overview of D & D applications under different ecological and socio-economic conditions	
12.30	Lunch break	
14.00	Pre-diagnostic information (the Kakuyuni Project)	F. Arap Sang 3/
15.00	Coffee/tea	
15.30	Preparations for the field exercise	Dirk Hoekstra John Raintree Ester Zulberti

1. Regional Economist, CIMMYT
2. Regional Training Officer, CIMMYT
3. Director, Kakuyuni Agroforestry Project

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PROGRAMME OF ACTIVITIES

DATE: TUESDAY 12

TIME	TOPIC/ACTIVITY	RESPONSIBLE
7.30 - 9.30	Travel to the Kakuyuni Project Site The groups will meet with local translators at Katangi and proceed the diagnostic survey in four working groups	ICRAF staff and team leaders
13.00 - 1400	Lunch at Katangi	
	Diagnostic survey continues	
	(Overnight in tented camps set up in the groups of Undugu Agricultural Society in Katangi)	

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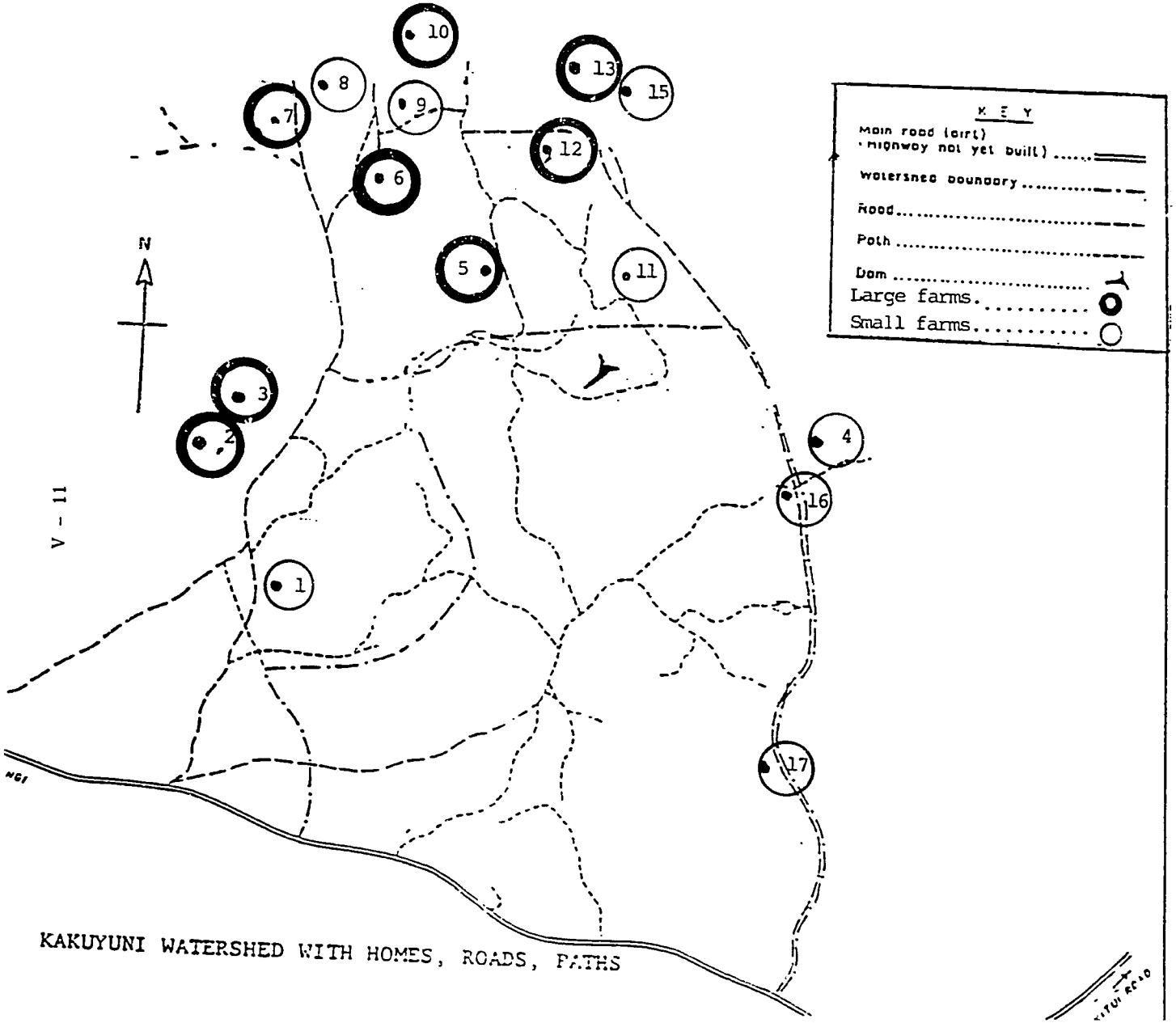
D & D FIELD EXERCISE: PARTICIPANTS' AND FARMER' DISTRIBUTION

GROUP NO.	LEADER/LOCAL INTERPRETER	COURSE PARTICIPANTS	TIME	TUESDAY 12 NOVEMBER FARMERS' NAME AND LOCATION (see map)	REF. No.	WEDNESDAY 13 NOVEMBER FARMERS' NAME AND LOCATION (see map)	REF. No.
1 LARGE FARMS	DIANNE ROCHELEAU MASAA KIMONYI	GABORYAHEZE MACHARIA KAUDIA RALAMBONDRAINY MAGID DAFALA REPOLLO SIBANDA	morning	MUNYIVA KILUNDO (H & W)	2	MAKAU NTHAKU (H & W)	7
			afternoon	KASWII MUTINDA (W)	3	KAVATA BERNARD (H & W)	10
LARGE FARMS	ERICK FERNANDES FRANCIS KIMONYI	NTAMAGENDERO ODUOL MOHAMMED MINAE MASABO RANDRIANRISON ODRA	morning	MBUTI MUTIE (W)	12 *	KYULI MUNYAO (H & W)	5
			afternoon	NGERU MALIKA (H & W)	13*	BEATRICE NYAMAI (W)	6
3 SMALL FARMS	JOHN RAINTREE MUMO NDETI	KAMANZI KAMAU LUBEGA HAILU HADI ADRIANIPINA MWANGI	morning	KAVATA NDUU (H & W)	9	MBULU MUTUA (H & W)	4
			afternoon	NZANGI MALUA (H & W)	15	RICHARD KIMONYI (H & W)	11
4 SMALL FARMS	DIRK HOEKSTRA JOYCE MUTINDA	ALOO OKAFOR SELASSIE HAMEID KISAKYE KWESIGA SAKA DJIMDE	morning	SYOMBUA ILUNGA (W)	1	MWELU MUKILYA (W)	16
			afternoon	KIMEU MWANIA (H & W)	8	KASILILI NGUMBI (H & W)	17

LARGE FARMS = over 10 acres SMALL FARMS = 10 or less acres (H) husband manages the farm (W) = wife manages the farm



KAKUYUNI WATERSHED WITH HOMES, ROADS, PATHS

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PROGRAMME OF ACTIVITIES

DATE: WEDNESDAY 13

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	Diagnostic survey continues	working groups
14.00	Lunch in Machakos town and return to Nairobi	

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PROGRAMME OF ACTIVITIES

DATE: THURSDAY 14

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	Diagnostic analysis (all day)	working groups
10.30	Coffee/tea	
12.30	Lunch	
15.00	Coffee/tea	
15.15	Plenary session working groups to report progress made in the diagnostic analysis	John Raintree (moderator)

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PROGRAMME OF ACTIVITIES

DATE: FRIDAY 15

TIME	TOPIC/ACTIVITY	RESPONSIBLE
9.30	Technical specifications for the AF systems identified in the diagnosis (all day)	Working groups
10.30	Coffee/tea	
	Plenary session. Working groups to present progress reports	Peter Wood (moderator)
12.30	Lunch break	
	Coffee/tea	
14.00	Second week review	Ester Zulberti
19.00	Travel to Mombasa by train	

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PROGRAMME OF ACTIVITIES

DATE: SATURDAY 16

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.00	Arrival at Mombasa and accommodation at the White Sands Hotel	
9.30	Visit to Mtwapa Agroforestry Center in Kilifi District to observe	Bashir Jama 1/ P. K. Nair Peter Wood
	a) MPT's tree nurseries b) tree seed collection c) tree seed orchard d) fodder experiments e) organic fertilizer experiments	Ester Zulberti James Wahome
	Lunch at the White Sands Hotel	
15.30	Visit the Baobab Farm to observe the rehabilitation of livestone quarry sites with *Casuarina equisitifolia*, *Canocarpus lancifolia*, *Prosopis juliflora* and other spp.	Rene Haller 2/
	Free evening	

1/ Mtwapa AF Center Manager
2/ Baobab Farm Manager

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PROGRAMME OF ACTIVITIES

DATE: SUNDAY 17 (Optional Programme)

TIME	TOPIC/ACTIVITY	RESPONSIBLE
7.30	Travel to Matuga Agroforestry Center in Kwale District to observe intercropping trials (maize - sorghum/ Prosopis, Leucaena, Sesbania, Gliricidia) and biogas programme	Bashir Jama
12.30.	Lunch at the White Sands Hotel	
	Free afternoon	
19.00	Return to Nairobi	

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DATE: MONDAY 18

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.00	Arrival at Nairobi	
	free morning	
14.00	- Technology Design Planning a) list possible interventions fitting the systems design specification	Peter Huxley Peter Wood (with participation from team leaders)
15.00	Coffee/tea	
15.15.	b) regroup/prioritize the agroforestry interventions	
16.45	Coffee/tea	
17.00 to 18.00	Demonstration of computer programme to predict Production/Sustainability of Tree/Crop mixtures	Peter Huxley Peter Muraya

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PROGRAMME OF ACTIVITIES

DATE: TUESDAY 19

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	(Technology Design Planning continues) provide c) provide technology specifications	Peter Wood Peter Huxley (with participation from team leaders)
10.00	Coffee/tea	
	d) identify components and management for each of the technologies	
12.00	Lunch break	
13.00	Meet with farmers at the ICRAF Field Station in for consultation on the agroforestry models designed by the working groups	Participants Team leaders Peter Wood

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PROGRAMME OF ACTIVITIES

DATE: WEDNESDAY 20

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	Technology Design Evaluation	Peter Wood Peter Huxley
	a) biophysical/environmental b) social/environmental	Dianne Rolecheau
10.00	Coffee/tea	
	c) economic	Dirk Hoekstra
12.00	Lunch break	
14.00	MULBUD exercises	Dirk Hoekstra Margaret Mutua Paul Waiguru Peter Muraya
15.00	Coffee/tea	
	- as above -	

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PROGRAMME OF ACTIVITIES

DATE: THURSDAY 20

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	MULBUD exercises continue	Dirk Hoekstra
10.00	Coffee/tea	
	as above -	
12.30	Lunch break	
14.00	Sources of agroforestry information, including specialized data bases	Peter Huxley Richard Labelle P.von Carlowitz
15.00	Coffee/tea	
15.15	AF Research Planning	Peter Huxley
	Experimental bases for selected agroforestry interventions	
18.00	Demonstration of computer programme for calculating systematic spacing designs	

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PROGRAMME OF ACTIVITIES

DATE: FRIDAY 22

TIME	TOPIC/ACTIVITY	RESPONSIBLE
8.30	Approaches to On-Farm experimentation	Peter Wood Dianne Rocheleau John Raintree Peter Huxley (moderator)
10.00	Coffee/tea	
	as above -	
12.30	Lunch break	
14.00	Final course evaluation	Ester Zulberti
	Certificates	ALL ICRAF staff & participants
	F A R E W E L L	

ANNEX VI: EVALUATION AND PARTICIPANTS MAIN COMMENTS

1. PRE-COURSE ARRANGEMENTS

Invitations to national institutions in the Africa region requesting them to nominate candidates who would attend the agroforestry course were sent out in May 1985. 93% of the selected participants indicated that they received the pre-course information before the start of the course while 96% indicated that the pre-course information was adequate.

Table 1. Summarizes the information on this section

Table 1. Summary of participants' responses on pre-course arrangements*

Aspect evaluated	Yes %	No %
Did participants receive the pre-course information before the start of the course?	93	7
Was the pre-course considered adequate?	96	4

* In percentage of total number of responses

Suggested improvements were:

- ICRAF should send a copy of the pre-course information to the institution/relevant ministry or authority.

- include an introduction to the concepts and practices of agroforestry.

- include a summary of the course contents so that participants are familiar with the subjects to be covered by the lecturers.

- provide more precise and specific easy-to-follow guidelines on preparation of participants agroforestry/country reports.

2. STRUCTURE OF THE COURSE

Participants views were requested on the adequacy and duration of the course, including length of the daily working sessions, the field exercises and independent work/study sessions. These aspects were evaluated in terms of too long, adequate or too short.

VI - 2Table 2. Summary of participants' views on the course structure*

Aspects evaluated	Too long %	Adequate %	too short %
The total length of the course	0	48	52
Daily working sessions	38	54	8
Field exercises	0	59	41
Independent work/study	0	40	60

* In percentage of the total number of responses
Suggested improvements were:
.extend the course by 1 or 2 weeks
.allow more time (e.g. one morning or afternoon per week for independent work/study).

.allocate more time for consultation with ICRAF staff

3. OBJECTIVES

Participants were requested to express their views on the appropriateness and effectiveness of the course objectives using the scale of 1 to 5, where = less appropriate/effective and 5 = very appropriate/effective. The terms were defined as follows.

Appropriateness - the relevance and usefulness of the course objectives to the participants' work

Effectiveness - whether appropriate or not-the extent to which the objectives were fulfilled.

The information summarized in Table 3 indicates that objectives were considered to be appropriate and effective (all above 3.7 values)

Table 3. Summary of information on appropriateness and effectiveness of the course objectives*

Objectives	Appropriateness	Effectiveness
(Main) To become:		
3.1 familiar with the concepts and procedures of ICRAF's methodology to diagnose AF related land use problems/potentials and design appropriate AF systems/technologies	4.6	4.1
(Complementary)		
3.2 acquainted with ICRAF's institutional organization and programme of work	4.1	4.2
3.3 familiar with the concepts of AF and systems approach to land use	4.5	4.3
3.4 acquainted with the experimental basis for selected AF interventions	4.2	3.7
3.5 updated on AF information, including specialized data bases	4.5	4.2

*Expressed in average values of the total number of responses

Suggestions for improvement were:

- More acquaintance with data bases would be useful.
- Include in the course information on practical work and results of experiments carried out in the research/field station.
- minimise the emphasis placed on trees and give more time to crops and livestock aspects.

4. PHYSICAL RESOURCES AND ADMINISTRATIVE SUPPORT

These aspects were evaluated. Using a scale from 1 to 5 where 1 = not adequate and 5 = very adequate, provided by the participants. In general, the physical resources and administrative support were considered adequate/very adequate as indicated by scale values of 3.3 and above.

Table 4. Summary of information on physical resources and administrative support*

Aspects evaluated	X
• Meal arrangements in the field	4.6
• Secretarial services	4.6
• Transportation arrangements during field exercises	4.5
• Library services	4.5
• Hotel accommodation	4.3
• Meeting rooms	4.2
• Travel arrangements	4.1
• Computer services	4.1
• Conference rooms	4.0
• Per diems payments	3.3

* Expressed in average values of the total number of responses.

Suggested improvements were:

- Make the computer services and the library services more available during the course.

5. GENERAL ORGANIZATION AND COORDINATION

Participants views were requested regarding the adequacy of training materials, the quality of presentations, the use of visual and training aids and availability of ICRAF staff for consultation. Again, a scale of 1 to 5 was used where 1 = not adequate and 5 = very adequate. As can be seen in Table 5 below, aspects evaluated were considered adequate/very adequate as evidenced by values higher than 3.8.

Table 5. Summary of information on the general course organization and coordination*

Aspects evaluated	X
• Training materials (written information given to participants and slide sets)	4.7
• Availability of visual equipment, training aids, stationery	4.6
• Availability of staff for consultations	4.2
• Quality of presentations (clarity of speaker, use of visual aids)	3.8

*Expressed in average values of the total number of responses.

Suggested improvements were;

- allocate more and specific times for participants to consult with ICRAF staff
- course lecturers should be encouraged to make use of a microphone

6. PARTICIPANTS

Participants were requested to express their views on the size of the groups, the different disciplines represented and the interaction among themselves as well as with ICRAF staff and invited speakers. A scale of 1 to 5 was used, i.e. from 1 = not satisfactory to 5 = very satisfactory. Table 6 below summarizes the information on this section. The participants felt that these aspects were satisfactory as indicated by values of 4.0 and higher.

Table 6. Summary of information about the course participants*

Aspects evaluated	X
• The interaction among participants	4.5
• The size of the group of participants	4.1
• The interaction between participants and ICRAF staff	4.0
• The various disciplines represented	4.0

* Expressed in average values of the total responses.

Suggested improvements were;

- adjust the number of participants so that they can be comfortably accommodated in the conference room.

- allow more time for participants to interact even informally with ICRAF staff and with each other.

7. PARTICIPANTS' GENERAL COMMENTS

1. The organization of the course by ICRAF is very efficient in the sense that, programmes are organized by knowledgeable and experienced staff. I appreciated how the speakers were organized with relevant points and always in time. The notes prepared were very important in supplementing the presentations of speakers which were relatively brief because of the time factor. The agroforestry systems is ideal for optimising agricultural, combinations of livestock and forest production. However, different approaches could be studied and applied in respect to the scale of the land owned by the farmer, because there are some parts of the world where people cannot easily agree to combine trees with food crops, due to high population density.

2. The course is worthwhile especially to those people who have not had a lot of exposure to agroforestry. Considering the time undertaken, I think the course was on the whole well organized.

3. In general, the course was very good. It has been an occasion for me to understand the concepts of AF, as a new approach to solve land use problems. I got enough documentation for my course but unfortunately, I did not get enough time to exploit the library. The course contained many interesting new ideas. The visits to farmers were very helpful and rich in information, the choice of the places visited was very good. The course inculcated enough AF in us. Not enough time was allocated to experimental AF and approaches to on-farm experimentation. As it was my first course in English, it gave me an occasion to practice and to improve it, and at the end to evaluate myself in this foreign language.

4. The course has been very well organized and run. I have learnt a great deal and made many new friends. I am happy and grateful to have attended this most exciting, instructive and enjoyable 3 week course.

5. The course has given me very important information on agroforestry which I knew very little about before.

6. The course was very useful and I think that all participants now have more knowledge and information about AF. I have been made very familiar with AF and I hope to gather more knowledge and information about AF in general, alley-cropping and D & D which I hope to apply in our area. I thank ICRAF staff for this useful course and the training officer for the good management of this successful course.

7. As an initiation, the course was very efficient. I think that participants who have experience in agroforestry should be allowed to present not only a report but also to give a lecture about what they know.

8. I learned many things through this course. So I would like to thank all the organizers (staff, especially Dr. Zulberti) for their devotion and for the training. I hope that in the future there will be a good collaboration with us to improve agroforestry and to improve the farmers conditions in our country.

9. Generally, the course has been of relevance to my duty in the field and has been very effective in provoking my working attitude and capability in planning future agroforestry trials.

10. No explicit explanation was given on reasons why grass-strips were left around the trees in the demonstration plots and why tractors as opposed to manual labour was used in tillage. What are the aims of the demonstration plots apart from visual display of agroforestry practice?

11. In general, the course was very useful. But due to the multdisciplinary nature of the group, some of the materials tend to be irrelevant in terms of future use and application. For example a socio-economic study would approach experimental design very differently from what is presented in the course.

The emphasis on trees by some ICRAF staff downplays the interactions of all the other agroforestry components. It is therefore not clear at the end what actually is agroforesty. Participants should also be given more time for discussion because a lot of them have experiences and ideas which would be useful to the other participants. But the course was useful because it provided participants with an opportunity to meet others with similar interests and problems.

12. On the whole it was a very well organized course. The field trips were interesting and varied. The camping and train experience not to mention the whole trip to the coast must have added variety and interest. The material gathered in the course will be most valuable in my work and will be put to immediate use.

13. The organizers of the course especially Ester and James did a wonderful job in coordinating all the activities. I must congratulate them on this point. The selection of participants was well done because there has been a diversity of disciplines as well as experience. The participation of everyone was a real contribution. However, I am sorry to point out that some ICRAF staff did not spend sometime with the participants during discussions. The way I look at this point is that as soon as some ICRAF staff finished their presentation, they left. It would have been better to have at least 5 members of ICRAF staff (I mean those who were not participants) to be at each session. I understand there is a time constraint but this could be reduced. This is where the interaction between the participants and ICRAF staff becomes effective.

14. The course was well organized, within the time available. It would be better if the course were extended for 2 or even 4 weeks. This will make the participants read all the materials while at ICRAF, and make a positive contribution to agroforestry. There was little time devoted to the definition of agroforestry. Unless people are very clear as to what agroforestry is, and appreciate what it is, they cannot talk with confidence on how it can achieve excellent results among small holder farmers.

All ICRAF staff did an excellent job. They were really prepared for the course. ICRAF should continue to organize workshops on different countries in various regions of Africa to keep those interested in agroforestry updated on new material and interventions and to talk about agroforestry experiences in their individual countries.

15. The general organization and plans are quite educative especially to me. The main objective is a good one but when one comes to the technical application in espacement of species in an experiment in the field I hope it will not be affected by our countries agricultural law of terracing, cut off drains etc. My conclusion is that since I am operating at district level I am going to try to apply the D & D method already received in areas of my district and try germplasm screening in the water requirements of various species and I will be informing ICRAF of the progress. I also this I intend to request for seeds from ICRAF Field Station and Mtwapa. This will help us in identifying the best species for the different eco-systems in the district.

16. The objectives were fulfilled. Some of the speakers were very interesting depending on their experience both in field work and researchs. The D & D exercise was a good tool but needed more time (maybe 2 more days) for further consultations with the farmers. The choice of farmers were commented upon earlier, but when it came to technology specifications,the idea did not bear certainty e.g. the group which dealt with small farmers should have concentrated on boundary planting of the farmland and enrichment of grazing land instead of improved fallow. Here, as a group, we learnt how certain interventions are relevant in particular circumstances but not in others. Alley cropping was over-emphasized but may not be very relevant. Improved crop varieties were not emphasized; may be we concentrated more on the tree component in the system which was the objective.

Again I need to emphasize on ICRAF having some demonstration plots at the field station because D and D has been done in various places in Machakos and I am sure certain interventions have come up to address certain constraints in the farming systems from which we could have demonstration for training. I am sure with time and experience the training programme will be even better in future.

17. The course was successful but we need to have more time for discussion, because the participants were from different regions and did not have enough time to air all their views. Even informal sessions should be encouraged. The D & D exercise evaluation should be given more time. The second visit to the farmer should be introduced so that the solution can be discussed with the farmers, after their (farmers) visit to the Field Station. I hope that in future, you will have a course consisting of people from different parts of the world and see how things work out. On the whole it was a good course.

18. I have appreciated ICRAF's training course very much. All information and documentation about agroforestry will help us in our national research institute. The course was in general very good and very successful.

19. The course period is short and this put much pressure on the participants and with the amount of materials given, it should be a 4-week course, or some materials can be sent to the participants prior to the course. These materials are mainly on the complimentary objective and hence more time will be given to the D&D exercise.

20. The course was generally good. The concept of agroforestry is useful in the African concept of agriculture. However, for the course to have a real effect on African farmers, ICRAF should try and carry out field experimentation in various African countries to quantify the usefulness of agroforestry technology.

21. The next course of ICRAF should be in French for Francophone countries.

22. The course would have to give other examples than those from the semi-arid areas so as to give a more views about agroforestry in the tropics.

ANNEX VII: TRAINING PACKAGE

The package of instructional materials contained selected articles and documents, case studies and practical exercises produced by ICRAF's multidisciplinary scientific staff. The material was arranged by week according to the development of the course programme. Lists of recommended readings were included and copies of these articles and documents were made available to participants upon request. A slide set on Agroforestry systems and practices in developing countries was included as part of the training package. The distribution of instructional materials by week was as follows:

Week 1 i) Required readings (approx.. 160 pp.)

- Torres, F. Agroforestry: Concepts and Practices. In "Agroforestry Systems for Small-scale Farmers." Proceedings of a workshop, Nairobi 5-10 September 1982.
  Nairobi: ICRAF. 29-32 pp.

- Odera, J.A. Agroforestry Research Programmes in Kenya. Nairobi: 36 pp. 1986.

- Huxley, P. A. Some characteristics of trees to be considered in agroforestry. Reprinted from "Plant Research and Agroforestry". Nairobi: ICRAF. 1983. pp. 3-12 1984.

- Huxley, P. A. The basis for selection, management and evaluation of multipurpose trees: an overview Nairobi: ICRAF 35 PP. 1984.

- Young, A. The environmental bases of agroforestry. Nairobi: ICRAF 21 pp. 1985.

- Torres, F. Role of woody perennials in animal agroforestry. Reprinted from "Agroforestry Systems" 1: 131-163 1983.

. Raintree, J.A. Human factors in agroforestry. Nairobi: ICRAF 10 pp. 1984.

. Hoekstra, D. A. Economic concepts of agroforestry. Nairobi: ICRAF. 12 pp. WP. 30. 1985.

ii) Recommended

(Concept of AF) . Nair, P. K. R. Classification of agroforestry systems. Naiorbi: ICRAF. 52 pp. WP. 28. 1985

(Concept of AF) . Nair, P. K. R. Multiple landuse and agrofestry. Reprinted from " Better Crops for Food: CIBA Foundation Symposium 97". London. Pitman Ltd. pp. 101-115 IR-1. 1983.

(Concept of AF) . Lundgren, B. O. and Raintree, J. B. Sustained agroforestry. Reprinted from "Agroforestry Research for Development: Potentials and challenges in Asia". Report of a conference held 24-29 October 1982, Jakarta, Indonesia. The Hague ISNAR. 37-49pp. IR-3.

(Agroforestry Information) . Raintree, J. B. and Labelle, R. A. Brief Guide to the Agroforestry Literature. Nairobi: ICRAF . 4 pp. 1985.

. Guide to the ICRAF Library.

. INFO/DOC-ICRAF. An Interactive User - Friendly Agroforestry Information Request Service. ICRAF. 1985.

(Data Bases) . von Carlowitz, P. G. Summary description of ICRAF's multipurpose tree and shrub data base (MUPOTAS). Nairobi: ICRAF.5 pp. 1985.

(AF Technology)

. Huxley, P.A. Experimental Agroforestry: progress through perception and collaboration. In "Agroforestry Systems" 3: 129-138. 1985.

. Huxley, P. A. Optimizing Tree-Crop Combinations; Part 4C.

(Field Trip)

. ICRAF Field Station, Machakos, Kenya. Status report. March 1985.

. Darnhofer, T. Meteorological elements and their observation. Nairobi: ICRAF. 30 PP. WP. 14. 1985.

(The environmental basis)

. Dent, D. and Young, A. Soil Survey and Land Evaluation. London. George Allen and Unwin Publishers. 1981.

. FAO Land evaluation for forestry. Rome, 1984.

. Young, A. An environmental data base for agroforestry. Nairobi: ICRAF. 60 pp. WP. 1 1983.

. Young, A. Land evaluation for agroforestry: the tasks ahead. Nairobi; ICRAF. 54 pp. WP 24. 1984.

. Young A. Evaluation of agroforestry potential in sloping areas. Nairobi: ICRAF. 54 pp. WP 27. 1984.

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iii) Books

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Week II and III

i) Required readings (approx. 74 pp.)

ICRAF . Guidelines for agroforestry diagnosis and design. Nairobi: ICRAF. 25 pp. 1983.

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ii) Recommended

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