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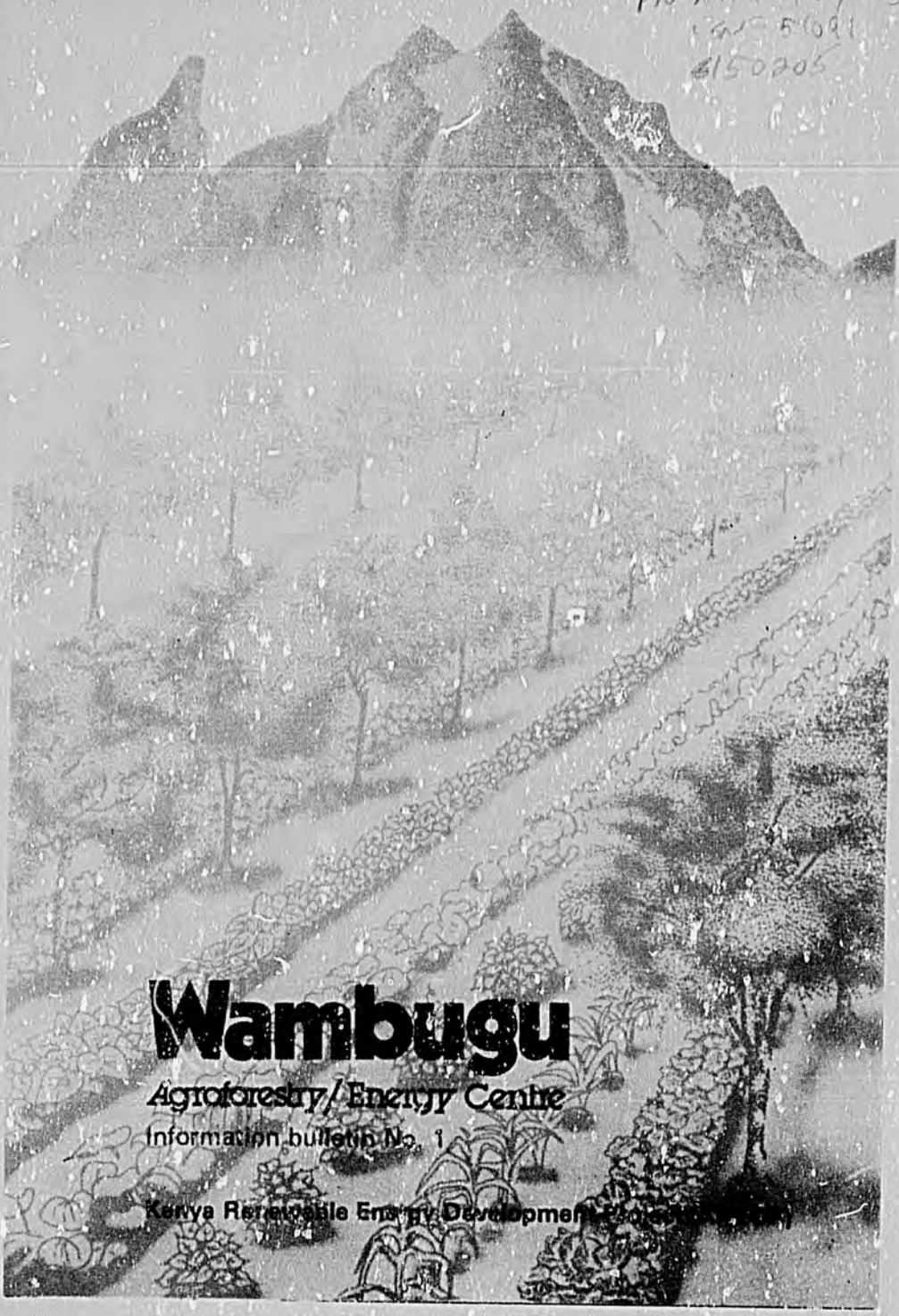


Wambugu

Agroforestry/Energy Centre

Information bulletin No. 1

Kenya Renewable Energy Development Project

Kenya Renewable Energy Development Project (KREDP) September 1985

The Wambugu Agroforestry/Energy Centre is part of the Kenya Renewable Energy Development Project (KREDP). KREDP was initiated in October, 1981, as a bilateral project between the Governments of Kenya and U.S.A. to address several critical national energy problems as well as to assist the Government's institutional capacity to solve these energy problems.

To achieve its objectives, the project operates several major components including:

- Agroforestry/Afforestation,
- Cookstoves and charcoal kilns,
- Energy conservation and fuel substitution, and
- Funding of small innovative projects (Energy Development Fund).

The implementation of KREDP is being administered by the Ministry of Energy and Regional Development (MOERD) with close collaboration from the following agencies:

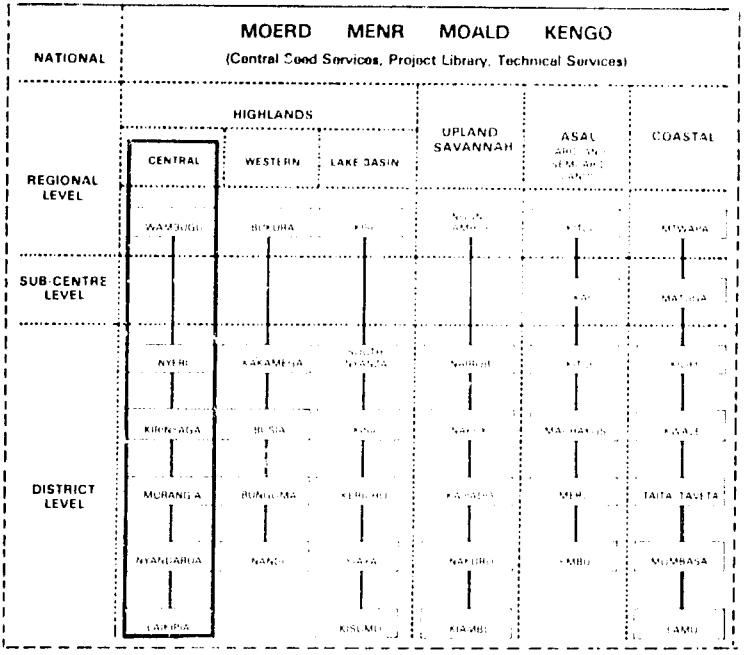
- Ministry of Agriculture and Livestock Development (MOALD),
- Ministry of Environment and Natural Resources (MENR), and
- Kenya Energy Non-Governmental Organizations Association (KENGO).

The physical, institutional and operational basis of KREDP are the six regional Agroforestry/Energy Centres of which Wambugu Agroforestry/Energy Centre, the subject of this bulletin, is one.

KREDP is partially funded by the United States Agency for International Development (USAID). The implementation of the project is being assisted by Energy/Development International (E/DI), a private consulting firm.

3

Present Regional and District Programmes of KREDP



The Wambugu Centre and its field programmes, the subject of this bulletin, are outlined in black.

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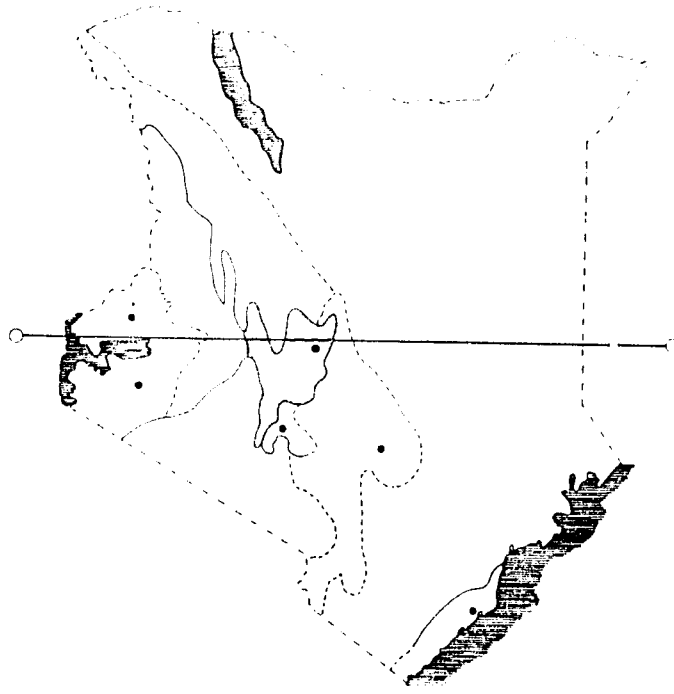
1. Location

Wambugu Agroforestry/Energy Centre is one of six regional centres. It is phyically housed within Wambugu Farmers Training Centre (F.T.C.) about 4 kilometres south of Nyeri Town and is within the Nyeri Municipality.

The centre's establishment was initiated in November 1982 to serve the Central Highland. region. The region being served by the centre is a high potential agricultural region with coffee and tea as the main cash crops. The region receives an annual rainfall ranging from 500 mm to 2000 mm/year and typically has a hilly topography dissected by numerous streams and rivers. The region is densely populated. Small-holder intensive agriculture is dominant. The Wambugu Centre serves Nyeri, Kirinyanga, Murang'a, Nyandarua and Laikipia districts (Figure 1).

Figure 1



Area Served by Wambugu Centre.

2. Goals and Objectives

Due to the need for increased production of both wood and food products, and also the urgent need to reduce ecological degradation, the centre endeavours to accomplish the following:

- Screen, develop and disseminate appropriate agroforestry technologies;
- Increase and improve accessibility of tree seeds/seedlings to the community;
- Promote energy conservation and develop relevant alternative renewable energy technologies;
- Produce and distribute tree seedlings and seed of appropriate agroforestry/wood fuel species; and
- Establish a cooperative and effective extension service through GOK Agencies, NGOs and other tree planting groups and organizations.

3. Present Programme Components

To achieve the above stated objectives the centre operates the following programmes and activities:

Agroforestry

- A 1.5 hectare nursery area of which 0.5 hectares have been developed to date with a production capacity of over 400,000 seedlings per annum,
- 6.5 hectares of research demonstration plots developed,
- 3 hectares of seed orchard developed,
- Extension and training on agroforestry practices, and
- Technical services on nursery establishment and maintenance.

Improved Cookstoves/Kilns

- Production and training in improved cookstoves technology, and
- Technical assistance and extension services.

Biogas Technology

Biogas technology development and artisan training.

4. Cooperation and Administration

The Wambugu Centre has enjoyed and continues to enjoy close cooperation from several GOK agencies and NGO's including:

- Wambugu F.T.C. (MOALD),
- District Soil Conservation Programmes (MOALD),
- Forest Department (MENR),
- Office of the President (OP),
- Local Coffee Cooperatives,
- KENGO, and
- Primary and Secondary Schools.

The rapid development of the Wambugu Centre and its services has been greatly facilitated by these organisations.

5. Physical Developments Completed

To date the programme has established five structures, namely:

- An office building
- A store house,
- A nursery shed,
- A guard house, and
- A jiko production/training workshop.

The Centre has full access to the dormitories, classrooms and dining facilties of the F.T.C. This facilitates the Centres training and extension programmes.

6. Agroforestry Programme

6.1. Nursery

Presently the nursery is capable of producing 200,000 seedlings per season. A wide range of tree species (44) are being produced including varieties suitable for fuelwood and timber, soil conservation and improvement, fodder browse, fencing, ornamental shade, and horticulture. The current tree species in production and their categories of use are presented in Table 1.

The wide range of tree shrub species in the nursery provides a wide choice of species for farmers and tree planting groups and helps to generate nursery production and management data. The tree shrub seedlings are both indigenous (40%) and exotics (60%). Many of the exotics have already been naturalised to the Kenyan environment. Species new to the area that are being evaluated include:

Calliandra calothyrsus,
Flamingia congesta,
Gliricidia sepium,
Gmelina arborea,
Leucaena leucocephala, and
Sesbania grandiflora.

Table 1. Current Tree Species in the Seedling Production Programme

Tree Species	Categories of Use*
1. *Aberia caffra*	C, D, F
2. *Acacia albida*	A, B, C, F
3. *Acacia padolyriifolia*	A, E
4. *Acrocarpus fraxinifolius*	A, C, E
5. *Ailanthus altissima*	A, C, E
6. *Albizia gummifera*	A, C, E
7. *Azadirachta indica*	A, C, E
8. *Balanites aegyptiaca*	A, B, C, F
9. *Calliandra calothyrsus*	A, B, C, E
10. *Calodendrum capense*	A, C, E
11. *Cassia siamea*	A, C, E
12. *Cassia spectabilis*	A, C, E
13. *Casuarina equisetifolia*	A, C, E
14. *Citrus limon*	C, F
15. *Cordia abyssinica*	A, C, E
16. *Cupressus lusitanica*	A, D
17. *Cupressus pyramidalis*	A, D, E.
18. *Delonix regia*	A, E
19. *Entada abyssinica*	A, C, E
20. *Erythrina abyssinica*	A, C, E
21. *Eucalyptus globulus*	A, C
22. *Eucalyptus maculata*	A, C
23. *Eucalyptus paniculata*	A, C
24. *Eucalyptus saligna*	A, C
25. *Flamingia congesta*	A, B, C
26. *Gliricidia sepium*	A, B, C, D, E
27. *Gmelina arborea*	A, C, E
28. *Grevillea robusta*	A, B, C, E
29. *Jacaranda mimosifolia*	A, C, E
30. *Juniperus procera*	A, C, D
31. *Leucaena leucocephala*	A, B, C, D, E
32. *Markhamia hildebrandtii*	A, C, E
33. *Melia azedarach*	A, C, E
34. *Podocarpus gracilior*	A, C, E
35. *Prosopis juliflora*	A, B, C, D
36. *Psidium guajava*	A, C, F
37. *Pterogyne nitens*	A, C, D
38. *Schinus molle*	A, C, E
39. *Sesbania grandiflora*	A, B, C, E, F
40. *Sterculia acerfolia*	E
41. *Tamarindus indica*	A, C, F

*Categories of Use
A. Fuelwood/Timber
B. Browse/Fodder
C. Soil Conservation
D. Hedge/Fencing
E. Ornamental/Shade
F. Fruit/Horticultural

The Nursery. *Tree nurseries are valuable sources of seedlings for wananchi and tree planting groups. Shown is a worker at Wambugu Agroforestry Energy Centre watering young seedlings.*

Because people in this region know little about these species, demand for their seedlings has been initially low. However, demand is picking up steadily through the centre's extension and training efforts. Previous exposure of the public to individual species influences demand and thus the number that should be produced in the nursery. Some of the most popular species include:

Cupressus lusitanica	— for fencing and timber,
Grevillea robusta	— a multipurpose species,
Eucalyptus spp.	for fuelwood and construction materials,
Leucaena leucocephala	for fuelwood and fodder, and
Schinus molle	ornamental and shade.

Scattered planting of these species around homesteads and within farms can already be observed in the region.

It has been observed that there is generally a low demand for seedlings of indigenous tree species such as *Albizia*

gummifera, Croton macrostachyus, Markhamia hildebrandtii and Cordia abyssinica. Compared to most exotic species many of these are slow growing but their products are of high value and their role in ecological and environmental maintenance justify their increased planting.

Each tree seedling in a polybag is sold at 20 cents. Seedlings are issued free to organised groups and individuals during the National Tree Planting Day, and for land rehabilitation.

Cordia abyssinica *is one of the indigenous species which has good potential for agroforestry systems. Though it has extensive shade, it looses its leaves during the rainy season, providing excellent organic fertilizer and reducing crop tree competition for light. It is typically planted in pasture lands. It is also planted near the home for timber and as an ornamental*

6.2 Seed Programme/Seed Orchard

Tree seed is a basic commodity in the establishment of a tree nursery. Seed availability at the right time is a major challenge. To date the centre has collected much seed locally (Table 2). Seeds of trees not available locally are obtained from other centres and from the Ministry of Environment and Natural Resources.

Table 2. **Local Seed Collected at the Centre as of June 31st 1985**

Tree Species	Kg.	Source
1. *Aberia caffra*	5.3	Kamakwa, Nyeri
2. *Albizia gummifera*	14.5	Muringato Forest, Nyeri
3. *Araucaria angustifolia*	1.0	Mathira Division, Nyeri
4. *Brachylaena hutchinsii*	0.3	Kieni West, Nyeri
5. *Callistemon spp*	2.7	Kiganjo, Nyeri
6. *Calodendrum capense*	70.5	Kiganjo, Nyeri
7. *Casuarina equisetifolia*	30.7	Kiganjo, Nyeri
8. *Cordia abyssinica*	113.0	Kiganjo, Nyeri
9. *Cupressus lusitanica*	113.3	Kiganjo, Wambugu Farm
10. *Cupressus pyramidalis*	35.0	Kiganjo, Nyeri
11. *Eucalyptus globulus*	36.2	Kamakwa, Nyeri
12. *Eucalyptus paniculata*	56.0	Tetu Division, Nyeri
13. *Eucalyptus saligna*	40.4	Tetu Division, Nyeri
14. *Grevillea robusta*	35.6	Tetu Division, Kiganjo
15. *Jacaranda mimosifolia*	5.6	Kieni West Division
16. *Juniperus procera*	10.6	Mathira Division
17. *Melia azedarach*	36.3	Kieni and Tetu Div.
18. *Podocarpus glacilior*	2.1	Kieni Division
19. *Pygeum africanum*	1.2	Kieni Division
20. *Schinus molle*	10.0	Kieni Division
21. *Sesbania sesban*	3.3	Kieni Division
22. *Spathodea nilotica*	3.4	Mathira Division
23. *Sterculia acerfolia*	2.0	Muringato Forest
24. *Tecoma stans*	13.5	Mathira Division
25. *Vitex keniensis*	38.6	Kiganjo, Nyeri
Total	681.1	

The centre's local tree seed collection programme is strong. To date, over 681 kilogrammes covering 25 species have been collected. Part of the seed is sown in the centre's nursery. The rest is used in extension work for group and school nurseries.

To reinforce the seed collection programme, the centre has established a 2 hectare seed orchard presently holding 11 tree species (Table 3). In addition to seed production, the seed orchard serves as a species screening trial. The seed orchard was established in November 1984 and was intercropped with beans. Each tree species is replicated with each plot holding 30 individual trees (Figure 2). The seed orchard will be expanded to hold over 30 different species. Intercropping will be continued and monitored.

Table 3. Survival and Growth Data for the Tree Species in the Seed Orchard

Tree Species	Survival* Percentage	Height Range (Metres)	Mean Height (Metres)
1. *Calliandra calothyrsus*	60	0.12 - 1.68	0.86
2. *Calodendrum capense*	43	0.08 - 0.14	0.11
3. *Cassia siamea*	68	0.13 - 1.43	0.82
4. *Cordia abyssinica*	40	0.07 - 1.07	0.5
5. *Eucalyptus maculata*	85	0.15 - 3.31	1.6
6. *Eucalyptus microcorys*	66	0.4 - 2.92	1.71
7. *Eucalyptus paniculata*	[illegible]	0.65 - 3.4	1.8
8. *Grevillea robusta*	85	0.2 - 1.41	0.65
9. *Jacaranda mimosifolia*	95	0.1 - 0.8	0.43
10. *Leucaena leucocephala*	86	0.17 - 2.54	1.45
11. *Spathodea nilotica*	82	0.2 - 1.02	0.47

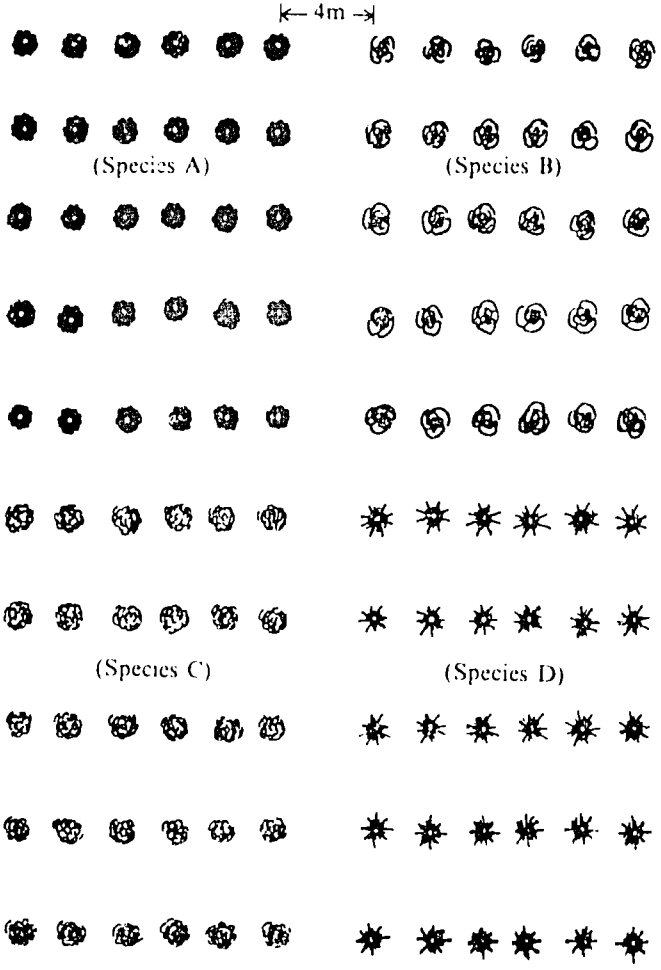
*Most of the trees were planted between 23 - 25 October 1984.

Tree Seed Programme. *Wambugu Centre collects seeds not only for its own use but for distribution to other local groups interested in tree planting. Here, seeds collected at the Centre are being dried and processed in preparation for packing and distribution.*

Figure 2.

Planting Plan of the Screening Trials (Seed) Orchards)

The general ground-plan is shown below. This figure represents only 4 blocks - therefore 4 species. Within each block, the trees are spaced 2 metres apart within the rows (horizontally in figure) and rows are 4 metres apar: (vertically in figure). The blocks are separated by 4 metre alleys on all sides. The blocks each contain 30 trees of one species.



6.3 Agroforestry Research/Demonstration

Background: Potentials and Constraints of the Region

The Central Highlands is a high potential agricultural region with coffee and tea as the main cash crops. Cotton, sunflower and tobacco are also produced in lower elevations and less humid areas. The mean annual temperature is about 20 degrees centrigrade with rainfall ranging between 500 and 2000 mm. The rains come in two distinct periods in some areas and in one long season in the higher elevations. See Table 4 for rainfall data as recorded by the meteorological station at Wambugu F.T.C., Nyeri.

The main natural vegetation type is montane rain forest, however tree cover diminishes with distance from Mount Kenya and the Aberdare range. The demand for wood products is high and is expected to rise due to the rapidly increasing population. Central Province already is the third most densely populated province in Kenya.

The reasonably favourable climate and fertile soils (though often with bad local topography) make farming an important occupation. Maize, beans, vegetables, bananas, sweet potatoes, coffee, tea, pyrethrum, cotton and livestock keeping are important farming activities. Woodfuel is an essential commodity in the region, both in homesteads and public institutions such as schools, hotels and hospitals. Fuelwood shortages are already severe in the tea and tobacco growing schemes, which represent the upper and lower end of the zone.

Increased tree planting with and without crops is now necessary both for tree products and to overcome the problems of environmental and soil degradation caused by continuous cropping and active deforestation. It is the objective of the centre, in cooperation with other GOK agencies, NGOs and other tree planting groups to help conserve existing resources and increase their productivity.

Table 4. **Rainfall data (mm) from the Wambugu F.T.C., Nyeri**

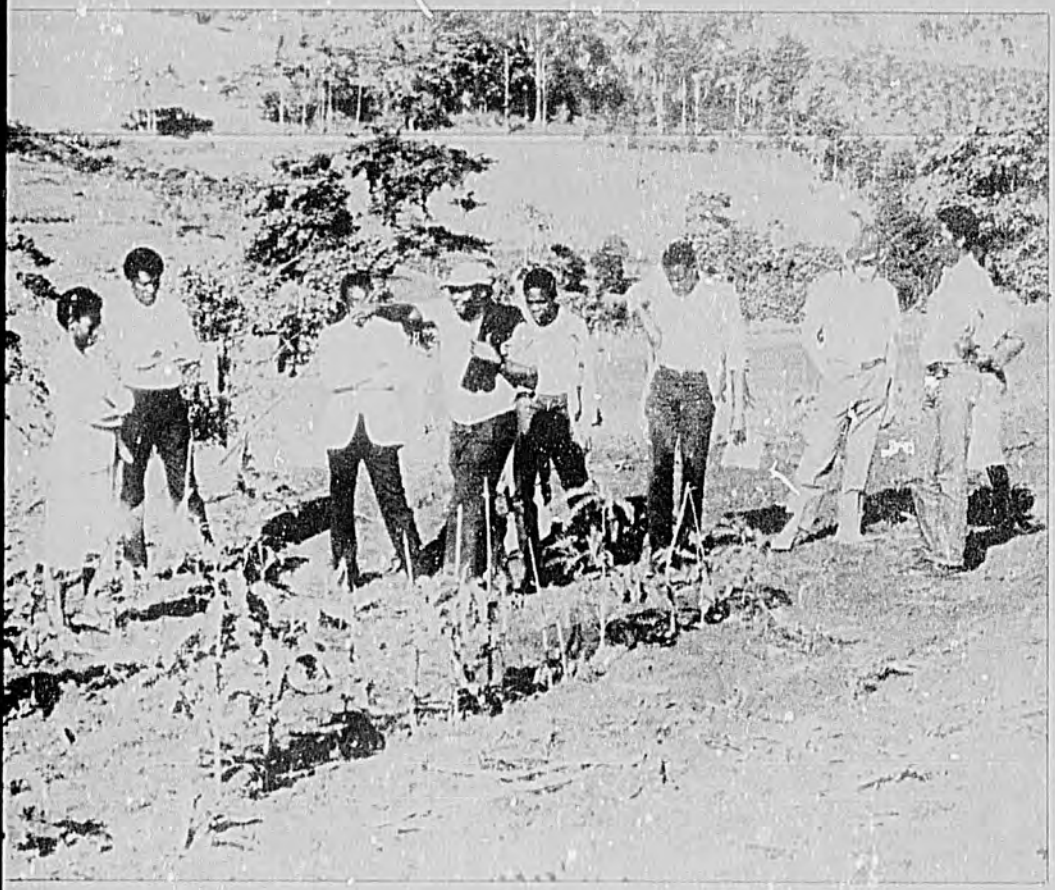
January	32.3	3.8	16.3	52.5
February	25.9	72.0	1.0	75.4
March	32.0	0.4	4.7	126.3
April	232.1	163.7	97.5	182.7
May	349.5	237.5	34.9	212.9
June	19.8	32.5	12.7	35.0
July	38.9	21.6	16.3	68.3
August	30.3	21.5	2.8	17.8
September	47.4	10.2	36.8	
October	229.1	74.9	176.3	
November	80.1	63.0	273.3	
December	74.2	220.0	79.5	
Total	1191.6	921.1	757.7	

In Nyeri District, rainfall in 1982 was adequate. In 1983 nearly half of the rainfall (401.2 mm) was received within two months, April and May. Relatively dry conditions then prevailed until December. It was not until September 1984 that a good amount of rain with fair distribution for good crop and tree performance was received.

Description of Agroforestry Research Programme

The practice and management of organised agroforestry is a recent concept. Its acceptability to farmers will depend on their needs and perceived benefits. Agroforestry research demonstration and trials are therefore an important component of the renewable energy development efforts.

The high population density and its rapid growth together with decreasing farm sizes necessitates tree planting within farms. In view of the fact that agricultural production must be sustained and improved, the agroforestry programme is trying to produce, promote and make available tree species whose overall effect will be to increase land productivity. Through monitoring and documentation of data collected from the research demonstration plots, the programme hopes to develop definite recommendations for successful



Research. *At the Wambugu Agroforestry Energy Centre, the research plots help to demonstrate important information on agroforestry tree species. Shown here, Cyrus Ndegwa of Energy Development International (E-DI) reviews the spacing of Sesbania grandiflora with staff of the Ministry of Energy and Regional Development and the Ministry of Agriculture and Livestock Development.*

agroforestry practices. Currently, the centre has 6.5 hectares of research farm planted with trees. Figure 3 and Tables 5 and 6 show the basic research plot design. The plots are intercropped with various agricultural crops in accordance with the recommendations of the Ministry of Agriculture and Livestock Development. There are a total of 9 tree species in the agroforestry experiments (Table 7).

Table 5.

Fuelwood/Agroforestry Experimental Trial Planting Modules

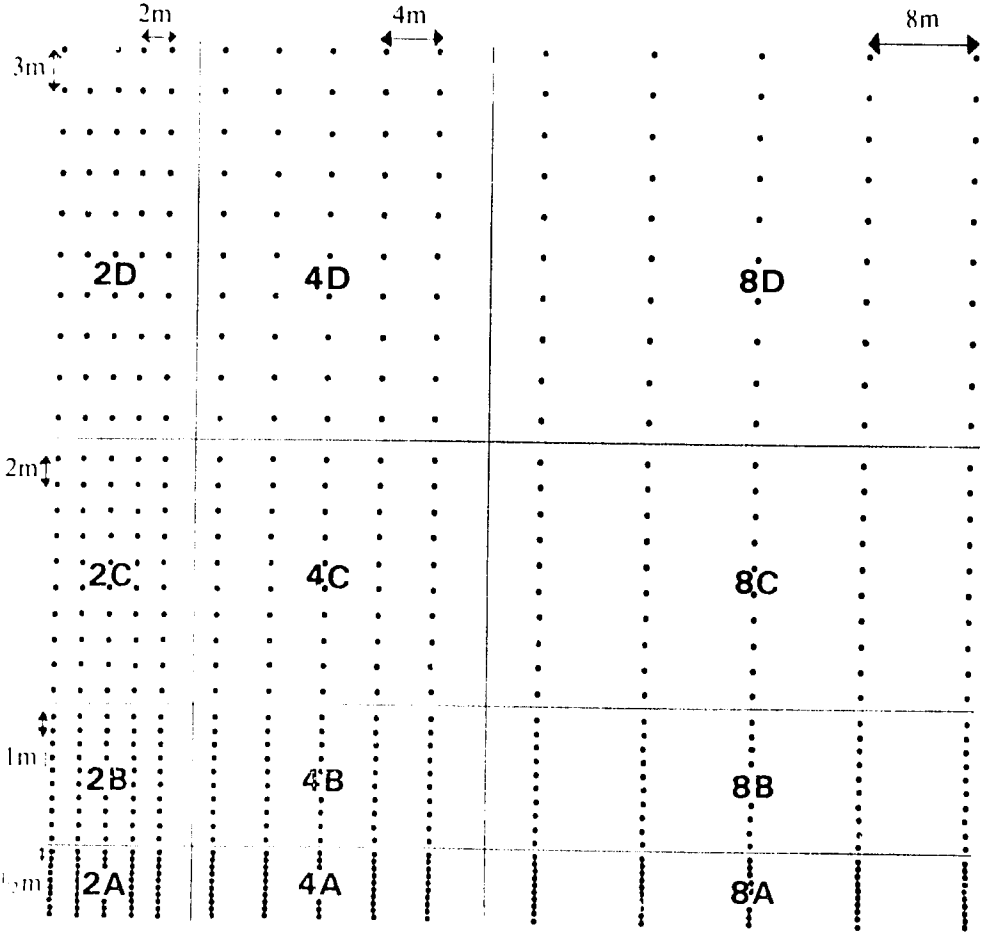
Row Width		Line Density			
		0.5m	1m	2m	3m
2m	Modules	2A	2B	2C	2D
	Area per Tree	$1m^2$	$2m^2$	$4m^2$	$6m^2$
4m	Modules	4A	4B	4C	4D
	Area per Tree	$2m^2$	$4m^2$	$8m^2$	$12m^2$
8m	Modules	8A	8B	8C	8D
	Area per Tree	$4m^2$	$8m^2$	$16m^2$	$24m^2$

Table 6.

Fuelwood/Agroforestry Experimental Trial Planting Densities

Area per Tree	$1m^2$	$2m^2$	$4m^2$	$6m^2$	$8m^2$	$12m^2$	$16m^2$	$24m^2$
Modules	2A	2B 4A	2C 4B 8A	2D	4C 8B	4D	8C	8D

Figure 3. Layout of the Research/Demonstration Plots



Each '•' represents a tree. In each row there are 10 trees spaced ½ meter apart, 10 spaced 1 meter, 10 spaced 2 meters and 10 spaced 3 metres apart. After the first row there are 5 rows that are 2 meters apart, 5 that are 4 meters apart and 5 that are 8 meters apart. This give the 12 different planting arrangements, from very dense to very dispersed. The crops are planted based on the recommendation of the Ministry of Agriculture and Livestock Development, irregardless of the tree.

Table 7. Trae Species Already Planted in the Research/ Demonstration Plots

Species	First Planting Date	Percentage Survival Feb 1985	Heights Range Feb. 1985	End Uses*
1. *Acacia albida*	April '84	97	0.12-0.78	ABCF
2. *Cassia siamea*	October '82	79	0.10-0.89	ACF
3. *Cordia abyssinica*	October '82	67	0.12-1.23	ACF
4. *Gliricidia sepium*	April '83	20	0.08-0.30	ABCDE
5. *Gmelina arborea*	October '82	57	0.08-0.65	ACF
6. *Grevillea robusta*	October '82	94	0.10-1.01	ABCF
7. *Leucaena leucocephala*	October '82	69	0.14-0.70	ABCDE
8. *Psidium guajava*	October '82	64	0.08-0.51	ACF
9. *Sesbania grandiflora*	May '83	67	0.33-2.11	ABCEF

**Categories of Use*

A. Fuelwood Timber — *D. Hedge Fencing*
B. Browse Fodder — *E. Ornamental Shade*
C. Soil Conservation — *F. Fruit Horticulture*

The species listed in Table 7 show great potential for use in agroforestry systems. Inter-row and intra-row spacing has been varied for comparison in order to determine the most effective tree planting densities with food crops (Table 5 and 6). The trees are seasonally interplanted with crops, including Irish potatoes, maize, beans and occasionally a fodder crop such as sweet potato vines. The tree establishment and growth rates given in Table 7 are low largely due to the bad rains of 1982 and 1983.

Extensive data are collected each season in order to establish baseline data with which to evaluate the modules. The data collected include:

1. Soil fertility (both chemical and mechanical analysis);
2. Light measurements (radiation available to crops);
3. Weed pest monitoring;
4. Crops yield (grain and crop residue);
5. Tree biomass yield; and
6. Agroforestry management practices.

Production costs are also kept for both the research and control plots so as to assess each module's efficiency with respect to land, labour and capital used.

6.4 Preliminary Results/Recommendations

The research demonstration plots and the seed orchards consist of trees interplanted with various crops depending on season. These plots provide information on appropriate agroforestry practices. Results to date are inconclusive because the centre is still young. However the following may broadly be taken to be applicable:

- Tree seedling survival and growth is greatly enhanced by intercropping and by use of tubed seedlings. Maize as an initial nurse crop forces the trees to grow more upright and tall. The crop also protects the palatable species such as *Leucaena* from browsing animals.

- Usable wood harvests are possible two years after transplanting for some tree species such as *Leucaena leucocephala*, *Gliricidia sepium*, *Calliandra calothyrsus*, *Sesbania grandiflora* and *Sesbania sesban*.

- The effect of the presence of trees on crop yields is neglible during their earlier stages of growth. They can therefore be incorporated into the normal cropping system. As the trees grow and develop canopies, silvicultural practices become necessary.

- In the central highlands region, the following tree species show great promise for agroforestry systems: *Grevillea robusta*, *Leucaena leucocephala*, *Calliandra calothyrsus*, *Sesbania sesban* and *Cordia abyssinica*.

A preliminary list of tree species recommended for the region is given below:

Tree species recommended for the Central Highlands

A. Fuelwood, Poles, Timber

1. *Casuarina equisetifolia*	ACE
2. *Cordia abyssinica*	ACE
3. *Croton megalocarpus*	ACE
4. *Eucalyptus maculata*	AC
5. *Eucalyptus saligna*	AC
6. *Gimelina arborea*	AC
7. *Grevillea robusta*	ABCE
8. *Jacaranda mimosifolia*	ACE
9. *Markhamia hildebrandtii*	ACE

B. Fuelwood, Soil Fertility and Browse/Fodder

10. *Acacia albida*	ABCE
11. *Calliandra calothyrsus*	ABCDE
12. *Gliricidia sepium*	ABCD
13. *Leucaena leucocephala*	ABCDE
14. *Mimosa scabrella*	ABCE
15. *Sesbania grandiflora*	ABCDF
16. *Sesbania sesban*	ABCD

C. Horticultural Trees

17. *Annona squamosa*	CEF
18. *Citrus spp.*	CEF
19. *Eriobotrya japonica*	CEF
20. *Macadamia spp.*	CEF
21. *Mangifera indica*	CEF
22. *Persea americana*	CEF
23. *Psidium guajava*	CEF

**Categories of Use*

A. Fuelwood/Timber
B. Browse/Fodder
C. Soil Conservation
D. Hedge/Fencing
E. Ornamental/Shade
F. Fruit/Horticulture

6.5 Extension, Training and Technical Services

The ultimate aim of the Centre is to reach the public. To achieve this the staff at the centre is using several approaches, namely:

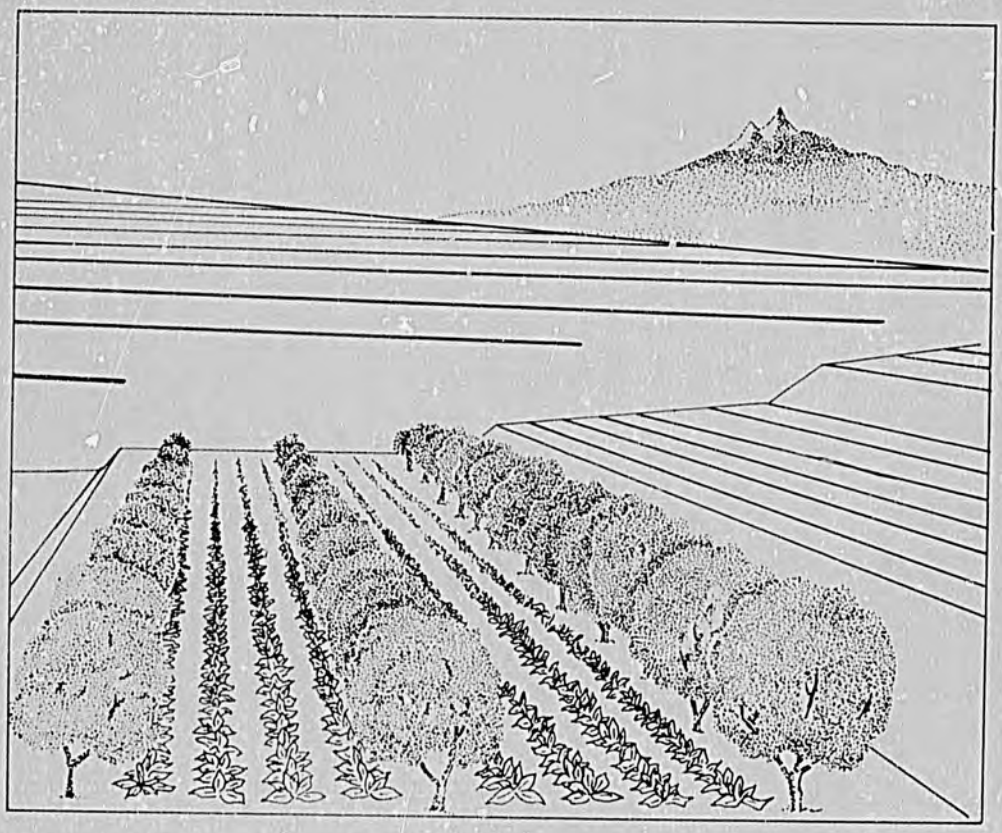
1. Holding 2-hour sessions with all farmers and groups attending courses at the F.T.C. The sessions are spent on classroom teaching and a guided tour of the field programmes and facilities.

2. Through the cooperation of the F.T.C. staff and its training facilities, week-long courses covering agroforestry, nursery establishment and management and fuelwood conservation are regularly held for farmers, local authorities and extension field staff.

3. Regular visits to farmers, community groups and schools have played an important role in extension.

Through the training and visit (T & V) programme of the Ministry of Agriculture and Livestock Development, the centre staff have worked together with the District Soil Conservation Officers (DSCO) and their staffs to approach farmers. The centre has made available transport facilities to increase mobility of the DSCO and their staff. The extension effort is further enhanced by U.S. Peace Corps Volunteers who are working in the districts with the DSCOs.

Annual participation in the Nyeri ASK Show helps the Centre to reach the community at large while communal tree planting during National Youth Week and National Tree Planting Day have helped to create awareness of the existence of the facilties and services offered by the Centre. Special assistance and demonstrations are offered to schools, cooperatives and societies in tree planting efforts.



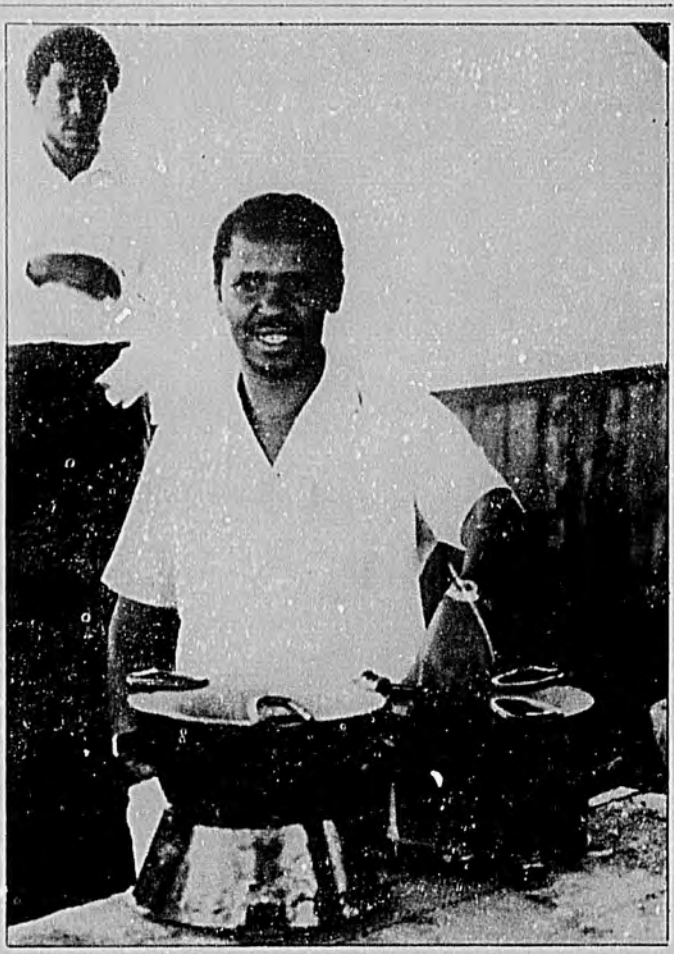
Agroforestry. *The practice of agroforestry has the potential to increase the overall productivity on a sustainable basis for farmers in the Central Highlands.*

Information Dissemination. *Seminars and tours are frequently conducted for interested groups such as schools, farmers and other organizations. Here, Mary Mwaingi (Wamunyu Centre Manager) gives a tour to other GOK officials to show the benefits of planting trees with crops.*

7. Improved Cookstoves Programme

Activities on the cookstoves programme were initiated in March of 1984. The first step was to locate sites where the liner material (clay) could be obtained. Then this new material had to be tested in order to establish the proper ratio of sand to clay to make durable liners. The purpose of the programme is to replace the traditional all-metal jikos with the improved ceramic cookstoves. In this way, available fuelwood will be used efficiently, thereby reducing woodfuel demand.

Public awareness and demand for the improved charcoal cookstove is high. To meet this demand, more training of artisans is needed to facilitate establishment of several workshops in various towns for mass production and dissemination.



Cookstoves. *Mr. F.M. Njoroge, head of the Stoves/Kilns Programme, displaying the improved charcoal jiko at the Wambugu Centre's stove workshop.*

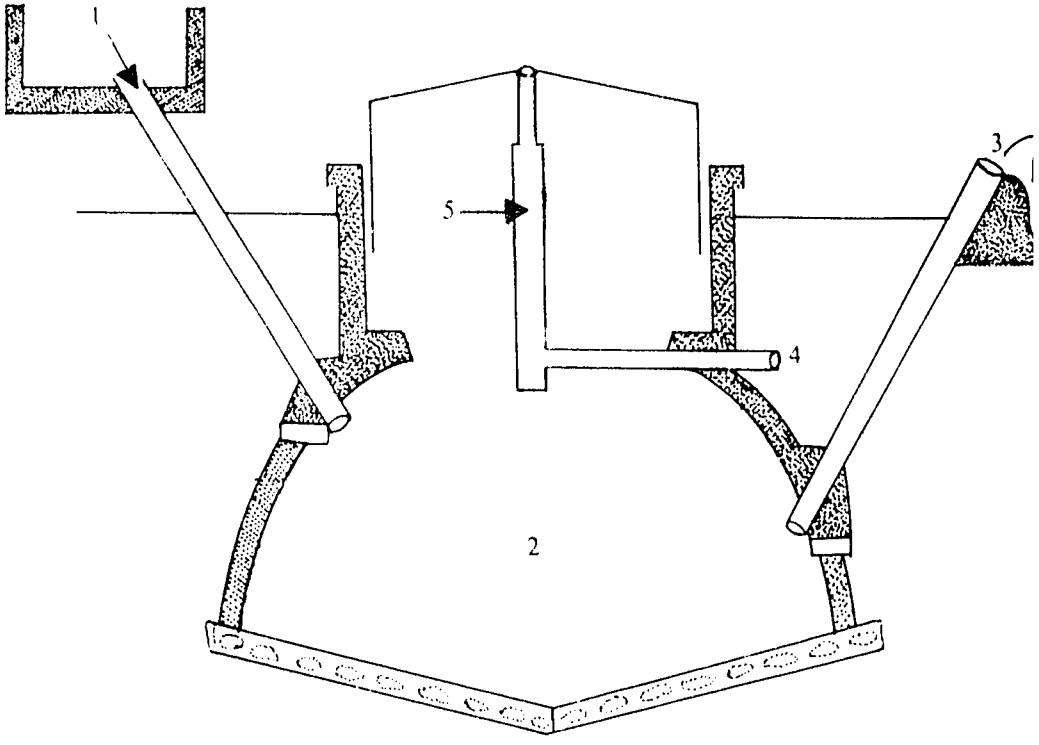
Cookstoves. *Training of local artisans is a major step in disseminating new improved cookstoves to the local community. Here a clay liner is being made for the improved Kenya Ceramic Jiko.*

8. Biogas Programme

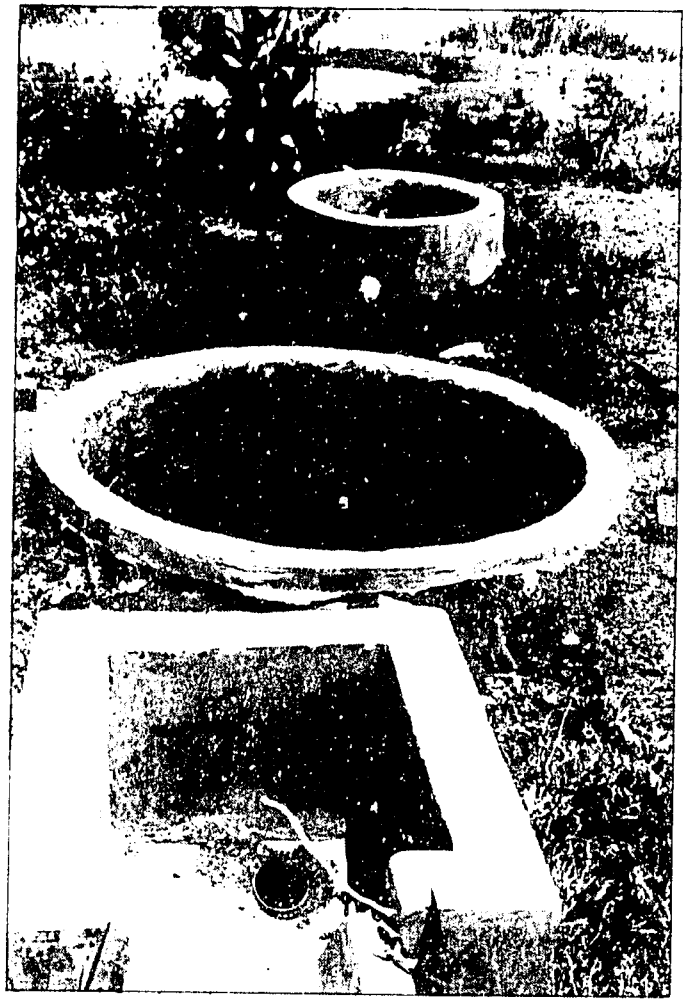
A biogas unit has been constructed at the centre. The unit has been used to train several biogas artisans. These trainees are now competent in the construction and maintenance of family size biogas units (Figure 4).

Training is an on-going programme for interested people to learn how to build biogas digesters. Each biogas course lasts between 10 and 14 days. A knowledge of masonary is an advantage for course participants.

Figure 4. Schematic drawing of a biogas unit.



1. Mixing chamber and inlet pipe.
2. Digester
3. Slurry outlet
4. Gas outlet
5. Floating drum gas holder



BIOGAS. *Top view of a biogas unit showing mixing chamber, the digester and the outlet. Biogas is used for cooking, light, refrigeration and generation of electricity. The fertilizer value of the dung used is greatly improved*

9. Wambugu Centre Staff

Centre Manager	Nyambura M. Mwangi
USPC Extension Officer	Peter Buckle – Murang'a District
USPC Extension Officer	Connie Fitzmaurice – Kirinyaga District
USPC Extension Officer	Jeff Inks – Nyandarua District
Centre Clerk	Dickson Njoroge
Nursery Foreman	Joseph Mbuchu
Demos Orchard Foreman	Macharia Ndigiriri
Storeman	Mwai Warutere
Artisan Trainer	James Muita

Associated Staff

Principal Wambugu F.T.C.	Mrs. Wanjohi
Soil Conservation Officer, Tetu	Owigo Nyogoro
District Soil Conservation Officer, Murang'a	Mr. Ruoro
Agricultural Officer, Mathira	Mrs. Orina
Soil Conservation Officer, Kiambu	P.M. Njenga
District Soil Conservation Officer, Nyandarua	S.N. Macharia

For more information or assistance, please contact the Centre Manager of Wambugu Agroforestry/Energy Centre

Wambugu Agroforestry Energy Centre
P O Box 5069
Ruringu via Nyeri

Application form for classes

Name

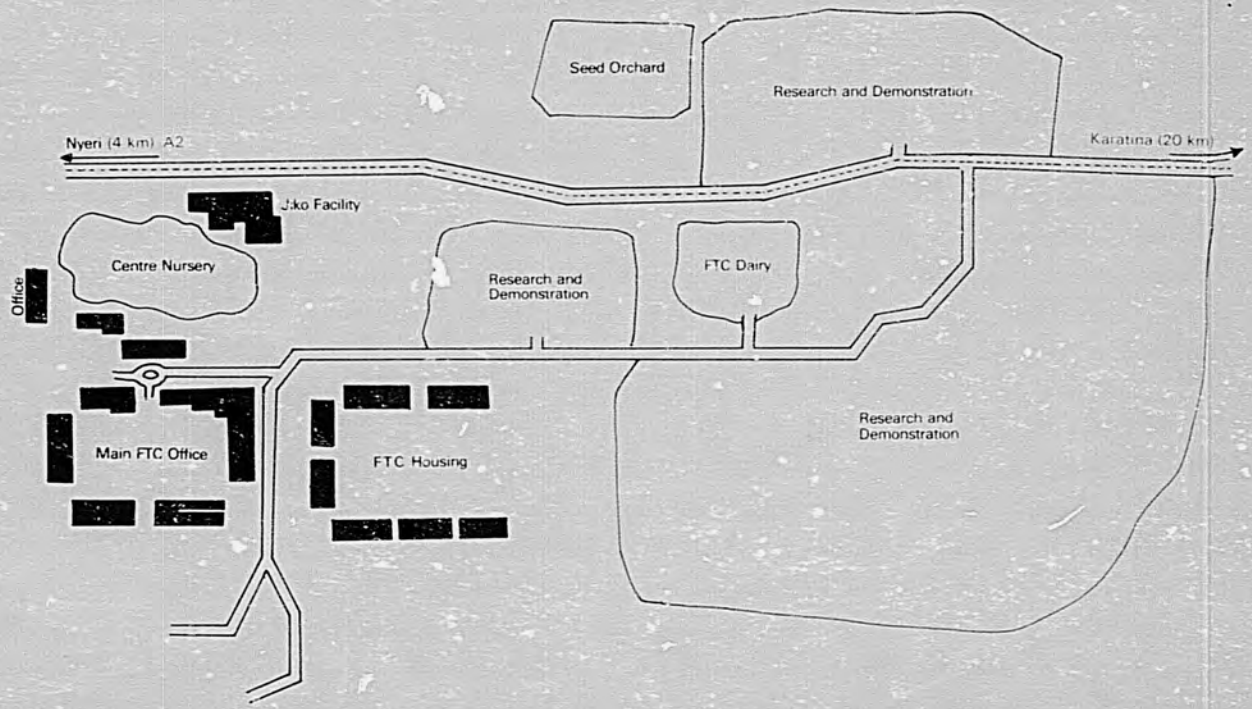
Address

Telephone number where you can be contacted

Check which class you are interested in attending

- [ ] Agroforestry
- [ ] Biogas
- [ ] Improved cookstoves/kiln

State reason you would like to take the class.

Please send this form to
Wambugu Agroforestry/Energy Centre

Map of Wambugu