

Research, Technical Training and Technology (MRTTT) for the fiscal year 1993-94. However, as implementation of the project has not been confirmed by the two governments, the budget for the project has not been allocated in the Government of Kenya for this fiscal year which is from July 1993 to June 1994. When this project is implemented within the limits of the Government of Japan's budget for fiscal 1993, it will be necessary for the Government of Kenya to allocate a provisional budget for the initial work to be done by the Kenyan side, for a period until June 1994. The Kenyan side has made definite promise to make a budget for this project when this project is formally approved. It should be noted that the early implementation of this project is premised on the Kenyan side's allocation of the budget and execution of all necessary procedures with the top priority.

Since all the projected facilities are to be operated and managed by the present personnel of KEFRI, there will be no increase in KEFRI's personnel expenses, which occupy the greater part of its facility operation and management budget, although there will be a slight increase in the cost of facility operation. Thus it will be easy for the Kenyan side to make budgetary appropriations for the operation and management of the projected facilities.

3-2-3 Examination of the Requested Facilities and Equipment

(1) Facilities

The results of our examination of the requested facilities by block and room are as described below.

1) Muguga Centre

① Research Block

There are a total of sixteen (16) research departments which belong to Muguga Centre. Three (3) departments, which are Biotechnology, Pathology and Ecology, out of the sixteen departments have two divisions. This makes a total of nineteen (19) research divisions which belong to Muguga Centre. There are seven (7) research divisions on the premises of Muguga Centre at present. Other twelve (12) divisions are leased from the Agricultural Research Institute (KARI) and regional forest offices of the Forest Department in Nderi and Nairobi. Due to such constraints in terms of location, sufficient communications are not maintained between the departments. At the leased laboratories for use in the twelve (12) fields of research, even equipment is leased, which makes it difficult to conduct necessary research. The Government of Kenya's request concerns the construction of a new "Research Block" which is aimed at integrating research facilities in ten (10) of the twelve (12) fields of research on the premises of Muguga Centre. It is expected that the construction of the "Research Block" will enhance efficiency in research work at Muguga Centre. Thus it is urgently necessary to construct the "Research Block".

The construction of laboratories and greenhouse will be determined on the basis of the results of the above examination. The following modifications are incorporated into the original request.

1. The Government of Kenya's request included the construction of a new "Research Block" to cover facilities for use in 10 fields of research, which have thus far been located outside of the premises

of Muguga Centre. A close examination of the relationship of Muguga Centre's existing research block to the projected research block reveals that some existing facilities will function better if moved to the new research block, although others can remain in the existing research block. In working out the basic design, the arrangement of individual laboratories should be considered paying close attention to the relationships between all the laboratories of 17 fields in Muguga Centre.

2. In order to provide facilities economically, overlap of facilities and equipment should be avoided unless it is mandatory to have one individually. For this reason, a "common laboratory" to contain facilities and equipment for common use is provided.
3. The Government of Kenya's request included 31 offices for a staff of 93 researchers and research assistants active in 10 fields of research at the projected "Research Block". While each chief researcher should be provided with an office, necessity for providing other researchers and research assistants with an office is questionable. For this reason, under this project the analysis room attached to the laboratory should be used also as an office.

Taking space requirements and research activities of the three research departments, which have two divisions each, into consideration, one laboratory for each division of Biotechnology and Pathology departments and one laboratory for two divisions of Ecology department are allocated. The figure 3-1 shows the arrangements of the research divisions at present and planned.

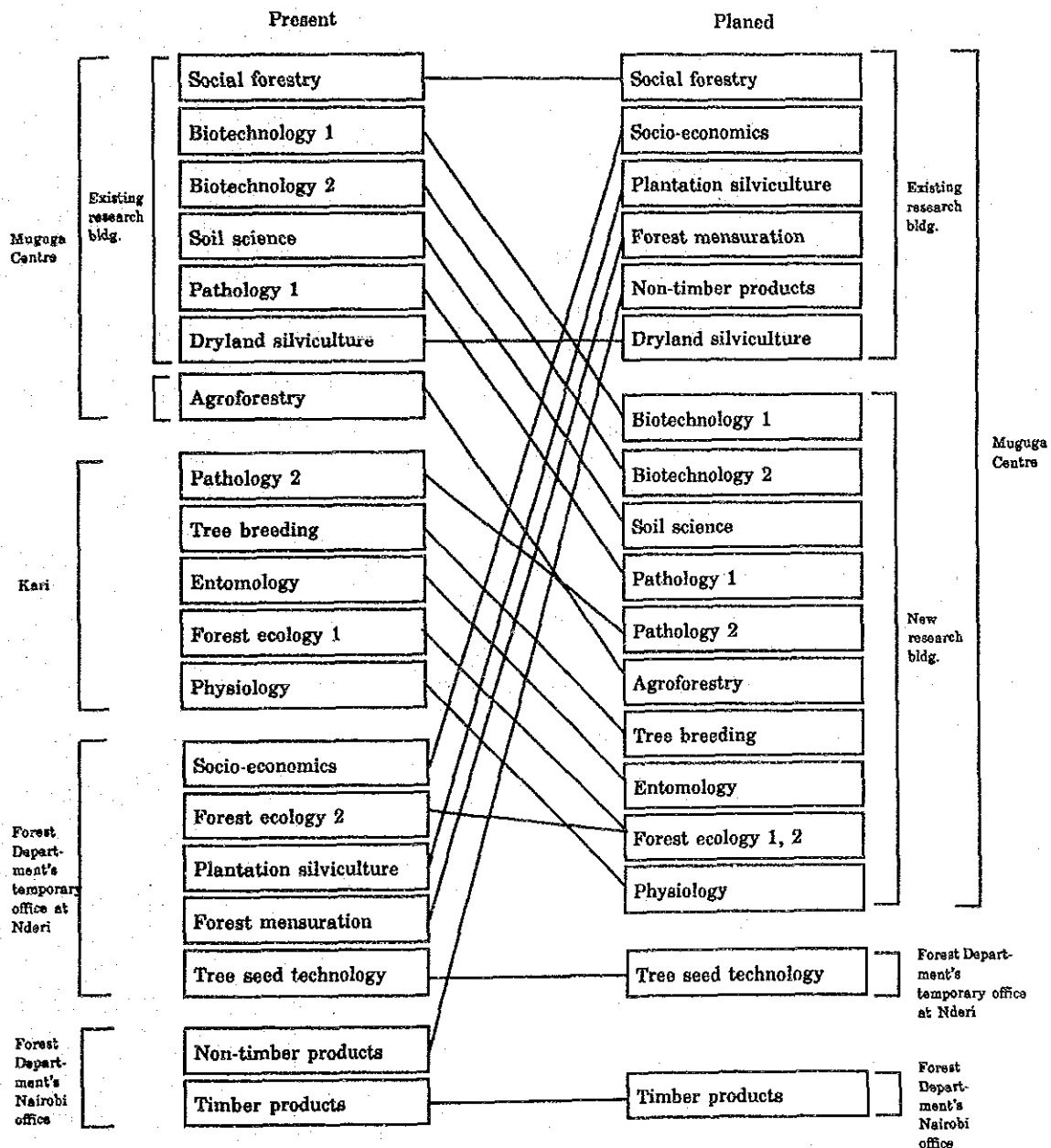


Fig. 3-1 Arrangements of the Research Divisions

② Information Block

KEFRI is positioned as Kenya's central forestry research organization. The scope of its operations are being expanded from year to year. Under such a background, KEFRI has plans to organize various conferences and training courses, including a researchers' conference, a national forestry conference, an East African forestry conference and third country forestry training. At present, however, it has only one small training room. Under such constraints in terms of facility, the research institute finds it impossible to organize such new projects. It is, therefore, reasonable and effective to construct an "Information Block" consisting of a multipurpose hall and such information rooms as a printing room, a library, a data room and so on in order to sort, arrange, stock, produce and publish the information on the results of researches. Each room in this block should be designed on the basis of the results of the following examination.

● Multipurpose Hall

KEFRI's projected training courses and conferences are as shown in the following table.

Table 3-2 Lecture · Conference Schedule

sponsor	training · conference	participants	days	No. per year	total days
KEFRI	KEFRI Scientific Conference	100~150	6	1	6
	KEFRI Colloquiums	80~100	4	6	24
	National Annual Forestry Symposia	150~200	5	1	5
	In-service courses	30~50	4	3	12
	Regional Workshop	60~80	7	2	14
	International Conference	120~150	5	3	15
	KEFRI Open Weeks		10	2	20
	Social Forestry Prize Day	200	3	1	3
	Other Courses	30~50	2	10	20
		(Sub-total			
KARI, etc.	Scientific Conferences	100~150	6	6	36
WID	Seminars and Workshops	100~160	9	2	18
AFNETA	Training, Workshop	80~100	8	2	16
Govt. Organizations	Training	30~50	2	8	16
	Total				205

The table 3-2 shows that 26 medium- to large-scale programmes (total number of days: 157) will be organized a year. If it is estimated that it will take a full day to make the conference room ready for a programme and put it in order after the programme is over, the total number of days of use of the projected multipurpose hall will be 209. If it is estimated that the annual total number of workdays is 260 (five-day workweek), the operating rate of the projected multipurpose hall will be about 80 percent. For this reason, it is urgently necessary to construct a multipurpose hall with a seating capacity of about 150.

It is also expected that 21 small-scale conferences (total number of days: 48) will be organized a year, that these small-scale meetings will be held during medium- to large-scale conferences, and that the research staff members will frequently have briefing sessions. It

will therefore be necessary to construct several small meeting rooms, each with a seating capacity of 20 to 40.

The projected multipurpose hall should not be designed solely for conferences. It should be designed also for exhibitions, assemblies and ceremonies.

• Printing Room

At present, the printing of data for use in training and extension activities and the results of Japan's technical cooperation is done at the data room. In the small space of the data room, a printer, drawing desks, work tables and shelves are placed promiscuously. It is expected, however, that as KEFRI's training and extension activities are expanded, there will be need to do large-scale printing. For this reason, it is necessary to construct a well-organized printing room. The projected printing room should be located nearby the library and the data room from the standpoint of convenience in handling necessary information.

• Data Room

The results of KEFRI's forestry research, details of its operations, its financial reports and other forestry-related items of information are to be managed intensively by the computer. Already preparations are being made for the development of an intensive information management system at KEFRI. It is expected that the efforts along these lines will continue into the future. Systematic use of a large quantity of information on forestry is indispensable in carrying out forestry research work. It is, therefore, necessary to provide a facility environment to facilitate such systematic use of information

on forestry. For this reason, the projected data room should consist of a computer section and a data storage section.

③ Administration Block

KEFRI requested the construction of an administration block with a total floor area of 1,200m² for the reason that the expansion of its administration department is of vital importance to the improvement of its organization. When an information block is constructed under this project, 3 rooms (training rooms and a conference room) and the library in the existing building will be included in the facilities of the projected information block. In this case, all the rooms in the existing training block, for example, can be used as an administration building or the library of the existing facilities can be used as an independent accounting block. For this reason, it is concluded that there will not be any need to construct a new "administration block".

④ Guest house and dormitories

KEFRI requested the construction of a guest house with 8 rooms for lecturers and dormitories with 22 rooms for trainees as facilities to support its planned training courses and conferences. However, in view of the fact there are already 4 rooms for lecturers and 20 rooms (capacity: 40) for trainees and that the hotels in Nairobi City can be used when these existing facilities are found to be insufficient, it is judged that the construction of requested guest house and dormitories is low in order of priority. It should be added that the existing lodging facilities, which were constructed in 1987, are functioning smoothly.

⑤ Remodeling of the Existing Facilities

KEFRI's personnel has increased more than initially planned and as a result, the existing facilities have become small for the increased personnel. Furthermore, some leakages have occurred in the existing facilities. In implementing this project, therefore, it will be necessary to repair the existing facilities and change the room layout where necessary so that both the existing and new facilities can function in harmony. It is reasonable to include the followings for remodeling work.

● Dining Hall

The existing dining hall has a seating capacity of 100. It is estimated, however, that about 600 staff members are always working on the premises of KEFRI, of which 300 are using the dining hall. If the dining hall operates in two shifts at lunch time, its seating capacity is not enough. Since trainees also utilize the dining hall, it is necessary to increase its seating capacity by about 100. It will also be necessary to improve such related facilities as the kitchen and the washing room in keeping with the extension of the dining hall.

● Equipment Storage and Maintenance Workshop

The provision of an equipment storage and a maintenance workshop is also included in the Kenyan side's request. KEFRI has a department responsible for the management and maintenance of its equipment. Partly because of a shortage of necessary facilities and equipment, however, the department is not fulfilling its intended functions. In light of the importance of the maintenance and management of KEFRI's

facilities and equipment, it is considered urgently necessary to provide the two requested facilities.

• Deep Tube Well

The existing deep tube well often breakdown, which constitutes an obstacle to smooth water supply on the premises of the research institute. The main cause of the wells' breakdown is the fact that each well has an open hall below the depth of 80 meters. It is presumed that the wall of the well collapses and sand included in the collapsed wall is swallowed into the pump. It will, therefore, be necessary to include rehabilitation work of the existing well and replacement of pump in the project to ensure sufficient water supply.

2) Kitui Centre

① Research Building

Kitui Centre where the Kenya/Japan Social Forestry Training Project Phase 2 is currently being implemented does not have any research facilities. Kitui Centre is positioned as a regional centre, which is lower than Muguga Centre in the organization of KEFRI. In the Government of Kenya's request, Kitui Centre is to start research in 3 basic fields of forestry research and to equip with the research facility and then the centre will be positioned as a national centre. At Kitui Centre, pilot forest plantation has thus far been carried out on tracts of land with a total area of nearly 300 ha, which has contributed to the development of forest plantation technologies for use in semi-arid areas. Furthermore, it is expected that various experiments will be conducted at the centre. For these reasons it is urgently necessary to construct laboratories to conduct research on

social forestry, semi-arid land silviculture and soil science within the premises of the centre.

② Facilities Related to Forest Plantation and Training

At present, the main activities carried out by Kitui Centre are forest plantation, training in social forestry and the extension of the social forestry in the semi-arid areas. A technical cooperation project to support these activities is being implemented by the Government of Japan. However, it became clear in the course of the carrying out of these activities that the centre was lacking in the following facilities, and the construction of such facilities has been considered.

● Seed Storage

Forest planting operations under the Government of Japan's technical cooperation are being carried out mainly at Tiva nursery. However, the nursery has no seed storage, which makes it difficult to store seeds for use in forest nurseries. It is quite reasonable to construct a seed storage to support the technical cooperation project being implemented at Tiva nursery.

● Greenhouse

There are nurseries for social forestry activities at Kitui Centre. However, no greenhouse for germination test is provided for the planned activities. It is, therefore, necessary to urgently provide simple greenhouses.

③ Remodeling of the existing building

It is necessary to repair a part of the ceilings of the second floor in the existing building because these ceilings have been damaged by leaks. At the time of repairing these ceilings, the arrangement of some partitions should be altered to make staff rooms more suitable for their present use.

④ Deep Tube Wells

The total quantity of water pumped up daily from the two existing deep tube wells is about 18m³ during the rainy season. It is less than 10m³ during the dry season. Total demand of the center including the new facilities will be about 30m³ a day. This means that it is impossible for these wells to supply sufficient amount of water to the existing and new facilities. It is necessary to construct an additional deep tube well.

3) Maseno Centre

As for Maseno Centre, an administration block, dormitories and a dining hall were requested. Maseno Centre is currently responsible mainly for practical aspects of agroforestry and promotion of agroforestry. It appears that field training in agroforestry is the main operation carried out at the centre. For these reasons, there is no strong need to construct dormitories for trainees or a dining hall on the premises of the centre. As the centre is supported by other international organizations, it seems that the objectives of its operations is being attained sufficiently. Unless there is a drastic change in its operations, it is judged that the priority to construct the requested facilities is very low.

4) Marigat Centre

As for Marigat Centre, a research block which covers 4 fields of research necessary for starting new research work on dryland silviculture was requested. However, in light of the possible financial and staffing burdens for KEFRI to carry out research in new fields, it is considered reasonable to exclude the construction of new research facilities for the centre from this project. It should be added that the priority to construct new research facilities at this centre is low compared with Kitui Centre at which a technical cooperation is being implemented by the Government of Japan and which is well staffed.

(2) Equipment

In principle, the selection of necessary equipment is conducted according to the request from the Government of Kenya. Particular attention paid in selecting equipment is as follows.

1. Automatic analyzer

An automatic analyzer, requested for Muguga Centre, is intended for automatic chemical analysis. It is generally used at hospitals, etc., where a large quantity of samples have to be analyzed in a short time. It is therefore understood that there will be very few occasions which require this equipment. In addition, technical and cost problems are likely to occur in its operation and maintenance. Thus, this item is not recommended for this project. It is regarded appropriate, however, to introduce an atomic absorption spectrophotometer, a Fourier transform infrared spectrophotometer and a gas chromatograph

instead. The main uses of those alternative equipment are briefed below.

- Atomic absorption spectrophotometer:

used to analyze metallic microelements of Mn, Mg, Zn, Ca, etc.

- Fourier transform infrared spectrophotometer:

used to analyze the structure of organic compounds.

- Gas chromatograph:

used for quantitative analysis of nitrogen and phosphides, etc.

2. Scanning electron Microscope

Observation by a scanning electron microscope is an effective way of identifying, for example, DNA molecules and atoms contained in the assimilatory tissues of a leaf of plant. However, this equipment is considered excessive judging from the standpoint of improvement of basic forestry research for the extension of social forestry, which is the main objective of the research department. Furthermore, a cost problem will be concerned in its operation and maintenance. For above reasons, it is decided to exclude this item. Instead, a fluorescence microscope and biological microscopes will be introduced for Muguga Centre.

3. Centrifuge

A centrifuge, requested for both centres, is indispensable in conducting analysis of the chemical and physical properties of substances in many fields relating to the study of soil and plants. In the field of soil science, in particular, this equipment is expected to be used frequently to determine the pF-value for analysis

of moisture content of soil. Thus, a centrifuge with a rotor and sample tubes whose specifications are suitable for determination of the pF-value (sample volume: 80g, a rotor for 4 tubes, 13,500 rpm.) is decided to be introduced for each centre. Apart from this, two general-purpose centrifuges will also be provided for Muguga Centre. The pressure plate, which was separately requested, will be excluded since this item is used for the same purpose as a centrifuge.

4. Mass spectrometer

A mass spectrometer is an instrument helpful to analyze and measure, for example, atomic mass contained in plant tissue, or atomic structure of organic compound ion. However, judging from the standpoint of extension of basic forestry research and maintenance cost, this item is not recommended for this project.

5. N/C analyzer

A study of mechanism and quantitative analysis of circulation of nitrogen and carbon in an ecosystem of tropical zone is yet to be conducted. And such analysis is thought to be valuable hereafter. This item, therefore, is judged to be provided for Muguga Centre together with a fluorescence spectrophotometer which is related to this item to extend research in this field.

6. Gel electrophoresis equipment

A gel electrophoresis apparatus is considered indispensable in conducting analysis of the chemical properties of substances such as enzymes and proteins in the process of classifying plants and insects. In particular, analysis by this apparatus is very effective in the case to classify morphologically similar species, such as acacias and

herbs. this item is therefore recognized to have high priority, and decided to be introduced for the department of tree breeding, forest pathology and non timber products of Muguga Centre.

7. Cation exchange capacity analyzer

A basic study of mechanism and quantitative analysis of exchange of cation in the soil is yet considered insufficient. And such analysis is also expected hereafter. This item therefore is judged necessary enough and decided to be introduced for Muguga Centre.

8. Rainfall simulator

A rainfall simulator, requested for Muguga Centre, is usually used to study, for example, the process of generation of an earth and sand flow in a mountainous district in high-rain area. In Kenya, however, most of whose land is semi-arid, and thus, the necessity of such equipment is not considered high. This item therefore is decided to be excluded.

9. Controlled environment cabinet

A controlled environment cabinet, requested for Muguga Centre, is flexible in setting the temperature, humidity and light quantity within the chamber, and is therefore used effectively and extensively in research on plant physiology and pathology. However, a controlled environment cabinet, generally used in the field of tree planting research, with a chamber of effective internal dimensions of 2,000mm × 2,000mm × 1,800mm and a luminous intensity of 20,000 to 50,000 lux (with artificial light source) requires an electric capacity of about 25 kW. If this item is installed under this project, therefore, it will pose such financial and maintenance problems as an increase of

electricity charges and the necessity of periodically exchange of light source, etc. And the efficient use of a growth cabinet (although smaller in scale) and a greenhouse is expected to cover the necessity of this equipment.

For those reasons, this item is not recommended for this project.

10. Growth cabinet

Since this apparatus is indispensable in experimenting on the germination of the seeds of leguminous plants and the culture of root nodule bacteria, two types of this apparatus, the open type and the closed type, are planned to be installed. The open type, which can keep almost natural light conditions, is used in experimenting on the germination of seeds and the growth of seedlings. On the other hand, the closed type, which controls unified light or dark conditions by artificial light source, is used in experimenting on the culture of root nodule bacteria. 10 growth cabinets, totally, are decided to be provided to the laboratories of agroforestry, tree breeding and biotechnology.

11. Fluorescence microscope

A fluorescence microscope, requested for Muguga Centre, is an effective device to observe selectively the specific substances with its mechanism of seizing fluorescent elements contained in the cells of a leaf by radiating exciting light. Since this item is determined to be useful and necessary in such fields as physiology, soil science and biotechnology, a set with selective exciting/absorption filters and a camera unit is recommended for the common laboratory of Muguga Centre.

12. Grinding mill

A grinding mill is an indispensable instrument to prepare samples for quantitative analysis by a gas chromatograph and an atomic absorption spectrophotometer. And it is also necessary to make the ground specimens such as leaves and outer barks of the plants. It is therefore decided to install totally 8 units of this item in the agroforestry and soil science laboratories of Muguga Centre, and in the soil science laboratory of Kitui Centre selecting from two types of grinding way: Willey system for hard samples such as timber and stone, and cross-beating system for soft samples such as leaf and sprouts.

13. Personal computer

A total of 13 personal computers is planned to be installed in Muguga Centre, and a set in Kitui Centre, as means of analyzing the results of experiments, storing data and preparing research papers and other documents. The configuration of each set is of general type, as shown in figure 3-2. However, the system for the library requires a CD-ROM drive/reader and a laser beam printer because CD-ROM based database software will be handled. It was decided to exclude the installation of a local area network (LAN) between laboratories since research activities of each laboratory are independent at present and it seems to take more time to develop a common database. However, the LAN-oriented devices should be selected for the necessity in the future. In consideration of the power supply situation in Kenya, each personal computer system will be provided with an UPS (uninterruptive power system) capable of about 10 minutes' backup.

Outline of hardware

- 8KB cache memory
- 8 MB RAM
- 1.44MB 3.5" diskette drive
- Fixed hard disk (120MB)
- 14" CRT
- Keyboard
- 5.25" external diskette drive
- CD ROM driver/reader (library system only)

Software

- Operating system
- Data base software
- Word processing software
- Spreadsheet programme software
- Graphic software

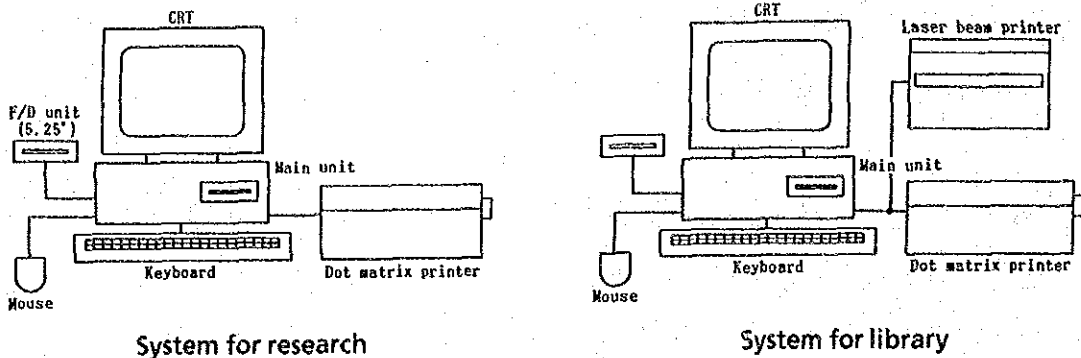


Fig. 3-2 Configuration of Computer System

14. Video camera system and video editing system

Those systems was requested for both centres. It is considered very effective to carry out promotional and public relations activities using audio-visual teaching materials, from the standpoint of the promotion of tree planting, which is one of the main objectives of this project. Generally, the production of video teaching materials involves a lot of planning time, personnel in charge, and the cost of purchase of videotapes and other expandable supplies. It was decided, therefore, to minimize the number of items on the basis of the following production schedule.

○ Examples of the contents of teaching materials and public relations programmes to be produced;

- Training and promotion:

how to make compost, the method of germination, how to raise nursery trees

- Public relations:

the centre's activities, the collapse of forests, nationwide tree-planting

- Others:

recording of research results and lectures

- Number of video teaching materials to be produced in a year;

It is estimated to require about 3 staff members and about 3 months to produce a 20- to 30-minute video teaching material. Therefore, the number of video teaching materials and public relations programmes to be produced in a year will be about three.

- Items to be provided;

- Video camera system:

Video camera, Videocassette recorder (S-VHS/VHS), Tripod/dolly, Portable monitor TV, Battery light

- Video editing system:

Videocassette player, Editing controller, Monitor TV

The format of videotapes will be VHS or S-VHS, both of which are commonly used in Kenya. The video teaching materials produced by those equipment will be shown via monitor TV set to be installed in the department of social forestry. It will also be possible to show those materials in multipurpose hall.

15. Video projection system

This system is necessary for showing the programmes made by other research organizations and ready made educational programmes as well as the programmes developed and prepared by KEFRI for training and

public relations purposes. A video projector and a screen will be installed in the multi-purpose hall. The size of the screen (120 inch) was decided according to the capacity of the multi-purpose hall (150 seats). A video cassette recorder (S-VHS/VHS) and a monitor TV will be installed in the control room. A slide film projector is also provided for the use of conferences and lectures.

16. Audio system

This system is necessary for holding conferences, lectures, ceremonies such as opening and closing ceremony and exhibitions for expansion of social forestry and other activities. The system consists of microphones (dynamic type and wireless type), power amplifiers, an audio mixer and other incidental accessories. Not only main speakers but ceiling speakers are provided in order to support the activities at the multi-purpose hall which can be partitioned into two parts to allocate various size of activities.

17. Pickup truck

A pickup truck, requested for both centres, is considered to be indispensable to transport nursery trees and forestry instruments and tools. In particular, it is quite necessary to carry more nursery trees to different afforested lands in order to extend further tree-planting activities. For those reasons, it is decided to provide a pickup truck with capacity of 1 ton for each centre.

18. Bus

The purpose of this item is to provide a transportation service for the activities of the trainees. A bus with seating capacity of about 60 is judged to be necessary, in particular, for Muguga Centre to

transport the trainees who stay in Nairobi city during the period of training. For Kitui centre, on the other hand, this item is not considered necessary since they already keep one for this purpose. Apart from this, a set of tools for maintenance and repair of the vehicles is also provided for both centre.

19. Water tank truck

This item, requested for Kitui Centre, is recognized to be indispensable in supplying water to the tree nursery in Tiva located near the centre and pilot forest as well as the adjacent model farmhouses. Also, it is quite necessary to secure water during the dry season since the two wells in the centre run dry. In conclusion, a water tank truck with capacity of 10ℓ is decided to be provided for Kitui Centre.

20. Other items

Although the following items were not requested, the necessity of them was discussed during the basic design study. As a result of a careful analysis, it is concluded that those items are necessary for this project and included in the equipment plan.

- Ultrasonic pipe washer: used to efficiently wash pipets without causing damage
- EC meter: used to determine salt content of soil
- Ice cuber: used to make ice cubes to cool test samples, etc.

3-2-4 Examination of the Necessity of Technical Cooperation

At KEFRI, the Kenya/Japan Social Forestry Training Project, a technical cooperation project by the Government of Japan, is being implemented. The project started with its preparatory phase (1985-87). Following the close of its first phase (1987-92), the project is now in its second phase (1992-97). The technical cooperation project, which is being implemented at Muguga Centre and Kitui Centre for the purpose of promoting social forestry, is producing excellent results in the areas of training and pilot forest plantation. When the requested grant aid project is implemented, operations under the project are to be carried out mainly in the areas of research and assembly/information, neither of which will be directly related to the operation under the ongoing technical cooperation project. For this reason, if any area of activity is to be added to the technical cooperation project to utilize the facilities provided by this grant aid, research would be the area. However, there is no need to implement an additional technical cooperation project because at KEFRI research work is carried out by a large number of researchers and staff under KEFRI's own long-term plan and also because judging from the technical level and past achievements of the researchers, the equipment which are included in the grant aid can be fully utilized.

Although the facilities included in this Project are primarily to strengthen the functions of KEFRI, the Kenya/Japan Social Forestry Training Project will also benefit by having access to research results of KEFRI as well as use of the conference rooms and some of the equipment provided under this Project.

3-2-5 Basic Principles of Implementation of the Cooperation

As a result of the above-mentioned examination, the expected effects and the feasibility of the project, as well as the Kenyan side's ability to implement this type of project, have been confirmed. In addition, the expected effects of this project have been found to be in line with the objective of the Government of Japan's grant aid system. For these reasons, it is judged to be reasonable and appropriate to implement this project under the Government of Japan's grant aid.

Therefore, the outline of the project will be examined and then the basic design for the project will be executed. As stated in the preceding process of examining the requested facilities and equipment, however, part of the Government of Kenya's request has been modified.

3-3 Outline of the Project

3-3-1 Project Management System

(1) Project Implementing Organization

Under the jurisdiction of the Ministry of Research, Technical Training and Technology (MRTTT), KEFRI will be the organization to implement this project. MRTTT exercises control over not only KEFRI but also all the other research organizations active in the field of forestry. Other research organizations equal in status to KEFRI include the Agricultural Research Institute, the Industrial Research Institute and the Medical Research Institute. KEFRI has a total of 20 centres operating in various parts of the country under the supervision of its headquarters, which are grouped into national centres, regional centres and sub-centres.

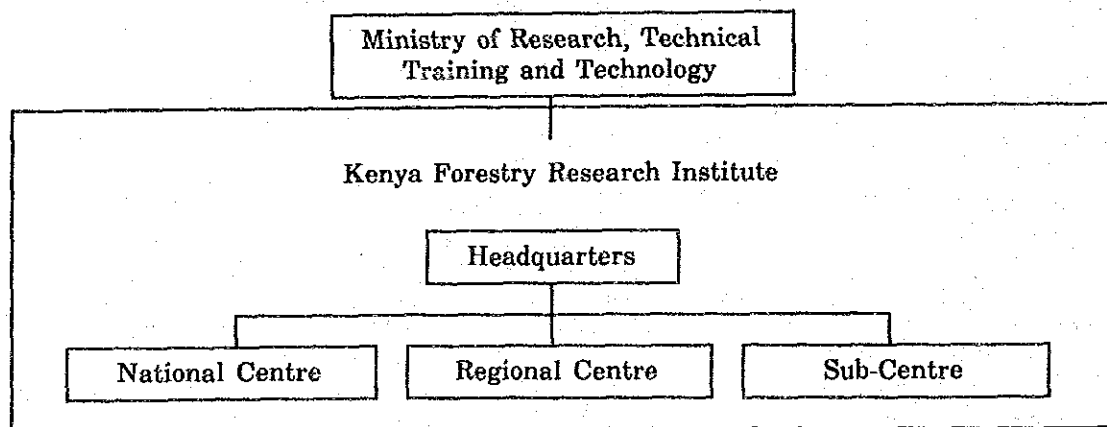


Fig. 3-3 Implementing Organization

(2) Project Management System

The implementation of this project will not entail any change in the organization or the personnel plan of KEFRI. At Muguga Centre, this project is aimed at integrating its research facilities and therefore there will be no change in its personnel organization. At Kitui Centre, the existing staff is to operate and manage the projected research

facilities and therefore there will be no need to recruit additional researchers. Figure 3-4 illustrates the operation and management organization of Muguga Centre during and after the implementation of this project.

Muguga Centre has a staff of about 1,441, which is divided into a full-time staff of 79 researchers, 13 office managers, 70 research engineers and about 213 office workers and a part-time staff of 1,010 assistants.

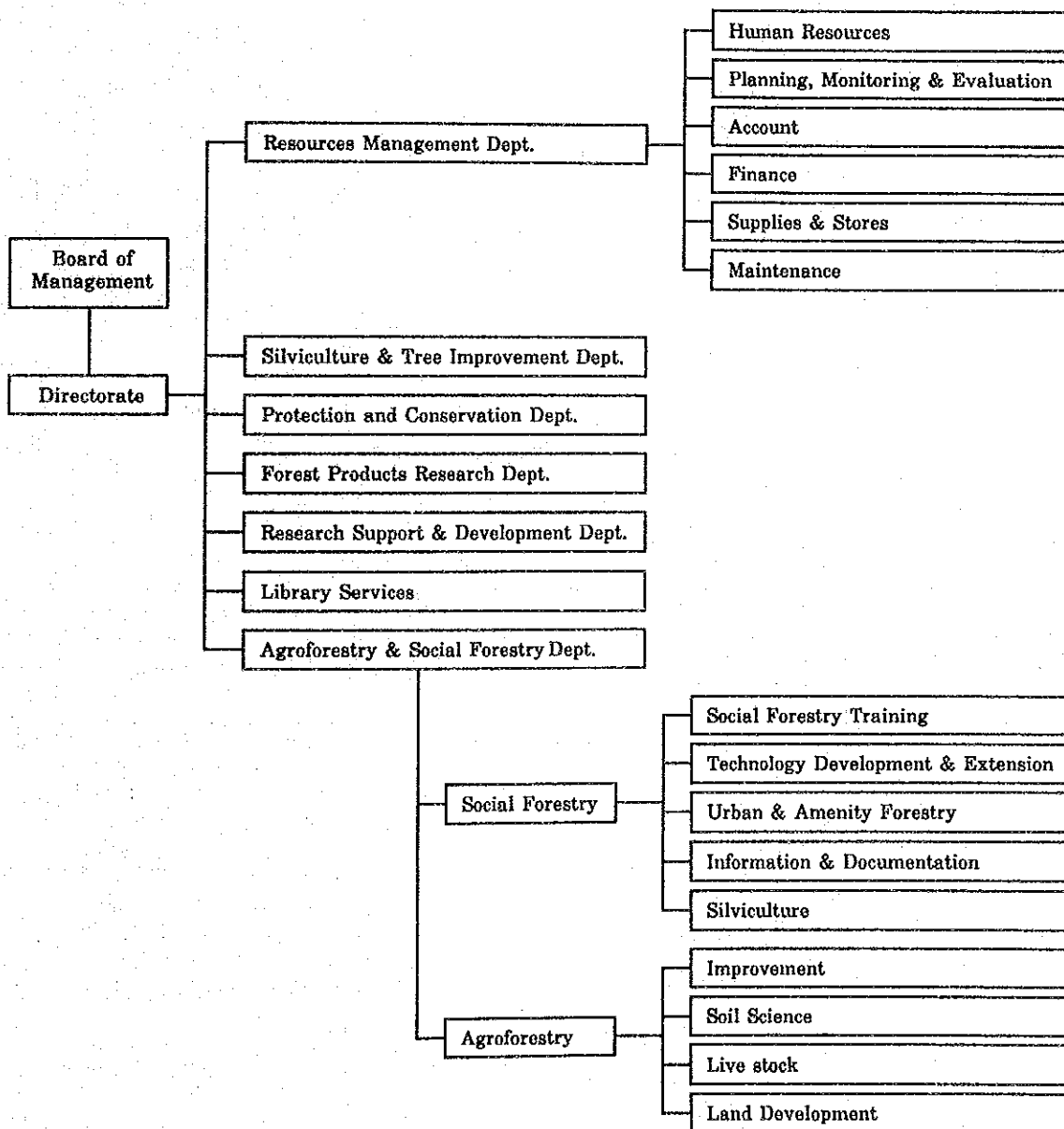


Fig. 3-4 Muguga Centre Organization Chart

3-3-2 Service Plan

KEFRI's Muguga headquarters and other centres located in various parts of the country are jointly carrying out operations in the fields of forestry research, training and extension, pilot forest plantation and information services. The implementation of this project is expected to enhance the quality of Muguga Centre's operations in the fields of research, training and extension and information services, as well as of Kitui Centre's operations in the field of research. More specifically, the quality of the following operations carried out at Muguga Centre and Kitui Centre is expected to be enhanced as a result of the implementation of this project.

(1) Muguga Centre

1) Research

The following operations are to be carried out in those fields of research which are to be integrated under this project.

Table 3-3 Fields of Research at Muguga Centre

Field of Research	Activity
1. Agroforestry	Research on the nitrogen circulation system which is affected by mixed cultivation; eg. planting leguminous trees along with food crops and fodder crops
2. Biotechnology	Research on the chemical and physical properties of root nodule bacteria which live symbiotically with leguminous plants and tropical soil, classification of root nodule bacteria, and research on relationship between leguminous plants and root nodule bacteria
3. Soil Science	Research on the chemical and physical properties of root nodule bacteria which live symbiotically with leguminous plants growing in the African continent and tropical soil and research the relationship between useful leguminous plants from Australia and root nodule bacteria
4. Forest Entomology	Research on the relationships between plant communities which exist in complex patterns in the ecosystem, environmental factors (light, water, temperature, soil), consumers (animals), decomposers (bacteria), and insect communities on trees and seedlings
5. Forest Pathology	Research on the mutual relationship between plant and insect communities which comprise the ecosystem, with particular reference to environmental factors, the causes of tree diseases, and their classification and analysis
6. Tree Breeding	Research on substances which comprise cytoplasts of tropical trees conducted for the purpose of utilizing the results in tissue culture, and development of effective seedling propagation methods

Field of Research	Activity
7. Non-timber Products	Analysis and utilization of useful herbs and seeds growing in cryptogamic plant and phanogamous plant communities
8. Ecology	Research on the effects of the growth of plants on environmental factors (light, water, temperature, soil) and production composition, competition between species, and distribution of plant communities
9. Physiology	Research on effect of environmental factors (light, water, temperature, soil) on transformation of physiological functions of tropical trees and seedlings
10. Plantation Silviculture	Research on the effects of the growth of leguminous plants and trees growing in economic forests, development of exotic and indigenous forest plantation
11. Dryland Silviculture	Research on the effects of the growth of leguminous plants in the semi-arid areas which have harsh environmental factors (light, water, temperature, soil), screening tree species for arid area
12. Forest Mensuration	Measurement of the volume of trees which comprise forest groups, research of future changes in stand volume, more specifically, the effects of volume in useful economic forests on environmental factors
13. socio-economics	Research aiming at developing forests in close collaboration of community residents, rather producing forests for the sake of forest management. Research in this field is sometimes conducted with emphasis on its relationship with agroforestry. Market surveys of urban areas are conducted to produce useful farm products which generate cash incomes and develop methods of grassroots forest development
14. Social Forestry	This programme consists of two parts (information/training and research), both of which are important in carrying out comprehensive forestry research and training activities. In the area of information/training, collection and management of the information related to the extension of social forestry and experimental extension activities of the social forestry are carried out. In the area of research, research on efficient training activities are carried out on the basis of the research in socio-economics.
15. Tree Seed Technology	Research on the germination of useful species' seeds (conducted in Nderi)
16. Wood Preservation	Research on the preservation of wood (conducted in Nairobi City)

2) Training and Extension

As a result of the procurement of a multipurpose hall and other lecture rooms under this project, it will become possible for KEFRI to organize its projected conferences and training courses concerning training and extension of social forestry (200 days, 4,000 participants a year). The multipurpose hall will be used also as an exhibition hall. Exhibitions aimed at promoting the extension of social forestry among community residents will be held there.

3) Information Services

Information concerning social forestry will be collected, prepared, put in order and managed. On the basis of such information, training

materials for use in training and extension and documents on the results of KEFRI's research work will be printed and distributed.

(2) Kitui Centre

At Kitui Centre, mainly development and extension of social forestry technology through pilot forest scheme and social forest training is carried out at this moment. Kitui Centre is to start research work and thereby become a comprehensive forestry research centre in the semi-arid area of the country after the implementation of this project. The fields of research activity to be started at the centre are as shown in the following table.

Table 3-4 Outline of Research Activities Carried Out at Kitui Centre

Field of research	Research activities
1. Social Forestry	<ul style="list-style-type: none"> • Basic regional economic research necessary for the growth of social forestry in the semi-arid area • Research on methods of promotion and practice of social forestry
2. Semi-dryland Silviculture	<ul style="list-style-type: none"> • Research on the effects of environmental factors on the growth of leguminous plants in semi-arid areas
3. Soil	<ul style="list-style-type: none"> • Research on the chemical and physical properties of root nodule bacteria which live symbiotically with leguminous plants, as well as of tropical soil (with emphasis on the effects of the environmental factors (light, water, temperature) on the physical and chemical properties of soil in tropical semi-arid areas)

3-3-3 Project Sites

The project sites are located on the premises of Muguga Centre and Kitui Centre. There are some facilities which were constructed under phase 1 of Japan's grant in 1985 and '86 at both Muguga and Kitui Centres. Shown in table 3-5 are the facilities at both Centres.

Table 3-5 The Facilities Constructed Under Japan's Grant Phase 1

Centre	Facilities	Area (m ²)
Muguga centre	1. Training facilities	1,085
	2. Dormitories	1,081
	3. Research facilities	2,028
	4. Nursery facilities	504
Kitui centre	1. Training facilities	1,165
	2. Dormitories	934
	3. Nursery facilities	575
Total		7,372

(1) Muguga Centre

1) Location

The project site is located about 2km west of a point which is about 25km northwest of the centre of Nairobi City on Route 104 (about a 30 minutes' car ride). Near the project site are the Agricultural Research Institute, a district forest office of the Forest Department, and experimental farms and forests. Administratively it belongs to Kiambu District, Central Province. It is free from legal restrictions on the use of buildings.

2) Present state of the project site

A place near the main entrance of Muguga Centre, which faces the existing administration and research blocks across an inner road, will be chosen as the proposed construction site. Most of the site is an open space, although part of the site is occupied by a temporary office used as a site office of the contractors during the first phase of the grant aid project. The road slopes gently westward. The difference of altitude is about 5 meters in the site, the mean incline being about 1/8.

3) Infrastructure

① Electricity

- Existing power supply

Electricity is supplied by a 11,000V high-tension service wire from the eastern side of the project site. The high voltage is reduced to 415 V with a 500kVA transformer installed in the substation. Muguga Centre is equipped with a generator but not a voltage stabilizer.

- Present condition of power supply

Power supply condition in and around the project site is not so good. Power stoppages last long, and the voltage fluctuates widely.

② Telephone

At present 9 lines and 85 extensions are used.

③ Water supply

- Source

At Muguga Centre, water is supplied from a deep tube well located about 1km north of the project site, which was constructed in 1979.

- Quantity of water pumped up from the well

The quantity of water pumped up from the well is about 22.8m³/h. However, the pump and the pipe are superannuated, which makes it difficult to maintain the well.

④ Drainage

- General waste water

General waste water is discharged into the ground after being treated in the septic tank.

- Waste water from laboratories

Waste water from laboratories is discharged into the ground after being neutralized.

- Rainwater

Rainwater is discharged through culverts.

(2) Kitui Centre

1) Location

Kitui Centre is located about 2km north of Kitui Town, which is located about 180km east of the centre of Nairobi City. It is about three hours' car ride from Nairobi City. Administratively the centre belongs to Kitui City, Kitui District, Eastern Province. The project site, which borders on the Kalundu River, is surrounded by arable land and shrubberies. It is about 1,100 meters above sea level. It belongs to the semi-arid area.

2) Present state of the project site

The project site is northern side of the existing training block, a space near the nursery. The ground is plain and has a lawn.

3) Infrastructure

① Electricity

- Existing power supply

The 11,000V high-tension service wire from the eastern side of the project site is changed into a 415V power line by a 315kVA transformer mounted on the utility pole. The Centre is not equipped with a generator or a voltage stabilizer.

- Present state of power supply

As is the case with Muguga Centre, Kitui Centre is suffering from wide fluctuations in voltage and frequent power failures.

② Telephone

At present, 4 lines and 11 extensions are used.

③ Water supply

- Source

Water for use at its general facilities is supplied from two deep tube wells. Water for the tree nursery is supplied from a shallow well constructed under the first phase of the grant aid.

- Quantity of water pumped up from the wells

One of the two existing deep tube wells (Well No. 1: quantity of water pumped up: 0.4 to 0.8 m³/hour) is not in use because of the breakdown of the pump. The other well has a small pumping capacity of 1 m³/hour. Constructed in November 1992, it has not yet been used during the dry season, and therefore it is not clear whether or not it will be able to meet the demand during the dry season. The shallow well supplying water to the tree nursery

takes water from the Kalundu River running near the project site. It can supply a sufficient quantity of water during the 4-month rainy season. During the dry season, however, its water supplying capacity declines sharply because the river dries up. For this reason, Kitui Centre purchases water from the Kitui Town's water taking station which is 8km away from the Centre.

④ Drainage

● General waste water

General waste water is discharged into the ground after being treated in the septic tank.

● Rainwater

Rainwater is discharged directly into the Kalundu River through culverts.

3-3-4 Outline of the Facilities and Equipment

It is judged to be appropriate to procure the following facilities and equipment under this project in order to make it possible for the research institute to carry out its projected services.

(1) Facility Plan

Centre	Department	Main facilities	Floor area (m ²)
Muguga Centre	Research Building	Laboratories (11), Analyzing room, Researcher's office	2,308
	Information Centre	Multipurpose hall, Lecture rooms, Library, Printing room, Data room, Clinic room, Offices	2,547
	Incidental facilities	Greenhouse, Special chemical storage, etc.	581
	Repair of existing facilities	Dining hall, Library, Nursery training facility	(579)
Kitui Centre	Research block	Social forestry lab., Semi-dryland Silviculture lab., Soil Science lab., Library, Researcher's rooms, Chemical Store	864
	Incidental facilities	Seed storage, Greenhouse, etc.	207
	Repair of existing facilities	2nd floor of the existing building	(311)
Total		New facilities 6,507 m ² Repair of existing facilities 890 m ²	

A deep tube well is to be constructed at Kitui Centre to ensure sufficient water supply.

(2) Equipment Plan

Given below is the outline of the equipment to be supplied under this project.

1) Analytical and experimental equipment

Atomic absorption spectrophotometer, Gas chromatograph, N/C analyzer, Gel electrophoresis apparatus, Centrifuge, Growth cabinet, Plant canopy analyzer, Pressure bomb, Realascope hupsometer, Ice cuber

2) Training and information equipment

Audio system, Overhead projector, Slide film projector, Video camera system, Electric typewriter

3) Vehicles

Pickup truck, Bus, Water tank truck

4) Equipment for maintenance and repair

Work bench, Logic analyzer, Oscilloscope, Drawing machine, Tool set for electrical work

3-3-5 Maintenance and Operation Plan

(1) Maintenance and Operation of the Facilities and Equipment

It is desirable to establish a viable maintenance and operation system paying close attention to the following in order that the procured facilities and equipment may work properly.

1. To establish a facility/equipment maintenance and operation system and improve the facility/equipment maintenance and operation techniques based on the operations carried out by the maintenance department and the supplies and stores department of KEFRI.

2. to make sufficient budgetary appropriations for facility/equipment maintenance and operation. To replenish and manage expendable supplies and spare parts in a manner that ensures uninterrupted operation of the facilities and equipment.
3. To establish an equipment repair system and define the method of communications jointly with manufacturers in order to ensure quick repairs.

(2) Facility Maintenance and Operation Plan

In principle, the maintenance department is responsible for the maintenance and operation of Muguga Centre's facilities. Maintenance of the facilities should be conducted in accordance with the following guidelines.

Part of facility	Item	Points to note	Intervals
Roofs	Leak	The cause of the leak is investigated and the results of the investigation are notified to the contractor.	Any time
	Roofing tiles	Strong winds will make some roofing tiles slip out of place. Steps should be taken to prevent such roofing tiles from falling down.	Any time
	Gutters	Gutters should be inspected for cracks in joints caused by dead leaves and dust.	6 months
Exterior walls	Surfaces of exterior walls	Surfaces of the exterior walls should be inspected for cracks in joints.	1 year
	Metal parts	Repairs by the use of paints and rust-inhibitor	1 year
Interior finishing	Floors	Floors should be inspected for cracks.	1 year
	Interior walls	Interior walls should be repaired by the use of paints every 5 years.	1 year
	Ceilings	Ceilings should be inspected for deflections and stains.	1 year
Fittings	Doors	Doors should be inspected for loosening of locks, knobs and hinges, and for detachment of paints.	1 year
	Windows	Windows should be inspected for difficulty in opening and closing, loosening of locks and leaks.	1 year
Equipment	Deep pipe wells	The pumps, the wall of the well and so on should be inspected.	6 months
	Water tanks	Water tanks should be inspected for stains and alien substances.	3 months
	Drainpipes and manholes	Drainpipes and manholes should be inspected for clogging.	3 years
	Transformers	The tap switch of the transformer should be inspected.	1 year

(3) Equipment Maintenance and Operation Plan

1) Operations Carried Out under Equipment Maintenance and Management Plan

The following operations are generally carried out under a standard equipment maintenance and management plan.

① Cleaning

Equipment which is used with chemicals, organic substances, metals or soil should be cleaned carefully each time it is used.

② Lubrication

The movable portions of equipment which works under power should be supplied with a lubricant or grease in accordance with the instruction manuals.

③ Replacement of expendables

Backup batteries, lamps and other expendable should be replaced in accordance with the instruction manual or the machine's alarm.

④ Inspection

Equipment provided with a thermostat, balances, weighing machines and the like should be inspected periodically.

⑤ Confirmation of safety

Safety of autoclaves and vehicles should be confirmed each time they are used. In addition, their safety should be confirmed periodically.

2) Methods of periodical inspection and maintenance

Periodical inspection and maintenance of the equipment can be conducted by the centre's staff members in charge or outside inspection/maintenance experts.

① Inspection and maintenance by operators

The inspection/maintenance manuals should be available to the operators of the equipment so that they may inspect and maintain the equipment in accordance with them.

② Inspection and maintenance by the Centre's staff members in charge

The centre's staff members in charge can easily inspect and maintain some electric machines and machine parts in accordance with the instruction manuals.

③ Inspection by outside inspection/maintenance Experts

Equipment can be inspected and maintained by its manufacturers' or its distributors' inspection/maintenance engineers.

④ Maintenance contract

In the case of photo copiers, typewriters, personal computers and other items, maintenance contracts should be concluded with their distributors under which the distributors shall offer proper after-sales services.

(4) Operating Costs

KEFRI's operating costs are defrayed out of the National Treasury. Since the implementation of this project involves no increase in the personnel of KEFRI, there is no need to increase the personnel expenses. However, there will be an increase in the operating costs to cover the newly procured facilities and equipment. Table 3-6 shows a breakdown of the estimated increase in the operating costs.

Table 3-6 Increase in the Operating Cost

Item	Operating cost	
	Muguga Centre	Kitui Centre
1. Facility operating costs		
① Electricity charges	352,000	88,000
② Telephone charges	64,000	12,000
③ Fuel expenses	187,000	93,000
④ LP gas	18,000	2,000
2. Facility maintenance costs		
① Facility maintenance expenses	194,000	34,000
② Equipment maintenance expenses	97,000	17,000
③ Material maintenance expenses	576,000	144,000
Total	1,488,000 Kshs	390,000 Kshs
Grand Total	÷ 1,880,000 Kshs	

It is expected that KEFRI will be able to earn some income through the sale of nursery trees. However, such income has to be returned to the National Treasury instead of being incorporated into KEFRI's operating budget.

1) Facility Operation and Management Costs

① Electricity Charges

1. Muguga Centre

$$\begin{aligned} 400\text{kW} \times 0.2 \times 8\text{h/day} \times 250\text{day/year} &= 160,000 \text{ KWH/year} \\ 160,000\text{KWH/year} \times 2.2\text{Kshs/KWH} &= 352,000 \text{ Kshs/year} \end{aligned}$$

2. Kitui Centre

$$\begin{aligned} 100\text{kW} \times 0.2 \times 8\text{h/day} \times 250\text{day/year} &= 40,000 \text{ KWH/year} \\ 40,000\text{KWH/year} \times 2.2\text{Kshs/KWH} &= 88,000 \text{ KWH/year} \end{aligned}$$

② Telephone Charges

1. Muguga Centre

Researchers

$$\begin{aligned} 69\text{person} \times 0.5 \times 3\text{min/time} \times 1\text{time/day} \times 250\text{day/year} &= 25,875 \text{ min/year} \\ 25,875\text{min/year} \times 2.5\text{Kshs/min} &= 64,687.5 \rightarrow 64,000 \text{ Kshs/year} \end{aligned}$$

2. Kitui Centre

Researchers

$$\begin{aligned} 13\text{person} \times 0.5 \times 3\text{min/time} \times 1\text{time/day} \times 250\text{day/year} &= 4,875 \text{ min/year} \\ 4,875\text{min/year} \times 2.5\text{Kshs/min} &= 12,187.5 \rightarrow 12,000 \text{ Kshs/year} \end{aligned}$$

③ Fuel cost for generator

Assumed operation time: 30min/day

1. Muguga Centre

$$\begin{aligned} 300\text{kVA} \times 1.2\text{PS/kVA} \times 0.165\text{kg/PS} \cdot \text{h} \times 1/0.87\text{kg/}\ell &\doteq 68 \text{ }\ell/\text{h} \\ 68\ell/\text{h} \times 0.5\text{h/day} \times 250\text{day/year} &= 8,500 \text{ }\ell/\text{year} \\ 8,500\ell \times 22\text{Kshs/}\ell &= 187,000 \text{ Kshs/year} \end{aligned}$$

2. Kitui Centre

$$\begin{aligned} 150\text{kVA} \times 1.2\text{PS/kVA} \times 0.165\text{kg/PS} \cdot \text{h} \times 1/0.87\text{kg/}\ell &\doteq 34 \text{ }\ell/\text{h} \\ 34\ell/\text{h} \times 0.5\text{h/day} \times 250\text{day/year} &= 4,250 \text{ }\ell/\text{year} \\ 4,250\ell/\text{h} \times 22\text{Kshs/year} &= 93,000 \text{ Kshs/year} \end{aligned}$$

④ LPG Cost

1. Muguga Centre

$51\text{Nos} \times 1,200\text{kcal/h} \cdot \text{Nos} \times 1/12,000\text{kcal/kg} \times 0.2 \times 2\text{h/day} \times 250\text{day/year}$

= 510 kg/year

$510\text{kg/year} \times 35.4\text{Kshs/kg} = 18,054 \rightarrow 18,000 \text{ Kshs/year}$

2. Kitui Centre

$7\text{Nos} \times 1,200\text{kcal/h} \cdot \text{Nos} \times 1/12,000\text{kcal/kg} \times 0.2 \times 2\text{h/day} \times 250\text{day/year}$

= 70 kg/year

$70\text{kg/year} \times 35.4\text{Kshs/kg} = 2,478 \rightarrow 2,000 \text{ Kshs/year}$

2) Maintenance costs

① Building maintenance costs

Assumed average maintenance cost of the new facilities for the next 20 years: 40Kshs/m²·year.

1. Muguga Centre

$4,855\text{m}^2 \times 40\text{Kshs/m}^2 = 194,200 \rightarrow 194,000 \text{ Kshs}$

2. Kitui Centre

$864\text{m}^2 \times 40\text{Kshs/m}^2 = 34,560 \rightarrow 34,000 \text{ Kshs}$

② Facility maintenance costs (Generator, Lamps, Pumps, Ventilation Fans, Pipings etc.)

Assumed average maintenance cost of the new facilities for the next 20 years: 20Kshs/m²

1. Muguga Centre

$4,855\text{m}^2 \times 20\text{Kshs/m}^2 = 97,100 \rightarrow 97,000 \text{ Kshs}$

2. Kitui Centre

$864\text{m}^2 \times 20\text{Kshs/m}^2 = 17,280 \rightarrow 17,000 \text{ Kshs}$

③ Equipment maintenance costs

Spare parts and expendables shall be counted.

1. Muguga Centre

576,000 Kshs

2. Kitui Centre

144,000 Kshs

CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Design Policies

The following design policies were developed taking into consideration the natural and social conditions in Kenya, as well as the actual situation of the local construction industry in working out the facility and equipment plans.

(1) Design Policies Set in Light of the Natural Conditions

At Muguga Centre, the annual average temperature is 13°C to 17°C, the annual average humidity is 60% to 78%, the annual average rainfall is 970mm, and at Kitui Centre, 18°C to 22°C, 63% to 74%, and 1030mm, respectively. The climatic conditions are favorable at both centres. At both centres the angle of solar radiation is high because both of them are located almost right on the equator.

The following design policies are set taking into account the above-mentioned natural conditions.

1. Room temperature should be controlled by natural ventilation. Therefore, no rooms should be equipped with an air conditioner.
2. In principle, the buildings should lie on an east to west axis. Deep eaves and hanging balconies should be attached to the exterior walls of the rooms facing the east or the west.
3. The ceiling of the uppermost floor should be highly resistant to heat so that the temperature in the rooms on the floor may not rise due to direct sunlight.

(2) Design Policies Set in Light of the Actual Situation of the Local Construction Industry

In Kenya, particularly in and around Nairobi City, the construction industry is well developed. General construction machines can easily be procured. On the other hand, however, the supply of building materials is unstable, and there is a shortage of skilled construction workers. In recent years, the construction cost has risen remarkably -- more specifically, at an annual rate of more than 40 percent. The following design policies are set in light of the above-mentioned situation of the local construction industry.

1. Priority should be given to the traditional methods of construction, which are widely used in the country.
2. Those locally available materials whose supply is stable should be used as much as possible, and at the same time the kinds of building materials should be minimized.
3. When building machines and materials procured from third countries are to be used, utmost emphasis should be placed on ease of maintenance and durability.

(3) Design Policies Set in Light of the Facility/Equipment Maintenance and Management Ability of the Implementing Organization of the Project

The Kenya Forestry Research Institute (KEFRI), which is the implementing organization of the project, is an independent public organization operating under the supervision of the Ministry of Research, Technical Training and Technology (MRTTT). KEFRI's maintenance department is responsible for the maintenance and operation of its facilities and equipment. Present conditions of facilities and equipment of KEFRI shows

that maintenance work has basically been carried out properly. However, it is essential to minimize the increase of maintenance cost upon the completion of this project in order to keep the same maintenance level. The architectural plan for this project should be worked out giving due consideration to the following points so that the financial burden imposed on KEFRI may be alleviated.

1. Natural ventilation and lighting should be made full use of in order to reduce the energy cost.
2. Materials which are highly durable and which are not easily soiled should be used. Also, those which can be repaired locally should be used.
3. Those pieces of equipment which can be maintained and managed locally should be selected as much as possible.

(4) Design Policies Set on the Scope and Grade of the Planned Facilities and Equipment

This project is to be implemented as the second phase of a grant aid project launched in 1988. Many of the projected facilities, such as the lecture rooms and the laboratories, are similar in function to those procured in the first phase of the project. The following policies on the scope and grade of the projected facilities and equipment are set in light of the present situation of the facilities procured in the first phase of the project.

1. The government of Kenya's request covers four districts. In consideration of the possible increase in the financial burden on

KEFRI, however, only Muguga and Kitui Centres should be included in this scope of the project.

2. The work to repair the facilities and equipment in the existing facilities should be included in this project so that the facilities of the Muguga Centre and Kitui Centre may be made effective use of.
3. The grade of the projected facilities and equipment should be the same as in the first phase of the project. However, the facilities and equipment similar to those which were procured in the first phase and which have already become defective should be upgraded and the methods of constructing or installing them should be improved.

(5) Policies on the Construction/Equipment Work Schedule

The project sites are located on the premises of the existing facilities. This means that they are favorably located in terms of access to the site and crime prevention. Muguga Centre where most of the construction work under this project will be carried out is located near Nairobi City, the capital of the country. This will greatly facilitate the procurement of construction machines and materials, as well as customs clearance and inland transportation of imported materials. Customs clearance of imported machines and materials will proceed smoothly after the tax exemption measures for the construction work under the project are approved by the Ministry of Finance.

The basic policies on the work schedule set in light of these factors are as follows.

1. The entire schedule (the construction and equipment procurement, installation work) should not be divided into phases. The duration of planned schedule is 12 months.

2. Most of the buildings should be two stories and the standard construction methods in Kenya should be applicable.

4-2 Examination of the Basic Design Conditions

In working out the basic design, the following items should be examined as the design conditions.

(1) Composition of Facilities

The project is to be composed of the following facilities.

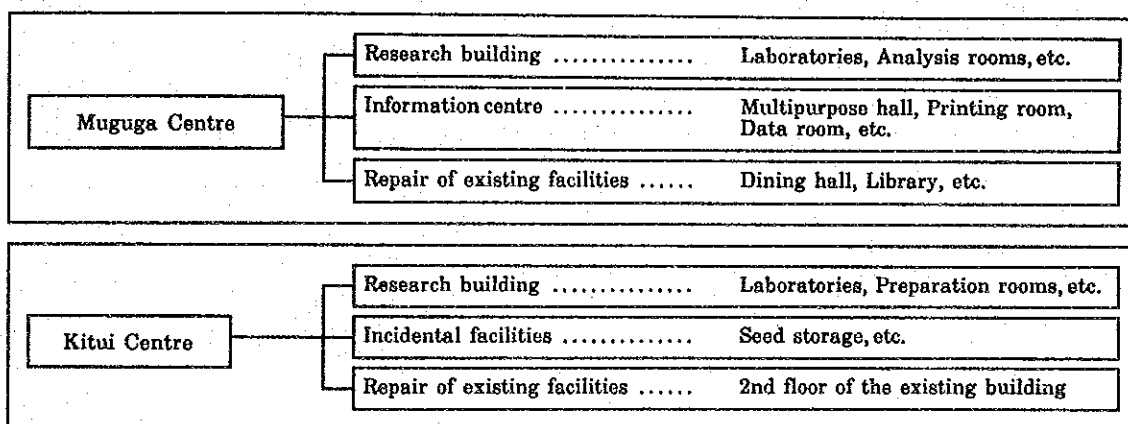


Fig. 4-1 Facility Composition

(2) Conditions for Determination of the Scale of the Projected Facilities

The scale of each facility should be determined on the basis of the function(s) required and the number of staff members and with reference to the scale of similar facilities in the country as well as the facilities procured in the first phase of the project. The conditions for the determination of the scale of each room are as shown in table 4-1.

Table 4-1 Conditions for Determination of the Scale of the Projected Facilities

Room	Determined scale	Criteria
Laboratory	The central laboratory tables should be arranged at intervals of 3.0 meters, and the length of each laboratory should be calculated by multiplying 3.0 meters by the number of laboratory tables.	Equipment arrangement plan
Multi-purpose hall	It is assumed that lectures will be given to an audience, each of whom is sitting on a movable chair and that the maximum number of chairs is 150. $150 \text{ persons} \times 1.0 \sim 2.0 \text{ m}^2/\text{person} \div 200 \text{ m}^2$	
Lecture room	Each training room is planned as a conference room with a setting capacity of 15. $15 \text{ persons} \times 2.4 \text{ m}^2/\text{persons} \div 36 \text{ m}^2$	Existing training rooms
Office	Chief/Sen. Officer : 12~16m ² /person Officer : 8.5~10m ² /person Office worker : 4.0~6m ² /person	Existing offices
Library	15,000 books (it is assumed that the number of persons using the library at a time is 15)	

Note: In determining the anthropometric dimension and the working dimension, the following documents were referred to

- ⊙ [Architectural Graphic Standards] - The American Institute of Architects (AIA) -
- ⊙ [Time - Saver Standards for Architectural Design Data] - McGraw-Hill Book Company -
- ⊙ [Architectural Data Book]
- ⊙ National Plumbing Code

(3) Applicable Laws and Standards

The following laws and standards are applicable to the basic design for this project.

- 1) Architectural Plan : ● Building Code
- 2) Structural Plan : ● Code of Practice for the Design and Construction of Building and Other Structures in relation to Earthquakes
 - BS CP 110, Reinforced Concrete Structural Plan Standards
 - BS, CP 3 Wind Load
 - Reinforced Concrete Calculation Standards (Japan)

- 3) Electrical Plan : • BS
 - Technical Instruction -- MOW
- 4) Mechanical Plan : • Drainage Standards
 - (Civil engineering section - MOW)
- 5) Other : • General Specification for Building Works
 - Standard Method of Measurement of Building Works

(4) Other Basic Design Conditions to Note

- Measures against termites:

It is necessary to take measures against termites. Wooden part of roof structures, in particular, are likely to be greatly damaged by termites, causing leaks.

- Measures against lightning:

It is necessary to take sufficient measures against lightning because it thunders often in the areas surrounding the project sites.

- Measures against earthquakes:

It is necessary to work out the basic design of Muguga Centre's facilities taking into consideration the seismic force specified by the Ministry of Public Works of Kenya.

- Measures against voltage fluctuations:

In and around the project sites, the voltage fluctuates widely (+20%). Computers and other items of precision equipment should be provided with a device to protect against voltage fluctuations. The Substation should also be equipped with AVR.

- Measures against black cotton soil (the kind of soil which is peculiar to Africa and which has a high rate of expansion):

When black cotton soil is found on the project sites, it must all be removed and after that the quality of the ground must be improved in accordance with the instructions of the Ministry of Public Works of Kenya.

4-3 Basic Design

4-3-1 Architectural Planning

(1) Site and Layout Plans

1) Muguga Centre

The site for the main buildings to be built on the premises of Muguga Centre under this project is a lot situated on the western side of the existing facilities, with a road running south to north in between. The information centre is to be located near the existing operation and management zone. Since this building is to be used for promotion and public relations activities targeted at the general public, as well as for lectures, conferences and meetings of the staff members, trainees and experts, its main entrance should be easy to find and located close to the road for easy access. The new research building is to be located on the western side of the existing research building. There should be a roofed passage between the two buildings to facilitate traffic between the two buildings. Figure 4-2 shows the positional relationship between the projected facilities and the existing facilities.

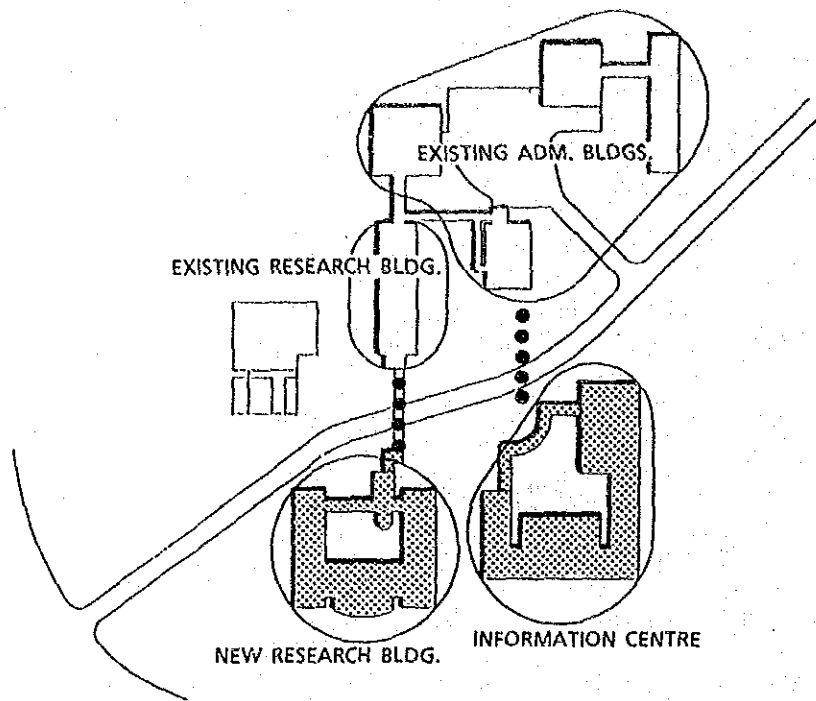


Fig. 4-2 Zoning Plan

2) Kitui Centre

At Kitui Centre, the site for the new research building is to be located on the northern side of the existing training building. There should be a roofed passage between the new research building and the existing training building to facilitate traffic between the new research building and the administration department of the existing building.

(2) Architectural Planning

1) Determination of the Scale of the Facilities

The scale of the laboratories, the analysis rooms and the printing room should be determined on the basis of the equipment arrangement plan, and that of the multipurpose hall, the conference rooms (to serve also as lecture rooms) and the offices should be determined mainly on the basis of the number of persons to occupy them.

Table 4-2 shows the determined scale of each room and the conditions for the determination of the scale.

Table 4-2 Planned Area of the Facilities

Muguga Centre

Room name	Nos.	Area (m ²)	Remarks
Information Centre			
Information dept.			
Information officer's rm	1	18.00	According to work and meeting space requirements
D. Information officer's rm	1	16.00	According to work and meeting space requirements
Secretarial rm	1	18.00	According to work and waiting space requirements
Office	1	36.00	According to work and meeting space requirements for 5 workers
Archives office & store	1	54.00	According to work space for 2 workers and storage space requirements
Data dept.			
Data rm	1	54.00	According to work space for 1 officer, layout of 8 computers and data storage requirements
Clinical dept.			
Clinic	1	36.00	According to treatment and work space requirements
Waiting rm	1	15.00	According to work and waiting space requirements
Bed rm	2	24.00	According to equipment layout
Public relation dept.			
Printing rm	1	51.00	According to work space requirements for 5 workers and equipment layout
Drawing and illustration rm	1	36.00	According to work space requirements for 3 workers and equipment layout
AV rm	1	36.00	According to equipment layout
Store	1	18.00	To store printing material and printed matters
Library dept.			
Library	1	168.00	15,000 books and 10 reading tables
Library office	1	36.00	According to the requirements of 5 workers' working space and storing books
Hall dept.			
Multi-purpose hall	1	216.00	Space requirements for 150 people's conference
Lobby/Exhibition rm/reception	1	135.00	According to the layout of permanent exhibits and others
Store for the hall	1	54.00	According to storage requirements for chairs, stages, etc.
Preparation rm	1	12.00	Preparation activities for conferences, exhibitions, etc.
Control rm/Store	1	65.00	According to equipment layout
Pantry	1	36.00	According to equipment layout
Security dept.			
Security office	1	17.00	According to work and meeting space requirements for 1 security officer

Room name	Nos.	Area (m ²)	Remarks
Administration dept. Office	1	51.00	According to work and meeting space requirements for 8 officer
Training dept. Lecturers' rm	1	36.00	According to work and preparation space requirements for 9 visiting lecturers
Meeting/Lecture rm	4	180.00	Meeting for 20 people
Training manager's rm	1	18.00	According to work and meeting space requirements
Secretarial rm	1	16.00	According to work and waiting space requirements
Training officers' rm	1	88.00	According to work and meeting space requirements for 8 officer
Experts' rm	1	54.00	According to work, storage and meeting space requirements for 3 officers
Centre management office	1	54.00	According to work and meeting space requirements for 7 officers
Janitors' rm	2	36.00	According to furniture layout
Store	2	53.00	
Corridor, staircase, lavatory, etc.		810.00	
Total		2,547.00	
Research building			
Tree breeding dept. Laboratory	1	63.00	According to equipment layout
Senior researcher's office	1	15.00	According to work and meeting space requirements
Staff office	1	27.00	According to work and meeting space requirements for 5 researchers
Soil science dept. Laboratory	1	63.00	According to equipment layout
Analyzing rm	1	42.00	According to equipment layout
Staff office	1	42.00	According to work and meeting space requirements for 4 researchers
Physiology dept. Laboratory	1	42.00	According to equipment layout
Staff office	1	21.00	According to work and meeting space requirements
Forest ecology dept. Laboratory	1	63.00	According to equipment layout
Senior researcher's office	1	15.00	According to work and meeting space requirements
Staff office	1	27.00	According to work and meeting space requirements for 4 researchers
Agroforestry dept. Laboratory	1	63.00	According to equipment layout
Analyzing rm	1	21.00	According to equipment layout
Senior researcher's office	1	15.00	According to work and meeting space requirements
Staff office	1	90.00	According to work and meeting space requirements for 14 researchers

Room name	Nos.	Area (m ²)	Remarks
Biotechnology dept.			
Laboratory	2	126.00	According to equipment layout
Analyzing rm	1	42.00	According to equipment layout
Staff office	1	42.00	According to work and meeting space requirements for 7 researchers
Entomology dept.			
Laboratory	1	63.00	According to equipment layout
Senior researcher's office	1	15.00	According to work and meeting space requirements
Staff office	1	27.00	According to work and meeting space requirements for 3 researchers
Forest pathology dept.			
Laboratory	2	126.00	According to equipment layout
Analyzing rm	1	42.00	According to equipment layout
Senior researcher's office	1	15.00	According to work and meeting space requirements
Staff office	1	27.00	According to work and meeting space requirements for 2 researchers
Common			
Common laboratory	1	63.00	According to equipment layout
Common analyzing rm	1	21.00	According to equipment layout
Fume chamber rm	1	21.00	According to equipment layout
Autoclave rm	1	63.00	According to equipment layout
Instrumentation dept.			
Instrumentation	1	42.00	According to equipment layout and work space requirements
Office	1	10.50	According to work and meeting space requirements
Store	1	10.50	According to equipment layout
Corridor, staircase, lavatory, etc.		943.00	
Total of research building		2,308.00	
Incidental facilities for research			
Greenhouse	8	340.00	Requirements from 8 research departments
Nursery house	1	60.00	For soil preparation requirements for the greenhouses
Special chemical storage	1	25.00	According to equipment layout
Neutralization facility	1	26.00	According to equipment layout
Other incidental facility (substation)	1	130.00	According to equipment layout
Total of incidental facilities		581.00	
Total	Main building	4,855.00	
	Incidental facilities	581.00	

Kitui Centre

Room name	Nos.	Area (m ²)	Remarks
Research building			
Soil science dept.			
Laboratory	1	45.50	According to equipment layout
Preparation/store	1	22.75	According to equipment layout
Researcher's office	1	22.75	According to work and meeting space requirements
Social forestry dept.			
Laboratory	1	45.50	According to equipment layout
Preparation/store	1	22.75	According to equipment layout
Researcher's office	1	22.75	According to work and meeting space requirements
Semi-dryland silviculture dept.			
Laboratory	1	45.50	According to equipment layout
Preparation/store	1	22.75	According to equipment layout
Researcher's office	1	22.75	According to work and meeting space requirements
Instrumentation			
Office	1	22.75	According to work and meeting space requirements
Common rooms in research			
Cold rm	1	22.75	According to equipment layout
Chemical store	1	22.75	According to equipment layout
Culture rm	1	22.75	According to equipment layout
Common rooms			
Conference rm	1	68.25	According to equipment layout
Meeting rm	1	22.75	According to equipment layout
Library	1	45.50	According to equipment layout
Store	1	22.75	According to storage space requirements
Corridor, staircase, lavatory, etc.		340.75	
Total of research building		864.00	
Incidental facilities for research			
Greenhouse	2	85.00	Requirements from 2 research departments
Neutralization facility	1	26.00	According to equipment layout
Seed storage	1	24.00	According to equipment layout
Other incidental facility (Substation)	1	72.00	According to equipment layout
Total of incidental facilities		207.00	
Total	Main building	864.00	
	Incidental Facilities	207.00	

Total floor area

Room name	Nos.	Area (m ²)	Remarks
Main buildings			
Muguga Centre	2	4,855.00	Research building, Information centre
Kitui Centre	1	864.00	Research building
Total		5,719.00	
Incidental facilities			
Muguga Centre		581.00	Greenhouses (8), Special chemical storage, etc.
Kitui Centre		207.00	Greenhouses (2), Seed storage, etc.
Total		788.00	
Remodeling of the existing facilities			
Muguga Centre		579.00	Dining Hall, Library, Offices
Kitui Centre		311.00	Training offices, Library, Lecture rooms
Total		890.00	

2) Floor Planning

① Muguga Centre

● Research Building

In consideration of the importance of the new research building's functional consistency with the existing one, the new research building is to be located opposite to the existing research building across the road, the two buildings being connected with a roofed passage. The laboratories and the analyzing rooms are to be located adjacent to the researcher's rooms and arranged on an east to west axis.

In working out the basic design for this project, the 17 fields of research were collected into three main clusters -- biochemistry, ecology and social science -- and in accordance with this arrangement,

these fields of research were allocated to the new research block and the existing research block.

- Information Centre

In this building, the multipurpose hall which can be used for conferences, exhibitions and special events, the meeting/lecture rooms, the library, the data room, the printing room, the medical office and the general offices are arranged around the courtyard so that the courtyard may serve as a place of relaxation for the participants in conferences and special events. This arrangement will provide a comfortable environment not only to the centre's staff members but also to the participants in annual conferences and special events and other visitors to Muguga Centre.

- ② Kitui Centre

- Research Building

The soil science laboratory, the social forestry laboratory, the semi-dryland silviculture laboratory, the researcher's rooms, the library, etc. are arranged on an east to west axis so that research activities at the Kitui Centre may be carried out smoothly.

3) Elevation planning

The materials of the exterior walls and roofs of the new facilities should be the same as those of the existing facilities. The elevation, coupled with the section, should be one that makes the new facilities look harmonious with the existing facilities.

4) Section planning

In working out the section, due consideration should be given to natural ventilation and lighting as well as protection against direct sunlight and rainwater. The story height should basically be the same as in the case of the existing facilities so that the new facilities look harmonious with the existing ones. Namely, it should be one-fifth of a meter from the ground to the first floor and 3.5 meters for the first and second stories. In the case of the new research block at Muguga Centre, however, the story height should be 4 meters in consideration of the space for plumbing.

4-3-2 Structural Planning

The outline of the facilities to be constructed under this project and the structural system for them are as described below.

(1) Outline of Structure

No. of stories : 2

Story height : 1st floor: 3.5 meters; 2nd floor: 3.5 meters

Basic span : 6.0m×6.0m

Type of structure : reinforced concrete rigid frame structure

Foundation : direct foundation

(2) Design Standards

The structural design is to be developed in accordance with the following local standards or the Japanese standards (when there are no applicable local standards)

- Building Code 1968
- Structural Manual 1973
- Code of Practice for the Design & Construction of Building & other Structures in relation to Earthquakes 1973
- B. S. CP. 110 Design Standards on Concrete Structures

(3) Outline of the Structural Design

1) Live Load

Office:	300 kg/m ²	Warehouse:	800kg/m ²
Multipurpose hall:	400 kg/m ²	Roof:	80 kg/m ²
Laboratory:	400 kg/m ²		

2) Seismic Load

According to the local design standards, Muguga is located in Earthquake Zone VIII-IX. The seismic load of a reinforced concrete structure in this earthquake zone is calculated on the basis of Usage Classification A, B, C or D.

$$F=1.3 CB.W$$

F : total horizontal load

W : total

$$CB: \frac{0.05}{\sqrt[3]{T}} \quad T = \frac{0.09H}{\sqrt{D}} \quad H : \text{building height}$$

$$D : \text{building width}$$

Kitui is located in Earthquake Zone V, and therefore the Kitui Centre's projected facilities need not be of earthquake resistant construction.

3) Wind Load

$$F = C_f q A_e$$

F : total horizontal load
C_f : coefficient of wind velocity
q : velocity pressure $q = 25 \text{ kg/m}^2$
A_e : aspect area

4) Bearing Capacity of Soil

The value of the bearing capacity of soil at a depth of 1 meter from the reference ground (cut ground) is set at 7.8 tons/m² for Muguga and 8.0 tons/m² for Kitui.

5) Design Strength

① Reinforced Concrete

Class 20 260kg/cm² 28-day strength

② Reinforcing Bar

SD35 (JIS G3112) $f_y = 3,500 \text{ kg/cm}^2$

or

BS 4461 $f_y > 425 \text{ N/mm}^2 (43 \text{ kg/mm}^2) 16 \text{ mm}$

$f_y \leq 460 \text{ N/mm}^2 (47 \text{ kg/mm}^2) 16 \text{ mm}$

③ Concrete Block

For single story reinforced masonry structure: Grade B concrete block

Average compressive strength : 3.5 N/mm² (36kg/cm²)

Minimum compressive strength : 2.8 N/mm² (26kg/cm²)

6) Expansion Joint

less than 40m meters

(4) Examination of the Types of Structure

1) Reinforced concrete structure:

This is a structure most commonly used in Kenya for buildings of the scale similar to that of those to be constructed under this project. When this structure is employed, all building materials can be procured locally, and many local construction workers can work efficiently. This structure is also considered suitable in terms of execution of work and cost.

2) Steel structure:

This structure is also considered suitable in terms of the scale of frame. It will also be effective in shortening the term of work. When this structure is employed, however, there will be some difficulty in procuring and processing materials. Judged overall, taking into account the cost of transportation of machines and materials imported from Japan, this structure is not better than reinforced concrete structure in terms of execution of work and cost.

3) Reinforced concrete block

This structure is commonly used in the country. When this structure is employed, it will be easy to procure materials. It is concluded, therefore, that this structure will be suitable in terms of scale of structure and cost for one-story or small-scale buildings.

4) Nairobi stones

This structure is suited for small-scale buildings. Nairobi stones are widely used, and the labor cost is relatively low. It can be said that this structure is a little more expensive than reinforced CB. It

is widely used in Kenya for the construction of reinforced concrete rigid frame exterior walls. In this case, a method of construction which is similar to that used for reinforced CB structure is used. This structure is considered best for the construction of exterior walls because it is maintenance-free and because it results in a beautiful appearance of the walls.

5) Wooden structure:

This structure can be used for small-scale buildings, but it poses some problems in terms of durability. Being inexpensive, this structure can safely be used for components free from damage by rain such as roof frames.

(5) Selection of Types of Structure

The following types of structure were selected.

- Foundation : continuous footing and individual footing
- Frame : reinforced concrete rigid frame
- Concrete floor : wire netting/reinforced concrete floor on polyethylene sheet
- Slab : reinforced concrete slab
- Curtain wall : concrete block, Nairobi stones
- Partition wall : concrete block, wood

(6) Structural Materials

In principle, the following structural materials should be used.

- Cement : BS12 ordinary Portland cement

- Reinforcing bars : JIS G 3112, SD30 or BS4461 twisted reinforcing bars

4-3-3 Electrical Planning

(1) Main Line Feeder/Power Equipment (Muguga Centre, Kitui Centre)

An main line feeder from the low-voltage switchboard of the power supply system to the distribution boards and the power control board is to be installed. The method of supply of the main line feeder is as follows.

- Electricity 3-phase, 3-wire 415V
- Outlet Socket 3-phase, 4-wire 415V/240V

(2) Lighting (Muguga Centre, Kitui Centre)

- Lighting Fixtures

Fluorescent lamps are to be used as light sources. In principle, the lighting fixtures will be of surface mounted type or hanging type. The following table show the target illumination level for each occupancy.

Table 4-3 Target illumination

Room	Lighting fixture	Target illumination level
Office/conference room	Fluorescent lamp 40W×2 surface mounted type	200~300 lx
Library	Fluorescent lamp 40W×2 surface mounted type	200~300 lx
Laboratory/analysis room	Fluorescent lamp 40W×2 hanging type	300~400 lx
Warehouse	Fluorescent lamp 40W×2 hanging type	100~150 lx

Outdoor lamps will be mercury lamps. The hall of the Muguga

headquarters' information centre will be used for multiple purposes, and therefore the lighting fixtures in the hall should be those suited for multiple purposes.

(3) Outlet Sockets (Muguga Centre, Kitui Centre)

Outlet sockets as power sources for small electrical appliances and experimental;/analytical equipment will be installed where appropriate. Outlet sockets must be in compliance with BS standards. Outlet sockets for generator circuits should be identified by their appearance.

(4) Telephone System (Muguga Centre, Kitui Centre)

Pipes and wires from the main terminal board to other terminal boards and those from terminal boards to outlet sockets will be installed.

(5) Public Address System (Muguga Centre, Kitui Centre)

A public address system for internal paging and communication will be installed. At the hall of Muguga Centre' information centre, pipes and wires for audio-visual equipment will be installed.

(6) Improvement of Power Supply System

1) Muguga Centre

Muguga Centre's present power supply system is as outlined below.

- Received power system 3-phase, 3-wire 11kV 50Hz
- Low-voltage power system 3-phase, 3-wire 415V/240V
- Transformer capacity 500kVA

The existing 500kVA transformer should be replaced by one with a capacity of 1,000kVA since the present transformer capacity of 500kVA will not match an increase in power supply capacity as a result of the

extension of the centre's facilities.

A private electric generator and an automatic voltage regulator should be installed in light of the unstable power supply on the premises of the centre: Power supply is cut often and the voltage fluctuates widely on the premises of the centre. Since the existing private generator is suffering from increases in load and its 50kVA capacity is not sufficient, it should be replaced by an ordinary generator and at the same time the circuit should be improved.

2) Kitui Centre

A private electric generator and an automatic voltage regulator should be installed in light of the unstable power supply on the premises of Kitui Centre: Power supply is cut often and the voltage fluctuates widely on the premises of the centre.

(7) Improvement of Switchboard

1) Muguga Centre

The existing switchboard is handling the following.

- Central office lines 9 lines (28 lined)
- Extensions 85 extensions (118 extensions)

(Figures in parentheses indicate capacity)

The existing switchboard should be replaced with anew one since there will be a considerable increase in the number of extensions as a result of the implementation of this project. The new switchboard should have a capacity of 12 central office lines and 160 extensions.

2) Kitui Centre

Switchboard

The existing switchboard is handling the following.

- Central office lines 4 lines (4 lines)
- Extensions 11 extensions (18 extensions)

(Figures in parentheses indicate capacity.)

The existing switchboard should be replaced with a new one since there will be a considerable increase in the number of extensions as a result of the implementation of this project. The new switchboard should have a capacity of 6 central office lines and 40 extensions.

4-3-4 Mechanical and Plumbing Planning

(1) Air Conditioning System

1) Muguga Centre

The project site is 2,100 meters above sea level. In and around the project site, the highest average temperature is 20°C and the lowest average temperature is 10.8°C (both figures are based on the 1953-80 statistics). There will be no need to install air conditioners since ventilation by the use of ventilation equipment will be sufficient.

2) Kitui Centre

The project site is 1,100 meters above sea level. In and around the project site, the highest average temperature is 26.9°C and the lowest average temperature is 14.6°C (both figures are based on the 1973-79 statistics). The temperature is a littler high at this project site

than at Muguga Centre. If natural ventilation is utilized as in the case of the existing facilities, however, there will be no need to install air conditioners.

(2) Ventilation System (Muguga Centre, Kitui Centre)

Ventilation by the use of ventilation fans will be sufficient. Laboratories where heat and bad smells will be generated should be equipped with an exhausted for forced ventilation.

(3) Plumbing System

1) Water supply system

① Muguga Centre

Rehabilitaion work for the existing bore hole will be carried out. Water for this project will be supplied by the use of the existing water pipes.

② Kitui Centre

In Kitui, the annual rainfall is 1,034mm (according to the 1963-77 statistics). In Tiva where the centre's tree nursery is located, the annual rainfall was only 335mm in 1992. At present, Kitui Centre has a total of 3 wells, including one to supply water to the tree nursery. However, the total quantity of water pumped up from these wells is too small for the centre's facilities. For this reason, the centre purchased about 1,240m³ of water from Kitui Town in 1992-93. Under such circumstances, a bore hole should be installed to secure a sufficient quantity of water for the centre's facilities during the dry season. The quantity pumped up from the bore hole will be treated by a sand remover, and then will be sent to the existing reservoir.

The present water supply system will be used to supply water to new facilities. Namely, water will be supplied utilizing gravitation.

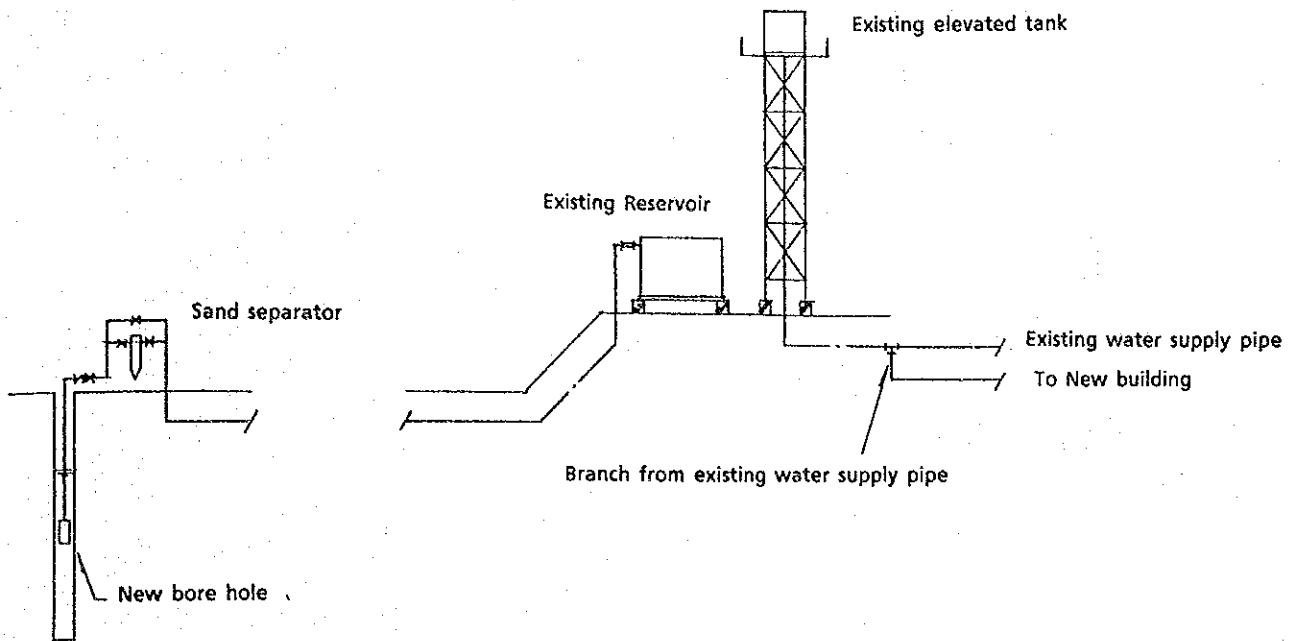


Fig. 4-3 Water Supply Schematic diagram of Kitui

2) Drainage system (Muguga Centre, Kitui Centre)

Sewage and other waste water will be separately discharged into the septic tanks for treatment. Then the treated sewage and other waste water will be discharged into the ground through french drain pipes. The septic tanks and french drain pipes must be in compliance with the specifications of the Ministry of Public Works. Sewage pipes installed on the ground floor should be connected to different outdoor pits.

3) Neutralization system (Muguga Centre, Kitui Centre)

Waste water from laboratories will be discharged into the ground through french drain pipes after the treatment of neutralization.

Concentrated liquid waste will be recovered at the source, not discharged into the waste water discharge system.

4) Hot water supply system

Hot water supply equipment will be installed in the medical examination and treatment room in the information centre at Muguga Centre.

5) Fuel gas supply system (Muguga Centre, Kitui Centre)

Laboratories will be supplied with LP gas. The gas cylinders will be installed outdoors.

6) Fire extinguishing System (Muguga Centre, Kitui Centre)

In principle, outdoor fire extinguishers and indoor hose reels will be installed. Nozzles and couplings which are in compliance with British Standards will be installed.

7) Sanitary equipment (Muguga Centre, Kitui Centre)

Sanitary equipment, such as water closets, urinals, lavatories, slop sinks will be installed. All these items of sanitary equipment should be installed firmly.

8) Kitchen equipment (Muguga Centre)

2 nos. of new refrigerator/freezer will be included in the Dining Hall remodeling work.

9) Other (Muguga Centre, Kitui Centre)

Other items of plumbing works which require improvement in the existing facilities will be improved.

3 sinks will be installed in existing training room and 2 shallow well pumps will be installed in Kitui Centre.

4-3-5 Construction Materials Plan

Construction materials which are suited to the local climate and the local methods of construction and which are functionally appropriate will be selected for the project. They should also be effective in ensuring the durability of the projected facilities, easy to maintain and manage, and highly economical.

(1) Main Structural Material

Main Structural Material

Component	Material	Remarks
Foundation, column, beam, floor	Reinforced concrete	Commonly used in the country with satisfactory results

(2) Exterior Finishing Materials

Table of Exterior Finishing Materials

Component	Materials	Remarks
Roof	Cement roof tile	Commonly used in the country. Quality control of articles stored below the roofs is necessary.
Walls	Nairobi stones	Commonly used in the country. Many existing facilities have walls of this type. Maintenance-free and therefore best as wall materials.
Doors and windows	Aluminum sash, steel doors	High-precision doors and windows should be installed to protect precision equipment.

(3) Interior Finishing Materials

Table of Interior Finishing Materials

Room	Floor	Wall	Ceiling	Remarks
Laboratory/ analysis room	Terrazzo	Paint finish	Inorganic acoustic board/perlite spraying	Excels durability and economy.
Office	Terrazzo	Paint finish	Inorganic acoustic board	Excels in durability and economy.
Multipurpos e conference room	Terrazzo	Glass wool/punched plywood	Calcium silicate board VP, grid pipe	Excels in durability and economy.
Data room	Free access floor	Paint finish	Inorganic acoustic board	Excels in equipment connecting function.
Hot water room	Terrazzo	Paint finish	Calcium silicate board VP	Excels in durability.
Toilet	Tile	Tile	Calcium silicate board VP	Excels in durability and water resistance.
Exterior corridor	Terrazzo	Spray tile	Calcium silicate board VP	

4-3-6 Equipment Plan

This project is aimed at improving the functions and operations of the research and training departments of KEFRI, which are necessary for the extension of nationwide social forestry. In light of the present situation of Kenya and through discussions with the persons concerned of Kenya, the following basic guidelines were formulated for the equipment.

1. To select items which will smoothen future operations on the basis of the result of survey of the present state of the existing equipment and the ongoing research activities

2. To give sufficient consideration on consistency with the existing equipment in selecting the equipment grades and types
3. To minimize the maintenance costs by selecting items which are easy to maintain
4. To select models and types which can be locally maintained to the utmost especiall for the precision equipment such as analytical and experimental instruments and audio-visual equipment

Judging from the results of the survey of the present state of the existing equipment and related facilities, the grade of the selected items of equipment is not excessively high. And they can be used in good order even in the future to achieve their objectives effectively. Listed in the following table are the main uses of principal equipment to be provided under this project.

Table 4-4 Use of principal equipment

Equipment	Main use
<p>1. Analytical and experimental equipment</p> <ul style="list-style-type: none"> • Atomic absorption spectrophotometer • Fourier transform spectrophotometer • Gas chromatograph • N/C analyzer • Water still • Centrifuge • Gel electrophoreses apparatus • Fluorescence spectrophotometer • Growth cabinet • Low temp. incubator • Drying oven 	<p>Used for the analysis of metallic microelements contained in plants.</p> <p>Used for the analysis of organic compounds contained in plants.</p> <p>Used for the separation of mixtures contained in plants and the quantitative analysis of each ingredient.</p> <p>Used for the analysis of quantities of nitrogen and carbon contained in plants and soil.</p> <p>Used for distillation of water on biochemical experiments, cleaning of glassware and many other purposes.</p> <p>Used for the separation of ingredients contained in a cell.</p> <p>Used for the analysis of proteins, particulaly enzyme, contained in plants and the classification of plants.</p> <p>Used for the quantitative analysis of small-quantity ingredients, such as vitamins, hormones and enzyme, of plant cells.</p> <p>Used for experimental culture of root nodule bacteria and experimenting on the growth of seeds and seedlings.</p> <p>Used for experimental accelerated culture of bacteria and microbes, etc.</p> <p>Used for drying samples for the drying of materials on chemical analysis of the growth of plants.</p>

Equipment	Main use
<ul style="list-style-type: none"> • Mist propagation unit • Plant canopy analyzer • Clean bench • Draft chamber • Personal computer 	<p>Installed in the greenhouse for use in experimenting on germination of seeds and seedlings.</p> <p>Used for observation of bacteria and plant cells.</p> <p>Used for transplanting of bacteria such as root nodule bacteria in the clean air.</p> <p>Used for experiments in which toxic substances come out.</p> <p>Used for analysis of data on results of experiments and preparation of papers.</p>
<p>2. Training and information equipment</p> <ul style="list-style-type: none"> • Video editing system • Video projection system • Audio system • Monitor TV set 	<p>Used for editing video sources on use in public relations, training and promotion.</p> <p>Installed in the multipurpose hall for use in promotion and public relations activities to extend social forestry.</p> <p>Used in lectures, conferences as well as ceremonies and exhibitions held at the multipurpose hall.</p> <p>Used for showing video materials in the training course.</p>
<p>3. Vehicles</p> <ul style="list-style-type: none"> • Pickup truck • Bus • Water tank truck 	<p>Used for transport of nursery trees and tools used at fields.</p> <p>Used for transport of trainees.</p> <p>Used for the supply of irrigation water to fields and for ensuring sufficient water supply during the dry season.</p>
<p>4. Equipment for maintenance and repair</p> <ul style="list-style-type: none"> • Oscilloscope • Drawing machine • Tool set for refrigerator • Tool set for electronic/electrical work • Automatic planer 	<p>Used for checking and repair of electrical and electronic equipment.</p> <p>Used for preparation of drawings of jigs and facilities, etc.</p> <p>Used for inspection and repair of freezers and air conditioners.</p> <p>Used for periodical inspection and repair of the equipment.</p> <p>Used for production of simple equipment.</p>

The following list shows the outline of the basic plan for the main items of equipment.

I. Muguga Centre

No.	Equipment	Q'ty	Unit
	1. Analytical and experimental equipment		
MA-1	Laboratory table (W3000×D1500×H800mm, with reagent shelf and sink units, etc.)	21	units
2	Table for equipment (Wall type, W1800, 1500, 1200×D750×H800mm, etc.)	84	units
3	Laboratory sink (W1500×D750×H800mm, double-sink type, 3-way faucet)	17	units
4	Table for balance (W900×D750×H800mm, for 0.1mg-sensitivity)	7	units
5	Cabinet for chemicals (W1800, 1500×D450×H1800mm)	19	units
6	Cabinet for instruments (W1200×D450×H1800mm)	16	units
7	Cabinet for samples (W1200×D450×H1800mm, for wide sample)	2	units
8	Storage rack (W1800×D600×H1800mm, for middle weight)	5	units
9	Wall cabinet (W900×D300×H600mm)	100	units
10	Clean bench (A) (Vertical laminar flow, with HEPA filter, UV lamps)	6	units
11	Clean bench (B) (Horizontal laminar flow, with HEPA filter UV lamps)	2	units
12	Draft chamber (W1800×D750×H2300mm, with ceramic table)	1	unit
13	Atomic absorption spectrophotometer (with 20 kinds of hollow cathode lamps, compressor)	1	unit
14	Fourier transform infrared spectrophotometer (with FTIR)	1	unit
15	Gas chromatograph (with FID, FTD, FPD detectors, data processor)	1	unit
16	N/C analyzer (Oxygen circulating combustion, gas chromatographic detection system)	1	unit
17	Fluorescence spectrophotometer (with CRT display, micro cell, fluorescence-free cell)	1	unit
18	Water still (A) (Capacity: 5ℓ/h, ion-exchange system, with softener)	4	units
19	Water still (B) (Capacity: 2ℓ/h, ion-exchange system, with softener)	4	units
20	Centrifuge (A) (for PF-value analysis, 13,500rpm.)	1	unit
21	Centrifuge (B) (for general use, 14,000rpm.)	2	units
22	Gel electrophoresis apparatus (Thin slab type)	3	units
23	Growth cabinet (A) (Open type, inner size: W520×D460×H970mm)	5	units
24	Growth cabinet (B) (Closed, high illumination type, inner size: W520×D500×H1100mm)	3	units

No.	Equipment	Q'ty	Unit
25	Low temp. Incubator (-10~+50°C, inner size: W620×D400×H600mm)	4	units
26	Drying oven (Max. temp: 200°C, inner size: W600×D500×H500mm)	11	units
27	Assorted glassware (Beaker, measuring cylinder, Weaton bottle, etc.)	1	set
28	Drying shelf for glassware (4 shelves, with baskets)	4	units
29	Glassware dryer (+40~+60°C, inner size: W600×D500×H1100mm)	7	units
30	Ultrasonic cleaner (Inner size: W220×D180×H100mm)	5	units
31	Ultrasonic pipet washer (Frequency: 28kHz, inner size: Ø150×H450mm)	4	units
32	Grinding mill (A) (Wiley system, cylinder size: Ø100mm)	4	units
33	Grinding mill (B) (Cross beating system, cylinder size: Ø100mm)	3	units
34	Microtome unit (Slicing capacity: 1~25µm)	1	unit
35	Blender/homogenizer (Cup: 500ml, stainless made)	5	units
36	Rotary evaporator (80~200rpm., with aspirator)	4	units
37	Autoclave (A) (Horizontal, inner size: Ø240×H340mm)	1	unit
38	Autoclave (B) (Vertical, inner size: Ø300×H650mm)	1	unit
39	Autoclave (C) (Vertical, inner size: W650×D900×H600mm)	1	unit
40	Deep freezer (-35°C, inner size: W780×D450×H700mm)	9	units
41	Refrigerator (2-door, total capacity: 300ℓ)	12	units
42	Ice cuber (Product capacity: 75kg/day, Storage: 50kg)	1	unit
43	Shaker (Orbital shaking, 20~400rpm, 500ml×9 place)	4	units
44	Incubating shaker (40~200rpm, +10~+60°C, 500ml×12 place)	1	unit
45	Low temp. water bath (+5~+50°C, inner size: W400×D350×H150mm)	1	unit
46	Hot plate (Plate size: 300×300mm)	4	units
47	Hot plate with stirrer (200~1500rpm, plate size: Ø150mm)	5	units
48	Colony counter (Digital type, with illumination)	17	units
49	Staining set (with staining pot, washer, staining liquid)	3	sets
50	Leaf area meter (Max. measuring width: 400mm, measuring speed: 80mm/sec.)	2	units
51	Plant canopy analyzer (Optical sensing method, with memory)	1	unit
52	Tensiometer (Air-pool type, with auger)	1	unit
53	Sealer (Heat sealing type, sealing width: 300mm)	3	units
54	Soil auger (Tip dia.: Ø115mm, total length: 1350mm)	3	sets

No.	Equipment	Q'ty	Unit
55	Soil thermometer (Glass rod type: -10~+40°C)	3	units
56	Soil humidity tester (Elec. potential difference measuring method)	3	units
57	Soil moisture meter (Measuring point: 4)	2	units
58	Shading net (Black, 58%, 83%, 180cm×100m)	1	set
59	Mist propagation unit (for greenhouse, with timer, mist controller)	3	sets
60	Recording thermometer/hygrometer (Bimetallic, -20~+40°C, 0~100%)	3	units
61	Soil heater (Electric heater, with temp. controller)	3	sets
62	Pressure bomb (40 bar, with bomb, cylinder)	2	units
63	Calorimeter (Adiabatic calorie measuring type, with thermometers)	1	unit
64	EC meter (Measuring range: 0~11mS/cm, temp.: 0~+50°C)	1	unit
65	Surveying equipment (Compass, tripod, pole, measuring tape)	5	sets
66	Tree measuring equipment (Hypsometer, measuring tape)	5	sets
67	Tree climbing set (12-step ladder, safety belt, hanger)	3	sets
68	Planimeter (For area/line length measurement)	2	units
69	Realascope hupsometer (Spiegel type)	2	units
70	Relative light intensity meter (Outer sensor 180mm, inner sensor 1000mm)	2	units
71	Camping tent (for 3~6 persons, polyester cloth made)	2	sets
72	Freeze dryer (with manifold for 24 ampules, vacuum pump)	1	unit
73	Electronic precision balance (180g, 210g, 2100g, 6100g)	19	units
74	Balance (30kg)	3	units
75	pH meter (Desk top type, analogue reading, with temp. compensation function)	9	units
76	Cation exchange capacity analyser (with liquid level sensor)	1	units
77	Biological microscope (Eyepiece×10, objective×4, 10, 20, 40, 100, with phase contrast equipment)	2	units
78	Fluorescence microscope (Eyepiece×10, objective×4, 10, 20, 40, 100, with epi-fluorescence/DIC equipment, photomicrographic attachment)	1	unit
79	Stereo microscope (A) (Eyepiece×10, with zooming body)	3	units
80	Stereo microscope (B) (Eyepiece×10, with zooming body, photomicrographic attachment)	1	unit
81	Micro pipet (20μℓ~5mℓ, 6 kinds)	13	sets
82	Bottle dispenser (1~30mℓ, 3 kinds)	13	sets
83	Charcoal hardness tester (for 6 steps)	2	units

No.	Equipment	Q'ty	Unit
84	Cooler box (33ℓ, with freeze packs)	13	pcs.
85	Personal computer (with 8MB RAM, 120MB hard disk unit, color display, printer, software)	13	sets
86	Stainless wagon (W850×D450×H900mm)	24	units
87	Work table (W1800×D900×H800mm)	8	units
88	Polyethylene tank (30ℓ, wide mouth)	22	pcs.
89	Stool (Ø330×H450mm)	128	pcs.
90	Work desk (A) (Single pedestal, W1200×D750×H700mm)	51	units
91	Work desk (B) (Double pedestal, W1500×D750×H700mm)	13	units
92	Work chair (A) (with arm rest)	13	units
93	Work chair (B) (without arm rest)	79	units
94	Conference table (W2100×D850×H700mm)	7	units
95	Cabinet (W1200×D400×H1800mm)	37	units
96	Rack (W1200×D400×H1800mm)	4	units
	2. Training and information equipment		
MB-1	35mm camera set (with standard, macro, zoom lens, tripod, speed light, camera bag)	1	set
2	Overhead projector (Stage size: 285×285mm)	2	units
3	Slide film projector (with remote controller, tray, pedestal)	1	unit
4	White board with screen (W1950×D550×H2050mm)	2	units
5	Monitor TV set	2	sets
	● Monitor TV (29 inch color, Multi system)	(2)	
	● Video tape deck (VHS, multi system)	(2)	
	● System rack (with casters)	(2)	
6	Video camera system	1	set
	● Video camera (3-CCD, with 15:1 zoom lens, finder, microphone)	(1)	
	● Video cassette recorder (Dockable type, S-VHS/VHS)	(1)	
	● Tripod/Dolly (Max. height: 1550mm, tilting angle: ±40°C)	(1)	
	● Portable monitor TV (10 inch, with battery, charger)	(1)	
	● Battery light (150W, with battery charger)	(1)	
7	Video editing system	1	set
	● Video cassette player (S-VHS/VHS)	(1)	
	● Editing controller (with jog, shuttle function)	(1)	
	● Monitor TV (14 inch color)	(1)	

No.	Equipment	Q'ty	Unit
8	Video projection system	1	set
	● Video cassette recorder (S-VHS/VHS)	(1)	
	● Monitor TV (14 inch color)	(1)	
	● Video projector (for 120 inch screen, with power lifter)	(1)	
	● Screen (Motor-driven rolling up type)	(1)	
	● Slide film projector (with sound synchronizing recorder)	(1)	
9	Audio system	1	set
	● Audio mixer (16 channel)	(1)	
	● Cassette tape deck (Double cassette type, automatic reversing system)	(1)	
	● Tuner/antenna for wireless microphone (VHF)	(1)	
	● Multi processor (for audio phase controlling, digital type)	(3)	
	● Power amplifier (for main, sub, ceiling speakers)	(5)	
	● System rack (W480×D480×H1800mm)	(2)	
	● Main speaker (2 way bass-reflex type)	(2)	
	● Sub speaker (Bass-reflex type)	(2)	
	● Ceiling speaker (2 way bass-reflex type)	(6)	
	● Monitor speaker (Full range, bass-reflex type)	(2)	
	● Microphone (Directional, dynamic type, with stand)	(3)	
	● Wireless microphone (Handy type, pin type)	(4)	
10	Photo copier (B/W, for A6 ~ A3 size, zooming function)	1	unit
11	Electric typewriter (English, with memory)	5	units
12	Knockdown stage (W2400×D1200×H600mm, with curtain, steps)	11	units
13	Stacking chair (With table, chair cart)	160	units
14	Lecturer's table (W1200×D600×H1000mm)	1	unit
15	Conference table for stage (W1800×D600×H700mm)	3	units
16	Work bench (A) (W1800×D900×H800mm)	1	unit
	3. Vehicles		
MC-1	Pickup truck (Seating capacity: 2, loading capacity: 1 ton)	1	unit
2	Bus (Seating capacity: 60)	1	unit
	4. Equipment for maintenance and repair		
MD-1	Work bench (A)(W1800×D900×H800mm)	2	units
2	Work bench (B)(W1800×D750×H800mm)	3	units

No.	Equipment	Qty	Unit
3	Instrument rack (W1500×D600×H1800mm)	3	units
4	Instrument cabinet (W1800×D400×H1800mm)	3	units
5	Instrument wagon (W500×D750×H880mm, with casters)	1	unit
6	Oscilloscope (4-input, 100MHz)	2	units
7	Digital multimeter (for voltage, ampere, resistance)	1	unit
8	Logic analyzer (16 channel, 100MHz)	1	unit
9	Signal/function generator (7 waveforms)	1	unit
10	Drawing machine (900×1200mm, with chair, light)	1	unit
11	Tool set for vehicles (Wrench, scraper, etc.)	1	set
12	Tool set for refrigerator (Manifold kit, pipe bender, etc.)	1	set
13	Tool set for electronic work (Screw driver, nipper, plier, etc.)	2	sets
14	Tool set for electrical work (Screw driver, radio plier, soldering iron, etc.)	3	sets
15	Tool set for mechanical work (Wrenches, hammer, etc.)	1	unit
16	Upright bench drill (Capacity: 13mm, with drill set)	1	unit
17	Automatic planer (Max. width of material: 320mm, with table height positioner)	1	unit
18	Circular saw (Ø380mm dia.)	1	unit
19	Stool (Ø330×H450mm)	12	pcs.
	6. Others		
	(Equipment for clinic)		
ME-1	Doctor's desk (Double pedestal, W1500×D750×H700mm)	2	units
2	Doctor's chair (with arm rest)	2	units
3	Consultation bed (W1900×D700×H620mm)	1	unit
4	Stool (Ø330×H450mm)	5	units
5	Bed (W2000×D920×H700mm, with mattress)	2	units
6	Bed side cabinet (W450×D400×H750mm)	2	units
7	Clothing basket (W450×D330×H750mm)	1	unit
8	Nurse table (Single pedestal, W1200×D700×H700mm)	1	unit
9	Nurse chair (without arm rest)	1	unit
10	Chemical/instrument cabinet (Unit system, W1800×D400×H1800mm)	1	unit
11	Partition (Folding type, W1800×H1650mm)	2	units
12	Boiling sterilizer (Desk top type, with electric heater)	1	unit
13	Chair for waiting room (without arm rest)	3	units

No.	Equipment	Q'ty	Unit
	(Equipment for laundry)		
14	Washing machine (Full automatic, capacity: 3kg)	3	units
15	Dryer (Capacity: 4kg)	3	units
	(Equipment for dark room)		
16	Safety light set (2-side, with safety glass: 3 types)	3	units
	(Equipment for administrative office)		
17	Work desk (A) (Single pedestal, W1200×D750×H700mm)	2	units
18	Work chair (B) (without arm rest)	99	units
19	Conference table (W2100×D850×H700mm)	25	units
20	Cabinet (W1200×D400×H1800mm)	3	units
21	Rack (W1200×D400×H1800mm)	3	units
22	Stool (Ø300×H450mm)	4	units
23	Bench (W2000×D500×H400mm)	5	units

II. Kitui Centre

No.	Equipment	Q'ty	Unit
	1. Analytical and experimental equipment		
KA-1	Laboratory table (W2400×D1500×H800mm, with sink unit, etc.)	3	units
2	Table for equipment (Wall type, W1800, 1500, 1200×D750 × H800mm, etc.)	11	units
3	Laboratory sink (W1500×D750×H800mm, double-sink type, 3-way faucet)	3	units
4	Cabinet for chemicals (W1500×D450×H1800mm)	3	units
5	Cabinet for instruments (W1200×D450×H1800mm)	3	units
6	Cabinet for samples (W1200×D450×H1800mm, for wide sample)	2	units
7	Storage rack (W1800×D600×H1800mm, for middle weight)	7	units
8	Wall cabinet (W900×D300×H600mm)	24	units
9	Clean bench (A) (Vertical laminar flow, with HEPA filter, UV lamps)	1	unit
10	Water still (A) (Capacity: 5ℓ/h, ion-exchange system, with softener)	1	unit

No.	Equipment	Q'ty	Unit
11	Centrifuge (A) (for pH-value analysis, 13,500rpm.)	1	unit
12	Growth cabinet (A) (Open type, inner size: W520×D460×H970mm)	2	units
13	Drying oven (Max. temp.: 200°C, inner size: W600×D500×H500mm)	1	unit
14	Assorted glassware (Beaker, measuring cylinder, Weaton bottle, etc.)	1	set
15	Glassware dryer (+40~+60°C, inner size: W600×D500×H1100mm)	1	unit
16	Ultrasonic cleaner (Inner size: W220×D180×H100mm)	1	unit
17	Ultrasonic pipet washer (Frequency: 28kHz, inner size: Ø150×H450mm)	1	unit
18	Grinding mill (A) (Wiley system, cylinder size: Ø100mm)	1	unit
19	Autoclave (B) (Vertical, inner size: Ø300×H650mm)	1	unit
20	Deep freezer (-35°C, inner size: W780×D450×H700mm)	2	units
21	Refrigerator (2-door, total capacity: 300ℓ)	2	units
22	Shaker (Orbital shaking, 20~400rpm, 500ml×9 place)	1	unit
23	Sieves (Mesh size: 28 kinds, with shaker)	1	set
24	Hot plate with stirrer (200~1500rpm, plate size: Ø150mm)	1	unit
25	Leaf area meter (Max. measuring width: 400mm, measuring speed: 80mm/sec.)	1	unit
26	Soil auger (Tip dia.: 115mm, total length: 1350mm)	2	sets
27	Soil nutrient tester (with chemicals)	2	sets
28	Pressure bomb (40 bar, with bomb, cylinder)	1	unit
29	EC meter (Measuring range: 0~11mS/cm, temp.: 0~+50°C)	1	unit
30	Tree measuring equipment (Hypsometer, measuring tape)	2	sets
31	pH meter (Portable type, Analogue reading, with temp. compensation function)	1	unit
32	Micro pipet (20μℓ~5ml, 6 kinds)	1	set
33	Bottle dispenser (1~30ml, 3 kinds)	1	set
34	Field glasses (×8, with case)	1	unit
35	Stainless wagon (W850×D450×H900mm)	3	units
36	Polyethylene tank (30ℓ, wide mouth)	3	pcs
37	Stool (Ø330×H450mm)	15	pcs
38	Work desk (A) (Single pedestal, W1200×D750×H700mm)	3	units
39	Work chair (B) (without arm rest)	3	units
40	Cabinet (W1200×D400×H1800)	9	units
41	Rack (W1200×D400×H1800)	17	units

No.	Equipment	Q'ty	Unit
	2. Training and information equipment		
KB-1	35mm camera set (with standard, macro, zoom lens, tripod, speed light, camera bag)	1	set
2	Overhead projector (Stage size: 285×285mm)	2	units
3	Slide film projector (with remote controller, tray, pedestal)	1	unit
4	White board with screen (W1950×D550×H2050mm)	2	units
5	PA system (Portable type, with built-in amp., speaker)	1	set
6	Photo copier (B/W, for A6~A3, zooming function)	1	unit
7	Electric typewriter (English, with memory)	5	units
8	Personal computer(8MB RAM, with 120MB hard disk unit, color display, printer, software)	1	set
9	Cabinet (W1200×D400×H1800mm)	4	units
10	Work desk (A) (Single pedestal, W1200×D750×H700mm)	1	unit
11	Work chair (B) (without arm rest)	1	unit
	3. Vehicles		
KC-1	Pickup truck (Seating capacity: 2, loading capacity: 1 ton)	1	unit
2	Water tank truck (Max. payload: 10kℓ)	1	unit
	4. Others		
KD-1	Work desk (A) (Single pedestal, W1200×D750×H700mm)	4	units
2	work Chair (B) (without arm rest)	12	units
3	Conference table (W2100×D850×H700mm)	2	units
4	Cabinet (W1200×D400×H1800mm)	4	units
5	Tool set for vehicle (Wrench, scraper, etc.)	1	unit