INSTITUTE OF CURRENT WORLD AFFAIRS

PJW-22
Much-Needed Research

Bururi, Burundi
30 July 1986

Mr. Peter Bird Martin
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Institute of Current World Affairs
4 West Wheelock Street
Hanover, NH 03755 USA

Dear Peter,

Where land is limited and agricultural productivity has been declining -- as is the case in many regions of Africa -- encouraging farmers to plant trees can be a difficult task. Most farmers recognize that traditional sources of forest resources have been diminishing, as more and more land has been cleared for agricultural production. When you ask the farmers, they usually tell you that they lack adequate trees on their land to meet their families' needs in forest resources, such as firewood and construction wood. They want more trees, they explain, but where can they put them?

In recent years, numerous forestry projects in Africa have been trying to promote agroforestry techniques, whereby trees can be planted on farms in conjunction with agricultural crops or forage for livestock. The major objective is to increase overall land use productivity, to produce more crops, tree products, and animal fodder, through integrated systems rather than through separate production systems. Thus, for example, instead of having a maize field on part of the farm, separate from a eucalyptus woodlot, one could attempt to intercrop maize with a fast-growing, nitrogen-fixing tree species such as leucaena to maximize wood and maize production.

To convince farmers to try such intercropping systems is not easy. First, many have been told by agricultural extension agents for years that they should not interplant trees and crops. Numerous reasons have been given, such as maximizing crop yields and minimizing disease.

Second, farmers are, understandably, reluctant to take any risks. For many, who have one hectare (2.5 acres) or less of land, yearly survival is too precarious to do much experimentation. What if these techniques or new species do not perform well? Often only the wealthier farmers, with lots of land or other sources of income, can afford to try such innovations. Others prefer to wait to see the results on somebody else's land.

As many agroforestry efforts are relatively recent, it is often difficult to get much information on how well they work, compared with traditional systems. Careful longterm research is still relatively rare. Without good data the extension agent is unable to tell the farmer what tradeoffs exist in adopting a particular agroforestry configuration of trees and crops, and what advantages might exist. Most projects working on agroforestry issues are not doing any applied research -- and thus are just asking farmers to adopt innovations on pure faith -- rather than demonstrated increases in farm productivity.

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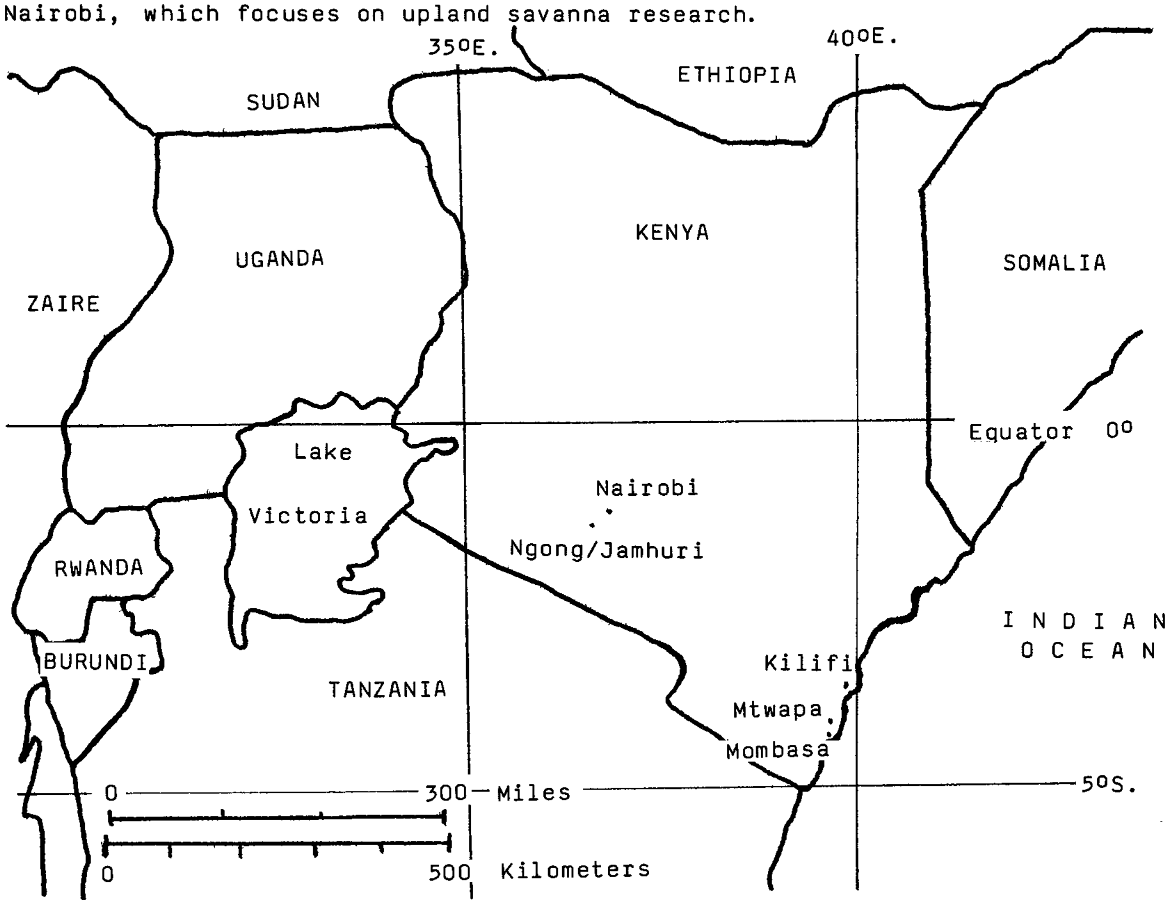
Fortunately, however, some useful agroforestry field research is currently underway. The Kenyan Renewable Energy Development Project (KREDP) has been conducting research at six agricultural research stations in different ecological zones in Kenya since 1981. Recently I attended a field day at the Mtwapa Agroforestry/Energy Centre, located on the coast of the Indian Ocean, just north of Mombasa (see Map). A year earlier I had visited the Ngong/Jamhuri Agroforestry/Energy Centre, located just outside of Nairobi, which focuses on upland savanna research.



Map. Mtwapa and Ngong/Jamhuri Agroforestry/Energy Centres in Kenya

(Map adapted from: World Travel Map of Africa. Scale: 1:10,000,000. Edinburgh, Scotland: John Bartholomew & Sons.)

The Kenyan Renewable Energy Development Project is part of a larger program, Energy Initiatives for Africa, which is funded by the U.S. Agency for International Development (U.S. AID) and being implemented by a consulting firm, Energy/Development International (E/DI). KREDP is being conducted with the assistance of the Kenyan Ministry of Energy and Rural Development and the U. S. Peace Corps. The project also collaborates with other organizations in Kenya, including the Ministry of Agriculture and Livestock Development, the Ministry of Environment and Natural Resources, and the Kenya Energy Non-Governmental Organizations Association (KENGO).

The project is designed to develop sources of renewable energy, such as the development of bio-gas energy and the production of firewood and charcoal through an agroforestry program, and to minimize energy consumption, through the introduction of fuel-efficient cookstoves and more efficient charcoal kilns. The project aims to assist in meeting the energy needs of Kenya's rapidly-growing population.

The Mtwapa Agroforestry/Energy Centre is part of the Coast Agricultural Research Station and the Mtwapa Farmers' Training Centre. The project has not attempted to begin agroforestry research stations from scratch. As Dr. Amare Getahun, the project director, explained, the project "was parachuted into existing agricultural institutions". The Coast Agricultural Research Station, for example, has been in existence for many years -- having been established under the British colonialists.

In addition, each research center is used for training farmers. The associated farmers' training center has a dormitory and cafeteria, to accommodate visiting trainees. (The Ngong/Jamhuri Centre has no farmers' training center, but does serve to educate the large nearby population of Nairobi.) Several times a year groups of forty farmers come to the center for sessions of one week's duration. The farmers are chosen by agricultural extension agents from interested applicants. In a group of forty, typically two or three will be women. Thus, the project locations make it easy to contact farmers, who can see the agroforestry trials when they visit the centers for other reasons. During their one-week courses, the KREDP staff usually teach a two-hour lesson on agroforestry. In addition, the project organizes other events, such as training sessions for non-governmental organizations or periodic field days, when farmers, schoolchildren, and others are invited for a one-day tour.

The field day was well-organized. Dr. Amare Getahun, Mr. Cyrus Ndegwa, and Mr. Bashir Jama of the Project staff conducted our tour of the research station. We were joined by several farmers and some other invited guests, including Mr. Mullei, who heads the section of Renewable Energy for the Ministry of Energy and Rural Development. Other project staff members conducted a simultaneous tour for approximately sixty school students.

At Mtwapa, the project has been allocated a research and demonstration site of four hectares (ten acres) out of the 302 hectares belonging to the agricultural station and farmers' training center. The project area is subdivided into a tree nursery, used for both research and seedling production purposes, research plots, and a seed orchard. In addition, the project has an office, a site for improved cookstove production and testing, a model charcoal kiln, and a demonstration bio-gas digester.

The nursery makes good use of <u>Gliricidia sepium</u> trees to provide shading during the dry season and plastic-lined, sunken beds to reduce the need for watering the young tree seedlings. (During the rainy season the trees are cut: the nursery, thus, does double-duty as a woodlot.) Aside from filling the plastic pots with dirt at the beginning of the planting season, the nursery requires little labor: one worker can manage the 200,000-seedling nursery alone. The nursery is well-laid out, with signs indicating the names and uses of species being grown.

Dr. Amare explained how various techniques for germinating seed are being explored, to ascertain easy techniques that farmers themselves could use. For example, by soaking leucaena seed in hot (80°C. or 176°F.) water for 3 minutes, 87 percent of the seed will germinate, as compared with only 14 percent of untreated seed. Germination trials on other species, such as tamarind (Tamarindus indica) are also being conducted. The project plans to write a brochure for farmers on how to germinate seed themselves.

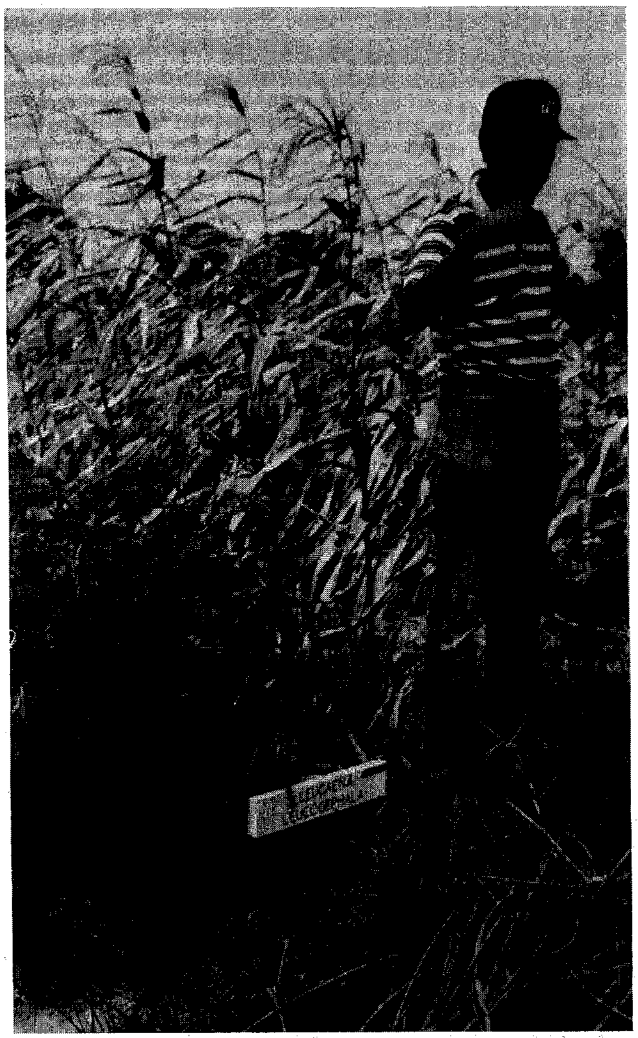
Ideally the project would like to eliminate the nursery. Currently it costs the project an average of 30 Kenyan shillings (almost US$ 2.00) to produce 100 tree seedlings. The bulk of the cost goes for buying plastic tubing used as pots for the seedlings, and paying the nursery workers. Because the Kenyan government has fixed the retail price of tree seedlings at 7.5 Kenyan shillings per hundred, the project is subsidizing the cost of production. (Horticultural species, such as grafted fruit trees, cost, and sell for, more.) But cost is not the only drawback to seedling production. For farmers who live some distance from the center, transporting heavy and bulky seedlings is a problem. Tree seedlings that are transported 20 kilometers (12 miles) or more have lower survival rates. In addition, seedlings can introduce disease into the farmer's own fields.

Along the coast, soils are primarily (92 percent) sand: as a result, nutrients quickly leach out of the soil. Thus, although rainfall is generally high, though variable, and temperatures warm, agricultural productivity is limited. In addition, weeds can reduce agricultural productivity by as much as 40 percent. Consequently, standard agricultural prescriptions for the coastal region advise using manure and fertilizers in the fields, and periodic weeding. The agroforestry trials employed these standard agricultural practices, but added trees into the crop system.

The research plots have been carefully laid out, to examine various permutations of trees and crops at different spacings, and with different treatments. The basic tree-crop configuration used is "alley-cropping", whereby rows of crops are planted between rows of trees. Thus, for example, trees may be planted in rows 2 meters, 4 meters, or 8 meters apart, with spacing between trees within rows varying from 0.5 meters to 2 meters. Agricultural crops used in the trials included maize, cassava (manioc), and green grams (mung beans). Several tree species are being evaluated in the trials, such as Leucaena leucocephala (Variety K28), Casuarina equistifolia, Eucalyptus camuldulensis, guava (Psidium guajava), cashew (Anacardium occidentale), Sesbania grandifloria, Gliricidia sepium, Prosopis spp. and Acacia albida.

The most impressive results have been achieved with leucaena and maize intercropping. The leucaena was planted during the first growing season with cassava. In subsequent growing seasons, maize has been alternated with green grams. (There are two growing seasons per year: maize is grown during the long rainy season, and green grams during the short rainy season.) During the first two and a half years the leucaena was allowed to grow without being cut, but it began to shade the crops and decrease yields. (The project laborers, however, appreciated having shade to work in while weeding the fields.) Attempts to trim the side branches decreased shading, but not enough. Consequently, at the beginning of the third year, the leucaena was coppiced -- cut 0.5 meters above the ground and allowed to resprout. The leucaena foliage was used as a green manure, or fertilizer, and was spread on the ground and dug in before planting the maize.

At the closest spacing of leucaena, with 2 meters between rows and 0.5 meters between trees within rows, the maize production in the third year was equivalent to 4 tons per hectare. This is a considerable improvement over the average maize production in the region of 2-2.5 tons per hectare.



Bashir in maize field with leucaena planted at 2 x 0.5 meter spacing. (Many maize plants tower above Bashir's 6-foot-plus frame.) The leucaena was cut only ten days earlier, showing the vigorous resprouting after coppicing. Harvested wood is also shown.

Bashir in control field of maize. (Few maize plants are taller than his waist.)

Project staff attribute increases in maize yields to increases in organic matter and nitrogen from the leucaena foliage, nitrogen-fixation, and weed control of the plots, due to shading by the leucaena, during the off-season. The tallest maize was that grown within 0.55 meters of the leucaena, suggesting that the leucaena nodules are increasing the availability of nitrogen in the soil.

These results are somewhat counter-intuitive. Most farmers assume that their crop productivity will be greatest at the wider -- not narrower -- spacings of trees. Even when farmers do see the results, they still prefer to plant trees at the 4-meter rather than 2-meter spacings. The project staff has noted that significant improvements in maize production can still be achieved at the 4-meter spacings if the leucaena trees are planted at close intervals within the rows. Project staff are now beginning trials with leucaena planted in rows 4 meters apart, but with only 0.30 meters between trees within rows.

The trees have also benefited from their association with the agricultural crops. When initially planted, the leucaena benefited from the shade provided by the cassava plants. With the weeding and fertilizer applied for the maize, the trees have also grown faster. Consequently, significant amounts of wood were available at the end of the third year -- 175 tons per hectare -- as opposed the more typical four to eight year rotation for harvesting leucaena for wood.

Along the coast, individual farmers do not yet perceive a firewood shortage. Consequently, improvement of agricultural productivity is the most important aspect of this agroforestry system for local farmers. The harvested wood can be used, however, for charcoal, and be marketed elsewhere where fuel is already scarce, thus earning coastal farmers income.

As indicated at right, casuarina, a nitrogen-fixing species, also benefits maize production.

Trials with other species are providing other results of interest. Some fruit species, such as cashew or guava, do not benefit crop production, and shade crops, but produce fruit for consumption or sale.

Acacia albida, a nitrogen-fixing species, behaves very strangely on the Kenyan coast. In the West African Sahel, Acacia albida has the highly-desirable characteristic of growing leaves during the dry season and dropping its leaves during the rainy season -- thus not shading adjacent crops. At Mtwapa, however, the Acacia albida trees keep their leaves during the rainy season. Project staff members have not yet determined the reason for this behavioral difference, but suspect that it may be related to the high water table. (Mtwapa is only 15 meters above sea level.)

Not all agroforestry systems necessarily maximize biomass production. Trials of intercropping eucalyptus with maize, for example, show that while significant wood production can be achieved, maize production will be severely reduced. Most farmers already know that eucalyptus inhibits crop production, and consequently plant eucalyptus in separate woodlots for the production of poles (construction wood) and firewood. Along the coast, a eucalyptus pole can bring 20-25 Kenyan shillings (US $1.25-1.50), or it can be cut to yield two to three fence posts, worth 13-14 shillings each.

Significant pole production

Consequences of intercropping eucalyptus with maize:

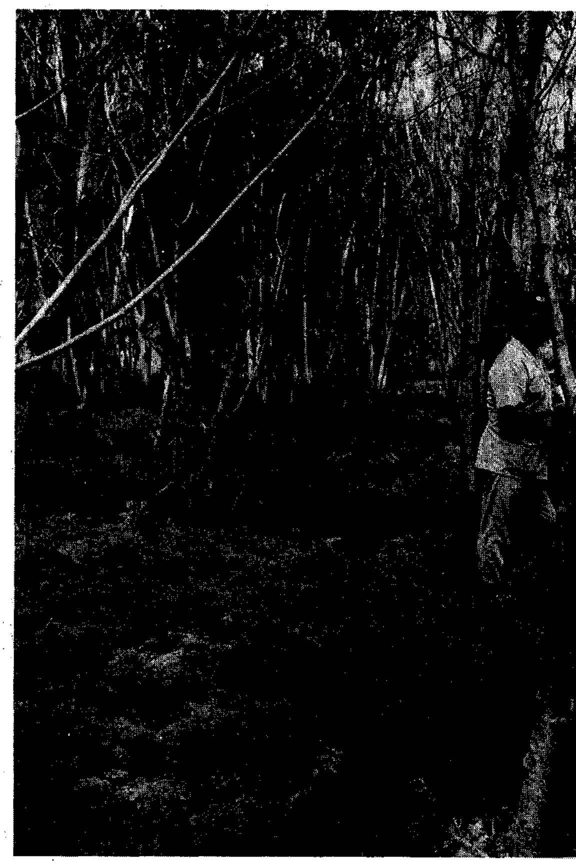
but

Negligible maize production

Project staff discussed other possible agroforestry systems, such as using leucaena for animal fodder. Leucaena foliage is high in protein, and has been shown to increase cow milk production. Project staff members have been working with a 100-member dairy co-operative in Kilifi. Co-operative members who have planted leucaena are convinced of its value as fodder, and now are enthusiastically planting more leucaena seed, using the hot water techniques for enhanced germination.

We saw two types of fodder production systems. Project staff are experimenting with intercropping leucaena with fodder grasses, such as banna grass and napier grass. The idea here is to produce the maximum amount of fodder to be cut and fed to animals, as in zero-grazing systems whereby the livestock are kept in stalls and fed with cut fodder. We also saw an alternative fodder production system when we visited seed orchard. Here widely-spaced 4-year-old leucaena have already achieved considerable height: underneath these trees is a carpet of young leucaena seedlings -- the perfect height for cows or goats to graze.

Leucaena and napier grass: leucaena is planted densely to maximize foliage for fodder



Four-year-old leucaena in the seed orchard, with carpet of young naturally-regenerated seedlings

As part of their energy conservation efforts, the center has built a demonstration bio-gas digester. A bio-gas digester is an underground tank where manure is decomposed, producing methane gas and a resulting semi-solid slurry. The bio-gas digester can be built downhill from animal stalls, so that the animal manure and urine will enter the digester by gravity feed. The methane gas can be used for lighting and cooking. Currently many dairy farmers in the region are burning cow manure to heat water to clean dairy utensils. Thus the value of the manure as fertilizer is being lost. If methane were used instead as fuel, crop productivity could be enhanced through the application of the slurry to the fields as fertilizer.

Another energy conservation technology being promoted is improved jikos, or fuel-efficient cookstoves. The improved jikos are 30-50 percent more efficient than traditional charcoal stoves. These jikos particularly appeal to urban residents, such as in nearby Mombasa, who usually purchase their fuel. The stoves have been well-received by local people: the major problem, in fact, is producing enough stoves to meet the demand.

These stoves are made with metal shells and fired ceramic liners. A one-pot jiko, which might be used by a household, sells for 60-80 Kenyan shillings (US$ 3.50-5.00) and a deluxe 2-pot model with oven and grill, which might be used by a small restaurant, for 350 Kenyan shillings (US$ 22). The project has been training local artisans to manufacture jikos, and hopes to obtain Peace Corps volunteers to work on stove extension efforts.

Research farms often can get impressive results, as they have all the necessary inputs -- labor, fertilizer, or technical expertise. The most important question, however, is whether such systems can be replicated elsewhere. The Mtwapa station is well set-up, in that many farmers can come and see the research/demonstration trials, get tree seedlings from the nursery, and obtain information and publications. In addition, the project has extension agents (district soil conservation officers and Peace Corps volunteers) who work with individual farmers, co-operatives, local women's groups, or institutions, such as government prisons. The extension activities feed back into the research process, by identifying what issues -- such as seed germination -- may most benefit the ultimate users.

Institutions approach agroforestry from different perspectives than do individual farm households. Prior to attending the field day at Mtwapa, ten of us had visited a nearby Kenyan government prison. The prison has been collaborating with the project on agroforestry trials for the past year. The prison has its own farm, to grow food for the 8000 prison inmates.

The prison guard, Paul, himself a former inmate, showed us the fields where the trees have been planted. Paul and Bashir explained that the agroforestry efforts aim to improve agricultural productivity, produce firewood to meet some of the prison's own needs, and also to generate some cash income. The trees planted are being managed as a seed orchard: the prison has been producing seed to sell to the project. Paul pointed out how, prior to the agroforestry efforts, some of the mango trees in the fields -- still capable of producing fruit -- had been cut solely to obtain firewood.

The other major goal of the prison's agroforestry trials has been to try to teach the inmates about the usefulness of agroforestry. The inmates, primarily teenage boys and young men, have come from all over Kenya. The project staff hope that some inmates will apply agroforestry techniques on their own lands once they leave the prison.

The prison agroforestry efforts, like the project's own research trials, showed considerable growth over a short period of time. Given the unlimited availability of labor, the crops can be adequately weeded. The high tree seedling survival and growth rates are significantly better, we were told, than those obtained by individual farm households, who generally lack adequate labor to do the recommended amounts of weeding.

As Mr. Mullei remarked, this approach has wide applicability for other institutions, such as schools, that also face problems in obtaining adequate food and fuel for their members. In Kenya, as in many other African countries, many secondary schools are boarding schools, so the schools have to feed their staff and students. Such institutions generally have problems obtaining ample firewood, but do not face labor constraints. These institutions differ significantly from individual farm households in scale, and thus can benefit more from fuel-efficient cookstoves or agroforestry technologies. What was most important, it was stressed, was that institutions capitalize on the educational aspects of the agroforestry trials -- rather than treating working in the fields as a punishment (whether for prison inmates or school students).

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Often one hears that African development needs practical, applied solutions, not more long-term research. Yet for agroforestry efforts, the two go hand-in-hand. Only with research efforts can the best management strategies be determined, and demonstrated to farmers.

A major constraint to long-range research is the adequacy of funding. Mr. Keith Openshaw, who heads up the Eastern Africa office of the Energy Initiatives for Africa Program, explained that the program funding will be exhausted in December 1986. The project had originally been scheduled to run longer, but monies have been spent at a faster rate than initially anticipated. In addition, the budget has been cut due to overall reductions in the budget for U.S. Agency for International Development. To meet the budget reductions mandated by the U.S. Congress (in conjunction with the Gramm-Rudman-Hollings legislation), U.S. AID programs in Africa are being severely reduced, with many projects being terminated -- irregardless of their development success -- or promise -- to date.

This situation -- of a project being ended just as it is starting to show some promising results -- occurs all too often in development work. Much development work is inherently long-term. Yet most development projects are only funded for short time periods, commonly five years or less. For forestry projects, this problem is particularly evident. As trees take a while to grow -- even in the best of tropical conditions -- and farmers take time to be convinced that they will personally benefit from growing trees, forestry and related resource management projects need longer time horizons.

Mr. Mullei stressed that the Kenyan government is very interested in continuing the research, demonstration, and extension activities of the project. The government can provide some funding, to insure that the research is continued. Unless other outside funding is obtained, however, the research will probably be on a reduced scale. The adequacy of funding will also affect the rate at which the government can expand the demonstration and training efforts to more centers throughout Kenya.

Sincerely,

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