Project no. 510790

FOREAIM

Bridging restoration and multi-functionality in degraded forest landscape of Eastern Africa and Indian Ocean Islands

Instrument: Specific Targeted Research Project

Thematic Priority : Integrating and Strengthening the European Research Area

Third reporting period of FOREAIM

Scientific report

Deliverables (list and CD-Rom)
Publishable results (list and CD-Rom)

Period covered: from 1st of June 2007 to 31st of May 2008
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Start date of project: 1st of June 2005 **Duration: 4 years**

Project coordinator name: Jean-Marc Bouvet
Project coordinator organisation name: CIRAD

Work package 1 – Traditional ecological knowledge, tree management practices, uses and economic dependency of local population on forests and tree based systems in the context of their degradation

In year 1 and 2 the team worked mainly on the two first objectives of the Wp1 characterizing the determining factors of the forest and the stakeholders' agro-ecological knowledge
Part of the results delivered to other Wps where on species
WP1 reports listed the preferred potential restoration indigenous species for various tree products
In Kenya, mostly for firewood, timber, construction poles and bees forage : *Juniperus procera, Prunus Africana, Zanthoxylum gilletti, Polycias fulva*.
In Madagascar,: *Dalbergia monticola, Ocotea sp,* Ramy *Canarium sp, Pinus sp, Eugenia sp, Uapaca sp, Prunus africanum, Eucalyptus robusta, Ravensara sp, Pandanus sp*
In Uganda, firewood, timber, construction poles, fruits mainly *Prunus africana* and *Maesopsis eminii* and also *C. edulis*. *Albizia coriaria A. grandibacteta, Antialis toxicalia , Milicia excelsa , Ficus natalensis, Calliandra collyrthsus, Moringa oleifera, Artocarpus heterophyllus, Mangifera indica Persea Americana and Citrus Spp.*

More details are provided in the specific deliverables of type D1.5

Prunus africana is the only tree retained in the three countries.
A lot of trees are multipurpose trees and some of the trees mentioned are yet incorporated on farm in agroforestry production systems.

In year 3 , while continuing working on uses, practices, representations of stakeholders on trees and forest (see deliverables of type D1.4 and D1.6), we focused on technologies of potential ecologic and economic importance (see deliverables of type D1.5 and D1.7) which can be implemented not only through WP7 but also through other projects after FOREAIM.

Uganda

The restoration of Mabira Forest reserve and surrounding areas can be achieved with the full participation of all key stakeholders such as the local communities. The major strategies identified out of WP1 activities of the FOREAIM project include: Promoting on farm tree planting, Large scale nursery establishment, Enrichment planting in the forest, Zoning for easy monitoring, Eco-tourism activities, Soil erosion control, Farming practices, Restoration of degraded sites and Controlling invasive species.

Promote on farm tree planting
Incorporating indigenous species on farm will directly address tangible local needs from the forest, reduce pressure on the most targeted species and allow substantial regeneration of the affected resources. Encouraging farmers to propagate trees in the nursery from seed can enhance restoration since wildings will be to some extent left intact with out destabilising the ecological functioning of the forest.

Large scale nursery establishment
This is important to complement or buffer short falls in supply of indigenous species seedlings. This could be done with intensification of indigenous tree seed technology research and development. Collaboration from research and technology development institutions will discourage the disturbance of forest habitats as a source of germplasm for on farm tree planting. Currently wildings of *Prunus africana* and *Maesopsis eminii* are obtained from the forest and planted on farm.

Enrichment planting in the forest-
Plant species used for charcoal, timber and medicine could be pioneered because they are highly exploited for monetary benefits. Providing tree seeds of first growing indigenous species will be important for arousing interest from the local inhabitants.
Collaboration from different stakeholders especially those in management, protection and research should be enhanced to ensure adequate protection of the remaining resource.

Zoning for easy monitoring
Currently, there is a general feeling among the local populace that the government accrues more benefit from the forest than the local people through timber selling. It is also not officially recognised from the current management that licensed logging in the forest actually contributes to degradation.
Looking for a market of forest tree seedlings will motivate local people to establish small scale nurseries as a direct or alternative source of income from forestry, other than the actual harvesting from the forest. In Mabira forest, incidences of pest attack, invasive species weeds and diseases among others are a common problem.

Eco-tourism activities
These activities mainly target the wealthier and interested resident of Kampala and Jinja and to some extent foreign visitors. The most immediate communities to Mabira forest do not attach values to eco-tourism activities unless they are physically involved in earning money from these activities.
Current documentation on eco-tourism in Mabira shows an almost equal share of benefits from these activities. Fourty percent of all revenue collected from eco-tourism is supposedly returned to do community work. This is generally not appreciated by individuals within the community since the revenue does not directly contribute to their household incomes. Promoting conservation programmes to such individuals is almost meaningless, since they look at the forest in terms of extracting products to obtain income for sustainability of their families. Allowing local people to use dead wood and other related resources in the forest can be a good incentive to encourage their participation in Management.

Soil erosion control
In places such as Najjembe and Nagojje sub-counties, opening up of the natural vegetation leaving the soils almost bare is perpetual. This is common where sugar cane and tea out growing are expanding. In the sugar cane fields, usually small un-sustained ridges are established on which sugar cane germplasm is introduced to reduce or minimise recurrent erosion effects. If not improved, dwindling soil fertility levels and crop yields is expected. The effect is likely to spread from the actual sugar cane and tea fields to adjacent agricultural fields. Locally the solution will be to clear more forest land that has maintained its nutrient recycling for agricultural purposes. In addition, the eroded soils end up in water catchment areas causing siltation.

Farming practices
Agroforestry is a common technology on over 80% people's farms. The technology is however practiced with and without farmers' awareness. Generally, tree/shrub species (e.g. *C. edulis* in Buwola parish) with potential to supply immediate frequent income (i.e. grows very first and locally demanded) to a family are used. On some farms, forest trees such as *Albizia coriaria A. grandibacteta, Antialis toxicalia* and *Milicia excelsa* are deliberately retained on farm. On others, first growing tree/ shrub species (e.g. *Maesopsis eminii Ficus natalensis*, *Calliandra collyrthsus* and *Moringa oleifera*) are incorporated with bananas and coffee. In most places fruit trees (*Artocarpus heterophyllus, Mangifera indica Persea Americana and Citrus Spp.*) are common on farm and in others non fruit but multipurpose trees are deliberately grown.
The technology has potential for complementing restoration practices especially if targeted species in the forest are promoted for on farm purposes. Extensive community sensitization will be necessary to create awareness and arouse interest about these species. Additionally, development of seed banks for the promoted species will be required to sustain the technology.

Restoration of degraded sites

In Nagojje sub-county, some restoration has been attempted by CIDEV through NACOBA. CIDEV supplied seeds of C. deeratus and Arauricaria Sp. and about 4 ha of degraded sites have been replanted with C. deeratus and 8 ha of Arauricaria Sp. have been established. Replanting C. deeratus contributes to restoration because it is indigenous in the area and people need it for craft making. However, introducing Arauricaria Sp and any other exotic species does not contribute to effective restoration. Restoring degraded sites using exotic species can constrain the indigenous species abilities to regenerate and generally distabilize the ecosystems functioning.

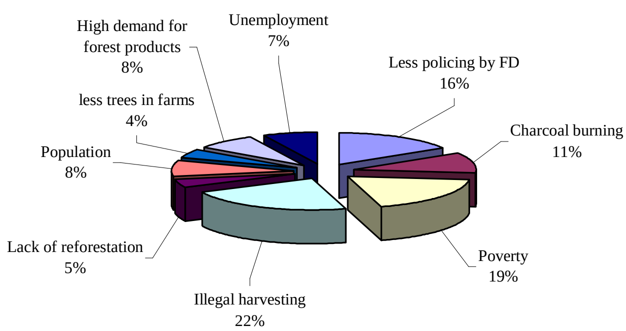
Indigenous species should be promoted since they are locally demanded and so planting in the degraded sites would contribute to restoring what is actually used. If an exotic species is to be introduced, adequate research on its likely behaviour (regeneration capacity, effect on other species, possibility of pest and disease hostage) in a new environment should be conducted. Where possibilities of community adoption are high, the people should be sensitized about the dangers of the technology or species and how they can be minimised.

Controlling invasive species
In Mabira there are minimum efforts to control invasive species. Species such as *Broussonetia papyrifera* are promoted in some places for fire wood because of its rapid growth abilities. In the tea estates, for example, it is replacing *Eucalyptus* and other species for firewood, and pure stands are established next to a strict nature reserve. Although it is periodically harvested, still little information is known about its actual effect on the ecosystem functioning of the forest. In addition, it is not certain whether the species has other useful roles to ecosystem functioning and the alternative importance to the local people could subject to it.

Kenya

Forest and livelihood
Mau forest is facing challenges because most areas bordering communities are degraded and this is likely to continue because of growing the population, poverty, and land hunger. The local community is highly dependent on the continued presence and availability of forest products and services for their livelihoods. Charcoal making has been identified as the main destructive use of the forest because the indigenous species used take long to mature and that alternative tree species on farms are limited or not available and therefore there is need to encourage commercial tree growing compatible with the current land uses and livelihoods of the people.
However, beyond the direct uses, the policy and its application is considered as a major factor of the future evolution of forest.
Fig 11 extracted from (Lang'at et al 2008)

Fig.11: Perceived threats to the forest, Itare



The promotion of agroforestry and multiple purpose trees is a priority to most households. The tree candidate species for intensification are: *Grevillea robusta, Dombeya torida, Podocarpus latifolia, Zanthoxyllum gilletti, Polycious fulva* and medicinal plants like *Prunus Africana, Dodalia abbysinica, Neem*. The medicinal plant trade is growing and there is potential for the local people to domesticate these species as diversification of their income sources. Farmers with big land sizes should be encouraged to intensify tree growing for target markets like timber, pole wood and firewood. The potential species are Cypress, Eucalypts, and Acacia spp. Most charcoal produced and consumed in Kenya are from unsustainable sources (indigenous forests and drylands) and is regarded as the most destructive use of the forest. The market for charcoal is immense and there is an opportunity for the farmers to go into energy plantations. The potential tree species for charcoal production in the area are: *Croton megalocarpus, Eucalyptus camaldulensis,* and *Acacia mearnsii.*

Stakeholders' involvement in restoration activities

Forest department has been involved in forest restoration activities to a limited extent because of in adequate capacity. Other stakeholders have been involved in reforestation. In the recent years this has only been restricted to companies who are permitted to harvest from public forests. The companies are involved in reforestation activities on areas harvested. Unfortunately this system has no developed framework and reforestation by private companies is undertaken as a show of goodwill to Forest Department by companies enjoying harvesting rights. A fundamental question other stakeholders are asking is: how will these benevolent companies benefit from activities or are they being strategic in their posturing so as acquire potential land leases in the areas they have helped reforest? If reforestations on public lands are to be fair and equitable there should be a sound framework with clear rules, roles and obligations of each stakeholder in reforestation.

The local community depends heavily on forest resources and if reforestation efforts exclude them, efforts may not yield desirable results. The forest department seems to be completely detached from the needs of the local people and in most cases the relationship with local people is antagonistic. If the communities have to be involved in restoration work the communities and forest department have to change their relations.

There is clear need for the development of a robust institutional framework which would cover both the forest service (Forest Department), NGOs, local communities and private sector which should bring all players together to improve the coordination in restoration degraded forests, management and conservation of indigenous forests. With the trend towards community participation there is need for flexible management approaches with broader representation.

Madagascar

Natural forests have decreased over the past 50 years due mainly to slash and burn practices. On the opposite, Eucalyptus forests areas have increased during the same period of time to fill the socio economical gap due to the loss of natural forest resources. Forest degradation is an iterative process which is caused by the search of new fertile soils for agricultural processes. The more the farmers burn, the more the fertility of the soil decreases, the less the agricultural production is. Therefore, farmers use Eucalyptus planting (which is at the same time highly recommended by the forest administration in the country) as an easy way of generating new incomes since eucalyptus plantations do not require much care.

Communities' practices as far as forest restoration or reforestation are concerned are based on looking for coppices and replanting them next to the village. But most of their trials fail. They would rather now grow eucalyptus and pines, although they think those species are not really adapted to the region.
For testing new species in their framing system, technical files describing 8 of the most used species of Anosibe an'Ala (see D 1.6 deliverable) should b a useful tool.

The perception of the vegetation dynamism and soil fertility in the region by the local communities (see D1.4 deliverables and next Fig. Vegetation dynamics) will help WP7 and other projects to build solutions with stakeholders

Developing restoration strategies

At a regional level, multi uses of the different spaces must be considered : species exploitation or collection in natural forests, fallows and swamps, tourism in primary forests, slash and burn cultivation on fallows and primary forests, honey production on fallows and near the villages

At the village and farm scale, types of degradation and solutions, especially those put forward by farmers, must be taken into account in restoration strategies so that participation by neighbouring populations is effective and efficient.
The state restoration strategies are aimed at restoring the perception of a 'virgin forest', which in fact does not exist. So, we propose to the development operators to abandon the idea of restoration of 'the natural forest' as a whole. The natural dynamics of forest ecosystems combined with restoration operations should lead to the establishment of a multifunctional landscape mosaic. The functions assigned to each patch change in space and time according to the functions to be restored for the stakeholders there and the potential of the environment (cf. Figure 1). Although the management of a patch is performed with the aim of restoring function F1, the range of functions effectively restored may be broader.

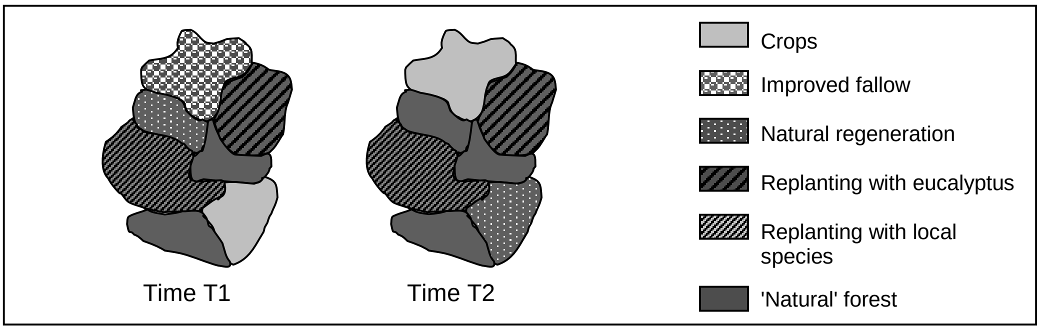
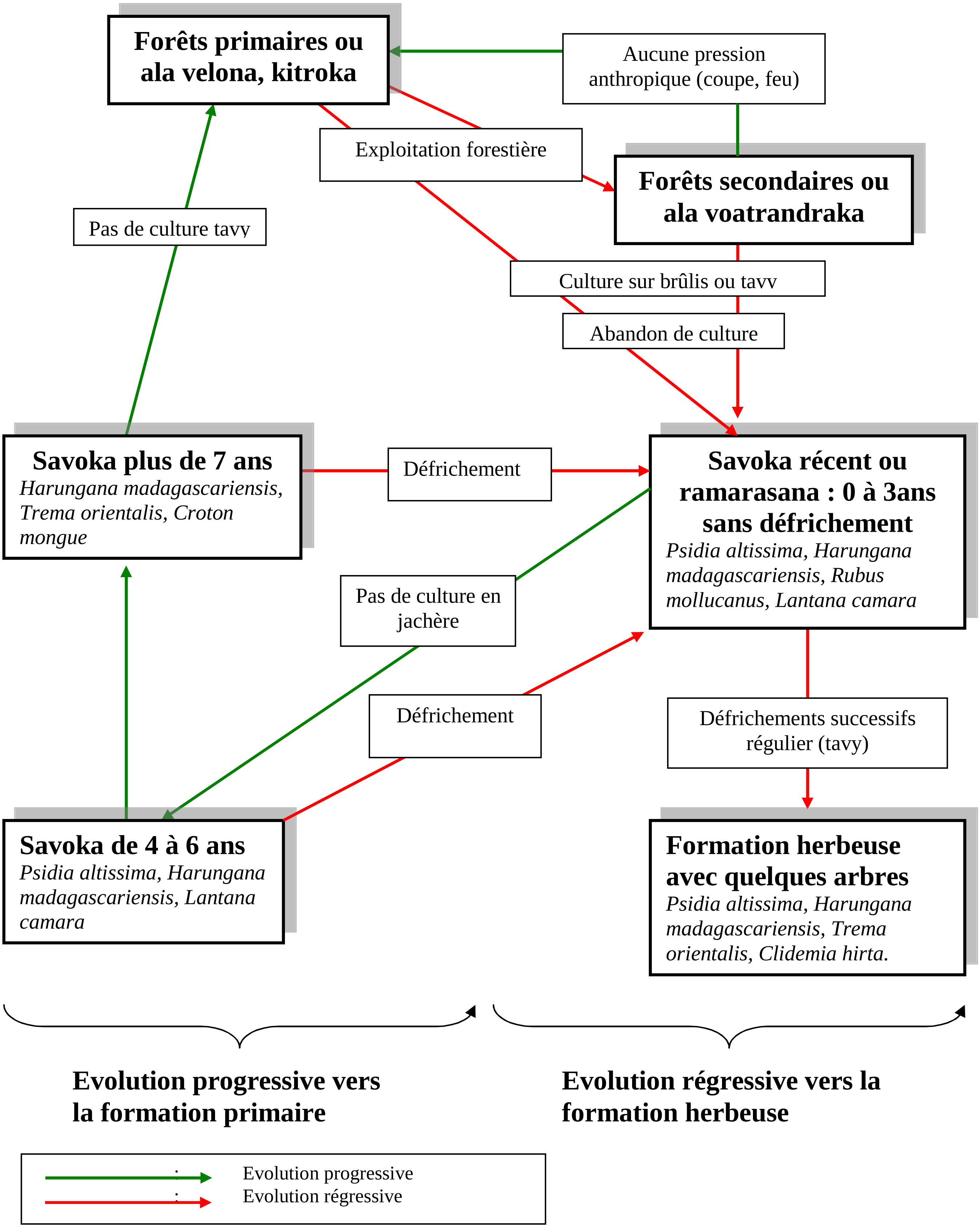


Fig. Diagram of multifunctional landscape mosaic (Rives, Sibelet, Montagne, 2008)

This aspect is clearly illustrated by plantations of eucalyptus. In some places, farmers plant eucalyptus to restore the timber production function (the restoration objective of local stakeholders); this action also restores soil protection function (functions effectively restored).

The diagram of multifunctional landscape mosaïc, showed ahead is a comprehensive model. For becoming a prospective-model, it has to be rebuilt case by case with further collaboration with stakeholders, especially in the next year of the project.
Accepting landscape mosaic that differs from so-called primary forest makes it possible to envisage other solutions that are better suited to the local socioeconomic context and that can therefore be handled by local stakeholders.

Fig. Vegetation dynamics according to local communities



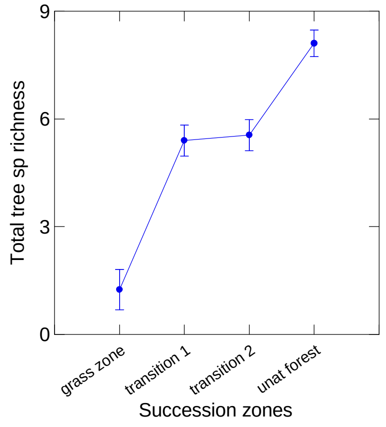
Work package 2 – Assessment of forest ecosystem degradation, and community structure and species biology for the development of restoration options

2.1 - Diversity and composition of species

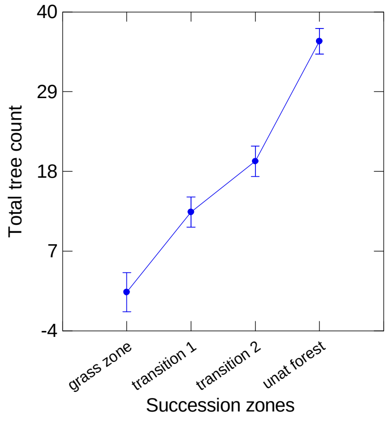
Mau forest, Kenya

The diversity and composition of plant species in areas of various degrees of degradation and succession in the Mau forests in Kenya have been described. Four stages, namely the heavily degraded grass zone, initial recovery and advanced recovery transition zones, and the undisturbed natural forest were described. Repeated measure Anova showed that plant species richness and abundance significantly varied along the succession stages from heavily degraded to advanced recovery and the natural forest (Fig. 1). The degraded zones had the lowest plant species richness and abundance. The difference in total tree species richness between initial stage of recovery and advanced stage was not significant. However, the species abundance differed significantly. Lianas, herbs, ferns and tree seedling species richness was significantly affected by season, with wet season having more species than dry season. Species abundance of lianas, herbs, ferns, tree seedlings (Fig. 1d) and tree saplings also varied with season. Canonical Correspondence Analysis showed that the most important environmental variables to explain the differences in species composition were succession stage, season and human disturbance, measured as length of paths crossing the plots. Succession stage had the highest explanatory power for all the plant forms. The results suggest a strong relationship between succession stage and plant species richness, abundance and composition in degraded forests.

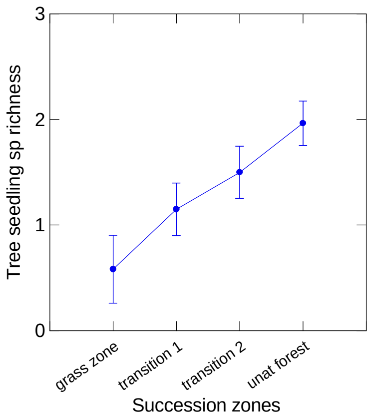
a)



b)



c)



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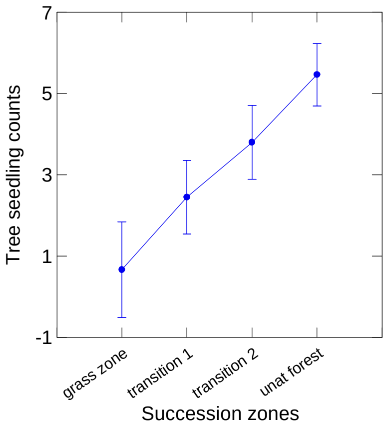


Fig. 211 Species richness and density of all stages of trees (a, b) and tree seedlings (c, d) in the four stages of degradation and succession; heavily degraded grass zone, initial recovery Transition zone 1, advanced recovery Transition zone 2, and the natural forest of Mau, Kenya.

Vohimana forest, Madagaskar

Slash-and-burn agriculture is an important driver of deforestation and ecosystem degradation, with large effects on biodiversity and carbon sequestration. Vohimana forest consists of fragments of slash-and-burn patches, intermingled in between secondary and primary forest. By measuring species richness and composition of plant species in fallows of different age and land use history, and in the secondary and primary forest, we examined how the degree of slash-and-burn intensity, number of slash-and-burn cycles, years since abandonment, or environmental factors, such as distance to the primary forest and topography, affect the vegetation succession and recovery of the forest ecosystem. By multivariate analyses of the species composition of the different succession stages of the fallows, we also aim to identify potential restoration species for the rainforest in Madagascar. Our results show that species richness and abundances of tree seedlings and saplings increase from the youngest fallows to the secondary and primary forest, and that number of years since abandonment is an important factor for the establishment of tree species. This suggests that the recovery of the fallows will develop towards the structure, diversity, and composition of the secondary and primary forest if they are left to natural succession, although it may take more than 30 years before secondary forest is established.

Study of strata :

Formation	Number of strata
Primary forest (F1)	03
Secondary forest (F2 f)	02
Secondary forest (F2w)	03
Secondary forest F2 f w)	03
Fallows	01 or 02

The secondary forest that underwent the passage of fire and the withdrawal of wood present or only a withdrawal of wood and the primary forest present the same number of strata.

Study of cover:

Formation	DBH cm	Area terriere (m^2/ ha)	Biovolume(m^3 / ha)
Primary forest (F1)	26 to 190	34 to 92	107 to 462
Secondary forest (F2f)	3 to 39	0,2 to 64	2 to 289
Secondary forest F2w	18	11	39
Secondary forest F2 f w	27 to 43	38 to 137	107 to 292
Fallows	-------	0, 1 to 42	0, 5 to 125

The area and the biovolume decreased according to the types of formation, with a general increase towards the primary forest. The values decreased, and are especially weak for the fallows. In the fallows, when the number of reclaim is raised, the herbaceous species are dominant, likely because the soil is not more compatible to the development of the woody species. However, the older fallows, which have undergone a number of reclamations, are characterized by the presence of woody pioneer species, such as *Harungana madagascariensis* , *Croton mongue* , *Trema orientalis,* associated or not to *Psiadia altissima* and to other forest species .These formations present a forest soil compatible permitting their installation. In the fallows the herbaceous cover varies between 6 and 38 %

a b

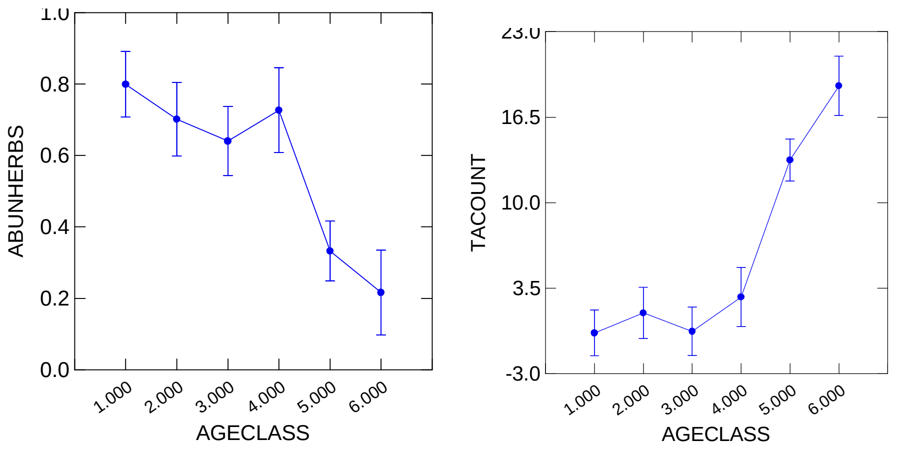


Fig.212 Species abundances of herbs (a) and trees (b) in fallows of different age classes (1-4), secondary (5), and primary forest (6) in the Vohimana forest, Madagaskar.

<u>Study of regeneration</u>

Formation	Rate of regeneration
Primary forest (F1)	340 to 797 %
Secondary forest (F2f)	42 to 2225 %
Secondary forest F2 w	252 to 1025 %
Secondary forest F2 f w	1340 %
Fallows	0 to 83 %

In the primary forests, the rate of regeneration is distinctly superior to 300 %, indicating a good regeneration of these formations. In the secondary forests, this rate depended on the type of pressure. This rate is lower to 100% in the fallows: the regeneration is weak.

a

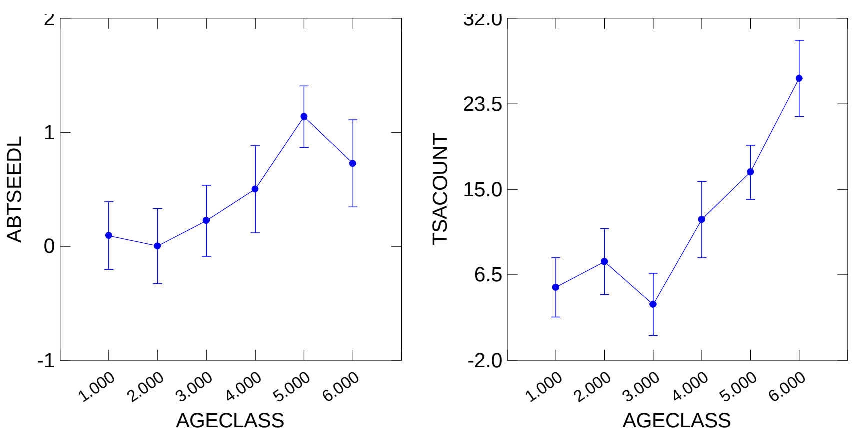


Fig. 213 Species abundances of tree seedlings (a) and saplings (b) in fallows of different age classes (1-4), secondary (5), and primary forest (6) in the Vohimana forest, Madagaskar.

Study of species richness

Formation	Species richness
Primary forest (F1)	57 to 83
Secondary forest (F2f)	20 to 43
Secondary forest F2 w	46 to 55
Secondary forest F2 f w	24
Fallows	11 to 47

The species richness is generally highest in the primary forest, and decreases and becomes relatively weak in the fallows. The composition of flora and the biologic types vary according to type of the formation, to the nature and the number of constraints undergone by the formation. The most represented families depended on the type of the formation:
The primary forests are rich in EUPHORBIACEAE, LAURACEAE, and MYRTACEAE. The MELASTOMATACEAE , the POACEAE and the ASTERACEAE are associated with the EUPHORBIACEAE and the LAURACEAE and sometimes with the MYRTACEAE and the CUNONIACEAE when the forest deteriorates in secondary forest . The fallows are rich in POACEAE and ASTERACEAE.

a b

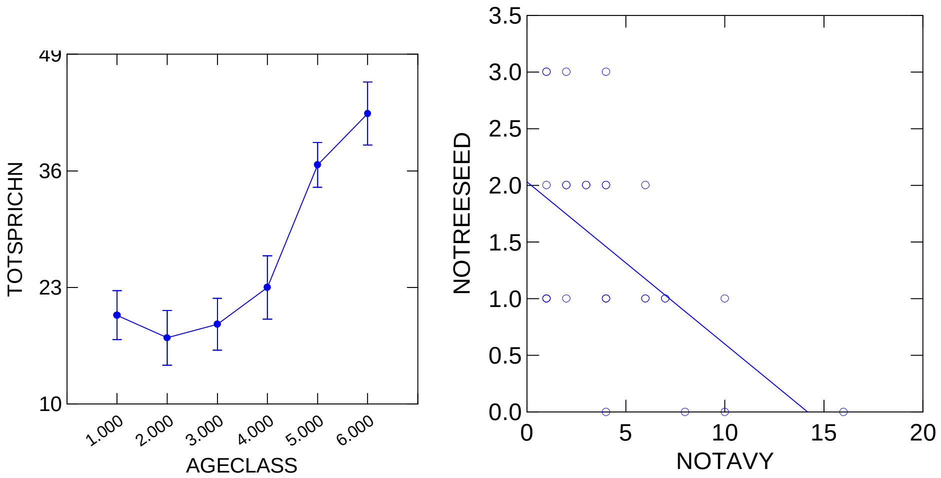


Fig.214 Total species richness in fallows of different age classes (1-4), secondary (5), and primary forest (6), and the relationship between tree seedling species richness and the number of slash and burn cycles (notavy) imposed to the fallows.

Study of dynamics of the plant formations

The primary forest reclaimed or having undergone a first passage of fire becomes a secondary forest where pioneer species can develop themselves next to the forest species. Two cases can occur:
1st case: According to the number of reclaim undergo by the formation, the forest turns progressively into more and more damaged fallow where the pioneer species disappear little by little. The herbaceous species become more and more dominant. Several stages of such an evolution have been

observed in the region. The ultimate stage is the fallow with *Neyraudia madagascariensis* , *Scalaria abortiva* and *Paspalum* sp. However, from the fallow to *Psiadia altissima,* associated with *Clidemia hirta* and *Lantana camara*, the forest can reconstitute itself after a prolonged rest.

2nd case: Fire transforms the secondary formation in fallow presenting pioneer species and herbaceous species. This formation turns into fallow to *Ravenala madagascariensis* where the herbaceous species dominate if it underwent an important number of reclaims. The presence of *Sticherus flagellaris,* invading species in the formation prevents all development of the woody species.

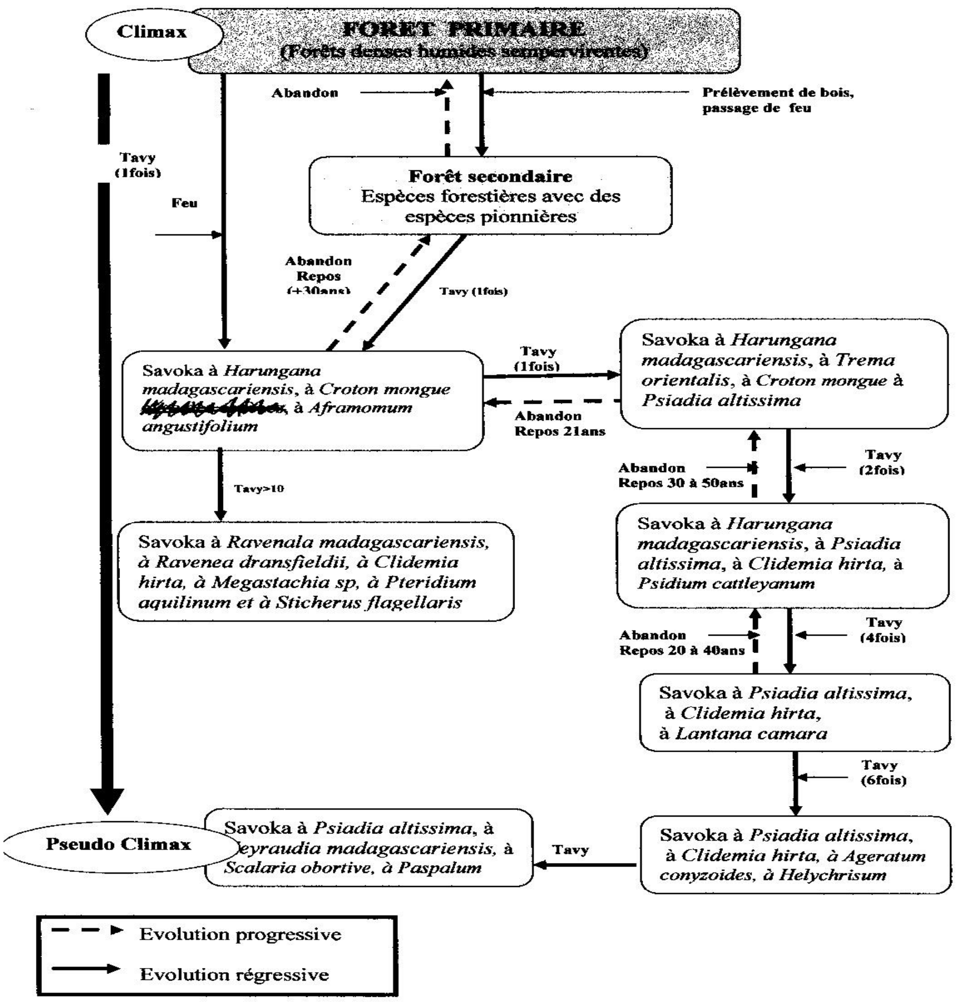


Figure 1. Schéma hypothétique de la dynamique des formations végétales de VOHIMANA

This shows that the evolution is regressive when the forest deteriorates to become more and more poor forest and pioneer species according to the more and more elevated number of the pressure undergone. If the disruption stops, and if the fallow is abandoned during prolonged period, the forest can reconstitute itself provided that the fallows present pioneer species and a forest soil. So, in Vohimana, the restoration is possible from the fallow to *Psiadia altissima*, *Clidemia hirta* and *Lantana camara*. It is more efficient from the stage to *Hatungana madagascariensis, Psiadia altissima, Psidium cattleyanum,* and *Clidemai hirta*

Table 1. Multiple regressions of the relationships between different parameters and the species richness and abundances of tree seedlings, saplings, adults, shrubs, herbs, and all species in fallows in the Vohimana forest. Parameters, standardized regression coefficients (β) and *P*-values are shown.

Parameters	Treeseedlings		Tree saplings		Tree adults		Shrubs		Herbs		All species	
	β	*P*	*β*	*P*	*β*	*P*	*β*	*P*	*β*	*P*	*β*	*P*
Species richness												
Distance to forest	**-0.40**	**0.016**	-0.28	0.146	-0.01	0.941	***-0.35***	***0.056***	-0.28	0.162	***-0.36***	***0.063***
Years since abandonment	0.00	0.987	***0.37***	***0.061***	**0.49**	**0.010**	**0.40**	**0.034**	-0.19	0.348	***0.32***	***0.098***
Slash and burn cycles (n)	**-0.59**	**0.001**	-0.19	0.343	-0.15	0.394	-0.21	0.261	0.04	0.838	-0.21	0.284
Slash and burn intensity	-0.08	0.621	-0.08	0.678	-0.17	0.328	0.07	0.693	0.06	0.775	-0.03	0.855
Slope	-0.00	0.990	-0.02	0.901	-0.17	0.352	-0.22	0.238	0.01	0.950	-0.04	0.856
Species abundances												
Distance to forest	-0.28	0.117	-0.21	0.237	0.01	0.952	-0.21	0.139	0.09	0.608		
Years since abandonment	-1.19	0.288	**0.53**	**0.006**	***0.33***	***0.093***	***-0.26***	***0.065***	-0.06	0.726		
Slash and burn cycles (n)	**-0.48**	**0.014**	-0.07	0.686	-0.21	0.281	**-0.30**	**0.043**	***0.35***	***0.065***		
Slash and burn intensity	-0.10	0.589	-0.04	0.839	-0.16	0.394	**0.47**	**0.002**	-0.02	0.926		
Slope	-0.14	0.453	-0.08	0.670	-0.21	0.277	**0.36**	**0.015**	***-0.35***	***0.067***		

Mabira forest, Uganda

2.2 - Report on survival and growth of selected tree species from Mabira Forest Reserve

1.0 Growth curves for *Albizia zygia*, *Maesopsis eminii*, *Canarium schwenfurthii*, *Zanthoxyllum macrophylla* and *Khaya anthotheca* are presented in Figures 1-7.

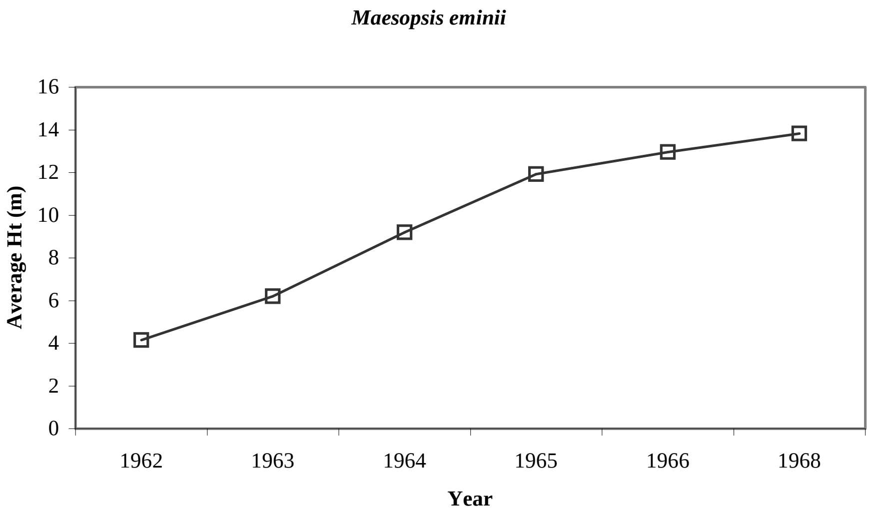


Figure 221: Growth curve of *Maesopsis eminii* by height from 1962 to 1968

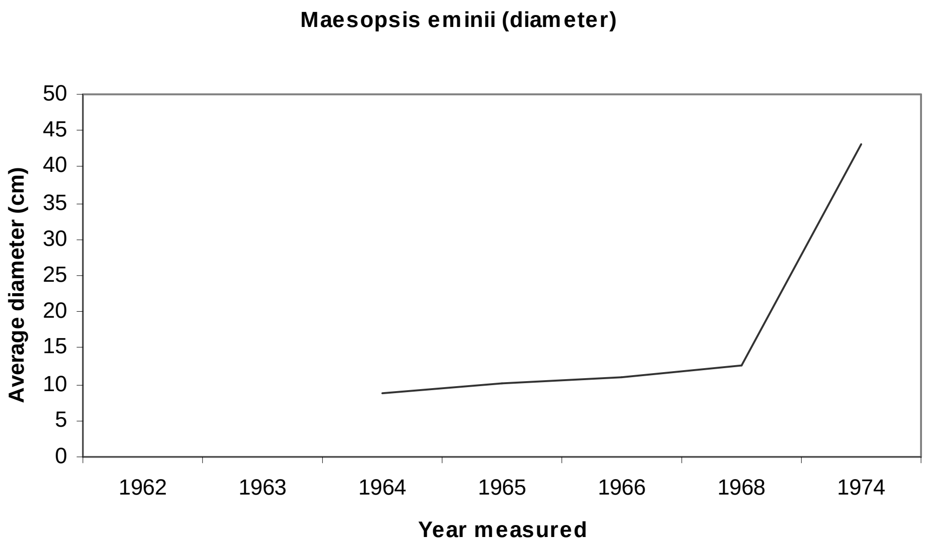


Figure 222: Growth curve of *Maesopsis eminii* by diameter (cm) from 1962 to 1974

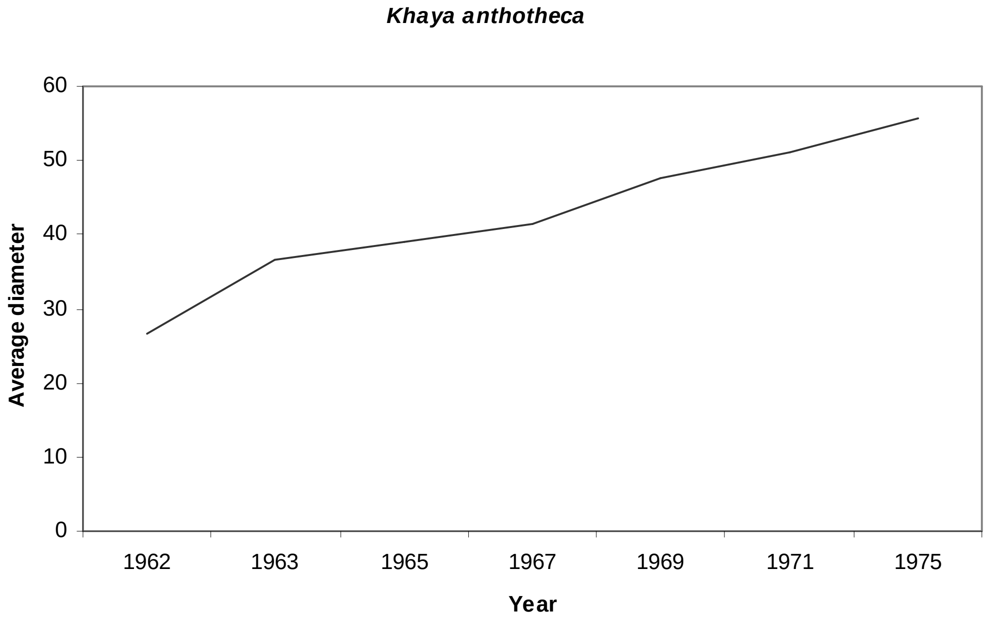


Figure 223: Growth curve of *Khaya anthotheca* by diameter from 1962 to 1975

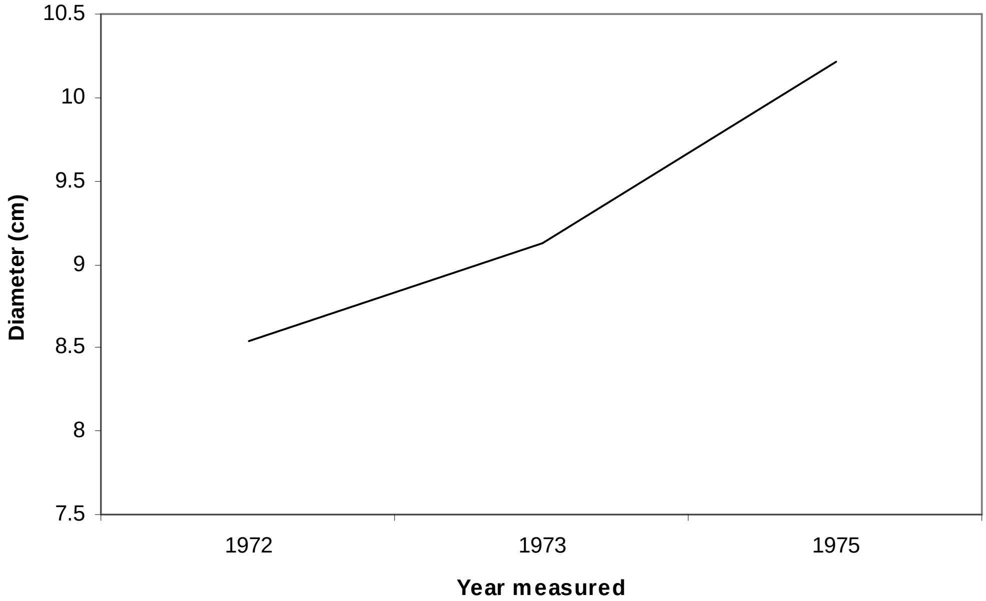


Figure 224: Growth curve of *Fagara macrophylla* by diameter from 1962 to 1975

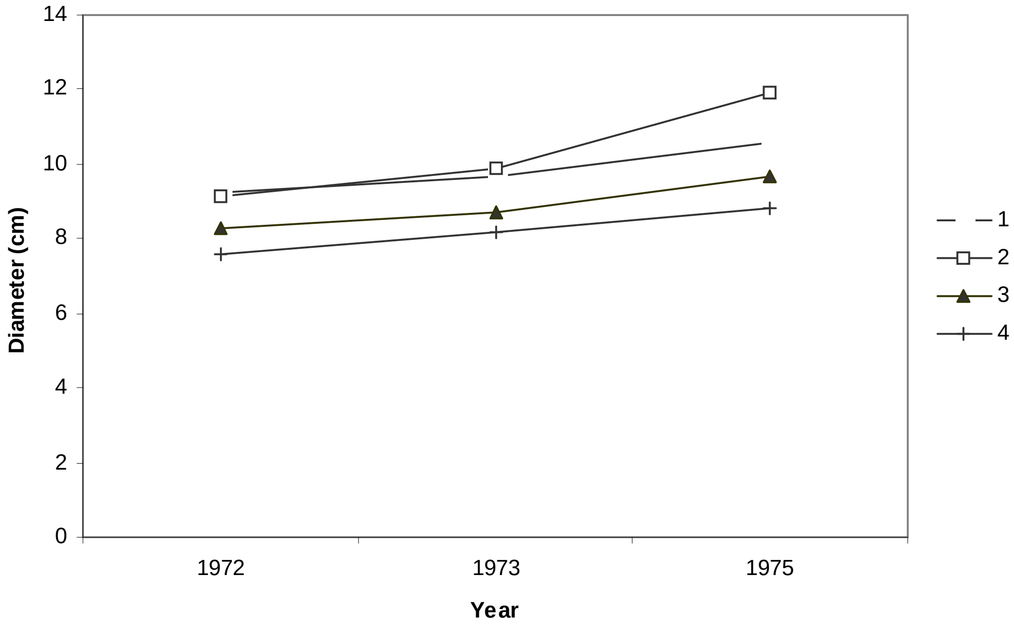


Figure 225: Comparison of *Zanthoxyllum macrophylla* growth performance from 1972 to 1975 in four plots (1, 2, 3 and 4)

2.0 Comparisons of species performance

Albizia zygia and *Canarium schweinfuthii Engl.* were in planted felled and refined blocks.

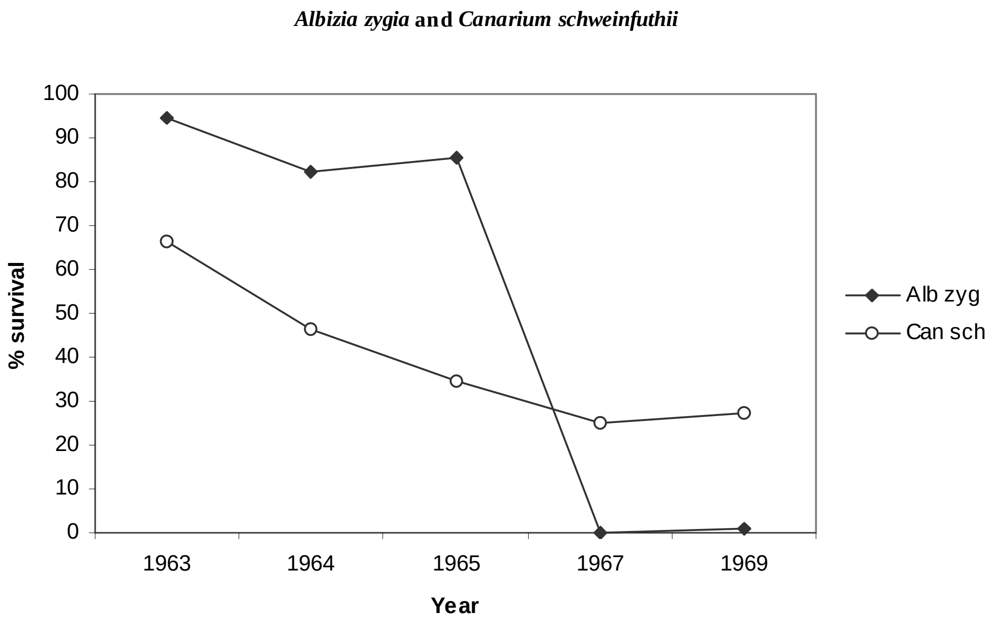


Figure 226: Comparison of growth performance of *Albizia zygia* and *Canarium sweinfuthii* in planted felled and refined blocks (1963 to 1969)

Although *Albizia zygia* survival was high in the first three years it failed completely in 1967 while *canarium sweinfuthii* continued to survive beyond 1969.

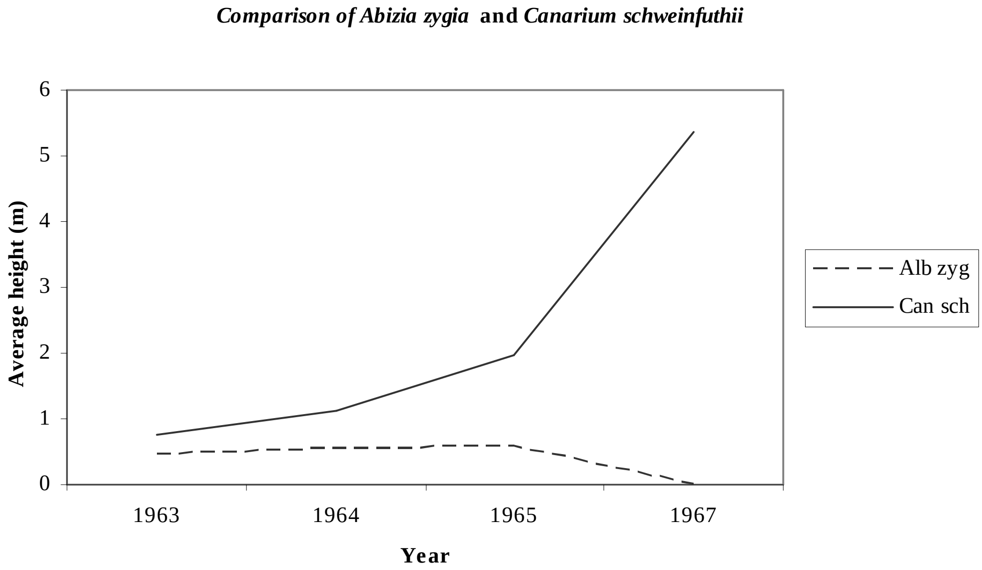


Figure 227: Comparison of height growth performance of *Albizia zygia* and *Canarium sweinfuthii* between 1963 and 1967

A sharp rise in the height of *Canarium schweinfuthii* curve occurred between 1965 and 1967 while *Albizia zygia* failed completely in 1967.

2.3 - On-Farm Tree Diversification Trial

On-farm tree diversification trials set up earlier are being monitored. The trials are to offer farmers a number of promising tree species to experiment with, and to provide a test of farmer priorities, practices and problems. This is very important as the introduction and improved management of high value trees on farm is a promising avenue for diversifying farm production and developing income opportunities.

Materials and Methods

Farmers from five sub-counties surrounding the Mabira forest were selected. The farmers were selected from the sub-counties of: Nagojje, Najjembe, Kimenyedde, Kyampisi and Nyenga. Twenty farmers were selected to undertake this trial on their farms. An assessment to ascertain growth performance and survival of the tree species is being carried out on various tree species in Table 1.

Table 231. Tree species selected for on-farm diversification trial

1 Species name	Exotic / indigenous	Purpose
Canarium schweinfurthii	Indigenous	Fruit
Cordia africana	Indigenous	Wood
Milicia excelsa	Indigenous	Timber
Prunus africana	Indigenous	Medicinal

So far, the growth parameters measured are tabulated (Table 2).

Table 232: Growth performance table for tree species under trial

Species' name	Average root collar diameter (cm)	Average height (cm)	Average crown diameter (cm)	Crown/Diameter ratio
Canarium schweinfurthii	6.44	462.00	123.33	5.22
Cordia africana	9.50	570.00	80.00	11.88
Entandrophragma spp	1.10	63.33	20.00	5.50
Milicia excelsa	1.77	190.00	103.33	1.71
Prunus africana	2.33	403.33	160.00	1.46

It is evident that *Prunus africana* and *Milicia excelsa* have shown generally low crown diameters. Since, crown diameter ratio has implications for intercropping trees and crops, trees species with large crowns such as *Cordia africana*, *Canarium sweinfuthii* and *Entandrophragma* spp can discourage farmers from planting them because such trees compete with the planted crops.

Phenology

The tree species monitored for phenology (in terms of flowering and seeding regimes) is presented in Table 3.

Table 233 Phenology of selected trees

Botanical name	Flowering time	Seeding time
Cordia millenii	March-April	Aug- Sept
Maesopsis emnii	June - Jan	April-May
Warburgia ugandensis	July-Aug	Nov-Dec
Lovoa trichiliodes	Aug-Sept	April-May
Khaya anthotheca	Jan- March	Jan – Feb
Canarium schweinfuthii	Feb/March	January
Zanthoxyllum macrophylla	February to August	July to Dec

This preliminary analysis reveals that flowering and seeding regimes vary between species.

Work package 3 – restoration/rehabilitation through planting: characterisation and silviculture of native and naturalised species to restore environmental and economical function

3.1 - Task 3.1 : Assessing the potential of species in plantations for accelerating restoration of degraded forest and producing wood and NWFP

3.1.1 - Identification of species in the forest of Mabira Uganda

Operational activities

Identification was carried on economically important species through reviews of literature on timber and non wood forest product species production date from various experimental sites in Mabira from as far back as 1959. All the available raw data were collected, analysed for those years and growth curves plotted.

Identified Species

The following species were identified and information sought on them:

Albizia zygia, Maesopsis eminii, Canarium schwenfuthii, Fagara macrophylla and *Khaya anthotheca*

2 On-farm tree diversification

The introduction and improved management of high value trees on farm is a promising avenue for diversifying farm production and developing income opportunities. The range of species made available to farmers is often restricted and does not always consider farmers' priorities. This trial offers farmers a number of promising tree species to experiment with, and will provide a test of farmer priorities, practices and problems.

Objective

The overall objective is to provide farmers a range of socio-economically useful tree species that can diversify farm production and generate income

2.1.1.1.1.1 Materials and Methods

Farmers from five sub-counties surrounding the Mabira forest were selected and trained. The farmers were selected from the sub-counties of: Nagojje, Najjembe, Kimenyedde, Kyampisi and Nyenga. Twenty farmers were selected to undertake this trial on their farms. An assessment to ascertain growth performance and survival of the tree species was to be done very after six months.

Table 311.Tree species for the diversification trial

Species name	**Exotic / indigenous**	**Purpose**
Canarium schweinfurthii	Indigenous	Fruit
Cordia africana	Indigenous	Wood
Milicia excelsa	Indigenous	Timber
Prunus africana	Indigenous	Medicinal

Results and highlights

4 Niche of planting

The farmers were left to choose their niche of planting for the tree species given and niche is an important factor in the survival, management and tells much about the growth characteristics of the tree and the value attached to it. The farmers' common planting niches are shown below:

Farmers' common tree planting niches

The farmers’ major niche was the home garden; fruit trees were especially planted in the home garden to ensure adequate management. However, known long rotation trees such as *Milicia excelsa* were mainly planted at the boundaries or scattered on the farm. The main reason for scattering was for trees to benefit from the general farm management such as weeding. The desired niche of planting has implications on the type of tree species planted. Trees with big and superficial roots are not recommended for planting in homesteads because they can easily lead to cracking of houses.

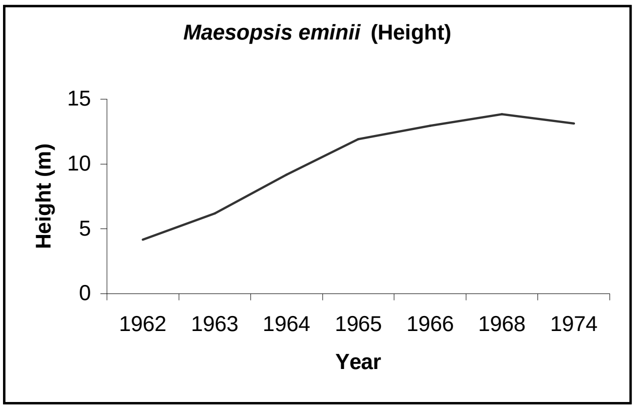
Table 312: Growth performance table for tree species under trial

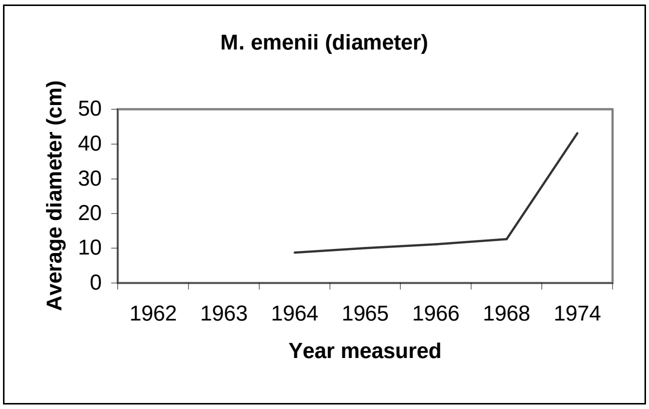
Species' name	**Average root collar diameter (cm)**	**Average height (cm)**	**Average crown diameter (cm)**	**Dia**
Canarium schweinfurthii	6.44	462.00	123.33	
Cordia africana	9.50	570.00	80.00	
Entandrophragma spp	1.10	63.33	20.00	
Milicia excelsa	1.77	190.00	103.33	
Prunus africana	2.33	403.33	160.00	

The diameter crown ratio has implications for intercropping trees and crops. Trees species with large crowns discourage farmers from planting them because such trees compete with their crops (see table above)

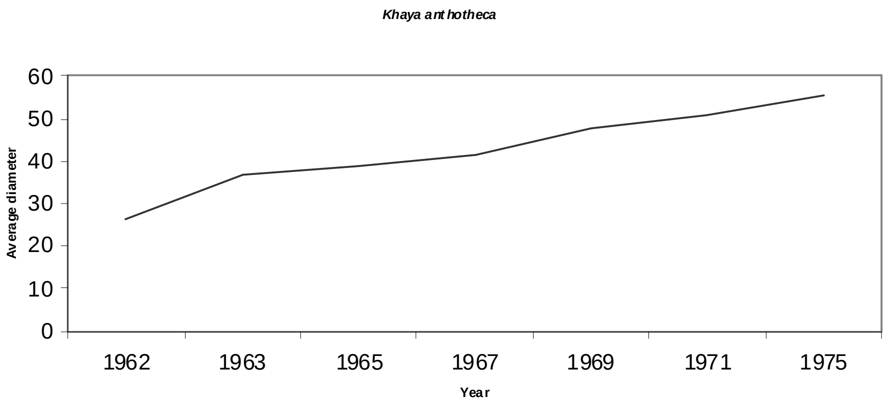
5 Species growth curves

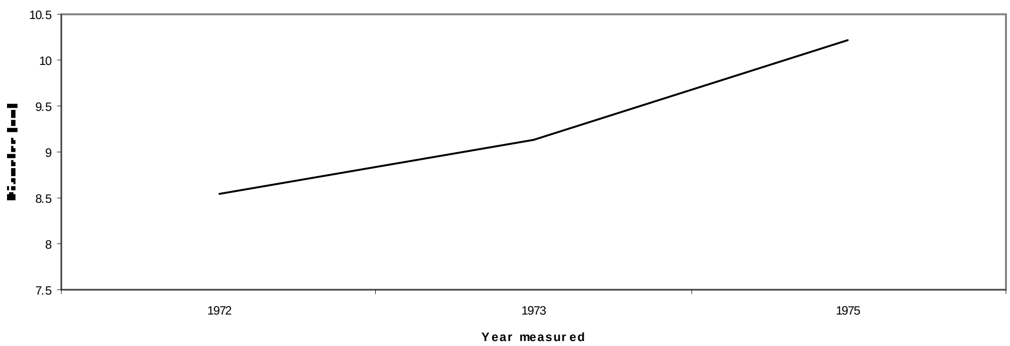
6 Single species trial



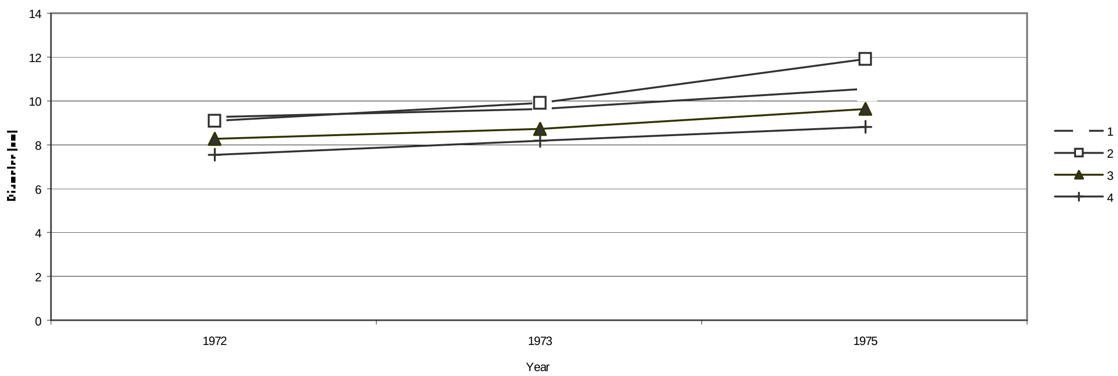


***Maesopisis eminii* growth performance**





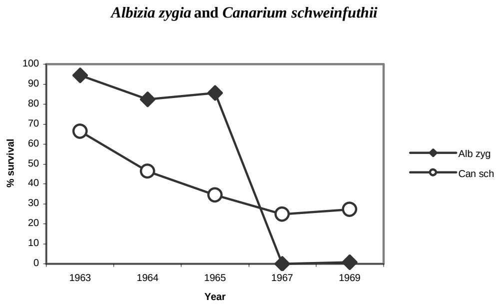
Fagara macrophylla growth performance

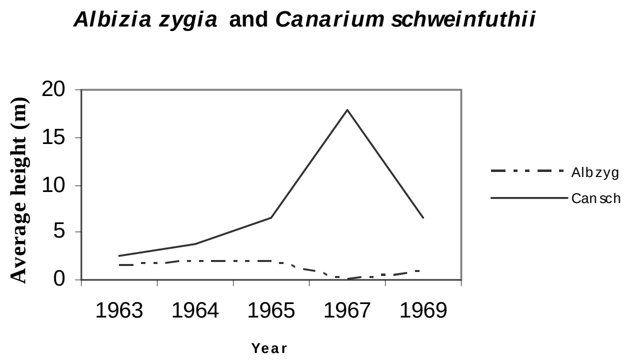


Comparison *Fagara macrophylla* performance in the four block

Species trial for under planting felled and refined forest

Albizia zygia and *Canarium schweinfuthii Engl.* were in planted felled and refined blocks.





Although *Albizia zygia* survival was high in the first three years it failed completely in 1967 while *canarium sweinfuthii* continued to survive beyond 1969. A sharp drop in height of *Canarium schweinfuthii* curve corresponded to the accidental cutting by pit sawyers and a small increase from 1967 – 69 inn the *Albizia* curve was due to natural regeneration of *A. zygia*.

3.1.2 - WP3 DELIVERABLE D3.1 - KENYA

Name of deliverable: Growth curves of native species from Kenya
Selected Kenyan indigenous tree species of economic and ecological importance are: *Prunus africana, Juniperus procera, Polyscias fulva and Xanthoxylum gilletti.*

Measurements (tree height, girth, and quality traits) were taken in temporary sample plots of the species growing in both plantation and natural forest situations

Table 313. Details of Forest Blocks in Kenya from which data was collected

Forest block	**Subcompartment**	**Species**	**Age (Yrs)**	**Spacing (sq. m)**	**Area (Ha)**
Suam	1 (A)	J. procera	30	2.5X2.5	10
Suam	1 (U)	J. procera	35	2.5X2.5	
Suam		P. fulva	71		
Kapcherop		J. procera	16	2.5X2.5	
Kobujoi	1 (F)	P. africanum	25	3.0X3.0	9.8
Kobujoi	1 (F)	P. fulva	25	3.0X3.0	9.8
Kobujoi	1 (F)	X. gillettii	25	3.0X3.0	9.8
Kobujoi	1 (M)	P. africanum	20	2.5X2.5	18.4
Kimondi		P. fulva	11		
Kimondi		P. africanum	33		
Malava		P. africanum	45		
Malava		X. gillettii	31		
Malava		P. africanum	57		
Malava		X. gillettii	33	2.5X2.5	
Kakamega		P. africanum	9	4.0X4.0	
Jubert		J. procera	84		

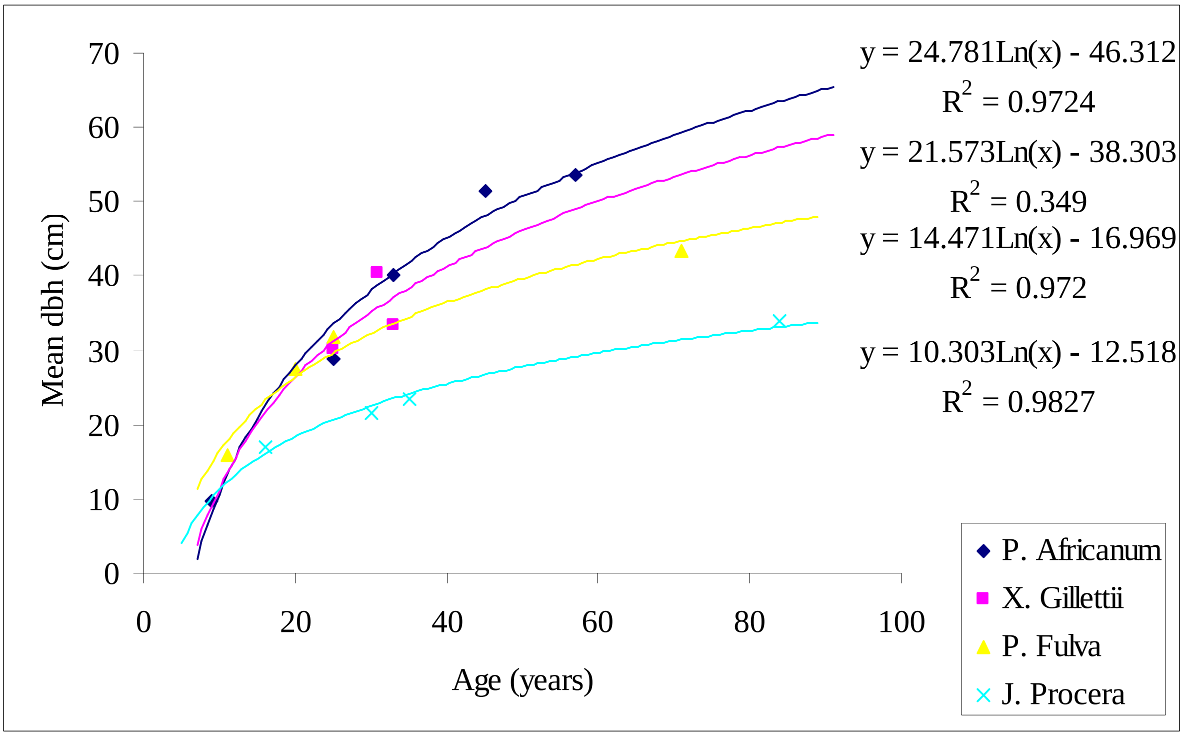


Fig. 1 Age-Dbh Growth curve for the Kenyan indigenous species

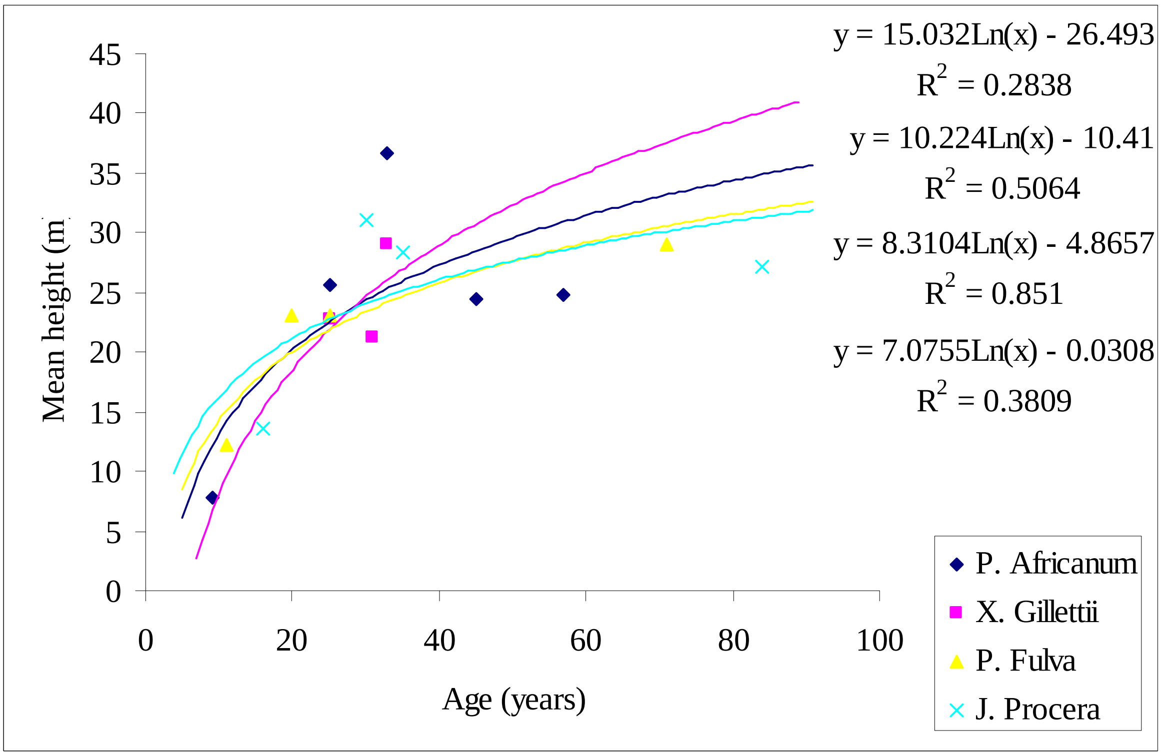


Fig 2. Age- height growth curves for the Kenyan species

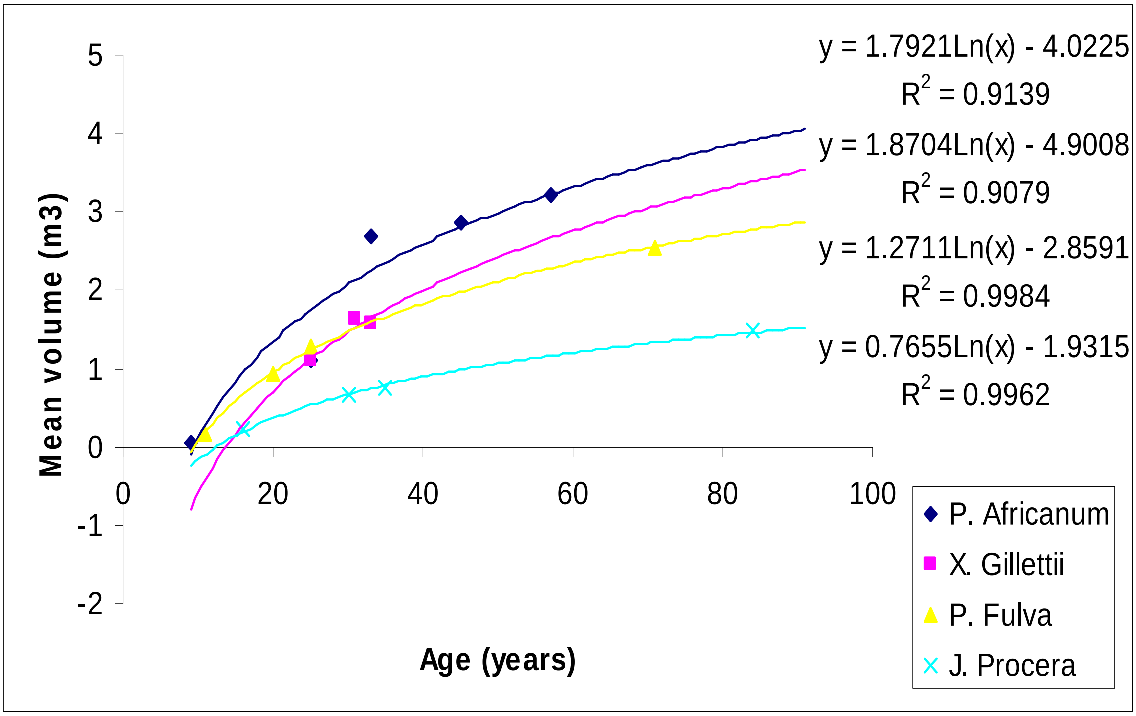
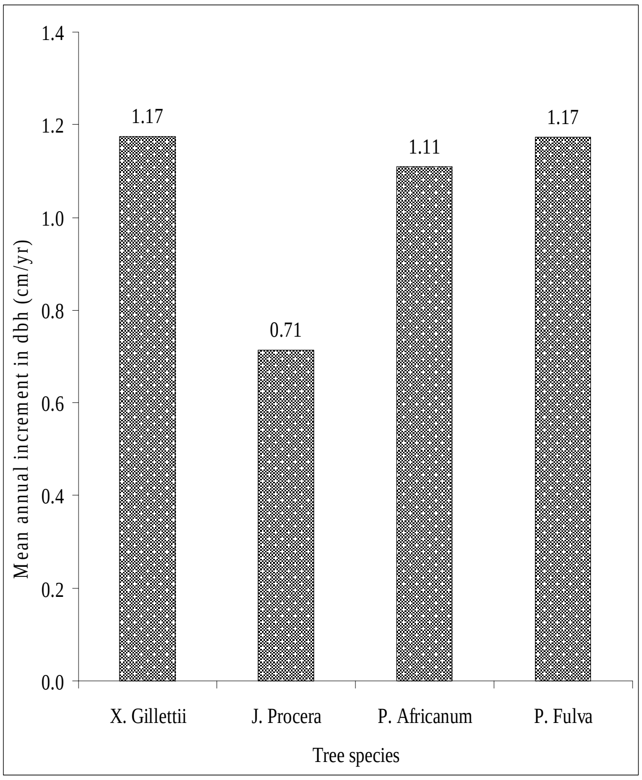


Fig 3. Age-mean volume per tree of the Kenyan species



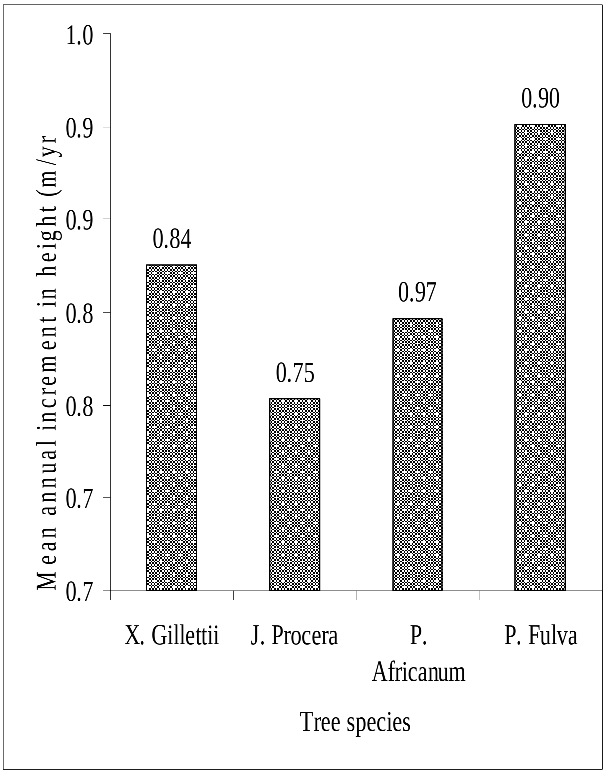
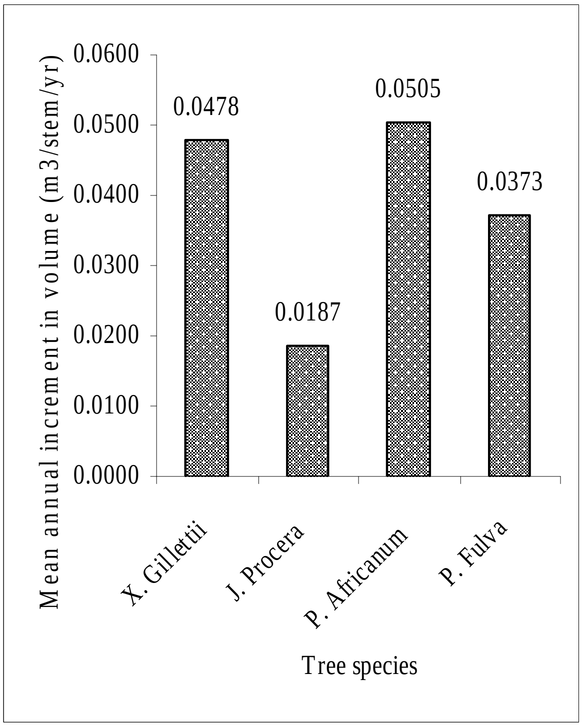


Fig. 4 and 5. Mean annual increment .n growth dbh and height respectively



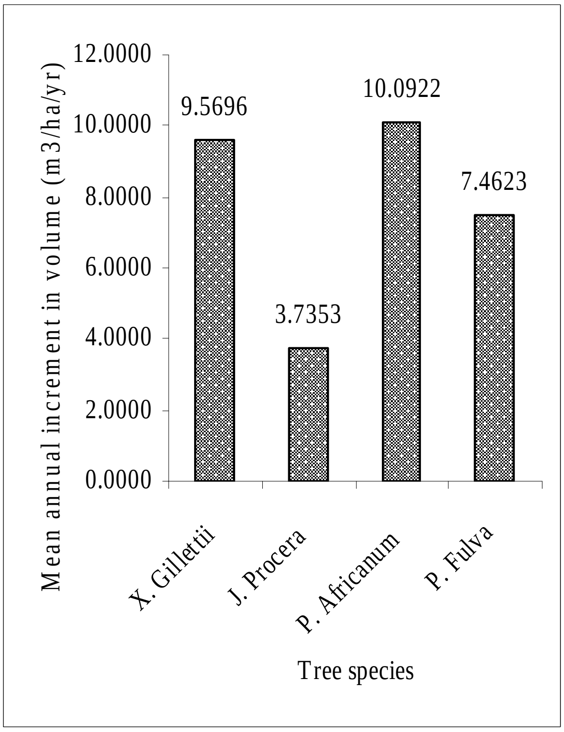
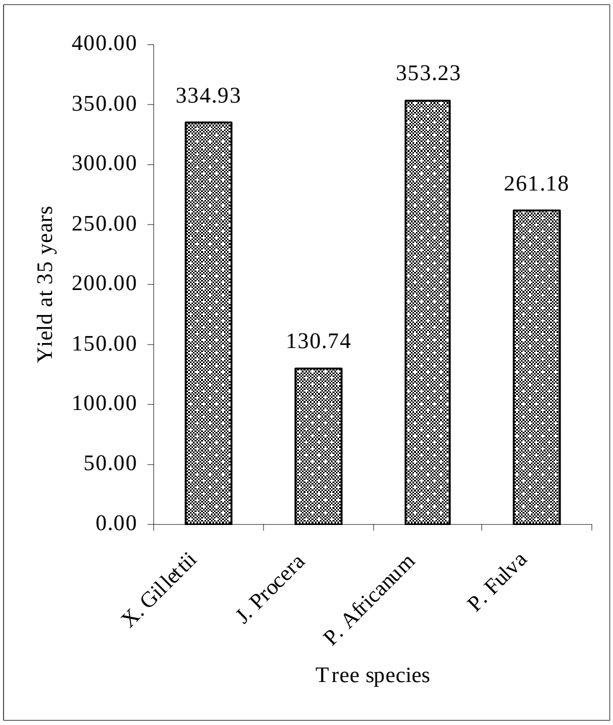


Fig 6 and 7. Mean annual increment in volume per stem per year and per ha. Per year respectively



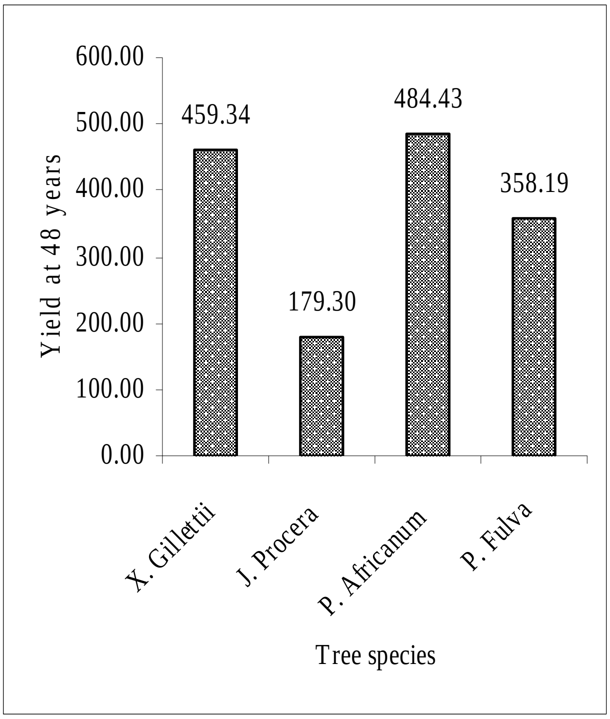


Fig.8 and 9. Total volume (m^3) of wood yield of the spp at 35 years and yield at 48 years respectively

3.1.3 - Report on Phenology of trees with on-farm domestication potential around Mabira Central Forest Reserve, Uganda

Phenology of Trees with Domestication Potential

The demand for forest products is increasing and this is putting pressure on our natural forests. As a result, the Agroforestry programme has embarked on domesticating useful & multipurpose tree species. This is done to enhance availability of tree products such as firewood, timber, fruits and medicine are near the users/farmers as possible. In this activity several tree species were marked in Mabira for phenology and some had data has been collected.

6.1.1.1.1 Objectives

To understand the flowering, fruiting and seeding regimes of selected tree species.

Methods

Several tree species both within Mabira forest and on-farm were marked using paint. Table 3 is a list of some of the tree species marked within Mabira forest showing their flowering and seeding regimes:

Table 3 Phenology of trees marked in Mabira forest

Tree code/ Location	Local name	Botanical name	Flowering time	Seeding time	Use(s)
CM3 (Comp190)	Mukebu	*Cordia millenii*	March-April	Aug- Sept	Timber/boats
ME6 (Comp 205)	Musizi	*Maesopsis emnii*	Feb	April-May	Timber
WU1 (Comp 189)	Habasa	*Warburgia ugandensis*	July-Aug	Nov-Dec	Medicinal
LT1 (Comp 189)	Nkoba	*Lovoa trichiliodes*	Aug-Sept	April-May	Timber

The flowering and seeding time varies within species and genera. It is necessary to monitor the tree species for at least four years if accurate phenology information is to be obtained.

3.1.4 - Training Report on Tree Phenology Study for Forest Department Field Staff-KEFRI

Held on 11th. October 2007 to 20th. October 2007

Introduction

The Kenyan species of economic and ecological importance being studied under FOREAIM Project WP3 are *Prunus africana*, *Polyscias fulva*, *Xanthozylum gilletii*, *Juniperus procera* and *Croton macrostachyus*. The four species grow in different sites in Mau forest block and western Kenya regions. With the exception of *J. procera* and *C. macrostachyus* which seeds abundantly, the rest of the trees have seed problems which range from poor seed crops, irregular seeding, quick loss of viability and damage or consumption by birds and other wild animals. It is therefore important to carry out phenology study in order to determine the time when seeds are ready for harvesting so that seed collectors can know the correct time and season when harvesting yields the highest quantity of seeds.

Objectives of the training

The objective of the training was to equip forest department field staff with the skills necessary to enable them make phenological observations on marked trees and record the finding on a prescribed data form.

Method

The training was conducted at each study site as per table 1 below. A total of twenty one forest department field staff in six different forest stations were trained on phonological observations and recording. The choice of the trainees was based on their experience, familiarity and knowledge of the local forestry conditions as a result of their working in those stations. After briefing them on the importance of the exercise and the procedure that would be followed, They were involved and participated in identifying and marking the study trees. They were then trained on how to focus onto the tree crowns, sometimes using a pair of binoculars, and observe the stage of flowering and seeding. They would then make appropriate entry in the data sheets (see attached sample sheets form1(a), 1(b)). The teams were also trained on seed collections and book the data on form 2. Germination trials were conducted by Kefri laboratory technologists and records entered on form 3. The field team participated with Kefri scientists on the first day of the exercise where they had an opportunity to put into use the newly acquired skills in phenological studies. Being satisfied with the trainees performance, the Kefri team made arrangement with the officer-in-charge of the forest office to allow the data collecting team one day each week to do the phenological work. Sufficient forms to capture the data were left behind for use by the field data team.

Output
At the end of the training 21 forest department staff (table 1, column 2) had acquired the necessary knowledge and skills to enable them conduct phenological study and data collection.

Table 1. Datails on the training of forest department field staff on phenological observations and data recording

Forest station/Site	**Names of field staff trained**	**Tree species to study**	**Number of trees selected and tagged for phonological study**
Kakamega	Erastus Anyonyi Calystus Malala Elkana Amoke Wilburforce Biera	*Prunus Africana*	25
		P. fulva	25
		Xanthixhlum gilletti	25
Malava	Alex Muyukuba Fidelis Oroni David Mambili Nicholas Cheruiyot	*Prunus africana*	21
		X. gilletii	21
Kobujoi	Phillip Boit David Chepkwony J. Morogo	*P. Africana*	21
		Polyscias fulva	21
		X. gilletii	20
Itare	Evans Ontiri Richard Merigo Manoa Oyoga	*P. africana*	25
		Polyscias fulva	25
		X. gilletii	27
Kibiri	J. Anyangu Hudson Muga Masai F. Moses Wesanza	*P. Africana*	26
		Polyscias. fulva	
		X. gilletii	
Kaimosi	Leonard Masai Ezakiel Savai Tom Musasia	*Polyscias fulva*	21
Resource persons conducting the training were Kefri scientists namely: Joram Mbinga, Giathi Gitehi, and Michael Okeyo			

Conclusion
The training team was happy that useful skill had been imparted on the forest department field staff and their capacity to carry out field work and data collection on phenological study was enhanced. They were tasked with making weekly observations of sampled trees and recording their findings on prescribed forms as shown in the appendix.

3.2 - Task 3.2: Developing propagation techniques for valuable tree species : fruit tree species, essential oil species, timber species and environmentally important species

The main results obtained so far can be illustrated by these two research activities

3.2.1 - Seasonal dependence of rooting success in cuttings from natural forest trees in Madagascar.

Four ligneous species from the tropical forest in the east of Madagascar, with a proven or potentially high economic value, were subject to 'low-tech' vegetative propagation tests from stem cuttings. The species concerned were *Aphloia theiformis*, *Ilex mitis*, *Prunus africana* and *Ravensara aromatica*. The cuttings were three-node segments of stems on which one leaf was retained. All the species proved amenable to rooting. The maximum percentage of rooting ranged from 33% for *P. africana* to 60% for *I. mitis*. Rooting success was dependant on the season of cutting (high in the hot season, from October to May, and null in cold season). This study is the first successful attempt at propagating cuttings from Malagasy forest species. This result is of particular importance to *P. africana*, threatened by destructive exploitation in Madagascar. It goes a step further in the domestication of this species by demonstrating the ability of cutting from ten year old ortets collected in natural forest to root as it offers the possibility of a reliable and effective method of reintroduction for the species in overexploited zones. Danthu P, Ramaroson N , Rambeloarisoa G (2008). Seasonal dependence of rooting success in cuttings from natural forest trees in Madagascar. Agroforest Syst. DOI 10.1007/s10457-008-9116-7.

Seasonal dependence of rooting success in cuttings from natural forest trees in Madagascar. Four ligneous species from the tropical forest in the east of Madagascar, with a proven or potentially high economic value, were subject to 'low-tech' vegetative propagation tests from stem cuttings. The species concerned were *Aphloia theiformis*, *Ilex mitis*, *Prunus africana* and *Ravensara aromatica*. The cuttings were three-node segments of stems on which one leaf was retained. All the species proved amenable to rooting. The maximum percentage of rooting ranged from 33% for *P. africana* to 60% for *I. mitis*. Rooting success was dependant on the season of cutting (high in the hot season, from October to May, and null in cold season). This study is the first successful attempt at propagating cuttings from Malagasy forest species. This result is of particular importance to *P. africana*, threatened by destructive exploitation in Madagascar. It goes a step further in the domestication of this species by demonstrating the ability of cutting from ten year old ortets collected in natural forest to root as it offers the possibility of a reliable and effective method of reintroduction for the species in overexploited zones.
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Albizia gummifera experiment to test the impacts of the use of non-local seed in reforestation on growth performance

To test the impacts of the use of non-local seed in reforestation on growth performance, two provenances of Kenyan Albizia gummifera were grown in a randomised block experiment in soils obtained from Kenya, Madagascar and Uganda. Soils were characterised for mycorrhizal community and measurements of seedling growth (height) were maintained for 6 months. At the end of the experiment, seedlings were destructively harvested and dry root and shoot weights were taken and rhizobial nodule numbers and weights were obtained for each plant. Rhizobial nodules are currently being characterised using DGGE. Preliminary analysis indicates that Kenyan provenances perform best over the whole period of the trial, when grown in Kenyan soils.

3.3 - Task 3.3 Studying the genetic variability of the most important economic species for their economical traits: growth, wood quality, essential oil, etc., to improve their performance and productivity

Essential oil production increases value of *Psiadia altissima* fallows in Madagascar's eastern forests. Fallow with *Psiadia altissima* is one of the most common post-'slash and burn' vegetation successions described in the evergreen forests of eastern Madagascar. Some fallows consist of almost pure stands of this species, of which the leaves produce an essential oil offering international commercial interest. The present research aims to evaluate the production potential of essential oil derived from different fallows rich in *P. altissima.* The study has revealed that fallows aged four and six years since the last crop abandonment produce the most essential oil (around 20 $L.ha^{-1}$), but relative to fallow duration, the youngest fallows (one or two year-old) are the most productive, respectively producing 12 and 6 $L.ha^{-1}.year^{-1}$. Additionally, the trees from the youngest fallows have a substantial capacity for regeneration from coppice shoots, on condition that the cut is performed well above the root collar. Although farmers earn five times less from harvesting leaves than from cultivating rice from *tavy*, the possibility is there for them to complement their income and diversify their production. The overall results show that sustainable exploitation of fallows of *P. altissima* is a conceivable option. However, this can only be achieved through an integrated approach that takes into account the environmental and social constraints associated with the development of this new activity.
These results were published under the following article : Danthu P, Rakotobe M, Mauclère P, Andrianoelisoa H, Behra O, Rahajanirina V, Mathevon B, Ralembofetra E, Collas de Chatelperron P (2008). Essential oil production increases value of *Psiadia altissima* fallows in Madagascar's eastern forests. Agroforest Syst, 72, 127-135.

Genetic structure of *Albizia gummifera* and its local adaptation to the associated arbuscular mycorrhiza

The aim of this study was to assess genetic structure and local adaptation of *Albizia gummifera* to associated mycorrhiza using three populations from Uganda, Kenya and Madagascar. Using variation in chloroplast DNA sequences, estimates of genetic diversity and differentiation were obtained. Local adaptation of *A. gummifera* to the associated mycorrhiza was investigated by planting seed from different *A. gummifera* provenances into soils inoculated with soil microbial samples from respective local sites. In addition, the stability of inoculum was tested by comparing the performance of fresh and stored soils as inoculum. Four weeks after seedling emergence, height measurements were initiated and continued for six weeks. Mycorrhizas in the soil inoculum were identified using direct microscopic observation. Genetic data were analysed using GENALEX while greenhouse data were analysed using GENSTAT. The results showed that the species is genetically diverse with 14 cpDNA haplotypes identified (h_{TOT} = 0.803), with Uganda showing most diversity (h =0813) and Kenya the least (h =0.398). Although the majority of variation was distributed within populations (75%), significant population differentiation was observed (Φ_{PT} = 0.249, p > 0.01) and each population contained private haplotypes: Uganda (5), Madagascar (3) and Kenya (1). Greatest genetic distance was observed between Kenya and Madagascar (2.711). The lowest distance was observed between Uganda and Kenya (0.298). The diversity of the mycorrhizal community varied between sites with Ugandan fresh soils being more diverse than Kenyan fresh soils. For the old soils, fungal diversity was highest in Kenya, followed by Madagascar and then Uganda. Based on the growth performance measurements, there was no evidence of adaptation of *A. gummifera* provenances to local mycorrhizas though plant performance for inoculated plants was higher than that of the control. From the study, it appears that the specific kind of fungi the *A. gummifera* plants are exposed to is not important, although they benefit from the exposure. The tree populations seem to have genetically differentiated and transferring them to sites outside their own may pose a genetic threat. More research is however needed to ascertain adaptive differences of *A. gummifera* to abiotic and other biotic factors, the suitable founding genetic diversity and other factors that may affect introductions. The exact mycorrhizas that colonise the plants also need to be identified

3.4 - Task 3.4 : studying gene flow of the most important economical species

Chloroplast DNA diversity in Albizia gummifera

To assess levels of population differentiation for a species common to all FOREAIM study sites, as part of an assessment of the impacts of seed transfer on performance, cpDNA markers were used to type a collection of approx. 30 individuals of Albizia gummifera from Kenya, Uganda and Madagascar. Considerable genetic diversity was identified (14 haplotypes) and population structure was evident, both between populations (most significant differentiation was between Uganda and Madagascar) and within site (Ugandan trees were mapped). Some doubt persists as to whether or not A. gummifera was recently introduced to Madagascar, although it has naturalised, but the cpDNA data show private haplotypes in Madagascar, suggesting either that the dispersal to Madagascar is ancient or that hybridisation and chloroplast capture has occurred with native Madagascan Albizia sp.. Local haplotype structuring within the Ugandan population most likely reflects predominantly local seed dispersal.

Characterisation of microsatellite markers in the rosewood (*Dalbergia monticola*)

Dalbergia monticola is one of the major components of the oriental forest of Madagascar. This economically and ecologically important tree is threatened because of the dramatic decrease of the forest. We have estimated the genetic diversity and structure of the species by studying nuclear microsatellites. We have developed eight pairs of primers to analyse 215 individuals distributed from the north to the south of the island. These markers will be useful for genetic and ecological studies of this species.

Impact of fragmentation and selective logging on the genetic diversity of *Dalbergia monticola* Jacq. in the oriental forest of Madagascar: an analysis at different scales

Forest ecosystems in Madagascar have been seriously impacted by a combination of fragmentation and selective logging. Our study analysed the impact of these two factors on *Dalbergia monticola*, a tree species that plays an important economic role in Madagascar and is representative of many taxa in the oriental forest.

Leaves from 546 individuals belonging to 18 populations scattered over most of the natural range and affected by different levels of fragmentation and logging (figure 1) were collected and genotyped using eight microsatellite markers. The impact of fragmentation on allelic richness (R=7.36-9.55) and gene diversity (He=0.64-0.80) among the provenances was not significant. No recent bottleneck effect was observed. Overall differentiation was low (F_{ST}=0.07) (figure 2) and a clear relationship was observed between genetic and geographic distance (figure 3), suggesting a pattern of isolation by distance. Analysis of population structure separated southern populations from central and northern populations. Analysis of the effect of logging showed that the fixation index F_{IS} was significantly higher, gene flow *N*m increased between patches, and the spatial genetic structure *S*p was more pronounced in logged (F_{IS}=0.283, *Nm*=5-8, *Sp30*=0.013-0.019.) than in unlogged provenances (F_{IS}=0.059, *Nm*=2, *Sp30*=0.010-0.011).

At the scale of the natural range, recent fragmentation has not reduced genetic diversity within, or increased differentiation among, populations of *D. monticola* in Madagascar, most probably because the phenomenon is too recent. However at the local scale, the combined effects of logging and fragmentation have changed genetic features.

Figure 1. Location and sample characteristics of the provenances (in bold) and populations (in italics) used in the study. (a) Map of the Madagascar showing remaining primary vegetation (grey); location of the provenances and populations sampled throughout the oriental forest. Provenances and populations listed in the box were used to investigate the impact of logging

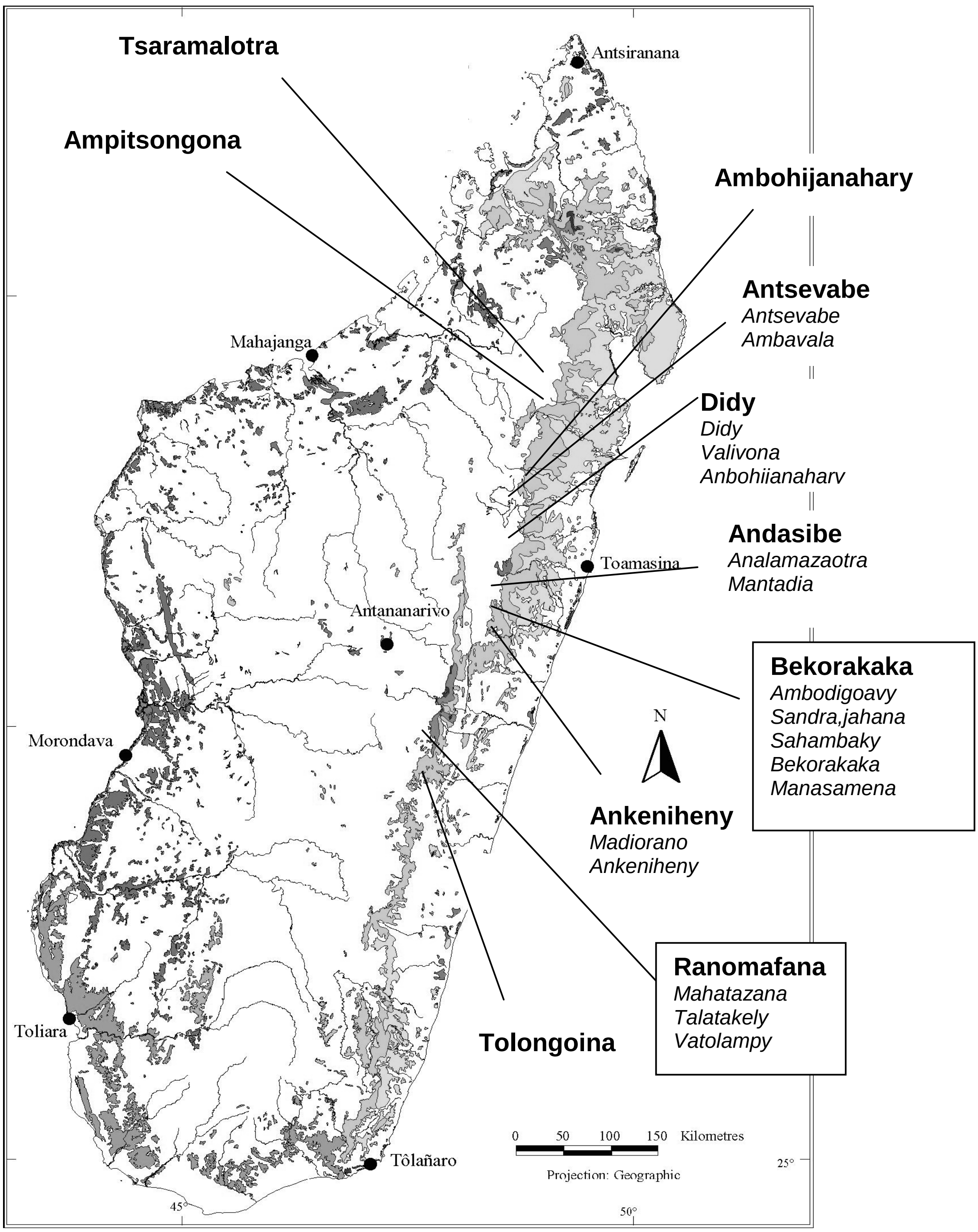


Figure 2. Unrooted neighbour-joining tree drawn with PHYLIP 6.1 (Felsentstein, 1993) with the matrix of genetic distances calculated using the Cavalli-Sforza distance (Cavalli-Sforza and Edwards, 1967). Numbers at the base of the branches correspond to the bootstrap values after 1000 replications.

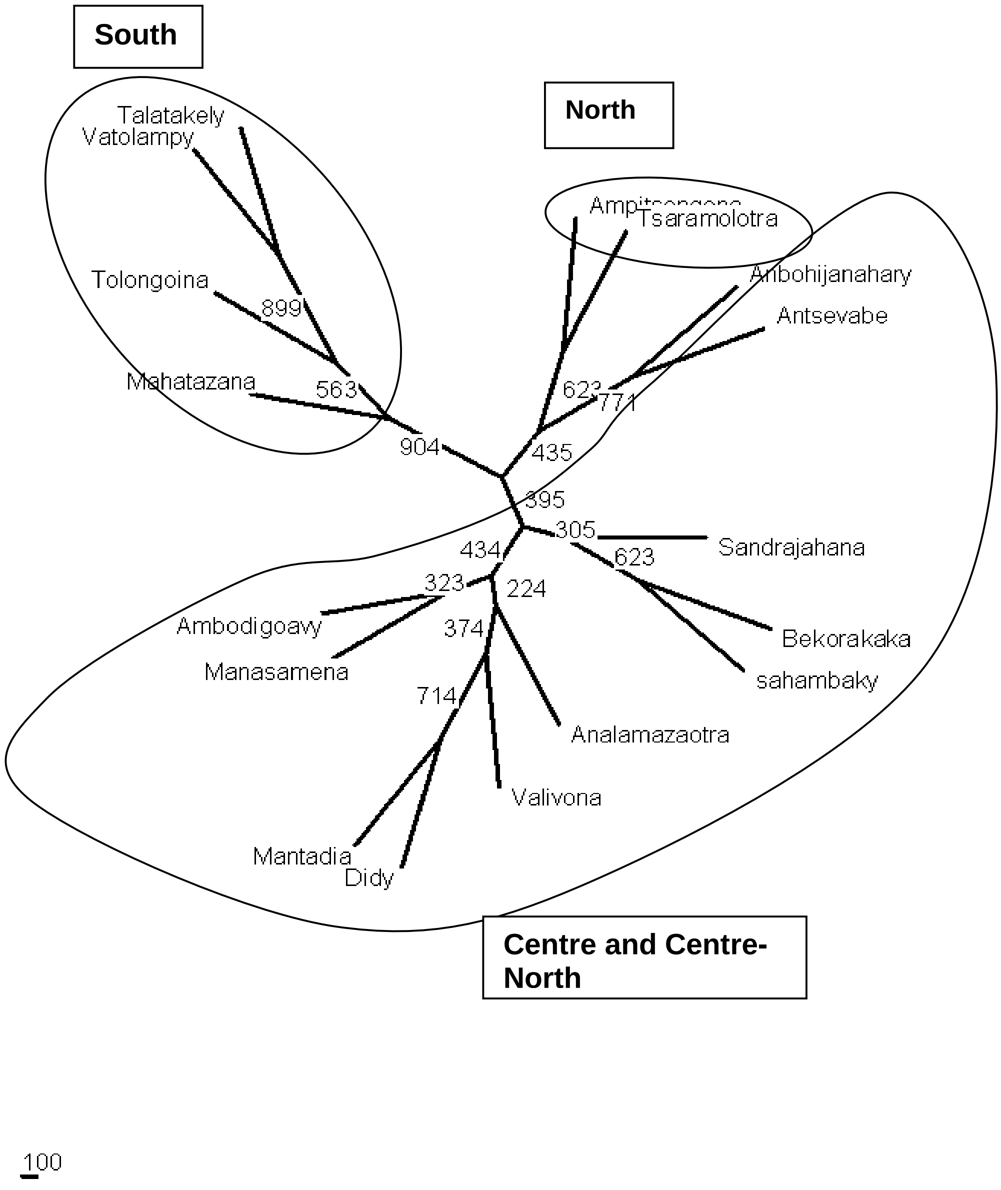
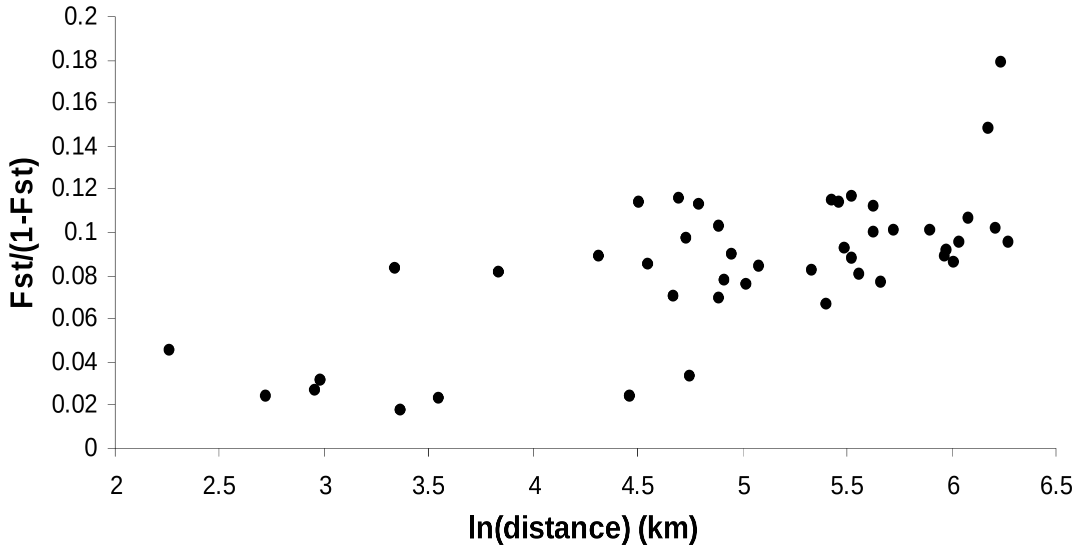


Figure 3. Relationship between genetic and geographical distances among populations of *Dalbergia monticola* Jacq. Matrices of genetic distances were calculated using pairwise F_{ST}. Populations were studied using the two-dimensional model (Rousset 1996)



Work package 4: Characterization of edaphic conditions in degraded forest landscape to predict forest restoration suitability

4.1 - TASK 4.1 ASSESEMENT OF CHANGE IN SOIL CHARACTERISTICS

As decided during the kick off meeting soil analyses performed by each partner (5, 7 and 8) are going to be cross-validated with those obtained from another where soils hab neen sent. Results presented corresponded to those obtained by each partner.

a) Vohimana Forest (Madagascar)

Studied plots

- Primary forest (plot 2),
- Secondary forest (plot 17)
- Fallow

Soil sampling design

Soils had been sampled at the different period

Start raining season *(october-november),*
During raining *(january – february),*
End of raining *(april-may)*

The collect period is corresponded the end of raining season (april-may 2008).

Results

Primary forest

Table411: Soil characteristic under primary forest at starting (t=0) and end (t=1) raining seasons

T=0	T=1
• pH : 4.36 – 4.60 • C/N : 11 – 16.9 • P : 1.8 – 12 • Ca : 0.03 – 0.41 • Mg : 0.06 – 1.66 • K : 0.09 – 0.25	• pH : 5.23 – 5.78 • C/N : 12.8 – 17.8 • P : 3.8 – 10.6 • Ca : 0.036 – 0.37 • Mg : 0.04 – 0.105 • K : 0.011 – 0.13

Secondary forest

Table 412: Soil characteristics under secondary forest at starting (t=0) and end (t=1) raining seasons

T=0	T=1
• pH : 4.1 – 4.9 • C/N : 13.3 - 18 • P : 2.5 – 6.2 • Ca : 0.26 – 0.39 • Mg : 0.06 – 0.13 • K : 0.03 – 0.05	• pH : 5.05 – 5.59 • C/N : 17.1 – 117.9 • P : 4.1 – 7.5 • Ca : 0.22 – 0.4 • Mg : 0.047 – 0.078 • K : 0.023 – 0.158

Fallow

Table 413: Soil characteristics under fallow at starting (t=0) and end (t=1) raining seasons

T=0	T=1
• pH : 4.13 – 5.31	• pH : 5.57 – 5.93

• C/N : 9.6 – 34.9 • P : 2 - 4 • Ca : 0.71 – 3.85 • Mg : 0.23 - 1 • K : 0.04 – 0.15	• C/N : 8.6 – 18.8 • P : 1.8 – 7.3 • Ca : 0.335 – 1.26 • Mg : 0.033 – 0.15 • K : 0.013 – 0.258

b) Mabira Forest (Uganda)

Soils of the six Mabira forest reserve blocks were sampled and analysed for nutrient contents in collaboration with WP5.
Most of the nutrients are adequate for plant growth (Okalebo *et al.*, 2001). The soil pH ranged between 5.66-7.02, and it was relatively higher to soils disturbed 10-40 years ago ($P<0.05$). The organic matter ranged between 3.26 - 7.12%. Organic matter was high for the soils disturbed at last 40 years ago and moderate for the other sites. Available phosphorus was above the critical values of 5 ppm for most of the soils, and was higher on soils disturbed 20 years ago. Potassium, magnesium and calcium were very high for all soils.

Table 414 : Chemical properties of different soils of Mabira Forest Reserve

Treatment	Av. P	OM	pH	K	Mg	Ca	Na	Fe	Cu	Mn	Zn
	mg/kg	%		cmol/kg				mg/kg			
0-3	9.2	4.08	5.72	0.57	4.71	8.37	0.50	59.7	2.77	138.8	4.03
10-20	5.8	3.53	6.22	0.30	4.27	11.46	0.57	24.3	6.46	141.2	8.24
20-30	39.6	4.79	7.03	0.88	3.92	24.93	0.51	18.7	7.38	146.2	7.88
30-40	7.2	3.26	6.21	0.34	3.60	9.49	0.44	39.8	3.38	142.6	3.67
40-50	7.3	7.12	5.66	0.69	1.61	5.23	0.52	62.5	1.88	118.6	2.00
> 55	6.8	7.02	5.79	0.76	2.23	4.79	0.51	56.5	3.52	149.5	4.80
LSD	7.95	1.73	0.34	0.16	0.69	3.12	0.03	13.8	1.29	13.91	1.85
S.E.D.	3.97	0.87	0.17	0.08	0.25	1.56	0.06	6.89	0.65	6.95	0.92

4.2 - TASK 4.2 ASSESEMENT OF SOIL BIO-INDICATORS

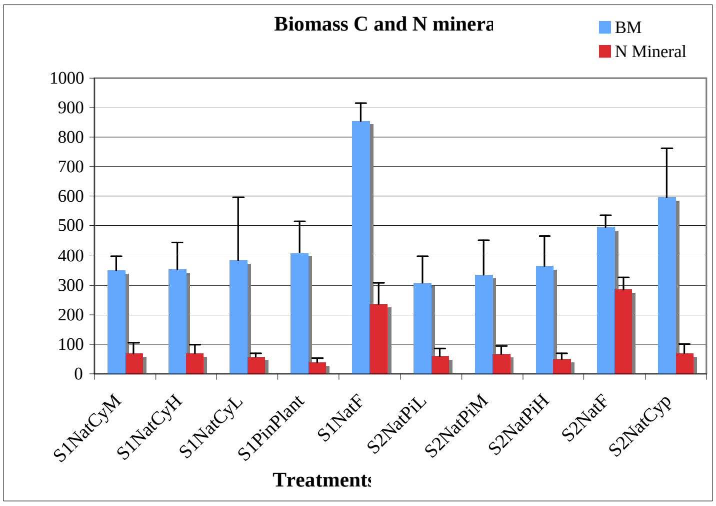
4.2.1 Abundance of biotic components

a) Kedowa (Forest)

Microbial biomass

Microbial biomass C (MB) of soil sub-samples (20 g EDW) was determined by a fumigation–extraction method (Amato and Ladd, 1988), using ninhydrin-N reactive compounds extracted from soils with 2M KCl after a 10-day fumigation period. Fumigated and unfumigated soil samples were suspended in KCl solution (1:3 dry soil/solution, w/v; 2M final concentration), shaken at 25°C for 1 h and then centrifuged for about 5 min (2000 x *g*). Extracts were filtered (0.45 m) and Ninhydrin-reactive nitrogen was determined from 0.5 ml of extract from each of the fumigated and unfumigated soils. Biomass C = ninhydrin-Nx21 (μg g^{-1} of dry soil). Soil collected from Natural Cypres regeneration (S2NatCyp) and Natural Forest (S1NatF) have shown significantly higher biomass C compared to the other treatment soil samples.
The mineralised N in the natural forests soil samples (S1NatF and S2NatF) was significantly high compared to that displayed in the other soil managed samples.

Figure 421 : Microbial biomass in Kedowa soils

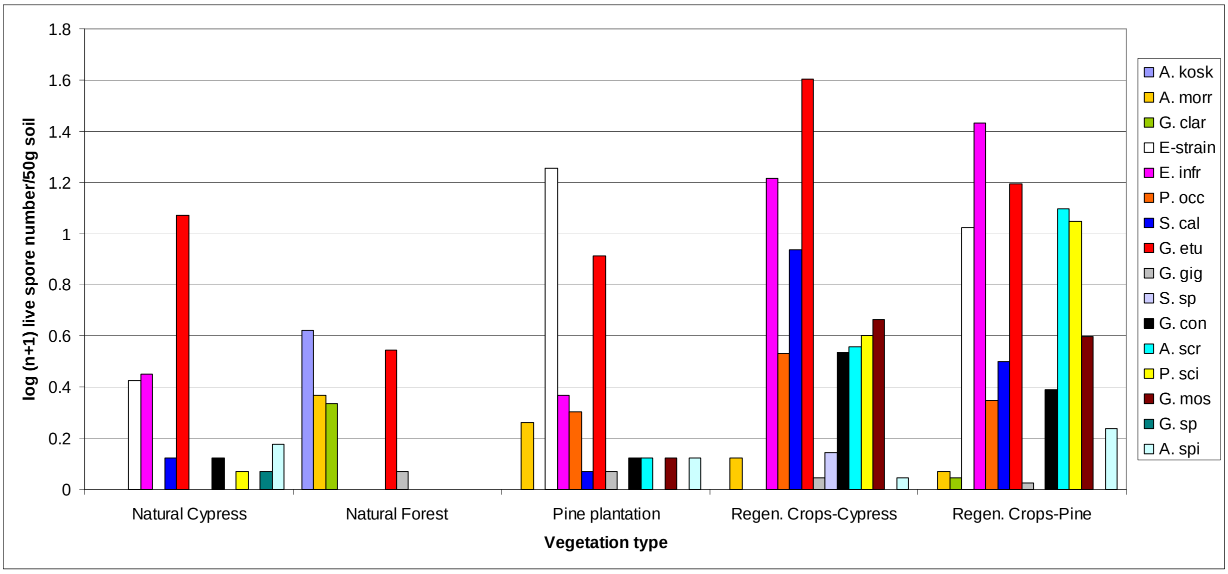


Mycorrhizal spore populations

Spore populations were assessed in duplicate soil samples to those taken by KEFRI and CIRAD. 54 soil samples from the 0-10 cm horizon were examined. There were 6 replicate samples from the natural forest, cypress plantation and pine plantation sites and 18 replicate samples from the pine-crop and cypress-crop regeneration sites (6 from each upper/middle/lower slopes). Spores were extracted from 50 g sub-samples of soil and numbers of total and 'live' spores were assessed with 'live' spores separated into species or types based on spore morphology.

Pine-crop and cypress-crop regeneration sites had more total spores, more 'live' spores, a greater % of 'live' spores and more diversity (species/types present) than the natural forest, cypress plantation and pine plantation (P<0.001). 'Live' spores were also more numerous on the upper slopes of the regeneration sites than the middle and lower slopes (P=0.015). There were also differences in the species/types of spores in the different soils: spores attributable to an 'E-strain' fungus (a group of Ascomycete fungi in the order Pezizales which form mycorrhizal associations with Pinaceae) were more numerous in the pine plantation soil than in the pine-crop regeneration soils and virtually absent in soil from the other sites (P<0.001). The arbuscular mycorrhizal (AM) spores *Glomus etunicatum* and *Scutellospora calospora* were most numerous (both P<0.001) in the cypress-crop regeneration soil, while *Acaulospora scrobiculata* (P<0.001), *Pacispora scintillans* and *Entrophospora infrequens* were most numerous in the pine-crop regeneration soil.

Figure 422. Populations of 'live' spores in Kedowa soils



** Nematofauna community*

Nematodes were extracted from 250 grammes of wet soil using the Seinhorst elutriation method (Seinhorst 1962), counted, fixed with formalin, transferred to glycerin and subsequently mounted in bulk on glass slides. From each sample, a mean of 190 nematodes was identified under a microscope at 400x, to family or genus level. Nematode taxa were assigned to trophic groups following Yeates et al. (1993) and then allocated to cp-classes following Bongers (1990). Nematodes that could not be assigned to a trophic group with certainty were classified in the group of the taxon having the most similar morphological feeding structure. The structure of the nematofauna (taking into accout the absolute abundance of all the taxa) was analysed using PRIMER software (versus 6, PRIMER-E Ltd, Plymouth, UK). Differences in nematode densities between treatments were assessed by Anova after transformation (log(n+1)) of the data ($p<0.05$).

In nematode communities of the whole Kedowa experiment situations, 42 taxa were recorded including different trophic groups as bacterial-feeders (40,5%), fungal-feeders (14,3%), omnivores & predators (16,7%) and plant-feeders (28,5%) (Table 1). All the nematode trophic group revealed in this study were found in the different soil situations with a strong dominance of plant feeding nematodes in the revegetation situations. As for *Pinus* plantations, they were dominated by bacterial and fungal feeders contrary to the natural forests soils where only very few fungivorous was found. The difference in the abundance of the trophic groups can be explained by the different vegetable covers and consequently the different quality of litter present in soils.

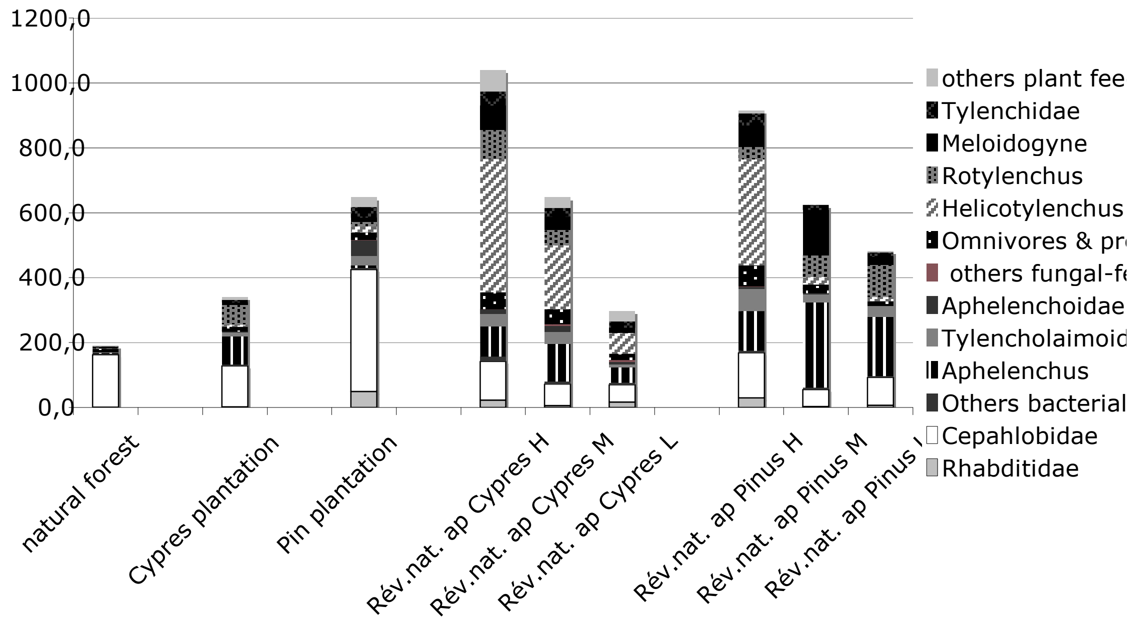
Table 421: Nematode trophic group found in the differents soil samples

Bacterial-feeders	Fungal-feeders	Omnivores & predators	Plant-feeders
Acrobeloides	Aphelenchus	Dorylaimoidea	Helicotylenchus
Heterocephalobus	Tylencholaimoidea	Discolaimus	Rotylenchus
Cephalobus	Aphelenchoidae	Ironus	Meloidogyne
Eucephalobus	Belondiridae	Aporcelaimus	Tylenchidae
Chiloplacus	Diphteropharidae	Mylonchulus	Hemicycliophora
Acrobeles	Ditylenchus	Tobrilus	Other Hoplolaimidae
Zeldia		Anatonchidae	Longidorus
Rhabditidae			Trichodoridae
Prismatolaimus			Xiphinema

Alaimus			Paratylenchus
Panagrolaimidae			Pratylenchus
Achromodora			Dolichodoridae
Plectidae			
Monhysteridae			
Teratocephalus			
Drilocephalus			
Leptolaimus			

The natural forests soil displayed low nematodes density nevertheless dominated by bacterial feeders. The nematode community density of the natural revegetation after crops-*Pinus* plantation and *Cypress* regeneration soils was different from the top to the lowest part of the experimental sites with the higher density at the top side. The nematodes structure displayed in the Kedowa soils provided evidence that there were significant differences between all the treatments excepted the soil samples from natural revegetation after crops-*Pinus* plantation and *Cypress* regeneration.

Figure 423 . Total nematode major taxa density (ind / 100 g dry soil)



4.2.2 Soil functioning

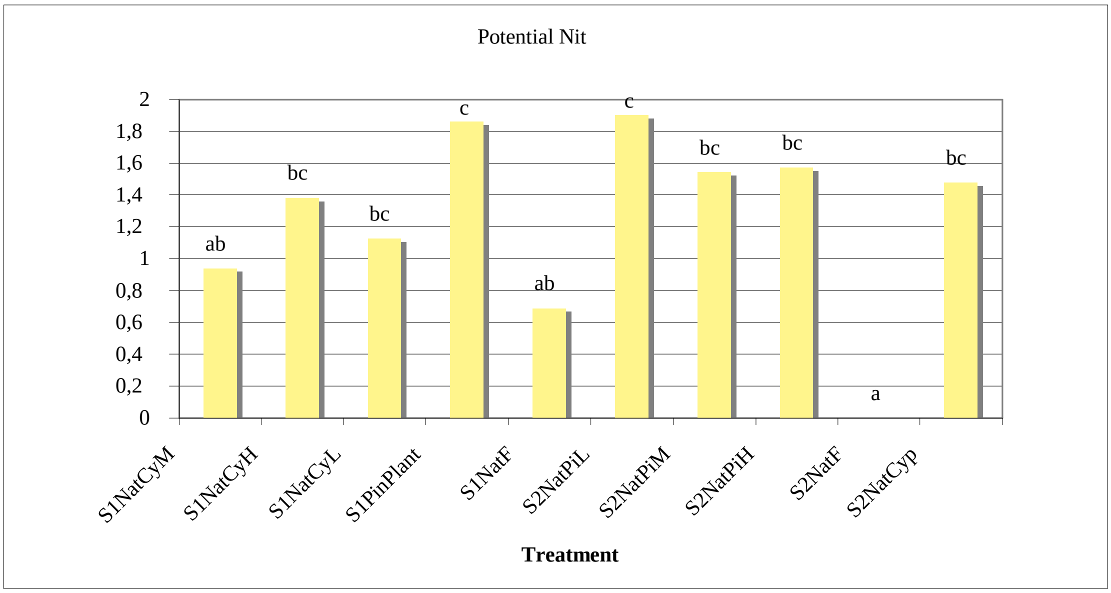
a) Kedowa Forest

** Nitrification*

The potential nitrification was determined using the shaken slurry method of Hart et al. (1994). A 10-g soil sample was taken from each soil sample and mixed with 20 mL of a solution containing (0.2 M KH_2PO4 ; 0.2M K_2HPO4 ; $(NH4)_2SO4$) in a 50-mL Erlenmeyer flask to make a slurry. The mixture was shaked during 24h. Extraction was performed by adding 5ml of soil slurry with 10 ml of 5M KCl for 1h followed by filtration through 0.45µ m nylon filters. Colorimetric analysis was done via a flow-injection auto-analyzer for determining NO3–N + NO2–N, which was reported as NO3–N.
The potential nitrification was significantly higher for soil samples collected from *Pinus* plantation (S1PinPlant) and from the natural revegetation after crops-*Pinus* plantation lowest site (S2NatPiL) than for soil samples from the other managed soil samples. There was no significant difference between the other soil samples from the 2

sites in regard to potential nitrification rates. Nevertheless S2NatF soil sample displayed no nitrification rates contrary to S1NatF.

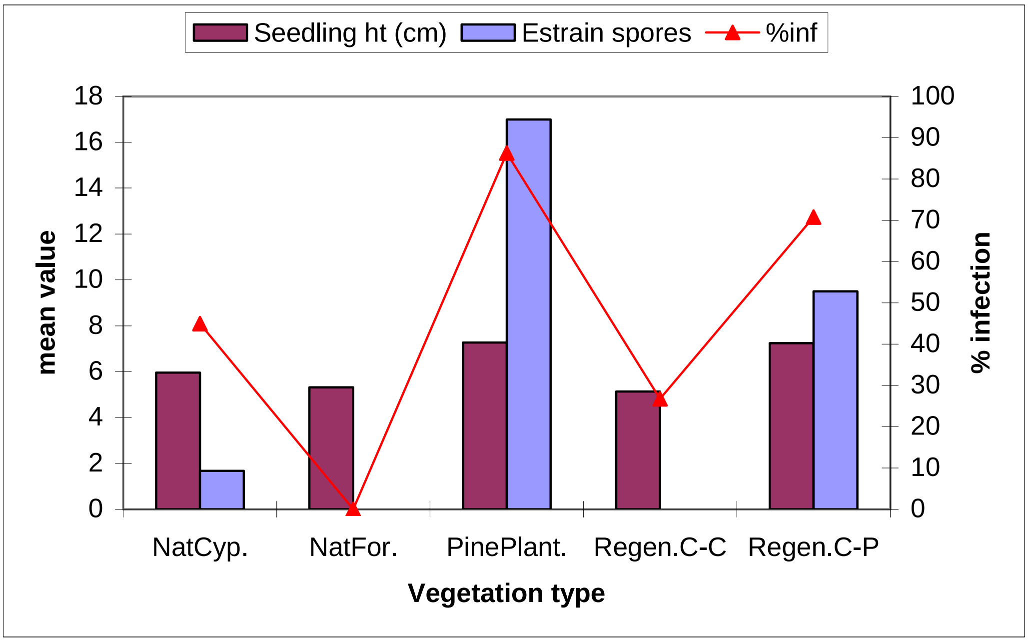
Figure 424. Potential nitrification in the different soil samples



* Growth and mycorrhizal infection of Pinus patula, Albizia gummifera and crop seedlings in trap cultures grown in Kedowa soils in CEH glasshouse

A mycorrhizal bioassay of the Kedowa soils was set up in the CEH glasshouse in order to examine the mycorrhizal activity in the soils, the effect on seedling establishment and growth, and to provide fresh spore and root material for taxonomic determinations and isolation of fungal material for molecular work. Seeds of *Pinus patula* (an ectomycorrhizal and ectendomycorrhizal host plant), *Albizia gummifera* (an arbuscular mycorrhizal host plant) and the crop plants millet and sorghum (fast-growing, arbuscular mycorrhizal plants) were sown in 1 litre pots containing approximately 100 g of test soil and a sterilised soil mixture. Mycorrhizal activity in the soils was determined by assessing root infection (ecto and arbuscular mycorrhizas) on the seedling roots. As there were only 2 replicate pots for each soil/host plant species, significant differences between test soils were often difficult to detect.

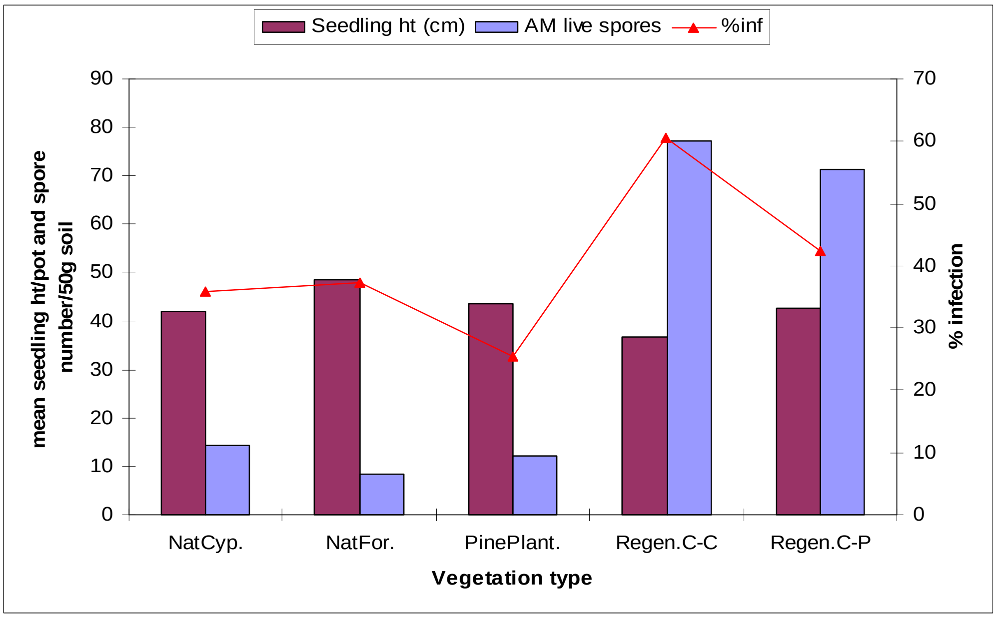
Figure 425 . Growth and mycorrhizal infection of pine seedlings in Kedowa soils, and numbers of E-strain spores present in original soils.



Height of the pine seedlings was greatest in soils from pine plantation and pine-crop regeneration sites (P=0.026). Although not significant, % infection was also greater in these soils, with the dominant mycorrhizal morphotype present on the roots attributable to an E-strain fungus. Other morphotypes present were attributed to *Rhizopogon* sp. and *Tuber* sp.. Seedling height was positively correlated with % mycorrhizal infection (P<0.05), numbers of mycorrhizal tips (P<0.05), numbers of E-strain mycorrhizal tips (P<0.01), and numbers of E-strain spores in the original soil (P<0.001).

These results indicate that soils from sites where ectomycorrhizal tree species have not been recently grown lack the ectomycorrhizal propagules necessary for the establishment and growth of ectomycorrhizal tree species. This conclusion has been more dramatically demonstrated in the KEFRI bioassay of the same soils, where pine seedlings were grown in soil from the site (i.e. the soils were not diluted with a sterilized nursery compost containing soluble nutrients). In the KEFRI bioassay, pine seedlings growing in soil from the pine plantation or in soil from plots regenerating after pine plantation survived and were growing well, whereas those growing in all the other soils died. Following the workshop in Nairobi, roots of surplus pine seedlings from the KEFRI bioassay experiment were examined and the E-strain morphotypes was found to be dominant on the root systems. Subsequently, fruitbodies of a Pezizalean fungus have appeared on the pots: this means that the causal fungus (or one of the causal fungi) can now be identified.

Figure 426. Growth and mycorrhizal infection of crop seedlings in Kedowa soils, and numbers of 'live' AM spores present in original soils.



No differences were observed in height or mycorrhizal infection of the *Albizia gummifera* or crop seedlings growing is soil from the different sites. However, seedling height was negatively correlated to % infection ($P<0.05$), while % infection was positively correlated with the number of 'live' spores in the soil. This suggests that greater AM activity at the regeneration sites resulted in higher levels of infection, and that high levels of soluble nutrients in the sterilised compost enabled plants with less AM infection to allocate more C for shoot growth.

b) Vohimana forest (Madagascar)

** Ectomycorrhizes*

Figure 427: Abundance of spores in each studied site

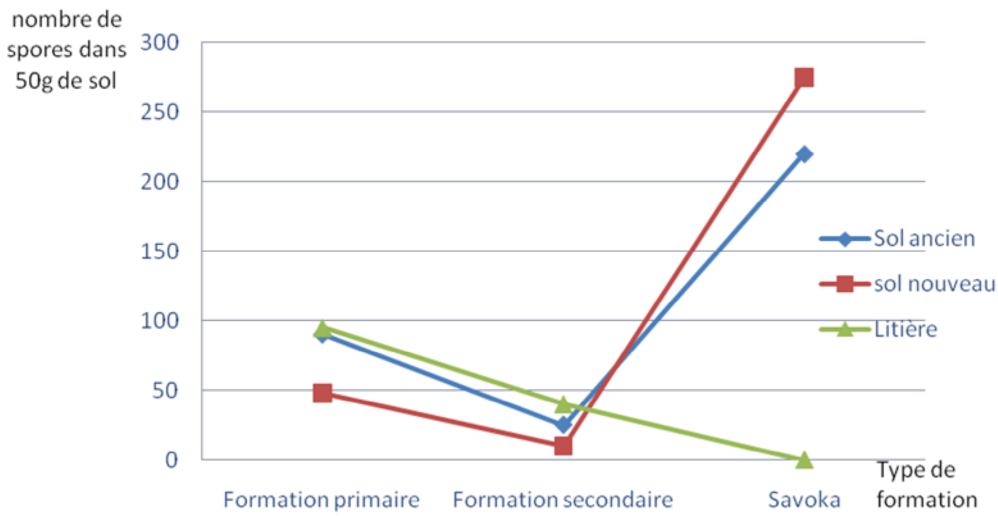
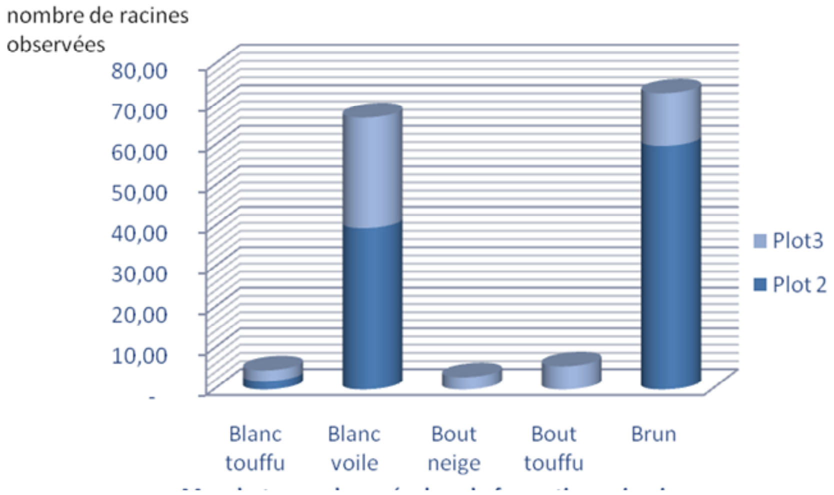
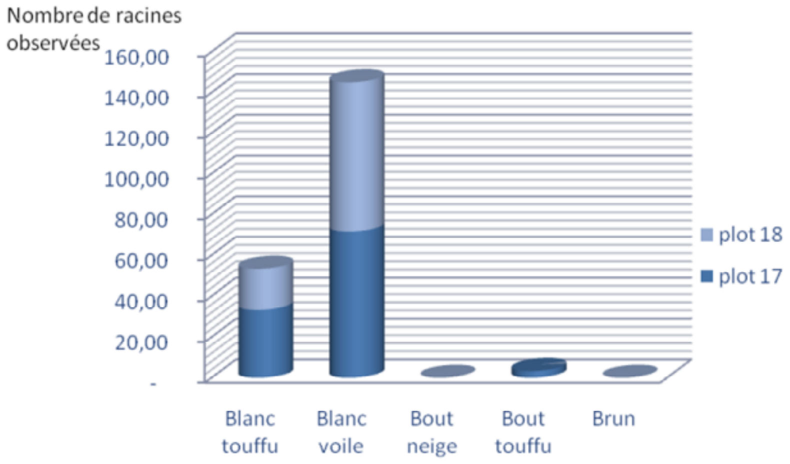


Figure 428: Morphotypes observed in the two different forest

In the primary forest



in the secondary forest



4.2.3 Microbial diversity

** soil bacterial community*

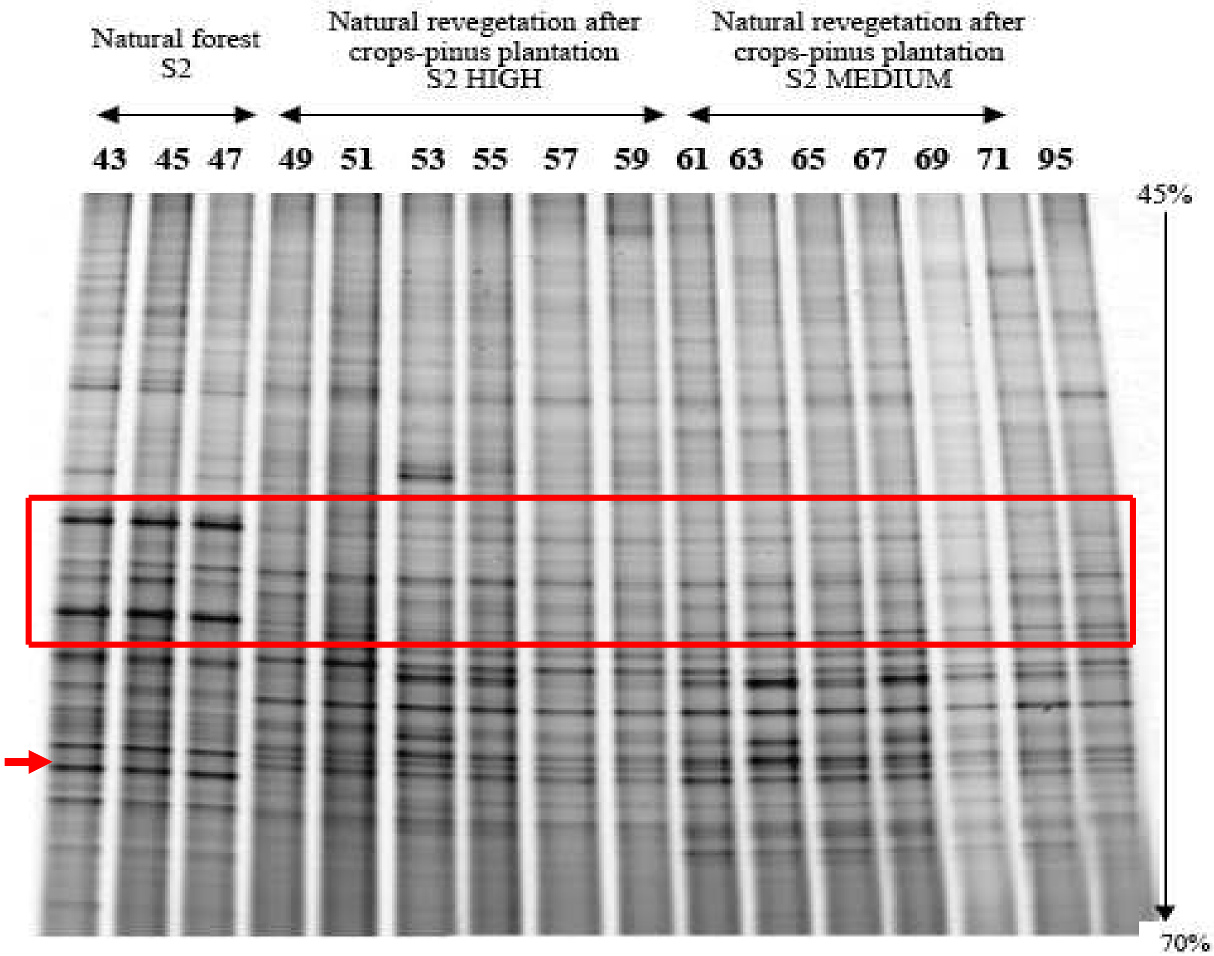
The genetic structure of the soil total bacterial and communities was assessed by PCR-DGGE. PCR amplification targeting total soil 16S rDNA bacterial community was performed with the eubacterial primer pair 338f-GC [Ovreas et al. 1997] and 518r [Muyzer et al 1993]. Total genomic DNA extraction, PCR amplification and DGGE analysis were performed as described previously (Assigbetsé et al. 2005).

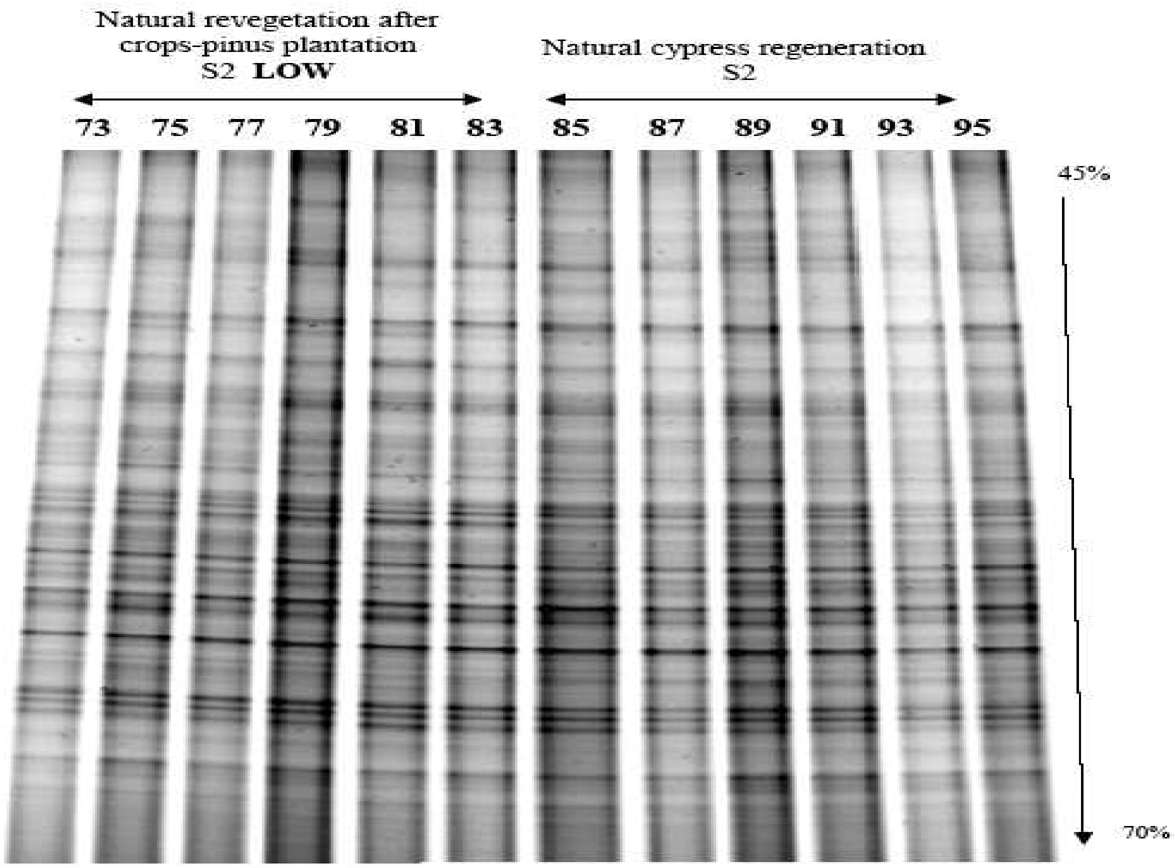
Numerous DGGE bands of various intensities that resulted from differences between the 16S rDNA gene sequences of different bacterial species were detected. They ranged in mobility approximately from 45 to 65% with different DGGE patterns between each soil sample. Nevertheless, the banding patterns from different soil treatments shared some of the intensely stained DGGE bands, indicating that a stable bacterial population colonized the soil regardless of the applied management.
The soils collected from natural forest treatments displayed more complex banding patterns in comparison to the soil from natural revegetation after crops-*Pinus* plantation and *Cypress* regeneration. Their DGGE patterns revealed a number of intense bands which were not detectable in the other forest managed soil samples (Fig 3: Red box and arrow). The different forest management have influenced significantly the structure of the soil

bacterial community by reducing its diversity.
The obtained dendrograms deduced from DGGE profiles displayed 2 main clusters. The first cluster contained samples from natural forest and the 2nd cluster divided into two closely related subclusters consisted of samples from natural revegetation after crops-*Pinus* plantation and *Cypress* regeneration (Fig 4). Samples from natural forest clustered together. Bacterial community structure in the soils from the top and middle sites of natural revegetation after crops-*Pinus* plantation was more closely related whereas DGGE profiles from the lowest site clustered together with the *Cypress* regeneration profiles.

Results from this study suggested that in Kedowa site, forest management practices affected the soil biotic components, soil functioning and the structure of the bacterial community, as evidenced by the changes seen when compared to natural forest. Some soil bio-indicators were revealed and could be useful for forest rehabilitation in Kenya.

Figure 429. DGGE profiles of 16S rDNA gene fragments amplified from DNA extracted from S2 site soils samples.




Natural revegetation after crops-pinus plantation
S2 LOW
Natural cypress regeneration
S2
73 75 77 79 81 83 85 87 89 91 93 95
45%
70%

Work package 5: Examining the effects of differing vegetative covers, enrichment planting, agroforestry and other remedial treatments on losses of soil, plant nutrients and organic matter from degraded agricultural, agroforestry, fallow and forested landscapes.

5.1 - Task 5.1 :SOIL AND NUTRIENT LOSSES FROM MABIRA FOREST RESTORED BLOCKS

Partner 8: Kizza, C. L., Majaliwa, J.G.M., Nakileza, B., Kansiime, F.

Introduction

Mabira forest reserve (MFR) underwent degradation from the early 1970s as a result of encroachment and conversion of the forest cover to agriculture and settlement. However, in the mid eighties, the government banned further encroachment to allow forest regeneration. The process has been gradual, with several forest blocks at different stages (time since last disturbance) of regeneration. There is no data on soil and nutrient losses in the restoring forest blocks. This study was therefore carried out to investigate the effect of forest ecosystem restoration on soil properties; soil and nutrient losses.

Materials and Methods

The study was carried out in Mabira forest reserve (MFR) (Figure 511) located between 32° 52' - 33° 07' E and 0° 24'-0° 35' N. The reserve is characterized by ferralitic sandy clay loam soils on undulating hills. There were six treatments representing the different forest block ages of restoration namely, most recently abandoned (1-3 yrs), secondary young forest (10-20 yrs), old secondary forest (20-30 yrs), very old secondary forest (30-40 yrs), almost intact secondary forest (40-50 yrs) and intact forest (> 55 yrs). In each treatment, three plots, measuring 150 x 50 m were selected, based on the slope (10%).

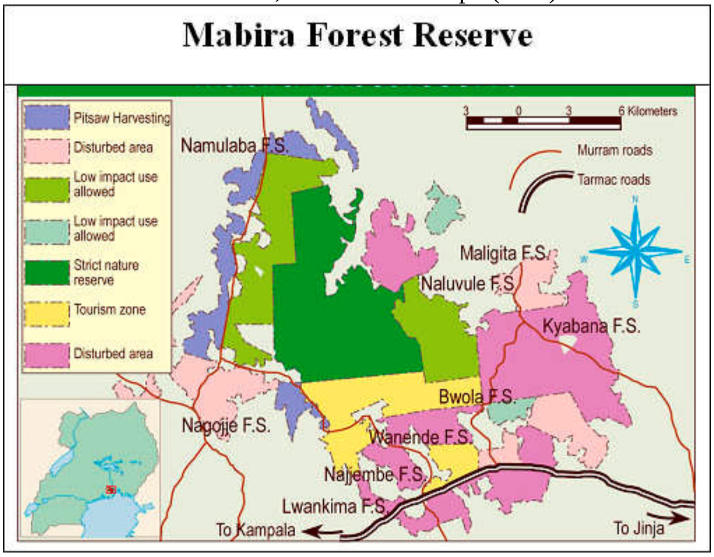


Figure 511 Mabira Forest Reserve

In each plot an erosion trap was installed covering an area of 2 x 20 m. Runoff and sediment were collected in a sampler (Figure 2) calibrated to collect 1% of the total runoff into a polythene bag tied at the end of collection pipe. The runoff was measured after a heavy rainfall or after three consecutive light rainfalls. Samples were then taken to the soil science laboratory for determination of soil loss (Figure 514) and analysis of nitrogen, phosphorus and potassium losses (

Table 51 1). In addition, site physical and chemical characterization was also carried out by collecting separate composite soil samples at the top and bottom of the plots. The samples were taken at 0-15 cm and 15-30 cm depths, and analysed for pH, organic matter, Kjeldhal nitrogen, available phosphorus, exchangeable bases and texture (Table 512). Furthermore, bulk density (core method), porosity, hydraulic conductivity (constant head method) and infiltration rate using double rings (Table 513,Table **514**, Figure 3) were measured.

Table 51 1 Nutrient losses (kg ha^{-1}) in relation to time since last disturbance

Years since last disturbance	Season					
	Short rains (S – N)			Long rains (M-J)		
	N	P	K	N	P	K
0 - 3	1.53	**0.11**	1.10	**3.82**	**0.19**	**38.71**
10 - 20	0.11	0.01	0.08	0.00	0.00	0.19
20-30	0.16	0.01	0.06	0.00	0.00	**6.89**
30-40	0.23	0.02	0.16	0.00	0.00	0.17
40-50	**2.97**	**0.16**	1.92	0.09	0.03	4.02
>55	**4.26**	**0.18**	**6.63**	0.12	0.02	3.30
LSD0.05 (Trt)	2.55	0.07	4.1			
LSD0.05 (Sson)	1.47	0.04	2.55			
LSD0.05 (Trt/sson)	3.60	0.10	6.23			

Table 512 Soil chemistry and texture

Age	**Av. P**	**OM**	**pH**	**K**	**Mg**	**Ca**	**Na**	**Fe**	**Cu**	**Mn**	**Zn**	**Sand**	**Clay**	**TC**
(yrs)	**mg/kg**	%		**cmol/kg**				**mg/kg**				**%**		
0-3	9.2	4.1	5.7	0.6	4.7	8.37	0.5	60	2.8	138	4.0	46	26	CL
10-20	5.8	3.6	6.0	0.3	4.3	11	0.6	24	6	141	8.2	37	41	CL
20-30	**12.9**	4.8	7	0.9	3.9	24.9	0.5	18.7	7.4	146	7.9	38	43	CL
30-40	7.2	3.3	6.2	0.3	3.6	9.5	0.4	39.8	3.4	142	3.7	48	25	CL
40-50	7.3	7.1	5.7	0.7	1.6	5	0.5	62.5	1.9	119	2	58	27	SCL
> 55	6.8	7.0	5.8	0.8	2.2	4.8	0.5	56.5	3.5	150	4.8	57	24	SCL
LSD	8	1.7	0.3	0.12	0.7	3.1	0.03	13.8	1.30	13.9	1.85			

Table 513 Effects of forest age on soil bulk density and porosity in Uganda

Years since last disturbance	Bulk density g/cm3		Porosity (%)	
	Top soil	Sub soil	Top soil	Sub soil
0-3	0.74	0.79	**72.3**	**70.7**
10-20	**0.82**	**0.93**	**69.6**	**65.5**
20-30	**0.82**	0.84	**69.6**	**68.8**
30-40	**0.95**	**1.05**	64.9	**61.1**
40-50	0.81	**0.87**	**70.2**	**68.3**
>55	0.8	**0.93**	**70.4**	**65.5**

Table 514 Effects of forest age on hydraulic conductivity and soil infiltration in Uganda

Years since last disturbance	**Top soil (cm/min)**	**Sub soil (cm/min)**	**Observed ic cm/min**
0-3	**143.2**	**120.3**	2.25
10-20	**97.1**	**88.8**	1.69
20-30	**144.1**	**90.8**	1.4
30-40	**148.2**	77.3	1.33
40-50	123.4	118.6	0.85
>55	60.6	57	0.91
LSD0.05 (last disturbance) =	33.3	21.0	

Figure 2 Run off and sediment trapping

Figure 3 Measuring infiltration

Results and discussion

Runoff and soil loss exhibited similar trends, being highest in the 0-3 yrs forest block (Figure 514,Figure **515**). Excluding the 0-3 yr forest block, run off and soil loss increased exponentially with forest restoration stage. Annual soil loss for the different restoration blocks never exceeded 600 kg/ha/yr. The high loss in 0-3 yrs was due to clearing of vegetation cover, preventing control of runoff and exposing soil to detachment and transportation.

Strong relationships were observed between runoff, steady state infiltration(IR) and forest restoration stage (Figure 516Figure 517). Bulk density in all the blocks was very low ranging between 0.74 and 0.95 g/m3 for the topsoil and between 0.79 and 1.05 g/m3. Bulk density increased with soil depth whereas porosity decreased with soil depth.

In conclusion, runoff, soil and nutrient losses were highest in the first 3 years after disturbance, when ground cover was least, however, in all the blocks, they were low compared to agricultural land elsewhere. The MFR had good hydrological properties favouring vertical water flow. Philip model was the best predictor of infiltration. These studies are relatively short term and further studies over a longer time period would be preferable. Studies are also recommended to determine the hydrological importance of MFR as a watershed.

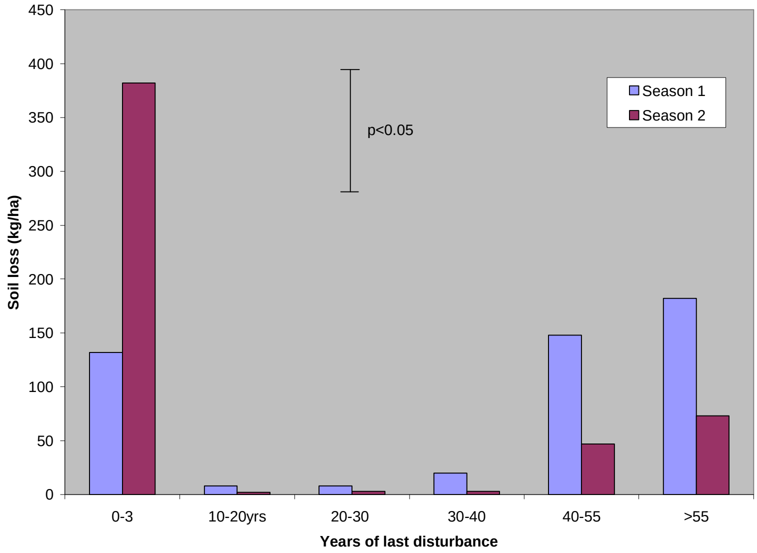


Figure 514 Soil loss in relation to time since last disturbance

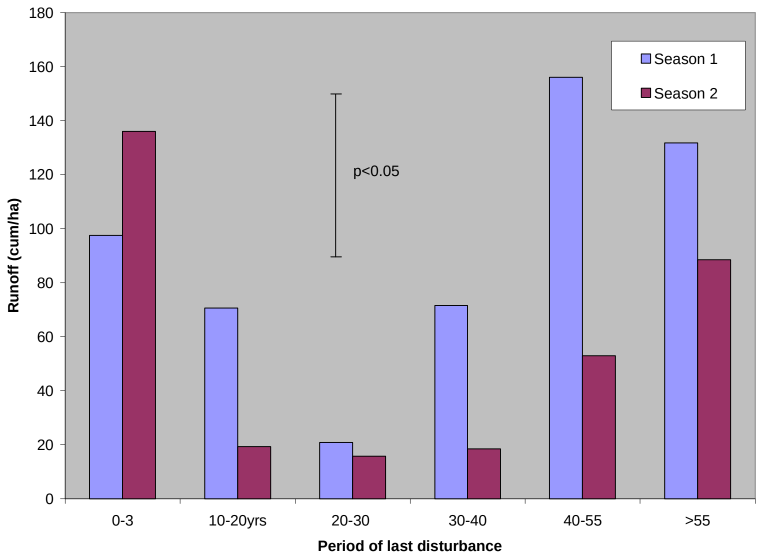


Figure 515 Run off in relation to time since last disturbance

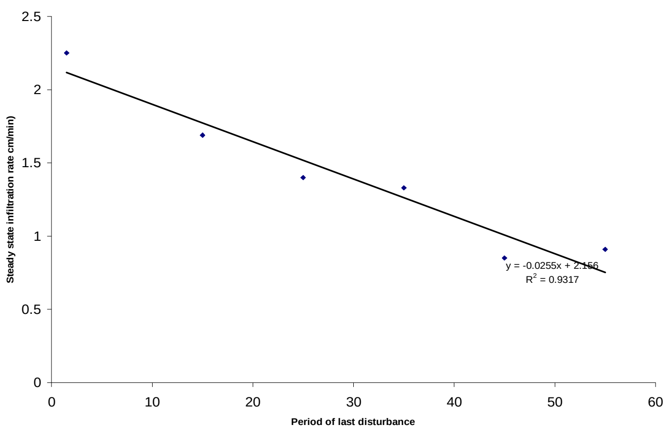


Figure 516 Relationship between infiltration and time since last disturbance

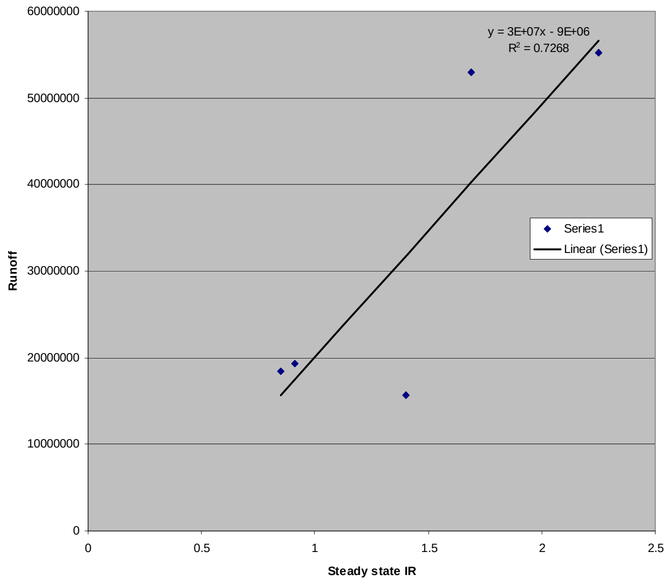


Figure 517 Relationship between runoff and steady state infiltration

5.2 - **Task 5.1: SOIL AND NUTRIENT LOSSES FROM KEDOWA, MAU FOREST, KENYA**

Partner 5: Njuguna, J.

(NB this report was written when the site had not been visited for several months due to the local unrest)

Introduction

Poor management, over-exploitation and inadequate protection of the natural forests over the years have led to forest loss and degradation of natural resources. Degradation is largely attributed to indiscriminate extraction of high value tree species associated with primary forest, with no due regard to sustainability. At the same time, several tracts of land have been abandoned due to the low capacity of forest department (KFS) to replant the clear-felled plantations.

These forests have been adversely affected by much illegal encroachment in the recent past. This has reduced the vegetation cover over large tracts of land which has reduced the water levels in most of the major rivers and the drying up of small streams. The consequences of these changes, seen both on-site and off-site, include the following:

- On-site reduction in landscape productivity because of increasing losses of nutrients and soil:
- Down stream impacts, such as reduction in water quality through increased sedimentation and changes in water yield: and
- Wide spread reduction in biodiversity and supply of various ecological goods and services.

The possible way of rehabilitating these degraded forests could be through enrichment planting, reforestation or allowing natural succession to take place.

The forest edge has been characterized by human encroachment and illegal clearance of high quality value species which are utilized for timber and charcoal.

The surrounding communities are peasant farmers mainly on the eastern slopes while the western part is bordered by large tea plantations, run by multi-national companies.

Degradation of the forest is largely experienced on the eastern side of the Mau where there is no steady income.

Site description

Kedowa is situated in the Mau forest block located at 35º.50E and 0º.69N. This forest ranges from intact inner core to degraded adjacent sites bordering human settlement.

The site is in compartment 3Q of Kedowa block in Londiani forest station of Kericho District. It is sandwiched between a natural forest and C*upressus lusitanica* regeneration. It is about fifteen kilometres from the Londiani KEFRI centre. The general slope is between 5% and 7% oriented in a north - west direction. The site was under pine plantation which was clear felled in 1995. Later, farmers were allowed to cultivate the land until 2003 when the shamba system was discontinued.

The dominant species on the site is vernonia with grasses but the adjacent natural forest is rich with the following species.

Trichocladus elllipticus (Dominant)	*Polycius fulva*
Albizia gummifera	*Podocarpus latifolius*
Olea africana	*Ekerbagia reuperiana*
Juniperus procera	*Prunus africana*
Fraxinus berandriana	*Croton microschysus*
Ficus nataliensis	*Teclea nobilis*

The layout of the wp5 plots which span natural forest and regeneration sites of different slopes is shown in Figure 8. Their individual characteristics are given in Table 5.

Table 521 Descriptions of the individual plots at Kedowa

6.1.2 Individual plot description
Up1 - slope 11% with 10% undergrowth and100% canopy cover comprising of big trees
Up2 - slope 13% with 50% under growth and canopy comprising of big trees
Up3 - slope 21% with 30% samplings & grass as the under growth and 90% tree canopy cover

Lp1 - slope 16% with 100% grass cover
Lp2 -slope 7% with 100% grass cover
Lp3 - slope 9% with 90% grass cover upper canopy 4% of shrubs (vernonia)
Lp4 - slope 6% with 100% grass cover
Lp5 -slope 2.5%, with 60% grass and 40% canopy of vernonia species
Lp6 - slope 10% with 90% grass cover 2% of croton spp
Lp7 - slope 7.5% with 80% grass cover with scatted castor oil plants
Lp8 - slope 3% with 100% grass cover
Lp9 - slope 2% with 100% grass cover

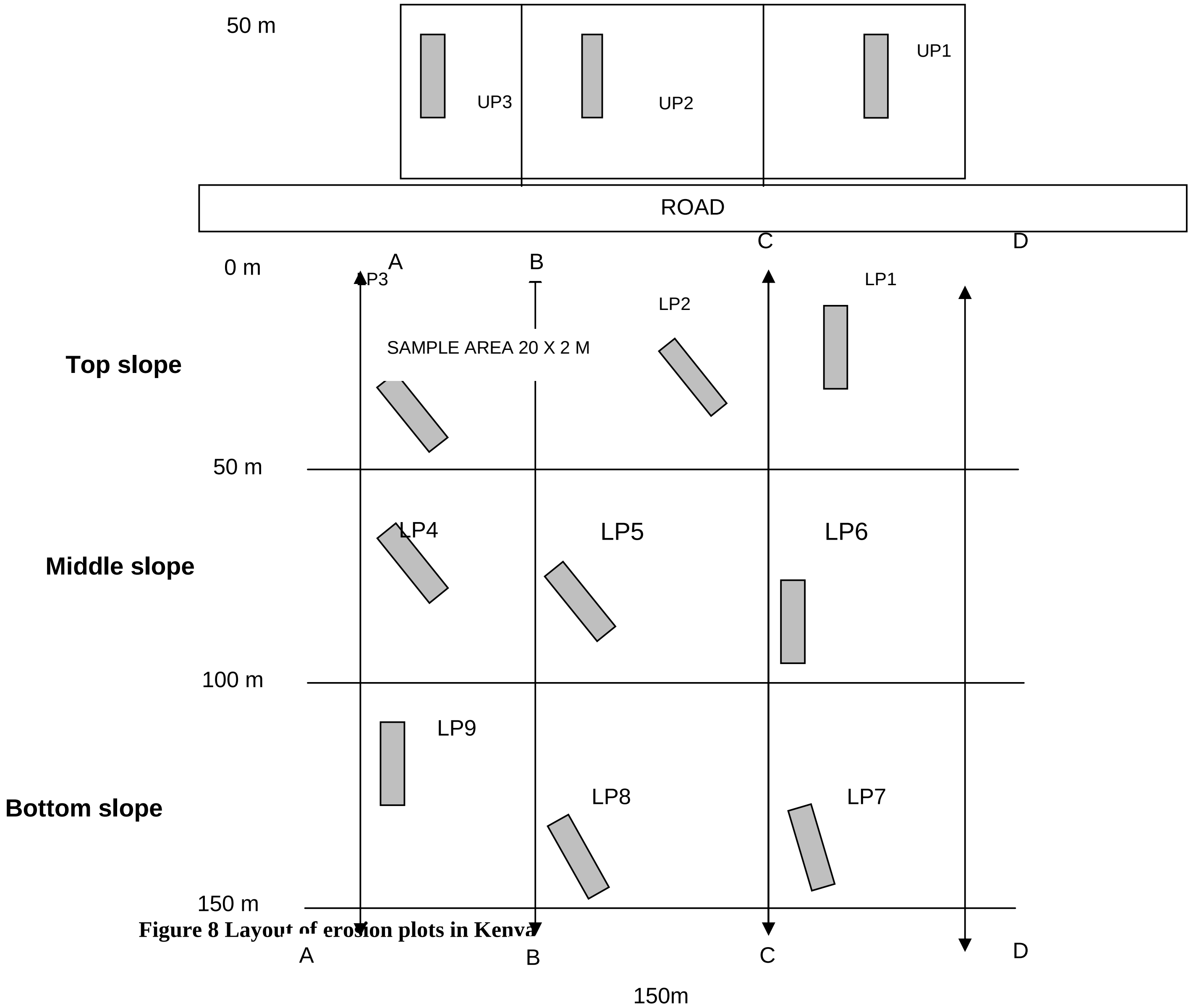


Figure 8 Layout of erosion plots in Kenya

Tree planting was done to assess its effects on soil erosion. The following design was adopted, which maps onto the regeneration erosion plots shown above.

Group planting	Random planting	Line planting
Line planting	Random planting	Group planting
Random planting	Group planting	Line planting

For line planting: 3 lines of individual species were planted , for group planting: the species were grouped into three and planted, and for random, the species were planted randomly.

Planting

Site preparation (pitting in the grassland) was done and the seedlings sorted according to species. The seedlings were first placed into the planting holes and ascertained that they were the right material for the treatment. Demarcation of the plot size was clearly indicated by pegs to avoid future confusion. The plots were temporarily fenced.

A total of 1500 indigenous seedlings were planted at a spacing of 3x3 metres and 300 bamboo at 5x5 to a plot of 2.0 Ha

During the land preparation, herdsmen and their employers were invited to attend a meeting with the forester in-charge and the project implementers. A total of thirty four people attended the meeting, which focussed on grazing of goats and donkeys in the forest. The forester pointed out issues of grazing in the new Forest Act which he said had stiffer penalties for the offender.

The farmers agreed to stop the grazing of goats and donkeys in the forest. To date no grazing of goats has been experienced in the forest and if this trend is followed great success will be realized. Survival count was done in September last year and the survival rate was 95% for all species. Seedlings were sourced from various nurseries as there were none in our nursery that were of the right sizes. The species planted included the following.

Prunus africana	*Vitex keniensis*
Croton megalocarpus	*Markamia rutea*
Podocarpus latifoliua	*Olea europea*
Polycias fulva	*Albezia gumifera*
Ekrbagia rueperina	*Misopsis eminii*
Cordial abyssinica	*Zyzgiun cordata*
Fagara microphyila	*Zyzgium guinesee*
Cussonia spicata	*Olea welwichisii*
Juniperus procera	*bamboo*

Interim results

. It is evident that the animals were causing a lot of degradation especially on the cover crops such as the herbaceous plants. There is a decrease in the discharge as grass has been established. The preliminary results indicate that the plots located in the forest discharge more water than the grassland plots.

The results from the soil and water analyses indicate that there is a nutrient drain from the site (Table 526). The elements mostly affected are calcium, sodium and potassium and total dissolved solids. Analysis of variance of the run off water data (Table 527) indicates that conductivity, potassium and total dissolved solids (TDS) varied between the plot types: conductivity and TDS were significantly higher in the natural forest and upper slope than the lower plots, and potassium in the run off water also tended to be higher although the results were less clear cut. Soil chemical analysis was also conducted on soil from soil pits (Table 528).

The water quality is acceptable when compared with the WHO standards.

Table 526 Chemical analysis of run off water from the erosion plots at Kedowa

	UP1	UP2	UP3	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
pH	6.2	6.39	7.01	5.55	6.5	6.55	7	6.1	6.7	6.47	6.7	6.3
Conductivity	169.6	79.3	97.2	122.7	81.7	122.1	61.3	38.5	58.7	53.8	49.6	43

TDS	105.15	49.16	60.26	76.07	50.65	75.7	38	23.87	36.39	33.35	30.15	26.66
Potassium	43	60	87	72	68	82	30	28	32	42	46	34
Sodium	60	58	10	2	44	97	10	6	62	74	12	4
Magnesium	2.442	2.434	1.223	2.448	1.950	1.709	3.647	2.675	4.136	1.947	3.161	2.432
Total Hardness	60	30	40	85	33	42	25	21	40	23	23	20
Calcium hardness	20	8	14	30	10	14	4	4	9.2	6	4	4
Chlorides	45	65	25	75	20	45	45	30	45	20	35	30
Fluorides	0.1	0.11	0.16	<0.1	0.15	0.15	0.13	<0.1	0.13	0.1	0.11	0.1
Sodium Adsorption Ratio	3.363	4.593	0.687	0.094	3.324	6.498	0.866	0.567	4.250	6.692	1.084	0.388

Table 527 Results of analysis of variance of water samples from Table 526 (results given where ANOVA indicated significant differences between plots at $p<0.05$)

	Natural forest (UP)	Upper slope (LP1-3)	Mid slope (LP 4- 6)	Lower slope (LP 7 – 9)	LSD
conductivity	115.4a	108.8a	52.8b	48.8b	44
potassium	63.3ab	74.0a	30.0c	40.7bc	24
TDS	71.5a	67.5a	32.8b	30.1b	27

Table 528 Chemical analysis of soil from different locations in the soil profile

Pit	Horizon	pH	%C	%N	P	Mg	Na	K	Ca	Cu	Zn	Mn	Fe		
Pit1 Top	O	5.8	7.02	0.63	839	1265	32	1209	5051	0.92	44.49	1116.9	447.32		
	OA	5.9	2.55	0.32	520	1035	33	1105	1816	0.16	20.29	1046.37	433.84		
	A	5.3	1.5	0.2	410	880	63	1076	945		3.62	767.71	354.64		
	B	4.9	1.31	0.18	365	742	55	935	765		1.87	631.58	310.32		
	BC	5.2	0.95	0.17	456	668	61	832	634	0.09	1.37	531.02	262.56		
P2 Bottom	O	5.8	8.57	0.61	739	1153	42	900	6237	1.37	43.31	1281.17	577.38		
	A	4.8	1.97	0.23	483	739	72	920	1370	0.23	7.41	776.35	454.39		
	B	4.8	1.91	0.18	420	581	56	833	973	0.28	4.29	578.54	385.65		
	BC	4.9	0.47	0.06	447	1242	87	811	3406	0.21	4.86	419.25	281.01		
Pit13 Middle	O	5.8	5.33	0.48	693	788	63	931	4706	0.93	23.45	1136.25	434.71		
	A	6.1	2.89	0.3	502	838	61	880	3056	0.19	11.44	956.55	427.99		
	AB	5.9	2.49	0.2	429	871	45	896	1947	0.18	3.73	643.43	365.45		
	B	4.8	1.62	0.18	410	709	99	818	1065	0.11	1.21	340.5	257.33		
	BC	5.2	1.13	0.17	383	438	102	842	1710	0.21	1.44	237.51	219.01		

Report from Partner 7
Andriamampianina Nicolas, Andriamampandry Hanitra, Rakotoarinarivo Charles

Location: *Vohimana forest Station*

Objectives for Year 3

- Monitoring of Soil sampling
- Literature review on Soil erosion research in the East eco-regional of Madagascar
- To quantify runoff and erosion losses from, and rainfall infiltration into, differing farming, fallows and forest.

The soil erosion in Eastern side of Madagascar was the subject of several studies since the sixties until now. We can draw from these studies some significant facts. Towards the beginnings of the sixties the CTFT (Centre Technique Forestier Tropical) undertook measurements of erosion in small catchment in the area of Périnet (more in the west of Vohimana). The objective of research was to quantify the runoff and the soil losses under various types of vegetable cover. Three types vegetative covers were studied:

- Slash and burn cultivation
- Primary natural forests
- Natural forests secondary
- Eucalyptus plantation
- Natural fallow

Results are very significant :

- The experimentation into small catchment area highlighted the role of forest cover for the reduction in the specific flow of flood (1, 5 times less in forest that in degraded grass land) and the regularization of the stream flows. Under forest, erosion misses whereas it can reach very high figures under slash and burn cultivation.
- The slash and burn cultivation is very prejudicial as regards as soil loss: 13t/ha.
- With an installation of level lines, some anti-erosion practices and improved farming methods, the soil losses are reduced.

From the Eighties, research was directed towards the study for alternatives to slash and burn. In the zone of Beforona, the soil erosion and conservation of the FOFIFA led measurements of erosion by testing alternative techniques to the "tavy". Measurements were carried out under standard erosion plot or Wischmeier plot (200 m²).

Some treatments have been tested:

- Slash and burn cultivation
- Improved fallow with *Grevillea banksii*
- Alley-cropping system
- Live contour with Vetiver grass.

These researches mentioned the importance of the “erosion” in the farming systems on strong slope:

- The live contour decreases considerably the soil losses.
- The improved fallows with *Grevillea banksii* or *Tephrosia vogelii* also decrease the erosion during the periods of cropping.
- Only one line of Vetiver grass located downstream from the plot of cultures reduces the soil erosion.

During the nineties, the Swiss co-operation Terre Tany project also carried out measurements of erosion in elementary Wischmeier plot. The various following vegetative covers were tested compared to the runoff and soil loss:

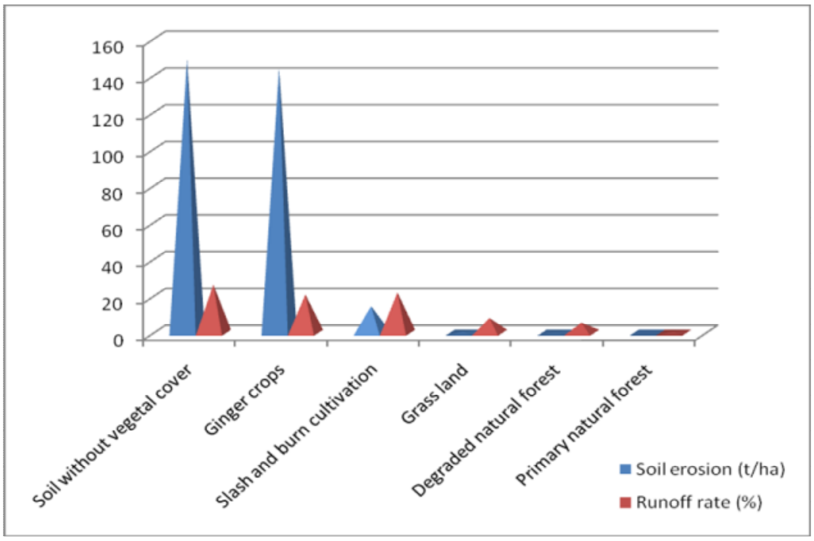
- Primary natural forest
- Degraded natural forest
- Slash and burn cultivation
- Ginger crops
- Grass land

- Soil without vegetative cover

The results are shown in the following table
Annual average soil loss according to types of vegetal formations
(Average slope 35%)

Vegetative cover type	Rainfall height (mm)	Soil erosion (t/ha)	Runoff height (mm)	Runoff rate (%)
Primary natural forest	1808	0,009	13	0,8
Degraded natural forest	1968	0,367	142	5,5
Slash and burn cultivation	2603	14,5	571	21,9
Grass land	2603	0,817	158	8
Soil without vegetative cover	2603	149	681	26,2
Ginger crops	2603	143,9	542	20,8

Source : Terre-Tany Project 1997



According to results' obtained by Terre Tany project, we can advance that:

- The forest plays a great role in the improvement of the of water balance by the importance of the infiltration compared to the runoff and progressive restitution of this water during the year. This process favors the forest area and their peripherals as regards availability of water. The water being the principal element of the agricultural production.
- The forest plays a dominating role as regards soil protection, which are the substrate of all agricultural activities. The figures of the following board give an outline of the soil loss under forest and other vegetable formations.
- The soil losses are relatively tiny and insignificant as long as the vegetable cover remains dense.
- The slash and burn cultivation cause a strong quantity of soil loss during the cultural period. But the recovery of the soil by the vegetable decreases these soil losses quickly.
- The ploughing on the strong slopes gives free field to the soil erosion. This practice, related to the culture of ginger, which starts to take importance in the area, is a source of destruction of the regional ecosystem.
- The tropical cyclones are exceptional phenomena which causes of enormous environmental damage in Malagasy eastern cliff.

USLE model application

A test of modeling of the soil losses in the zone by the theoretical application of the formula of Wischmeier gave very interesting results as regards erosion. The step consists in giving values for each terms of the formula:

A = 2.24.R.K.LS.C

A = soil loss in t/ha

2.24: coefficient to translate acre to metric system

R: climatic aggressiveness index
K: Soil erodibility index
LS: Topographic index (Length and value)
C : Vegetative cover index

For the Vohimana's benchmark site the values of the all parameters of the Universal Equation were expressed as follows :
R index = 563
K index = 0,03
C index =

- For primary and secondary natural forest, C index = 0,005
- For crops, C index = 0,02

LS :

- For slope class, LS index = 0-40% : 8
- For slope class, LS index = 40% et + : 4

With these values the annual soil losses, under the various topographic and the vegetative cover conditions, arise as follows :

Annual soil loss by using USLE Model

Cover type	Slope class	R index	K index	LS index	C index	Annual soil loss (t/ha)
Natural forest	0 – 40 %	563	0.03	8	0,005	1,51
	40% et +	563	0.03	4	0,005	0,76
Crops (up land rice)	0 – 40 %	563	0.03	8	0,02	6,05
	40% et +	563	0.03	4	0,02	3,03

Compared to the data obtained in standard erosion plot, the values of the soil losses resulting from the application of the Universal Equation of Wischmeier are more significant under forest but less significant under crops. This situation requires a revision of the value of the C index. However the application of USLE model will be a reliable means for the theoretical evaluation of erosion.

Activité 3 : Erosion monitoring
Installation of the erosion plots

The erosion plot were installed in May 2008. Three erosion plot (4 x 10 m) were installed according to the great slope.

Each plot is equipped with:

- *Galvanized sheets, inserted in the ground to delimit the plot (40m²)*
- *A collecting vat*

The collecting vats of runoff were installed in order to recover the sub-surface flows which are very significant in forest. The higher edge is inserted to 5 to 10 cm below the surface of the ground (surface is covered by important weak broken up litter (up to 50 cm of depth)

- *A spirit level*
- *A can collector*
- *A rain-gauge*

It's envisaged to install a recording rain-gauge in the site.

Plots description
Plot 1 :

- Vegetation : natural forest
- Main forest species observed : *Uapaca thouarsii*,
- Soil type : ultisol
- Soil profile description

- **Higher slope**

Vegetation : degraded natural forest
Horizon A0: litter weak broken litter
Horizon A1: [0 – 10 cm]: broken up organic matter
Horizon A/B: [10 – 20 cm]: mineral and organic, yellowish of stain of rust, abundant rooting.
Horizon B: [> 20 cm]: mineral, reddish, weak rooting.
Horizon C: Non visible on the profile

- **Semi-slope**

Végétation: degraded natural forest
Horizon A0: litter weak broken
Horizon A1: [0 – 10 cm]: broken up organic matter
Horizon A/B: [10 – 20 cm]: mineral and organic, yellowish, existence of stain of rust, abundant rooting.
Horizon B: [> 20 cm]: mineral, reddish, weak rooting.
Horizon C: Non visible on the profile

- **Lower slope**

Vegetation: degraded natural forest
Horizon A0: litter weak broken
Horizon A1: [0 – 10 cm]: broken up organic matter
Horizon A/B: [10 – 20 cm]: mineral and organic, yellowish, existence of stain of rust, abundant rooting.
Horizon B: [> 20 cm]: mineral, reddish, weak rooting.
Horizon C: mineral, silty-sand, presence of stain, presence of rock: ∅ 5 cm to 10 cm

Plot 2 :

- Vegetation: primary natural forest
- Main forest species observed: *Uapaca thouarsii*
- Soil: ultisol
- Soil profile description

- **Higher slope :**

Vegetation: Dense fern
Horizon A0: weak broken litter
Horizon A1: 0 – 10 cm broken up organic matter
Horizon A/B: 10 – 20 cm: Mineral and organic, yellowish, existence of stain of rust, abundant rooting.
Horizon B: > 20 cm: mineral, yellowish, weak rooting.
Horizon C: Non visible on the profile

- **Semi-slope :**

Vegetation: primary natural forest
Horizon A0: weak broken litter
Horizon A1: 0 – 10 cm – broken up organic matter
Horizon A/B: 10 – 20 cm: mineral and organic, yellowish, existence of stain of rust, abundant rooting.
Horizon B: > 20 cm: mineral, yellowish, weak rooting, existence of rock.
Horizon C: Non visible on the profile

- **Lower slope :**

Vegetation: primary natural forest
Horizon A0: weak broken litter
Horizon A1: [0 – 10 cm]: broken up organic matter

Horizon A/B: [10 – 20 cm]: mineral and organic, yellowish, presence of stain of rust, abundant rooting.
Horizon B: > 20 cm: mineral, reddish, weak rooting, presence of rock at low depth
Horizon C: mineral, silty-sand, existence of stain, presence of rock: ∅ 5 cm to 10 cm

Plot 3 : 4 to 7 year old fallow

- Vegetation :
    - Natural fallow
    - Main fallow species observed : *Psiadia altissima (Dingadingana), Clidemia hirta (mazambody) , Rubus molucana (takoaka), molanga, Panicum maximum (ahiim-pody) …*
- Soil : ultisol
- Soil profile description

    - **Higher slope**

Vegetation : *Psiadia altissima* (*Dingadingana), Clidemia hirta (mazambody) , Rubus molucana (takoaka), molanga, Panicum maximum…*
Horizon A0: weak broken litter.
Horizon A1: [5 – 10 cm] : broken up organic matter
Horizon A/B: [10 – 20 cm] ; mineral and organic, yellowish, existence of trace of rust, relative abundant rooting.
Horizon B : [> 20 cm] : mineral, reddish, weak rooting.
Horizon C : Non visible on the profile

- **Semi-slope**

Vegetation : *Psiadia altissima* (*Dingadingana), Clidemia hirta (mazambody) , Rubus molucana (takoaka, molanga), Panicum maximum (ahimpody)…*
Horizon A0: weak broken litter
Horizon A1: 0 – 10 cm – broken up organic matter
Horizon A/B: 10 – 20 cm: mineral and organic, yellowish, existence of trace of rust, abundant rooting.
Horizon B: > 20 cm: mineral, yellowish, weak rooting, presence of rock: ∅ 5 cm to 10 cm.
Horizon C: Non visible on the profile

- **Lower slope**

Vegetation: *Psiadia altissima* (*Dingadingana), Clidemia hirta (mazambody) , Rubus molucana (takoaka, molanga), Panicum maximum…*
Horizon A0: weak broken litter
Horizon A1: 0 – 10 cm – weak broken organic matter
Horizon A/B: 10 – 20 cm: mineral and organic, yellowish, existence of trace of rust, abundant rooting.
Horizon B: > 20 cm: mineral, yellowish, weak rooting, presence of rock: ∅ 5 cm to 10 cm.
Horizon C: Non visible on the profile

- As the rain season have just finished, it was considered reasonable to begin the observations in those erosion plots only about September 2008
- It's necessary to install a rain-gauge by plot and a recording rain-gauge for the whole of the site.
- We also considered interesting to install a control erosion plot using standard tanks collectors with distributors to check the sampling rate of the "sensors". This plot will be installed at the site n°3 under natural fallow.

Workpackage 6: Improving human well being by developing market access and economic benefits for local populations

6.1 Results for technical and economic charts for main potential restoration species

6.1.1 In Uganda

See specific deliverables

6.1.2 In Kenya

WP1 report listed the preferred species for various tree products mostly for firewood, timber, construction poles and bees forage. From the report and discussions during the steering committee in 15-18th January 2007 five species were selected for WP 6. The species are *Juniperus procera, Prunus Africana, Zanthoxylum gilletti, Polycias fulva* and *Croton macrostachyus.*

WP3 has submitted report for growth data for only 4 species out of the 5 recommended due to unavailability of tree stands to collect data in all plantation restoration areas in Kenya. The data provided by WP3 for use by WP6 in biomedelling on potential restoration indigenous species were *Juniperus procera, Prunus Africana, Polycias fulva* and *Zanthoxylum gilletti*. These species were used in the calculation of the economics of the potential restoration indigenous species for Kenya. An MSc student from Moi University has written a thesis on the economics of potential indigenous species for forest restoration in Kenya.

The study revealed a strong correlation between growth in yield per tree and age as the coefficient of determination of all the species was over 50%. The mean annual increment in volume were 10.09 m^3/ha for *P. africana*, 9.57 m^3/ha for *X. gilleti* 7.46 m^3/*ha P. fulva*, and 3.73 m^3/ha for *J. procera* that is relatively low as compared competing exotic species that ranged between 15 to 60 m^3/ha/yr. The optimal financial rotation for *X. gilleti*, *P. fulva* and *J. procera* was 38 years while that for *P.africana* was 48 years. The study revealed that at an interest rate of ten percent the four species was found to be financially viable for use in forest restoration activities. However, more experimental plots need to be established for collection of accurate data for better growth and yield assessments

See also specific deliverables.

D6.2: A Draft technical and economics chart for main potential restoration species was completed.

6.1.3 In Madagascar

From June 2007 to May 2008, the main results was coming from CIRAD and UnivTana students. See D6.4a to D6.4d.

The list species those proposed by populations for restauration were

Timber trees : Voamboana *Dalbergia monticola,* Varongy *Ocotea sp,* Ramy *Canarium sp,* Pin *Pinus sp*, Rotra *Eugenia sp,* Voapaka *Uapaca sp*
Medicinal tree : Kotofy *Prunus africanum*,

Charcoal and Fuelwood tree : Kinina *Eucalyptus robusta*
Essential oil tree : Tavolo *Ravensara sp*
Fibre tree : Vakoana *Pandanus sp*

Those various tree products are named mostly for firewood, timber, construction poles, essential oils or forest fruits.

It appears that *Prunus africanum is the only tree we can find in the three countries.*

6.2 Detailed technical and market analysis for targeted restoration species, including processing aspects done.

6.2.1 Uganda

See specifics deliverables

6.2.2 Kenya

The studies on wood and NWFP presently and potentially produced in restored areas was completed in December, 2007 and draft report completed.

The study was carried out on selected households from selected villages adjacent to West Mau forest. Some work was done on extractors, processors and merchants along the market value chain starting from the forests to consumers in local, regional and national markets. Some literature work was done on the potential trade on forest products from restored forests in the national and international market destinations.

The problems faced by the study team was the fact that most of the extraction from forest West Mau forest was illegal and where allowed by forest rules was only for household consumption not for trade. The only legal licenses for extraction were for grazing and firewood from dead tree for domestic consumption only. Given these conditions it was not possible to invest in efficient processing technologies as most of the extractors used simple hand tools (machetes and axes). Small quantities of products were extracted at any one time and even smaller quantities entered into in legal market value chain especially outside the local area. This was because extractors or merchants could not get movement permits to transport forest produce to distant market.

From the study the following conclusions were drawn:

- Forest adjacent communities are dependent on various forest products for domestic use and income generation mostly charcoal, timber, grass, firewood, poles, honey, herbal medicine parts.
- Most of the tree products extracted were for households own consumption
- Trade in extracted products is limited to household and local markets by policy and legislation that sets stringent conditions for movement of tree products by roads hence the reason for low long distance trade activities.
- However, there are great market opportunities for various tree products in the local and national market outlets.
- The study revealed that marketing systems are relatively developed and highly efficient in price transmission but relatively experience high transactions costs due to policy and legislations
- The share of consumer price received by producers for most tradable tree products was relatively lower as compared to agricultural products partially due high processing and transaction costs in trade tree products.

D6.3: Detailed technical and market analysis for targeted restoration species, including processing aspects done.

D6.4: Report on local, national and international main competitors and of potential market position for countries institutions and organisations was attempted and a draft report made.

6.2.3 Madagascar

See specifics deliverables

6.3 Legal and judicial aspects regarding trade in wood and non-wood forest products

6.3.1 In Uganda

See specifics deliverables

6.3.2 In Kenya

The studies done in Kenya on judicial structures covered two levels domestic trade and international trade. It revealed that there are many laws that directly or directly govern trade in tree products from Kenya. The following sections present the highlights of the study.

Domestic legal instruments

The enactments that constitute the legal framework for regulating trade in timber and NTFPs among others are:

- Forest Act No. 7 of 2005
- Chief's Act Cap 128 of 1970 (Revised in 1988)
- Timber Act Cap 386 of 1972
- Water Act, Cap 372
- Wildlife Conservation and Management Act, Cap 376
- Agriculture Act, Cap 318
- Environmental Management and Coordination Act of 1999 (EMCA)
- Export and Import Control Act
- Kenya plant health inspectorate services Act
- Forest Act No. 7 of 2005: Charcoal Production, Transportation and Marketing: Forest Rules and Regulations 2006.

The Forest Act, 2005 is the dominant legal instrument, with a primary focus on sustainable management of forests for climate amelioration, soil, water and biodiversity conservation and wood production. It regulates all forestry activities in government, trust land and private forests including harvesting, processing, transportation and trade. It prescribes procedures for logging, licensing, payment of royalties, processing and grading and certification for export markets.

For non-consumptive use of forests, the user must contact the concerned forest authorities formally to seek their approval. If such use is approved then official documents attesting the approval should be provided.

The timber Act, 1972 establishes the guidelines and documentary requirements for trade in timber products. In this Act, timber refers to wood from any tree grown in Kenya, Uganda and Tanzania. The Act provides for grading and certification of timber. The Act requires importers and exporters of timber to be issued with an import or export permit, certificate of grading, certificate of origin and transport permit, and provides the procedures for application and form of these documents. It prescribes the marks to be placed on different grades of timber to indicate the origin and grade of such timber, and the method of placing such marks and the registration thereof. The Act also elaborates the circumstances under which such documents may be revoked and the authorities with the powers to issue and revoke them. Further, it prescribes the penalties which may be annexed to any breach of its provisions and subsidiary legislations.

The Chief's Act empowers the Chief to enforce various environmental conservation provisions within the limits of their jurisdiction, including the control of the use of tree resources on private land. Though mainly concerned with trees on private land, the Act plays an eminent role in charcoal transportation since the Chief must ascertain the origin of charcoal before the District Forest Officer (DFO) can issue a transport permit.
The Wildlife management and conservation Act implemented by Kenya Wildlife Service, (KWS) prohibits logging of any kind of any tree of any species in national parks and game reserves and protect exploitation and trade in endangered species including plants.
The Export and Import Control Act regulates the import and export of timber and NTFPs. The Act establishes the framework for regulating trans-boundary trade to be implemented by the Customs Department, under the Ministry of Finance. It provides for the authorization of entry and exit points for importing/exporting products by sea, air and land, the collection of duties, and prevention of smuggling. The plant health inspectorate services Act deals with the imports and exports of plants, plant parts and plant materials. Its concern is to ensure that plants, plant parts or plant materials entering or leaving the country are free from any infections.

International obligations
Kenya is a signatory to the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). The Convention specifically addresses the link between species conservation and their trade in international markets. The Convention restricts or prohibits international trade in certain fauna and flora listed in three Appendices on the basis of their respective vulnerability and degree of protection needed.

Kenya is also a party to the International Tropical Timber Agreement (ITTA), although no specific obligations accrue from it. It focuses on the relationship between international trade in timber and forest conservation, seeks to facilitate the development of homogenized trade standards and guidelines in tandem with the International Tropical Timber Organization (ITTO).
Kenya has ratified the United Nations Framework Convention on Climate Change (UNFCCC) and is a signatory to Convention on Biological Diversity. The provisions of these conventions on trade in forest products are binding in Kenya.

D6.5: Report on legal and judicial aspects of trade in wood and NWFP produced from restoration areas was partially done and draft report available.

6.3.3 In Madagascar

Report on legal and judicial aspects of trade in wood and NWFP produced from restoration areas in Madagascar is available. See D6.5.

It shows :

The legal setting of the trade of wood and the non wood forest products coming from restoration zones.

- It is about determining in positive right the legal setting of the trade of wood and non wood forest products coming from restoration zones;

- It is not about planning what could be in prospective right the legal setting of the trade of wood and the non wood forest products coming from restoration zones.

Basic questions are : Determining the legal setting positive of the trade of wood and the non wood forest products coming from restoration zones supposes to answer the basic questions as follow :

- Some of these questions are linked to the resource :
  - Can we restore with trees or plants who are able to be marketed?
  - Is it about any tree or marketable plant?
  - Does it necessarily have to be indigenous trees or plants?
- Other questions concern the natural space :
  - Are we allowed to restore on any common or private ground with such trees or plants?
  - Is it necessary to distinguish whether it is about protective zone or production zone?
  - Does the distinction of such zones exist?
  - What are the different existing forest zones and their respective statute?
  - Can one restore with different manners those zones?

- These first two sets of question ask the previous question of the definition of the restoration notion :
  - Do different definitions exist, in particular legal?
  - What are they?
  - What are the existing differences?
  - What definition to use?

- Fundamental reserve: It is important to underline that the access to the legal texts in Madagascar is difficult. It is especially difficult that, often, the existence of some texts is ignored or is forgotten including by those who are in charged of applying them. So, we must accept that :
  - We cannot always have a complete view of the positive right
  - It is difficult and uncertain to determine the statute of the operators acting in forests which are under restoration regime
  - So, numerous appreciations are therefore hypothesis those should be confirm by the analysis of the practice

- Legal regime of the restoration :
  - There is not special legal and unified regime of the restoration in Madagascar currently
  - So, it is necessary to build on this regime therefore

- Method of construction : How can we build on the legal positive positive of the restoration? For that, we need to determine and to recall:
  - What are the applicable norms?
  - How are links and relations between these rules?

- Identification of the applicable norms
  - What are the applicable rules?
  - Many texts and arrangements are applicable. Among the main:
    - Cf lists of legal texts which are currently in force

- Identification of the coordination rules: How are links and relations between these rules? Five main categories of rules are necessary to construct a coherent legal regime from different and scattered arrangements. They are :
  - the coming in force of the norms,
  - the hierarchy of the norms,
  - the abrogation of the norms and the consecutive fate of the decrees of application,
  - the regulation of the conflicts in the time and in the space, and

  - the legal value of the circular and instructions.

- The coming in force of the norms :
  - the legislative and regulations acts that are forgotten to be submit to the formality of the publication in the JORM must be considered like not having a legal value

- The hierarchy of the norms:
  - the decrees are themselves subordinates to the laws
  - the category of the regulations is herself in also in a hierarchy system : the authorized decrees of the ministers, the mayors and all other responsible men are subordinated to the authorized decrees form a downward hierarchy under the reserve of the respective rules of determination of the clean assessments of each of these authorities

- The abrogation of the norms and the consecutive fate of the decrees of application:
  - the authorized and legislative texts remain so much applicable that they have not been abrogated
  - the abrogation of a law doesn't automatically lead the abrogation of the regulations that has been taken for its application

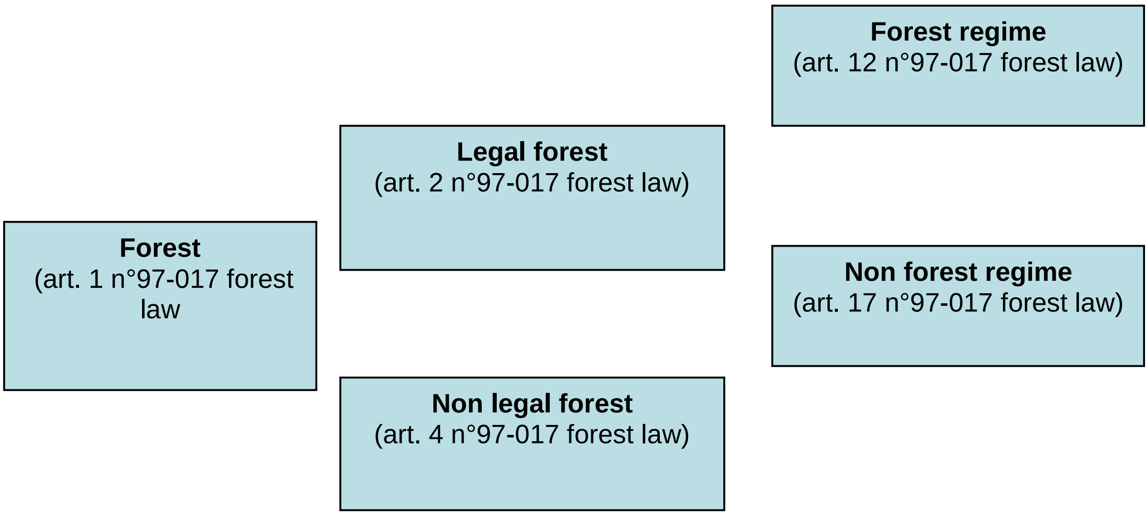
- The regulation of the conflicts in the time and in the space:
  - a question governed by a specific disposition that concerns it is excluded of the field of application of the general disposition concerning the generic category to which this question belongs
  - the new law cannot apply to facts previous to its entry in force
  - the rule is that the old law cannot apply to posterior facts to its abrogation, therefore to the entry in force of the new law
  - the regulation immediately applies to the situations existing at the time of their entry in force, including to future effects of the new situations without contracts

- The legal value of circular:
  - Towards public employees, they have an obligatory character
  - Towards citizens, the circular doesn't have any obligatory strength

- The legal value of instructions:
  - the administration can refer to it without soiling its decision of illegality
  - the refusal of the administration to apply a guideline can be contested by a citizen who fills the conditions foreseen by this one, except if some particular circumstances justified this derogation

- Results
  - With these rules of coordination between the norms, it is possible to determine distinctly:
    - the field of application of the legal regime of the restoration and
    - the nature of the rights and the obligations of the operators acting in subject forests to this regime.

- The field of application of the legal regime of the restoration
  - Following the reconstituted forest right, different types of forests exist. Three categories can be distinguished:
    - non legal forests,
    - non subject legal forests to the forest regime and
    - legal forests submitted to the forest regime.



- It is possible to make an ecological restoration in each of these forests but the legal regime of the restoration doesn't apply at all these forests. It concerns :
  - o the forests which are legally considered like such, and
  - o among the legal forests those are submitted to the forest regime.

- The nature of the rights and the obligations of the operators acting in forests subject to the legal regime of the restoration. Reports :
  - o The rights and obligations take out from general norms. The operators benefit in individuals from "various advantages." But the set of these rights and these obligations is not completely récised
  - o It exists in addition to the rights and the special obligations

- The general advantages : The set of the forests submitted to the forest regime benefits various advantages (article 11 of the Law n° 97-017 of August 8, 1997 carrying revision of the forest legislation). These advantages are not completely identify. Those which are not completely identify are not applicable (except arrangement of fact whose juridicité should be verified): for example:
  - o Fiscal and fundamental advantages especially in the case of reforestation (article 9 of the Decree relative n°2000-383 to the reforestation of June 07, 2000)
  - o Essentially economic advantages in the setting of the Gelose (article 54 of the Law 96-025 of relative September 1996 30 to the local management of the renewable natural resources

- Rights and specific obligations: Reports:
  - o The rights and the obligations of the operators of a forest which will be subject to the restoration are clear when these forests are in a perimeter of restoration (subject to have all texts what is not in the possible state).
  - o Out of this one, the nature of the rights and the obligations of the operators remained uncertain.

- The restoration in the setting of the restoration perimeters: Three rights and obligations clearly appear :
  - o Interdiction of all exploitation (article 51 of the Law n° 97-017 of August 8, 1997 carrying revision of the forest legislation)
  - o The rights of use can be exercised, but subject to the respect of some regulations including surely of restrictions (these reglementation stays unknown) (article 11 of the Decree n 55-582 of relative May 1955 20 to the protection of the forests in the territories of Africa

being a matter for the Minister of France of overseas). It is necessary to note that the rights of use don't include rights of exploitation (article 34 of the Décret°98-781 fixing the general conditions of application of the law n°97-017 of August 08, 1997 carrying revision of the forest legislation)
    - It is possible to take a forest out of the restoration (opinion of the forest commission) perimeter. It is then possible to exploit it (general regime of the exploitation) (article 8 of the Law n° 97-017 of August 8, 1997 carrying revision of the forest legislation)

- The restoration outside of the perimeters of restoration: It is legally possible to make the restoration outside of the perimeters of restoration. What statute does himself apply then outside of these zones? It seems obvious that the one clean to the perimeters of restoration doesn't apply itself. What is the other statute? Can one make in particular, in these forests of the exploitation? To what conditions and with what advantages?
    - The legal definition of the restoration doesn't help to answer.
    - In fact, it agrees to renew the classic fashion of analysis of the applicable texts to manage to formulate an answer. However, this one stays a simple hypothesis.

- The legal definition of the restoration: There is not legal definition of the term restoration in the Malagasy texts. It is possible to pull forest Malagasy (in particular Decree relative n°2000-383 to reforestation and Decree n 55-582 of relative May 1955 20 to the protection of the forests in the territories of Africa being a matter for the Minister of France of overseas) two distinct descriptions of the restoration notion from the right: one strict and the other large :
    - In a first analysis, it would seem that the strict description of restoration does'nt include the exploitation.
    - In a second analysis, we could advance that the exploitation would be also includes in the restoration to the strict sense. In this hypothesis, the exploitation would be finally possible in the two senses of the term restoration but with severe conditions in the restoration taken in the strict sense.
    - But it is only hypothesis. Finally, one doesn't know too much if one can make the exploitation or no on a restored zone.

- So we need to make another analysis of the texts: To determine the legal statute of the restoration outside of the perimeters of restoration, especially to specify the statute of the exploitation in this setting, the analytic gait was until now the following:
    - to search if the texts and the relative arrangements to the restoration allow the exploitation via the legal definition of the term restoration, then if it is yes,
    - to search for the content of this regime of the exploitation.

- The logic of analysis should not be this one. Indeed, it doesn't finally permit to delimit easily and really the rights and obligations of the operators of forests restored. However, this delimitation is possible while following another gait:
    - if the ecology people and the agronomists, on a given land, show that it is ecologically possible to restore while exploiting, that will quite be allowed and the technical conditions of this exploitation will be fixed in the plan of planning and the specifications.
    - if the ecology people and the agronomists think that one cannot exploit while restoring, they won't allow anything on the land.

Thus, it would be always the technical aspect that would determine the legal regime (same case that the delegation of management of the forest private domain of the state).

The logic of the gait. Analytic Gait

- logical shown / visible / affirmed in the texts

Exploitation permit | Exploitation regime

- real logic rebuilt by the jurist

Ecological datas | Permit | Exploitation regime

- These two logics can contradict themselves. The second logic can succeed to legal consequences: creation of rights, cancellation of arrangement contrary to those implied by the logic shown in the texts.

- Taken in account of the legal regime to the look of the real logic. By application of the real logic, the regime of the forests restored outside of the perimeters of restoration becomes then legible and coherent. This regime is the next one :

    - except the perimeters of restoration, there is not principle that dictates what one can make or no on a zone of restoration and therefore the silence or the very big imprecision of the texts to this topic
    - all would depend of the ecological data of basis on the zone: one would leave from the ecological data that would determine the authorization or no to exploit all this then would be concretized including the technical conditions of the exploitation in the plan of planning and the specifications in the determined zone

- Synthesis: On this basis, it is possible to propose the following synthesis of the restoration notion, including the rights and possible obligations:
    - Restoration = Plants non natives + exploitation of these plants
    - Restoration = natives Plants + non exploitation of these plants
    - Restoration = Plants non natives + non exploitation of these plants
    - Restoration = natives Plants + exploitation of these plants

Of a hypothesis to a reality: This definition of the restoration outside of the perimeters of restoration and therefore the rights and the obligations of the operators are confirmed by the practice

- Legal regime positive of the restoration. General synthesis
    - It is prohibited from exploiting a forest includes in a perimeter of restoration. Only can be exercised of the rights of use which consists of no right of exploitation. An exploitation is possible as soon as the forest left by the administration of the restoration perimeter.
    - Outside of the perimeters of restoration, a forest can also be restored. Following a particular analysis, one could consider that the exploitation of this forest including while introducing of the plants natives and marketable possible home subject to be ecologically feasible and of the respect of ecological prescriptions. It is however only there about hypotheses.

- General recommendations
    - All will to market the restored products descended of forests must necessarily come with a precise definition work:
    - of the statute of the restoration out of the perimeters of restoration (rights and obligations of the operators) and

- of the nature of the advantages offered these operators.

6.4 Technical and markets analysis, and processing of targeted restoration species for potential local national and international markets

See deliverables

In Kenya, work on potential economics of three proposed restoration species has been completed. The draft report by an MSc student from Moi University Robert O. Mugabe under the supervision of the PI is complete

6.5 Reviewing the potential eligibility to CDM and voluntary markets of tree planting in relation to restoration activities

To begin after Kampala 2008 April meeting

6.5.1 In Kenya

D6.6: Data and Excel simulation for economic interest draft evaluation. In relation to customary, national and international laws and regulations is planned for 4th year.

D6.8: Review the potential eligibility to CDM of tree planting in relation with restoration activities. Eligibility criteria, principal and regime periods done

D6.9: Excel based simulation for economic evaluation of carbon sequestration planned for 4th year.

Work package 7 – Effective tools for uptake by stakeholders of sustainable restoration strategies

Summary : As multidisciplinary integration between biological sciences and socioeconomic has proved to be a complex question, part of the scientific activities have been devoted to the analysis and description of operational methodology adapted to the forest restoration subject.
The reports described thereafter gave precise information on the methodologies which have been developed under Sigrid Aubert scientific coordination and which have been shared between all Foreaim project participants during the Kampala meeting.
The work developed in Kenya (Kubler and al) has allowed describing stakeholders involved in restoration processes, and to precise agents to be included in simulation tools.
The development of the negotiation and simulation tool (Cormas) has started (Mirana Ratovoniaina PhD under scientific direction of Sigrid Aubert) in close partnership involving three research units.

ANNEX 1: list of deliverables

Work package 1 – Traditional ecological knowledge, tree management practices, uses and economic dependency of local population on forests and tree based systems in the context of their degradation

DELIVERABLE WP1

Deliverable title	Name of deliverable	Main characteristics (format etc…)	Date of release	Partners involved	Corresponding scientist
D1.1 : Definitive choice of study site in each country.	First year annual report	Report	The choice was made in January 2006 and reported in june 2006	KEFRI Univ. Makerere Univ. Antananarivo FOFIFA CIRAD	Foreaim leader of each country
D1.2 :Blueprint providing a comparative state of art on degradation of the forests and tree based systems and restoration practices in the different study sites;	State of art on forest degradation and restoration	3 Reports	June 2006	KEFRI Univ. Makerere Univ. Antananarivo FOFIFA CIRAD	WP1 leader of each country
D1.3 :Work plan on concerted approaches with other WPs and methodological steps for field diagnosis (tasks 2 &3).	Mission reports	3 reports	June 2006 April 2007 June 2007	KEFRI Univ. Makerere Univ. Antananarivo FOFIFA CIRAD	Nicole Sibelet
D1.4 : Site-specific diagnosis reports with characterization of stakeholders' values on forests, trees and associated components;	1) Fanny Rives, Madagascar 2) Cécile Hervo, Uganda 3) Anaïs Oddi, Kenya 4) Daniel Kübler, Kenya 5) Maïwenn Riche, Madagascar 6) Rado Randrianasolo Madagascar 7) Jean-Charles Randrianmiarinjato, Madagascar 12) David Lang'at, Kenya 13) Maafaka Ravelona, Madagascar 14) Fidèle Raharimala,	10 reports (8 reports delivered and 2drafts to be delivered end of 2008)	2007-02 2007-10 2007-10 2007-10 2007-10 2007 2008-06 2008-04	KEFRI Univ. Makerere Univ. Antananarivo CIRAD	WP1 leader of each country Nicole Sibelet

	Madagascar 17) Madagascar/soil fertility perception.doc 18)Uganda/D1.4 WP1UNIVMA.doc	Word file 7 p Word file 7 p	2008-12 2008-12		
D1.5 : List of ideotype species and allied technologies of potential ecological and economic importance;	8) Alex Tumuramye, Uganda 12) 19) D1.5 UNIVMA 3 p	1 report (1 report mentioned above) Word file 3p	2008	KEFRI Univ. Makerere Univ. Antananarivo FOFIFA CIRAD	WP1 leader of each country
D1.6 : Data base on agro-ecological knowledge on trees, uses and management practices.	8) 9) Lucy Mulugo, Uganda 11) Charles Galabuzi, Uganda 12) 20) Uganda/D1.7 WP1 UNIVMA .doc 15) Madagascar/Most_used _ plants_technical_files_Anosibe_ an_ala.doc 16) Madagascar/List of useful plants in Vohimana.doc	2 reports (2 reports mentioned above) Word file 6 p Word file 18 p Word file 17 p	2008 ppt 2008-08 2008-07 2008-06 2008-06 2008-06		WP1 leader of each country
D1.7 : Report on stakeholders' assessment of natural resource management activities and proposed technologies;	10) Rindra Nirina Raveloarison, Madagascar 11) 12)	1 report (2 reports mentioned above)	2007-04		WP1 leader of each country
D1.8 : Guidelines for the empowerment of local communities in participative actions and capacity building processes;	11) 22) Nicole Sibelet	(1 report mentioned above)	2008-10 2008-12		WP1 leader of each country Nicole Sibelet
D1.9 :Press releases to publicise the results;	) Lucy, Gerald, Judith, Esther on Uganda Boradcasting Corporation (TV)) Gerald in new vision		2007		WP1 leader of each country

	)) NTV) Charles Galabuzi) David Lang'at) Yari /press) Yari/movie		2007 2008 2008-04 2008 2008-09 2008-05 2008-04 2008-04		
D1.10 :Communications in regional and international meetings and scientific articles.	IFSA France KEFRI Conference WCA AETFAT Plant diversity, taxonomy and sustainable development		2008-07 Scheduled : 2008-10 2009-08 2010		Nicole Sibelet Several Several Contact Yari
Scientists and students trainings Scientists, students, partners trainings on methods for FOREAIM issues with CIRAD funds	Kenya, Uganda, Madagascar Madagascar 10 days workshop		2006 2007-11		Nicole Sibelet Nicole Sibelet

Work package 2 – Assessment of forest ecosystem degradation, and community structure and species biology for the development of restoration options
DELIVERABLES WP2

Deliverable title	**Name of deliverable**	**Format and file name**	**Date of release**	**Corresponding scientist**
D2.1: Experimental design, plot network in the study sites in each country	D2.1.1. Experimental design of vegetation analyses in Mau forest, Kenya	Word file: Fieldworkplan Kenya.doc	2005	Ørjan Totland Kari Klanderud
	D2.1.2. Experimental design of vegetation analyses in Vohimana forest, Madagaskar	Word file: Fieldworkplan Madagaskar .doc	2005	Ørjan Totland Kari Klanderud
	D2.1.3. Experimental design of vegetation analyses in Mabira forest, Uganda	Word file: Fieldworkplan Mabira.doc	2005	Gerald Eilu Ørjan Totland Kari Klanderud
D2.2: Data base on vegetation composition and selected variables characterising degraded areas	D2.2.1.Data base on the species composition and population densities in the Vohimana forest, Madagascar	Excel file: Species data Vohimana forest.xls	2007	Kari Klanderud, Marie Agnes Radimbson, Edmond Roger
	D2.2.2. Data base on the species composition and population densities in the Mau forest, Kenya	Excel file: Species data Mau.xls	2007	Jared Amwatta Mullah
	D2.2.3. Data base on the species composition and population densities in the Mabira forest, Uganda	Excel file: Species data Mabira.exl	2008	Gerald Eilu, Paul Segawa
	D2.2.4. Species check list for sites in Kedowa and Itarre, Kenya	Excel file: Species list Kenya.xls	2007	Jared Amwatta Mullah
	D2.2.5. Species list and plot characteristics of Vohimana forest, Madagascar	Word file: Species list Vohimana.doc	2008	Marie Agnes Radimbson, Manjato Nadiah Vololomboahangy
D2.3: Data base on vegetation composition and selected variables characterising natural succession areas – plantations and fallows	D2.3.1. Data base on the species composition and population densities in the Vohimana forest, Madagaskar	Excel file: Species data Vohimana forest.xls	2007	Kari Klanderud, Marie Agnes Radimbson, Edmond Roger
	D2.3.2. Data base on the species composition and population densities in the Mau forest, Kenya	Excel file: Species data Mau.xls	2007	Jared Amwatta Mullah

	D2.3.3. Data base on the species composition and population densities in the Mabira forest, Uganda	Excel file: Species data Mabira.exl	2008	Gerald Eilu, Paul Segawa
	D2.3.4. Species check list for sites in Kedowa and Itarre, Kenya	Excel file: Species list Mau.xls	2007	Jared Amwatta Mullah
	D2.3.5. Species list and plot characteristics of Vohimana forest, Madagascar	Word file: Species list Vohimana.doc	2008	Marie Agnes Radimbson, Manjato Nadiah Vololomboahangy
D2.4: population dynamics of the important ecological species in secondary forests that characterise different succession stages and that can serve as keystone species, erosion mitigation (soil holding/binding), nurse species etc.	D2.4.1. Data base on the species composition and population densities in the Vohimana forest, Madagaskar	Excel file: Species data Vohimana forest.xls	2007	Kari Klanderud, Marie Agnes Radimbson, Edmond Roger
	D2.4.2. Data base on the species composition and population densities in the Mau forest, Kenya	Excel file: Species data Mau.xls	2007	Jared Amwatta Mullah
	D2.4.3. Database of tree functional groups in Kenya	Excel file: Functional traits Kenya.xls	2007	Jan Dick, Jared Amwatta Mullah
	D2.4.4. Data base on the species composition and population densities in the Mabira forest	Excel file: Species data Mabira.exl	2008	Gerald Eilu, Paul Segawa, David Nkutu
	D2.4.5. Database of tree functional characteristics (Mabira Forest Reserve)	Excel file: Functional traits Uganda.xls	2007	Jan Dick, Muthalib Katumba
D2.5: population dynamics of the important economic species in secondary forest to assist in establishing harvesting potential, regeneration and restoration needs.	D2.5.1. Tree functional characteristics (Mabira Forest Reserve)	Excel file: Functional traits Uganda.xls	2007	Jan Dick, Muthalib Katumba
	D2.5.2. Database of tree functional groups in Kenya	Excel file: Functional traits Kenya.xls	2007	Jan Dick, Jared Amwatta Mullah
D2.6: results of restoration/rehabilitation tests/experiments in the context of species establishment conducted in WP3.	Data on survival and growth of a few species jointly with wp3	Word file: Growth WP3		Muthalib Katumba, JBL Okullo

D2.7: Restoration/rehabilitation options for each site.				
D2.8 Publications in international journals and locally for use by forest managers, GOs and NGOs etc.	See list of publishable results			

Work package 3 – restoration/rehabilitation through planting: characterisation and silviculture of native and naturalised species to restore environmental and economical function

DELIVERABLES WP3

Deliverable title	**Name of deliverable**	**Main characteristics (format etc…)**	**Date of release**	**Project Partners involved**	**Corresponding scientist**
D3.1 : report on growth curves and table of production of timber species and table of production for non wood forest product species	Growth curves of natives species from Uganda	Excel file	May 2009	UNIV MAKERERE	JB Okullo
	Growth curves of native species from Kenya	Excel file	May 2008	KEFRI	J Mbinga
	Growth curves of native species of Madagascar	Excel file	Decembre 2008	FOFIFA	Z Rakotovao
D3.2 : data base on the phenology of the economically important species	Species phenology from Kenya	Excel file	May 2009	KEFRI	J Mbinga
	Training on phenology	Small report	May 2008	KEFRI	J Mbinga
	Phenology of important species of Madagascar	Excel file	Decembre 2008	FOFIFA	Z Rakotovao R Rabevohitra
	Phenology of important species of Madagascar	Excel file	Decembre 2008	UNIVTA	Y Jeannoda
	Phenology of important species in and around Mabira Central Forest Reserve	Excel File	May 2009	UNIV MAKERERE	JB Okullo
D3.3 : guidelines for propagation by seeds and nursery techniques for ecological and economically important species	Germination test on Ugandan species	Excel file	September 2008		JB Okullo
	Germination test on Kenyan species	Excel file	September 2008	KEFRI	J Mbinga
	Cutting technique with Kenyan species	Excel file	September 2008	KEFRI	J Mbinga
	Germination test and propagation techniques of Malagasy species	Campaign Report	May 2008	FOFIFA	Z Rakotovao
	Germination test and propagation techniques of	Campaign Report	May 2008	UNIVTA	Y Jeannoda

	Malagasy species				
D3.4 : molecular markers for economically important species	Data base on nuclear microsatellites of Dalbergia monticola	Excel file	January 2008	CIRAD FOFIFA/SNGF	JM Bouvet
	Data base on chloroplastic microsatellites of Dalbergia monticola	Excel file	January 2008	CIRAD FOFIFA/SNGF	JM Bouvet
	Data base on nuclear microsatellites of Ravensara aromatica	Excel file	January 2009	CIRAD FOFIFA	Z Rakotovao JM Bouvet
	Data base on chloroplastic microsatellites of Ravensara aromatica	Excel file	January 2009	CIRAD FOFIFA	Z Rakotovao JM Bouvet
	Data base on molecular markers on Prunus africana		May 2008	CEH KEFRI	S Cavers
	Data base on markers of Albizzia gummifera	Excel file	May 2008	CEH KEFRI	S Cavers
	Data base on markers of Polyscias Fulva	Excel file	May 2009	CEH KEFRI	S Cavers
	Data base on markers of Juniperus procera	Excel file	May 2009	CEH KEFRI	S Cavers
D3.5 :data base on the variation of economical important traits within the natural range of the species in each country	Data base on chemical components of ravensara aromatica	Excel file	January 2009	CIRAD FOFIFA	Hanitra P Danthu
D3.6 : handbook on planting of native species in restoration	Data base on trial on Albizzia gummifera	Excel file	May 2008	CEH UNIVTA KEFRI UNIVMA	S Cavers
D3.7 : scientific papers on genetic analysis, propagation of native species	See the publishable results				

Work Package 4 - Characterisation of edaphic conditions in degraded forest landscape to predict forest restoration suitability

DELIVERABLES WP 4

Deliverable title	Name of deliverable	Main characteristics (format etc…)	Date of release	Project Partners involved	Corresponding scientist
D4.1 Experimental design, network of plots in the main site of each country					
	Document on design and network of plots in Kenya	Microsoft word	May 2008	KEFRI, CEH, CIRAD	Wilson, Odee, Kimiti, Lesueur
	Document on design and network of plots in, Madagascar	Microsoft word	June 2008	UA, IRD	Ratsimila Ramonta
	Document on design and network of plots in Uganda	Microsoft word	May 2008	MU	Mwajaliwa, Eilu, Nyeko
D4.2 Data base on nutrient limiting factors for forest restoration.	See deliverables 5.2				
	Dataset on Soil characteristics in Kenya	Excel	June 2008	KEFRI, IRD	Kimiti, Chotte
	Dataset on Soil characteristics in Madagascar	Excel	June 2008	FOFIFA, UA, IRD	RakotoarinarivoChotte
	Dataset on Soil characteristics in Uganda	Excel	June 2008	MU, IRD	Nyeko , Chotte
D4.3 Data base on dynamics of the major biota compartment according to forest degradation status					
	Dataset on rhizobia, mycorrhiza in Kenya	Excel	Mycorrhiza June 2008 Others May 2009	KEFRI, CEH, CIRAD	Odee, Kimiti, Wilson, Lesueur
	Dataset on nematodes in Kenya	Excel	January 2007	IRD	Villenave
	Dataset on rhizobial populations associated with *Albizia gummifera* in Kenya, Uganda and Madascar	Excel	June 2008	KEFRI	Kimiti, Odee
	Dataset on rhizobia, mycorrhiza in Madagascar	Excel	Mycorrhiza August 2008	UA	Isabelle Ratsimiala Ramonta

			Others May 2009		
	Dataset on nematodes in Madagascar	Excel	June 2008	IRD	Villenave
	Dataset on rhizobia, mycorrhiza and nematodes in Uganda	Excel	Mycorrhiza September 2008 Others May 2009	MU, CIRAD	Mwajaliwa, Eilu, Nyeko
	Dataset on nematodes in Uganda	Excel	June 2008	IRD	Villenave
D4.4 data base on the capacity of native tree species (legumes and non-leguminous) to form efficient symbiosis with endogenous rhizobial and mycorrhizal populations					
	Document on tree species and assumed mycorrhizal associations for Kenya and Uganda	Excel	June 2008	CEH KEFRI CIRAD	Wilson, Odee, Lesueur
	Data on *Uapaca densifolia* and associated mycorrhiza	Excel	August 2008	UA	Isabelle Ratsimiala Ramonta
	Data on Albizia gummifera and associated mycorrhiza [check with WP3]	Excel	May 2008	MU	Okullo
	Data on Albizia gummifera and associated rhizobia	Excel	May 2009	UA	Isabelle Ratsimiala Ramonta
D4.5 Data base and set of equations on the symbiotic N2-fixation (and mycorrhizal association) and the level of available nitrogen in soil.					
	Data on N_2-fixation and mycorrhiza association in *Albizia gumifera*, and soil available N in Kenya	Excel	May 2009	CEH KEFRI	7 Kimiti, Odee
D4.6 Assessment of relationships between microbial diversity and soil functioning in terms of the nitrogen cycle.					
	Dataset on total microbial biomass, potential nitrification, bacterial diversity in Kenya	Excel	January 2007	IRD, CIRAD	Assigbetsé, Chotte
	Dataset on total microbial biomass, potential nitrification, bacterial diversity in Madagascar	Excel	September 2008	IRD	Assigbetsé, Chotte
	Dataset on total microbial biomass, potential	Excel	September 2008	IRD	Assigbetsé, Chotte

	nitrification, bacterial diversity in Uganda				
D4.7 Set of predictors of forest dynamics					
D4.8 Publications in international journals and locally for use by forest managers, GOs and NGOs, etc	See table on publishable results				

Work package 5: Examining the effects of differing vegetative covers, enrichment planting, agroforestry and other remedial treatments on losses of soil, plant nutrients and organic matter from degraded agricultural, agroforestry, fallow and forested landscapes.

DELIVERABLES WP5

Deliverable title	Name of deliverable	Main characteristics (format etc…)	Date of release	Project Partners involved	Corresponding scientist
D5.1 experimental design, network of plots in the main sites of each country	Uganda Experimental Design Document	Word file	June 2008	MU & CEH	Majaliwa
	Kenya Experimental Design Document		June 2008	KEFRI & CEH	
	Madagascar Experimental Document		June 2008	FOFIFA & CEH	Nico
D5.2 Comparative data showing the effects of erosion control methods on soil , water , organic matter and plant nutrient losses from plots containing differing experimental treatments and from control plots lacking anti erosion treatments	Uganda control plot nutrient data, plus rainfall	Excel file	May 2008	Makerere Univ and CEH	Majaliwa
	Uganda erosion control data		May 2009		
	Kenya?				
	Madagascar?				
D5.3 On site demonstration and dissemination workshops ….INCLUDING FIELD VISITS TO OTHER LOCATIONS??	To be decided	Word report	May 2009		
D5.4 Publications in international literature and dissemination presentations at other fora	See proposed publications list				
Additional deliverable D 5.5 GIS data set for Mabira forest reserve	GIS data set for Mabira forest reserve	Shape file	May 2009	Makerere University	Majaliwa

Workpackage 6: Improving human well being by developing market access and economic benefits for local populations

DELIVERABLES WP6

Deliverable n°	Deliverable title	Name of deliverable	Main characteristics (format etc…)	Date of release	Partner involved	Corresponding scientist
38	• D6.1 : Commented bibliography on wood and NWFP markets for local forest species in East Africa (reports and CD Rom)					
	• D6.1a	MadagascarComplete library data base foreaim WP6.enl	Endnote file	Oct 2007	CIRAD	G. Chaix
	• D6.1b	MadagascarSynthese biblio_Foreaim_WP6.doc	Word file	Oct 2007	CIRAD	G. Chaix
	• D6.1c	MadagascarBibliographPrésentationWP6.ppt	Powerpoint file	June 2006	CIRAD	G. Chaix
	• D6.1d	KenyaBIBLIOGRAPHY.doc		Oct 2007	KEFRI	J. Cheboiwo
	• D6.1e	Ugandabibiliography.doc		May 2006	MAK	M. Tweheyo, N. Turyahabwe
39	• D6.2 : Draft technical and economics charts for main potential restoration species					
	• D6.2a	KenyaWP6EconomicsOfRestoration2008.doc Growth, yield, and economic benefits from four potential indigenous species for restoration of Mau Forest in Kenya. Paper presented to FOREAIM Regional held on 24th to 30th April 2008 in Makerere University. Kampala, Uganda. Mugabe Robert Ochieng1, Joshua K. Cheboiwo2 and Joram Mbinga3	Word file	Draft April 2008 Final report expected September 2008	KEFRI	J. Cheboiwo
	• D6.2b	KenyaWP6EconomicsOfRestoration2008.ppt	PowerPoint file		KEFRI	
	• D6.2c	KenyaPresentationKefri060531.ppt	PowerPoint file		KEFRI	
	• D6.2d	MadagascarForeaimQnr_version_francais.doc	Word file	July 2006	UNIVTA ESSA	P. Ranjatson
	• D6.2e	UgandaReportExpected		Final report expected Sept 2008	MAK	M. Tweheyo, N. Turyahabwe

[1] Student School of Natural Resource Management Moi University, Email mugabero@yahoo.com
[2] Principal Research Officer , Co-PI WP6 Leader, Kenya Forestry Research Institute, Londiani RRC Email: kefri-ln@africaonline.Co.ke or jkchemangare@yahoo.com
[3] Senior Research Officer, WP3 Leader, Kenya Forestry Research Institute, Londiani RRC Email: kefri-ln@africaonline.Co.ke or jmbinga@yahoo.com

Deliverable n°	Deliverable title	Name of deliverable	Main characteristics (format etc…)	Date of release	Partner involved	Corresponding scientist
40	• D6.3 : Detailed technical and market analysis for targeted restoration species, including processing aspects.					
	• D6.3a	Kenya Markets for forest products-FOREAIM.doc Analysis of potential markets for products from Mau forests Mugabe O. Robert[4] and Joshua K. Cheboiwo[5]	Word file	March 2008	KEFRI	J. Cheboiwo
	• D6.3b	BENEFITS FROM MAU KAMPALA PAPER.ppt	Powerpoint file			
	• D6.3c	UgandaFOREAIM wp 6 2008 draft report.doc Economic potential of main restoration species in Mabira Forest Reserve, Central Uganda A Draft Progress Report on deliverable Six of Work Package 6	Word file	April 2008 Final report expected sept 2008	MAK	M. Tweheyo, N. Turyahabwe
41	• D6.4 : Report on local, national and international main competitors and of potential market position for countries institutions and organisations.					
	• D6.4a	MadagascarMémoire Elyse Prunus version finale.doc Rahelisoa Elysée. 2006. Importance de l'exploitation de Prunus africana dans l'activité économique des paysans. Cas de l'exploitation de Prunus africana dans la forêt de la commune de Moramanga.	Word file	Sept 2006	CIRAD	P. Montagne
	• D6.4b	MadagascarMémoireMaïwennRiche2007_10_05.pdf MadagascarAnnexesMaïwennRiche2007_10_05.pdf Riche Maïwenn. 2007. Etude des filières de plusieurs espèces forestières de réhabilitation des terroirs agroforestiers du triangle Moramanga – Vohimana – Didy, Madagascar	Pdf file	Oct 2007	CIRAD	P. Montagne
	• D6.4c	MadagascarMemoireNirisoaRavensaraA2006VF.do c Razafitsiarovana NH., 2006 Fonctionnement de la filière huile essentielle et pérennisation d'une espèce	Word file	Dec 2006	CIRAD	P. Montagne

[4] Student School of Natural Resource Management Moi University, Email mugabero@yahoo.com
[5] Principal Research Officer , Co-PI WP6 Economics and Benefits from Forestry Restoration, Kenya Forestry Research Institute, Londiani RRC Email: kefri-ln@africaonline.Co.ke or jkchemangare@yahoo.com

Deliverable n°	Deliverable title	Name of deliverable	Main characteristics (format etc…)	Date of release	Partner involved	Corresponding scientist
		forestière endémique menacée de disparition : Ravensara aromatica à Madagascar				
	• D6.4d	MadagascarRaveloarisonRindraNirinaLa conversion forestière.pdf Raveloarison Rindra Nirina., 2006. La conversion forestière: la régression de la forêt naturelle et la dynamique des plantations d'eucalyptus en forêt d'Ankeniheny, sur l'axe Moramanga - Anosibe An'Ala et entre Moramanga et Ambatondrazaka.	Pdf file	April 2007	CIRAD	P. Montagne
	• D6.4e	KenyaFOREAIM MARKETS AND BENEFITS IN MAU.doc POTENTIAL MARKET ACCESS AND SOCIAL ECONOMIC BENEFITS FOR WOOD AND NON WOOD FOREST RESOURCES BY COMMUNITIES LIVING ADJACENT TO WEST MAU FORESTS Martha Mukonyi6 and Joshua K. Cheboiwo7	Word file	Dec 2007 Final expected sept 2008	KEFRI	J. Cheboiwo
	• D6.4f	UgandaTimothy_proposal_24th.04.07 final.doc THE MARKETING STRUCTURE FOR WOOD AND NON-WOOD FOREST PRODUCTS OBTAINED FROM MABIRA FOREST RESERVE	Word file	April 2008 Final expected September 2008	UNIV MAKERERE	T. Barongo
	• D6.4g	MadagascarRavelona, Maafaka. 2007. La filière illicite du bois d'œuvre dans la région Alaotra-Mangoro		Décembre 2008	CIRAD UNIVTA	P. Montagne
	•					
42	• D6.5 : Report on legal and judicial aspects of trade in wood and NWFP produced from restoration areas					
	• D6.5a	MadagascarRapport_restaurationKarpe.doc Le cadre juridique du commerce du bois et des produits forestiers non ligneux issus des zones de restauration Karpe et Randrianarison	Word file	Nov 2007	CIRAD UNIVTA	P. Karpe
	• D6.5b	MadagascarRestaurationRegimeJuridique.ppt	Powerpoint file	Nov 2007		

[6] Student School of Natural Resource Management Moi University,
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Deliverable n°	Deliverable title	Name of deliverable	Main characteristics (format etc…)	Date of release	Partner involved	Corresponding scientist
	• D6.5c	KenyaLegislataions regulaing forest uses-FOREAIM.doc LEGAL AND JUDICIAL PROSPECTS ON TRADE OF PRODUCTS FROM FOREST RESTORATION Mugabe O. Robert8 and Joshua K. Cheboiwo9	Word file	April 2008 Final expected sept 2008	KEFRI	J. Cheboiwo
	• D6.5d	UgandaD 6.5 Legal aspects.doc Report on legal and judicial aspects for trade in the wood and NWFP produced from restoration areas		May 2007	MAK	M. Tweheyo, N. Turyahabwe
44	• D 6.7 Disseminating the findings through local media and press release	1) Present TV and radio Uganda 2) Newspapers		June 2007 May 2008	MAK	M. Tweheyo, N. Turyahabwe
45	• D 6.8 Reviewing the potential eligibility to CDM and voluntary markets of tree planting in relation to restoration activities					
	• D6.8a	CBDBoisNON Oeuvre2.doc Sustainable management of non-timber forest resources	Word file	May 2008	MAK	M. Tweheyo,
	• D6.8b	KenyaReview of the Potential Eligibility of Tree Planting in Restoration Activities to CDM.doc REVIEW OF THE POTENTIAL ELIGIBILITY OF TREE PLANTING IN RESTORATION ACTIVITIES TO CDM Mugabe O. Robert10 and Joshua K. Cheboiwo11	Word file	April 2008	KEFRI	J. Cheboiwo
	•	UgandaExpected		Sept 2008		M. Tweheyo, N. Turyahabwe
	• D 6.6 : Data and Excel(r) simulation for economic interest draft evaluation in relation with customary, national and international laws and regulations;	UgandaDraftExpected	Masters thesis	Sept 2008		T. Barongo
	• D6.9 : Excel based simulation for					

[8] Student School of Natural Resource Management Moi University, Email mugabero@yahoo.com
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[10] Student School of Natural Resource Management Moi University, Email mugabero@yahoo.com
[11] Principal Research Officer , Co-PI WP6 Economics and Benefits from Forestry Restoration, Kenya Forestry Research Institute, Londiani RRC Email: kefri-ln@africaonline.Co.ke or jkchemangare@yahoo.com

Deliverable n°	**Deliverable title**	**Name of deliverable**	**Main characteristics (format etc…)**	**Date of release**	**Partner involved**	**Corresponding scientist**
	economic evaluation of carbon sequestration potential earnings					

Work package 7 – Effective tools for uptake by stakeholders of sustainable restoration strategies

DELIVERABLES WP7

Deliverable title	**Name of deliverable**	**Main characteristics (format etc…)**	**Date of release**	**Project Partners involved**	**Corresponding scientist**
Spatially explicit combined Cormas (Sma-Gis based negotiation tools.	Méthodologie opérationnelle : Préparation de l'atelier de Kampala dans le cadre du WP 7 du Projet FOREAIM à Madagascar	Worf file	48	CIRAD FOFIFA	S Aubert B Mallet

ANNEX 2: list of publishable results

Work package 1 – Traditional ecological knowledge, tree management practices, uses and economic dependency of local population on forests and tree based systems in the context of their degradation

PUBLISHABLE RESULTS WP1

Publishable result title and reference (authors journal)	**Type of publication (article, student report, booklet,**	**Deliverables concerned** Country/file name
Galabuzi C, Tabuti JRS, Kakudidi EK, Eilu G, Sibelet N. 2008. Traditional ecological knowledge, Management practices, use and economic dependence of local populations on forests and tree based resources: A state of art report for Mabira forest reserve, central Uganda, Makerere University, Kampala, 71 p.	Report	Uganda/D 1.2 WP1 UNIVMA.doc Uganda/Galabuzi Presentation.ppt 27 slides
Hervo C. 2007. Study practices, uses and representations of stakeholders in the forest to develop strategies for restoration of Mabira Forest Reserve, Central Uganda. AgroParis Tech, Montpellier. 88 p.	Master Thesis	NSstudents(Uganda)/ Présentation-Hervo-makerere.ppt NSstudents(Uganda)/ Rapport-HERVO-Ugandan FOREAIM WP1-2007.pdf NSstudents(Uganda)/ Rapport stage - foreaim uganda-1.pdf
Kübler D. 2007. Comment optimiser la participation des acteurs de la forêt de Mau dans la lutte contre la dégradation forestière? Tome 2 Comprendre les processus de décision pour construire des stratégies de restauration. AgroParis Tech, Montpellier. 67 p.	Master Thesis	NSstudents(Kenya)/ Rapport_Daniel_Kubler_Kenya.pdf
Lang'at D, Cheboiwo J, Sibelet N. 2008. Traditional ecological knowledge, tree management practices, uses and economic dependence of local population on forests and tree based systems in the context of their degradation, Nairobi, 30 p.	Report	Kenya/WP1 Kenya Report 2008.doc
Langat D, Cheboiwo J, Sibelet N, Garcia C. 2006. WP1 State of the Art Kenya, KEFRI, Nairobi, 22 p.	Report	Kenya/WP1_Kenya_state-art-draft3.doc
Mulugo L. 2008. Traditional Ecological Knowledge on tree management and restoration for Mabira forest, Uganda. Makerere, Kampala	Master Thesis	Uganda/FOREAIM- Lucy.ppt

Oddi A. 2007. How to optimise the operation of Mau forest's stakeholders participation in the struggle against forest degradation, Montpellier. 75 p.	Master Thesis	NSstudents(Kenya)/ Raport Oddi Kenya.pdf
Randriamiarinjato Charles J. 2008. Utilisation des ressources forestières dans la région de Anosibe an'ala. Antananarivo, Antananarivo. 94 p.	Master Thesis	Madagascar/Mémoire Jean Charles DRAFT.rtf
Randrianasolo R. 2006. Madagascar. Comparative study of Vohimana and Raboana, University of Antananarivo, Antananarivo, 104 p.	Master Thesis	Madagascar/2008_Mada_Randrianasolo_Rado.doc
Raveloarison RN. 2007. La conversion forestière: la régression de la forêt naturelle et la dynamique des plantations d'Eucalyptus autour de Moramanga. Antananarivo, Antananarivo. 49 p.	Master Thesis	Madagascar/Mémoire Rindra Madagascar.pdf
Razafindrabe R. 2006. WP1 state of the art Madagascar, FOFIFA, Antananarivo, 9 p.	Report	Madagascar/FOFIFA State of Art Draft2.doc
Razafindrabe R. 2006. Caractérisation de la degradation et etude des possibilités de restauraration du milieu forestier. FOFIFA, Antananarivo, 9 p.	Report	Madagascar/Rapport_FOFIFA_WP1_2008.rtf
Riche M. 2007. Etude de l'amont de filières de produits forestiers en vue de la réhabilitation des terroirs agroforestiers du triangle Moramanga-Beforona-Didy, est de Madagascar. Paris XII Val de Marne, Paris. 62 p.	Master Thesis	NSstudents(Madagascar)/ MémoireMaïwennRiche2007_10_05.pdf
Rives F. 2006. Faire le deuil de la forêt primaire pour sauver les forêts? Etude des pratiques, des usages et des représentations de la forêt pour élaborer des stratégies de restauration dans le corridor forestier de Ankeniheny Zahamena, est de Madagascar. ENGREF, Montpellier. 102 p.	Master Thesis	NSstudents(Madagascar)/ Rapport Mastère FNS Fanny RIVES.pdf
Rives F., Sibelet N, Montagne, P., A Mosaic of Worlds and Forests, Study of social perceptions to reconcile international concerns and local needs, *CIRAD, Montpellier, 2 p + poster*	Scientific poster	NSstudents(Madagascar)/ Rives-Sibelet-Montagne_2008_poster_Mosaic.pdf NSstudents(Madagascar)/ Rives-Sibelet-Montagne_2008_poster-texte_Mosaic.pdf.doc
Sibelet N. 2005. Start up meeting 24-28/10/2005 in Antananarivo, Madagascar, CIRAD, Montpellier, 13 p.	Mission report	NS missions reports/ Rapport_Mission_WP1_Mada_NS_2005_oct.pdf
Sibelet N. 2006. Lier restauration et multifonctionnalité pour les régions forestières dégradées en Afrique de l'est et à Madagascar. Rapport de Mission du 15 au 23 mai 2006 à Madagascar, CIRAD/FOFIFA/CENRADERU/UNIA, Montpellier, 6 p.	Mission report	NS missions reports/ Rapport_Mission_WP1_Mada_NS_2006_mai.pdf
Sibelet N. 2006. Mission Report: 2006, June 09-17, Workshop on State of The Art, CIRAD/MAK/KEFRI/FOFIFA/UNIA, Montpellier, 3 p.	Mission report	NS missions reports/ Mission_report_WP1_Uganda_NS_2006_june.pdf

Sibelet N. 2007. Listening to the stakeholders in a Research and Development project: Mission Report: 2007 May 28th June 23rd, CIRAD/UNIMAK/KEFRI, Montpellier, 30 p.	Mission report	NS missions reports/ Mission Report WP1 Uganda Kenya June-2007.doc
Sibelet N. 2007. Rapport de mission à Madagascar du 16 au 26 avril 2007, CIRAD, Montpellier, 36 p.	Mission report	NS missions reports/ Rapport mission WP1Mada NS avril 2007.doc
Sibelet N, Garcia C. 2006. Mission Report: Kenya-Uganda, CIRAD/KEFRI/MAK, Montpellier, 10 p.	Mission report	NS missions reports/ Mission_report_WP1_Kenya_Uganda_NS&CG_2006_feb.pdf
Tabuti JRS, Eilu G, Kakudidi EK, Sibelet N, Garcia C. 2006. WP1 State of the Art Uganda, University of Makerere, Kampala, 19 p.	Report	Uganda/UNIVMA WP1 State of Art Draft 2.doc
Tumuramye AM, Tabuti JRS, Muwanika V. 2008. Bridging the gap between utilization and conservation of plant resources in degraded forest landscapes of Uganda: a case study of Mabira Forest Reserve. Makerere, Kampala	Master thesis	Uganda/Presentation to FOREAIM.doc
University A. 2006. WP1 State of the Art Madagascar, University of Antananarivo, Antananarivo, 15 p.	Report	Madagascar/ WP1_state_of_art-WP1 univTana.doc
22 – 23 May 2008: Presented Paper on *Albizziz gummifera* at the Ecological Society for Eastern Africa ESEA in Sokoine University of Agriculture, Morogoro, Tanzania	Communication	Uganda/ see Ugandan team to get it

Work package 2 – Assessment of forest ecosystem degradation, and community structure and species biology for the development of restoration options

PUBLISHABLE RESULTS WP2

Publishable result title and reference (authors journal)	Type of publication (article, student report, booklet,	Deliverables concerned	Date of publication	Project Partners involved	Corresponding scientist
Approche sur la dynamique des formations vegetales de la reserve experimentale de Vohimana. H.Z. Hasiniaina M., C. Rajeriarison, M.A. Radimbison, E. Roger. *Tohiravina 2: receuil of document for the ecological follow-up of the program envoronnemental. Department of Vegetable Biology and Ecology. Faculty of Science, University of Antananarivo.* pp 75-83	Article	D2.2 D2.3 D2.4 D2.5 D2.7 D2.8	2007	University of Antananarivo	M.A. Radimbson, E. Roger, C. Rajeriarison
Typologie des formations vegetales de Vohimana. H.Z. Hasiniaina M., C. Rajeriarison, M.A. Radimbison, E. Roger. *Tohiravina 2: receuil of document for the ecological follow-up of the program envoronnemental. Department of Vegetable Biology and Ecology. Faculty of Science, University of Antananarivo.* pp 360-368	Article	D2.2 D2.3 D2.4 D2.7 D2.8	2007	University of Antananarivo	M.A. Radimbson, E. Roger, C. Rajeriarison
Caractérisations écologiques des formations végétales de la réserve expérimentale de Vohimana en vue d'une restauration écologique : inventaire floristique , Typologie , Profil écologique et étude diachronique . N.V. Manjato. Université d' Antananarivo . 110 p.	Master thesis	D2.2 D2.3 D2.4 D2.5 D2.7 D2.8	2008	University of Antananarivo	M.A. Radimbison, E. Roger, N. Manjato
Inventaire et typologie des formations vegetales de Vohimana en vue d'une restauration ecologique, H.Z. Hasiniaina M. 92 p.	Master thesis	D2.2 D2.3 D2.4 D2.5 D2.7 D2.8	2007	University of Antananarivo	M.A. Radimbson, E. Roger, H.Z. Hasiniaina M.
Effects of slash and burn agriculture on plant species richness and composition in the Vohimana forest, Madagascar. K. Klanderud, H.Z. Hasiniaina M., N. Manjato, C. Rajeriarison, M. A. Radimbson, E. Roger, Ø.Totland	Article in scientific journal	D2.2 D2.3 D2.7 D2.8	2009	University of Antananarivo, UMB	Kari Klanderud
Effects of *Psiadia altissima* and *Lantana camarra* on the establishment of primary forest species in Vohimana forest, Madagaskar, K. Klanderud, Ø. Totland, H.Z. Hasiniaina M., N. Manjato V., C. Rajeriarison, M.A. Radimbson, E. Roger	Article in scientific journal	D2.4 D2.5 D2.7 D2.8	2009	University of Antananarivo UMB	Kari Klanderud
Species diversity and composition in degraded areas of Mau Forest in Kenya.	Article in scientific	D2.2	2009	KEFRI	Jared Amwatta

Jared Amwatta Mullah, Kari Klanderud, Orjan Totland, David Odee	journal	D2.3 D2.8		UMB	Mullah
Effects of the invasive species *Fraxinus pennsylvanica* on the population density of indigenous tree species in degraded Sub-humid Forests, Jared Amwatta Mullah, Kari Klanderud, Orjan Totland, David Odee	Article in scientific journal	D2.4 D2.5 D2.7 D2.8	2010	KEFRI UMB	Jared Amwatta Mullah
Characterazation of functional attributes of species colonizing degraded areas of natural forests, Kenya. Jared Amwatta Mullah, Kari Klanderud, Orjan Totland, David Odee	Article in scientific journal	D2.7 D2.6 D2.8	2010	KEFRI UMB	Jared Amwatta Mullah
Regenerational potential of selected species of ecological and economic importance in Mau forest, Jared Amwatta Mullah, Kari Klanderud, Orjan Totland, David Odee	Article in scientific journal	D2.4 D2.5 D2.8	2010	KEFRI UMB	Jared Amwatta Mullah
Potential species for restoration of degraded areas of sub-humid natural forests in Kenya, Jared Amwatta Mullah, Kari Klanderud, Orjan Totland, David Odee	Article in scientific journal	D2.4 D2.5 D2.7 D2.8	2010	KEFRI UMB	Jared Amwatta Mullah
Assessment of plant species diversity and composition in degraded areas of Mau Forest, Kenya. Jared Amwatta Mullah	PhD thesis	D2.2 D2.3 D2.4 D2.5 D2.6 D2.7 D2.8	2011	KEFRI UMB	Jared Amwatta Mullah
Population structure of selected timber species used for furniture making in Mabira FR, Balimunsi Moses	MSc Thesis	D2.5 D2.8	2007	Makerere Univ	Gerald Eilu, Joseph Obua
Tree species functional classification and its use in restoration of degraded forest: Case of Mabira Forest Reserve, Uganda. Muthalib Katumba	MSc Thesis	D2.7	2008	Makerere University	Gerald Eilu, Jan Dick
Effect of harvesting techniques on the regeneration of *Acalypha neptunica* in Mabira FR, Mukono District, Kawooya Yasin	BSc.Special Project Report	D.2.5 D2.8	2007	Makerere Univ	Joseph Obua
Survival and growth of selected tree species. Muthalib Katumba, JBL Okullo	Scientific article	D2.5 D2.6 D2.8	2009	Makerere Univ	JBL Okullo, Gerald Eilu
The present and future value of floras for functional ecologists. Jan Dick, Ron Smith, Richard Wadsworth. *Descriptive Taxonomy Serving Biodiversity,* CRC Press - Systematics Association Special Volume series.	Scientific article	D2.8	2008	CEH	Jan Dick

Plant community succession after human disturbance in the Mabira forest. Paul Ssegawa, Gerald Eilu, Kari Klanderud, Ørjan Totland, et al.	Scientific article	D2.2 D2.3 D2.8	2009	Makerere Univ, UMB	Gerald Eilu
Effects of the invasive *Broussonetia papifera* on the plant species composition and diversity of degraded sites in the Mabira forest, Uganda. Mnason Tweheyo, Gerald Eilu, Paul Ssegawa, Kari Klanderud, and Ørjan Totland	Scientific article	D2.2 D2.3 D2.8	2009	Makerere Univ, UMB	Gerald Eilu
Biomass recovery after forest degradation in Mabira forest. Mnason Tweheyo, Gerald Eilu, Paul Ssegawa, Kari Klanderud, and Ørjan Totland	Scientific article	D2.2 D2.3 D2.7 D2.8	2009	Makerere Univ, UMB	Gerald Eilu
Soil properties and plant species composition following succession regimes in Mabira Forest Reserve. Gerald Eilu, Paul Ssegawa, Gilbert Majaliwa, Mnason Tweheyo, Bob Nakileza, Kari Klanderud, and Ørjan Totland	Scientific article	D2.2 D2.3 D2.7 D2.8	2009	Makerere Univ, UMB	Gerald Eilu
Potential of *Maesopsis eminii* for the restoration of degraded sites around Mabira Forest Reserve, Central Uganda: Godwin Ndemeere. Gerald Eilu	BSc.Special Project Report	D2.6 D2.8	2007	Makerere Univ	Gerald Eilu
AVSKOGING I ØST AFRIKA OG PÅ MADAGASKAR: SUKSESJON, SAMFUNNSSTRUKTUR, OG ARTSKOMPOSISJON I ET RESTAURERINGSPERSPEKTIV Kari Klanderud, Ørjan Totland, Jared Amwatta Mullah. *Årsmelding INA*, 20-23.	Popular science article	D2.2 D2.3 D2.8	2008	UMB	Kari Klanderud

Work package 3 – restoration/rehabilitation through planting: characterisation and silviculture of native and naturalised species to restore environmental and economical function

PUBLISHABLE RESULTS WP3

Publishable result title and reference (authors journal)	Type of publication (article, student report, booklet,	Deliverables concerned	Date of publication	Project Partners involved	Corresponding scientist
Intraspecific chemical variability and highlighting of chemotypes of leaf essential oils from Ravensara aromatica Sonnerat, a tree endemic to Madagascar Hanitriniaina Sahondra Andrianoelisoa, Chantal Menut, Philippe Collas de Chatelperron, JérômeSaracco,4 Panja Ramanoelina and Pascal Danthu3* FLAVOUR AND FRAGRANCE JOURNAL Flavour Fragr. J. (In press)	Article in scientific journal	D3.5 D3.7	2008	CIRAD FOFIFA	P Danthu
Essential oil production increases value of Psiadia altissima fallows in Madagascar's eastern forests. Pascal Danthu, Miarantsoa Rakotobe, Pascale Maucle`re Æ Hanitra Andrianoelisoa, Olivier Behra Æ Voninavoko Rahajanirina Æ Barbara Mathevon Æ Eliane Ralambofetra Æ Philippe Collas de Chatelperron Agroforest Syst (2008) 72:127–135	Article in scientific journal	D3.5 D3.7	2008	CIRAD FOFIFA	P Danthu
Seasonal dependence of rooting success in cuttings from natural forest trees in Madagascar P. Danthu N. Ramaroson G. Rambeloarisoa Agroforest Syst DOI 10.1007/s10457-008-9116-7	Article in scientific journal	D3.3 D3.7	2008	CIRAD UNIV TANA	P Danthu
Characterization of microsatellite markers in the rosewood (Dalbergia monticola Bosser & R. Rabev.) BENEDICTE FAVREAU, OLIVARIMBOLA ANDRIANOELINA,† PHILIPPE NUNEZ, ALEXANDRE VAILLANT, LOLONA RAMAMONJISOA, PASCAL DANTHU and JEAN-MARC BOUVET Molecular Ecology Notes (2007) 7, 774–776 doi: 10.1111/j.1471-8286.2007.01692.x	Article in scientific journal	D3.4 D3.7	2007	CIRAD FOFIFA/SNGF	JM Bouvet
Genetic diversity of Dalbergia monticola (Fabaceae) an endangered tree species in the fragmented oriental forest of Madagascar	Article in scientific journal	D3.4 D3.7	2006	CIRAD FOFIFA/SNGF	JM Bouvet

OLIVARIMBOLA ANDRIANOELINA1, HERY RAKOTONDRAOELINA2, LOLONA RAMAMONJISOA1, JEAN MALEY3, PASCAL DANTHU4 and JEAN-MARC BOUVET, Biodiversity and Conservation (2006) Springer 2006 DOI 10.1007/s10531-004-2178-6					
Analyse de la diversité des populations naturelles d'une espèce forestière menacée : *Dalbergia monticola* à Madagascar. Approche par marqueurs microsatellites nucléaires et chloroplastiques. NUNEZ Philippe	Thesis of master of science University of Monpellier II	D3.4 D3.7	2006	CIRAD FOFIFA/SNGF	JM Bouvet
DIVERSITE GENETIQUE D'UNE ESPECE FORESTIERE EN MILIEU FRAGMENTE : APPROCHE A PLUSIEURS ECHELLES CAS DE DALBERGIA MONTICOLA A MADAGASCAR	Thesis of master of science University Pierre et Marie-Curie Paris	D3.4 D3.7	2007	CIRAD FOFIFA/SNGF	JM Bouvet
Propagation and utilisation and conservation of African Satinwood species (Zanthoxylum Gillettii) in Kenya Michael OKEYO	Thesis for a master of science	D3.3 D3.7	September 2008	KEFRI	J Mbinga
Microsatellite markers in Prunus S Cavers et al Conservation genetics	Article in scientific journal	D3.4 D3.7	December 2008	CEH KEFRI	S Cavers
Genetic structure of Albizzia gummifera and local adaptation to associated Natongo et al	Poster at the FOREAIM 3rd Steering Committee meeting	D3.4 D3.6 D3.7	March 2008	CEH UNIVTA KEFRI UNIV MAKERE	JB Okullo S cavers
Genetic structure of Albizzia gummifera and local adaptation to associated Natongo et al	Oral power point presentation at the	D3.4 D3.6 D3.7	May 2008	CEH UNIVTA KEFRI UNIV MAKERE	JB Okullo S Cavers
Genetic structure of Albizzia gummifera and local adaptation to associated Natongo et al	Master thesis University of Makarere	D3.4 D3.6 D3.7	September 2008	CEH UNIVTA KEFRI UNIV MAKERE	JB Okullo S Cavers
Genetic structure of Albizzia gummifera Natongo et al African Journal of Ecology	Article in scientific journal	D3.4 D3.6 D3.7	Beginning 2009	CEH UNIVTA KEFRI UNIV MAKERE	JB Okullo S Cavers
Adaptation of Albizzia gummifera Natongo et al	Article in scientific journal	D3.4 D3.6	Beginning 2009	CEH UNIVTA	JB Okullo S Cavers

Forest Ecology and Management		D3.7		KEFRI UNIV MAKERE	
Handbook on silviculture of some native Malagasy species used in restoration	handbook	D3.6	May 2009	FOFIFA	Z Rakotovao N Razafindrianilana
Technical report on the planting of Malagasy species in degraded forest	Technical report	D3.6	December 2008	FOFIFA	Z Rakotovao
Booklet on the silviculture of four Malagasy species	booklet	D3.6	May 2008	FOFIFA	H Randrianjafy
Technical report on propagation techniques for valuable Malagasy tree species : germination and vegetative propagation	Technical report		May 2008	FOFIFA	Z Rakotovao
ESSAI DE RESTAURATION ECOLOGIQUE ET REHABILITATION DE LA FORET DE VOHIMANA PAR PLANTATION D'ARBRES Christophe MANJARIBE	Master thesis University of Antananarivo	D3.6	September 2008	UNIVTA	Yari Jeannoda
Movie on the explotation of Ravensara aromatica	movie			FOFIFA CIRAD	P Danthu

Work package 4: Characterization of edaphic conditions in degraded forest landscape to predict forest restoration suitability

PUBLISHABLE RESULTS WP4

Publishable result title and reference (authors journal)	**Type of publication (article, student report, booklet,**	**Deliverables concerned**	**Date of publication**	**Project Partners involved**	**Corresponding scientist**
Mycorrhiza assemblages in relation to restoration stages and selected soil properties in Mabira Forest reserve, Uganda (presented at 3rd FOREAIM Steering Committee meeting, 2008) Sebuliba, E, Eilu, G., Nyeko, P. Majaliwa J.G.M, and Obua, J.	Poster and oral presentation (Student project)	4.3	2008	MU	
Mycorrhiza assemblages in relation to restoration stages and selected soil properties in Mabira Forest reserve, Uganda (Student: Sebuliba, E)	MSc. thesis	4.3	2009	MU	
Genetic structure of *Albizia gummifera* and its adaptation to associated mycorrhiza (Student: Nantongo J.)	MSc. thesis	4.4	See WP3, D3.4,3.6,3.7		

Characterisation of edaphic conditions in degraded landscape to predict forest restoration suitability in Vohimana (presented at 3rd FOREAIM Steering Committee meeting, 2008)	Oral presentation	4.2, 4.3	2008	UA	Isabelle Ratsimiala Ramonta
Characterisation of edaphic conditions in degraded landscape to predict forest restoration suitability in Vohimana (Student: Rakotondraina Misa L.)	MSc. thesis	4.3	2008	UA	Isabelle Ratsimiala Ramonta
Fungal communities variations with plant communities in Kedowa Forest reserve, Kenya	Scientific publication	4.3	2009	KEFRI, CEH	Lesueur
Characterization of edaphic conditions in natural plantations and fallow lands in Kenya (Kedowa, Rift Valley)	Poster presentation	4.6	2007	IRD, CIRAD, KEFRI	Assigbetsé
Diversity and activities of soil microfauna and microorganisms affected by forest management (Kedowa, Kenya)	Scientific publication	4.6, 4.3	2009	IRD, CIRAD, KEFRI	Assigbetsé

Work package 5: Examining the effects of differing vegetative covers, enrichment planting, agroforestry and other remedial treatments on losses of soil, plant nutrients and organic matter from degraded agricultural, agroforestry, fallow and forested landscapes.

PUBLISHABLE RESULTS WP5

Publishable result title and reference (authors journal)	**Type of publication (article, student report, booklet ..**	**Deliverables concerned**	**Date of publication**	**Project Partners involved**	**Corresponding scientist**
Soil hydrological properties of Mabira forest reserve (presented at SSSEA, 2006) J Hydrology Majaliwa J.G.M, Nakileza, B., Eilu, G., Wilson J., W. Kizza, C.L	Scientific paper	5.2		Uganda	
Effect of land use on properties of soils within and around Mabira forest reserve. Tillage Majaliwa J.G.M, Nakileza, B., Eilu, G., Wilson J.. Kizza, C.L	Scientific paper	5.2		Uganda	
Role of the forest reserve in stability of the Mabira watershed	MSc (student not yet identified)	5.2	2009	Uganda	
Role of the forest reserve in stability of the Mabira watershed ……., Majaliwa J.G.M, Nakileza, B., Eilu, G., Wilson J.. Kizza, C.L	Scientific paper	5.2	2009	Uganda	
Soil and nutrients losses from restored Mabira forest reserve blocks Kizza C.L	MSc	5.2	2008	Uganda	
Soil and nutrients losses from restored Mabira forest reserve blocks. To be submitted 2008 Forest Ecology and Management Kizza, C.L , Majaliwa J.G.M, Nakileza, B., Eilu, G., Wilson J.	scientific paper	5.2	2009	Uganda	
How to control erosion on farm	Booklet / handout	5.3 and 7.X	2009	Uganda	
Landuse in the Mabira Forest Reserve and implications for erosion and nutrient balance	Briefing note	5.3 and 7.X	2009	Uganda	

Workpackage 6: Improving human well being by developing market access and economic benefits for local populations

PUBLISHABLE RESULTS WP6

Publishable result title and reference (authors journal)	Deliverable title	Main characteristics (format etc…)	Date of publication	Partner involved	Corresponding scientist
	D6.2				
KenyaWP6EconomicsOfRestoration2008.doc Growth, yield, and economic benefits from four potential indigenous species for restoration of Mau Forest in Kenya. Paper presented to FOREAIM Regional held on 24th to 30th April 2008 in Makerere University. Kampala, Uganda. Mugabe Robert Ochieng12, Joshua K. Cheboiwo13 and Joram Mbinga14		Word file	Draft April 2008 Final report expected September 2008	KEFRI	J. Cheboiwo
	D6.3 :				
Kenya Markets for forest products-FOREAIM.doc Analysis of potential markets for products from Mau forests Mugabe O. Robert15 and Joshua K. Cheboiwo16		Word file	March 2008	KEFRI	J. Cheboiwo
UgandaFOREAIM wp 6 2008 draft report.doc Economic potential of main restoration species		Word file	April 2008 Final report	MAK	M. Tweheyo, N. Turyahabwe

[12] Student School of Natural Resource Management Moi University, Email mugabero@yahoo.com
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[15] Student School of Natural Resource Management Moi University, Email mugabero@yahoo.com
[16] Principal Research Officer , Co-PI WP6 Economics and Benefits from Forestry Restoration, Kenya Forestry Research Institute, Londiani RRC Email: kefri-ln@africaonline.Co.ke or jkchemangare@yahoo.com

Publishable result title and reference (authors journal)	**Deliverable title**	**Main characteristics (format etc…)**	**Date of publication**	**Partner involved**	**Corresponding scientist**
in Mabira Forest Reserve, Central Uganda A Draft Progress Report on deliverable Six of Work Package 6			expected sept 2008		
	D6.4.				
MadagascarMémoire Elyse Prunus version finale.doc Rahelisoa Elysée. 2006. Importance de l'exploitation de Prunus africana dans l'activité économique des paysans. Cas de l'exploitation de Prunus africana dans la forêt de la commune de Moramanga.		Word file	Sept 2006	CIRAD	P. Montagne
Riche Maïwenn. 2007. Etude des filières de plusieurs espèces forestières de réhabilitation des terroirs agroforestiers du triangle Moramanga – Vohimana – Didy, Madagascar		Pdf file	Oct 2007	CIRAD	P. Montagne
Razafitsiarovana NH., 2006 Fonctionnement de la filière huile essentielle et pérennisation d'une espèce forestière endémique menacée de disparition : Ravensara aromatica à Madagascar		Word file	Dec 2006	CIRAD	P. Montagne
Raveloarison Rindra Nirina., 2006. La conversion forestière: la régression de la forêt naturelle et la dynamique des plantations d'eucalyptus en forêt d'Ankeniheny, sur l'axe Moramanga - Anosibe An'Ala et entre Moramanga et Ambatondrazaka.		Pdf file	April 2007	CIRAD	P. Montagne
POTENTIAL MARKET ACCESS AND SOCIAL ECONOMIC BENEFITS FOR WOOD AND NON WOOD FOREST RESOURCES BY COMMUNITIES LIVING		Word file	Dec 2007 Final expected sept 2008	KEFRI	J. Cheboiwo

Publishable result title and reference (authors journal)	**Deliverable title**	**Main characteristics (format etc…)**	**Date of publication**	**Partner involved**	**Corresponding scientist**
ADJACENT TO WEST MAU FORESTS Martha Mukonyi17 and Joshua K. Cheboiwo18					
THE MARKETING STRUCTURE FOR WOOD AND NON-WOOD FOREST PRODUCTS OBTAINED FROM MABIRA FOREST RESERVE		Word file	April 2008 Final expected September 2008	UNIV MAKERERE	T. Barongo
MadagascarRavelona, Maafaka. 2007. La filière illicite du bois d'œuvre dans la région Alaotra-Mangoro			Décembre 2008	CIRAD UNIVTA	P. Montagne
MadagascarRapport_restaurationKarpe.doc Le cadre juridique du commerce du bois et des produits forestiers non ligneux issus des zones de restauration Karpe et Randrianarison	D6.5	Word file	Nov 2007	CIRAD UNIVTA	P. Karpe
UgandaD 6.5 Legal aspects.doc Report on legal and judicial aspects for trade in the wood and NWFP produced from restoration areas			May 2007	MAK	M. Tweheyo, N. Turyahabwe
CBDBoisNON Oeuvre2.doc Sustainable management of non-timber forest resources	D 6.8	Word file	May 2008	MAK	M. Tweheyo,
REVIEW OF THE POTENTIAL ELIGIBILITY OF TREE PLANTING IN RESTORATION ACTIVITIES TO CDM Mugabe O. Robert19 and Joshua K. Cheboiwo20		Word file	April 2008	KEFRI	J. Cheboiwo

[17] Student School of Natural Resource Management Moi University,
[18] Principal Research Officer , Co-PI WP6 Economics and Benefits from Forestry Restoration, Kenya Forestry Research Institute, Londiani RRC Email: kefri-ln@africaonline.Co.ke or jkchemangare@yahoo.com

Work package 7 – Effective tools for uptake by stakeholders of sustainable restoration strategies

PUBLISHABLE RESULTS WP7

Publishable result title and reference (authors journal)	**Type of publication (article, student report, booklet,**	**Deliverables concerned**	**Date of publication**	**Project Partners involved**	**Corresponding scientist**
Comment optimiser la participation des acteurs de la forêt de mau dans la lutte contre la dégradation forestière Daniel Kubler	Master of science thesis	D7.1	2007	Cirad KEFRI	

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[20] Principal Research Officer , Co-PI WP6 Economics and Benefits from Forestry Restoration, Kenya Forestry Research Institute, Londiani RRC Email: kefri-ln@africaonline.Co.ke or jkchemangare@yahoo.com