CSM
BGBD

World Agroforestry Centre
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Nairobi, Kenya

TSBF- CIAT

Conservation and Sustainable Management of Below-Ground Biodiversity Project

Report of the Project Annual Meeting, April, 2005

Inventory of below-ground biodiversity in eleven benchmark areas, within seven tropical countries

TSBF

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

UNEP

Report of the Annual Meeting 2005

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1. Words of Welcome

By Fatima Moreira

Ladies and gentlemen,

I would like to welcome all of you to the IV annual meeting of the project CSM-BGBD, in which the BIOSBRASIL project is inserted. Starting the first session, I would like to invite the following persons to the table:

Dr. Edinaldo Nelson dos Santos Silva, deputy director of INPA (National Research Institute of the Amazonas)

Dr. Henrique Pereira, Director IBAMA-Amazonas (Brazilian Institute of Environment)

Dr. Marieta Sakalian, UNEP/GEF

Dr. Nteranya Sanginga –Director TSBF-CIAT

Prof. Dr. Eric Smaling- external evaluator for GEF/UNEP

Prof. Mike Swift, former director TSBF

Dr. Jeroen Huising, global coordinator BGBD project,

I would like to say that is an honor to receive all of you coming from all over the world to contribute to the success of this meeting.

I also would like to thank the local authorities that kindly accepted our invitation and for allowing us the opportunity to show them the importance of this project for the conservation of the biodiversity in tropical forests and to improve environmental quality and agricultural sustainability.

The hard work done during these three years of phase I, resulted in a significant amount of data that will be shown during this meeting. I hope that all these efforts will convey towards public policies that will favor the maintenance of the environment and improve life conditions for future generations all over the countries.

The choice for Manaus for hosting this meeting is highly significant because we are in the heart of Amazon that has the highest biodiversity on the planet. The magnificent view of Rio Negro and the luxurious rain forest surrounding us in this place, make us to reflect upon our responsibility as scientists to help in the conservation of this wonderful world.

2. Opening remarks to the 4th Annual Meeting 2005 of the Conservation and Management of Belowground Biodiversity project.

Dr. Henrique Pereira, Executive manager IBAMA-Amazonas

Good Morning Ladies and Gentlemen!

On behalf of the Ministry of Environment and the Brazilian institute of Renewable Natural Resources – IBAMA, I would like to welcome all the participants to the 4th BGBD annual meeting and to wish you all a pleasant stay in Manaus, the capital city of the Amazonas state.

The Executive office of IBAMA at Amazonas State was properly asked by the BGBD Brazil program for obtaining the necessary legal authorizations for the access, collecting and transportation of biological material from its research spots at the high Solimões river region to several research labs that comprise its multi-institutional network.

Such authorizations were issued as BGBD have fulfilled all formal IBAMA's requirements. In this process, our analysts made acquaintance with BGBD's objectives and methodologies, in details. Based on the analysis of BGBD research strategies we are able to state that this program represents the most diversified, intensive, systematic and combined ongoing survey on belowground biodiversity in Brazilian territory.

BGBD experimental and sampling designs were carefully applied so that researchers will be able to develop a genuine knowledge on the functional links between traditional agriculture practices and the belowground biodiversity of forested landscapes of the Amazon region.

BGBD research spots are closely located to the Brazilian-Peruvian-Colombian triple frontier. This easternmost region of the Brazilian Amazon remains as a region of difficult access. A region maintained and projected to be the most preserved portion of the Amazon.

The High Solimões river basin is the homeland of most of the remaining indigenous Amazonian people and one of the most important hotspots for the Amazonian agro-biodiversity. BGBD innovates at choosing that area to place its research sites since most information on Amazonian ecology and biodiversity inventories have been obtained from research sites near Manaus, at the central portion of the Amazon region.

BGBD deserves a special attention by IBAMA not only by its proportions and innovative scientific merits but mainly because BGBD research efforts are perfectly in tune with some of the directives of the Brazilian Biodiversity National Policy stated in the 2002 by the Presidential Decree # 4339.

The second component of Brazil's National Biodiversity Policy refers to Biodiversity Conservation strategies and its general objective is to promote in-situ and ex-situ biodiversity conservation, including ecosystem, species and genetic variability as well as environmental services maintained by such biodiversity.

BGBD is specially related to the First Directive of the biodiversity conservation component, which is the directive that expresses ecosystem conservation strategies. This directive calls attention to the need of in-situ conservation actions at areas, which are not included in conservation units such as open-access or private areas converted into agricultural land. Brazil´s National Biodiversity Policy recognizes that environment services and ecological processes are key factors for agriculture lands sustainability.

BGBD´s goals correspond to some specific objectives of the Ecosystem Conservation Component. At studying agricultural practices of traditional farmers, BGBD program will contribute to a better understanding of how such practices as environmental intermediate disturbances can result in conservation, increase or decline of biodiversity.

Finally, I would like to emphasize that BGBD puts into light an important and fundamental parcel of biodiversity, the below-ground biodiversity, that have been largely neglected and still is poorly known by science and recognized by conservation governmental programs.

We look forward to BGBD results.

Thank you

3. Objectives of the 4th Annual Meeting of the BGBD project 2005.

Jeroen Huising, BGBD project coordinator

Esteemed invited guest,

Deputy Director of INPA, Dr. Edinaldo Nelson dos Santos Silva and director of IBAMA, Dr. Henrique Pereira,

Dear members of the Project Advisory Committee, chaired by Prof Michael Stocking,
Prof. Okwakol, chair of the Project Steering Committee,
Dr. Marieta Sakalian of UNEP/GEF,
Dr. Nteranya Sanginga, Director of TSBF-CIAT,
Dear Country Programme Conveners and participants of this Annual Meeting 2005,

I welcome all of you heartedly to this fourth annual meeting. There are quite a number of new faces; people belonging to the project but attending the annual meeting for the first time, but also people that are new to the project. I want to welcome specifically the members of the project advisory committee (PAC) who will be gathering for the first time during this annual meeting. Also there a number of technical advisors that may not be new to the project, but that are at least new to me. Country programmes are presented in large numbers then before at this meeting and quite some will be attending the annual meeting for the first time. The large congregation for this annual meeting illustrates the importance of this annual meeting.

Before we proceed, I want to commemorate one person that we are missing at this annual meeting. Last year we had to announce the decease of Prof Shiou Huang who departed at too young an age. Prof Shiou was convening the nematode task force and he was a very accomplished and dedicated scientist and a dear friend to his colleagues in the BGBD Brazil programme and we will miss him for that.

The year 2004 has been a troubled year in some of the BGBD countries. I am referring to Côte d'Ivoire where the political situation took a turn for the worse. In November last year hostilities flared up with subsequent political unrest in the country. There was a delegation from the BGBD project visiting the Ivorian BGBD team, just shortly before the unrest broke out. It is only recently that we have heard about some positive development, but the operations of the Ivorian BGBD project will have been and will be affected in different ways.

Then of course the Tsunami struck at the end of December 2004, with Sumatra, Indonesia, being severely hit, but also India being among the countries heavily affected. Recently a second earthquake off the coast of Sumatra inflicted further heavy casualties among the Sumatran population. Nobody of the BGBD project Indonesia was directly affected, but a disaster of this magnitude affects everybody in one way or another. We sympathize with all those affected and wish them success with rebuilding their homes and reconstructing the affected areas.

The objectives

This years meeting will have a different character from the previous ones. The number of participants, as mentioned already, is far bigger this meeting. Where refer to these meetings nowadays as the "annual meeting" which I think is more appropriate for a congregation of this size. The importance of this year's annual meeting is signified by it being the last meeting before the end of phase I of the project. Whereas during last year's annual meeting we were still very much preoccupied with organising ourselves to get the inventory started and carrying it out, the focus of this year's meeting will be on results o that inventory and outputs of the project.

The request for submission of papers for this year's annual meeting aimed to generate output in the form of proceedings for this meeting. I observe that we have delayed with producing outputs and I hope to improve this through publishing proceedings of this meeting (partly). This is the first objective of the Annual Meeting. I do urge everybody to still submit their papers if they have not done so already, such that we will be able to present a comprehensive report.

The analyses of the data have not been completed. Partly fieldwork in ongoing and the results that will be presented during this annual meeting will be preliminary findings to some extent. We need to identify what still needs to be done and what we want to present as final results for phase one. We need to determine how we are going to synthesis these results and who will be responsible for this synthesis. We need to agree on procedures for getting these outputs. The second objective therefore is to agree on a plan of work for 2005, what activities still be undertaken in phase one and which activities to carry over to the second phase.

So far we have not addressed quality aspects (or quality assurance) of our work explicitly. We do want to make a significant contribution to the knowledge and understanding of BGBD and the role it plays within the agro-ecosystem. This requires that we apply sound procedures and methods of inventory and that we produce high quality outputs. As part of that process we invited external advisers to review the work we have done and the results we have generated so far on technical grounds and advise on opportunities for synthesis of these results. The technical advisers are assumed to play the role as independent observers, though some have been involved in the project already from the early stages.

Apart from a technical evaluation we want to assess and evaluate the progress made by the project. This is an internal evaluation of the progress made in term of output generated and outcomes achieved, as formulated in the project documents, considering factors that determine this progress like project implementation, project management and organisation. The project advisory committee is the main body within the project to assist in this task. We hope to receive valuable recommendations on the project's strategy for the second phase.

Last month UNEP/GEF initiated the mid-term evaluation of the project. It is an external evaluation and the evaluators will report to the GEF council. The evaluators are Prof. Eric Smaling, who is professor at ITC in the Netherlands, and Prof. Mateete Bekunda, who is dean of the Faculty of Agriculture at Makerere University, Uganda. It is a coincidence that the mid-term evaluation coincides with the first PAC meeting, but it could be to their mutual advantage. The evaluators will evaluate the performance at the level of the global coordinating office, the working groups and at the country programme level. The evaluators will not be able to visit each BGBD country programme and the annual meeting therefore provides a welcome opportunity to interact with representatives from all the country programmes. We want to facilitate the mid-term evaluation, as this evaluation will be to our own benefit as the mid-term evaluation aims to provide recommendations for further operation of the project during the second phase.

There are still outstanding issues regarding project governance and operation. The most urgent issue may be the project's policy on data sharing and protection of intellectual property rights. On several occasions I have experienced hesitation within the country teams as well as between country teams and the GCO to share and exchange data and information. We need to solve this issue if we want to move forward as a project. Ownership of the data in itself is not a controversial issue, since nobody owns the data that is being generated. The ownership lies with the institute one works for or with the funding organisation. It is important to realize that people are not part of the project on an individual or personal basis, but rather as staff of a collaborating institute. The "data sharing" issue needs resolve by adopting a policy during this AM that will guide our further actions concerning the sharing of data.

A derivative objective of the above one could be to foster as sense of belonging to the project and a feeling of solidarity (and trust maybe) within the project. The question should not only be "what can the project do for me", but also "what can I do for the project". Meetings like these are important in that respect, and we hope you may enjoy and have fun as well during this annual meeting.

We will further have to agree on the capacity building programme for the project for 2005, realizing that the need for training varies per country programme and also that the capacity of the country programme to organize their own training events may differ. The training will for the coming period still target the members of the project and we will need to consider student training as an explicit component of the training and capacity building programme. Gradually we will have to shift our attention however to training and sensitising of farmers and other stakeholders.

Finally, this AM 05 aims to be the starting point for developing plans for the second phase of the project. I very much advocate that country programmes develop their own proposals, or plan of activities. The plan of activities should not be aimed to satisfy one particular objective only, but rather a multiple of objectives. And countries may consider putting various alternative plans forward. We need to agree at this annual meeting on how to proceed: What will be the guidelines and procedures for the development of these workplans, including who will be responsible for developing these proposals, vetting and approval.

Finally concerning the programme, we need to settle many project affairs, as we have only one annual meeting per year. Consequently the programme is very tight and we need to be very efficient. The role of the chair of the sessions will be very important, not only to keep time, but also the direct and control the discussions. Separate sessions are schedules for discussion and planning.

The programme

The programme is organised broadly conform the outcomes of the project and is guided by the objectives as presented earlier. In session 2 – 7 we will present results of the inventory and on standard methods obtained so far we and it will enable us to asses the progress achieved. For publishing the proceedings of these sessions we rely on the commitment of the project members to submit their papers. It requires that all outstanding papers are still to be submitted.

There will be more room for discussions on the inventory and methods in session 8, the session linked to the technical review. The discussions will be introduced by the various invited experts. Aim of the discussion will be to identify gaps, to assess the technical relevance of the work done, to identify opportunities and give recommendations for the synthesis of the results. Provision is made on Friday to discuss further arrangements especially with respect to the synthesis of the results.

Session 9, 10 and 11, deal with specific aspects of standard methods for the characterisation and evaluation of BGBD (including a set of indicators), that have not been addressed explicitly by the current inventory. The topics are ecosystem services and indicators, land use intensity (and scale aspects of BGBD) and economic evaluation. Separate task forces are assigned to deal with these topics and they will report in those sessions. These sessions provides a bridge to the later planning sessions, since the activities associated with these topics are largely to be initiated still, but results of these studies will feed into the planning for the second phase.

The planning sessions (sessions 13, 14 and 15) are organised by working group, assuming that working group 1 not only will deal with the standard methods but also the inventory. WG3 and WG4 planning sessions are combined. The aim is that these planning sessions will result into a comprehensive plan of work for 2005 that can be table at the PSC meeting for their approval. The sessions will deal with planning of remaining activities for the inventory, final reporting for phase one, and planning activities in preparatory activities for the second phase (including proposal development). After this, country programmes will present their ideas for the second phase and we will discuss how to maintain some coherence between the country programmes during the second phase.

The Friday and Saturday are reserved to further concretize our plans; to agree on guidelines and procedures and to assign tasks and responsibilities such that we can immediately proceed with the tasks ahead after the annual meeting. Already scheduled are a session to decide on the implementation of the project database and one session to draft a project policy on data sharing and protection of intellectual property right.

4. Progress and Achievements of the BGBD Project in 2004

Jeroen Huising

1. A short history of the project and achievements in 2002 and 2003

I want to report here only on the progress made during 2004. The presentation does not include an introduction to the project it itself, but the report on progress may at the same time provide introductory information on the project. More information is provided in the annual progress report distributed to member of the PAC and members of the PSC and available to everybody upon request. Other than in previous annual meetings the country programmes will not present individually on their progress. Rather, that information is incorporated in the in the annual progress report, and therefore in this presentation, in so far that information was availed to me. The country programmes will report on progress achieved on the inventory and standard methods through the presentation of results in session 2 to 7, and will not be included in this presentation.

A short history of the project: The project idea was conceived around 1995 and further developed into a proposal during 1996 and 1997. However, it was not until August 2002 that the final proposal was approved. A start-up workshop was held later that month in Wageningen. At that time the executing agency (TSBF) was undergoing major institutional and personnel changes. For the project at that time administrative and institutional arrangement were still pending. MoAs with parties concerned were finalized in December 2002 and it was only until February 2003 that all country programmes had received their first disbursement of funds. Project staff, including the project coordinator was recruited during 2003.

The project management and implementation structure was decided upon during the second global workshop that took place at the end of February in Sumberjaya, Indonesia. During that workshop we also agreed on a 'global' plan of work. The country programmes had to (re)organize themselves and national planning workshop were held by all country programmes. Start of the field work activities by September 2003, as planned, proved not to be feasible. Questions on the sampling strategy, that was earlier agreed at the Lampung workshop, and on methods of inventory caused delay of the start of fieldwork. Definition of standard methods was very much hampered by problems of communication within the project, which in itself again cab be attributed partly to the delay in the implementation of the project structure.

2. BGBD project highlights 2004

Emphasis of the project in 2003 has, therefore, been on selection of sampling windows and definition of standard methods. The annual meeting 2004 was held in Embu, Kenya, from February 23-29. It was more of an internal affair, compared to previous global workshops. It was time to organise ourselves; investigated the causes of the delay that had occurred so far and to move one.

Figure 1 Views on Mt. Kenya from the venue of the annual meeting 2003

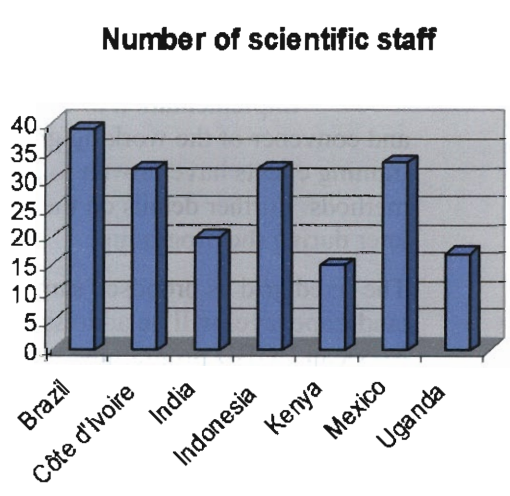
We agreed on the extension of phase 1 to June 2005, implying revision of the budget and adjustment of the plan of work. Country Programmes submitted their revised budgets quite late, some even only towards the end of the year, which had consequences for the release of funds to the country programmes.

During the annual meeting the first newsletter and project brochure were presented. More important was the agreement that was reached on the standard methods for the inventory and decision on the functional groups of soil organisms to be addressed by each of the country programmes. This was a breakthrough since the standard methods had been an obstacle to the start of the field work. It was clear that the emphasis in 2004 would be on the inventory; carrying out the fieldwork and getting preliminary results to check whether we were on the right track. Some country had by that time already made considerable progress, especially by Brazil, Mexico and Indonesia, with the Mexican programme being able to present the very first preliminary results by the end of June. During the annual meeting we also agreed on a priority list for the training and capacity building programme.

3. Project implementation; Staffing levels

By that time the implementation of the project structure should have been completed. The figure below indicates the staffing of the project. It is based on data from October 2004 for most of the country programmes, for others we have more recent information.

Figure 2 Number of scientific staff in each of the BGBD country programmes



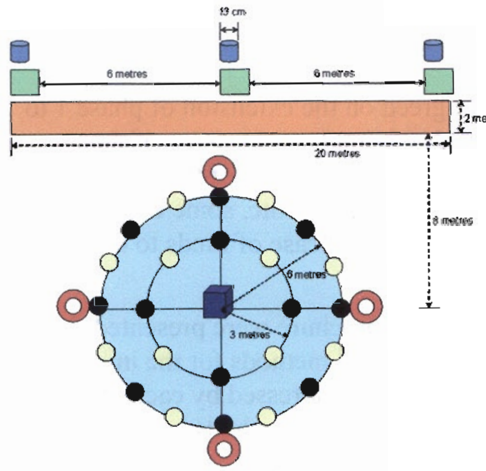
Currently there are in total 194 people directly involved in the project as scientific staff, of which 188 in the combined country programmes and 6 are involved in global coordination. Most are involved in the project on part-time bases. The figures do not include technicians or administrative staff. Nor does it include anybody on the project advisory committees (at national or global level), the project steering committee outside the country programme conveners, or (external) technical advisers.

The large differences between country programmes in the level of staffing is striking, reflecting the difference in capacity between the country programmes. Reasons and possible implications will be discussed elsewhere.

4. Achievement with respect to outcome one: Standard methods

Progress is reported per project outcome as defined in the project document and against project milestones and outputs as specified in the monitoring and evaluation document.

Standard methods for the inventory (outcome 1 of the project) were agreed at the Embu annual meeting of February 2004. This included protocols for sampling at each sample point (a shown to the left). The methods were distributed on a CD. A few copies are being distributed still at this meeting, for internal use only and not for further distribution. The milestone "methods selected" (see M&E document) is therefore completed



Proposed methods are implementing by each of the country programmes, and thus tested. However, methods and protocols have not been implemented in the same way for all functional groups and by each country programmes. This may relate to the sampling strategy as well as to protocols for sample collection, isolation and identification. This will be further discussed during the session on standard methods. Deviation from the standard proposed methods may be conceived as an experiment, and will allow comparing between alternative methods.

***Figure 3** Scheme for collection of samples at each sampling point as agreed at Embu, February 2004.*

Brazil	
CDI	✓
India	✓
Indo	
Kenya	
Mexico	✓
Uganda	

Some countries purposefully experimented with methods for inventory. This may refer for example to adding additional monoliths for sampling of earthworms or to sampling across the various seasons rather then for one point in time. We need to mention the Ivorian, Mexican and Indian team in this respect. We hope the results will prove valuable in defining the standard methods.

A manual for the 'final' standard methods is still foreseen. Protocols and guidelines for doing such should be agreed during this annual meeting. The milestone "Methods tested" is considered to be completed, whereas the output "methods documented" is partly realized.

Implementation of the methods has been reviewed by the project coordinator and convener of the working group 1 during visits to the country programmes. Also the training events have proven to provide a very valuable opportunity to discuss standard methods. Further details on the standard methods will be provided in the special session later during the programme.

The fixed grid as proposed sampling method for inventory of BGBD at plot and landscape level will be addressed as a separate case study. Simoneta Negrete from the Mexican BGBD programme was commissioned to develop a proposal for such a study (looking at spatial distribution and scale aspects of BGBD) and will discuss this later during the annual meeting.

The indicators of loss of BGBD (that is part of the output for outcome 1) will be looked into partly based on the results of the inventory. However, as early as 2003 we held a training course on molecular techniques that may possibly be used to assess and monitor BGBD. Indonesia has included the testing of (biological) indicators in their plan for work for 2005. Discussions have meanwhile started on the measurement of parameters in relation to ecosystem services, as a function of BGBD. The task force will report in session 9.

5 Outcome 2a - Inventory of BGBD: progress made

At Embu we also decided on functional groups that are mandatory for the inventory of BGBD and those FG that are optional. The mandatory ones are the LNB, AMF, Nematodes (parasitic and free living), macrofauna and phytopathogenic fungi. In one country only they will also inventory the entomo-pathogenic fungi and nematodes, as an example of an optional functional group. Results on the inventory for each of these FG will be presented in the following sessions.

Figure 4 Matrix indicating the functional groups addresses by each of the country programmes

Country / Functional Group	BRL	CDI	INDI	INDO	KEN	MEX	UGA
Legume Nodulating Bacteria (LNB)	Y	Y	Y	Y	Y	Y	Y
Arbuscular Mycorrhizal Fungi (AMF)	Y	Y	Y	Y	Y	Y	Y
Nematodes (parasitic and free living)	Y	Y	Y	Y	Y	Y	Y
Mesofauna (Collembola and Acari)	Y	Y	Y	Y	Y	Y/N	Y
Macrofauna (Ants, Beetles, Termites and Earthworms)	Y	Y	Y	Y	Y	Y	Y
Phyto-pathogenic fungi (Phythium, Fusarium, Rhizoctonia)	Y	Y	Y	Y	Y	Y	Y
Plant pests (white grubs-fruit flies)	Y	N	Y	Y	Y	N	Y
Ectomycorrhizae*	N	N	Y	Y	Y	N	?
Entomopathogenic Nematodes and Fungi	Y	N	N	N	N	N	N
Saprophytic fungi	N	N	N	N	Y	?	N

Outcome 2a refers to the inventory of BGBD, which includes components like site characterisation and land use inventory. As details on the inventory of BGBD will be presented in session 2 -7, I think is fair to say that sample collection has been completed, including the sample collection for soil analyses, and the land use survey. Inventory of a few specific functional groups or surveys still pending in some countries: e.g. fruit flies in Indonesia, socio-economic baseline survey in Kenya and meso-fauna in Mexico for example.

Brazil	✓ (100)	
CDI	✓ (40)	(-)
India	✓ (?)	✓ (?)
Indo	✓ (?)	✓ (?)
Kenya	✓ (60)	✓ (40)
Mexico	✓ (100)	
Uganda	✓ (100)	(-)

Table 2. *Number of sample points completed by each country programme for each benchmark site. (Note India has two sites in the Nilgiri Benchamrk area)*

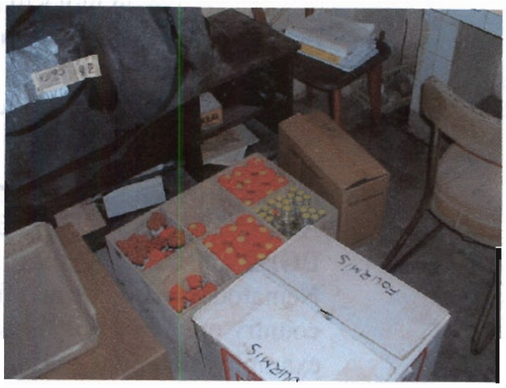


Figure 5. *Boxes of vials to keep termite and ants specimen collected from the semi-quantitative transect in Cote d'Ivoire*

Preliminary results were presented by all country programmes, with India closing the line in December 2004. Laboratory and greenhouse activities (for trapping, culturing, isolation and identification) are continuing in many countries still. One has to appreciate the enormous amount of work involved with the inventory of these different functional groups of soil biota, including the taxonomy.

What may deserve some further attention is the variation in the number of points sampled and the distribution of sampling points within the benchmark area, considering that the environmental conditions within the benchmark area may vary considerably.

Another output defined for outcome 2a is the mapping and description of the benchmark area, and that should include the socio-economic survey.

Geographical data is available and has been collected for most benchmark areas, except maybe for the benchmark areas in India. Land use mapping has been undertaken by all country programmes. Individual land use maps may be available for particular benchmark areas, like for the Brazilian BA illustrated here. However it has not resulted in a comprehensive description for any of the benchmark areas in 2004, or some kind of uniform presentation of the benchmark areas on the project's WEB site. More recently considerable progress has been made though.

Brazil	
CDI	◘
India	✓
Indo	✓
Kenya	◘
Mexico	
Uganda	◘

Table 3. *Countries that are carrying out case studies on economic evaluation. The African BGBD countries are included in a study by Danso, who is commissioned to look at the economic benefits from the symbiotic relation ship between promiscuous soybean and LNB.*

As far as the economic valuation is concerned, case studies on the rhizobium inoculation technique and on national programmes to develop these techniques are initiated by the Indonesian and Indian country programmes. We also commissioned an external expert to look at the (possible) economic benefits derived for symbiosis of promiscuous soybean with bradyrhizobium strains that is relevant especially for the African situation. All studies are in a preliminary stage.

6. Progress made with respect to the project information exchange network and database

Outcome 2b concerns a "global" information exchange network. A very first prototype of the database was developed by June 2004 and subsequently discussed with a number of BGBD country teams to further concretize the purpose, function and content of the database. The prototype has evolved accordingly. The next stage and challenge will be the actual implementation of the database by the country programmes.

The first newsletter of the project was presented during the annual meeting 2004 and the project brochure was already printed the month before, in January. A second newsletter is still foreseen before the end of phase one.

Figure 6. *The logos of the BGBD project and of the Brazilian BGBD country programme BIOSBRASIL*

Conservation and Sustainable Management of
Below Ground Biodiversity

BioSBrasil

The project's WEB site (www.bgbd.net) was established in July 2004. The WEB site integrates the functionality of a list serve, an electronic discussion forum, a database facility intended to register the experts in the project and their expertise. The main purpose of the WEB site, however, is to provide information about the project and its products, announce events and to keep documents mostly for internal consultation. The list-serve aims to facilitate the communication across and within country programmes which has been a problem in the project.

The WEB site is being updated constantly and evolving further. The focus for 2005 will be on stimulate the effective use of the facilities provided on the WEB site and to develop it into an effective tool for disseminating information to third parties as well as project participants. The Brazilian country programme has launched her own WEB site: "BiosBrazil". The site is in Portuguese. We will stimulate also the other country programmes to establish their own WEB site, as an effective means of providing information on the project in different languages. The Indonesian country programme has announced her intent to establish a WEB already.

7. Awareness and sensitisation

Raising awareness is part of the activities of working group 3 and 4 and contributes to the outcome 4 for of the project: policy recommendation and alternative land use scenarios. Where most of the activities for outcome 3 an 4 and schedules for the second phase, quite some work ahs been done during phase one on awareness raising and sensitization of farmer communities. We name the following:

- International press conference in London announcing the BGBD initiative in November 2002
- Press coverage of annual meeting at Lampung (2003) and Embu (2004)
- Stakeholders meetings: BGBD Mexico presentation of the BGBD programme to stakeholders at the benchmark site (covered on television) and more recently the Kenyan stakeholder meeting.
- Official Launch of the BGBD programme Kenya, with invited ministers and covered on prime time news.
- Representation of the BGBD project on various international conferences in 2004 (e.g. XIVth CISZ, Rouen; ISCO Brisbane; ISME Cancun; Ecoagriculture, Nairobi)
- National and local coverage of the national BGBD programmes (national and local press, newsletters, interviews for journals, papers presented at conferences and workshops)
- BGBD Kenya: MSc in political sciences

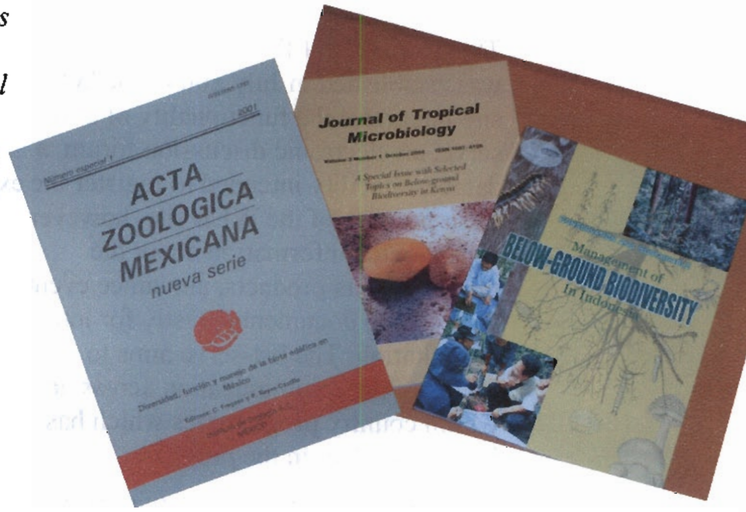
Sensitization workshops for farmer communities have been held in most BGBD countries.

8. Project outputs generated

In 2004 the BGBD reviews of Kenya and Indonesia were published. Erlier on Mexico had already published their BGBD review and the Indian BGBD will be presented during this annual meeting. The Brazilian BGBD review is ready to be sent to the publisher.

Brazil	■
CDI	
India	✓
Indo	✓
Kenya	✓
Mexico	✓
Uganda	

***Table 4.** Country programmes that have published their BGBD reviews. At this annual meeting the Indian BGBD review was presented and the Brazilian BGBD review has been sent to the publisher.*



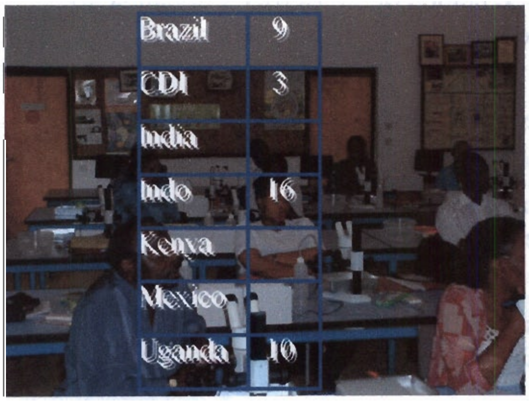
The current status of the BGBD review from the Ivorian BGBD programme is not very clear. The manuscript has been reviewed twice by the editor which suggests that the document is nearly complete. The Ugandan team presented a detailed content of their BGBD review, but status of the chapters is not very clear.

9. Progress and achievements on capacity building (Outcome 5)

Up to April 2005, five international training courses have been organized as listed below, of which two were conducted in 2004 with a total of 44 participants.

- Molecular techniques (T-RFLP), 2003
- **Ecology and taxonomy of earthworms, 2004**
- **Ecology and taxonomy of nematodes, 2004**
- Ecology and taxonomy of termites and ants, 2005
- Training workshop on AM Fungi and Ectomycorrhiza, 2005

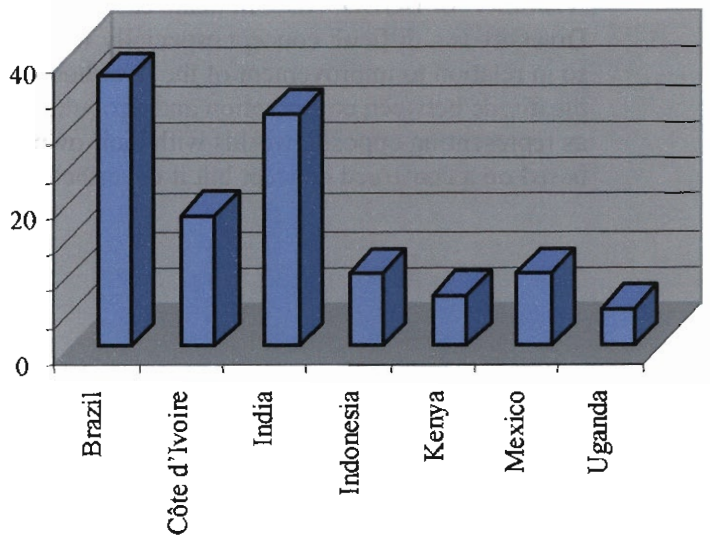
In national or regional training workshops in total 38 persons were trained in 2004, distributed over the country teams as indicated below. In total 82 persons were trained in short courses during 2004. Training courses have been on various topics, e.g. soil ecology, termites, mesofauna (collembola), mycorrhiza, GIS, rapid assessment of biodiversity, etc



Brazil	9
CDI	3
India	
Indo	16
Kenya	
Mexico	
Uganda	10

***Figure** 7. Particpants' number in short term training courses per country programme*

Currently around 120 students are involved in total with the BGBD country programmes and we have currently one Kenyan student and 3 foreign students at the global office. Again the difference in number of students between country teas is striking. But it is not the place to discuss it here.



10. Project management challenges

Communication between country programmes (and GCO) and within country programmes has been identified by all programmes as a problem. This problem has technical and managerial dimensions. We have many partners in the project, people are very dispersed (globally and within the countries) and therefore communication is mostly done by email. The solution would be to meet more often, but that would have severe cost implications

The lack of response to email communication from GCO or working groups seems to indicate that ownership of the project by its members mat be a problem. The question is whether the national programmes consider themselves as part and parcel of the 'Global' project and even whether individual member from the different institutes feel part of the national team. We also see that the personal involvement may differ considerably. Cultural differences play a role as well.

As for the organizational structure the functioning of the working groups and task forces and project management unit is a concern, which may be partly related to staffing. Also, many institutions are involved in the BGBD country programmes which complicate implementation of a project management structure. Furthermore the remote location of the benchmark areas causes logistic problems in many countries.

Further mention needs to be made especially on the difference between countries in the available resources and capacity. In future more explicit account has to be taken of the available capacity in defining the country programme of work. The varying size of the country programmes (staff) is an expression of this and it also reflect on the difference in access to co-financing resources between the country programmes.

11. Scientific and Developmental challenges

To conclude I want just to indicate the stiff scientific and developmental challenges the project faces. A wide range of disciplines of disciplines is involved in the project. Taxonomy for many of the groups of soil organism we are dealing with is unresolved and sometimes many different keys may exist (or even be absent for a particular region) for the identification of species. Then the development in molecular techniques poses a challenge to the project as also the attraction to engage these molecular techniques is quite strong. Finally the big challenge for this project is to link bio-diversity to function. It requires specific research that the project may not be equipped for.

Apart from doing good research the project is challenged to translate the result from research into practical techniques to conserve and manage BGBD for the benefit of the farmer and rural communities. Particular problem in achieving that goal is the low 'visibility' of BGBD. Also, in mane cases effects will be visible only on the longer term. Diversity is a difficult concept especially when applied to soil organisms and even more so in relation to improvement of the livelihood of people. Finally the project operates on the divide between conservation and agricultural development; these are often conceived as representing opposite worlds with their own interests. This antagonism may partly be based on a construed concept but it nevertheless is difficult to reconcile both worlds.

Results on the Inventory of Below-Ground Biodiversity

Abstracts of papers presented in sessions 2 to 6 of the programme

Session 2: Benchmark area description and socio-economic characterisation

Content

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1. Introduction

The Indian subcontinent supports diverse flora and fauna due to its habitat diversity and is aptly considered as one of the twelve mega-biodiversity countries of the world. Nilgiri Biosphere Reserve located in the Western Ghats and Nanda Devi Biosphere Reserve located in the Himalayan mountain region are globally significant from the point of their rich biological diversity and immense environmental services (Mayer et al, 2000) (Figure 1).

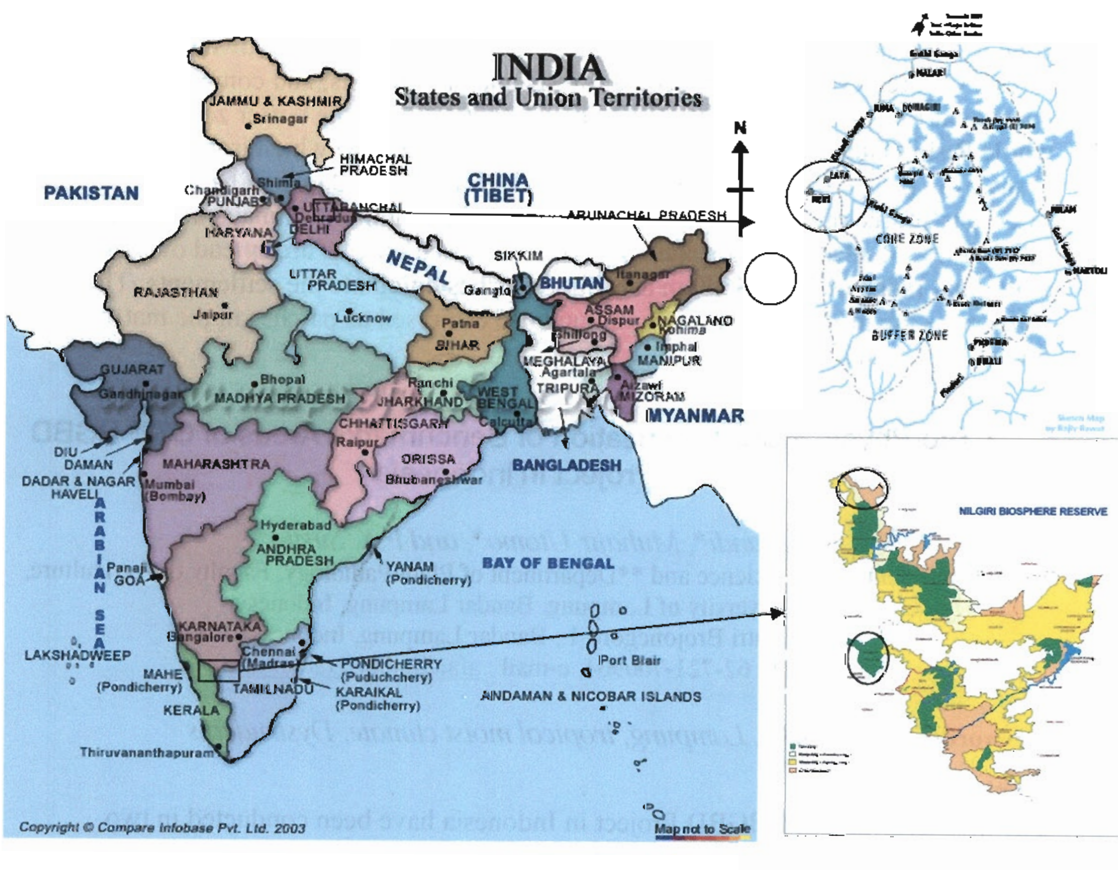

Figure 1. Location of benchmak sites and study windows in India

2. General features of the Nilgiri Biosphere Reserve

The Nilgiri Biosphere Reserve (NBR), embraces sanctuary complex of Wyanad, Nagarhole, Bandipur and Mudumalai, the entire forested hill slopes of Nilambur, the Upper Nilgiri plateau, Silent Valley and the Siruvani hills in the the Western Ghats mountain region. The total area of the biosphere reserve is around 5520 km2, of which 1240 km2 constitutes the core zone. The area of the reserve covered in the State of Karnataka covers an area of 1506 km2 falling in Nagarahole (640 km2) and Bandipur (866 km2) National Parks. The Kerala part of NBR covers an area of 1455 km2 covered in the Wayanad Wildlife Sanctuary, Silent Valley National Park, Nilambur Reserved

Forests (RFs), New Amarambalam RFs, Attappady Valley and Muthikulam RFs. The Nilgiri Biosphere Reserve is one of the critical catchment areas of Peninsular India. Many of the major tributaries of the river Cauvery like the Bhavani, Moyar, Kabini and other rivers like Chaliyar, Punampuzha, etc., have their source and catchment areas within the reserve boundary. Many hydroelectric power projects are present in the Kundah, Bhavani and Moyar basins. The topography of the NBR is extremely varied, ranging from an altitude of 250 m to 2650 m. The west facing slopes of the rivers and streams drain into the Arabian sea, while the rivers rising from the eastern slopes flow through Tamilnadu to enter the Bay of Bengal.

3. General Features of the Nanda Devi Biosphere Reserve

On 18th January 1988, taking a cue from UNESCO's Man and Biosphere programme, Nanda Devi National Park (NDNP) was given the status of Nanda Devi Biosphere Reserve (NDBR). In 1992, NDBR got the recognition of a world Heritage Site. The reserve is located in the northern part of the western Himalaya and covers a total area of 5861 km^2 with two core zones viz. Nanda Devi National Park (625km^2) and Valley of Flowers National Park (88 km^2). The buffer zone (5148.50 km^2) covers part of the districts of Chamoli, Pithoragarh and Bageshwar of Uttaranchal State. Land in buffer zone is classified as privately owned agricultural land, government owned and managed forests viz., reserve forests, protected forests and civil forests, and community managed panchayat forests. From geomorphologiacal point of view, the buffer zone occupies the whole Rishi Ganga catchment, (a tributary of Dhauli Ganga) which is encircled by High Himalayan peaks. India's second highest peak Nanda Devi flanks in Northern part and the reserve is source of water to the major rivers originating in the Himalaya. A total of 47 villages are situated in buffer zone of NDBR. The settlements are spread over an altitudinal range of 2200-3600 m asl. Bhoiya tribes dominate the settlements. The cultural landscapes are mosaics of agricultural land use dispersed as patches in the matrix of forests all through the region.

2. Bio-Physical Characterization of Benchmarks Areas of CSM BGBD Project in Indonesia

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Keywords: *CSM-BGBD, Lampung, tropical moist climate, Dystrudepts*

Abstract

The inventory of CSM-BGBD Project in Indonesia have been conducted in two benchmark in Sumatra Island, Lampung benchmark and Jambi benchmark, and this paper described the Lampung benchmark. Lampung benchmark represented the area with high population density and high pressure on natural resources in Sumatra Island. The benchmarks covers an area of approximately 20 km x 30 km within coordinate of 4o64' S to 5o10' S and 104o15' E to 104o20' E. A representative sampling area in benchmark is called a window, which sized 1.2 km x 1.2 km, was gridded with the distance 200 m x 200 m. The soil samples have been done by stratified gridded sampling method, and 7 land uses were found in 88 sampling points. The benchmark is situated in Recent Volcanic Formation, consisted of andesitic to basaltic breccias, lava, and tuff, with altitude ranged from 600 m asl to 1718 m asl. About 85% of the benchmark is hilly areas, with slope is mostly moderately steep to abrupt (16- >45%). The climate is characterized by the abundant rainfall (2500-2600 mm/year) moderately distributed over the year with wet and dry season weakly developed, with the average temperature is around 22oC and

classified as tropical moist climate (Af) rainforest type. The soils is dominated by Inceptisols, especially Vertic and Typic Dystrudepts in the great group category and generally very deep (150 cm). The soil fraction is dominated by clay, and the soil texture is clayey with low bulk soil density (1 g cm-3) and low particle density (< 2.65 g cm-3). The angular blocky soil structure in the surface horizon showed that high intensity of soil erosion occurred in the past. The soil organic matter was quite high in forest area while in intensive land use was low, which indicated that the soil was degraded. The pH is very acid with high Al-saturation; other soil fertility parameter was low, such as P, CEC and cation bases.

3. Land Use History, Intensity, and Socio-economic Background of the CSM-BGBD Sumberjaya Window, Lampung Benchmark

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***Key words:** history, land use intensity, household income*

Abstract
A farmers' household and on-farm survey was conducted in the Sumberjaya Window of the Lampung Benchmark in 2004, to study land use history, land use intensity, and socio-economic background using graded stratification sampling method. The opening of the forest to establish fields started in 1952 by West Java migrants. Now these plots are owned the second generation of migration who opened secondary forest, shrub, or old coffee fields in 1970-ies. Land use history (land uses followed by its age) may indicate continuous coffee farming (such as F(?)Hc(4)Tc(14)S(3)Tc(5) where F = forest, Hc = horticulture-crops, Tc = tree-coffee, S = shrub) or coffee followed by crops (e.g. S(9)Tc(16)Hc(4). The land use dynamic change from shrub to coffee to crops represents a continuous cultivation system. Land use intensity (LUI) could be quantified by calculating the mean intensification level, production level, and system intensity scale, using primary forest as standard. For land use type in the Sumberjaya window, the results showed that land use intensity (LUI) of undisturbed forest (FLI) lay between 0 – 9.9%, disturbed forest between 5.3 – 27.2%, shrub between 6.1 – 34.4%, monoculture coffee (TBI) lay between 35.1 – 64.5%, LUI of shade coffee (TBLI) between 30.9 – 66.2%, LUI of food crop (CBLI) between 55.3-63.5%, LUI vegetable (CBLI) between 66.4 – 84.7%. Farmers growing vegetables (CBI) had the highest income compare to other farming systems, but it is only practiced on a small scale. Income from monoculture or shaded coffee farming systems was low and household were not food security. Coffee farming mixed with high compatible commodities will increase farmers' income.

4. Benchmark Site Description of the Los Tuxtlas, Veracruz, Mexico

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***Keywords:** Benchmark site, Los Tuxtlas, Biosphere Reserve, Soil Organisms.*

ABSTRACT
The Los Tuxtlas Biosphere Reserve is located in the state of Veracruz and the coastal plains of the Gulf of Mexico. The Los Tuxtlas Biosphere Reserve is characterized by the physical, biological, and social diversity that it covers. The region of Los Tuxtlas is a

volcanic massif dating back to the Tertiary period, lava flows, volcanic ash, and other pyroclastics cover almost the entire area. A volcanic massif, whose principal longitudinal axis measures 80 km, seven large and partially eroded volcanoes and 300 small volcanic cones can be distinguished. The altitudinal range is from sea level to 1780 meters with the San Martín Tuxtla volcano as the highest elevation. The climate of the region is hot and sub humid on the coastal plains, and temperate and humid in the highlands.

The Los Tuxtlas reserve is one of the most threatened protected areas in Mexico. It suffers pressure resulting from human demands on nature in the region. This has led to continuous and rapid disappearance of habitat and natural vegetation. The principal causes are the expansion of agricultural activities, expanded livestock production, and population growth that places demands on the areas natural resources. It is therefore necessary and of great importance that investigation about natural resource management be realized in order to design action plans to combat the threats that put the integrity of the protected area at risk.

Three windows were selected in the benchmark site in order to study of soil organisms for their diversity and functional attributes. The three windows in Los Tuxtlas region are associated with three communities or *'ejidos'*. They were the Adolfo López Mateos Community, the Venustiano Carranza Community and the San Fernando Community. Adolfo López Mateos is an *ejido* that corresponds to the "San Juan Volador" terrestrial landscape. Venustiano Carranza is an *ejido* that corresponds to the "Mirador Pilapa" terrestrial landscape and San Fernando is an *ejido* that corresponds to the "Buena Vista" terrestrial landscape. The three "ejidos" present differences in cultural customs, altitude, C concentration, C:N relationships, soil pH, soil type, mean rainfall, rain forest cover and size, which could be important in order to explain the patterns in the soil organism diversity founded.

5. Socio-economic Context of the Sampling Sites in the Tuxtlas region and Biosphere reserve in Veracruz State, Mexico

Isabelle Barois

Abstract

BGDB project sampling sites in Mexico are located in the territory of three communities within the buffer zone of the Biosphere Reserva of Los Tuxtlas, in the southern part of Veracruz State, Mexico. Efforts to preserve the environment in this mega diverse area started in the decade of 1930´s, since then the region has been object of several protection decrees. Government institutions, NGO´s, academic centers and Foundations (national and international) had promoted conservation-development projects in the last two decades. Despite these efforts this Reserve is considered critically threatened. The environmental deterioration of Tuxtlas region as part of the destruction of tropical forest in México, among the main causes are:

- Colonization of the tropical forest (1950-1980) as response of land demand from rural sectors after the post revolutionary agrarian reform.
- Government supported land use change from forest to grass and agriculture during this period.
- Population increase in the region.
- Immigration from other parts of Mexico.
- Lack of environmental perspective in public polices.

Economic activity and population

Livestock is the main economic activity in the region. Corn (maize) is the major crop grown through practicing slash and burn agriculture. Yields are generally poor (ranging

from 300-1500 kg/hectare) due to the low fertility of the soil. Erosion and the loss of soil are common threats for the land. Most of the farmers own an average of 1.5 ha.

This region hosted the first civilization of Mexico and maybe in the Americas; the Olmec culture. Cultural diversity is present with Populca and Nahua population that holds a deep and acute knowledge of the agroforestal systems. Cultural erosion due to extreme poverty and marginalisation is linked to adoption of external productive models and acculturation related to migratory process.

Farmer's economy is in the worst crisis of its long history of poverty. Actually migration to cities and USA has blunt social impacts, such as rural population aging and feminization

THE THREE COMMUNTIES

Land tenure at the three sites is ejidal, a form of collective property, were use of land was individual, but not the property. This form of land tenure changed in 1992, allowing private property. This weakened the ejidal structure and its capacity to take effective decisions to regulate communitarian life, such as access and regulation to natural resources use. As result communitarian life at regional level is highly disorganize dew to the weakening of the internal government structures, and the lack of new forms for public matters regulation.

This is the case of Venustiano Carranza and San Fernando, large communities where diverse conservation-development programs and projects had operated in the last 10 years, achieving low impacts and permanence. In both ejidos the last communitarian forest reserves were distributed and deforested after 1992 reforms to land tenure. López Mateos is a small ejido highly organized around a communitarian conservation project; ecotourism.

A common trait in the three "Ejidos" is that the young man migrates to the north of Mexico or the USA to get cash and sent it to their family. This migration can be for a season or for many years.

Adolfo López Mateos

After practicing slash and burn milpa for several years the ejidal general assembly of this Mestizo (i.e., a mixed Spanish and indigenous inheritance), community decided ban deforestation and adopted communitarian ecotourism as they key project. This decision made of López Mateos a referent to communitarian ecotourism at regional and national level, diverse foundations, NGO´s, government institutions and academic centres have collaborated with the ejido in this project.

Typical land use trajectories in López Mateos have involved the initial clearing of rainforest during a period of three to five years. As rainforest was eliminated, maize poly-cultures were substituted. These poly-cultures, or milpas, included other annual crops such as beans and squash. Following approximately three to five years of continuous planting of milpas, the croplands were allowed to fallow. Since that time, fallowed plots have been permitted in many cases to revert to secondary forests of varying ages. The general consensus among local residents is that a secondary forest, upon attaining approximately 20 years of age, is now a fully restored rainforest.

The more general trend in the López Mateos area has been to convert these cleared and briefly farmed plots to cattle pastures by relying especially upon exotic species of grass. Some families in López Mateos have implemented agro-forestry practices in their plots. These practices have principally included the production of coffee (low quality coffee) oranges and tangerines. Local residents perceive these activities to have little current economic viability

In recent years the Mexican government has provided local residents with tree seedlings (primarily cedar, walnut and mahogany) for reforesting and eventual selective commercial extraction. The first harvest is still some years into the future such that the activity does not yet provide an income for local residents. Because López Mateos is located within the buffer zone of the *"Los Tuxtlas"* Biosphere Reserve (where rural communities are legally permitted to engage in low-to-no impact economic activities), ecotourism has been perceived as a desirable, alternative source of income.

Venustiano Carranza

Peasant farmers seeking land under the agrarian reform act were also involved in the founding of Venustiano Carranza in 1967. The conversion of rainforests to cattle pastures has been more extensive and pervasive though. The most common land use practice in V. Carranza following the clearing of rainforest in the early years was the planting maize poly-cultures (milpas). In addition to maize as the staple crop, plantings of yucca, squash, beans, bananas were common on farm plots. The milpa was intended to meet the food self-sufficiency needs of individual households. However, harvests were generally only adequate for the first few years following the initial felling of the forest. Extensive cattle ranching was introduced quickly into the area and accelerated rapidly, resulting in the felling of more and more forested lands throughout the ejido. Forested tracts have become increasingly smaller, inaccessible and fragmented. Subsistence-level hunting and fishing by local people have since disappeared.

Many peasant families saw the production and sale of *azucena* bulbs (lilies) to regional and out-of-state intermediaries as an economically viable activity. However, bulbs and foliage soon became infected with plant pests and pathogens, and the losses of potential yields were (and still are) substantial. Small agroforestry plantations were started by many property owners throughout the ejido (planting cedar and mahogany with government support). It is noteworthy to mention that these trees are not growing satisfactorily most probably due to poor soils (i.e., soils low in organic matter, are acid and with heavy clay sub-soils). Since early 1990´s several projects were implemented by NGO´s and government. Such project included pisciculture, reforestation with commercial species (cedar, mahogany), horticulture, vermicomposting, camedor palm and ixtle growing, green manure and cover crops, etc. Nevertheless, in less of 5 years all most all this initiatives were abandoned.

San Fernando

Since early XX century Populacas farmers practiced a productive system were shade coffee was a key component of a traditional agro-forestery system which long contributed to the conservation of the ecosystem. This system is threatened by the international crisis of coffee prices, thus a tendency to shade coffee conversion to other land uses (pasture mostly) or abandon is observed.

During the years of the Mexican Revolution the region of San Fernando came to be settled by members of the Popoluca indigenous group who arrived from the lower elevation and nearby community of Soteapan. Especially beginning in 1935, the cultivation of "criollo" coffee (i.e., locally adapted varieties of shade-grown coffee) was introduced into the San Fernando region.

In 1960, forested lands in the San Fernando area covered approximately 1500 hectares. By 1990 this had been reduced by more than half, as additional lands were cleared to meet the growing, self-sufficiency needs of rural families. Many local coffee growers prefer to continue the traditional practice of "rustic" coffee. Rustic coffee relies upon the use and selection of local forest trees (primarily of the genus Inga) to provide the necessary shade cover for the proper growth, maturation, and harvesting of the coffee plant. The activity is basically organic, requiring little-to-no external chemical inputs by peasant farmers.

In the 1990´s decade several conservation and development initiatives were implemented by the PSSM, a long established in the region NGO. Impact and permanence of the projects is low, with some outstanding exceptions, like the Popolucas palm producers cooperative of San Fernando. In 1994, the planting of "mucuna" (*mucuna derengianna*, a type of leguminous, "green manure") was introduced into the traditional "milpa" (maize polyculture). Initially, some 25 peasant farmer families adopted this practice, but currently only about 10 are actively engaged in this form of maize cultivation. Additional government-sponsored programs of special note in San Fernando began in 1997 and 1997. These included the planting of ornamental palms (mostly "Palma Camedor") under remaining forest canopy (and for eventual sale to outside markets) and the reforestation of agricultural lands with precious wood species such as red cedar (Cedrella odorata) and mahogany (*Swietenia macrophylla*). In 2000, the first harvest of Palma Camedor took place, which resulted in both local and out-of-state sales. To date, this alternative economic activity continues to grow in strength and participation in San Fernando. Trees planted for reforestation purposes have yet to reach harvestable maturity.

7. Social-economic Characteristics and Farmer Indicators of BGBD in Mabira Forest Ecosystems of Uganda

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Abstract

BGBD has been alleged to be increasingly reduced with increasing emphasis on agricultural market economy and a profit maximization motive, reduced farm size, increased population and depressed yields have degraded all but mostly the biological resource base. Sustainable management of agricultural resources requires knowledge of the status of the biological resource base (BGBD), farmer indicators of the BGBD resource, their values and activities that impact on soil biota.

This study is aimed at identifying social economic characteristics and farmer indicators of BGBD in Mabira forest ecosystems of Uganda. Farm type categories and activities are identified and classified to determine their impact on BGBD.

A sample of 306 farming households were randomly selected between Aug 2003 and November 2004, from six sampling units (parishes) in Mukono district in which the forest reserve is located. Questionnaires were administered and key informants interviewed. Six discussion groups were held to supplement secondary data. Data was analysed by SPSS program. Descriptive statistics included frequencies, means, while Chi-square tests explained relationships and associations between variables.

Social economic characteristics identified were: farming as a major activity and off-farm activities a secondary activity by 98% and 58% of respondents respectively. Agro - forestry was practiced by 28%. Average land size was less than 1ha, owned by 82%, 17% rented land for production. Almost all who owned (73%) land also kept 2-3 livestock on average, of cattle, goats or pigs. About 70% attained primary level education,10% had no education, while only 20% had attained secondary and high school education. Average age was 42 years and majority were youths (18-30 years).Household size was on average 6 people and the majority (74%) married and heavily relied on (97%) family labour for agricultural production. These socio-economic characteristics affected BGBD variously.

Land was owned and controlled by very few people who were mostly elderly landlords of above 60years of age. These often decided on how long a household could use land and preferred perennial crops on their land. Tree crops, perennials and agro-forestry were often discouraged.

Seven farm categories were identified basing on land under production, activity, level of commercialization and management practice. They included typical subsistence

production, market oriented farms, Sugar-cane estates, Tea plantations, Out- growers of Sugar-cane and Tea, Privately owned forests and the Government (strict nature) forest reserve.

Correlation results showed a strong association between land ownership and agro-forestry, land size and fallowing, production land use of organic manure. Each association registered a $P<0.01$ level of significance. Investment in long term SWC technologies was positively associated with household size (labour), farming experience and education level. The level of significance between them was $p<0.01$, $P<0.046$ and $P< 0.05$ respectively. Pest and disease prevalence was reported by 60% of farms that practiced mono-cropping (e.g. maize, coffee) and it was also prevalent by 40% on farms that crop rotated and had fallows. Almost all (>90%) farms typical of subsistence production reported increased pest and disease incidences.

Over 90% of respondents believed that soil was a living thing.50% said that this was evidenced by the living organisms that lived underground, 50% based their reasoning on crop vigour and high yields. Indicators of BGBD by farmers included low crop yields, increased pest and disease incidence, presence of certain soil organisms (e.g. earthworms, chaufergrabs etc) which were said to aid in decomposition, improve soil aeration, water penetration and this enhanced soil health/BGBD. Various types of ants and termites were notoriously destructive to crops, however somehow enhanced soil health and BGBD through crop residue breakdown. Mole rats, millipedes, centipedes among others were reported destructive, however believed to enhance soil aeration and water penetration through tunnelling. Specific local weeds were indicators of soil salinity, acidity and soil fertility.

The majority (92%) said forest ecosystems must be conserved because of their economic benefits which were in terms of functions/activity and included temperature regulation and rainfall by 98%; rainfall, firewood and building materials(poles) by 89%; temperature regulation, rainfall and food provision (fruits) 72%; provision of mushrooms, ants, vines ,firewood and papyrus (25%); and medicinal plants and firewood (22%); soil formation and decomposition (56%).

Possible causes of BGBD loss identified by farmers were :repeated use of smallholdings with minimal or no rest period, lack of control of land resources, inability to invest in long term SWC technologies which are both costly and labour demanding, use of slash and burn practice for land preparation, over-use and misuse of agro-chemicals and chemical fertilizers and replacement /abandonment of traditional crops/cultivars in preference for a few cash crops for the market.

Based on the above preliminary results, the study recommended the following:

1. Further and detailed investigation of BGBD and use of advanced techniques for analysis of BGBD soc-econ data.
2. Putting in place a monitoring system for economic evaluation of BGBD for at least 30 years when soil regeneration is expected, and periodic monitoring and economic valuation thereafter by soc-econ teams in each country.
3. Training of economists on standard valuation methods of soil biota and additional Msc. And PhD training in the soc-econ area.
4. Including at least one ecosystem service function specialist (ecologist) in each country who will work closely with the economists.
5. Establishment of valuable BGBD demonstration sites in each country.
6. Encourage establishment of competitive specialized markets for agro-chemical and chemical fertilizer free products.

8. CHARACTERIZATION OF LAND USE TYPES IN MABIRA FOREST ECOSYSTEM, UGANDA

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Abstract

A study was carried out to characterize land use types in Mabira Tropical High Forest Ecosystem in Uganda. The land use characterization focused on the identification and description of land use types in the benchmark area and characterization of soil physiochemical parameters. This study provided background information for the interpretation of the diversity and abundance of below-ground biodiversity under the study in the area.

Six study sites (windows) each measuring 1 km x 1km were established within the benchmark area and within each window sixteen sampling points were marked in a 200m grid pattern using GPS giving a total of 96 points. At each sample point four soil samples were taken at depths 0 –10cm, 0-20cm and 20 – 30cm using soil auger for physical and chemical analysis. Litter was sampled and soils sample taken for bulk density using tube core method and soil profiles were studied at selected representative sample sites. Vegetation and land use types were identified and classified. Soils and litter samples were taken to laboratory at Makerere University and analyzed using standard methods for pH, total organic carbon, total nitrogen, potassium, phosphorous, calcium, magnesium and iron. Bulk density and soil texture were also determined. Soil data were analyzed using excel and SAS 2005 software for analyses of trends and relationships between the parameters.

Nine land use types were identified based on the distribution of the 96 sampling points. These included undisturbed forest, low disturbance forest zone, disturbed (secondary forest), grassland, fallow area, agroforestry, multiple cropping, tea plantation and sugarcane plantation in increasing order of magnitude of disturbance. Grassland and fallow areas are subjected to constant grazing by domestic animals. Agroforestry land use in the area is generally poorly managed. Multiple cropping consists of a combination of variety of annual and perennial crops mainly bananas, coffee, beans, maize, peas and cassava. There is no clear crop rotation pattern. Combination of annual crops on any plot tends to vary from season to season and from plot to plot within the land use type. There in no mechanization, use of fertilizer or irrigation in this land use type. Tea plantation is characterized by high inputs such as use of fertilizers and herbicide and intensive labor. The sugar cane plantation is very intensively used with heavy application of fertilizers such as urea and organic fertilizers from sugar cane processing residues.

There are significant differences in mean nutrient values between the land use types. Mean values for total organic carbon, total nitrogen, sodium, calcium and pH are highest in sugar cane plantation and significantly different from values in other land use types as indicted by Duncan's Multiple Range Test. In tea plantation mean nutrient values for total organic carbon, nitrogen, sodium, calcium, magnesium, potassium and pH are the lowest compared to other land uses. The values are significantly different from values from other land use types. Grassland also show very low level of the above soil nutrients and the mean values are significantly different from those of other land use types. Variations between the remaining windows are low.

Variations in nutrient levels between windows are also evident. Window six in which most of the points fell in sugar cane plantations has high mean values for total organic carbon, total nitrogen, sodium and pH and the values are significantly different from

values fro other windows. Window four where most of the points fell in agroforestryb and grassland respectively registered low mean nutrients values for all the above soil nutrients. Except for window six there is little difference between the windows in terms of mean nutrient level. This is largely because windows contain many land use types which are repeated in other land use types. Except for total organic carbon and pH there is no significant difference in soil nutrient levels with soil depths.

Analysis of correlation between soil nutrients shows weak and strong correlations between the variables. Strong positive correlations were observed between organic carbon and total nitrogen (0.63), pH (0.5) and magnesium (0.5). Strong positive correlation also exists between total nitrogen and pH (0.5), sodium (0.55) and magnesium (0.81 Weak negative correlation was observed between and all other nutrients. Calcium also shows weak negative correlation with organic carbon, total nitrogen, pH potassium and sodium

This study shows that differences in land use affects nutrient levels in the soil. Although land use intensification was not used there is apparent indication that the amount of some soil nutrients tends to increase with increase in land use intensity while some decrease with increase in land use intensity. There are some strong correlations between soil nutrients. This could be an important factor in soil fertility assessment. It may also have important role in influencing the diversity and abundance of some soil biodiversity.

9. Land Use Land Cover Mapping of the Benjamin Constant Benchmark Area, Brazil, using High Resolution Images

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Abstract

The present work was performed with the objective of identifying land use land cover and its spatial distribution at the six sample windows, and to get information about land use history at the sample points aiming to identify the intensity of land use.

Multispectral images of the Ikonos satellite, with 4 meters resolution, were used do map land use land cover at the six windows sample. To characterize land use at the sample points field work was done in order to get GPS coordinates for the points, and information about field plot (size, location – center or edge – type of edge, and so on), cultural practices, and history of use.

The selected 101 sample points (in total) are representatives of the main land uses of the region, being 20 in forest, 10 in old secondary forest, 30 in young secondary forest, 10 in agro-forestry, 18 in crop (annual or semi-perennial), and 13 in pasture.

Agriculture is most frequently developed under shifting cultivation, in small plots (less than 1 hectare). The main crops are banana and cassava, often cultivated simultaneously. In the agro-forestry system, also practiced in small plots, fruit trees are mainly cultivated. In both cases, the cultural practices are very similar, no agrochemicals are used, and clearing and weeding are made manually.

The pasture, where 13 points were located, has an area of 3.5 square kilometres. In this area, no agrochemicals are also used, and land preparation and weeding are made manually.

To proceed with this work, the data collected in the field will be analyzed, aiming to identify different land use intensities.

10. The Physical Environment with Emphasis on Upland Soils of the Upper Solimões river, Benjamin Constant County (am, Brazil)

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Abstract

A prior condition to select and establish research areas is the precise knowledge of soil properties and soil distribution in the landscape. This may only be obtained with the detailed observation of the soils through soil surveys. The present work is a report of the soils of upland areas identified in the soil survey of six (6) pilot areas selected in Benjamin Constant County, Amazon State. It is part of a larger project, whose objective is to improve the perception, the knowledge and the understanding of the Amazon soils biodiversity.

With a total area of approximately 54 hectares, the 6 pilot areas are sparsely distributed in Benjamin Constant County, between the geographical coordinates (UTM) 9,514,396 and 9,514,076 m of south latitude and 386,922 and 387,327 m of longitude west. The selected areas are inserted in Solimões Formation's geological compartment, characterized by alluvial and lacustrine sediments of the tertiary age (red and gray claystones, siltstones and sandstones, with shells and lignite layers). The relief varies from level in the tops of small hills and in alluvial plains, to undulating and strongly undulating in other positions of the landscape. The predominant climatic type is Af, according to the classification of Köppen, with temperature and yearly average rainfall of respectively, 25.7°C and 2,562 mm. Soils of Inceptsols (Typic Dystrudepts) classes prevail in the study area. Relief variations, profiles internal drainage, texture and intimate associations with other soil classes (Aquents predominantly) were the main approaches used for distinction of the different classes of Inceptsols identified by the soil survey accomplished in the pilot areas. Usually, that soils are shallow and well structured (Bi horizon with strongly developed structure), with subsoil (C horizon) at a few meters depth (70 cm on the average). The subsoil either shows several colors (variegated colors) or total white colors, inherited from the parent material.

Chemically, these soils present high and abnormal extractable aluminum contents, with values varying from 1.4 to 9.6 $cmol_c/kg$ of soil in surface and of 4.7 to 15.3 $cmol_c/kg$ of soil in depth. Recent works have questioned the inefficiency of the extraction method (KCl 1M) for similar soils studied in other areas. Consequently, extractable aluminum contents in upland Inceptsols of Benjamin Constant may not be correlated with contents of the active aluminum in the soil solution under natural conditions and, therefore, with its toxicity.

Within the peculiarities in relation to the physical conditions of the studied Inceptsols, stand out the high silt content and the soil microporosity (75% of the total porosity) and the much lower amount of available water for plants. This high silt contents and presence of phylosilicates 2:1 (smectite and smectite with interlayered Al-OH) put in evidence the less pedological development in relation to the great majority of the soils previously described and mapped in the Amazon basin, which greatly influence their morphological, chemical, physical, hydrological and biological properties, as well as their behavior in response to the different uses and management practices. Due to peculiarities of such soils, little known in Brazil, studies are necessary for better understanding of their physical-chemical processes as well as their behavior in relation the several uses and management practices, aiming to search which procedures are best suitable for their best sustainable uses and management practices. Such procedures require a precise knowledge of soil properties and their geographical distribution in the landscape.

11. Floristic Inventory of the Benjamin Constant Study Area (AM, Brazil)

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ABSTRACT

O Inventário Florístico teve como objetivo avaliar o impacto do uso do solo para fins agrícolas sobre a biodiversidade do solo tendo-se como pressuposto ser a vegetação superficial uma indicadora do funcionamento do sistema como todo. Foi utilizado o método de estimativa florística, diversidade e riqueza de espécies e similaridade entre as áreas afins. Na coleta de dados no campo adotou-se a metodologia padrão preconizada para esses estudos. Para obter-se o máximo de informações botânicas de cada ponto, estabeleceu-se, no caso de **Floresta Primária**, **Capoeira "antiga"** (mais de 10 anos) e **Sítios**, parcelas de 400m², fazendo coincidir o seu centro geográfico com o respectivo ponto de amostragem. As parcelas foram sub divididas em 4 porções de 5 x 20 m dentro das quais quantificou-se todos indivíduos, discriminando-se as categorias de arbóreos, palmeiras, herbáceas e lianas com DAP $\geq$ 5 cm, sendo os indivíduos abaixo desse DAP levantados em sub-subparcelas de 2 X 2 m, localizadas na extremidade de cada parcela de 5 x 20 m. Para classificação da vegetação em categoria de tamanho adotou-se uma metodologia, geralmente adotada para estimar regeneração florestal, que consta do seguinte critério: **Classe I – indivíduos com altura < 50 cm; Classe II – indivíduos com alturas > 50 cm < 1,5 m; Classe III – indivíduos com altura > 1,5 m < 3,0 m; Classe IV – indivíduos com altura > 3,0 m e DAP $\leq$ 5 cm,** estando incluídos árvores, palmeiras, herbáceas e lianas. A coleta de dados em **Roças** e **Capoeira "recentes"** foram obtidas em parcelas 100 m² divididas em 4 sub-parcelas 2,5 x 10 m, mensurando-se todos os indivíduos com DAP $\geq$ 5 cm e, também, sub-subparcelas de 1x 1 m para mensurar os indivíduos abaixo de 5 cm de DAP. Nas áreas de **Pastagem** utilizou-se os mesmos critérios de tamanho dos indivíduos, mas neste caso, adotou-se parcelas de 5 x 5 m, sub-divididas em 4 porções de 1,25 x 5 m onde foram mensurados todos os indivíduos com DAP $\geq$ 5 cm e sub-subparcelas de 1x 1 m para mensurar os indivíduos abaixo de 5 cm de DAP. Simultaneamente fez- se coleta botânica dos espécimes para identificação das espécies para se estimar os parâmetros de densidade, dominância e frequencia; a diversidade e riqueza das espécies usando metodologia clássica de fitossociologia, assim como, estudos de similaridade entre parcelas afins. Até a presente data terminamos a coleta de campo e estamos realizando com o apoio do Herbário do INPA a identificação do material trazido à Manaus. As estatísticas de ocorrência de indivíduos com DAP $\geq$ 5 cm dos dados preliminares mostram que na Janela 1 - Floresta (Guanabara II) o registrado de 912 indivíduos; na Janela 2 Capoeira, Roça e Sítio (Guanabara II) 645 indivíduos; na Janela 3 Capoeira, Roça e Sítio (Nova Aliança) 232 indivíduos; na Janela 4 Capoeira, Roça e Sítio (Nova Aliança) 316 indivíduos; na Janela 5 Capoeira, Roça e Sítio (Nova Aliança) 385 indivíduos e na Janela 6 Pastagem e Capoeira 129 indivíduos. O número de parcelas amostras por componente do sistema foram: Capoeira de Estádio Avançado 12; Capoeira em Estádio Inicial 24; Floresta 16; Sítio 14; Roça 22 e Pastagem 13, totalizando 101 parcelas amostradas. Os resultados preliminares mais importantes referem-se ao descobrimento, muito provável, de duas novas *Sterculia* sp – Sterculiaceae e *Drymonia* sp – Gesneriaceae e um registro inédito de ocorrência, para o Estado do Amazonas, da espécie *Marila tormentosa* Poepp. & Endl.

12. Land-use mapping and typology in Oumé benchmark site (Centre-West Côte d'Ivoire)

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***Keywords**:Côte d'Ivoire, land-cover typology, land-use index, remote sensing, mapping.*

Abstract
The role of remote sensing in biodiversity assessment at landscape level is of paramount importance. This study was carried out in the Centre-West region of Côte d'Ivoire specifically, in the areas of semi-deciduous forest. It aims at identifying and mapping within the benchmark area, a representative range of land-use systems. The methodological approaches consisted in: (1) site selection, (2) allocation of sampling point within the grid (3) exhaustive land-use systems mapping. As results, 128 points were allocated in a mosaic of land use covering 4 km2. Ten land-use types were identified in the grid: primary forest (15.9%), secondary forest (24.1%), multi-specific planted trees (22.9%), 20 year-old (4.4%), 10 year-old (5.2%), 4 year old (9.1%) teak trees, coffee plantation (0.1%), cocoa plantation (3.6%), recurrent fallows (5.9%), old fallows (4.7%) and mixed crop fields (3,9%). Combining socio-economic and agro-ecological data allowed defining a land-use index (LUI). According to this index, land-use types were ranked from less used (primary forest: 0) to most used (mixed crop fields: 0.38).

13. Demographic and socio-economical characterisation of the Oumé benchmark area (Centre-West Côte-d'Ivoire)

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***Keywords**: Agricultural practices, biodiversity, land tenure, local knowledge.*

Abstract
The Oumé Region is an active zone of plantation economy (coffee, cocoa) and a strong migration area. These two phenomena are the major driving forces of high human activities and a decline in soil fertility and agricultural outputs. This constitutes a real threat to biological diversity. To remedy to this ecological problem, through sustainable agricultural management, requires a diagnostic survey based on site characterizations. The survey area covered 3 localities (Goulikao, Djèkoffikro, Mafia) selected according to land use patterns within a grid system. Quantitative and qualitative approaches as well as four means of data acquisition (documentation, questionnaire, group meeting, observations or site visits) were used. Three main stakeholders were identified, namely SODEFOR (State Forest Management Agency), ANADER (National Agricultural Extension Agency) and farmers of various social and ethnic backgrounds. On a demographic level, the population is characterized by a high density (58 inhabitants/km^2, against 48 at national level) and composed of natives, allochtones and foreigners. Farming systems started with food crops which are gradually substituted to perennial crops using extensive techniques. Finally, on social point of view, there was strong implication of community-based organizations (tribes, lineages), as well as modern structures (cooperatives, associations, mutual, political parties) in management. Local knowledge of natural resources showed that indigenous people devised their own soil nomenclature and soil organism identification criteria.

14. Morphological and physical characteristics of soils along a gradient of land use intensity in Centre-West Côte-d'Ivoire

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***Keywords**: Côte d'Ivoire, land-use types, Oxisols, soil compaction, soil morphology, water infiltration.*

Abstract

Soil morphological, chemical and physical characteristics are of paramount importance in root development and plant growth. In order to assess the relationships between soils parameters and land use type and intensification, soil profiles were dug across the landscape varying from forest to cropland in a Centre-western Region of Côte d'Ivoire. Some physical characteristics such as water infiltration, soil compaction were also measured in the field. The morphological characterisations revealed that the soils of the area are oxisols of homogeneous distribution across the landscape, with however, differences observed along a transect starting from hilltop to bottom slopes. Generally, soils from the hilltops are of redder hue (2.5 YR to 5YR). Surface organic layer is thin (20-30 cm) and friable (resistance to penetration varies between 200-1000 Kpa) and well mineralised. Irons concretions and layering (ironpan) are also frequent within 60-100 cm depth, leading to an important compaction with depth (1000-5000 KPa). This decreases to bottom slopes, where soils are usually sandy, with a layer of quartz gravels (10-20 cm thick) at 60 to 100 cm depths. Rates of water infiltration within profiles follow the same trend. The values were 7-1 cm mn^{-1}, higher in hilltops 5-0.5 cm mn^{-1}, 3-0.2 cm mn^{-1} for hilltops, mi-slopes, and bottom slopes, respectively. For all soil parameters measured, it was found that the physiographic position of the profile in the landscape was more important than land use types in determining soil distribution and morphological, as well as the physical characteristics.

15. Impact of Human Activities on Floral Diversity in the Oumé Region (Centre-West Côte d'Ivoire)

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***Keywords** : Agro-ecological unit, Côte d'Ivoire, diversity index, flora.*

Abstract

The study site is located in Oumé (Centre-West Côte d'Ivoire) with a mosaic of land uses materialised by a grid system of 4 km^2. This work aimed at assessing the impact of different uses on flora diversity. All plants species encountered at each sampling point were identified and recorded. The identifications revealed a flora rich of 471 plant species distributed over 312 genera and 72 families. Among these species, one endemic of Côte d'Ivoire and 15 rare and threatened of extinction have been determined. The 3 species most frequently observed over the entire site are Chromolaena odorata (86.72 %) Motandra guineensis (65.42 %) and Paquertina nigrescens. (65.42 %). The Rubiaceae and the Poaceae, with 6 and 5%, respectively of the species identified, are the most important families in terms of number. The analysis showed that the generic diversity index of the first 30 families was low and ranged from 1 to 3. The Shannon specific diversity index varied from 5.91 to 7.28. Areas with low human activities (forests) had high diversity indexes values (7.10 and 7.28). They were followed by mixed food crops (6.64), cocoa plantations (6.31), multi specific planted trees (6.28), 4 year-old (6.13) and 10 year-old (5.91) teak trees. Leguminous trees, which presence seems to be related to human

activities were more diversified in cocoa plantations and mixed food crops (3.4) than in primary forests (2.25).

16. Land Use and Biophysical Characterization of Below-Ground Biodiversity (BGBD) Benchmark Site in Kenya

E.M. MUYA, NANCY KARANJA, H.ROIMEN, AND B.MUTOSOTSO

***Key words**: Land use intensity gradient; soil structure, acidity and fertility*

Abstract

Characterization of the BGBD benchmark sites with respect to land use and biophysical soil characteristics was done to assess land use intensification levels in the site and provide the opportunities for testing the methods adopted by the project scientists. Examination of land use intensity gradients across globally significant ecosystems in relation to physical and chemical attributes of land formed an important component of site characterization.

Desktop study of the existing information and analysis of satellite imagery provided the basis of selecting the site and general description of benchmark area. Three windows (W1, W2, and W3) were selected in the Embu site, while only two were selected in Taita Taveta. Soil inventory at the scale of 1:50,000 was used to collect biophysical data for detailed description of the individual windows in each benchmark site. The individual windows were described in terms of geology, geomorphology, soils and land degradation status.

Parameterisation of land use intensity was achieved by quantifying and indexing the four attributes, namely: inputs and their frequency of application, cultivation intensity and cropping density. The results show that the benchmark sites selected constituted an area with land use intensification gradients. Each of the seven land use systems identified had a different level of land use intensity, measured by intensity index. The highest level was found in maize-based system with 0.38, followed by tea with 0.25. Coffee and Napier grass had 0.16 and 0.12 respectively. The main factor contributing to relatively high level of intensity in maize-based system was frequency of cultivation. The lowest level was found in planted and indigenous forests, whose intensity index was found to be 0.00.

Both benchmark sites are characterized by typical tropical highlands with altitudes ranging from 1500 to 4500 m above the sea level and a cool to warm tropical moist climate. The soils are developed from Tertiary basic igneous and basement system rocks and are well drained, deep, dusky red to dark reddish brown, friable clay loam to clay, in places with humic topsoils. Fertility gradient exists across different ecosystems: soil pH increases from 3.2 in indigenous forest to 4.8 in cultivated area, while organic carbon and nitrogen show a reverse trend, being 5.9 and 0.94 respectively in indigenous forest and 2.5 and 1.3 in cultivated area. Soil acidity decreases while phosphorous increases from the indigenous forest to cultivated area. These results show that different levels of nutrients exist in different ecosystems and can, therefore, be used to explain the composition, abundance and diversity of soil organisms in different ecosystems as well as their spatial distribution over the landscapes.

Session 3: Result of the Inventory of Macrofauna

Content

1. Diversity and Abundance of Termites in Sumberjaya, Lampung - Indonesia

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***Key words**: termite, diversity, feeding groups, land use*

Abstract

Inventory of termites has been conducted during the rainy season of 2004 in a range of land use intensification gradient in Sumberjaya area, Lampung, Indonesia. Termites were collected using 20 m x 2 m semi quantitative transect from 35 sample points distributed in 7 land use types of increasing intensity, i.e. undisturbed forest, disturbed forest, shrub, polyculture coffee, monoculture coffee, food crop, and vegetable crop. Results showed firstly that overall we found 37 species of termites from 15 genera, 4 subfamilies, 2 families and with 2 functional groups (soil feeders and wood feeders). Second, termite diversity and abundance decreases along increasing gradient of land use intensification. Third, the collapsing effect of land use intensity was more apparent on soil feeding termites than on the wood feeding termites.

2. Diversity and Abundance of Ants in Sumberjaya, Lampung - Indonesia

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***Keywords**: ant, diversity, land use*

Abstracts

Inventory of ants has been conducted during the rainy season of 2004 in a range of land use intensification gradient in Sumberjaya area, Lampung, Indonesia. Ants were collected using Winkler method from 35 sample points across 7 land use types of increasing intensity, i.e. undisturbed forest, disturbed forest, shrub, polyculture coffee, monoculture coffee, food crop, and vegetable crop. Results showed first that overall we found 53 genera of ants. Second, ant diversity and overall abundance decrease along increasing gradient of land use intensification. The decrease in diversity might be accounted for by that of the predatory ants while the decrease in abundant could not be accounted for by either predatory or forager ant components.

3. Diversity and Abundance of Beetles in Sumberjaya, Lampung - Indonesia

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***Keywords**: beetle, diversity, feeding groups, land use*

Abstracts

Inventory of beetles has been conducted during the rainy season of 2004 in a range of land use intensification gradient in Sumberjaya area, Lampung, Indonesia. Beetles were collected using Winkler method from 35 sample points across 7 land use types of increasing intensity, i.e. undisturbed forest, disturbed forest, shrub, polyculture coffee, monoculture coffee, food crop, and vegetable crop. Results showed that, first, overall we found 59 families and subfamilies of beetles with 4 feeding groups (herbivores, predators, scavengers, and fungivores). Second, beetle diversity and abundance decreases along

increasing gradient of land use intensification. Third, the collapsing effect of land use intensity was more apparent on the predatory, scavenging, and fungus eating beetles than on the herbivorous beetles.

4. Diversity, Abundance and Biomass of Earthworm in a Range of Land Use Types in Sumberjaya, Lampung, Sumatra, Indonesia

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Abstract

Land conversion from forest into agricultural system would cause significant changes in the soil (and its litter) conditions which in turn could affect the life and distribution of soil biota therein, especially for "an ecosystem engineer" such as earthworm. The objective of the research was to record the origin, functional groups, abundance, diversity and biomass of earthworm as affected by land use change in Sumberjaya, Lampung, Indonesia. Earthworm was sampled from the monolith (25 x 25 x 30 cm deep) at seven different land uses, *i.e.* undisturbed forest, disturbed forest, shaded coffee (polyculture), sun coffee (monoculture), food crops, vegetable crops, and Imperata grassland or shrubs. All land uses are located in mountainous region with average temperature 23°C and rainfall 2000 mm.year^{-1}. The field sampling was conducted during the rainy season from January to February 2004 and species identification was conducted thereafter in the laboratory of the University of Lampung. A total of 10 earthworm species found in the study site although its diversity was not significantly different among land uses (ranged from 0 – 5 species). Native species remained in the forests, whereas exotic species thrived well in agricultural lands. Most epigeic and endogeic species were distributed in 0-10 cm . Land use change from forest into horticulture crops increase the abundance and earthworm biomass. High number of small size endogeic earthworm was also found in agricultural lands.

5. BioDiversity of Macrofauna in Santa Marta los Tuxtlas , Veracruz México.

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Introduction

In the context of the project Conservation and Sustainable Management of Below Ground Biodiversity (UNEP/GEF, TSBF-CIAT) an inventory of soil macrofauna was carried out in the Biosphere Reserve Los Tuxtlas around the slopes of Santa Marta Volcano in Veracruz Mexico, in order to observe: 1- the diversity of the macrofauna in the region, 2- the impact of land use on the macrofauna and 3- the taxonomic units that could be used as an indicator of the soil quality and the intensity of land management. The sampling was carried out in November – December 2003

Study area

The study area is localized around the volcano Santa Marta in los Tuxtlas, Veracruz, México Located near the Gulf of Mexico between 18°10' y 18°45' of north latitude and 94°42' y 95°27' of west longitude. Three sites were selected: 1) "Adolfo López Mateos" (LM), 2) "Venustiano Carranza"(VC) and 3) "San Fernando"(SF) Community" .

Macrofauna sampling methodology

In each point one monolith (25x25cm x30 cm Anderson and Ingram, 1993) was carefully manually revised. All fauna > 2mm was collected. The earthworms were preserved in formaldehyde at 4% and the other organisms, first in a "Pampel" solution (acohol/acetic acid /formol) and then in alcohol at 70%. The Sampling was: done in 3 sites or windows, 4 land uses (forest, agroforestry or secondary forest, pasture and maize), and in each land uses 8 points were sampled (96 points in total). Although each sampling points were 150m separated (trying to keep the grid design), not all were true replicas. Thus we had only 49 true replicas

The *Response variables studied were:* Taxa richness, density and biomass of the respective taxa. The *Explanatory variables* were: discontinuous: site and land use and continuous: soil bulk density, humidity, electric conductivity and pH

Data analysis

We did Analysis of Variance (ANOVAS) of taxa diversity (Richness, Shannon- Wiener (H'), Evenness (J) and Simpson (D)). As it is not possible to consider replica with 0 individual, the rule taken was that replica with 0 individuals will have a D=0.

ANOVAS of most abundant taxa with land use type (4 levels) and site (3 levels) as treatments were done. For the macrofauna from the litter the taxa selected were with density > 4 ind m^{-2} and biomass> 0.3 g m^{-2} from the soil were with density > 4 ind m^{-2} and biomass> 0.3 g m^{-2} . To observe patterns a Detrended Correspondence Analysis (DCA) of community data (only taxa biomass in litter presented) Some

Correlations of most abundant taxa and soil physicochemical parameters were performed. These analysis were with the programs: Statistica, Canoco and Mini Tab

Most relevant results

There is no difference between the land uses. The sites are not different in community composition (DCA) but in richness ($F(2, 43) = 4.52$ $P= 0.02$) and diversity (H´, $F(2, 43) = 5.41$ $P= 0.008$; D, $F(2, 43) = 3.69$ $P= 0.03$) they are. The VC site is less diverse in macrofauna than the other 2 sites. Richness is correlated with environmental parameters (bulk density and humidity). The DCA showed a slight grouping of the macrofuana community from the litter. Diplopoda had presented significant differences ($F(2, 43) = 5.78$ $P= 0.006$) between the sites and significant correlations with soil bulk density.

	Litter				Soil			
	Density (ind./m2)		Biomass (g/m2)		Density (ind./m2)		Biomass (g/m2)	
Taxon	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Aranea	12.02	21.96	0 123	0.595	4 74	9.27	0.17	0.88
Blattoidea	3.31	7.9	0 026	0.068	0 98	3.63	0.01	0 04
Chilopoda	1.64	4.29	0.006	0.025	20 44	35.04	0 42	2.21
Coleop. Larv.	1 39	5.19	0 027	0 135	28.4	51.55	3 66	14.23
Coleoptera	15.91	46.09	0.049	0 129	11 15	18 47	0 46	2.27
Staphylinidae	4 53	12.74	0.006	0.016	3 86	8.25	0.02	0 05
Dermaptera	0 44	2.39	0.002	0.014	3.28	17.96	0.02	0 08
Diplopoda	1 7	5.65	0.016	0 061	15.99	27 1	0.48	1 83
Diptera	0.76	2.83	0.002	0 008	3 11	6.29	0.01	0.04
Diptera larv	1.73	5.66	0.021	0.12	5.37	16.47	0.06	0 17
Formicidae	20 63	49.04	0.026	0 054	18.59	48.39	0.33	2.22
Gasteropoda	0.61	1 92	0 038	0.251	1.74	7 12	0.03	0 13
Hemiptera	0.83	2.9	0.002	0.008	0.96	3.77	<0.001	0.02
Hymenoptera	0.37	2.3	<0.001	0 002	0 49	2.32	0.01	0.06
Isopoda	4.53	14.39	0.018	0.062	3.22	12.27	0.63	4.44
Isoptera	0.27	1.36	0.004	0.025	40.54	124.77	0.35	2.22
Lepidop. Larv	2.33	6.1	0 194	0.819	1 76	5.04	0.29	1 68
Lepidoptera	0.33	1.6	<0.001	0.003	<0.001	<0.001	<0.001	<0.001
Mantoidea	0.2	1.37	<0.001	<0.001	—	—	—	—
Oligochaeta	—	—	—	—	292.94	341.27	48 9	76.2
Opiliones	1 5	5.26	0.02	0.078	<0.001	<0 0010	<0.0010	<0.0010
Orthoptera	0.86	4.89	0.013	0.069	0.65	2 16	0.21	1.14
Pseudoscporpionidae	<0 001	<0.001	<0.001	<0.001	0.35	1 58	<0.001	<0.001
Thysanoptera	0 09	0.65	<0.001	0.001	<0.001	<0 001	<0.001	<0.001

Table 2. Mean and standard deviation of macrofauna density and biomass per taxon per real replica (n=49). All sites and land uses included

Conclusions

As no differences were observed in the macrofauna community among the four land uses, a better discrimination of it could be done if: the identification of the groups is made at lower taxonomic levels and supplementary sampling is done with more real replicas per land use.

As the Diplopoda had shown significant differences with soil parameters it can be considered as a sensitive group or indicator of the land use and soil quality. The DCA that showed the formation of groups need further exploration to know which the variables that promote this grouping are.

Acknowledgements

We acknowledge the financial support provided by UNEP/GEF, TSBF, CIAT and INECOL. We also recognized the field assistance of "Adolfo López Mateos", "Venustiano Carranza" and "San Fernando"farmers's and the participation of biologist students of the Universidad Veracruzana. Similar, we are very grateful to Antonio Gonzalez and all personnel of the Reserve of Los Tuxtlas, Veracruz. Oligochaeta data were provided by L. Coria & C. Fragoso (in prep) and L. Camarena & C. Fragoso (in prep), Soil data by Silke Kram et al (in prep).

6. Diversity of Termites (insecta: isoptera) in Los Tuxtlas Biosphere Reserve: Influence of Land Use

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Abstract

The diversity of termites in "Los Tuxtlas" Biosfere Reserve was studied. The reserve is located in southeastern Mexico (18°10'–18°45' N and 94°42'–95°27' W) and extends over an area of nearly 90 by 50 km. Formerly covered by tropical rain forests, this region of volcanic origin, is now a mosaic of forests and agro-ecosystems. The study was carried out in the southern part of the Reserve, in three localities (windows) that differed by the amount of forested area: 1) López Mateos (LM): 75%, 2) San Fernando (SF): 50% and 3) Venustiano Carranza (VC): 25%. Four different Land Use Systems (LUS) were sampled in each one of the three windows: 1) Tropical rain forests (F), 2) Agroforestry plantations (A), 3) Pastures (P) and 4) Annual crops (C). In each of these windows, 5 sampling points per LUS were set, making a total of 60 sampling points. In each sampling point one 20x2 m transect was delimited and, in turn, subdivided in four 5x2 m sections. In each one of the 5x2 m sections, 2 persons searched for termites in soil, logs, base of trees, vegetation at 2 m height, twigs, etc. A series of termite specimens of each "nest" was separately collected and preserved in alcohol 80%. The approximate time for search and capture of termites in each section was 15 min (1 hour for each 20x2 transect). The total number of 20x5 m transects and 5x2 m sections sampled were 60 and 240, respectively. The efficiency of our sampling protocol was evaluated comparing observed species accumulation curves with the curves predicted by the estimators Bootstrap and Jacknife 1. This comparison was performed by region, by window and by LUS.

Nine species of termites were found in the reserve: *Amitermes aff. emersoni* Light, *Anoplotermes fumosus* (Hagen), *Calcaritermes* sp., *Coptotermes crassus* Snyder, *Heterotermes aureus* (Snyder), *Nasutitermes corniger* (Motschulsky), *Nasutitermes mexicanus* Light, *Nasutitermes* sp. and *Reticulitermes* sp. The three species that we have unable to identified probably are not yet described (Constantino 2004, pers. comm.). The most common species were: *Coptotermes crassus* was present in 30% of sampling points, *Heterotermes aureus* in 26.6% and *Nasutitermes corniger* in 25%. Considering the relative frequency of species, the most abundant species were the former three, although the pattern was inverted: *Nasutitermes corniger* was present in 30% of the 147 samples obtained, *Heterotermes aureus* in 23% and *Coptotermes crassus* in 16.3% of samples. The less common species were *Calcaritermes* sp. and *Nasutitermes* sp. each one with

only a single record: 1/60 (1.6%); both species were found in the most forested window (LM 75% of forested area).

Total richness was higher in the more forested window (LM 75% 7 species), although the window with the lowest forested area (VC 25%) had the highest average species richness (1.75 species by site). This pattern may be due to the presence of generalist species like *Coptotermes crassus* and *Heterotermes aureus*, that ocurred in many sites of VC, the most disturbed window.

As expected forests had the higher total richness values (7 spp.); average values however, did not differ from agro-forestry and crop systems. Not surprisingly pastures presented the lowest average (0.8 sp.) and total (3 spp.) species richness values.

Diversity values (Simpson and Shannon indexes) did not show significant differences between the three windows and between the four LUS. Pastures however, were the less diverse systems, mainly due to the values found in LM and SF localities.

At a regional scale species accumulation curves indicated that termite species richness was well sampled, but still lacked 1-2 species. To the level of window the curves indicated that in the more forested area (LM 75%) 1-2 species were still lacking, whereas in the less forested area (VC 25%) the inventory was almost complete (we expect to find only one more species); finally in the medium forested area (SF 50%) we found the total species richness (as predicted by both indexes). Regarding the four LUS, the species accumulation curves indicated that: a) in both agro-forestry systems and pastures the total species richness was recorded; b) in annual crops only one species is still lacking; c) in the case of forests, the sampling effort performed was not enough, because at least 1-3 species are still missing.

Acknowledgements
We acknowledge Dr. Reginaldo Constantino (Universidade de Brasilia, Brazil) for his valuable help in the identification of the species. P. de Biól. Julio Bello (Universidad Veracruzana) kindly helped during the field work.

7. Coleoptera in Santa Marta Los Tuxtlas, Veracruz, Mexico

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Introduction
Beetles are key stones of soil communities because of their: 1)taxonomic richness, 2)abundance of individuals, 3)frequent large biomass, 4)ecological diversity and 5)different ecological role during their life cycle (larvae – adults)

Material and Methods
The Coleoptera identified here come from the sampling of the Macrofauna carried out in November- December 2003 in the 3 sites or windows of the slopes of Santa Marta Volcano and in four land uses (rain forests, corn fields, agro-forestry lands and grasslands) with 8 sampling points in each land use. The methodology for the sampling was the manual collection of organisms (>2mm) of a monolith (25x25x30cm, Anderson and Ingram 1993) per sampling point. The monolith was divided in 4 strata: the litter, 0-10, 10-20 and 20-30 cm.

Results
From the 384 sub-samples (96 samples x 4 strata), 286 (75%) of them had Coleoptera. The total amount of specimens in these 286 sub-samples is 874. These coleopteran are distributed in 545 collection records, of which 284 records are of adults and 251 of larvae. These Coleoptera belong to 37 different families and present 164 morpho-species. The families that have more morpho–species or species richness are:

Staphylinidae - 26 morphs – mainly adults
Carabidae – 18 morphs – mainly adults
Chrysomelidae 14 morphs mainly adults
Melolonthidae – 12 morphs – only larvae
Scarabaeidae 11 morphs – mainly adults
Elateridae – 9 morphs – mainly larvae

The families that are more abundant are:

Melolonthidae – 184 larvae
Ptilodactylidae – 150 larvae & adults
Staphylinidae – 131 adults & larvae
Scarabaeidae – 66 adults & larvae
Chrysomelidae – 64 larvae & adults
Carabidae – 61 adults & larvae
Elateridae – 54 larvae & adults

From these 37 species, 19 are typically from the soil (their larvae develop in the soil) and 18 are found occasionally in the soil.

Discussion

The density of Coleoptera is very disperse because only in 11 samples of the 286 we found more than 10 individuals; from these 11 samples 10 come from the forest and grassland of San Fernando. The Melolonthidae larvae by their density and biomass are the most important rhizophagous and saprovorous coleoptera in San Fernando. Thus San Fernando is the site with more Coleoptera and morpho-species. In contrast Venustiano Carranza site is the site with less Coleoptera and less morpho- species.

The Staphylinidae can be a key group because of their density and diversity and their role in the food web as predators and detritivorous. The carabidae also is an important group because they predate other soil arthropods. The Ptilodactylidae are abundant but their habit is not well known although they might have an important role as detritivorous

8. Diversity and relative abundance of ants, beetles, termites and earthworms in a lowland tropical forest, Uganda; the influence of land use.

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Keywords: *Land use, disturbance, earthworms, termites, ants, beetles, monolith, Winkler bags, pitfall.*

Abstract

The influence of land use on the species richness and relative abundance of ants, beetles, termites and earthworms was assessed using four sampling methods (monolith, Winkler bags, pitfall traps, transects) in nine land use types (LUT) in and around a lowland tropical forest in Uganda. The LUT represented a disturbance gradient from the most disturbed crop monocultures to the least disturbed intact primary forest. A minimum of seven points per LUT were sampled (range 7-16).The appropriateness of the sampling methods for the taxa was also evaluated. A total of 11 55 ant genera, 17 beetle genera, 14 termite genera, and earthworm species were recovered. For all the taxa, species diversity and mean relative abundance (and biomass for earthworms) declined with increasing disturbance from the forest systems through to the crop monocultures (tea and sugarcane). These trends may be related to soil physico-chemical parameters and to land management practices in the benchmark areas. The monolith was inadequate in capturing all the genera and benefited from the use of pitfalls (beetles, ants) and soil scrapes in the transect

(termites, earthworms). Winkler bags were also important in capturing myrmicine ants that had been inadequately sampled by monoliths and pitfalls.

Macrofauna are important components of ecosystems as they are key determinants of ecosystem processes. Their numbers and diversity have been known to vary in response to landscape changes brought about by natural and/or anthropogenic events. They can thus serve as indicators of ecological disturbances. The literature on macrofauna (ants, beetles, earthworms and termites) in Uganda is highly skewed towards termite ecology and to a lesser extent, their taxonomy, with very little known about the other groups. It is therefore expected that the below ground biodiversity project will generate plenty of baseline information on the taxonomy and ecological roles of these macrofauna groups.

The objectives of this study were to make an inventory of the ants, beetles, earthworms and termites in the benchmark area (Mabira forest), to evaluate the proposed sampling scheme and methods with a view to suggesting refinements that could be used in developing standardized methods for macrofauna sampling and, assess the intensity of land use (disturbance) on the diversity and relative abundance of these groups.

A total of 96 points (in a 4 X 4 16-point grid) were sampled for ants, beetles, earthworms and termites during the rain season. The points represented nine land use types (LUT) in and around a lowland tropical forest in Uganda. The LUT represented a disturbance gradient from the most disturbed crop monocultures to the least disturbed intact primary forest. A minimum of seven points per LUT were sampled (range 7-16). A combination of a 25 X 25 X 30 cm deep monolith (all groups), unbaited pitfall traps (ants, beetles), soil scrapes in a 2 X 20m transect (termites) and Winkler bags (ants, beetles) was used to sample the groups. Specimens were washed of debris, preserved in 70% ethanol (ants, beetles, termites) or formo-acetic alcohol (earthworms) and later identified to genus (ants, beetles, termites) or species level (earthworms).

Over 55 ant genera, 14 termite genera, 17 beetle genera and 11 earthworm species were recovered in the entire benchmark area. Two morphotypes of earthworms are suspected new species and await confirmation. The land use types showed significant differences ($P<0.05$) in the diversity and biomass of earthworms. Generally, less disturbed LUTs had a higher diversity and biomass of earthworms than the more intensively used LUTs. The exception was multiple cropping which had a high diversity and biomass comparable to the forest systems. The land management practices in this LUTs will be assessed to determine whether they explain these observations.

Forest systems had a higher number of ant, beetle and termite genera than the crop monocultures but LUTs of intermediate disturbance had an equal or higher number of genera and a greater relative abundance than the forest systems. Closer scrutiny of these systems revealed that they had genera that occurred in both the forest and crop monoculture systems.

The number of beetle genera that were recovered in each of the LUTs was lower (varied between 2-5) than for the ants but the genera that occurred in LUTs of intermediate to high level of disturbance were different from those that were recovered in the forest systems. These trends may be related to the ecological roles/guilds of the genera involved. Termite diversity decreased sharply from the forest systems to the crop monocultures; the latter LUTs were dominated by genera (*Macrotermes, Pseudoacanthotermes*) that are litter/wood feeders that sometimes acquire a pest status.

The monolith recovered significantly less genera than either the pitfall, Winkler bags or the transects. Thus macrofauna diversity studies are benefited by the additional use of Winkler bags (ants), pitfalls (ants, beetles) and transect (earthworms, termites).

In conclusion, the findings show that land use intensity decreases macrofauna diversity and may also change the composition of taxa in the land use.

9. The Abundance and Diversity of Earthworms and Termites in the BGBD Benchmark Sites.

G. H. N. Nyamasyo, M. Kibberenge and Fred Ayuke.

ABSTRACT

Sampling of earthworms and termites was carried out at Embu and Taita Hills benchmark sites in Kenya using four methods: the monolith, pitfall, quadrate and transect. All the land use types which included agricultural plantations and natural forests were covered in the 60 and 40 points sampled in Embu and Taita Hills respectively. A total of 3800 invertebrate specimens collected from Embu comprised of 11 orders, 25 families, and 11 genera while those from Taita Hills comprised 16 orders, 31 families, and 37 genera. Of these macrofauna the earthworms and the termites accounted for 5.1% and 28.1% respectively from the Embu site. Out of the 8 land use types identified in Embu there were more earthworms in coffee and natural forest while napier and fallow recorded more termites. There were significant differences in earthworms and termites composition between the different land uses.

10. Diversity of Earthworm along a Gradient of Agricultural Landscape in Centre-West Region of Côte d'Ivoire

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***Keywords**: Abundance, Côte d'Ivoire, diversity, earthworm, land-use index*

Abstract

This study was carried out in Central-West Region of Ivory Coast and aimed at assessing the impact of land-use systems on earthworm abundance and diversity. Eight land-use types were identified as a consequence of human activities in this area: primary forest, secondary forest, multi-specific planted trees, 10 years teak, 4 years teak, cocoa plantation, recurrent fallow and mixed crop fields. An index of land utilization was used to rank systems along a gradient of land-use type. The main hypothesis of our study is that agricultural practices have detrimental effect on earthworm abundance and diversity. To test our hypothesis, earthworms were hand-sorted across five points per land-use type chosen randomly within a grid of 4 km^2. At each point, three monoliths (50x50x20 cm) were dug out every 5 m along a transect. Biodiversity was measured by the species richness, Shannon's diversity index and non parametric diversity estimators (Sobs, ACE). From primary forest to mixed crop field, our results showed a significant increase in earthworm density (H=60.98; p=0.00001) and biomass (H=47.41; p=0.00001). In addition, there was a significant relationship between land-use index of (LUI), earthworm density (r=0.76, N=8, p=0.029) and biomass (r=0.81, N=8, p=0.015° across the landscape. There was a significant variation of the average species richness (H=47.41, p=0.00001) and the Shannon index (F=3.42, p=0.0024) per land-use type. However no significant relationship was found between observed species estimated by accumulation curves and of land-use index along the gradient of agricultural landscapes. These results are in contradiction with most of available information in literature.

11. Diversity of termites and ants along a gradient of land-use in a tropical forest margins (Oumé, Côte d'Ivoire)

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Keywords: Ants; biodiversity; Côte d'Ivoire; land-use types, termites

Abstract
Tropical forests that contain more than half species at global level are subject to increasing human pressure. In Africa in particular, land-use and agricultural intensification are major threats to natural forest diversity. The aim of this study was to evaluate within different land use types, the diversity of termites and ants, two major components of tropical soil macrofauna. The study site was located in Centre West Côte d'Ivoire. Soil macrofauna were collected in each land-use type, using four combined standardized transects (50m x 2m) for termites and 50 x 10 m for ants leaf litter (Winkler). In addition, 3 monoliths (30 x 30 cm) were excavated along the ants transect to sample soil dwelling ants. After taxonomical identification at the genera level, Principal Component Analysis and dendrograms were used to separate the different morphospecies. Species richness estimator (ACE and ICE), diversity indexes (Shannon and Simpson) and species accumulation curves were used to estimate termites and ants diversities. Comparisons between land use types were realized by means of Similarity indexes (Jacquard and Sorensen), ANOVA and statistical correlation tests. Results showed a shift in termites and ants community taxonomy and function. Primary forest and fallows showed the highest diversity (40 and 38 species), as compared to secondary and planted forests (20, 23 and 22 species) for ants. For termites, secondary forests and fallows exhibited higher species richness (23 and 25 species) than planted forests (16, 18 and 16 species). Between these two land use types, mixed food crops presented intermediate species richness values for both groups. Humivorous termites were found to be sensitive to habitat changes, which make them a good indicator of the status of forest conservation. Conversely, fungus growing and xylophageous termites seem to be less sensitive to changes in land uses. Overall, the study underlined the importance of the combined standardized transect, as a method for rapid assessment and monitoring of ants and termite diversities.

12. COMPOSITION OF SOIL MACRO-INVERTEBRATES COMMUNITIES IN DIFFERENT LAND USE SYSTEMS IN ALTO SOLIMÕES, BRAZIL

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Abstract
Soil macro-invertebrates communities of are very diverse and abundant; however they can have their activity differentiated in the different ecosystems. These organisms, inhabitants of the soil upper layers, through their role in the decomposition of soil organic matter and in the liberation of nutrients, they are high importance for the conditions of growth of planted species and the development and function of agricultural systems. The present work aimed to identify to the communities composition of soil macro-invertebrates in different land use systems managed by communities in the Alto Solimões region, State of Amazonas, Brazil.

The soil macro-invertebrates were collected according to the methodology recommended by the Tropical Soil Biology and Fertility Programme (TSBF) in six grids with different sample size for each land use system: forest, young secondary forest, old secondary forest, agroforestry, crops and pasture. The preliminary results show that diversity (numbers of taxa) was higher in young secondary forest, agroforestry and forest. Total density of soil macro-invertebrates was significantly higher in young secondary forest (2932 ind.m^{-2}) and agroforestry (2175 ind.m^{-2}) than in the other land use systems. Ants and termites were the predominant groups in all the systems, however only ants were

significantly different among the systems, being more numerous in young secondary forest (1026 ind.m^{-2}) and agroforestry (1116 ind.m^{-2}).

Two species of Oligochaeta were identified: *Rinodrilus tico* and *Pontoscolex corethrurus*, the latter being much predominant and its density and biomass were higher in the pasture. The results showed that young secondary forest and agroforestry were the land use systems which presented the highest soil macro-invertebrates densities, with the predominance of ants and termites, which would maintenance their participation in the decomposition of soil organic matter in those systems.

13. Community structure of ants in different land use systems in the upper Solimões River – AM

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Abstract

O projeto tem como objetivos fazer verificar o efeito de diferentes intensidades de uso da terra sobre a diversidade de formigas na Amazônia Ocidental e propor técnicas de manejo agroflorestal que minimizem perdas de biodiversidade local. A coleta dos formicídeos foi feita de acordo com o protocolo internacional pelo método do extrator de Winkler, em cinco diferentes sistemas de uso da terra: Floresta (n=21), Capoeira (n=40), Sítio (n=10), Roça (n=16) e Pastagem (n=13), constituindo um gradiente de intensidade de uso de solo. O desenho experimental constituiu-se de grids ou janelas, divididos em quatro transectos, com quatro pontos cada um, distantes 100m um do outro, totalizando 16 pontos de coleta. Em cada ponto foram coletadas três amostras de 1m^2 da serapilheira, distantes 10m uma da outra. O material coletado foi transferido para os extratores e mantidos por 72h para a extração das formigas e outros artrópodes. Todas as formigas das amostras do extrator de Winkler foram triadas no Laboratório de Mirmecologia da UFLA e identificadas em nível de espécie com o auxílio da chave dicotômica de Bolton (1994) e coleção de referência do Laboratório de Mirmecologia do Centro de Pesquisas do Cacau-CEPEC, sob a orientação do Dr. Jacques Delabie. Foram coletados 2195 espécimes, distribuídos em nove subfamílias, 29 tribos, 58 gêneros e 239 espécies de formigas. A subfamília com mais representantes foi a Myrmicinae com 131 espécies. Foram coletadas algumas espécies raras como *Cheliomyrmex megalonyx, Gnamptogenys* sp1 gp *minuta, Typhlomyrmex* sp1, *Talaridris mandibularis, Acanthognatus stipulosus, Stegomyrmex manni, Adelomyrmex sp1, sp2 e sp3, Amblyopone orizabana, Amblyopone sp. n.,* além de cinco espécies novas, pertencentes aos gêneros *Octostruma* (Dietz, 2004), *Pyramica* (Bolton,2000), *Megalomyrmex* (Brandão, 1990, 2003) e *Amblyopone* (Lacau & Delabie, 2002). Foram registradas 151 espécies na capoeira, 142 na floresta, 104 na roça, 96 no sítio e 65 na pastagem, de um total estimado de 264, 202, 190, 171 e 122, respectivamente. O índice de diversidade (Shannon-Wiener) indicou uma alta diversidade nas áreas de capoeira, floresta, sítio e roça com valores muitos próximos, diferindo do ambiente de pastagem, onde a diversidade de espécies foi menor, apresentando uma estrutura de comunidade mais simplificada, comprovando que quanto maior a complexidade estrutural do ambiente, maior a diversidade e riqueza de espécies, devido o aumento da quantidade de recurso e substrato de nidificação. A partir da curva de riqueza acumulada verifica-se que os ambientes mais pobres em número de espécies são pasto e roça. Conclui-se que os sistemas de uso da terra com vegetação mais complexa são mais diversos em espécies de formigas, portanto devem ser recomendados.

14. Scarabaeidae (Insecta: Coleoptera) community structure in different soil use systems in the Amazônia.

SILVA, P. H.; Louzada, J. N.C. & Schiffler, G.

Abstract

The role of biodiversity in tropical agricultural systems is little studied and its knowledge is fundamental to the identification of different soil systems as sustainable agro-ecosystems. Seeking this knowledge, this study will depart from arguments that set the Scarabaeidae as good indicators of biodiversity since they answer negatively to human alterations in the environment. The study aims at evaluating the impact that different systems of soil use in the Amazon region have on the beetles of the Scarabaeidae family. The hypothesis is that the diversity of Scarabaeidae decreases with the reduction of the structural complexity of the vegetation. The work was carried out in three research areas located at Alto Solimões, in the Amazon state, Brazil.

The Scarabaeidae gathering was made with traps of *pitfall* type, baited with human faeces. We collected of 3.048 individuals, distributed in 51 species, 15 genera and 6 tribes. It was evaluated the abundance, richness, similarity and composition of the species. Whereas, the highest estimate of species richness was obtained for the forest (46, 83 ± 0, 74); the lowest was obtained for Pasture (1 ± 0). As for the similarity of the species, Forest and Old Secondary Forest rated 73%, while the Agroforestry and Young Secondary Forestry exhibited 90%.

Regarding the composition of the species, the soil use systems holding a more similar pattern among them were Forest and Old Secondary Forest. The Agro-forestry, Young Secondary Forest and Crop showed similar richness of Scarabaeidae species, however inferior to the Forest, which confirms the association between the vegetation's structure and the community of Scarabaeidae. From the soil use systems studied in the Amazon region, the Pasture shows the most negative impact in the community of Scarabaeidae. In conclusion, it can be said that soil use systems with greater vegetation complexity favour the increase of animal diversity.

15. Diversity of Termites in diverse Land Use Systems in Benjamin Constant Municipality, AM, Brazil

Agno Accioly and Reginaldo Constantino

Abstract

Termites were sampled in 100 transects following the standard protocol. We collected 1300 samples and recorded 76 species. The diversity was higher in primary forest, followed by fallow, cropland, agroforestry and pasture. The observed diversity in agroforestry sites was lower than expected, but few agroforestry sites were sampled. Assemblage similarity measured by Morisita's index indicates that fallow, crops and agroforestry are very close, while pasture is very different from all other systems. Rank-abundance distribution shows that relative abundance in forest assemblages is more balanced, while pasture assemblages are dominated by a few very abundant species. The other systems show intermediate patterns. The main conclusions from the preliminary analysis are: 1) the traditional crop – fallow system has a termite diversity which is very close to that of the primary forest; 2) pastures are the worst system; 3) the mean number of species per transect does not show much difference between land uses, indicating that most of the difference in total diversity is due to species turnover (beta diversity).

16. Inventory of macrofauna in different land use systems in the Nilgiri and Nanda Devi Biosphere Reserve in India

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Introduction

About 60 grid intersection points in each of the four windows, two windows in the Niligiri Biosphere Reserve and two in Nanda Devi Biosphere Reserve, were sampled for macrofauna. In case of the Nanda Devi Biosphere, only one monolith over a given intersection point was sampled for hand-sorting of all macrofauna. In window 1 of Nilgiri Biosphere Reserve three monoliths, one at the centre point of the 'triangle' and the other two at a distance of 10 m from this point towards apex and base of the triangle, were sampled.

The surface castings at each of the point were collected and air dried to get the amount of castings released by existing population of earthworms in Window 1 of Nilgiri Biosphere Reserve. In addition to monoliths, transects of size 40 × 5 m was marked in each land use system and was divided into 4 sections, each of 10 × 5 (Kerala area)/ 10 x 2 (Karnataka area) m dimension for termites. Termites foraging on litter, wooden logs, stem/bark of plants, and animal excreta were checked in these semi-quantitative transact (2×10 m) of the triangle in each sampling point of the ecosystem. Ants, beetles, and other macro fauna were also collected from the pitfall traps with 1% detergent (13 cm dia.) placed at three angles of triangle in each sampling points.

Niligiri Biosphere Reserve

Eartworms

In Nilgiri biosphere reserve, earthworm abundance did not differ in unmanaged (social forestry) plantations sampled in the two windows, while the population level was slightly higher at window 1 for natural forests. In managed plantations, the earthworm population level in window 2 was nearly 50% lower than what was observed, in coffee and cardamom plantations of window 1. Species of families of Moniligastridae, Megascolecidae, Ocnerodrilliadae, Octochaetidae were quite common. The list of species is incomplete as the identification work could not be completed in window 2. The species richness was found to be higher (11 species) in coffee plantations compared to natural forests (8 representative species of earthworms). *Drawida somavarapatana* Rao, was the most abundant and was of common occurrence in all collection spots. *Curgia narayani* Mich. was the species of low incidence in natural forest and *Megascolex feliciseta* Steph. was the species of low incidence in coffee plantation. *Pontoscolex corethrurus* exhibited wide range of distribution and this was the species that could be collected more frequently even during the pre-monsoon collection, showing its ability to withstand adverse conditions prevailed during that season.

Ants

In NBR window 1, ants were distributed in all the ecosystems during February 2004.Natural forest harboured ants belonging to five subfamilies with 15 species of ants. More numbers of ants species (16) were collected in the cardamom plantation, but the ants belonging to the Subfamily Dorylinae was absent. Coffee provided shelter for 12 species of ants belongs to 2 Subfamilies. Ants belonging to the Subfamily Dolichoderinae were absent in coffee, acacia and grassland. Dorylin ants were represented only in natural forest and Acacia ecosystem.

In NBR window 2, degraded forest and rubber plantations showed maximum abundance of ants, significantly different from other land use systems. The other three land use systems *viz.*, PA (annual cropping area), teak plantations and semi-evergreen forest were similar in terms of ant abundance, but the values were much lower compared to that of degraded forest and rubber plantation

Beetles

Adult beetles were collected in the pitfall traps. The majority of these belonged to Carabid and Scarabid groups. The relative abundance of beetles varied from 0.23 (Acacia) to 5.06 % (grassland) during February collections. Beetles were not represented in Acacia during November 2004.The relative abundance varied from 3.23 (paddy) to 5.71 % (natural forest) during November 2004. Apart from this, smaller beetles and grubs were also observed in the soil samples of all the ecosystems.

Nanda Devi Biosphere Reserve

Earthworms

In low elevation zone, earthworms showed the highest density during monsoon season in agricultural land use, during post-monsoon season in oak forests and similar abundance during pre- and post-monsoon in pine forests. In higher elevation zone, earthworms were found to be absent in alpine pasture and *Cedrus* forests, but present in all types of agricultural land uses. Homegarden and medicinal plant cultivation area showed the highest density during post monsoon season, potato field during pre-monsoon and a similar density during pre and post monsoon period in pea cultivation area. Homegarden was the only land use where earthworms occurred in all seasons.

In both elevation zones, earthworms were more numerous in agricultural land use compared to forests and pastures. Within agricultural land use, earthworm density was significantly higher in home gardens as compared to other agro-ecosystem types. At lower elevations, where both rainfed and irrigated agriculture are practiced, earthworm population rainfed system was higher than that in the irrigated one.

In all, eight species of earthworms were captured. Two species were sampled from higher altitudes compared to six species from lower altitudes. *Dendrodrilus rubidus* occurred only in high altitude agroecosystems, *Aporrectodea caliginosa* in all high elevation agroecosystem types and home garden system in lower altitudes and, the remaining six species viz., *Lannogaster pusillus, Metaphire houlleti, Ocnerodrilus occidentalis, Metaphire anomala, Amynthas corticis* and *Drawida nepalensis* only in agroeceosystms and forest ecosystems at lower elevations. Comparing species richness by season, it is observed that only one species occurred during pre-monsoon season compared to six species during monsoon and post monsoon season. Species occurrence seemed to be related to season

Hymenoptera

In almost all land use types, hymenoptera population was lowest during post-monsoon season, while the differences between pre-monsoon and monsoon seasons were not significant. This group was sampled from all land use types in all seasons, except during post-monsoon in *Cedrus* forest, medicinal plant cultivation and potato cultivation at higher elevations. At lower elevations, oak forests showed the lowest hymenoptera population during pre-monsoon and monsoon months, while there were no significant differences in population size in different forests and agro-ecosystems during post monsoon

Isoptera (termites)

Isoptera individuals were altogether absent in higher elevation zone. In lower elevation zone, significantly higher density was noted during monsoon season in all land uses except homegardens where numerical abundance observed during monsoon and summer did not vary significantly. Isoptera population density was significantly higher in rainfed agriculture compared to irrigated agriculture and in pine forests compared to oak forests in all the three months. Homegardens had a significantly higher density during summer compared to all other land use/cover types.

Coleoptera

The highest coleopteran population was observed during monsoon season in all land uses at lower elevations except irrigated agriculture where this group showed highest abundance during summer season followed by monsoon, with nc significant difference between the two seasons. In higher elevations, the population density during rainy season was significantly higher than that in post-monsoon and/or summer season in cedrus forests and medicinal plant cultivation area.

Session 4. The inventory of nematodes and mesofauna

Content

1. Collembola Communities of Seven Land Uses Types in Sumberjaya, West Lampung, Indonesia

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Keywords: *Collembola, land uses changes, agroecosystem, West Lampung, Indonesia*

Abstract

The impact of land uses changes to Collembolan communities was studied. The study is conducted in Bodong Jaya, Sumberjaya, West Lampung from 10 -29 February 2004. The objectives of the study are to measure the effect of different land use type on the Collembola diversity and abundance. Identification had been done based on the difference of morphological characters (morphospecies). The data is analyzed by cluster analysis to indicate their similarity and clustering of Collembolan communities. The result show that the diversity and abundance of Collembola are not paralleled with the increasing of land use intensity. Crop base intensive had the richest species number followed by tree base intensive; both land uses are an open area abundant in deep soil collembola. There are some special collembolan species: *Folsomia* sp. 1 and *Pseudosinella* sp. 2 are present in all land uses. *Isotoma cf. trispinata* is absent in undisturbed forest and could be an indicator of disturbed ecosystem due to agricultural practices. *Pseudosinella* sp. 1 is absent in undisturbed forest and disturbed forest and present in agricultural ecosystem (polyculture coffee, monoculture, food crops, vegetable crops) and shrub. The comparison of species composition revealed two clusters. The first consisted of food crops and vegetable crops, whereas the second cluster consisted of other land uses. Surface dwelling Collembola is dominated by Entomobryidae (43.25%), Hypogastruridae (39.18%), and Sminthurididae (8.52%).

2. Nematode Diversity in Sumberjaya Lampung Benchmark Indonesia

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Keywords: *Nematode, abundance, diversity, land use type, Sumberjaya, Indonesia*

Abstract

Land use change by deforestation to agricultural system through cultivation and chemical inputs affects soil organisms including nematodes. The study of the effect of land use change on the diversity of taxonomic and functional groups of soil nematodes was conducted in Sumberjaya Window, Lampung Benchmark, Indonesia from January to December 2004. Soil cores were collected from January to March 2004 (mid rainy season). The soil cores were taken from 14 sampling points on each of seven land uses including undisturbed forest (forest less intensive = FLI), disturbed forest (forest intensive = FI), shrub and grassland (Shrub), polyculture coffee (tree base less intensive = TBLI), monoculture coffee (tree base intensive = TBI), food crops (crop base less intensive = CBLI), and vegetable (crop base intensive = CBI). As much as 300 cc soil was extracted by flotation and centrifugation technique using sucrose solution method. The collected nematodes were mounted on slides with glycerin. One hundred randomly cached of

nematodes from each sample were identified to genus level. The data was analyzed to obtain the abundance, number of genera, and abundance of trophic groups. The results showed that the total of 113 nematode genera in seven orders was collected from all land use type in Sumberjaya, Lampung. There was no significant relationship between increasing land use intensity and the population of soil nematodes. Number of genera tends to decrease as land use intensity increase. The bacteriovore nematodes were mostly found in forests (undisturbed forest and disturbed forest); whereas plant feeder nematodes were mostly found in more intensive land uses shrub, food crops and vegetable crops.

3. Diversity of nematodes under different land use intensities inside the biosphere reserve "los Tuxtlas", Veracruz, Mexico.

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Abstract

The present study was performed inside the Biosphere Reserve "Los Tuxtlas", located in Veracruz State, Mexico, for determining the effect of different land use intensities on nematodes diversity. Inside the Reserve, three localities were chosen as replications and from each one of them, several representative areas of four land uses were selected: Jungle, as a non-disturbed system, Agroforesty, as a system with low perturbation, both Pasture field and Maize field, as mono-cropping systems with intensive land use.

Eight sampling points were settled in each locality and from each land use, following a grid pattern with a distance between points of at least 200 m for eliminating any correlation effect. In each sampling point eight sub-samples (100 g) were taken, to a depth about 10-30 cm, following concentric circles scheme around marked point. On the concentric circles, four subsamples on circumference of internal circle (3 m of diameter) were taken and other eight on external circle (6 m of diameter). All subsamples from each sampling point were mixed in plastic bags which were carried to laboratory. Thirty two soil samples were taken per locality and ninety six in total inside the Reserve. Samples were taken during the dry season.

Nematodes were extracted from 300 cm^3 of soil of each compound sample by sieving and then by centrifugation-using the sugar flotation method (Jenkins, 1964; Hooper, 1986). Once extracted, nematodes were relaxed and killed by heat at 60°C and then fixed with formalin 4% (Stone, 1974). Once fixed all samples, nematodes suspensions were adjusted to 10 ml and three aliquots of 1 ml were taken for counting all nematodes from each sample. Total number of nematodes was estimated by the mean of three counts X 10. Counting was done considering mophological groups detected in the samples (Morphogenera). Samples were processed by Mass Dehydration (Seinhorst, 1959; Franco-Navarro, 1999) and the nematodes were mounted in permanent slides using wax ring as sealer (Hooper, 1986).

Data were transformed into some ecological parameters (Abundance, Morphogenera's Richness, Simpson´s Diversity Index and Shannon´s Diversity Index), specimens were grouped in trophic groups and the level of Soil Disturbance in an indirect way was quantified.

Of the total of samples have been identified approximately 165 different morphogenera, grouped in five trophic groups: bacterial feeders (*Rhabditis, Plectus, Aphanolaimus, Acrobeles*, etc.), fungal feeders (*Aphelenchus, Tylenchus*, etc.), omnivores (*Dorylaimus, Dorylaimoides, Aporcelaimus*, etc.), predators (*Miconchus, Mononchus, Prionchulus*, etc.) and plant parasitic (*Meloidogyne, Discocriconemella, Hemicycliophora, Helicotylenchus*, etc.).

Although in abundance of nematodes there weren't significant differences, the number of nematodes was a little higher in Jungle (937 individuals/300 cm^3 of soil) than Pasture field and 43.2% higher than in Maize field. In Morphogenera's Richness there were significant differences (Tukey, α=0.01); the highest Richness was observed in Jungle (23 morphogenera), followed by Agroforesty (19 morphogenera) and Pasture field with the same number that Maize field (16 morphogenera). The highest Simpson's Diversity Index was obtained from Jungle (0.85), being significantly different (Tukey, α=0.01) to the index from Pasture field (0.74), but not in comparison with Agroforesty and Maize field (0.82 and 0.81, respectively). For Shannon's Diversity Index, in Jungle the highest value was observed (2.41), significantly higher (Tukey, α=0.01) to Pasture field (1.92) and Maize field (2.12), but not in comparison with Agroforesty (2.20).

About Soil Disturbance level, the following indirect parameters for evaluating it were considered: total number of individuals of Dorylaimida and Mononchida Orders, both very sensitive groups against any disturbance level, and total number of Bacterial feeders, a colonizer group which usually is numerous in environments with high disturbance grade. The highest quantity of individuals of Dorylaimida Order in 300 cm^3 of soil was found in Jungle (53) and Pasture field (54); respect to the number of individuals of Mononchida Order in 300 cm^3 of soil, in Jungle thirteen individuals were found, a number twice higher than in Agroforesty and Maize field, and six times higher than Pasture field. In the case of Bacterial feeders, the higher quantity was present in Pasture field (100 in 300 cm^3 of soil), 30% more than in Jungle and approximately twice that in Agroforesty and Maize field.

More indexes related with Soil Disturbance (Maturity Index, Trophic Diversity Index, Plant Parasitic Index, etc.) will be estimated. In a preliminary way it's observed that the highest Morphogenera's Richness and Diversity of nematodes correspond to the Jungle, as well as the highest quantities of sensitive individuals to disturbance; these results indicate that disturbance level in soil of this system is such that allows the presence of these groups of nematodes (low disturbance). In opposite of Jungle, in Pasture field the Morphogenera's Richness was lowest as well as respective Diversity Indexes, in spite of a high abundance of individuals; moreover, Mononchids group (sensitive to disturbance) showed very low values while Bacterial feeders (colonizers of disturbed environments) were more abundant in Pasture field than in the rest of land uses.

4. Sampling of the mesofauna of Sierra de Santa Marta in Los Tuxtlas Veracruz, México

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Abstract

The sampling of Mesofauna was performed in February and March 2005. The sampling was carried out in 3 sites or windows (Lopez Mateos, San Fernando and Venustiano Carranza) on the slopes of The Santa Marta Volcano in the biosphere reserve of Los Tuxtlas. In each sites 4 land uses (forest, agroforestry, pasture and Maize) were sampled. At least 5 samples were taken in each land use; per site we have 24 samples. The sampling points were decided following the previous ant sampling in December 2003 and the recommendations that came from the pilot analysis of this anterior sampling

The sampling methodology and extraction of soil mesofauna used is the one recommended by Franklin and Morais for the BGBD project, although few modifications to this protocol were made. For collecting the sub-samples of litter and soil we used a cylinder of a 5 cm diameter and a 5 cm height. Per point we took 8 sub-samples (that we mixed; per point we required 3 funnels, 1 for the litter and the2 others for the soil, per

window we settled 72 funnels. The Berlese-Tullgren funnel was home made with kitchen sieves (20cm diam., 10 cm depth), an additional sieve of 1.5 mm mesh size and black plastic material. During 5 days we left the Berlese and samples with electric light, the mesofauna was collected in formol at 5%. All the samples before their separation into Collembola and Acari mainly are being transferred to alcohol at 70%. For the identification up to now we have the possibility to collaborate with two persons Jose Antonio Gomez (Collembola, INECOL) and Jose Palacios (Oribatids, UNAM).

5. Effects of land use change on the diversity and abundance of soil nematodes in the Mabira forest ecosystem of Uganda

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Abstract

Different land use types may favour different nematode feeding habits, thus affecting nematode diversity, while land use intensity may affect abundance of the nematodes. However, no such information is available for any of the Ugandan ecosystems. This study was, therefore, conducted to establish the diversity and the effect of land use intensity on the abundance of the soil nematode community in the Mabira Forest ecosystem in Uganda.

Soil samples were collected from the 16 points each of the six windows established in Mabira Forest ecosystem for the study of belowground biodiversity. Soil samples were taken from 4 points along the circumference of an inner circle of 3 m radius and 8 from an outer circle of a radius of 6 m, at a depth of 0 - 20 cm and transported immediately to the laboratory where they were kept in a refrigerator at 7°C. Sampling was done during second rainy seasons in 2003 and 2004.

Nematode extraction from samples was done by centrifugation method prescribed by the conservation and sustainable management of belowground biodiversity project. The supernatant containing nematodes was decanted and washed through 250 and 38μm aperture sieves. The nematodes were washed off the 38μm aperture sieve and the suspension collected in two 50 ml centrifuge tubes, which were spun at 3500 rpm for 5 minutes. The supernatant was discarded and replaced with sucrose solution (456g/l) and spun at 1000 rpm for 2 minutes. The supernatant was washed through the 38μm aperture sieve from which the nematodes were collected.

Nematodes identification and counting was done from 5 ml aliquots using dissecting and compound stereomicroscopes. Nematode counts were standardised to 1 kg of soil. The encountered nematode genera were categorized by feeding types (Yeates *et al*, 1993) and mean nematode diversity and abundance calculated for each land use type as defined as follows by the country team namely; strict nature reserve forest, low impact production forest, secondary forest, grassland under grazing, fallow area grazed, agro-forestry, multiple cropping, tea plantation and sugarcane plantation.

Nematodes belonging to 20 genera were identified in a study to establish the diversity and the effect of land use intensity on the abundance of the soil nematode community in the Mabira Forest ecosystem in Uganda. The majority of nematodes encountered are plant feeders belonging to the genera *Meloidogyne*, *Rotylenchulus Pratylenchus*, *Helicotylenchus*, *Hoplolaimus*, *Rotylenchus*, *Scutellonema*, *Hemicriconemoides*, *Hemicycliophora*, *Xiphinema*, *Longidorus*, and *Trophurus*. Others include *Aglenchus* and *Aphelenchus*, which are epidermal or root hair feeders, and *Acrobeloides*, *Alaimus*, *Cephalobus*, *Rhabditis* which are bacterial feeders. *Meloidogyne, Rotylenchulus*, *Helicotylenchus* and *Scutellonema* were the most frequently encountered nematode genera. In addition, two nematode families were recorded in the case where the specimens

were identified only up to family level. There were also some nematodes, which were not identified at all but were recorded as unidentified non-plant parasitic nematodes.

The highest nematode diversity was observed in the strict nature reserve forest (least disturbed land use type) while the highest nematode abundance was recorded in sugarcane plantation (most disturbed land use type). However, the trends were not very clear in the rest of the land uses. The most commonly encountered nematode genera were *Meloidogyne, Rotylenchulus*, *Helicotylenchus* and *Scutellonema*, all of which are plant feeders. The reason for this observation could be because crop husbandry has been associated with this forest ecosystem and plant feeders tend to multiply rapidly under continued cropping. In addition, these nematode genera have a wide range of plant hosts. However, these observations are not conclusive. More data are being analysed which could reveal more trends.

6 Inventory of mesofauna in different land use systems in the Nilgiri and Nanda Devi Biosphere Reserve in India

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Introduction

Among the soil organisms, the mesofauna comprises nematodes and microarthropods like acarina, collembola, protura and diplura. The classical role of the soil faunal elements is in the breakdown of dead plants and animals, which are returned to the soil, thereby improving the quality of the soil. Numerous studies have shown that agricultural management decreases soil biodiversity and alters the structure of soil biological communities compared to natural forests or grassland ecosystems. These changes can be attributed to at least three factors commonly associated with agricultural intensification. It is widely accepted that conversion of native forest or grassland systems to arable cropping results in a decline in soil biodiversity. By its very nature, agricultural intensification seeks to lower plant diversity in exchange for maximizing the primary productivity of selected crops. Nematodes are found at places with sufficient moisture and among them are found both parasitic and free living forms. The free-living nematodes are mostly microbivores whereas the parasitic nematodes attack a wide variety of plants and animals. The saprobic nematodes play a key role in nutrient cycling in soil and aquatic environments. There is also evidence that nematodes may play a role in determining the bacterial population in some soils.

Collembolans are generally found in damp places. Majority is saprophytic, but some are phytophagous. A few are recorded as pests of plants. They are known to exist in high altitudes and it is recorded that collembolans flourish well at 6000 m high in the Western Himalayas where no other insects are noticed (Nayar *et al.*, 1976). Collembolans influence the process of decomposition in soil. They are the most abundant group in the soil (Ananthakrisnan, 1996). Mites are predaceous, parasitic or scavengers. They are present in almost every habitat suitable for animal life. They have got significant role in the food chain.

The present study was taken up to generate the baseline inventory of belowground biodiversity in relation to different land use systems and the data on mesofauna are provided. The major groups included are nematodes, Collembolans, Mites, Protura, and Diplura. In the absence of species level identification, diversity indices were not worked out.

Sampling and extraction of mesofauna

Soil samples were brought to laboratory for the extraction of mesofaunal elements. Tullgren Funnel extraction method was followed for the extraction. The funnels containing soil was illuminated with an electric bulb of power 60W.

The nematodes extraction was carried out by sieving and sugar centrifugation procedure suggested by TSBF. But in Kerala part of Nilgiri Biosphere Reserve (NBR window 2) nematode extraction was carried out by water migration technique. In the water extraction method, known quantity of soil was placed over a filter paper placed above the wire gauze. This was kept above a petri plate with water in such a way that, the bottom of the gauze with soil just touches the water column. This was kept undisturbed overnight, and the nematodes, which migrate from soil to water, were collected. The number of nematodes per volume of soil was obtained.

Results

Nilgiri Biosphere Reserve – Karnataka part (NBR window 1)

The higher abundance of litter mesofauna was noticed in Paddy ecosystem during February 2004. This was followed by Cardamom plantation. The invertebrate's population in Paddy litter was significantly higher compared to the population in Coffee, Grassland, Natural forest and *Acacia* litter (Table 1).

During November 2004, the Grassland showed the maximum relative abundance of mesofauna and the minimum was recorded in *Acacia* (Table 3). The probable reason could be that the invertebrates in general do not prefer the litter of *Acacia*.

Table 1. Relative abundance of litter invertebrates in different ecosystems (Feb. 04)

Type	Acacia	Cardamom	Coffee	Grassland	Paddy	N. Forest
Acari	51.62	43.68	28.38	52.00	85.86	53.84
Insects	45.15	49.14	57.33	42.00	13.94	32.06
Non-insects	3.23	7.18	14.29	6.00	0.20	14.10

Table 2. Relative abundance of litter invertebrates in different ecosystems (Nov. 04)

Type	Acacia	Cardamom	Coffee	Grassland	Paddy	N. Forest
Acari	67.57	79.69	66.98	80.82	81.76	75.28
Insects	30.63	18.66	31.52	17.62	16.87	22.31
Non-insects	1.80	1.65	1.50	1.56	1.37	2.41

The soil mesofaunal abundance was maximum in Cardamom plantation and minimum in Grassland during February 2004. The former land use system harboured significant higher invertebrates compared to Grassland, Paddy and Acacia land use. Natural forest soil provided significantly good habitat for soil invertebrates compared to Acacia and Grassland. The Grassland also registered highest relative abundance of soil mesofauna during November 2004. The lowest relative abundance of mesofauna was noticed in the Cardamom and Paddy.

The presence of nematodes was noticed only in three land use systems *viz*., Natural forest (86.66 /200 g), Cardamom plantation (41.53 /200 g) and Paddy (32.50/ 200g) during February 2004. Absence of nematodes in other land use systems may be due to less moisture content in the soil during the observation period. The soil samples were also analysed for nematodes during November 2004. However, nematodes were not present in these samples. This may be due to long preservation of soil samples (25-30 days) in the refrigerated conditions before extraction of nematodes.

Nilgiri Biosphere Reserve – Kerala part (NBR window 2)

The abundance of the mesofaunal elements, except nematodes is represented in the table below. Diplura showed highest numerical abundance in Mixed garden (OG) whereas they were totally absent in the Degraded forests (DF) and were very meagre in Moist Deciduous Forest (MDF) and Coconut mixed with other tree crops (CM). Other land use systems showed moderate number of Diplura. Rubber plantations (RU) showed the highest number of Protura and were totally absent in Cashew (CA) and Coconut mixed with other tree crops (CM).

Table 3. Abundance of different mesofaunal elements (Number/m^2)

Sl. No.	Land use type	Diplura	Protura	Collembola	Mites
1	AM	3869	1179	1365	11588
2	AR	2731	1214	4856	8094
3	AV	3642	1571	303	10015
4	CA	2731	0	1305	2597
5	CM	122	0	122	5918
6	CO	2731	455	455	455
7	DF	0	910	455	5952
8	HG	2913	910	546	7648
9	OG	8194	182	274	7466
10	PA	2731	1360	0	4007
11	RU	2731	4097	1821	5488
12	TE	1214	1214	607	4249
13	TE (KFD)	2731	455	0	3742
14	MDF	303	910	303	6069
15	SEF	1715	980	245	1470

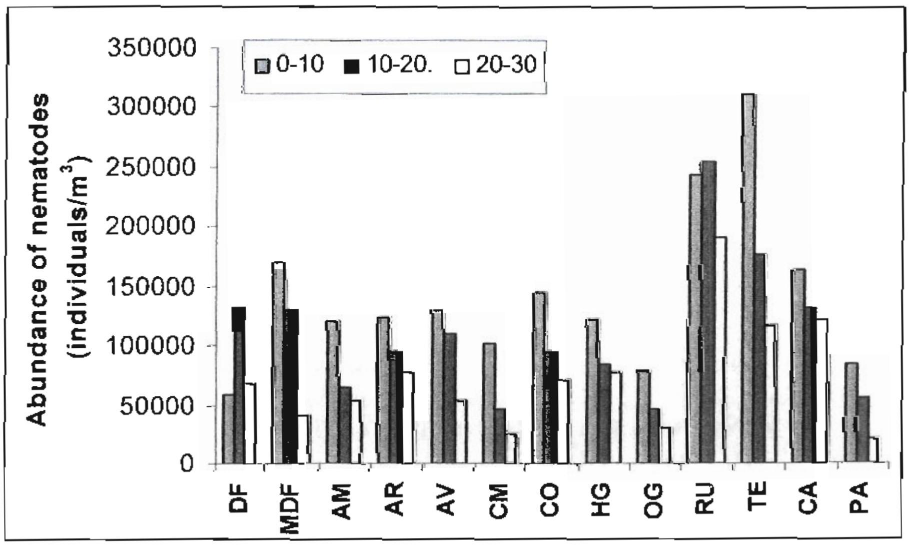

Figure 1. Numerical abundance of nematodes in soil at various depths in NBR window 2

Collembolans were totally absent in Annual Cropping System (PA) and Monoculture Forest Teak plantations (TE) but showed maximum abundance in Arecanut plantations. All other land use systems showed moderate abundance of Collembolans. Mites were the most abundant group among the mesofauna and were present in all land use systems. It showed highest number in Arecanut (AR) and lowest in Coconut plantations (CO). All other land use systems showed more or less the same trend with regard to the abundance of Mites.

The nematode abundance in different layers of soil was found significantly different from each other. In most of the land use systems, the first layer of soil (0-10 cm) was found to have the highest number of nematodes. Variation in the moisture content of different soil layers must be contributing to the difference in nematode abundance in the different soil layers (Figure 1).

3.3. Nanda Devi Biosphere Reserve

Relative proportion of different microarthropod groups in litter component of different land uses indicate that mites constituted the most dominant group of microarthropods associated with litter on all sites. Collembola was the second most dominant group in rainfed and irrigated agro-ecosystem land use and diplura, the third most dominant group in these land uses. In Oak forest and pine forest diplura was the second most abundant group followed by collembola. Pine forest microarthropod group was represented exclusively by mites. Oak forest lacked collembolan and diplura. Rainfed and irrigated agriculture land lacked microscopic ants and diplura.

With respect to total population (soil + litter), mites were the most dominant group in all sites but the degree of dominance varied. They contributed 97% of total individuals in pine forest followed by 79% in oak forest, 75% in rainfed agriculture, 65% in homegarden and 54% in irrigated agriculture land use. Total population of all microarthropods varied from 560 individuals m-2 in pine forest land use to 1231 Individuals m-2 in Homegarden. Differences between sites were more marked in population size of individual groups as compared to the total population considering all groups together.

The abundance of collembola was more in Rainfed agriculture and Irrigated agricultures (>170 individualsm-2) compared to Oak forest and Pine forest (total population <10 individuals m-2). Litter population was much smaller than the soil population size (Figure 2)

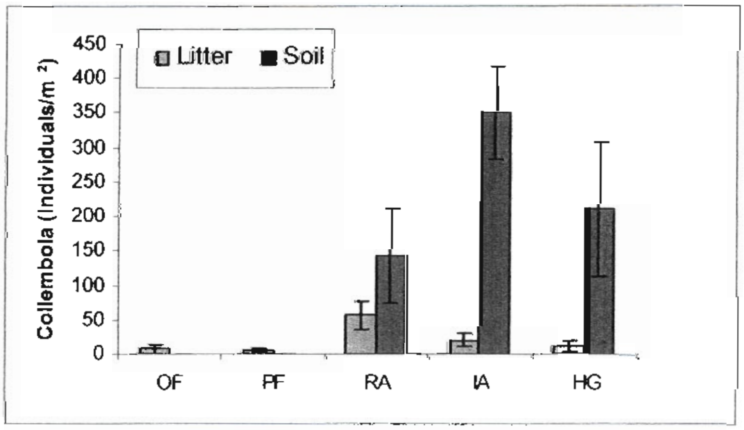

***Figure** 2. Absolute abundance of collembola in different land uses during post monsoon period (October) at lower elevation in Himalaya.*

The abundance of protura was higher in Oak forest, Rainfed agriculture and Irrigated agriculture compared to the Pine forest. Relative proportion of population in soil and litter varied across sites. Pine forest showed absence of protura in soil and they were also absent in Oak forest litter.

Diplura was found only in litter in all land uses except Homegardens (HG). Rainfed agriculture and Oak forest showed population abundance compared to Irrigated agriculture and Pine forest land use systems (Figure 3).

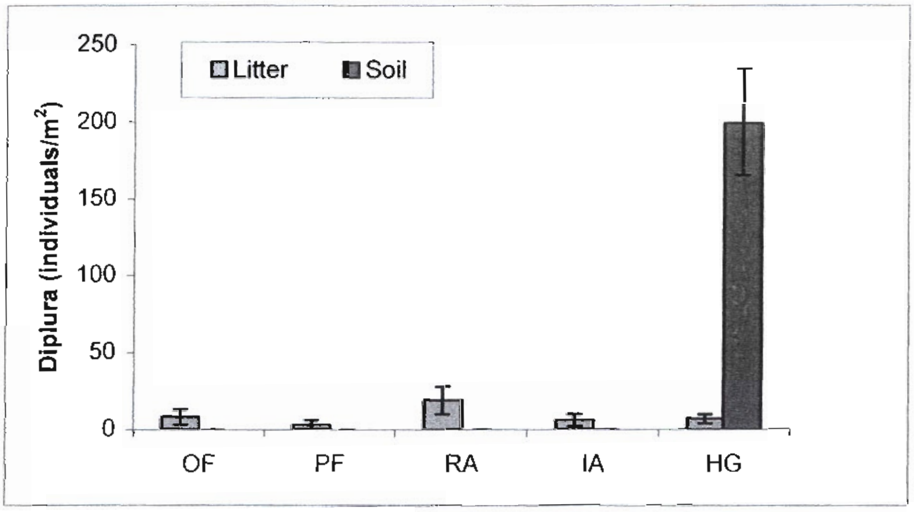

Figure 3. Absolute abundance of Diplura in different land uses during post monsoon period (October) at lower elevation in Himalaya

Mites showed maximum number in all the land use systems and were present both in litter and in soil. Rainfed agricultural land showed higher population compared to other land use systems. The population of mites was more in soil (>80%).

Nematode abundance in 0-10 cm soil layer was significantly higher than that in 10-20 cm layer in all land use systems, but the rate of decline differed between species. The steepest decline was observed in Homegardens. The trend in abundance in 0-10 cm layer was Irrigated agriculture > Rainfed agriculture > Abandoned agriculture > Homegarden > Scrubland > Pine forest > Oak forest. In case of 10-20 cm layer, the forest sties had significantly lower abundance as compared to agricultural lands and scrubland (Table 9). When the data of the two depths were pooled, it was observed that nematode density was highest in Irrigated agriculture, Rainfed agriculture and Abandoned agricultural land and the lowest in forests while Scrubland and Homegardens showed intermediate values (Figure 7).

Table 4. Nematode density (individuals/100 g soil) in different land uses during post monsoon period (October) at lower elevations in Himalaya

Land use	0-10 cm		10-20 cm	
Oak Forest (OF)	181.33	±73.07	97.33	±67.87
Pine Forest (PF)	158.66	±54.55	72.00	±10.05
Home Garden (HG)	250.66	±97.76	78.67	±2.66
Irrigated Agriculture Land (IA)	349.33	±105.68	198.67	±89.33
Rainfed Agriculture Land (RA)	306.66	±156.76	146.67	±48.77
Abandoned Agriculture Land (AA)	349.33	±7.41	162.67	±49.37
Scrub Land (SL)	248.00	±116.00	101.33	±23.69

7. [1]Response of the Nematode Communities to Different Land-Use Systems in the Upper Solimões river, Benjamin Constant (Amazonas, Brazil).

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Abstract

The objective of this work was to evaluate response of the nematode communities in soils under different management systems, in the municipality of Benjamin Constant, region of upper Solimões River, State of Amazonas, Brazil.

During March, 2004, 97 soil samples had been collected from six sampling windows under a variety of land use systems. Windows I and II were placed at the Community of Guanabara II, windows III, IV and V at the Community of Nova Aliança, and window VI, nearby the tows of Benjamin Constant. Fifteen samples were collected from forest, 41 from free fallow, 9 from home gardening (mixed perennial and annual crops), 19 from monocrops (banana, cassava or maize) and 13 from pasture grasses.

Complete methodology set applied to this work is in accordance with the CSM-BGBD protocol for nematodes. Each window was previously marked with cross lines in a grid system with quadrants of 100 x 100 m. Each soil sample was collected, in a point of crossing lines. One sample was composed with twelve soil cores, from zero to 20 cm deep (four equidistant soil cores on a circle of 3 m radius, and eight other cores on a concentric circle of 6 m radius). Nematodes were extracted from 300 cc of soil, by combined techniques of sieving and sugar solution centrifugation, fixed in 3% formalin, counted and infiltrated with glycerin. Permanent slide mounts were prepared with 100 nematodes randomly picked for identification to the genus level. The identified nematode counts from each sample were converted into ecological measures such as abundance, diversity and disturbance indices.

A total of 82 genera belonging to 36 families were identified. Preliminary analyses indicate highest nematode abundance in pasture. The highest values for genus richness were recorded for forest and home gardening systems. For the other diversity indices (Shannon, Simpson and their evenness indices) no significant differences were observed between systems. Trophic diversity was higher in forest as compared with the other systems. Fungivores were more abundant in forest, contrarily the plant parasites were less abundant in Forest and more abundant in monocrop systems. As the plant parasitic nematodes, the bacteriovores were in higher numbers in monocrops. Higher values of maturity index (MI) were from free fallow and forest plots, while for the plant parasite index (PPI), monocrops and home gardening scored highest. Principal component analyses taking in account total diversity of the nematode communities clearly placed forest and pastures systems in opposite positions, with the other land-use systems (free fallow, home gardening and monocrops) in an intermediary position.

Although, more analyses are still underway, the nematode community reflected differences between land-use systems in a way to establish a gradient according to land-use intensity, considering the forest system as a reference.

8. Density and diversity of soil meso-invertebrates in different land use systems, in Alto Solimões, Amazonas, Brazil

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Abstract

The goal of this work is to study the density and diversity of soil meso-invertebrates in different land use systems at Alto Solimões, Amazonas State, Brazil. To collect the samples we used a 3,5 x 3,5 x 10 cm metal core introduced 5 cm into the soil from the surface. We collected 3 samples composted of 4 sub-samples each in 101 collect points. The samples were carried to the laboratory where the meso-invertebrates were extracted using Berlese-Tullgren method. The sample distribution in the different land use systems was the following: forest, young secondary forest, old secondary forest, agroforestry, crop and pasture.

The largest diversity has been found in young secondary forest (25 groups) followed by crop (23 groups), pasture (20 groups), old secondary forest (18 groups), agro-forestry (15 groups) and forest (14 groups). The mean density of meso-invertebrates was significantly different between the systems, being largest in pasture (291 ind.m^{-2}), followed by agroforestry (287 ind.m^{-2}), old secondary forest (263 ind.m^{-2}), young secondary forest (239 ind.m^{-2}), crop (193 ind.m^{-2}) and forest (132 ind.m^{-2}). The higher density in pasture was caused by the presence of Acari Oribatida (181 ind.m^{-2}), which was significantly different between the systems. Immature Coleoptera and larvae were different and higher in the young secondary forest. Collembola were also different between systems, more numerous in the forest than in the others land use systems. The results showed a largest density of soil meso-invertebrates in pasture and largest dominance of Acari Oribatida which intensifies the information that mites can adapt more easily to environmental perturbation that others groups of meso-invertebrates.

9. Effects of various land uses on nematode communities in Côte d'Ivoire

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Keywords: Côte d'Ivoire, nematode diversity, land-use types.

Abstract

In the Centre-West of Côte d'Ivoire, a grid system covering different ecosystems (primary and secondary forests, tree plantations, fallows, perennial and mixed food crops) was used to assess the effect of land uses on nematode communities. One hundred and seven sampling points and 8 main land uses were identified. For each land use, 8 points were randomly selected for soil sampling. At each sample point, two concentric circles with 3 and 6 m radius respectively were drawn. Four and 8 soil cores were taken with a drill, on the inner and the outer circles respectively at 20 cm depth. Results showed that, free-living nematodes were abundant and represented more than 60 % of the community. Concerning parasitic nematodes, species diversity was greater in forest and perennial crops than in mixed food crops and fallows. This diversity was well described using Shannon and Simpson indexes which detected consistent differences ($p< 0,05$) between land uses.

Session 5. Inventory of legume nodulating bacteria and arbuscular mycorrhizal fungi.

Content

1. Leguminosae nodulating bacteria in 4 land uses from Santa Marta Los Tuxtlas, Mexico

Esperanza Martínez, Lourdes Lloret , Pablo Vinuesa, Aline Lopez y Julio Martinez

Centro de Ciencias Genómicas UNAM, Cuernavaca Morelos

Abstract

Soils from four land use systems have been analyzed to evaluate the effects of different managements on rhizobia diversity. Around 1,200 rhizobial isolates have been recovered from *Macroptilum atropurpureum*, *Vigna unguiculata* and *Phaseolus vulgaris* used as plant traps and we are in the process of isolating more bacteria with these hosts from new soil samples obtained last month. Bacteria have been grouped by ERIC-PCR profiles and by sequence of 16S rRNA genes or *dnaK* genes for *Bradyrhizobium*. *Bradyrhizobium* spp. were predominant in *Macroptilum atropurpureum* and *Rhizobium* species in *Phaseolus* nodules. *Rhizobium etli* is a marker species of agricultural use in fields where the main crop is maize in association with bean or other plants. *Sinorhizobum americanum* that normally nodulates *Acacia* spp. legume trees was found in cropping areas. Bradyrhizobia from the rain forest were recovered from maize fields or pastures and this may be in relation to their long survival in soils even without their host legumes. *Bradyrhizobium yuanmingense* strains were found both as forest, deforested areas and pastures; *B. elkanii* strains were found at the four land use systems and strains of *B. betae* were found in pastures and deforested areas.

2. Land Use and Diversity of Arbuscular Mycorrhizal Fungi in Mexican Tropical Ecosystems

Varela, L.[1], D. Trejo[2], F.J. Álvarez[3], I, Barois [4], E. Amora-Lazcano[5], P. Guadarrama[3], L. Lara[2], D. Olivera[3], I. Sánchez-Gallén[3], W. Sangabriel[3], R. Zulueta[2].

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Abstract

Three field sites (windows) were studied according to disturbance gradient: López Mateos (LM) (75% of forest cover), San Fernando (SF)(50% forest cover) and Venustiano Carranza (VC) (25 % forest cover). They are located in the Reserva de la Biosfera de Los Tuxtlas, Veracruz. The use of the soil in each window includes tropical rain forest, "acahual" (secondary forest), "milpa" (policultures with maiz) and pasture. Soil samples (five replicates per land use per site; plot size ~ 114 $m^{2)}$ were taken in December 2003 and January 2004. This date correspond to the end of the rainy season in the region. In each plot sixteen core samples were taken up at 20 cm depth by using a soil core. The soil of the sixteen samples was carefully ground by hand and mixed. Each composite sample was kept in plastic bags and stored for 0 - 4 months at 4 °C temperature. Spores were separated from 100 g of soil by wet sieving and decanting (Gerdeman and Nicholson 1963). Each swirling soil suspension was poured through two mesh sieves, 700 and 45 μm. The sediment was resuspended in water and resieved. This process was done 3 times. Soil caught in the small sieve was transferred with water into 50 ml centrifuge tubes and centrifuged for 5 minutes at 1800 rpm. The supematant liquid was carefully decanted, the pellet resuspended in a sucrose solution (440 g L^{-1}) and centrifuged at 1800 rpm for 10 seconds. The supematant was sieved (45 μm) and washed thoroughly at least one minute. The solid material from the sieve was washed in a Petri dish. Spores were collected under a dissecting microscope, using ultra-fine forceps or glass micropipettes. Spores were mounted with Polyvynyl alcohol-lacto-Glycerol on slides marked with a grid. Spores were counted at a compound microscope at magnification up to 10x. Identifications were

based in current descriptions, identification manuals and International Culture Collection of arbuscular mycorrhizae fungi (AMF) (http://invam.caf.wvu.edu/Myc_Info/Taxonomy.species.html). The abundance of spores was determined for each sample and expressed as the number of spores per 100 g of dry soil. For every AMF species, land use and site, abundance relative and spore number were counted. AMF diversity was calculated using the Shannon (H') and Simpson (S) index; evenness (J) was also measured .In total 45 morphospecies could be distinguished on the basis of morphological criteria. Twenty one species were identified as Glomeraceae, 21 as Acaulosporaceae (twenty of them were in the genus *Acaulospora* and one was in the genus *Entrophospora*) and 3 species as Gigasporaceae (two in the genus *Scutellospora* and one in the genus *Gigaspora*). The abundance of spores was higher for the acahual in SF and VC (1044 y 679 spores in 100g of soil, respectively); in LM lowest values were observed (46 spores in 100g of soil). Forest sites were the next according to abundance values with 522 and 451 spores (in 100 g of soil, respectively); LM had the lowest values again .Richness had the highest values in SF, no matter land use. There were not significant differences between land uses, and there were significant differences between sites. Highest H values were observed in acahual land use for LM window, and lower were in VC pasture. This is according to Connel's disturbance hypothesis, which highest diversity values are observed in the previous steps to the end of succession.

3. The Diversity of Rhizobia under Different Land Uses System in Lampung

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***Keywords**: rhizobia, MPN, siratro, Vigna, Lampung*

Abstract

Forest conversion into agricultural land may alter soil fauna's life, i.e. the abundance and diversity of micro-organisms such as rhizobia. The aim of the study was to elucidate the occurrence and enumeration of rhizobia and identify them as affected by land use change. Rhizobia were collected from soil core sampling of seven land uses in Sumberjaya, Lampung Indonesia. The presence of rhizobia was detected with two host plant, sorghum and yard-long bean. Populations of rhizobia were estimated by the Most Probable Number method. Harvested nodules were then crushed and cultured on Congo red YMA medium. The characters observed include growth rate (time of appearance of isolated colonies = TAIC), the extent of extra cellular polysaccharide deposition, colony shape and colony colour, and texture. The result indicated that MPN of rhizobia was not significantly different among land uses, although coffee shaded (TBLI) had slightly highest MPN number (7.78 cell g^{-1} soil). Land intensification tended to increase the nodulation in both siratro and Vigna; sample from forests did not nodulate in siratro. Isolate number was no correlated with nodule number, and this indicated that rhizobia diversity was not directly related to nodule abundance. A total 121 isolates were collected from siratro and 228 from Vigna. The implementation of PCR methods, which unfortunately is still underway, is intended to further characterize the isolate and name the rhizobia down to species level.

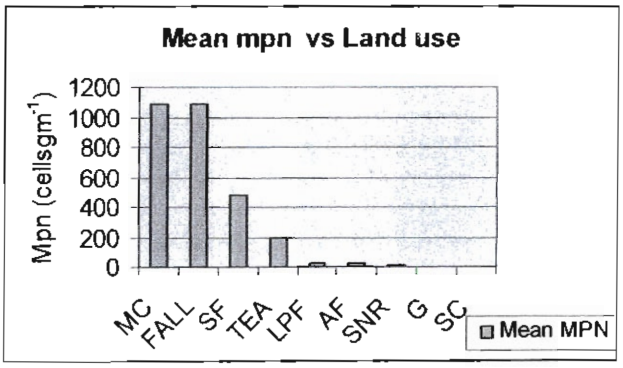
4. Characterization of *Phaseolus vulgaris, Glycine max* and *Macroptilium atra purpureum* nodulating bacteria under different land uses in Mabira Forest, Uganda

M.C. Rwakaikara-Silver, J.D. Zawedde, C.L. Kizza, G. Lamtoo and J. M.N. Okwakol

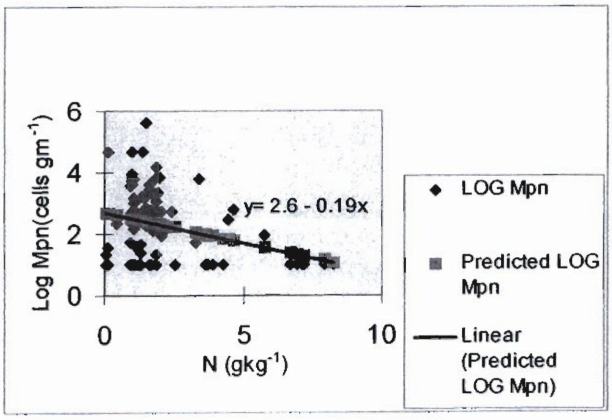
Abstract

Several factors including land use intensification impact on the populations and diversity of soil and fauna including legume nodulating bacteria (LNB). However, often the magnitude of the effect is unknown. Yet LNB significantly contribute to N additions in both natural and agro-ecosystems; particularly in tropical low in put production systems typical of Mabira Forest. Thus the thrust of this study was to determine shifts in populations and diversity of LNB in Mabira forest and adjacent derived areas following land use changes/ intensification.

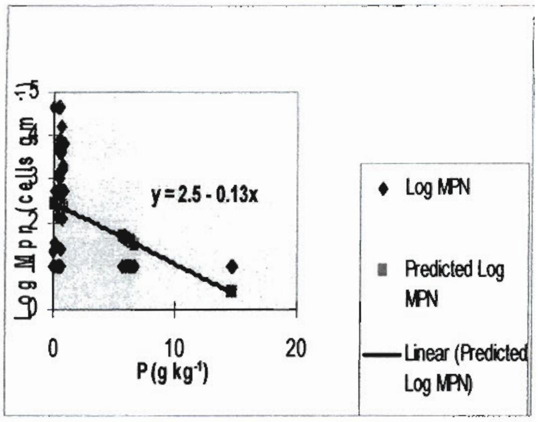
Phaseolus vulgaris beans variety K132, Glycine max soybean variety NAM2 and Macroptilium atrapurpureum, siratro as trap hosts were used to determine LNB populations and establish the level of diversity. Genera level identification was accomplished by obtaining isolates from the trap nodules based on their reaction on Yeast Extract Mannitol Agar (YEMA) plus Bromothymol Blue (BTB) indicator medium.

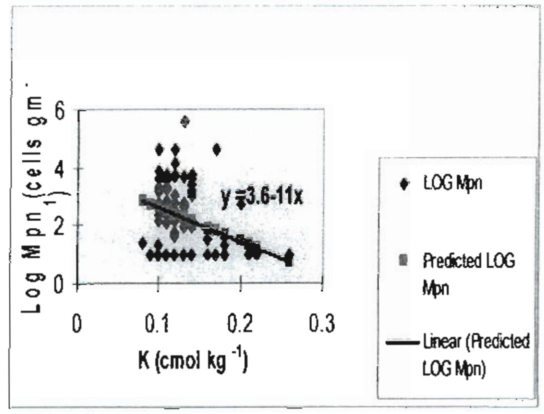


Bean nodulating bacteria populations were highest under multiple cropping, secondary forest and tea plantation in a descending order. The bacterial populations grossly declined in agro forestry, strict nature reserve and grassland systems and were completely absent under sugarcane plantation. The observed trends were partially attributed to either presence or absence of homologous or related hosts which would continually stimulate LNB multiplication.



Likely under multiple cropping, some legumes existed that enriched LNB population. Contrary, under strict nature reserve or under sugarcane monoculture, legumes were absent. Further more, populations for bean nodulating bacteria were significantly ($P = 0.001$) but negatively correlated to N, P, and K (r = -0.73, -0.49, -97) respectively. However, there were no correlations between organic carbon and Ph. These findings suggest that land use intensification particularly where external inputs were added decreased the population. In addition, LNB in beans were predominantly *Rhizobium* species, while siratro was nodulated by *Bradyrhizobium* species. Definitive species identification will be accomplished by molecular analysis.





5. Impact of Land use change on the Diversity and Abundance of Mycorrhiza in Mabira forest ecosystem, Uganda

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Abstract

It is evident that arbascular mycorrhiza fungi (AMF) are crucial for the functioning of terrestrial ecosystems. Modem intensive farming practices are a threat for AMF and their abundance and effectiveness with respect to root colonization, the result of which plant growth is declining upon agricultural intensification (Fritz, Ewald ,Kurt, Paul, Thomas and Andres, 2003). It is therefore important to determine the factors which affect their abundance and diversity in the ecosystem.

The impact of land use change on the diversity and abundance of arbuscular mycorrhiza fungi (AMF) was investigated in the tropical Mabira forest benchmark site located 20 km from north of the lake Victoria shoreline in Central Uganda. The six windows selected cover parts of the forest and agricultural land near the forest. The area studied was classified into 9 land use types which include; strict nature reserve, low impact production forests, secondary forest, grassland under grazing, fallow area grazed, agro forestry, multiple cropping, tea plantation and sugarcane. The purpose was to assess the impact of land use change on the diversity and abundance of mycorrhiza along land use intensification gradient from forests to agricultural land.

Representative soil samples including roots were taken from a total of 96 sampling points in the six windows following the standard sampling protocol. At each point was made 12 augers of soil of 20cm deep which was bulked and a subsample taken. Spore extraction from the field soils was done following Gerdemann and Nicolson (1963) method. The AMF spores present were morphologically identified and counted. The roots were separated and treated for AMF colonization according to the method given by Giovannetti and Mosse 1980). The same soil samples also served as inoculums for determining most probable number of infective propagules (MPN) using the method given by Porter (1979) using onion seedlings. The method for trap cultures is to be done using a mixture of sorghum and cowpeas as suggested by Bagyaraj (1992).

The data generated gave a comparison between land use types and windows in relation to AMF diversity, abundance and root colonization based on field soils. Analysis of soils, revealed a high number of AMF spores in tea plantation and multiple cropping, and least in sugarcane plantation. The spore genera represented in all land uses include; *Scutellospora, Glomus, Gigaspora, Acaulospora* and *Entrophospora.* The commonest genera were *Glomus, Acaulospora* and *Scutellospora*. The rate of root colonisation was found highest in multiple cropping and least in sugarcane. It was observed that AMF abundance and diversity varied with change in land use. Tea plantation was significantly different from all the other land uses by having high AM fungi abundance. Sugarcane land use was significantly different from the others; it gave the least spore abundance. Mean diversity also showed significant differences between land uses with the highest diversity in grassland grazed and lower in secondary forest, low impact production forest and strict nature reserve. The abundance and diversity of AM fungi in the six windows was compared using Duncan's multiple range Test. This revealed significant differences between the windows (CV for abundance = 38.2 and for diversity = 14.5). Using the Pearson's correlation coefficients, there was a positive relationship between spore abundance, diversity and root colonization. This implies that increase in spore abundance may affect increase in AMF diversity and percentage root colonization. There was no significant difference between AMF diversity and land use types.

It appeared some AMF genera were to be found at virtually all the sampling points. The dominant genera in all the land uses were *Acaulospora, Scuttelospora* and *Gigaspora* while least was *Paraglomus.* The land use types with low

Intensification had unexpectedly low AMF abundance as observed in strict nature reserve and low impact forest. The spore genera in the different land use types were counted and their differences determined using SAS statistical package

The percentage root colonization on the roots obtained from the field soils were compared for the different land use types and land use intensification. A different trend was observed compared to what was found in AM fungi abundance. The tea plantation, fallow area under grazed land and multiple cropping had a higher root infection than the others while sugarcane plantation still had a low percentage of root infection

The differences in diversity within land use could be explained by the ecological conditions at the time of sampling. Some of the odd observations were areas affected by charcoal burning and high input of fertilizers.

The dominance of *Acaulospora, Glomus* and *Scutellispora* in all the land use types is of significant importance in the ecosystem maintenance and plant growth. Since AMF spore formation is known to be highly variable, depending on species type (some species may not form spores at all), host plants, seasons of the year, and other environmental factors (Bever, Schultz, Pringle and Morton, 2001), the actual conclusions can not be based on only the spore morph types from field soils. Results from trap cultures and determination of MPN will be more conclusive. It is not clear whether the increase in land use intensification decreases mycorrhizal abundance and diversity in the soil. However, farmer practices such as land conversions and agriculture intensification do not only exhaust soil productivity but also influence life in the soil. This was clearly seen in sugarcane plantation with significantly low levels of mycorrhiza.

6. Morphological diversity of AM fungi isolated from the TENE area in Centre-West Côte d'Ivoire

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Abstract

The morphological diversity of AM fungal spores originating from the TENE region in Center-West Côte d'Ivoire was estimated using spore counting, color, shape and size as criteria. Soils were sampled according to a land use classification comprising natural forests, artificial forests and cultivated areas. Overall 8 land use sub-classes were used to investigate spore composition and diversity according to these criteria. Presence or absence of AM fungal spores in soils were investigated by wet sieving either 100g of field soils or 100g of soils from pot culture using cowpea as trap plant. In general the trapping strategy allowed us to recover a higher spore number in all the land classes analyzed. Overall more spores were found in the forest area compared to the cultivated ones. Spore with diverse sizes as well as diverse shapes were recovered either from field soils or from trapping system in all land sub-classes. At least 10 different spore types were observed in terms of spore color. However, it was observed that the forest areas harbored a higher diversity in terms of spore colors. The analysis showed that within a land class the criteria used to classify the spores were more or less homogenous.

7. Investigation of Rhizobia Resources in the OUME region (Centre-West Area of Côte d'Ivoire)

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***Keywords**: Côte d'Ivoire, rhizobia, investigation, Oumé.*

Abstract

We have investigated presence of rhizobia in Oumé region in Centre-West of Côte d'Ivoire considering land use classification. Forty species of leguminous tree in both forest and cultivated areas were identified. *Mucuna pruriens*, *Cacia hirsuta*, *Acacia pinata* and *Abrus cannescens* were mostly found in the areas investigated. One thousand rhizobia strains were isolated and purified directly from leguminous trees. Of those strains, 650 were isolated from *Mucana pruriens* mostly found in fallows. It was shown that leguminous tree such as *Acacia pinata* found in the forest areas did not harbor nodules at the period of investigation. In order to recover soil nodulating rhizobia, a trapping system using cowpea as a trap plant was considered. Two thousand isolates were isolated and cultured. These colonies were classified according to the growing rate. Both slow-growing and fast growing colonies were identified. However intermediate growing isolates were also found.

8. Assessment of diversity of legume nodulating bacteria (LNB) in Nilgiri and Nandadevi Biospheres of India

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Abstract

The work on belowground biodiversity of LNB was under taken with following objectives: 1) Isolation of LNB from nodules of cowpea/other legumes used as trap plants

and from wild legumes and 2) Morphological, physiological and molecular characterization of diversity of LNB in Nilgiri Biosphere Reserve in the Western Ghats and the Nanda Devi Biosphere Reserve in the Himalaya.

Methods

Nodules obtained either from nature or from legumes grown as trap plants were washed thoroughly and surface sterilized with 1% sodium hypochlorite/0.1% $HgCl_2$. These nodules were subsequently washed by 5-6 changes of sterile distilled water. Sterilized nodules were crushed in sterile tubes in a 0.5 ml of sterile water. A loopful culture was streaked on Yeast Extract Mannitol Agar (YEMA) plate supplemented with Congo red (dye) and incubated at 28°C for 2-4 days till the colonies appeared. Individual unstained (white) colonies were isolated, transferred and maintained on YEMA slants.

Soil rhizobia were enumerated using most probable number (MPN) method through plant infection test (Vincent, 1970). 100 gram of dry soil samples taken from each land use were diluted from 10-1 to 10-6 as described in the ***Standard Methods for Assessment of Soil Biodiversity and Land Use Practices*** and 1 ml from each dilution was used to inoculate cowpea (trap plant) seedlings grown in pouches/glass tubes supplemented by nitrogen free Jensen's nutrient solution. Based on the observations on presence or absence of nodules in each dilution, the most probable number was calculated using MPN table (Brockwell,1963).

Isolates of *Rhizobium* were streaked on YEMA plates containing bromothymol blue for testing acid/alkali production. Change of media color from green to yellow indicated acid production and green to blue indicated alkali production. Visual observations were recorded on time of appearance of colonies and slime production.

Results and Discussion

Isolation of *Rhizobium* was done from nodules collected from plants grown as trap plant as well as those from legumes of selected wild legumes. It was done at all the three windows and number of isolates maintained is given in table 1.

Table1. Number of isolates of *Rhizobium* collected at two bench mark areas

Benchmark Area	Number of isolates	
	From trap plant	From field
NBR Window 1	53	-
NBR Window 2	29	144
Nandadevi	45	15

*NBR window 1 and 2 refer to Karnataka and Kerala part of Nilgiri Biosphere Reserve. Two Windows were also attempted in Nanda Devi Biosphere, one in lower elevation zone. However, LNB work was done only in lower elevation zone.

During the survey and collection of the nodules, the variety of leguminous plants both wild and cultivated was identified. A list of such plant is given in table 2 that was helpful in describing the rhizobial diversity.

Table 2. List of cultivated and wild legumes in two bench mark areas used for LNB isolation

Location	Name of the legumes
NBR Window 1	*Mimosa sp., Desmodium triflorum, Crotolaria sp. Vigna unguiculata*
NBR Window 2	*Desmodium triflorum, D. gangeticum, D. triangulare, Centrosoma pubescens, Mimosa pudica, Mucuma prurita, Vigna sp.,Calapagonium sp, Acacia sp., Abrus precatorius Crotolaria quinquefolia, Tephrosia pupurea, Gliricidia sp*
Nandadevi	*Cajanus cajan, Glycine max, Glycine* sp., *Lens esculenta, Macrotyloma uniflorum, Phaseolus vulgaris, Pisum sativum, P. arvense, Vigna angularis,*

V. mungo, V. radiata, V. unguiculata, V. umbellate.

Results on enumeration of rhizobia is given in table 3 which indicates that highest rhizobial population was present in managed plantation in NBR window 1 and 2, whereas cropland showed maximum population of rhizobia in Nandadevi biosphere. However, rhizobial population was highest in forest plantation in NBR window 1, followed by NBR window 2 and lowest in Nanda Devi.

Table 3. Population of root nodulating bacteria (Rhizobium) in different land uses of Nilgiri and Nanda Devi biospheres.

	Average cells per g of soil		
Land use	NBR window 1	NBR Window 2	Nanda Devi
Natural Forest	1.75×10^2	3.2×10^2	6.2×10^2
Plantation	35.0×10^2	3.1×10^2	4.7×10^2
Cropland	3.64×10^2	0.2×10^2	7.8×10^2
Plantation (managed)	68.14×10^2	3.4×10^2	2.6×10^2

Isolates of *Rhizobium* from different land uses and trap plants were characterized on the basis of growth rate, acid/alkali production and slime production. In NBR window 1, out of 53 isolates, 42 were slow growing and alkali producing but all were slime producing, an unusual observation. In NBR window 2, all isolates grew fast, 63 isolates did not produce slime and 61 isolates produced alkali in the medium. Usually fast growing strains produce acid in the medium.

A total of 286 isolates from different land use types have been maintained. The rhizobial population is low in both Biosphere Reserves (Benchmark sites). All morphological/physiological types of Rhizobial occur in both reserves but fast growing and slime producing ones dominate the population.

9. Diversity of AM fungi across a gradient of land uses in Western Ghats and Nanda Devi biosphere

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Abstract

The aim of this study was to characterize the diversity of AM fungi in different land use systems of the Nilgiri Biosphere Reserve in Western Ghats and the Nanda Devi Biosphere Reserve in the Himalayan region of India. Nilgiri biosphere is located in the Southern part of India and experiences a warmer and more humid climate as compared to Nanda Devi Biosphere reserve located in the northern part of India.

Soil samples from different grid points were collected during pre-monsoon season. These soil samples were stored in a refrigerator at 5^0C till the analysis is over. Further, whatever the roots were present in the soil sample were collected for determining the percent root colonization. The roots were stained with trypon blue as per the procedure given by Philips and Hayman (1970), with modifications by Kormanik *et al.*, (1980) for assessing AM fungal colonization and observed under compound microscope.

Determination of the percent mycorrhizal colonization was carried out using the gridline intersection method (Giovannetti and Mosse, 1980). Spores of AM fungi in soil were estimated by wet sieving and decanting method (Gerdemann and Nicholson, 1963); The number of infective propagules was estimated by the most probable number method (Porter, 1979).

Results from the Nilgiri Biosphere Reserve indicate that spore density in Window 1 of the Nilgiri Biosphere was significantly higher in forest plantations (15.32 g^{-1} soil) and grasslands/fallows (12.82 g^{-1} soil) compared to managed plantations (4.34 g^{-1} soil), natural forests (4.02 g^{-1} soil) and agricultural lands (3.60 g^{-1} soil). In window 2 of the Nilgiri Biosphere, spore density was higher in forest plantations (5.62 g^{-1} soil) compared to the natural forests (2.92 g^{-1} soil), grasslands/fallows (2.52 g^{-1} soil), managed plantations (2.20 g^{-1} soil) and least spore density was in agriculture lands (1.40 g^{-1} soil). In window 2 also, the forest plantations showed significantly higher spore density (5.62 g^{-1}soil) but the other land use types *viz.* managed plantations, agricultural lands and grasslands/fallows did not significantly differ from one another. Spore density in different and use types in window 1 of the Nilgiri Biosphere follow a definite trend with that of infective propagule number, as spores of AM fungi also form part of the infective propagules.

The highest level of AM root colonization was observed in Managed plantations (65.11 % and 70.0 %) followed by grassland/fallows (63.55 % and 66.0 %) and lowest in agricultural lands (47.22 % and 49.0 %, in Window 1 and Window 2, respectively). However, there were no significant differences in percent root colonization in window 1 and window 2.

The abundance of spores was higher in forest plantations and grassland/fallows. The most abundant species was *G. faciculatum*. The frequency of distribution of AM fungi across different land use types is presented in Table 6. In window 1 of the Nilgiri Biosphere *G. facciculatum, G. feosphorum and G. mosseae, A. bireticulata, A. lacunose, G. hoi, G. maculosum, G. multicaule* were distributed very frequently while *A. scobiculata, A. spinosa, G. aggregratum, G. citricleum, G. diophanum, G. etunicatum, G. halonatum, G. heterosporum, G. lactem, G. manihosis, G. monosporum, G. phamondd* were distributed frequently. In the case of window 2, all the AM fungi are rated as rare or occasional.

Among the different biospheres, the diversity of AM fungi was more in window 1 of the Nilgiri Biosphere, with maximum diversity in natural forests (4.41) and least in agricultural lands (3.26). In window 2 of the Nilgiri Biosphere also the diversity of AM fungi was more in forest plantations (4.82) and least in agricultural land fields (0).

Results for the Nanda Devi Biosphere Reserve indicates that in all 34 species, 13 belonging to the genus *Acaulospora*, 3 to *Gigaspora*, 8 to *Glomus* and 10 to the genus *Scutellospora* could be identified in the soil samples collected from different land uses in the lower elevation village landscape. It may be noted that about 3% of spores in abandoned agricultural land to 13% in oak forests could not be identified at species level.

Four species of *Acaulospora* (*A. lacunose, A. rugosa, A. sporocarpia, A. tuberculata*), one of *Glomus* (*G. manihotis*), and six of *Scutellospora* (*S. carolloidea, S. cerradensis, S. dipurpurascea, S. gregaria, S. rubra* and *S. scutata*) were present in 0-10 cm surface but absent in sub-surface soil (10-20 cm). Only one species viz. *S. erythropa* was present in sub-surface but absent in surface soil. These species confined to only one depth belonged to rare or occasional frequency class (1-20% and 21-40% frequency of occurrence). In the landscape, only one species of *Scutellospora* was dominant compared to 3 of *Glomus*, 5 of *Acaulospora* and none of *Gigaspora*. Twenty three species were sampled from the subsurface soil compared to 34 species in surface soil, indicating a decline in species richness with increasing depth of soil (Table 8).

Acaulospora lacunosa was sampled only from pine forests, *Gigaspora geosporum* only from abandoned agricultural land and, *Scutellospora dipurpurascea* and *S. scutata* only from irrigated agriculture. Twelve species occurred in all land uses but the degree abundance varied between sites. Thus, *Acaulospora delicate* and *G. tenebrosum* occurred in all land uses but more abundant in scrub land. *Glomus pansihalos* and *G. tenebrousum* were more dominant in pine forests compared to oak forests, while *Acaulospora morrowiae* was more abundant in oak forests. Irrigated agriculture differed from rainfed agriculture in terms of higher density of *Acaulospora morrowiae, Glomus tenebrosum* and *Glomus pansihalos* spores but lower of *Glomus intrradices* and *Glomus aggregatum* compared to that in rainfed agriculture (Table 9 and 10).

Three species of *Glomus* viz., *Glomus aggregatum*, *G. intraradices* and *G. tenebrosum* accounted for > 50% of spores in almost all land uses, considering 0-10 cm and 10-20 cm horizons together or separately. Coefficient of variation differed by species and depth but, in none of the cases it exceeded a value of 190%.

Total spore abundance decreased with depth in all land use types except rainfed agriculture and scrub where no change or a marginal increase was observed. There was a significant interaction of land use and depth. Oak and pine forest did not differ in terms of spore abundance in 10-20 cm depth but the latter showed markedly higher abundance compared to the former in 0-10 cm horizon. Abandoned agricultural land had comparable spore density in 0-10 cm depth but about 50% lower in 10-20 cm depth compared to rainfed agriculture or scrubland. Pooled spore abundance in 0-20 cm horizon showed a trend of pine forests > oak forests = rainfed agriculture = scrubland > irrigated agriculture > homegardens = abandoned agricultural land (Figure 1).

Spore abundance in rhizosphere of four important agroforestry species across the entire soil profile shows that a significant effect of species and depth is evident. Spore abundance significantly declined below 20 cm depth in *Bauhinia variegata* (a legume) and below 30 cm depth in *Celtis australis*. Spore abundance in *Grewia oppositifolia* and Chhanchri (local name) was very low compared to *Bauhinia* and *Celtis*. The change in spore abundance with depth in these two species was not as marked as in *Bauhinia* and *Celtis*. It is evident that significant number of spores is present in deeper soil layers.

Among the different genera of AM fungi, *Glomus* was the most dominant genus in Nilgiri biosphere and *Gloumus* and *Aculospora* were the most dominant genera in Nandadevi biosphere. At species level, in Nilgiri biosphere reserve the most abundant species was *G. faciculatum* while in Nanda devi biosphere the most abundant species were *G. aggregatum* and *Acaulospora delicata*.

10. Density and diversity of associative diazotrophic bacteria in soils under diverse land use systems in Amazonia

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Abstract

Associative diazotrophic bacteria are among the important functional groups of microorganisms that live in soils. These bacteria contribute to plant growth mainly through biological N_2 fixation. The aim of this work was to evaluate the density and diversity of associative diazotrophic bacteria *Azospirillum* spp., *Azospirillum amazonense* and *Herbaspirillum* spp., in soils under diverse land use systems (LUS) in Amazonia.

Thirty soil samples at different LUS in Amazon region were collected in March, 2004: forest (6 points); young secondary forest (5 points); old secondary forest (1 point); crop (6 points); pasture (6 points) and agroforestry (6 points). The density was evaluated in August, 2004, with serial decimal dilutions (10^{-2} to 10^{-8}) of soil samples to determine most probable numbers (MPN) in media: JNFb (*Herbaspirillum* spp.); NFb (*Azospirillum* spp.); Fam and LGI (*Azospirillum amazonense*). Phenotypic diversity of isolates and strains were evaluated through cell morphology in optic microscope, cultural characteristics on potato and GNA media as well as protein profiles by polyacrylamide gel eletroforesis (SDS-PAGE), compared to type and reference strains of *Azospirillum, Herbaspirillum* and *Burkholderia* species.

No grown in JNFb was observed. In NFb medium the MPN increase in the following order: forest (2.1 X 10^2 bacteria g^{-1} soil); old secondary forest (2.3 X 10^2 bacteria g^{-1} soil); pasture (4.6 X 10^2 bacteria g^{-1} soil); young secondary forest (8.6 X 10^2 bacteria g^{-1} soil); crop (18.2 X 10^2 bacteria g^{-1} soil) and agroforestry (20.6 X 10^2 bacteria g^{-1} soil). In Fam medium the MPN increased in the order: agroforestry (1.1 X 10^2 bacteria g^{-1} soil); forest (1.6 X 10^2 bacteria g^{-1} soil); young secondary forest (1.7 X 10^2 bacteria g^{-1} soil); old secondary forest (3.0 X 10^2 bacteria g^{-1} soil); crop (3.7 X 10^2 bacteria g^{-1} soil) and pasture (11.2 X 10^2 bacteria g^{-1} soil). In LGI medium MPN increased in the order: agroforestry (1.7 X 10^2 bacteria g^{-1} soil); crop (2.7 X 10^2 bacteria g^{-1} soil); young secondary forest (3.5 X 10^2 bacteria g^{-1} soil); forest (4.1 X 10^2 bacteria g^{-1} soil); old secondary forest (4.2 X 10^2 bacteria g^{-1} soil); and pasture (8.1 X 10^2 bacteria g^{-1} soil). Higher numbers were obtained in NFb medium (10.6 X 10^2 bacteria g^{-1} soil), followed by LGI (4.1 X 10^2 bacteria g^{-1} soil) and Fam (3.9 X 10^2 bacteria g^{-1} soil).

Twenty-two isolates were obtained. Cell diameters varied from 0.61 to 1.21 µm with rods or spirillum shapes. Twenty groups were obtained by cultural phenotypic characterization on potato medium (2 in forest, 2 in young second forest, 4 in crop, 4 in agroforest and 9 in pasture) and GNA medium (2 in forest, 2 in young second forest, 4 in crop, 5 in agroforest and 9 in pasture). Protein profile through SDS-PAGE analysis showed diversity amongst isolates.

The LUS affected the density of diazotrophic populations and these effects depend on the medium: soils under crop and agroforestry presented larger numbers in NFb medium; in Fam and LGI media pasture usually presented larger density. The LUS also affected the diversity of diazotrophics, soils under pasture presented larger number of cultural phenotypic characteristics. This is explained by the well known positive effect of grass rhizosphere on this group of organisms.

11. Diversity of leguminosae nodulating bacteria from three different land use systems in Brazilian Western Amazon

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***Keywords**: rhizobia, density, siratro, cultural characteristics.*

Abstract

The aim of this work was to evaluate the effect of three different land use systems from the Brazilian Western Amazon on Leguminosae nodulating bacteria diversity.

The land use systems studied were a cassava crop, a peach palm crop and an upland forest. Rhizobial densities were evaluated by the most probable number technique, after inoculation of *Macroptilium atropurpureum* with diluted soil samples, and they were similar for the three systems studied. Two hundred fifty-seven bacteria isolated from the nodules formed were characterized and these were clustered into sixty-three groups of isolates with eighty percent similarity. Few isolates were obtained from forest, whereas a large number of isolates was obtained in the crop systems. The highest richness and Shannon diversity was found in the cassava crop and the lowest ones were found in the forest. However, the richness was similar for the three systems when it was determined with a rarefaction analysis. Differences in the proportion of types of growth were found

and these differences can be explained by differences amongst the systems. The land use systems influenced the Leguminosae nodulating bacterial diversity.

12. Diversity of Leguminosae nodulating bacteria in diverse land use systems in the upper Solimões River Basin, Benjamin Constant Municipality, AM- Brazil.

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Abstract

Soil samples were collected in March 2004 from 98 sites comprising six different LUS distributed within two indigenous communities (Guanabara II and Nova Aliança) and the city of Benjamin Constant at this Municipality. Leguminosae nodulating bacteria were trapped from soil by using the promiscuous hosts: siratro (*Macroptilium atropurpureum*), cowpea (*Vigna unguiculata*) and common bean (*Phaseolus vulgaris*). Experiments were carried out with these species under greenhouse conditions in the Soil Microbiology Laboratory of the University Federal of Lavras (UFLA) to evaluate density, efficiency and diversity of LNB populations. Soil samples were kept in cold chamber (4°C) until analysis.

The experiment with siratro was carried out one month after soil sampling. Siratro was cultivated in plastic pouches with nutrient solution and inoculated with serial decimal dilutions (10^{-1} to 10^{-7}) of soil samples to determine most probable numbers (Most Probable Number Enumeration System - MPNES) and to isolate LNB. Controls with and without mineral nitrogen were included. The experiment comprised a total of 2100 plastic pouches. The dry matter weight (DMW) of plants in the first dilutions were determined and compared to the controls without inoculation and with or without mineral nitrogen (DMW of 1.58g and 0.16g, respectively) in order to calculate native LNB populations efficiencies in promoting plant growth by nitrogen fixation (DMW average: 'Crop' - 0.31 g; 'Old secondary forest' - 0.34 g; 'Young secondary forest' 0.3g; 'Pasture' - 0.35g; 'Forest' - 0.27g; 'Agroforestry' - 0.29g).

A total of 1,891 isolates were obtained from all the nodules formed on siratro roots. The cultural characterization of isolated colonies in 79 medium was recorded by the time of appearance of isolated colonies (TAIC) and pH modification. Total number of isolates and the number of cultural types (between brackets) were distributed among LUS as following:

- **Crop** - 553 (acid fast 232; neutral fast 200; neutral intermediate 44; alkaline intermediate 23; alkaline slow 54);
- **Young secondary forest** - 498 (acid fast 235; neutral fast 96; neutral intermediate 18; alkaline intermediate 50; alkaline slow 99);
- **Old secondary forest** - 128 (acid fast 63; neutral fast 48; neutral intermediate 4; alkaline slow 13);
- **Pasture** - 219 (acid fast 93; neutral Fast 95; neutral intermediate 7; alkaline intermediate 1; alkaline slow 23);
- **Agroforestry** - 354 (acid fast 125; neutral fast 114; acid intermediate 1; neutral intermediate 53; alkaline intermediate 25; alkaline slow 36).

The densities of LNB populations were (ranges by LUS log cell .g^{-1}): - Crop 4.47; - Old secondary forest 3.75; - Young secondary forest 3.44; -Pasture 2.72; - Forest 1.93; - Agroforestry 3.27).

The calculated Shannon index for each LUS were: - Crop - 1,29; - Old secondary forest - 1,05; - Young secondary forest - 1,35; - Pasture - 1,10; - Forest - 1,3 2; - Agroforestry - 1,45).

Experiments with cowpea and common bean were carried out under greenhouse conditions (Leonard jars with 750 mL sterilized Jensen solution without nitrogen - $CaHPO_4$ 1g L^{-1}; K_2HPO_4 0,2 1g L^{-1}; $MgSO_47H_2O$ 0,2 g L^{-1}; NaCl 0,2 1g L^{-1}; $FeCl_3$ 1g L^{-1}) five months after soil sampling. The experiments were disposed in the completely randomized design (DIC) with 3 replications and 98 treatments (sampling points), plus the control treatments: inoculation with the cowpea efficient reference strains INPA 03 11b and UFLA 03 84, and the common bean efficient strains CIAT899/Br 322 and UFLA 02 100, control with mineral nitrogen (NH_4NO_3 - 70 mg de N/pot) and control without both nitrogen and inoculation. Ten to twelve nodules from each plant were used for LNB isolation and further cultural characterization were recorded as mentioned before. About 2,000 isolates were obtained from cowpea and common bean.

A total of 1010 isolates were obtained from cowpea. Total number of cowpea isolates and the number of cultural types (between brackets) were distributed among LUS as following:

- **Crop** – 158 (acid fast 76; neutral fast 11; alkaline fast 7; alkaline intermediate 10; acid intermediate 3; neutral intermediate 2; acid slow 15; neutral slow 16; alkaline slow 16; acid very slow 1; neutral very slow 1);
- **Young secondary forest** – 106 (acid fast 81; neutral fast 14; alkaline fast 3; alkaline intermediate 3; acid intermediate 4; neutral intermediate 10; acid slow 13; neutral slow 82; alkaline slow 25; alkaline very slow 1);
- **Old secondary forest** – 118 (acid fast 56; neutral fast 5; alkaline fast 6; alkaline intermediate 6; acid intermediate 5; neutral intermediate 5; acid slow 4; neutral slow 14; alkaline slow 14; neutral very slow 1; alkaline very slow 2);
- **Pasture** 206 (acid fast 100; neutral fast 23; alkaline fast 3; alkaline intermediate 4; acid intermediate 2; neutral intermediate 6; acid slow 7; neutral slow 37; alkaline slow 21; alkaline very slow 3);
- **Forest** - 104 (acid fast 29; neutral fast 1; alkaline intermediate 1; acid intermediate 1; acid slow 26; neutral slow 31; alkaline slow 12; acid very slow 2; alkaline very slow 1);
- **Agroforestry** - 188 (acid fast 67; neutral fast 16; alkaline fast 5; alkaline intermediate 12; neutral intermediate 4; acid slow 7; neutral slow 27; alkaline slow 50).

Shoot dry weight was measured to evaluate LNB populations efficiency (LUS - DMW average: - Crop 0.88g; - Young secondary forest 1.0g; - Old secondary forest 1.35g; - Pasture 1.64g; - Forest 0.45g; - Agroforestry 1.26g) compared to the control treatments (DMW average control with nitrogen, 5.53g; control without nitrogen, 0.30g; INPA 0311 b, 2.9g and UFLA 03 84, 5.25g).

The Shannon index calculated for each LUS were: - Crop - 1,73; - Old secondary forest - 1,79; - Young secondary forest - 1,64; - Pasture - 1,60; - Forest - 1,57; - Agroforestry - 1,68).

A total of 950 isolates were obtained from common bean. Total number of isolates and the number of cultural types (between brackets) were distributed among LUS as following:

- **Crop** - 163 (acid fast 44; neutral fast 109; alkaline intermediate 8);
- **Young secondary forest** - 277 (acid fast 49; neutral fast 228);

- **Old secondary forest** - 63 (acid fast 10; neutral fast 51; alkaline intermediate 2);
- **Pasture** 229 (acid fast 37; neutral fast 191; alkaline intermediate 1; alkaline slow 2);
- **Forest** - 51 (acid fast 10; neutral fast 41);
- **Agroforestry** - 167 (acid fast 29; neutral fast 136; alkaline intermediate 2; alkaline slow 2).

Shoot dry weight was measured to evaluate LNB populations efficiency (LUS - DMW average: - Crop - 0.79g; - Young secondary forest - 0,81; - Old secondary forest - 0.85g; - Pasture - 1.09g; - Forest - 0.66g; - Agroforestry - 0.94g) compared to the control treatments (DMW average – control with nitrogen, 7.3 g; control without nitrogen, 0.64g; CIAT899/Br 322 and UFLA02 100, 2.27g).

The Shannon index for LUS: **Crop - 0,82; Old secondary forest** - 0,57; **Young secondary forest** - 0,47; **Pasture** - 0,47; **Forest** - 0,49; **Agroforestry** - 0,49).

Cultural diversity varied among LUS and these effects depend on the trap plant species. Highest diversity index were obtained by using cowpea as trap species and the lowest by using common bean. The highest diversity was obtained in Old secondary forest both by using cowpea or siratro. Pastures usually have the lowest diversity index calculated from isolates of all three trap species. Cultural characteristics based on TAIC and pH modification revealed part of the diversity among isolates, which can be highest considering fine tune cultural characterization that is being carried out and when measured by genotypic characterization. Pure cultures of these isolates (about 4,000) are being stored at 4°C in 79 and – 80°C in 79 medium with glycerol 20% for further sequencing of specific genes and genotypic and phenotypic characterization by REP and protein profiles, respectively.

13. Diversity and Community Structure of Arbuscular Mycorrhizal Fungi in Several Land Use Systems in the Amazon

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Abstract

Arbuscular mycorrhizal fungi (AMF) are a ubiquitous group of soil fungi that establish a mutualistic symbiosis with plant root systems. They are present in nearly all soil and ecosystems where they help plants to uptake immobile nutrients especially phosphorus. The host provides all necessary carbon compounds for the fungus to grow, sporulate and complete its life cycle. These fungi are directly involved on the maintenance of plant diversity and ecosystem functionality as they are involved on plant nutrition, soil aggregate formation and interfere on plant competition relationships. The objective of this work was to assess AMF species diversity and activity in several land use systems situated in tropical soil of the Amazon region in Brazil.

We tested the hypothesis that both species diversity and mycorrhizal activity will increase from highly disturbed to less disturbed land use. Soil samples were collected between 07 and 12 of March, 2004, in the municipality of Benjamin Constant located in the Alto Solimões region in the state of Amazon, Brazil. Six plots (300 x 300m) were established in Benjamim Constant, in Nova Aliança community and in Guanabara community. A total of 101 soil samples were collected in the following land use systems: Pasture (13 samples), Agroforestry (14 samples), Crops (22 samples), Secondary forest (32 samples)

and Forest (20 samples). Within each plot, 16 to 21 sampling points were distributed in a grid where each sampling point was located 100m apart from the next point. In each sampling point, 12 subsamples were collected with a soil core sampler in two concentric circles: 4 and 8 subsamples were collected in these two imaginary circles located at 3 and 6 meters from the main point, respectively.

Soil samples were stored in plastic bags at 4°C and used to establish MPN, to extract and count AMF spores and to establish trap cultures, following the BGBD protocols. For MPN, soil dilutions (10^{-1} to 10^{-5}) were established with sterilized diluent, placed in 50ml cones and seeded with onions (*Allium schoenoprasum*). After 7 weeks, roots were stained with trypan blue and the presence or absence of arbuscular mycorrhizal colonization recorded. From each sample, 100ml of soil was wet sieved using two nested sieves (710 and 45 µm opening); material retained at the 45 µm sieve was placed in tubes containing a 20%/60% sucrose gradient and centrifuged at 2000 rpm for 1 min. The supernatant was placed on Petri plates and observed under a dissecting microscope. Spores were separated by morphotypes, mounted on slides with PVLG and Melzer´s reagent to identification and counting. Trap cultures were set up by mixing *ca.* 700 ml of field soil with sterilized sand and placed in 1.5 Kg plastic pots. Approximatelly 50-60 seeds of sudangrass (*Sorghum sudanense*) and 3-6 seeds of cowpea (*Vigna unguiculata*) were seeded in each pot. After growing traps under greenhouse conditions for 3-4 months, a 100 ml soil core was sampled from each pot and spores extracted to observe sporulation and identification of AMF species.

Soils under Crops (cassava) and Pasture had the highest mycorrhizal inoculum potential with values of 23.02 and 9.16 infective propagules g^{-1} soil followed by Secondary Forest with 3.56 infective propagules g^{-1} soil. Soil samples from other land uses had no mycorrhizal infective propagules as evaluated through the MPN technique. Only 47 samples (out of 101) were analyzed up to now for spore counting and identification, corresponding to 100% of samples from Pasture, 77% of Forest, 36% of Secondary Forest and 36% of Crops.

A total of 65 different morphotypes were recovered representing all 7 genera within the Order Glomales. Species of *Glomus* and *Acaulospora* were predominant regarding number of species recovered per genera, although a high proportion of morphotypes of *Glomus* could not be assigned to describe species. Sporocarpic *Glomus* species like *Glomus sinuosa, Glomus clavispora* and *Glomus coremioides* were commonly detected in soil samples as well a high number of dead, parasited spores.

Total number of species ranged from 28 to 32 in Forest, Pasture and Crops while this number was 52 in Secondary Forest. Conversely, mean species richness per sample was 14.2 in Crops while it ranged from 8.1 to 10.1 on other land uses. Spore abundance decreased from Pasture (1300 spores/100g soil) to Forest (420 spores/100g soil) with intermediate values for Crops and Secondary Forest. *Acaulospora delicata* and *Acaulospora mellea* were the most abundant species in all four land use systems. Other species that were the prolific sporulators were *A. scrobiculata*, *A. morrowiae*, *Entrophospora colombiana* and an undescribed *Acaulospora* sp. and *Glomus* sp.. Species rank-log abundance graphs depicts that regardless of land use, mycorrhizal community are dominated by two or three fungal species approaching the geometric series model. Trap cultures analyzed up to now yielded 5 criptic species that were not sporulating in the field: *Entrophospora infrequens*, *Archaeospora leptoticha*, *Gigaspora* sp. and two undescribed *Glomus* sp. Our data suggest that land use system with intermediate degree of disturbance (Crops and Secondary Forest) are more diverse than those with extreme (highly disturbed Pasture and non-disturbed Forest) levels of disturbance although spore abundance and mycorrhizal activity decrease from more disturbed to less disturbed land use systems.

14. Abundance and growth characteristics of legume nodulating bacteria in Embu and Taita benchmark sites of Kenya

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Abstract:

The populations of legume nodulating bacteria (LNB) were assessed under glasshouse conditions in soils collected from various land use systems in Embu and Taita benchmark sites. The populations were estimated by the most-probable-number (MPN) plant infection technique with *Macroptilium atropurpureum* (DC.) Urban (Siratro) as the trap host. All the soils tested contained LNB ranging from <2.5 to 2.1×10^2 cells g^{-1} of soil (this is only for Embu). (In both soils?) there was no apparent effect of land use on abundance of LNB. However, differences were observed between contiguous sampling points (within a window) and between windows. LNB were isolated from root nodules of nodulated siratro inoculated with dilution series of the soils. The characteristics of the isolates were assessed on yeast extract mannitol mineral salts agar (YEMA) media containing bromothymol blue. Most isolates were slow-growing and produced alkali. There were also fast growers and acid producers.

15. Arbuscular Mycorrhizae Fungi (AMF) spore abundance and species composition along land use gradient in Embu and Taita.

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Abstract

A study on Arbuscular Mycorrhizal Fungal (AMF) spore abundance and species composition was undertaken along land use gradients at two benchmark sites in the geographical regions of Embu and Taita in Kenya. Soil samples were collected from 60 and 40 sampling points within 7 and 5 land use types in Embu and Taita respectively. The soil samples were air dried and processed for AMF spore abundance, AMF species composition and soil trap cultures at the National Museums of Kenya.

Land use had no significant effects on AMF spore abundance ($p<0.05$) at both benchmark sites. However in Embu, land use with napier, tea and coffee had higher spore numbers than land use types with tree plantations, maize and natural forest. At the benchmark site in Taita, natural forest and shrubland had the highest spore abundance compared to tree plantations, maize and agroforestry. Although land use had no effect on spore abundance, there were variations in spore abundance within land use types with napier, coffee, tea and to some extent maize being higher compared to plantation trees, fallow/pasture and natural forest. At the Taita benchmark site, the variations in spore abundance within land use types were evident in natural forest and agroforestry and less in plantation forest, shrubland and maize.

Observations made on percentage colonization of four months old *Mucuna pruriens* (L.) DC grown in field soils collected along the land use gradients in Embu showed root colonization not to differ significantly although colonization was significantly ($p<0.001$) different in the thee windows. The differences between windows was particularly evident in soils from tea plantations with AMF colonization higher (72) window 1 compared to window 2 (49.4), indicating other factors contributing to differences in spores.

A total of 52 AMF morphotypes were isolated with 20 morphotypes from Embu and the remaining from Taita. Only 15 morphotypes were distinguished into species but no specific taxa has been asignedame have been assigned yet. The effect of land use types on the spore abundance of individual AMF species was evaluated. Land use type had a significant ($p < 0.01$) effect on the abundance of individual AMF species at both benchmark sites. Taita had a higher species composition than Embu. At the Embu site the spores of *Glomus* sp. 1 and *Acaulospora* sp. 1 were present in all land use types in variable abundance. *Acaulospora* sp. 1 was highest in napier, tea and coffee; *Acaulospora* sp. 3 and 6 were highest in tea; *Scutellospora* sp. was present in fallow and coffee and Myc 1 was highest in tea and napier. Land use with coffee, tea, fallow and plantation forest had all the 6 AMF species. At the Taita site, *Glomus* sp. 7, *Entrophospora* sp., *G. margarita* and Myc 7 were present in all land use type. Agroforestry was the only land use with all the AMF species. However, *Glomus* sp 7 was dominant in indigenous forest, plantation forest and shrubland and *Entrophospora* was dominant in indigenous forest and agrforestry systems. The remaining species were restricted to specific land se types: *Glomus* sp. 8 & 9 and was present in only agroforestry and maize based systems *Acaulospora* sp. 10 was present in all land use types except plantation forest.

The spore numbers of species were variable in each land type. A species with unique characteristics that were similar to *Glomus* in sub-tending hyphae and spore wall characteristics and with surface wall ornamentation was isolated from the Taita benchmark site The spore abundance of Individual AMF species seemed to be better indicators of land use type compared to the total spore abundance of all species. The observations made on variation within land use types suggest that management within a land use type is a one of the parameters that could affect spore abundance.

Session 6. Inventory on pathogenic and antagonistic fungi and insect pests

Content

1. Inventory and Diversity of Soil-Borne Plant Pathogenic Fungi in the Biosphere Reserve of los Tuxtlas, Veracruz, Mexico.

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Introduction.

Soil-borne plant pathogenic fungi have been studied mainly as a cause of disease and economic losses; however, they may play also ecological and evolutive important roles in the natural plant communities and in the soil microbial communities through their participation in multitrophic interactions with the soil microorganisms and the plant roots. Several interesting questions about the role that the root pathogenic fungi (RPF) play in soil can be asked: Would be possible to talk of a characteristic RPF community for an specific type of plant community? Does the diversity and community composition of RPF change when the soil ecosystem is disturbed? Could RPF be used as bioindicators of soil health? Does RPF play an important role in the regulation of natural plant communities? How important is to know the RPF community for the management and conservation of the soil biodiversity?

In order to answer some of these questions, the general objective of this research is to assess the diversity, abundance and root damage causde by some of the main root pathogenic fungi, *Phytophthora spp*., *Pythium spp*., *Fusarium spp*. and *Rhizoctonia solani*, in four different types of land use: rainforest, agroforestry, grassland and maize crop.

The specific objectives are: a) identification of the main root pathogenic fungi present in each land use, b) assessment of the inoculum density of the main root pathogenic fungi in soil of the rhizosphere, and c) assessment of the disease incidence (damage) caused by the main root pathogenic fungi in the roots of the vegetation present.

Materials and Methods

Three communities: López Mateos, Venustiano Carranza and San Fernando ubicated at the Los Tuxtlas Biosphere Reserve, in the State of Veracruz, México, were chosen to establish a window in each one. Each window considered four different categories of land use: rainforest, agroforestry, grassland and maize, with eight plots per land use. At each one of the 32 plots a point of sampling was established. On this point eight subsamples were taken equidistantly, four at six metes of distance and four at 12 meters.

Soil samples were taken at the first 30 cm of depth, tagged and kept in a field freezer until they were sent to the Ecology of Soil-Borne Plant Pathogens Laboratory at Colegio de Postgraduados, where the samples were kept at 5° C in a cold room.

Different selective media for the isolation and culture of the main phytopathogenic fungi were used: PARHP for *Phytophthora spp*, 3P for *Pythium spp*., Kerr and SNA for *Fusarium spp*., Ko and Hora for *Rhizoctonia solani*. General culture media PDA was also used for the isolation of saprophytic soil fungi.

Soil dilution plate technique was applied for isolation and quantification of the soil population density (number of propagules per gr of soil) of the RPF from soil of the rhizosphere, using a soil dilution of 10^{-2}. Assessment of disease infection was made plating ten 1.0 cm longer pieces of feeding roots (every time was possible) in each of one plate with the different selective media mentioned before. This roots were selected from the same roots from which the soil of the rhizosphere was taken for the assessment of the soil population density.

PDA media plates were incubated at 28 °C for two to three days. After this process they were kept at room temperature and direct light. PARHP and 3P media plates were incubated at 30 °C for 10 to 20 days under dark conditions. KERR media plates were incubated at 28 °C in the dark from three to five days; after this time they were kept under room temperature and light. Ko and Hora plates were incubated at 28 °C from three to five days under dark conditions.

Results

Results presented in this summary include information about some of the main RPF like *Fusarium spp.*, isolates in the Pythiaceae family (*Pythium spp.* and *Phytophthora spp.*) and *Rhizoctonia sp.*; and also information about other soil fungi: saprophitic and antagonistic like *Rhizopus, Penicillium, Aspergillus* and *Trichoderma*. However there is not yet a species taxonomic identification for all isolates found in this research.

The highest number of different RPF isolates (morfospecies) was detected in the agroforestry (143) and grassland (135) sites, followed by the rainforest (126), and the lowest number was found in the maize crop sites (111) (Table 1). A similar number of different isolates of RPF were obtained from roots (258) than from soil of rhizosphere (257). In the three communities sampled, the highest number of diferent RPF isolates were detected in San Fernando (114), followed by López Mateos (79) and Venustiano Carranza (75) (Table 1).

Assessment of the number of infected roots by each different RPF isolate (disease incidence), indicated that rainforest sites had the highest values for the diversity index of Shannon (H), followed by grassland and agroforestry land use, while maize plots had the lowest values (Fig.1). However, assessment of the inoculum density (number of propagules per gram of soil) in the soil of the rizosphere indicated that agroforestry sites had the highest values for the diversity index of Shannon, followed by rainforest and grassland, and the maize plots had the lowest values.

Table 1.Summary of the number of different soil fungi (phytopathogens, saprophytes and antagonistic) found in soil of the rhizosphere and plant roots, in three communities of the Los Tuxtlas BiosphereReserve, Veracruz, México.

COMMUNITY	**López Mateos**		**Venustiano Carranza**		**San Fernando**		TOTAL	
LAND USE	Soil of rhizosphere *	Roots*	Soil of rhizosphere	Roots	Soil of rhizosphere	Roots	Soil of rhizosphere	Roots
Rainforest	20	26	19	16	18	27	57	69
							Total = 126	
Agroforestry	24	20	32	20	32	15	88	55
							Total = 143	
Grassland	27	36	18	15	20	19	65	70
							Total = 135	
Maize	17	20	20	15	10	29	47	64
							Total = 111	
Lily plot	----	---	12	14	----	---		
						Total =	257	258
TOTAL**	43	36	33	42	53	61		
Great total	**79**		**75**		**114**			

*In each community, some of the different soil fungi isolates are repeated because they were found in different land uses. **Total number of soil fungi isolates includes only the real number of different fungi found per community for soil of rhizosphere and plant roots.

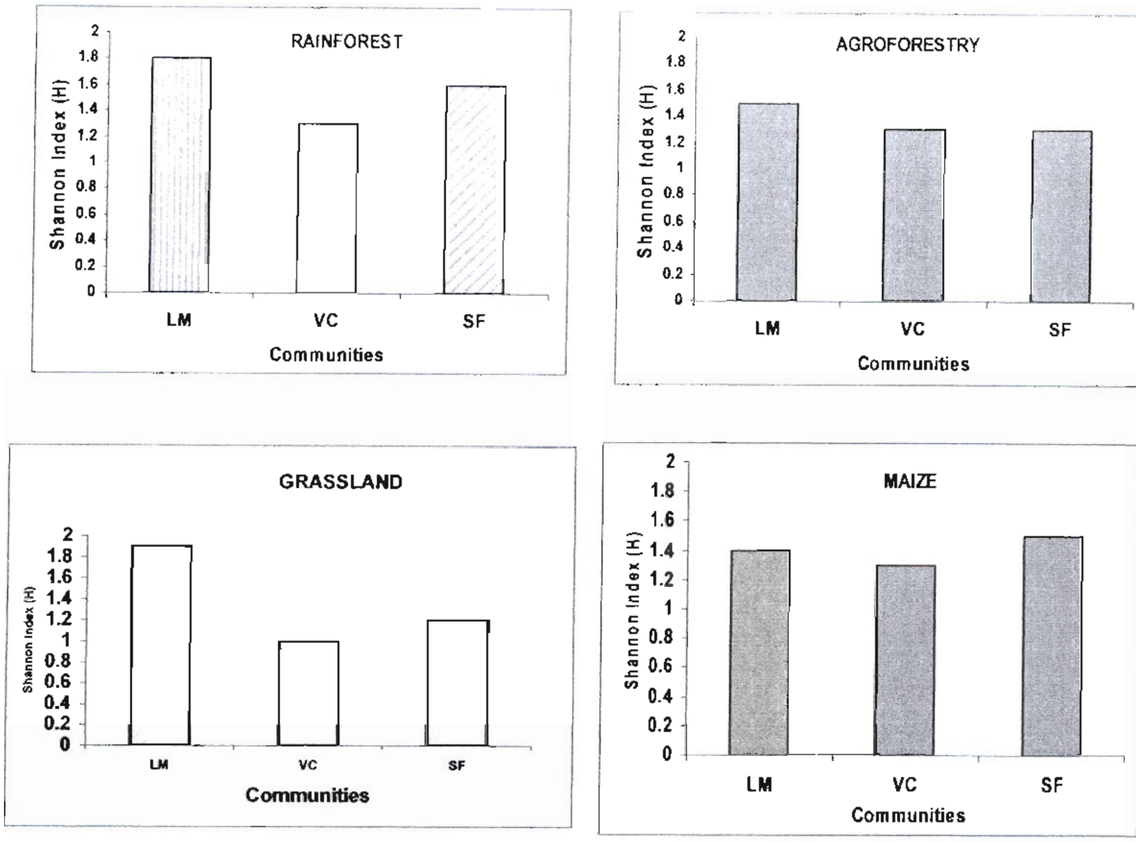

Fig.1. Diversity index of Shannon calculated for soil fungi (root pathogenic, saprophytes and antagonistics) in different land uses: rainforest, agroforestry, grassland and maize, in three communities of the Los Tuxtlas Biosphere Reserve in México, LM=López Materos; VC= Venustiano Carranza and SF= San Fernando. Diversity Index data shows that rainforest had the highest values, followed by grassland and agroforestry, and the maize crop plots had the lowest values.

General Observations.

Studies of the soil-borne plant pathogenic fungi from the population and community ecology point of view are very rare. Intuitively we expect a low presence and incidence of the root pathogenic fungi in natural ecosystems than in agroecosystems; however, it is necessary to consider that pathogenism is a very important relationship that in some cases has reached very deep evolutive interactions between the pathogen and the host in time, playing a very improtant role in the development and evolution of strategies for resistance and for virulence, and as a consequence, in the variability of the two involved species.

Therefore, it is possible to expect that there would be RPF in all ecosystems and agroecosystems, but possibly the difference would be in the grade of damage caused by the RPF in the plant community and in the composition of the species present in the RPF fungi, but maybe this will not be a significative difference in the biodiversity of the RPF community . In order to get more precise data and conclusions about the RPF in Los Tuxtlas Biosphere Reserve, we need more time for the taxonomic identification and for laboratory and greenhouse experiments.

2. Diversity and Abundance of Plant Pathogenic Fungi in Sumberjaya Lampung

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Key words: *abundance, diversity, land-use, phytopathogenic fungi*

Abstract

Soil borne pathogens, including plant pathogenic fungi, are among the most neglected factors that affect plant production in many regions because of their microscopic size and non-specific symptom of infection. Their roles, however, are tremendously important as complexes both in soil and plant tissues. Changing in soil management practices and cropping practices may affect the population and diversity of phytopathogenic fungi in the soil. This study was aimed to investigate the effect of land use types on diversity and abundance of phytopathogenic fungi in the soil. Soil samples were collected from Sumberjaya, West Lampung district, Province of Lampung, Indonesia, during rainy season on February to March 2004. The total of 92 soil samples were collected from point samples within seven land use types: (1) undisturbed forest (forest less intensive = FLI,), (2) disturbed forest (forest intensive = FI,), (3) fallow or grassland (shrub = S,), (4) shade coffee or polyculture coffee (tree-based less intensive = TBLI,), (5) , sun coffee or monoculture coffee (tree-based intensive = TBI), (6) food crop (crop-based less intensive = CBLI,), and (7) horticulture crop or vegetable crop (crop-based intensive =CBI).

Soil samples were laboratory analyzed by a serial dilution technique and plated in potato dextrose agar medium. The results showed that the mean of diversity of phytopathogenic fungi in the seven land use types in Sumberjaya, Lampung was not significantly different. However, the mean of abundance of phytopathogenic fungi was significantly different, fungal plant pathogens seemed to be more prevalent in intensive land uses and shrub than that of in less intensive land uses and forest.

3. Diversity and Abundance of Cellulose and Lignin Degrading Fungi (Decomposers) On Different Land Use Types in Lampung

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Key words: *abundance, diversity, land-use, phytopathogenic fungi*

Abstract

Conversion of primary forest to secondary forest, plantation, agriculture land and pasture has a large impact on above ground biodiversity, carbon storage in biomass and soil and may substantially alter carbon sink. This conversion of primary forest also change the amount and quality of organic matter input to that particular ecosystems, alter the microclimate such as temperature, humidity and soil water content significantly. These changes undoubtly affect the microbial composition and their activities in the soil. Cellulose and lignin are the most important natural organic compounds as far as quantity is concerned. This study was aimed to investigate the effect of land use types on diversity and abundance of phytopathogenic fungi in the soil. Soil samples were collected from Sumberjaya, West Lampung district, Province of Lampung, Indonesia, during rainy season on February to March 2004. The total of 92 soil samples were collected from point samples within seven land use types: (1) forest less intensive (FLI), (2) forest intensive (FI), (3) tree-based less intensive (TBLI), (4) tree-based intensive

(TBI), (5) grassland and shrub (Shrub), (6) crop-based less intensive (CBLI), and (7) crop-based intensive (CBI). Soil samples were laboratory analyzed by serial dilution technique and plated in selective media for either lignin degrader or cellulose degrader. The results showed that several isolates have a role both as lignin degrader and cellulose degrader and have been identified as the same genus. Diversity and abundance of both lignin and cellulose degraders were affected by different land use types. However, there was no conclusive pattern that can be drawn. There is a tendency that the mean of abundance of lignin and cellulose degrading fungi decrease as the land use more intensive.

4. Relative abundance of soil-borne phytopathogens in a range of land use types (Uganda).

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Key words: Land use, disturbance, *Phytophthora, Pseudomonas, Pythium,* Uganda.

Abstract

The incidence and relative abundance of *Pythium, Phytophthora* and *Pseudomonas* in soils from nine land use types (LUTs) in and around a lowland tropical forest that differed in the degree of disturbance from human-induced activities was investigated. A minimum of seven points per LUT were sampled (range 7-16). *Pythium* and *Phytophthora* were isolated from soils using bait tissues (maize and apple, respectively) while serial dilutions of soil suspensions were used to extract *Pseudomonas*. In all cases the infective agents were isolated on appropriate selective media. The three genera occurred in all the LUTs. Mean abundance of *Phytophthora* did not differ significantly ($P>0.05$) among the LUTs in contrast to *Pythium* and *Pseudomonas* which showed significant differences ($P<0.05$). *Pythium* increased along the land use intensification gradient while *Pseudomonas* decreased along the same gradient. We conclude that *Phytophthora* was less sensitive to disturbance than the other two genera. Trends for *Pythium* and *Pseudomonas* may be related to soil chemical parameters such as pH and/or competitive interactions with saprophagous mesofauna; this remains to be analysed.

5. Monitoring diversity of microfungi in soils under different conditions of land-use (Brasil)

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Abstract

Agricultural activities may affect diversity of soil-borne organisms, which play an important role with regard to nutrient cycling or equilibrium between pathogens and their antagonists. The assessment of fungal diversity in tropical soils under different land uses is one objective of the project "Conservation and Sustainable Management of Below Ground Biodiversity" (UNEP-GEF). Broadly accepted standard methods for inventorying fungal diversity are not yet available. Therefore, we propose the use of an improved isolation technique to evaluate the impact on soil microfungi diversity and frequency changes due to agricultural practices. A set of soil-borne plant pathogens and their natural antagonists represents a putatively good option since species comprise a well studied group of fungi whose distribution and dominance changes can be addressed to human intervention on soil by agricultural practices. In March of 2004, 98 soil samples were

collected under a gradient of land-use including primary and secondary forest, perennial and annual crops and pasture, in different locations of Amazon State, Brazil. Occurrence and frequency of *Pythium* species as representatives of Oomycota was assessed using grass leave blades and sorghum seeds as baits. Potentially plant pathogenic Ascomycota such as *Cylindrocladium*, *Fusarium*, *Lasiodiplodia*, *Verticillium*, and their respective antagonists such as *Clonostachys*, *Coniothyrium*, *Paecilomyces*, *Talaromyces*, and *Trichoderma* were recovered by an advanced soil washing and particle filtration methodology coupled with the use of selective culture media and antibiotics. Occurrence and relative frequency of species have been assessed in sampling points representing different degrees of disturbance. Diversity of other genera and species was registered as far as possible. From 3313 soil particles, 2140 CFU´s were discriminated and more than 50 fungal genera were identified. The five most frequent fungal genera were *Trichoderma* (18,6%), *Fusarium* (7,2%), *Paecilomyces* (3,4%), *Clonostachys* (2,6%) and *Acremonium* (2,1%). *Trichoderma* and *Clonostachys*, known as antagonists to plant pathogens and agents for biological control, had higher frequencies of colonization in forest soils, in comparison with more disturbed sites. The potentially plant pathogenic genus *Fusarium* presented higher frequencies of colonization in soils cultivated with crops like cassava and banana or in orchards. *Pythium* showed an even distribution, with colonization frequency of the baits between 25% and 80%. Areas under pasture showed lower frequencies of fungal colonization when compared with other soils. The studied sites did not suffer profound anthropogenic interventions yet. However, the results showed that intensification of land-use led to differences in fungal populations among the sites investigated, with an increase of colonization by the potential plant pathogenic genus *Fusarium* and an opposite effect on common antagonistic genera. Soil under pasture revealed to be the most disturbed environment.

6. Inventory of entomopathogenic nematodes and fungi on soil samples (Brasil)

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Abstract

We developed activities on a second collect during October/2004, 13-17, from soil samples among 0-20 cm depth, composed of six sub samples from the sampling places marked previously, in a total of 96 samples. This second collect was necessary due to the hard consistence of the samples collected in a first occasion, making impracticable the nematode isolation. For entomopathogenic nematodes, samples were placed immediately in plastic boxes consisting insect traps with *Galleria mellonella* larvae. The larvae mortality was verified during the fifth to seventh following days, period of storage since the collect. Dead larvae were placed in a device for nematodes collection (White trap), to collect infective juveniles from the cadaver. Collected nematodes were washed with sterilized distilled water and Ringer solution, passing by sieves of 200 and 500 mesh, where they were retained. Nematodes were stored at a concentration of 10.000/mL in Ringer solution, in closed recipients of 50 mL, at temperature conditions near 11°C. It was possible to isolate 5 (five) new strains of entomopathogenic nematodes from *Heterorhabditis* genus (Nematoda: Heterorhabditidae) from the samples 5, 41 and 61 (samples in forest, from Guanabara II and Nova Aliança locates – windows 3 and 4, respectively), 64 (young secondary forest, from Nova Aliança locate – window 4) and 71 (old secondary forest, in an initial stage of regeneration, from Nova Aliança locate – window 5). These nematodes will be identified at the level of species during the second half of 2005, at the Florida University/USA, with the help from Dr. Nguyen, K.B., supervising a PhD training for Andaló, V., co-author of this work. For fungi, we are now working with aliquots of 1 g of each sub sample, originally collected for nematode

isolation, following the same sampling methods, stored at refrigerator conditions, between 4-8 °C, until successive dilution in sterilized distilled water up to 10.000 times (10^{-4}). Replicates of 0,1 mL of the dilutions 10^{-3} and 10^{-4} of each sample will be made in a selective culture medium (with fungicide Dodine) and in PDA medium (potato-dextrose-agar). This methodology is a modification from the original methods conducted for saprophytic and plant pathogenic fungi group. After fungi growth, the identification of the cultures of interest (mainly *Metarhizium anisopliae, Beauveria bassiana* and *Paecilomyces* spp.) will be made in an optical microscope, with subsequent culture purification and conidia storage in Eppendorf tubes at freezer conditions. We are also isolating entomopathogenic fungi from *G. mellonella* larvae used in nematodes isolation, but naturally infected by fungi in the soil sample, using the same culture media previously described.

7. Conservation and Sustainable Management of Below Ground Biodiversity: Biodiversity of Fruit Flies (Diptera: Tephritidae) of Economic Importance and Hosts Plants (Brasil)

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Abstract

The evaluation of fruit flies biodiversity is being based in samples of host fruits and traps. Occurrence and distribution of these insects were studied in the county of Benjamin Constant - AM, at the windows selected by the project (Benjamin Constant, Guanabara I, Guanabara II, Nova Aliança I, II e III). Fruits were collected of three botanic species (*Passiflora nitida*, *Passiflora* sp (Passifloraceae), *Psidium guajava* (Myrtaceae) and *Bellucia grossularioides* (Melastomataceae)) from orchards, backyard orchards and native forest, near sampling points. A total of twelve traps (like McPhail model) were placed in the six windows, being two traps per window. These traps remained for three months (february - may of 2004), located just outside the canopy at a height of 2.50 - 3.00 m with an eastern exposure. The distance between traps was at least 200m. The bait was passionfruit juice (concentration of 10%) and sugar (concentration of 10%). The traps were replaced every seven days. A total of 355 fruit fly specimens of genus *Anastrepha* were collected and twenty one species of this genus were recorded. *A. striata* was the most frequent (29,6%), predominating in all of the windows collect. *A. bahiensis* was the second specie most frequent (13,5%). Guanabara and Nova Aliança were the windows with the most diversity index in terms of fruit flies species.

8. Characterization of soil fungi in different agro-ecological units in Centre-West Côte-d'Ivoire

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Keywords : *Agro-ecological units, diversity, fungi, morphological typing*

Abstract

Soil fungi play a key role in ecosystem functioning. In order to identify these organisms from different agro-ecological units, varying from primary forest to mixed crops fields, samples were taken within a grid system. Forty composite soil samples were randomly obtained from eight land use types and fungi isolated using two techniques (dilution and particles plating). Results showed that both perennial and food crops exhibited the lowest

numbers of spores per gram of dry soil. The highest numbers were obtained in fallows and secondary forest. Moreover, several fungi groups and genera were identified. It appeared that the genera *Aspergillus*, *Penicillium*, *Trichoderma* and *Fusarium* were the most abundant. Rare species such as *Sclerotium*, *Acremonium*, *Geotrichum*, *Pythiopsis* and *Phytophthora* were mainly found in agricultural areas. No *Fusarium* was found in teak plantations and neither was *Trichoderma* in fallows.

9. LAND USE SYSTEMS AND DISTRIBUTION OF *TRICHODERMA* SPECIES IN EMBU REGION, KENYA

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Key words: *Trichoderma, Land use, Soil attributes*

Abstract

The distribution of *Trichoderma* species in soils of Embu region was investigated. The study area was chosen because of its significant land use intensification. Soil washing and dilution plate techniques were used to recover *Trichoderma* spp from the soil samples. The fungal isolates were identified and assigned to eight species. Greater populations as well as a wider range of species were obtained in soils collected from the natural forests while coffee farms were the poorest ones. Land use affected the distribution of *Trichoderma*. Napier farms had the highest abundance of this fungus. The species which showed the highest incidence in all cases was *T. harzianum*. Both inorganic and organic fertilizers are used in the region. There was a negative correlation between amount of chemical fertilizers and abundance of the fungus. Organic fertilizers were used exclusively in Napier farms that had the highest fungal abundance. Soil pH and amount of phosphorus were limiting and influenced the occurrence and abundance of this fungus. However carbon and nitrogen were not limiting though they were high in the forests and napier farms where the fungus was also abundant. *Trichoderma* showed tolerance to soil acidity since it was abundant in the most acidic soils under napier.

Land intensification affected *Trichoderma* distribution. Land use system and type of fertilizer used influenced the distribution and abundance of *Trichoderma*. Populations of this fungus in soil with a history of organic production practices were higher than in soils under conventional production practices.

Session 7. Standard methods for inventory of BGBD

Content

1. Rapid assessment of the abundance and diversity of earthworm communities in tropical ecosystems: a study case from Cote d'Ivoire

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Introduction

Under the tropics, the study of earthworm diversity has long been neglected for three mains reasons: (1) the lack of a rapid protocol to assess their abundance and diversity, (2) the absence of an agreed upon sampling scale of their community and (3) the increasing issues related to the measurement of their ecosystem services.

For over a decade, most of studies on earthworms have been undertaken using the so-called TSBF method (Anderson & Ingram 1993) for soil macroinvertebrates sampling in Africa (Gilot et al. 1995, Haynes et al. 2003, Dlamini & Haynes 2004) in Asia (Bhadauria et al. 2000) and South-America (Decaëns et al. 1994, Barros et al. 2002, Decaëns et al. 2004, Mathieu et al. 2004). The sampling unit of this method is a soil square monolith of 25x25 cm and 30 cm depth; the protocol consists in digging at least five soil monoliths along a transect per study plot.

Despite the relative success of the TSBF method to estimate soil macroinvertebrates abundance and diversity, Agosti et al. (2000) and Eggleton et al. (1999) have proposed exhaustive sampling protocol respectively for ants and termites because of their specificity due to the extreme scarcity of nests and their clumpy distribution. As a result, there has been a growing interest for searching more appropriate sampling protocols based on the biology and ecology of earthworms. However, small soil monoliths have been successfully used to show significant changes in earthworm diversity under different land management practices (Fragoso et al. 1997, Decaëns & Jiménez 2002) at plot level. Few investigations have focused on the assessment of earthworm abundance and diversity in agricultural landscape.

Originally, earthworm populations have been studied using large soil monoliths of 1 m^2 (1mx1mx40cm) for demographic purposes (Vincent 1969, Lavelle 1978). Recently, the combination of large (1mx1mx40cm) and small (25x25x30cm) soil monoliths has been efficiently used to survey population dynamics of the peregrine earthworm *Hyperiodrilus africanus* (Tondoh & Lavelle 2005). Regardless of the efficiency of large monoliths for demographic survey in earthworm populations, they were not frequently used because they were time-consuming and tedious. The need of an alternative size of soil monolith has been tested by using medium-size (50x50x40cm) monolith to assess the impact of mulching with velvet bean on earthworm populations (Ortiz-Ceballos & Fragoso 2004).

Since agriculture practices result in a mosaic of land-use types covering a large land surfaces, the great challenge for the coming years is to develop a rapid sampling protocol to assess abundance and diversity of earthworm communities at landscape scale. This point is crucial for developing indicators of land degradation (Moreno et al. 2000, Burel et al. 1998) using small animal as earthworms known to be sensitive to human-induced changes (Fragoso et al. 1997, Fragoso et al. 1999, Decaëns & Jiménez 2002).

As part of the UNEP/GEF funded project entitled "Conservation and Sustainable Management of Below-Ground Biodiversity" (CSM-BGBD), this paper is a contribution of the output 1 aiming at developing a standardized method for sampling earthworm abundance and diversity.

The purpose of this paper was to propose an integrated method to compare earthworm communities abundance and diversity across the seven countries involved in the project (Brazil, Côte d'Ivoire, Indonesia, India, Kenya, Mexico and Uganda).

Overview of sampling protocol used

- Mandatory : one monolith (25x25x30 cm) per sampling points within a grid system (ALL THE COUNTRIES)
- Optional : large monoliths (50x50x20 cm)
    - Mexico = two large monoliths per sampling points
    - Côte d'Ivoire = tree large monoliths chosen randomly in 5 sampling points per land-use types

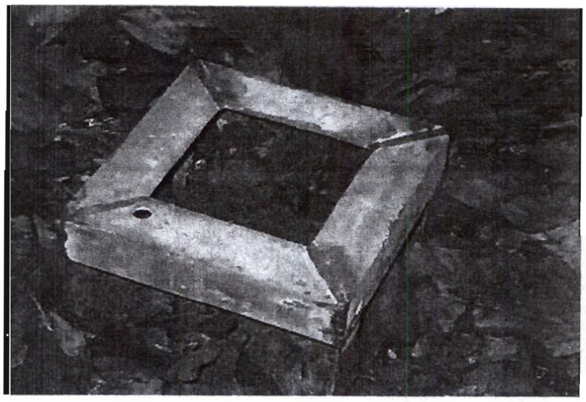

Figure 1. *Iron frame used for the delimitation of small soil monoliths*

Details of the sampling procedure

Sampling point allocation

The sampling was performed within a grid system installed within a benchmark area using aerial photographs or satellite images.

Depending on land-cover fragmentation in each benchmark area, one or several windows were laid out. A single window was laid out as to cover a gradient of representative land-use types in the benchmark area. In case of land-use systems characterized by the presence of large land-use types, where it was quite impossible to catch diverse land managements, each window should cover one or two representative land-use type in order to select a gradient of land-use intensification, from natural ecosystems to tree-based and crop systems.

Regular sampling points spaced out by 100 to 200 m were allocated to the whole grid systems. Each sampling plot was materialized by a central stake.

Figure 2. *Direct hand-sorting of earthworms in aluminium trays*

Earthworm sampling protocol

Sampling campaign was conducted at the end of the rain season where earthworms are known to be more active (Tondoh & Lavelle 2005). The protocol consists in combining the regular and random sampling approaches.

Regular sampling protocol

At each sampling point, one small monolith (25x25x30 cm) was dug out (Fig. 1). Each monolith was stratified into three layers each 10 cm deep and earthworms were collected by hand-sorting (Fig. 2).

Stratified sampling protocol

Five sampling points were randomly chosen in each land-use types. At each selected point, earthworms were sampled following TSBF sampling procedure (Anderson & Ingram 1993). Three large monoliths of 50 cm side and 20 cm depth (Fig. 3) were dug out at 5 m interval along a random transect perpendicular to the slope (modified TSBF protocol, Anderson & Ingram 1993). Contrary to the regular protocol, three monoliths were excavated in order to take into account heterogeneity at plot level (Fig. 4). Each monolith was separated in two layers (0-10 and 10-20 cm) because most of individuals (57 to 99%) are located in the first 20 cm during the raining season (Tondoh & Lavelle 2005) Earthworms were hand-sorted and stored in 4% formalin solution. After a raw identification at morphospecies level, representative individuals were sent to Natural History Museums for further confirmation of identification or correction by experts in earthworm systematic. Individuals were then identified, counted and weighed.

Integrated sampling protocol

The trade-off between the requirement of taking into account the whole landscape for the sampling of earthworms and the need to take into account local variation in populations can be reached by developing a protocol that would combine the digging of one TSBF monolith (25x25x30 cm) and three large monoliths (50x50x20 cm) along a transect at each sampling point (Fig. 4). The integrated sampling protocol is therefore a stratified sampling scheme combining small and large soil monoliths.

Data processing

Earthworm abundance

Earthworm abundance was estimated through the density (number of individuals per m^2) and biomass (g of individuals per m^2).

Earthworm diversity

Earthworm diversity can be studied at two complementary levels: taxonomic and functional diversity (Bouché 1977, Lavelle 1983, Fragoso et al. 1997). The functional aspect of diversity is of utmost interest when it comes to assessing the relationship between diversity and ecosystem services.

- α diversity (species richness of a particular land-use type) was analyzed using three expressions of species richness: (1) the cumulative species richness (2) the average species number (3) the Shannon index
- β diversity (turn-over of species among different land-use types of the entire landscape was measured by the complementarily index of Colwell and Coddington (1994) = degree of difference between species lists
- C= (species exclusive to one list)x100/(combined richness), C is ranged between

0 and 100

- γ diversity (species richness of the entire landscape) was estimated as the sum of the average species number of each land-use types (Moreno & Halffter 2001)

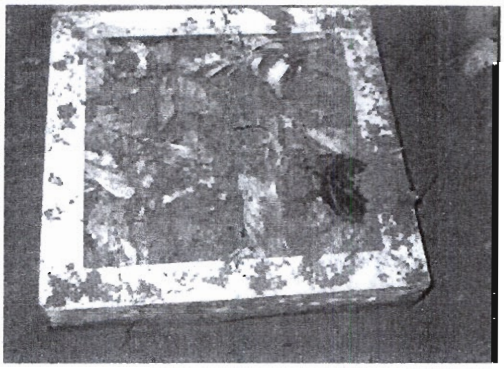

***Figure 3.** Iron frame used to excavate large soil monoliths (50x50x20 cm)*

Taxonomic diversity

The first level of taxonomic diversity deals with the number and the identity of earthworm species. It was analysed using three expressions of species richness: (1) the cumulative diversity, which is the total number of species recorded in the total number of monolith per land-use type, (2) the average diversity expressed as the mean of species number per land-use type and (3) the Shannon-Wiener index of diversity (Pielou 1966):

$$H = -\sum_{i=1}^{n} p_i \log_2 p_i$$

Where, p_i is the frequency of the i species.

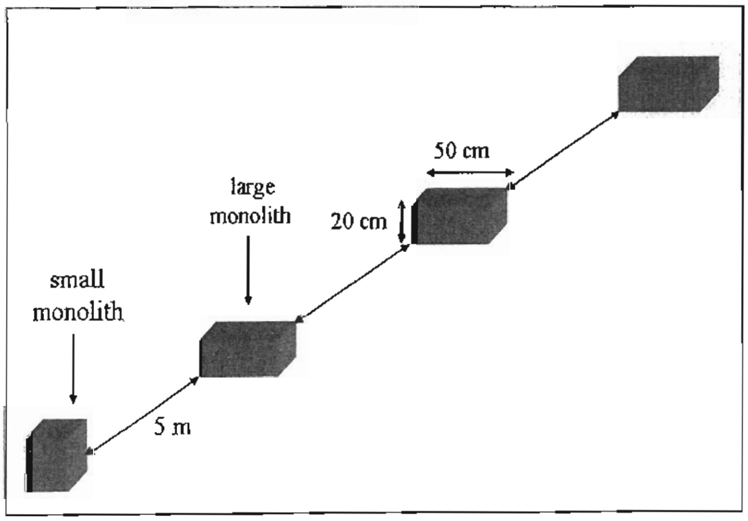

***Figure 4.** Sampling scheme of large soil monoliths*

The second level of taxonomic diversity deals with earthworm biogeography (Fragoso et al. 1997). In a given ecosystem, two groups of earthworms can be distinguished according to their origin: native or exotic species.

Native species are characterized by a restricted distribution at local, regional and continental levels. Exotic species are in many cases introduced by human. They have been called peregrine to point out their wide distribution at regional and continental levels (Lee 1987).

The ratio of native to exotic can be used as an index for native species extinction or invasion index of exotic or peregrine species.

The analysis of earthworm communities through this approach was done by identifying in each land-used type native and exotic or peregrine species. The structure of earthworm communities was characterized through the density and the biomass of native and exotic worms.

Functional diversity

The importance of functional diversity of earthworms has been documented widely (Fragoso et al. 1997, Lavelle et al. 1999, Lavelle 1983, Blanchart et al. 1997). Ecosystem services of earthworm are related to the impact of their activity on the soil system (Lavelle et al. 1997). From an ecological point of view, earthworm communities can be divided into three groups: epigeic, endogeic and anecic (Bouché 1977, Lavelle 1981):

- epigeic earthworms: they are small size with pigmentation and live in the litter system at soil surface;

- endogeic earthworms: they are medium-size worms, unpigmented and live within the soil. As a result of their activity, casts are produced within the soil profile and at soil surface;

- anecic earthworms: they are large and unpigmented. They live in soil but feed at the surface. Their activities result in dense network of burrows within the soil.

Most earthworms belonging to the endogeic and anecic type are called ecosystem engineers (Lavelle et al. 1997) because they are active in mixing and digging the soil, modifying then hydraulic and chemical processes.

Earthworm can be classified according to the ecological categories on the basis of their density and biomass.

Statistical and data analysis

Species accumulation curves were obtained by taking the number of soil monolith randomized 500 time using EstimateS software version 6.0b1 (Colwell 2000). Mean comparison of Shannon-Wiever index, species number and earthworm cast production were performed using the Fisher PLSD test at 0.05 probability level. The Kruskal-Wallis test was used to assess the impact of land-use types on earthworm abundance. The relationship between earthworm abundance and land-use index was tested using regressions.

Another approach is to normalize earthworm density and biomass before performing ANOVA test.

Multivariate analysis like Principal Component Analysis (PCA), Correspondence Analysis (CA), Co-inertia analyses can be used to stress factors affecting earthworm density and diversity across agricultural landscapes (Thioulouse et al. 1995).

Conclusion

The next step will be the collection of data to test the completeness of earthworm diversity inventories using this rapid sampling protocol. The advantage of this protocol is its self-control due to the possibility to test the efficiency of sampling the abundance and diversity of earthworm communities at plot level. The main issues arising from the use of the methodology included:

- Data availability!?
- Project structure: WCC, EA, CTK. Who is doing what?
- Internal evaluation: Kenya, Uganda, Brazil, India!?, Indonesia!? MEXICO, COTE D'IVOIRE
- Formalin method as agreed in Nairobi???

- Molecular characterization???

A study case from Cote d'Ivoire

- Use of a COMBINED rapid system of biodiversity inventory
- Two approaches: regular and stratified grid sampling
- Density and biomass characterization
- Three-step biodiversity measurement method (Hallfter 1998)

Results

- Large monolith (50x50x20 cm) versus small monoliths (25x25x30 cm) in the stratified grid approach
- Stratified approach versus regular approach

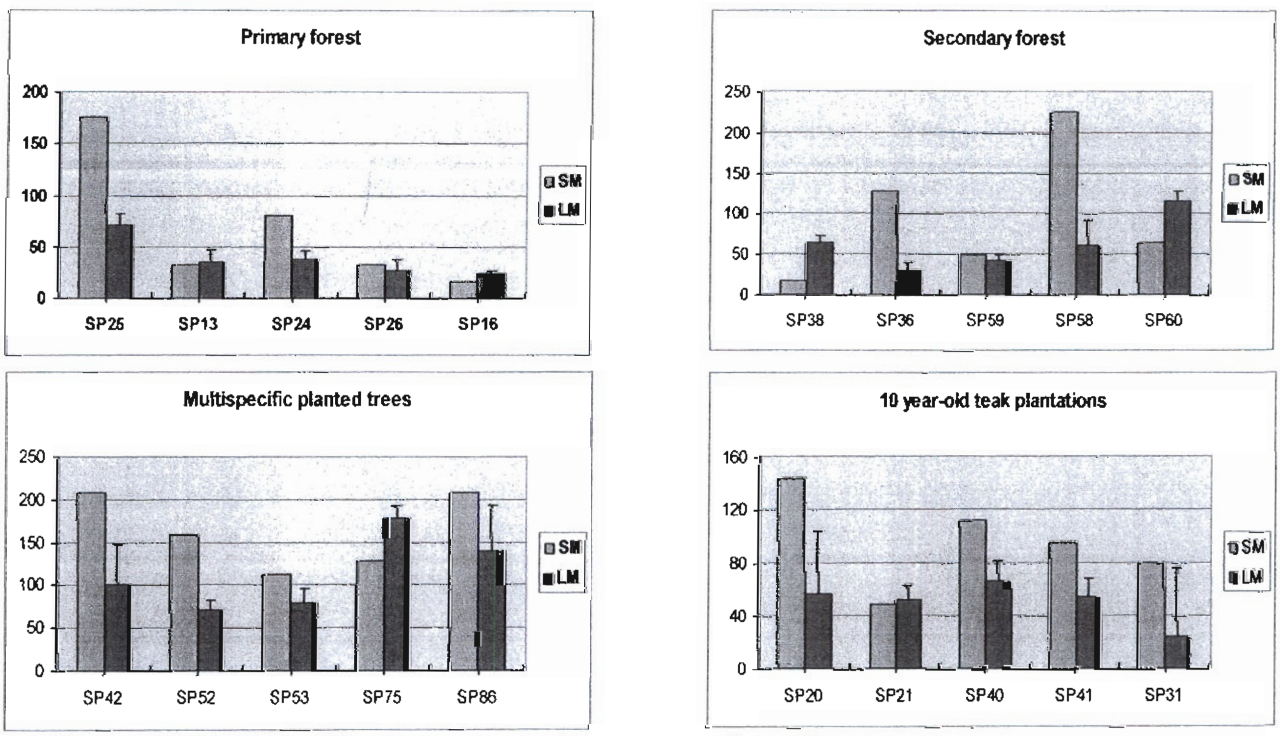

***Figure 5**. Large monoliths vs small monoliths (individuals m-2)*

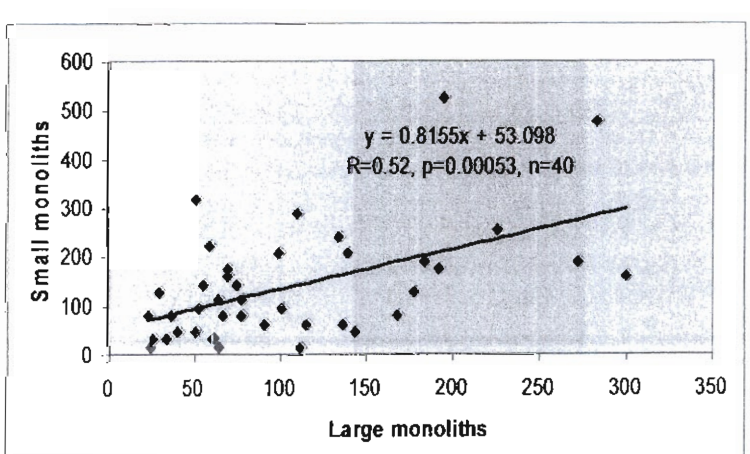

***Figure 6**. Significant linear relationship between SM and LM*

Table 1. Correction index (SM/LM)

	Individuals m-2	Species m-2
LM	108.0 ± 11.7	5.2 ± 0.22
SM	141.1 ± 18.2	3.2 ± 0.2
Correction index	1.6 ± 0.2	-

Table 2. Data for small monoliths

Agro-ecological units	Sobs	ACE	Efficiency (%)
Primary forest	6	8.26	72.6
Secondary forest	7	9.27	75.5
M; planted trees	8	8	100.0
10 year-old teak	7	7	100.0
4 year-old teak	5	5	100.0
Cocoa plantation	7	8.5	82.4
Recurrent fallow	10	12.14	82.4
Mixed crop fields	6	6.78	88.5

Table 3. Data for large monoliths

Agro-ecological units	Sobs	ACE	Efficiency (%)
Primary forest	11	11.43	96.2
Secondary forest	8	8	100.0
M planted trees	10	10	100.0
10 year-old teak	10	10	100.0
4 year-old teak	10	10	100.0
Cocoa plantations	11	11.56	95.2
Recurrent fallows	11	11	100.0
Mixed crop fields	11	11.68	94.2

Table 4. Stratified (11 species) VS regular (13 species) sampling

R. SAMPLING	S. points	Density	Species	H
Primary forest	5	66.7	2.2	0.83
Secondary forest	25	149.1	3.5	1.36
MSPT	21	190.5	4.5	1.93
20 year-old teak	8	192.0	3.3	1.26
10 year-old teak	7	86.9	2.6	0.69
4 year-old teak	7	221.7	3.0	1.36
Cocoa	8	188.0	3.1	1.42
Old fallow	5	272.0	4.6	1.59
Recurrent fallow	11	1048.7	4.1	1.77

R. SAMPLING	S. points	Density	Species	H
Mixed crop fields	9	142.2	3.2	1.21

Table 4. continued.

R. SAMPLING	Sobs	ACE	Efficiency (%)
Primary forest	7	8.09	86.5
Secondary forest	12	13.6	88.2
MSPT	13	13.61	95.5
20 year-old teak	11	13.45	81.8
10 year-old teak	7	7	100.0
4 year-old teak	7	7	100.0
Cocoa	8	8.51	94.0
Old fallow	9	9.29	96.9
Recurrent fallow	12	15	80.0
Mixed crop fields	9	9.78	92.0

For regular sampling approach: β diversity ranged 0-33.3%; γdiversity = 34 species

Table 5. Stratified sampling

	Sobs	ACE	efficiency (%)
Primary forest	11	11.43	96.2
Secondary forest	8	8	100.0
Multisp. pl. tree	10	10	100.0
10 year-old teak	10	10	100.0
4 year-old teak	10	10	100.0
Cocoa plantation	11	11.56	95.2
Recurrent fallow	11	11	100.0
Mixed crop fields	11	11.68	94.2

	Mean number of species ± SE	Shannon index ± SE
Primary forest	4.20 ± 0.46 a	1.70 ± 0.19 ab
Secondary forest	3.93 ± 0.41 a	1.56 ± 0.17a
Mspt	6.07 ± 0.40 b	2.03 ± 0.11 bc
10 year-old teak	4.20 ± 0.28 a	1.79 ± 0.11 ab
4 year-old teak	6.00 ± 0.37 b	1.97 ± 0.12 bc
Cocoa plantat	6.93 ± 0.30 c	2.21 ± 0.08 a
Recurrent fallow	4.60 ± 0.21 b	1.55 ± 0.10 c
Mixed crop F.	5.33 ± 0.36 a	1.92 ± 0.08 bc

For stratified sampling: β diversity (0-22.2%); diversity (41 species)

2. STANDARD METHODS FOR THE INVENTORY OF TERMITES AND ANTS

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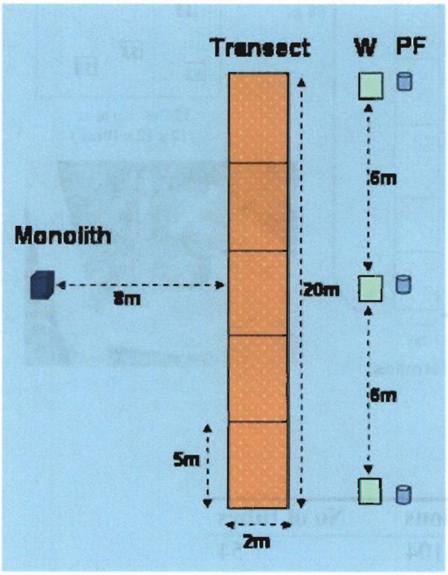
1. Outline

- Overview on standard methods for inventory of termites and ants
  - BGBD minimum sampling protocol
  - Natural History Museum of London (NHM) rapid protocol
- Standard protocol used by the different countries in BGBD
  - Study case from Côte d'Ivoire
  - Synthesis from the workshop in Kenya
- Some open questions



2. Overview on standard methods for inventory of termites and ants

1. BGBD-CSM Minimum sampling protocol for termites, ants and beetles

MANDATORY

a) **1 monolith** (25x25x30cm) per sampling point

► Subterranean (litter) termites, ants and beetles

(b) **1 transect** (20x2m) per sampling point

► termites in soil scrape, soil surface and trees

► standardized sampling effort

(c) **3 Winkler** extractors (1x1m) per sampling point

► ants and beetles in litter

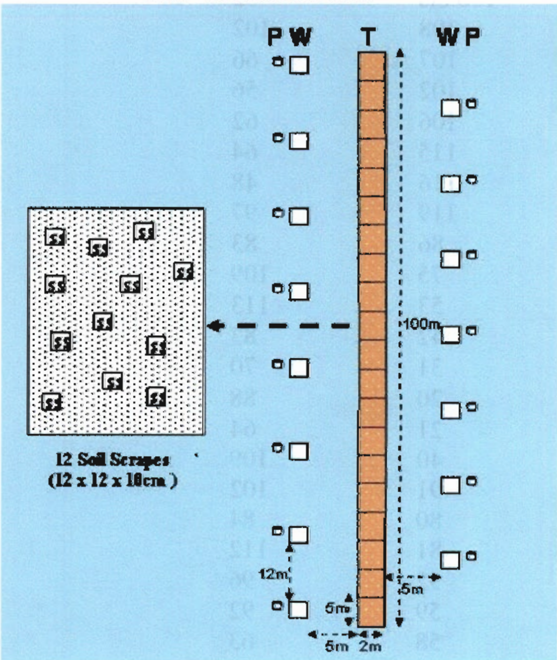
(d) **3 pitfall traps** (13cm diam) per sampling point

► ants and beetles in litter

OPTIONAL

► Transect should be perpendicular to the slope and baited pitfall trap are optional

2. Natural History Museum of London (NHM) rapid sampling protocol for soil and litter invertebrates



TERMITE TRANSECT

(from Jones *et al.*, 2000) :

- 1 transects of 100 m
- 20 section of 10 m² / transect
- 12 soil scrapes / section
- 2 persons/ transect
- 45 minutes / transect

(30min scrape/15min microsites

ANTS TRANSECT

(from Agosti *et al.*, 2000) :

- 2 transects of 100m each
- 15 Winklers of 1m²
- 15 pitfall trap
- 2 persons / transect

Sampling efficiency : More than 70%

3. Standard protocol used by the different countries in BGBD

1. Study case from Côte d'Ivoire

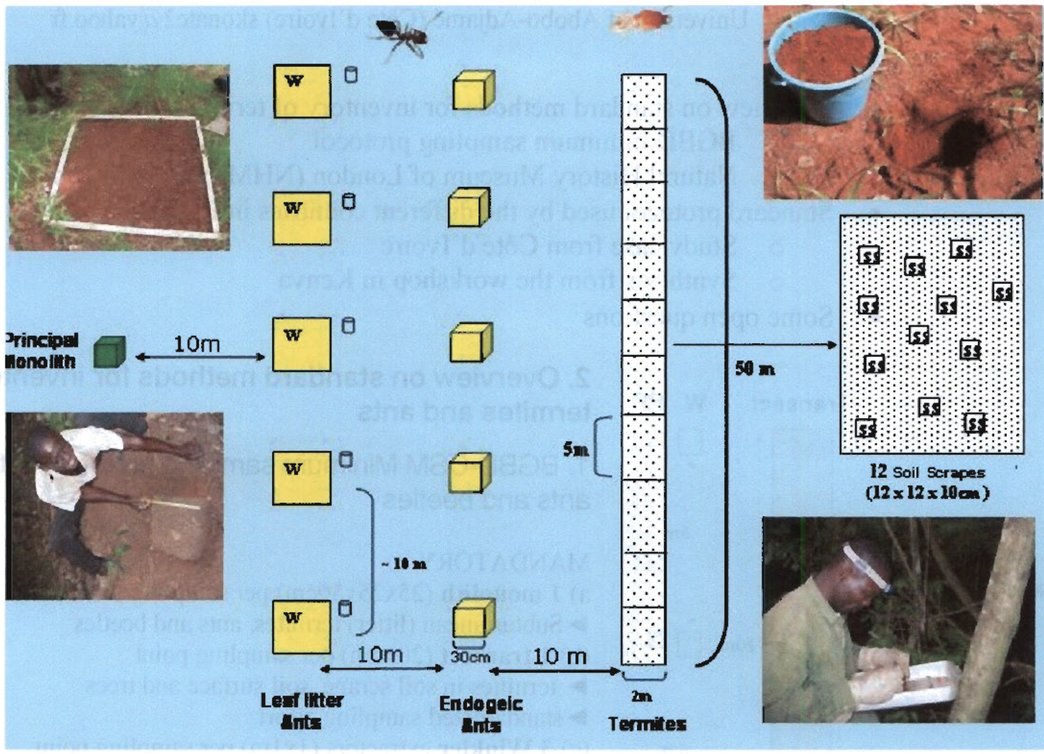


Table 1. Sampling effort in Cote d'Ivoire

Land use types	Dates	Locations	No of tubes
Annual Crops (AC)	30/06/04 - 05/07/04	104	54
		103 bis	59
		101 bis	87
		96bis	101
Perenial Crops (PC)	29/06/04 - 07/07/04	106 bis	62
		108	102
		107	66
		102	56
Fallow (FA)	08/07/04 - 12/07/04	106	62
		115	64
		116	48
		119	97
Plurispecific Reforestation (PR)	13/07/04 - 16/07/04	86	83
		75	109
		53	113
		42	83
Old Monospecific Reforestation Teck 1994 (OMR)	17/07/04 - 21/07/04	31	70
		20	88
		21	64
		40	109
Young Monospecific Reforestation Teck 2000 (YMR)	22/07/04 - 26/07/04	91	102
		80	84
		81	112
		92	96
Primary forest (BF)	27/07/04 - 30/07/04	59	92
		58	63
		60	53
		36	79

Land use types	Dates	Locations	No of tubes
Secondary Forest (UF)	31/07/04 - 04/08/04	25	83
		26	82
		16	53
		13	104
TOTAL	30/06/04 - 04/08/04 (32 jours)	32 (320 sections of 10m2/ 400s)	2580

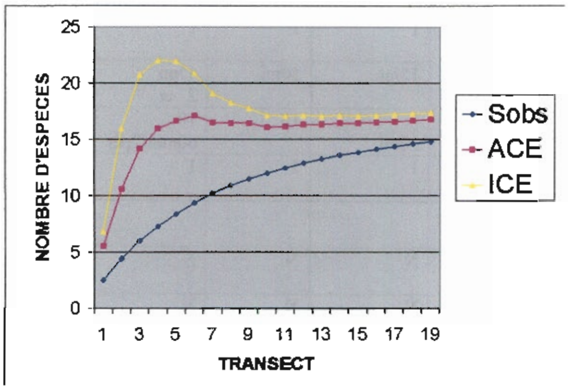


Figure 1. Sampling efficiency > 70%

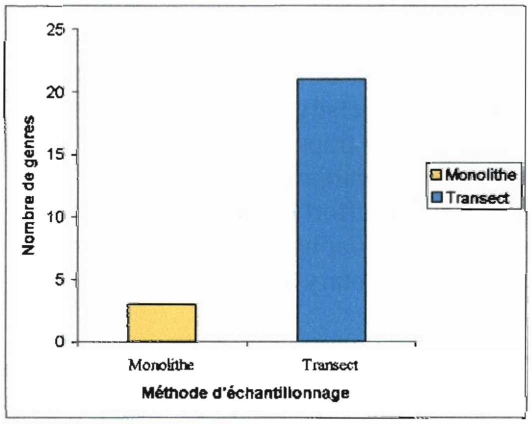


Figure 2. Monololith :4 genera & 7 species; Transect: 21 genera & 47 species

	Family	Sub-family	Genera	SP
Tai forest	3	7	303	44
Oume Forest	2	5	21	47

- From Sangaré et Bodo (1978)

1. Synthesis from the workshop in Kenya

	BRAZI	MEXIC	INDONESI	INDI	UGAND	KENY	COTE	MINI
BENCHMAR USE		1	1	2			1	1
WINDOW USE	6	3	4	2	6	5	1	1
GRID USE	Y	Y	Y	Y	Y	Y	Y	Y
POINT PER LU		5	5	6	7	3	4	3
PROTOCO USE	BGBD Minimu	BGBD Minimu	BGBD Minimu	BGBD Minimu	BGBD Minimu	BGBD Minimu	Hal HN	BGBD Minimu
ADDITIONA PROTOCO	Winkle Pitfal		Winkle Pitfal	Winkle Pitfal	Winkler Pitfal	Pitfal	Winkler Pitfal /Mon	W & Pi Separate tra s
TRANSEC LENGT	20x2	20x2	20x2m	20x2	20x2m	20x2m	50x2m	20x2m
TRANSECT PER		1	1	3	1	1	1	1
SAMPLIN EFFOR /	15mi 4	15mi 2	90mi	60mi	15mi	30mi	45mi 2 er	60
CASUA SAMPLIN	Some		14	10	30mi	10	10 60min/2per	60 surfac ?
SEASONA SAMPLIN	1	1	1	2	1	1	1	To be
DENSIT DETERMINE	N (frequency			YES (M.)				To be
BIOMAS DETERMINE	N	N	N	N	N	N	N	To be
BAITE PITFAL	N	N	N	N	N	N	N	To be
SAMPLIN EFFICIENC	GOO	GOO 80					GOO 70	To be

Open questions

1. Density and biomass of higher termites (fungus growing) in Asia and Africa
2. Abundance and diversity of subterranean ants
3. Question of baiting traps
4. Effect of seasonal variation on sampling
5. Optimal sampling effort (time spent/transect)
6. Co-location with sampling of other taxa (earthworm and microflora)
7. Need of complementary sampling

3. Standard Methods for Mesofauna Inventory: BGBD Programme Indonesia

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Introduction

Mesofauna comprises animals of body sizes ranging from 0.2 to 2.0 mm, *i.e.* Acarina and Collembola, whose abundance can not be assessed by means of hand sorting from the soil. The sampling for mesofauna (and other soil biota) was conducted in accordance with the proposed standard methods for BGBD inventory.

Sampling Methods

Mesofauna was collected by using two sampling methods; the composite of soil cores and the pit-falls trap. Soil core samples were used to collect Collembola that inhabit in the deep soil, whereas pit-fall trap methods were applied to collect soil surface dweller Collembola (and other arthropods).

A. Soil cores sampling and Berlese's extraction

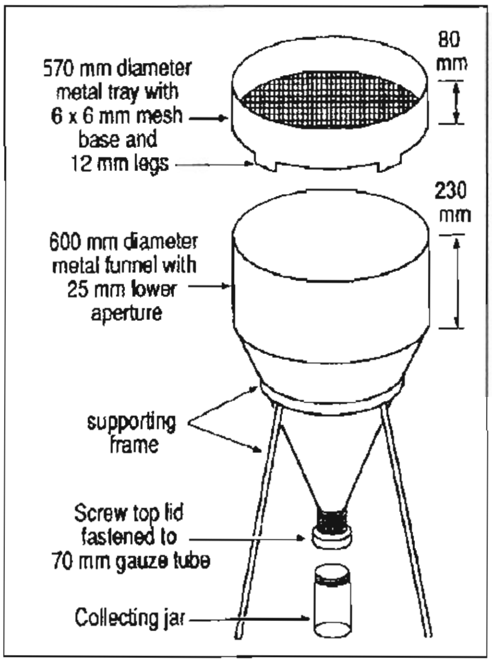
The soil cores were located in ring of 3m and 6m, whereas the closest pit-fall was located 14m from the monolith centre. In the 3 m ring, four sub-samples were located equidistant in between two sub-samples of nematode/microbes (so in the 3 m ring there should be one north-east + one south-east + one south-west + one north-west of the monolith). The rest of the mesofauna soil cores were located in the 6 m ring, each was located equidistant in between two sub-samples of nematode/microbes. Soil sample was collected from 3.5 x 3.5 x 3 cm by using a small spade with certain volume. Soil from 12 sub samples was then placed on a 5-kg plastic bag as a composite.

The composite soil sample of was then divided into 10 plastic bags averaging of 1 kg, labelled, and all bags were transferred into a 30 x 35 cm cloth bag to prevent the death of Collembola. Cloth bags have been very efficient for temporary storing and transporting sample for a longer distance and time because the cloths allow air to circulate and prevent unwanted rise in temperature. As opposed to the use of big plastic-bag that could substantially increase the soil temperature and may lead to Collembola's death. Avoid unnecessary exposure to direct sunlight during sample bagging in the field. Upon arrival in the base-camp, all cloth bags were arranged according to their respective land use and window. Soil samples were then packed in a cartoon box pre-layered with paper to maintain moisture stability inside the box. Samples were then transported using an air-conditioned automobile to the Entomology Laboratory at Museum Zoologie Bogoriense (MZB) Cibinong, Bogor.

Upon arrival in the laboratory, one litre of soil was immediately transferred into a Berlese funnel, *i.e.* soil was spread evenly on a 6x6 mm mesh wire platform inside the coned-aluminium funnel (Figure 2 and 3). A light bulb of 10 watt was set on top of the soil samples and the lid on top was closed to prevent entry of other insects during incubation time of 4-5 days. In some cases, heating/drying process could be done using sunshine or room temperature (incubation time of 10 days or depending on the soil moisture content). The use of light bulb might attract nocturnal insect especially if Berlese funnel was not properly closed or soil might be dried too soon due to increasing temperature. The incoming insect could overestimate the number of the catch while the fast drying soil might cause the death of the faunas. Applying room temperature was relatively safe but the top of the funnel had to be tightly closed.

Figure 2. *Berlese funnel filled with soil and litters.*

Figure 3. *Schematic diagram of Berlese funnel made from aluminium.*



The basic principle of Berlese's funnel is that soil organisms will avoid the increase temperature or dryness in the soil. The soil or leaf sample is placed in the removable upper part of the funnel. Heat or light from the lamp creates a temperature gradient in the soil sample; the upper part of the soil will be warmer than the lower one. This condition stimulates the downward movement of soil arthropods, and similar organism, into deeper layers to find lower temperature/more humid environment, and finally through the gauze (wire mesh) to a receiver container attached to the base of the funnel. The position of the lamp should be adjustable to enable the temperature of the soil to be raised gradually thus preventing the slower moving species from becoming trapped in hard dry cakes of soil. The receiver, usually a jar or a bottle, is filled with 96% ethanol for preservation and harvested at 4-5 days intervals.

B. Pit-fall Trap

Materials for setting pit-fall trap were 13.5 cm plastic buckets, small spade, plastic cover, bamboo sticks, 1% of detergent solution.

Three unbaited pit-fall traps were set at 2 m from the Winkler samples or 14 m from the monolith centre. Pit-falls trap, made of a 13.5 cm diameter plastic bucket, was buried in the soil with its mouth approximately 0.5 cm above the soil surface (Figure 4) for not allowing rain-water flow into the bucket (the sampling was conducted during the rainy season). The trap was filled with 200 ml of 1% detergent solution to avoid faunas escaping from the trap. A plastic cover with dimension of 20 x 20 cm was placed 15 cm above the mouth bucket to prevent the rain falls directly into the bucket.

The basic principle of the pit-falls was to collect all possible actively dwelling meso- and macro- faunas on the soil surface that falls into the trap. A 24 hour after its instalment, the bucket was emptied and any faunas caught along with the detergent was transferred into plastic bag and labelled for its location, date, window, and land use.

Figure 4. *The placement of pit-fall trap (a 13.5 cm diameter plastic bucket) in soil (top)*

Upon arrival in the base camp, sample faunas were washed with water to remove the detergent. Ant and termites were stored in vials filled with 75% ethanol, whereas Collembola was filtered with Collembola filter (53 μ mesh). After the specimens were freed from soil and other debris, Collembola was transferred into vial filled with 96% ethanol and ready to be brought to the laboratory. Termites and Collembola were identified up to species level while ants are up to generic level.

Collembola Sorting & Identification

- Laboratory of Soil Arthropods of Zoology Division of LIPI in Bogor, Indonesia
- Identified up to genus or species level after Yosii (1981, 1982a, 1982b and 1983)
- Sample previously stored in 70% ethanol
- Clearing specimen w/ Nesbitt's fluid
- Mounting specimen w/ Berlese solution
- Slides are dried at 70oC for 7d in an oven

Clearing Specimen

Nesbitt's fluid:

- 25 ml distilled water
- 40 g chloral hydrates
- 2.5 ml of 1N HCl

✓ **Alternative: KOH or NaOH**

Mounting Specimen

Berlese solution: a mixture of ....

1. 20 ml distilled water
2. 15 g Arabic gum
3. 50 g chloral hydrates
4. 5 ml glycerine, &
5. 5 ml glacial acetic acid

Hoyer's medium

- distilled water 50 ml,
- gum arabic 30 g,
- chloral hydrate 200 g,
- glycerine 16 ml.

Data Analyses

Sorting and Identification

Sorting and identification of Collembola were done in the laboratory of Soil Arthropods of Zoology Division in Cibinong, Bogor, Indonesia. The Collembolan fauna was identified up to genus and species level. Slides were made to identify Collembola specimen through clearing and mounting process. Observation was done under compound microscope. Specimens can be cleared in Nesbitt's fluid (Wang *et al.*, 2003) (distilled water 25 cm^3, chloral hydrate 40 g, 1N hydrogen chloric acid (HCl) 2.5 cm^3). Berlese solution was used for mounting process on object glass and covered with cover slip and dried up in the oven before observed under microscope. Berlese solution was a mixture of 20 ml aquadest, 15 g Arabic gum, 50 g Chloral hydrates, 5 ml glycerine, and 5 ml glacial acetic acid (Christiansen in Dindal, 1990).

Identification of a specimen is best done using a phase contrast compound microscope. Identification and classification were based on Yosii (1981, 1982a, 1982b and 1983). Number of individuals of each order from each site was counted to study the abundance. Collembolan species composition comparison among land uses was performed by hierarchical analysis using Average linkage of agglomerative clustering based on transformed abundance numbers. The number of individual was transformed using following equation: $x'=\log10(x+1)$. Transformation was used to avoid the risk of over emphasizing of dominant species in the data analysis. Collembolan species diversity was performed by using Shannon-Wiener Diversity (H) and Simpson's Diversity (1-D) with

Program DIVERS Ver. 5.1 from Ecological Methodology Package for Windows. The Shannon-Wiener index is particularly sensitive to the abundance of rare species, in contrast, Simpson's Index is more sensitive to changes in the more abundant species than rare species (Krebs 1989), Simpson's index is used to calculate the distribution of abundance each species (equitability).

Result of Collembola inventory in Indonesia

The two sampling methods were successfully conducted for the study of the Collembola inventory in Sumberjaya, Indonesia. The soil cores were intended to catch deep soil Collembola, whereas the pit-fall trap was aimed at catching soil dweller Collembola. Both methods were comparable with pit-fall resulting in higher number of catch than that of coil cores (Table 2). The family composition of Collembola obtained from both sampling method is shown in Figure 5 and 6.

Table 2. Comparison between two sampling methods for mesofauna inventory

Description	Type of Sampling	
	Soil Cores	Pit-fall
A. Sampling		
Protocol in each sampling point	12 soil cores bulked into composite and take @ 1 kg of soil from it	3 pit-falls; faunas collected 24 h after trap setting
Sample handling	Soil sample is put in Berlese funnel to collect faunas.	Collected samples are washed and filtered thru 53 µ mesh.
B. Result		
Total no. of catch	3154	14245
No. of taxa identified	20 order	21 order
The most dominant taxa	Collembola 41 % Acarina 36 % Diptera 4.6 %	Collembola 60 % Hymenoptera 24 % Diptera 7.2 %
Collembola	7 families 44 species 1305 individuals	9 families ? 8527 individuals
Dominant family	Isotomidae 41.68% Entomobryidae 39.40% Hypogastruridae	Entomobryidae 42.25% Hypogastruridae 39.18% Sminthurididae 8.52%
Abundance	ranged from 4.5 to 44.30 encounters/litter	20-110 encounters per trap
Diversity	ranged from 10 to 24 species	nd*

*nd = not determined

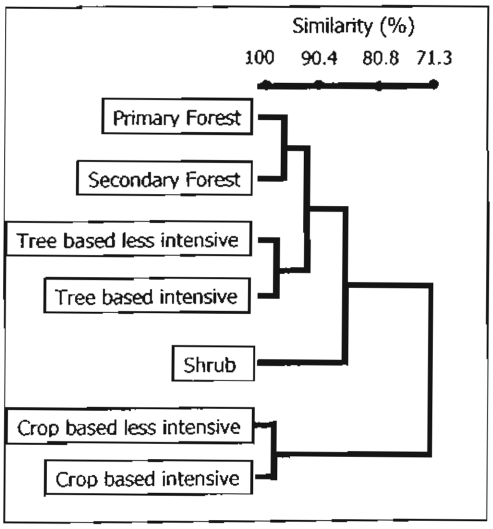
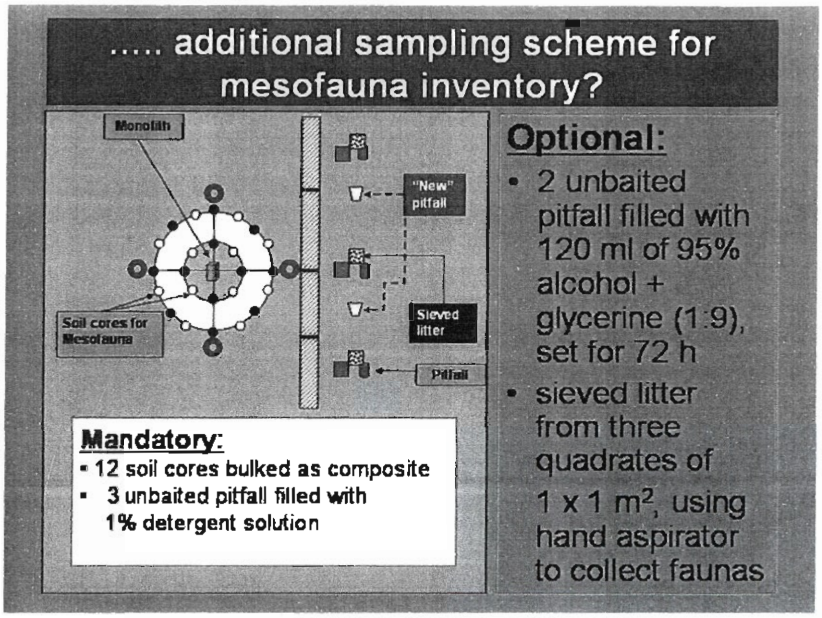


Figure 5. *The cluster analysis of Collembolan communities in seven land use in Indonesia based on Average linkage using MINITAB Program for Windows (from Rahmadi, 2004)*

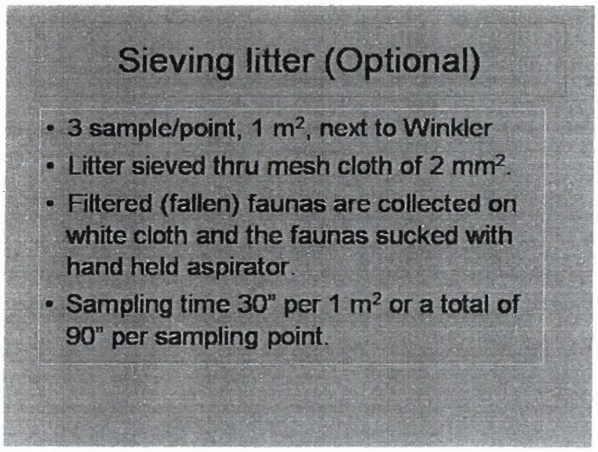
Discussion

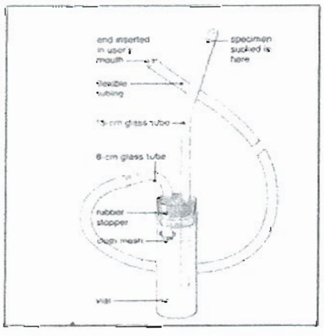
Indonesia selected 7 land uses in Lampung benchmark for BGBD inventory and each land use type had previously (desktop study) been assigned to have 14 sampling points, with a total of 98 (7 x 14) sampling points. In fact, not all land use types could contain 14 sampling points due to their low availability in the field, for instance CBLI (crop-based less intensive) could only accommodate 6 sampling points and FLI (forest less intensive) only had 12 sampling points, and hence the total sampling points in Sumberjaya were 88. Nonetheless, we feel that the number of sampling points per land use type was still too many and need to be reduced any way. Five or six sampling points per land use type may be a reasonable number.

Collembola was the most dominant fauna collected from both soil cores method and pit-fall traps, which composing of 41- and 60-% respectively of the total catches. Both methods were able to catch significant number of Collembola in the study site and they, therefore, should be implemented for the study of Collembola. An elaboration of pit-fall trap, however, needs further investigation, *i.e.* using 120 ml of 96% alcohol solution, instead of 1% detergent solution, and faunas are collected 72 h after trap setting (compare to 24 h with detergent solution).



Other means for collecting mesofauna from litter could be done by hand using a "mouth operated aspirator", a manually sucking device with plastic pipes attached on collecting transparent tubes that operate like a vacuum cleaner. A worker puts one end of plastic pipe into his/her mouth, sucking it, whereas the other end is an inlet to collect faunas previously filtered (sieved) from litter that fallen on white cloth. The litter is obtained from 1 x 1 m^2 soil surface with three replicates per sampling point. The time needed to collect the faunas is 30 minutes in each quadrate, and 90 for the total of 3 quadrates. Collected samples are then stored into vial filled with 96% alcohol.





A sucking-type aspirator

Compare to Simpson index diversity, the Shannon-Wiener was relatively more fluctuating. The Shannon-Wiener index is more sensitive to rare species rather than Simpson index (Krebs 1989).

Conclusion

1. The sampling protocol was conducted according to the plan although the number of sampling points per land use needs to be reduced. We suggest that five sampling points per land use are considered representative enough to study the mesofauna.
2. Twelve soil cores and tree pit-falls per sampling points are very representative methods to study the diversity and abundance of Collembola.
3. Additional sampling methods are proposed; (1) "new" pit-fall trap filled with 120 ml of 96% alcohol solution and set in the field for 3 days, and (2) sieving litter methods by using aspirator to collect the faunas.

4. Methodology for soil nematode diversity evaluation

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1. Soil sampling:

In the grid system, from each point, draw two vertically cross lines and two circles, with 3 m and 6 m radius, respectively. A carbon steel tube makes four sampling cores with 20 cm depth in the small circle, and eight cores in the large one, as below figure shown. The twelve soil cores are placed into a plastic bag, which has to be sealed to avoid desiccation, and also kept out of sunlight. They are transported in an insulated box to the laboratory, and stored at 4 °C until extraction that should be done as soon as possible.

2. Soil water content and Nematode extraction:

After the soil sample is uniformly mixed, 300 cc of soil from the soil bag is added with 2-liter water in a bucket, agitated for 30 seconds, and waited another 2 min for sedimentation of soil particles. The suspension is then passed through a 60-mesh (250 µm) screen, and nematodes are collected directly by 400-mesh (37 µm) screen. The nematode suspension is further clarified by a modified centrifugation sugar flotation method (Jenkins, 1964). By the method, the suspension is rotated at 3500 rpm for 5 minutes to discard the supernatant. After the residue in the centrifugal tube is re-suspended with sucrose solution (456 g/l), and re-rotated at 1000 rpm for 1-2 min, nematodes are then collected from the supernatant by a 37-µm screen.

3. Nematode fixation and counting:

The extracted nematodes are killed by hot water at 50-70 °C within less than 1 min, and fixed with Golden solution (final in 3 % of formalin) (Hopper, 1970), and the suspension is adjusted to 15 ml. The nematode population is totally counted, or counted by randomly removing 1 ml from the solution, and the total number is calculated by the mean of three counts x 15.

4. Glycerin infiltration and nematode observation:

Seinhorst's method (Seinhorst, 1959) is modified to avoid picking up nematodes one by one for making high amounts of permanent slides. By this method, the nematode suspension is reduced to 3 ml, also added with 7 ml of Seinhorst I solution in a 5-cm-diameter Petri dish, and placed into a desiccator at 43 °C for overnight. The solution, being removed from the desiccator on the second day, is dried at the same temperature for 4 hrs or more, to reduce at least half volume. After being completed to the same volume (10 ml) with Seinhorst II solution, the dish is returned to the desiccator for overnight again. The process is repeated for three times (it is not necessary to add Seinhorst II for the last time), and the dish is maintained at the same temperature for at least 48 hrs, the time sufficient to evaporate all alcohol. After this process, the nematodes from the dish are mounted on slides. One hundred nematodes from the slides in each sample are randomly selected for identification to genus level by using a compound light microscope (400-1000x).

5. Functional groups:

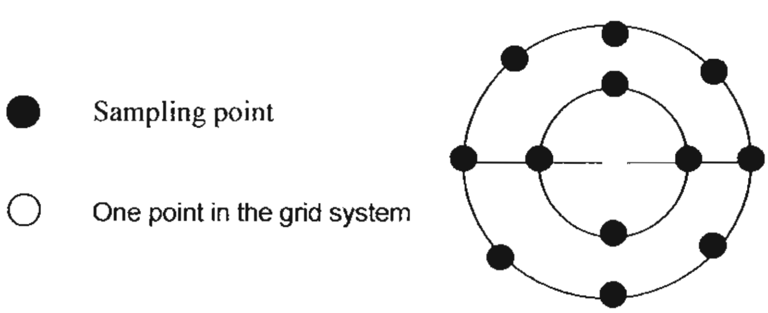
The nematodes in genus level are then allocated into five trophic groups (bacterial and fungal feeders, plant parasites, omnivores and predators) based on information of Yeates *et al.* (1993).

6. Indices and parameters:

The data are then transformed into the following measurements with formulas described for absolute frequency, total abundance, relative abundance, trophic groups (bacterial and fungal feeders, plant parasites, omnivores and predators) (group allocation after Yeates *et al.*, 1993) (If one nematode had two types of feeding habits, its population number was divided by two for each one), genus richness index ($d = (S - 1)/\log N$, where S = number. of genera, and N = total number. of nematodes), Simpson's diversity index ($Ds = 1 - \Sigma(p_i)^2$, where, p_i = percent of genus "i" in the total abundance), Shannon-Wiener's diversity index ($H' = -\Sigma\, p_i \log_2 p_i$), evennesses of Simpson's diversity index ($Es = Ds/Ds_{max}$ where $Ds_{max} = 1 - 1/S$) and of Shannon-Wiener's diversity index ($J' = H'/H'max$, where $H'max = Log_2\, S$), trophic diversity index ($T = 1/\Sigma\,(p_i)^2$, where p_i = relative abundance of one trophic group) (Norton, 1978; Magurran, 1988; Krebs, 1994), the ratios of fungivore/bacterivore (FF/BF) and of (fungivore+bacterivore)/plant parasite ((FF+BF)/PP), and percentages of criconematids and of dorylaimids in population.

Bongers (1990) allocated soil nematodes from colonizers (c) to persisters (p) (similar to r- and k-strategists, respectively) into cp scale from 1 to 5. The cp 1 colonizers were characterized with short generation time, producing many small eggs, always active, present dauer larvae and growth under food-rich conditions, in contrast, the cp 5 persisters were distinguished by long generation time, producing few but large eggs, low motility, absent dauer larvae and very sensitive to pollutants and other disturbance factors (Bongers & Bongers, 1998). Based on these concepts, several indices have been used as soil assessments: the maturity index (MI) (only including these free-living nematodes) (Table 1) and the plant parasitic index (PPI) (only including those plant parasites) (Table 2). To measure soil disturbed level (Bongers, 1990), both indices were calculated by the same formula, $\Sigma\, v_i \times f_i$ (where, v_i = c-p value from 1 to 5 for genus "i", and f_i = relative frequency of genus "i"), $MI_{2\text{-}5}$ (same as MI, but the cp-1 nematodes excluded) to evaluate pollution-induced stress factors, the PPI/MI ratio to assess soil fertility (Bongers & Bongers, 1998).

Figure 1. *Scheme of 12 soil sampling points:*



Scheme of Modified Seinhorst´s method

(Process of infiltration of glycerin to high amount of nematode population)

3 parts Golden X, 7 parts Seinhorst I → Desiccator at 43 °C overnight → Drying at 43 °C for 4 h, to reduce about ½ volume → Complete Seinhorst II → Desiccator at 43 °C overnight → Drying at 43 °C for 4 h, to reduce reduce about ½ volume → Complete Seinhorst II → Desiccator at 43 °C Overnight → Drying at 43 °C for 4 h → Desiccator at 43 °C overnight → Drying at 43 °C for 48h

(In this process, the desiccator is filled about 1/3 of volume with 96% alcohol)

Composition of reagents used for nematode fixation and glycerin infiltration

	Golden X	Golden 2X
Formalin (± 40% formaldehyde)	8 parts	16 parts
Glycerin	2 parts	4 parts
Distill water	90 parts	80 parts

	Seinhorst I	Seinhorst II
96% Alcohol	20 parts	95 parts
Glycerin	**2 parts**	**5 parts**
Distill water	78 parts	

Table 1. Families and cp values used for the maturity index*:

Neotylenchidae	2	Achromadoridae	3
Anguinidae	2	Ethmolaimidae	3
Aphelenchidae	2	Cyatholaimidae	3
Aphelenchoididae	2	Desmodoridae	3
Rhabditidae	1	Microlaimidae	3
Alloionematidae	1	Odontolaimidae	3
Diploscapteridae	1	Aulolaimidae	3
Bunonematidae	1	Bastianiidae	3
Cephalobidae	2	Prismatolaimidae	3
Ostellidae	2	Ironidae	4
Panagrolaimidae	1	Tobrilidae	3

Myolaimidae	2	Onchulidae	3
Teratocephalidae	2	Tripylidae	3
Diplogasteridae	1	Alaimidae	4
Neodiplogasteridae	1	Bathyodontidae	4
Diplogasteroididae	1	Mononchidae	4
Tylopharyngidae	1	Anatonchidae	4
Odontopharyngidae	1	Nygolaimidae	5
Monhysteridae	1	Dorylaimidae	4
Xyalidae	2	Chrysonematidae	5
Linhomoeidae	3	Thornenematidae	5
Plectidae	2	Nordiidae	4
Leptolaimidae	3	Qudsianematidae	4
Halaphanolaimidae	3	Aporcelaimidae	5
Diplopeltidae	3	Belondiridae	5
Rhabdolaimidae	3	Actinolaimidae	5
Chromadoridae	3	Discolaimidae	5
Hypodontolaimidae	3	Leptonchidae	4
Choanolaimidae	4	Diphtherophoridae	3

*after Bongers (1990)

Table 2. Families and cp values used for plant parasitic index*

cp2	cp3	cp4	cp5
Tylenchidae	Dolichodoridae	Trichodoridae	Longidoridae
Psilenchidae	Hoplolaimidae		
Tylodoridae	Pratylenchidae		
Ecphyadophoridae	Heteroderidae		
Paratylenchidae	Meloidogynidae		
Anguinidae	Hemicycliophoridae		

*after Bongers (1990)

5. Report on the "Methodology for assessment of arbuscular mycorrhizal fungal diversity"

based on discussion during the training course on the subject held from March 21-25, 2005 at Bangalore, India.

The methodology for the assessment of AMF diversity originally proposed by **Dr. D. Joseph Bagyaraj**, was discussed thoroughly during the first day of the training course on " Arbuscular mycorrhizal fungi and ectomycorrhizae" held at Bangalore from March 21 - 25, 2005.

The participants did not express any difficulties regarding the method of staining the root, determination of percent mycorrhizal colonization, extraction and enumeration of AM spores in soil and MPN method for estimating the number of infective propagules of AM fungi in soil (All these are optional methods). Regarding the identification of the diversity of AM fungi using trap plants, some of the participants expressed that the plants suggested for 'trap pot culturing' viz., sorghum and cowpea do not grow well or get diseased after a few days. After discussion, it was decided to use any suitable host plants, preferably a legume and a grass mix, for this purpose. Similarly Indonesian participants expressed the difficulty in getting onion seeds in Indonesia (as onion crop is raised from bulbs in their country). They were also suggested to use any suitable host, preferably a grass, for this purpose. The discussions were followed by a practical on all the above methods.

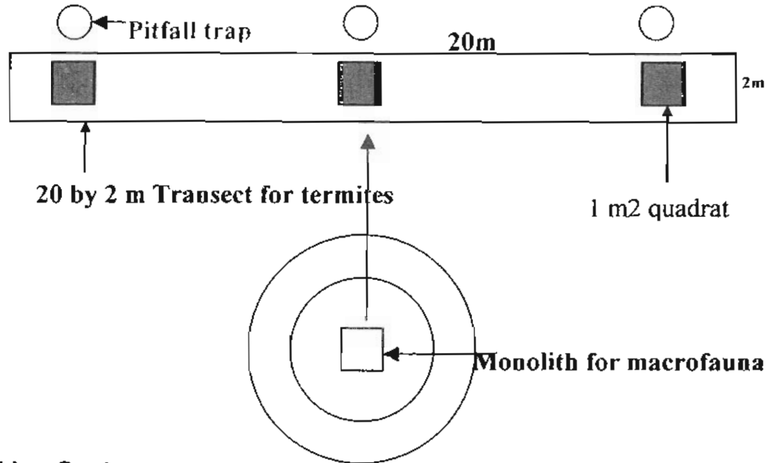
6. Methods for the inventory of phytopathogenic, saprophytic and antagonistic fungi

1. Methods used by BGBD Mexico

(In charge: Dr. Pilar Rodriguez-Guzman)

Field Sampling

- 8 Composite soil samples (without litter) obtained by coring (0-20cm deep)
  - 4 cores from a circle with a radius of 3m around the grid point.
  - 4 cores from a circle of 6m radius around the grid point.
- 8 points chosen in every land use.



Land Use Systems

- Rainforest
- Agro rainforest
- Pasture
- Maize

3 Windows:

- Lopez Mateos: samling done1st -10th Dec 2004
- Venustiano Carranza: sampling done 12th -20th Dec 2004
- San Fernando: sampling done 22nd -31st Dec

Handling of Soil Samples

- Soil collected in polythene bags
- Kept at 5^0 C in field freezers
- Transported to laboratory and kept in cold room at 5^0 C.

A. Isolation from Soil Samples

- Aspergillus, Penicillium, Trichoderma, Fusarium studied
- Soil dilution plate technique used

  1g of soil and roots added to 9ml of 2% agar water (10^{-1}). Shaken in a Vortex shaker. After that 1.0 ml of the first dilution was pippeted and added to 9.0 ml of 2% agar water (10^{-2}) .The solution was shaken in a Vortex. From this last soil dilution 1.0ml was taken and pippeted into plates.

Media

- For isolation of Aspergillus, Penicillium, Tridroderma, Fusarium PDA used
- For isolation of Phytophthora , Pythium
  - PARHP media (Jeffers and Martin, 1986)

- 3P media

Observation

- Done after 72 hours (in case of few fungal colonies the plates were kept in incubation for more time).
- Mostly on PDA - kept for 3-5 days
- PARPH - kept for 10-20 days
- 3P - kept for 10-20 days

B. Isolation from roots

- Aspergillus, Penicillium, Tridroderma, Fusarium and Rhizopus studied
- Washed in 1% Sodium Hypochlorite for 30 seconds and then washed in sterilized distilled water , dried in sterilized paper towels cultured on PDA, PARPH,

Selective Media

- Used for the following:
- (i) *Fusarium* spp.
  - -Kerr medium 28^{0}C in darkness for 3days
  - -SNA medium 28^{0}C in darkness for 3days, then room temperature and light.

  Methodology like above but plates incubated at 28^{0}C in the dark from 3-5 days then kept under room temperature and light.

  Observation - growth characteristics , texture , color.
- (ii) *Rhizoctania solani* - Komada and Hora medium
- (iii) Trichoderma sp.
  - - PDA + lactic acid medium
  - - PDA + pink of Bengal medium

  Method similar to the one described above for *Pythium, Phytophthora* and *Fusarium* but plates kept at room temperature under direct light conditions for 5days.

Identification keys

1. Isolates of ***Fusarium spp***., obtained from SNA medium are being identified applying the next references and taxonomic keys:

- Nelson, P.E., Toussoun, T. A. and Marasas, M. F. O. 1983. Fusarium species: An Illustrated Manual for Identification. .Pennsylvania State. University Press. University Park.
- Burgess, L. W., Summerell, B. A., Bullock, S., Gott, K. P., and D. Backhouse. 1994. Laboratory Manual for Fusarium Research. Third Edition. Fusarium Research Laboratory. Department of Crop Sciences. University of Sidney and Royal Botanic Gardens. Sidney. Australia.

2. ***Phytophthora spp***. isolates will be identified applying Waterhouse taxonomic keys:

- Waterhouse, Grace M. 1963. **Key to the Species of *Phytophthora* de Bary.** Mycological Papers, No. 92, Commonwealth Mycological Society, Kew, Surrey, England

3. ***Pythium spp***. isolates will be identified with

4. ***Rhizoctonia solani*** will be identified with the next key:

- Sneh, B., Burpee, L., and Ogoshi, A. 1991. Identification of Rhizoctonia Species. APS Press. The American Phytopathological Society. ST. Paul Minnesota,U. S. A.

5. ***Trichoderma* spp** isolates will be identified with the next keys:

- Samuels, G. J., Chavarri, P., Farr, D. F., and McCray, E. B. (n.d.) ***Trichoderma***

Online, Systematic Botany and Mycology Laboratory, ARS, USDA. Retrieved March 21, 2005, from http://nt.ars-rin.gov/taxadescriptions/keys/TrichodermaIndex.cfm

2. Methods applied in BGBD Indonesia

In charge: Ms Titik Aeny

Field Sampling

- 12 Composite soil samples (without litter) obtained by coring (0-20cm deep)
- 4 cores from a circle with a radius of 3m around the grid point.
- 8 cores from a circle of 6m radius around the grid point.
- Total number of soil samples 88

Land Use systems

- Intensive forest
- Less intensive forest
- Tree –based system non (less) intensive including shade coffee or multi-strata coffee
- Tree- based intensive (including coffee monoculture)
- Crop-based (food crops)
- Crop-based (horticulture)

Isolation from Soil Samples

- (i) Soil Dilution Plate Technique

  30g soil in 300ml sterile 0.1 water agar. Blend , then transfer 1ml to 99ml in a bottle to give 1:1000 . Serial dilutions repeated up to 1:10000

  Transfer 1.0ml to selected media

  5 replicates

  Incubation –room temperature

Media

- *Thielaviopsis* - carrot discs
- *Fusarium* – Komada media (Komada, 1975)
- *Pythium* – Reischer Agar
- *Verticillium* – Soil Extract Agar
- *Phytaphthora* – V-8 juice media

Isolation from soil sample

- (ii) Baiting Technique; Soil samples put inside baits.

  Apples, cucumber and carrots used as baits

  Bored by 1cm cork-borer with 2cm depth. Holes filled with soil samples then covered with a cello tape and incubated in room temperature for 2-3 days. When dark brown spots observed, infected tissue transferred to PDA.

- (iii) Disease Incidence Assessment

  Number of plants that show disease symptoms; Diseases identified using the Index of Plant Diseases.

- IDENTIFICATION KEY
- ????????

3. Methods for inventory of phytopathogenic fungi used in KENYA

Field Sampling

- Same as Indonesia
- Land Use Systems
  - . Tea
  - . Coffee
  - . Maize based
  - . Natural Forest
  - . Planted Forest
  - . Napier farms
  - Maize
- Sample sites – Embu 60 points; Taita 40 points

Handling of Soil Samples

- Collected in paper bags and brought to laboratory. Kept in fridge at 2-5^0 C
- Kept at room temperature for 3days before analysis.

Laboratory Analysis

A. Isolation from Soil Samples

Trichoderma

(i) Soil dilution plate technique

The dilution plate method was used for the estimation of the fungus. 1/10, 1/100, 1/1000 dilutions of the samples were prepared (Warcup, 1955). Before the setting of the organic matter and soil particles, 1 ml of the dilutions was applied to prepared plates of malt extract (MEA.MERCK)

(ii) Soil washing technique

Set of 4.0 mm, 1.0mm, and 0.5 mm sieve

Media

- Malt Extract Agar (MEA) and Cornmeal with 2% of dextrose (CMD) with streptomycin 50mg /L and Cyclosporine 10mg/L .
- For initial isolation, cultures kept at room temperature .
- For identification, cultures grown on PDA and maintained at 15, 20, 25, 30, 35°C.

Observation

- Morphology study –lactophenol in cotton blue.
- Measurements done on KOH and water.
- Key compiled by DR. Gary J. Samuels from USDA , Beltsville, USA http://nt.ars-grin.gov/taxadescriptions/keys/trichodermaIndexa.cfm
- Morphological key with descriptions and over 500 images for the 32 species of *Trichoderma*.

Pythium

Baiting Technique

- Baiting tissue Kikuyu grass (*Pennisetum clandestinum*) leaf blades
- Infected tissues transferred into sterile water with antibiotics (Chloramphenical) for few hours.
- The growing mycelium are verified directly by water mounts in a microscope or transferred from the bait to the isolation media CMA with antibiotic Chloramphenical

(20mg/L) and Benomyl (10mg/L

- Species that produced submerged cultures on CMA were cultured on PCA for further screening

Observation

- Number of infected tissues counted
- Morphological features used
- *Monograph of genus Pythium:* Van Der Plaats – Niterink (1983)

4. Côte d'Ivoire: methods for phytopathogenic fungi

In charge: Dr. Hortense Diallo

Field Sampling

- Like Indonesia and Kenya
- 107 points covering eight land uses were sampled.
- Due to major constraints only 40 samples are being processed.

Isolation from soil samples for

Trichoderma Aspergillus, Penicllium, Gliocladium, Fusarium, Curvularia.

i) Soil Dilution Plate Technique

- 10g of soil in 90ml of sterile water. Serial dilutions made (10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, and 10^{-5}).

- Acidified malt agar (0.25 mg of citric acid/l) in suffusion was added.
- The Petri dishes were then incubated in the dark at 28°C.

(ii) Soil Washing Technique

- Set of 1, 0.5 and 0.25 mm mesh used
- Six particles from 0.5 and 0.25 mm mesh size
- Media acidified malt agar.
- The plates were then incubated in the dark at 28°C.

Observation

Identification keys

- Barnett H.L. and Hunter B.B. 1972. Illustrated genera of imperfect fungi. Third Edition, Burgess Publishing Company, Minneapolis, Minnesota.
- Kiffer E. et Morelet M. 1997. Les Deuteromycètes: classification et clés d'identification générique. INRA Edition, Paris, France.
- Bottom B. et al. 1990. Moisissures utiles et nuisibles : importance industrielle. 2ème édition. Edition MASSON, Paris, France.
- Lanier L., Bondoux P. and Bellemer A. 1978. Mycologie et pathologie forestière. Edition MASSON, Paris, France.

5. UGANDA methods PPT

In charge: Gerald Kyeyune

Field Sampling

- 8 Composite soil samples (without litter) obtained by coring
  - -4 cores from a circle with a radius of 3m around the grid point.
  - -4 cores from a circle of 6m radius around the grid point.
- A sample of about 500gm of soil was taken from this composite sample.

Handling of soil samples

- Sample packed in polythene bag, put in cool box taken to laboratory within 5days since sampling.
- In laboratory kept in cold room at 40C.

Isolation from soil samples

Pythium and Phytophthora

Baiting Technique

- Baiting tissues are maize leaves and apple slices added.
- After 5days transferred to PDA containing chloramphenical 20 mg/l and benlate 10mg /l.
- Number of infected tissues counted.
- Identification keys ?????????
- **NOTE: *Pseudomonas* also studied**

6. BRAZIL: methods PPT and other

In charge: Dr. Ludwig Pfenning.

Genera Isolated

- Oomycota (Straminipiles): *Pythium*;
- Basidiomycota: *Rhizoctonia*;
- Ascomycota - plant pathogens *Cylindrocladium*, *Fusarium*, *Lasiodiplodia*, and *Verticillium*;
- Ascomycota – saprophytes, antagonists: *Clonostachys* (former *Gliocladium)*, *Coniothyrium Talaromyces, Trichoderma;*
- Ascomycota – entomopathogens: *Paecilomyces, Metarhizium, Beauveria.*

Isolation of soil samples

Pathogenic and saprophytic ascomycetes

- **Soil Washing Technique and Particle Filtration** methodology and use of **selective culture media**.
- Sequence of sieves with mesh size of 1.0 mm, 0.7 mm, 0.5 mm and 0.21 mm

Pythium and Phytophthora

- Baiting Technique
  - The baiting tissues were lupine radicels and grass leaf blades for *Phytophthora* and *Pythium* respectively.
- Infected tissues were transferred into sterile water with antibiotics (chloramphenical) for few hours.
- Counts done

Rhizoctonia

(iii) Soil particles method.

- A suspension of 10 g of soil sample and tap water were agitated and decanted in a 0.5 mm sieve. The settled soil was re-suspended and sieved for a few times. The retained soil particles was dried in sterilized paper towel and transferred to water agar medium (2%) containing 250 mg/L of chloramphenicol. After an incubation period of 24 – 48 hours at 25°C typical *Rhizoctonia* growth was verified, the soil particle colonization frequency was assessed and the mycelia tips transferred to PDA (potato dextrose agar) for an eventual characterization (Sneh et al. 1991).

Offered major problems and was not successfully done. The high frequency of fast growing *Trichoderma* on baits and plates and the similarity of initial mycelial growth between *Rhizoctonia* and *Trichoderma* did not permit the correct identification of *Rhizoctonia* from the studied soil samples. An attempt was made with benomyl for inhibition of *Trichoderma* on culture medium however, at low concentrations (50 ppm) no inhibition was verified and no fungal growth occurred at higher concentrations of benomyl (100 ppm). In this case, the use of a molecular method, using *Rhizoctonia* specific primers, is highly indicated.

- Rhizoctonia isolation experienced major problems of contaminaion and was not successfully done
- Use of benomyl for inhibition of *Trichoderma* on culture medium at low concentrations (50 ppm) was unsuccessful and at higher concentrations of benomyl (100 ppm) complete inhibition of growth occurred.
- In this case, the use of a molecular method, using *Rhizoctonia* specific primers, is highly indicated.

Identification

- *Trichoderma* – to genus level
  Within the genus *Trichoderma,* all species are saprophytes and good cellulolytic competitors. Therefore, we consider species identification is not essential.
- Form –genus *Fusarium* –to species level
  In the case of the form-genus *Fusarium*, biological characteristics and function can vary considerably between recognized species. Species include potential pathogens like *Fusarium oxysporum, F. solani* or *F. decemcellulare*, as well as saprophytes or secondary invaders like *Fusarium semitectum* or *F. equiseti*. For this reason, species identification is recommended.
- *Pythium* – to species level
- Other genera studied
  Paecilomyces (3,4%), Clonostachys (2, 6%) and Acremonium (2, 1%).

> *Recommendation by Brazilian team*
>
> *Molecular techniques can be a powerful tool for the assessment of diversity of soil-fungi and in identification processes, although they DO NOT substitute good basic mycological work. Advantages and restraints of molecular methods available are evaluated and reviewed in our chapter on "Tropical soil microfungi" that will be published soon.*

Identification Keys

- Domsch, K.H., Gams, W. & Anderson, T. 1980. Compendium of soil fungi. Vol. I. + II. Academic Press, London. Reprint 1993.
- Complementary:
- Arx, J.A. von 1970. The genera of fungi sporulating in pure culture. Cramer, Lehre.
- Barron, G.L. 1972. The Genera of Hyphomycetes from soil. Williams & Wilkins Co., Baltimore.
- Crous, P.W. 2002. Taxonomy and pathology of *Cylindrocladium* (*Calonectria*) and allied genera. APS Press, Saint Paul MN, 294 pp.
- Gams, W., Hoekstra, E.S. & Aptroot, A. 1998. CBS-Course of Mycology, 4th ed., CBS, Baarn, The Netherlands, 165 pp.
- Nelson, P.E., Toussoun, T.A. & Marasas, W.F. 1983. *Fusarium* species: an illustrated manual for identification. The Pennsylvania State University, University Park and London, 193 pp.

- Samuels, G.J., Chaverri, P., Farr, D.F., & McCray, E.B. (n.d.) *Trichoderma* Online, Systematic Botany & Mycology Laboratory, ARS, USDA. Retrieved March 17, 2005, from http://nt.ars-grin.gov/taxadescriptions/keys/TrichodermaIndex.cfm
- Seifert, K.A. Fusarium Key. http://sis.agr.gc.ca/brd/fusarium/

7. INDIA

(Information missing)

Session 9 Ecosystem Services (Session of the ESERV Task Force)

Content

1. The Ecosystem Services (ESERV) Task Force

Edmundo Barrios

Objectives of the ESERV Task Force

- Review of existing methods for measuring/quantification of ecosystem services.
- Propose standard methods reflecting discussion within ESERV task force and consultation with the Economic Evaluation task force.
- Assistance to BGBD member countries in implementing the standard methods to assess ESERV, in diagnosing problems and constraints to ESERV provision, and in identification of opportunities for improving ESERV through enhancement of BGBD (ecological profiles/management options)

Ecosystem services Working Groups

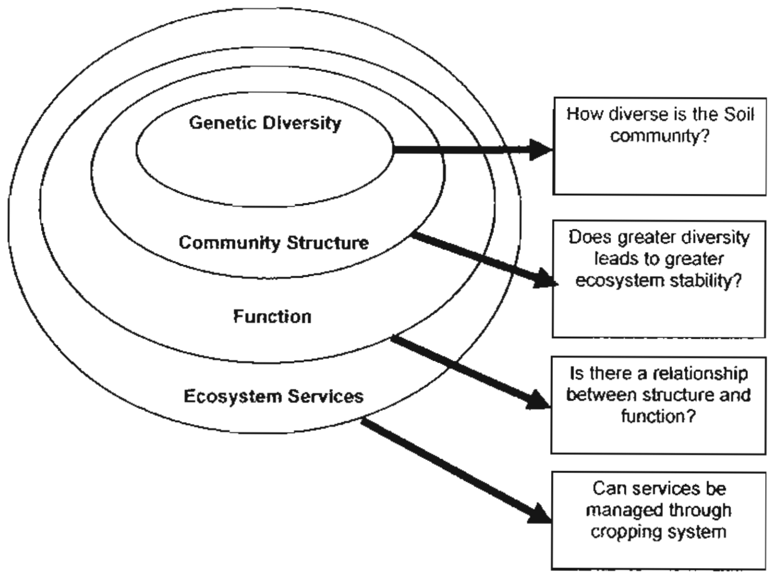
- Soil Structure Modification
- Control of Pest and Diseases
- C sequestration and control of GHG emissions
- Maintenance and restoration of Soil fertility

SSMWG of ESERV.

- **Potential parameters to assess the influence of soil biodiversity on Soil Structure Modification**

Parameter	Scale	Method	Ref	Propo
Tillage history	Per plot	Farmer surveys	LISQ guide	EB
Texture	Per point	Boyoucos	Methods of Soil Analysis - ASA	MS
Porosity	Per point Per point Per point?	Methylene blue Dye Infiltration Method Bulk density/volume of compacted soil Pore distribution	? ? ?	JA, M JA EA
Water Infiltration Rate	Per point	?	?	IB
Water retention capacity	Per point (per m^2 in the whole profile)	?	?	IB
Aggregate distribution	Per point	Particle size distribution	Methods of Soil Analysis - ASA	EA
Percent of water stable aggregates	Per point	Yoder Method	Beare et al., 1993	EB, E
Biogenic structures Macrofauna	Selected points and soil depths	Thin sections analysis	Fitzpatrick et al.??	JA
Biogenic structures Macrofauna	Per point	Undisturbed soil monolith 5 cm per side	Velasquez, et al. PhD thesis	PL, BS JH
Biogenic structures AMF fungi	Per point	Glomalin content in soil aggregates	Wright&Jawson, 2001.	EB, IB
Biogenic structures "biological signature"	Selected biogenic structures	NIRS	Lavelle et al.	PL, EE

JA= Jo Anderson, IB= Isabel Barois, BS= B.K.Senapati, EA= Edgar Amézquita, PL= Patrick Lavelle, MS= Mike Swift,
JH = Jeroen Huising, EB = Edmundo Barrios



2. BGBD and Farmer Appreciation of Ecosystem Services; Reconciling scientific and farmer perspectives

Jo Anderson

Ecosystem function and services

Functions are the physical, chemical and biological processes that contribute to what the ecosystem does (e.g. carbon and nutrient cycling, BD habitat).

Ecosystem functions are value-neutral.

Ecosystem services are the transformation of ecosystem properties and functions into assets valued by society.

Ecosystem Services

- People's cultural, spiritual and intellectual needs.
- Production of commodities (food, fuel, fibre, NTFP).
- Maintenance and provision of genetic resources.
- Pollination.
- Maintenance and regeneration of habitats for wildlife.
- Provision of shade and shelter.
- Regulation of climate.
- **Waste absorption and breakdown.**
- **Regulation of water quality, storage and flows.**
- **Nutrient provision for crops.**
- **Control of soil erosion.**
- **Pest and pathogen control.**
- **Maintenance of soil structure.**

Soil structure

- **Properties:** porosity, aggregate stability, depth
- **Processes:** Infiltration, hydraulic conductivity, water retention, nutrient leaching

- **Functions:** Aeration, root penetration, nutrient and water availability, biodegradation
- **Determinants:** climate/texture > vegetation management > SOM/plant roots > soil organisms

Do biota become a service for farmers only when they reduce soil constraints to crop production?

Farmers generally have a concept of 'healthy soil' how to improve soil properties - but rarely the mechanisms involved

Issues of cause and effect

- Management practices (fallows, crop rotations, tillage, organic manures, fertilisers, mulches) can be valued in direct returns as improved crop performance.
- Indirect returns from processes carried out by BGBD may not be valued because of the scales, variability or cumulative time over which they manifest effects.

Crops, roots and management

Plant roots are key determinants of soil structure and organic matter content

Species, cultivars and management affect root morphology, density, depth penetration and hence crop nutrition and drought tolerance

Crotolaria or *Tithonia* green manures and fertilisers affect maize root length (& thickness)

Treatments	Root length (mm)		
	Primary	Nodal	**Total**
Soil	2742	622	5449
Soil + Fertiliser	2482	815	6951
Crotolaria	3102	542	6059
Crotolaria + Fert	2792	835	7348
Tithonia	3035	756	6684
Tithonia + Fert	2757	995	7676

Sangakkara et al. (2004) J Agron& Crop Sci 190:339-346

Root density

Species	Soil Depth (cm)	Root density (cm cm-3)
Eucalyptus marginata	0-15 50-60	9 0.2
Fodder grasses	0-15 25-30	50 15
Cereals	0-15 25-50	5-25 4

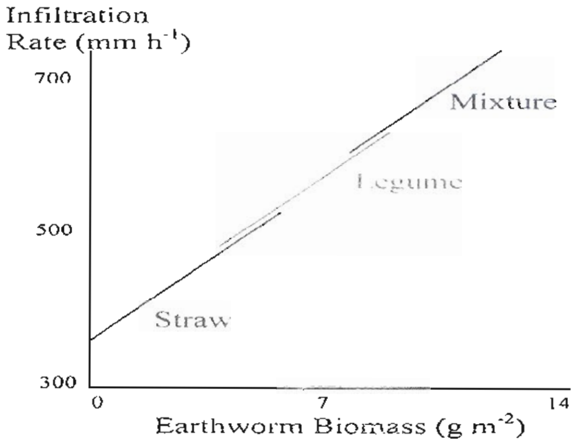
Bowen 1985

Farmers use mulches to suppress weeds, conserve moisture, prevent erosion.........

but mulches also have indirect effects on soil properties through BGBD

'Biopores can act as root conduits to improve access to water and nutrients at depth but this is offset by poor root contact in the biopore and laterals impeded by the compact biopore walls'
(Stirzager et al. 1996)

Mulch quality can have dramatic localised effects on rainwater capture and nutrient leaching



'Preferential flow pathways created by earthworms can potentially affect nutrient losses from the system in leachates'

(Lachnicht *et al.* 1997)

Pests and Pathogens

Determinants of microbial diversity and disease suppression

- Plant type and age
  - (exudates from young roots stimulate r-strategist bacteria → specific disease suppression)
- Soil biophysical conditions
  - (texture, structure, SOM, pH, etc)
- Management
  - (crop rotation, tillage, herbicide and fertiliser applications, irrigation.

SOM and crop rotation are key determinants of general disease suppression

Plant and microbial domains

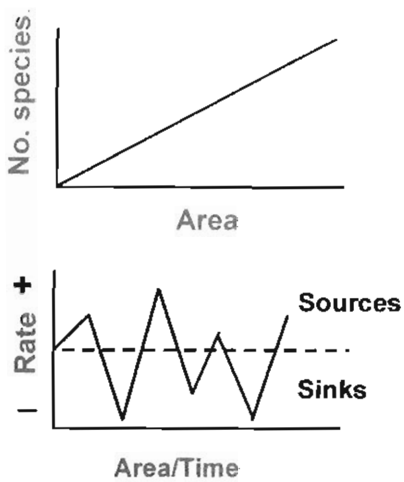
Specific disease suppression is confined to rhizosphere but legacy of effect on bulk soil depends on plant size and density

Farmers' perceptions of cause and effect

- Biological control, IPM are adopted because most insect pests have observable effects on crop plants
- Nematodes are not readily observed and plant symptoms can be confused with other causes.
- Effects of soil pathogens are often sporadic so crop performance may be related to other factors.
- Management practices and soil properties that enhance microbial BD and disease suppression also have more direct biophysical effects on crop performance.

Can farmers be sensitized about specific attributes of BGBD rather than just indicators of soil health?

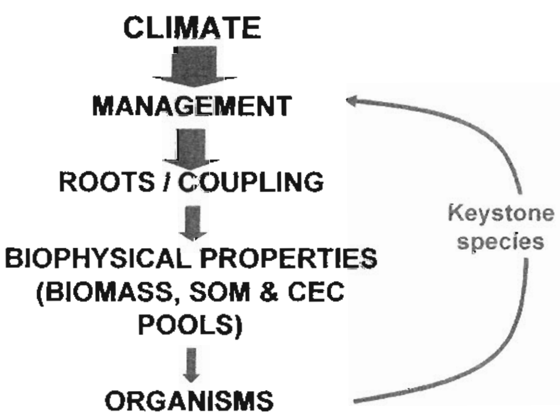
Problems of scaling up from species effects to plot scale: 'sink and sources'



Species/area relationships increase as curvilinear functions

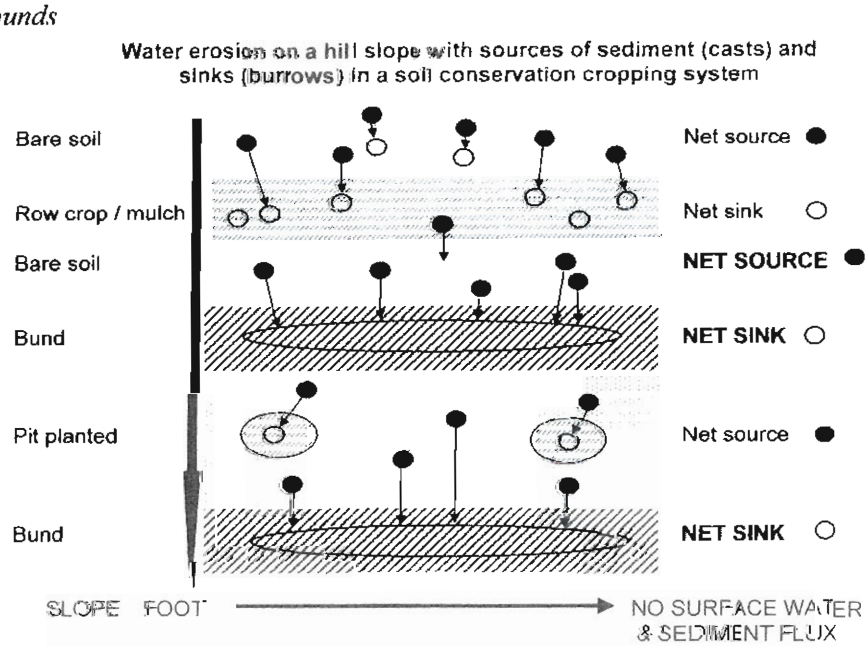
Process measurements integrate over time and space.

Spatial integration involves depth (SOM/CEC) as well as horizontal dimensions



Hierarchy of ecosystem process controls affecting carbon, nutrient & hydrologic fluxes

Sources and sinks of sediment in surface water on a hill slope with soil conservation bunds



Understanding cause and effect relationships

Scientific understanding based on knowledge projection. Measure co-variance of crop and soil biota and soil biophysical parameters .

Farmers' understanding based on legacy of observation. See spatial patterns of crop root/shoot characteristics and soil properties associated with fauna as proxy of soil health

Conclusions

Scientific Approach

- challenge in linking the scales at which BGBD affect ecosystems services at plot scale and bove.
- issues of reductionism – aggregate functions eg biopores ?

Farmer perceptions

- More practical to promote concept of developing / maintaining soil health through sound soil management?
- Assess farmer appreciation of BGBD values by demonstrations and then surveying later for adoption?

VALUE OF ECOSYSTEM SERVICES PROVIDED BY PLANT/SOIL

Component	Direct use value	Indirect use value	Option value	Existence
Crop yield	Food, income		Gene bank Bioproducts	Traditional
Crop residues	Animal feed, fuel, fibre, income	Mulch, compost, nutrients, SOM, Soil structure, Water retention, Erosion control	Biofuel	Conserving SBD
Weeds	Negative	Pollination, Nutrient retention Erosion control		Conserving SBD
Cover crops	Animal feed	Nutrients (BNF), Erosion control,	Biocontrol (eg *Stnga*)	Conserving SBD
Roots	Food, income	SOM, Nutrient retention, Erosion control	Carbon storage	
Soil/SOM		Nutrient cycling Hydrologic functions	Carbon stores Bioremediation Trace gas flux	Landscape values Conservation

Farmer perception of value?

National/global perception of value?

VALUES OF SOIL BIODIVERSITY

Component	Direct use value	Indirect use value	Option Value	Existence Value
Macrofauna	Low commodity values	Vermicomposts Soil physical structure/erosion Soil diagnostics Termite 'engineers'	Management of soil processes, pest control	Intrinsic (low)
Pests	None			
Microorganisms	Low commodity values	Primary decomposers Soil aggregation Pest control	Pest control, Bioremediation Medical, industrial uses	Aesthetic (low)
Plant pathogens	None (high perception)		As above	None
Micro-symbionts	Low perception?	BNF, plant nutrition, water relations	Improved strains	Limited
Soil Biodiversity Aggregated benefits	Low values	Farm: > yields, less erosion, fewer pests	Society: environmental benefits	Intrinsic

Farmer perceptions?

National/global perceptions of value?

Problems of linking SBD to functions

Farmers priorities

Ee.g stover allocation is generally accepted to improve soil fertility and BGBD but is not adopted by many farmers who have more immediate uses for stover or who have been advised to remove crop residues to avoid pest problems.

Low apparency of cause and effects relationships

C.f. biological control and use of pesticides.

Hierarchy of responses perceived from treatments

E.g. mulch: soil protection > moisture retention > weed control > BGBD effects.

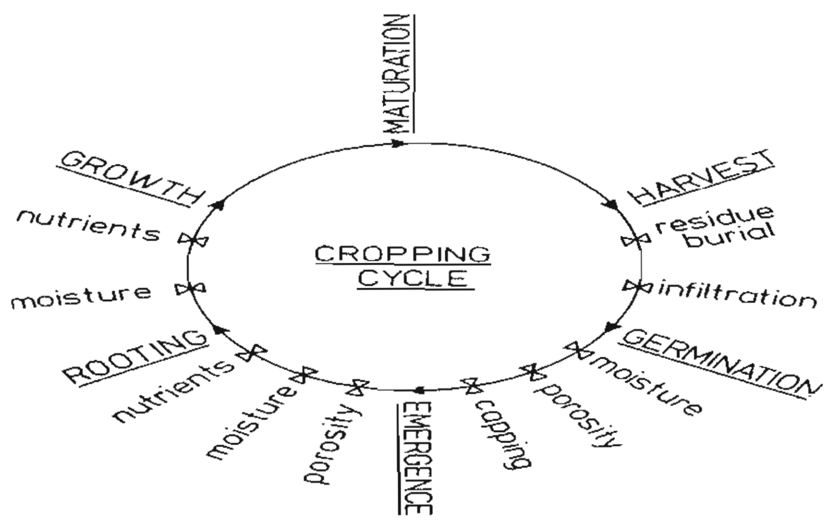
Time lag between treatment and response

Biophysical properties of soils e.g. CEC and SOM buffer water, carbon and nutrient fluxes so that instantaneous effects of biota are not apparent.

Scaling-up BGBD.

Effects of BGBD on soil processes are most evident if flux measurements are made at the scle at which the organisms operate. When effects are increased to plot scale the signal of specific organism effects is obscured by total community activities and buffering by biophysical processes. Scaling up can not be simply in a horizontal dimension; increasing depth dimensions of < 0.5m often engages weathering effect of parent material!

NB see ref to water uptake by roots in tensionless macropore channels



Healthy Soil	Unhealthy Soil
Soil easily tilled (e.g virgin soil)	Soil hard to till
Litter or plant fragments on the surface	Bare and compacted soil surface
Darker colour because the soil has been fed with organic matter	Lighter colour because the soil is starved
An open structure that allows air and water to pass through the soil	A compact soil with poor aeration and drainage (plants and animals idie in an air-tight box)
Lots of fine roots holding the soil together	Few roots or large roots of problem weeds such as couch grass
Channels formed by earthworms and/or termites (termite galleries have a fine-textured lining of soil)	Few channels and large pores.
More visible organisms	Few visible organisms

3. Communication title: Carbon stocks under different land uses in Oumé Region (Centre-West Côte d'Ivoire)

Yao K.M[1], Abbadie L[2], Konate S[1], Benest D[2].

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***Keywords**: Carbon stocks, Côte d'Ivoire, land use types*

Abstract
Soil organic matter plays a key role in sustainable agricultural management. A study, initiated in the Oumé area (Centre-West Côte d'Ivoire), aimed at evaluating the impact of land use mosaic on organic matter dynamics and factors governing organic carbon stocks and fluxes. Soils samples, using an auger, were obtained from a10-cm layer within a grid system covering the main land use types. Results showed that total soil organic matter content decreased from primary forests to mixed crop systems. The values range from 2.41 to 2.58 % in primary forest, 1.69 to 2 % in planted forests, 1.29 to 1.48 in mixed crops systems and 1.56 in fallows. Clay content varied from 18.87 to 21.1 % under natural forests, 9.46 to 25.71 % in planted trees, 10.34 to 19.39 % in mixed crops systems and 8.8% in fallows. In addition, soil pH values were on average around 7.2, between 6.12 to 7.25, 5.98 to 6.9 and 6.36 under natural forests, planted trees, mixed crops and fallows, respectively. There was no significant relationship between land use system and carbon stocks.

4. Assessing soil morphology : a simple and robust method to evaluate the role of soil ecosystem engineers and other soil structuring processes

Elena VELASQUEZ and Patrick LAVELLE

IRD, UMR 137 BIOSOL, Bondy, France

Aggregation is a basic attribute of soils that sustain a number of ecosystem services that they provide. When stable they allow to maintain structural porosity that facilitates water infiltration and storage and root aeration. When compact, they are microsites where C is stored and largely protected from mineralization for the life duration of the aggregates..

We present here a simple method based on the manual separation of aggregates from a small cube of soil (5x5x5cm) according to their size and shape, and other components of soil (roots, twigs, gravels etc…). Statistical methods to process these data are proposed and a few examples from different environments are discussed. These results show significant coinercias among soil macroinvertebrate communities and soil morphology as assessed by this method.

5. Using Near Infra Red Spectroscopy to assess changes in soil quality. Theoretical bases and applications

Elena VELASQUEZ and Patrick LAVELLE

IRD, UMR 137 BIOSOL, Bondy, France

Near Infra-red Spectroscopy - applied philosophy
The success of multichannel NIR analysis is founded on a combination of precision instrumentation ,statistics, computer software and - philosophy of technology.

Water, most organic molecules and some inorganic molecules can be determined directly by NIRS analysis, because their absorbance signals in the NIRS wavelength range are generally overtones and combination bands from the molecules fundamental vibration bands in the IR region. These higher order bands grow progressively less sharp as we go from the IR through the NIR to the visible region; hence each wavelength channel becomes non-selective- i.e. sensitive to several different molecule types. The selectivity must therefore be mathematically enhanced by multivariate calibration.

Most NIR users have clear analytical goals: Routine analysis in a rapid, relevant and reliable way, be it for quality analysis or process monitoring. Today's NIR technology demands a highly interdisciplinary activity, and that takes guts, time and effort (Martens and Martens XXXX)

Soils, particularly low organic matter soils, are somewhat unique when compared to most of the organic-based materials, for which NIRS calibrations have been developed, in that they contain a large amount of material of little or no interest to these other users, namely minerals.

Also NIRS has generally been found to be poor at determining minerals in forages and similar samples, since the constituents in question (Ca, Mg, P etc.) do not absorb near infrared radiation (Reeves et al 1999).

Near Infrared light (400-2000mμ) is reflected in highly specific ways by water and organic compounds providing different reflectance spectra according to the composition of the organic material. NIRS has therefore proved to be a very good tool to assess the concentration of C, N, P and other components in soils, and also the overall "quality" of soil organic matter. It is a cheap, non destructive and reliable technique.

We present here details of the methodology and some examples showing the ability of the method as an indicator of soil quality. Application of NIRS to the whole range of soils and land use types represented in the BGBD programme is a unique opportunity to intercalibrate our soils and situations and relate NIRS spectrometric data to a number of other characters linked to soil biodiversity.

6. Soil Engineering by Arbuscular Mycorrhizal Fungi

Edmundo Barrios and Matthias Rillig

AMF and ecological processes

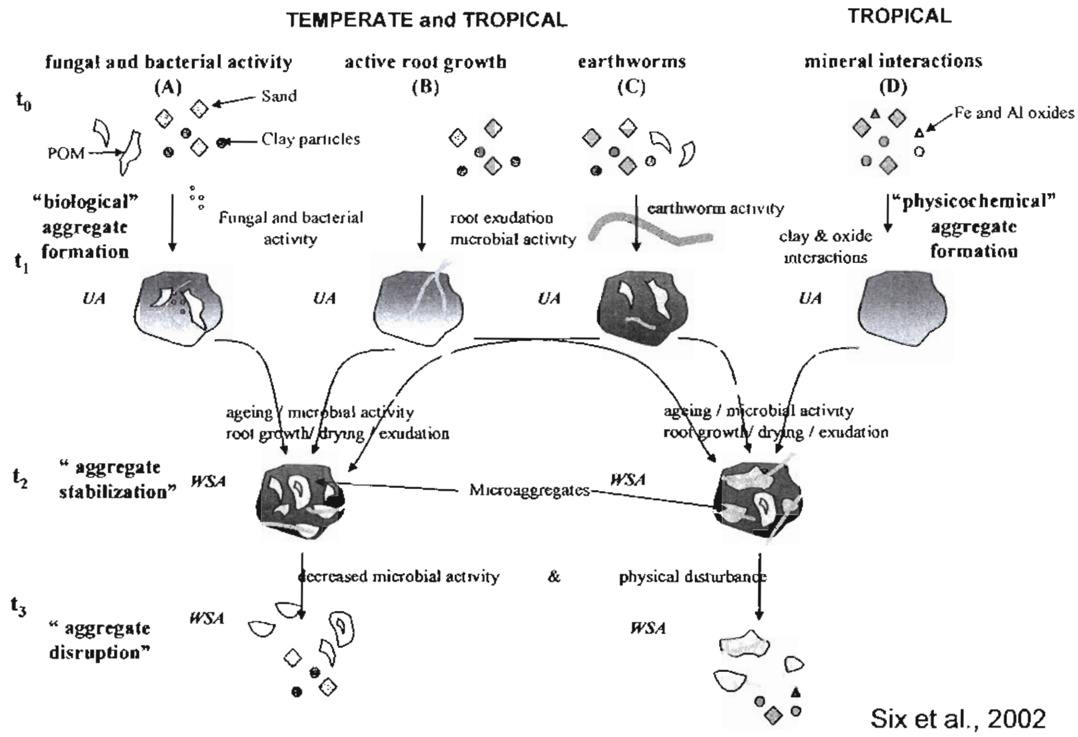
AMF →mutualistic associations plants (crops and pasture species

Plant host level: nutrient acquisition, plant protection

Plant community level: mediators of competition and important co-determinants of plant-species diversity

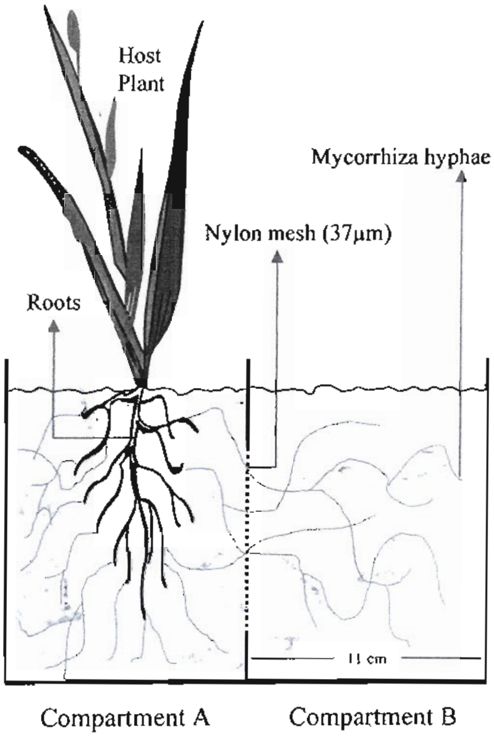
Ecosystem level: participation in nutrient cycling and soil aggregation

Soil Aggregate Formation and Disruption Mechanisms



Six et al., 2002

Soil aggregation by AMF (what follows is from Reyes et al., 2003)



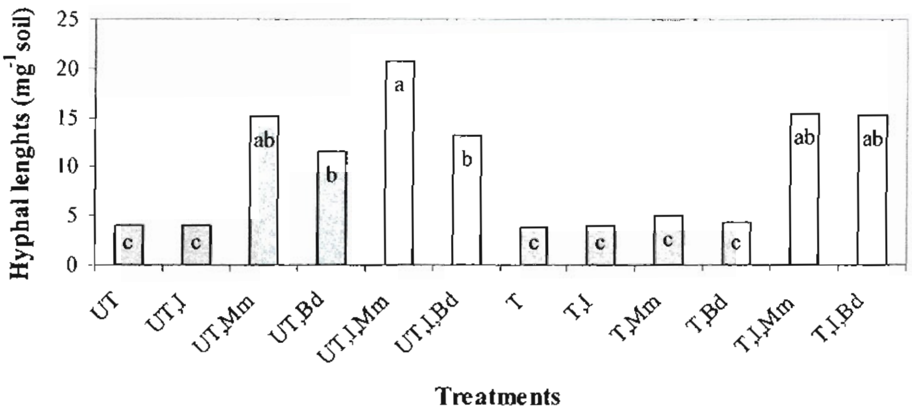
Greenhouse experiment: 12 Treatments, 4 Replications

Treatments consisted of combinations of three factors:

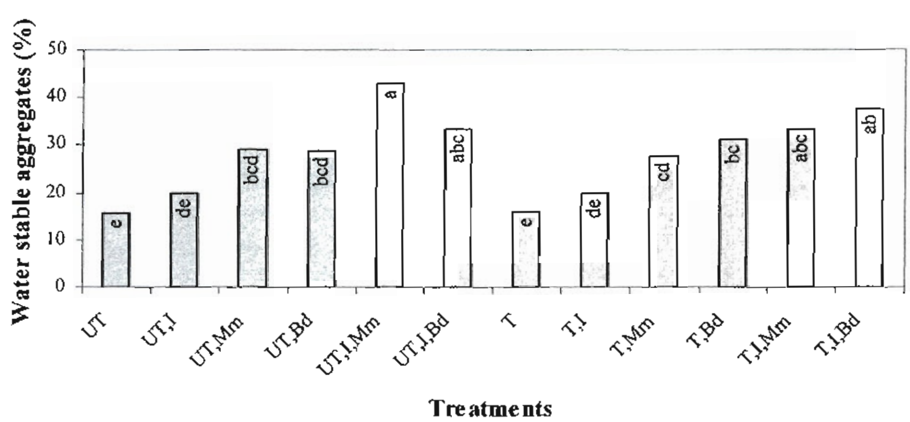
1. Host plant (*Mellinis minutiflora, Brachiaria dyctioneura*, NP)
2. Soil pretreatment (without, with fungicide Basamid-98% Dazomet)
3. AMF inoculation (without, with *Entrophospora colombiana +Gigaspora margarita + Glomus manihotis*
4. 4) Controls

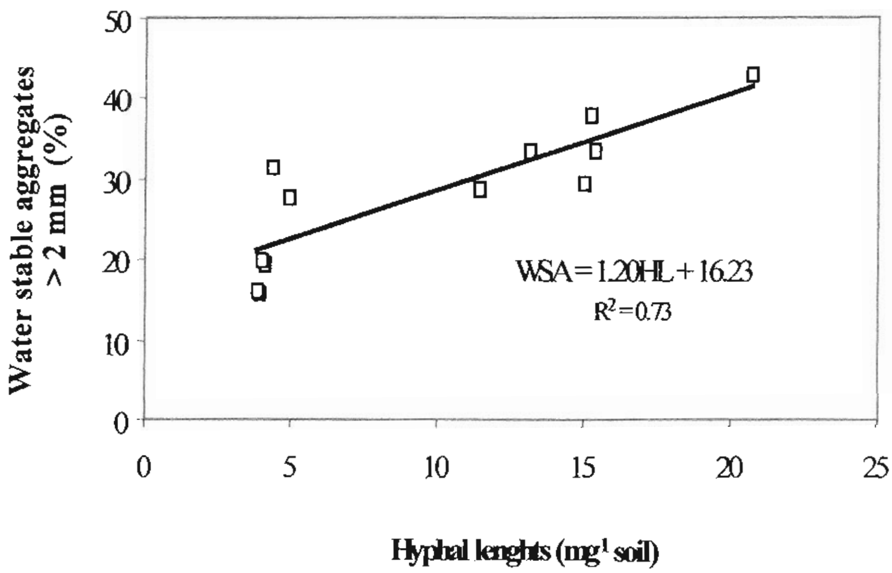
Fig. Experimental unit

Hyphal lengths



% WSA > 2 mm





Correlation hyphal lengths and %WSA > 2 mm

AMF-glomalin and soil aggregation
Background:

Wright and Uphadyhaya (1986) Extraction of an abundant and unusual protein from soil and comparison with hyphal protein of AMF. (Soil Science 16(9): 575-586)

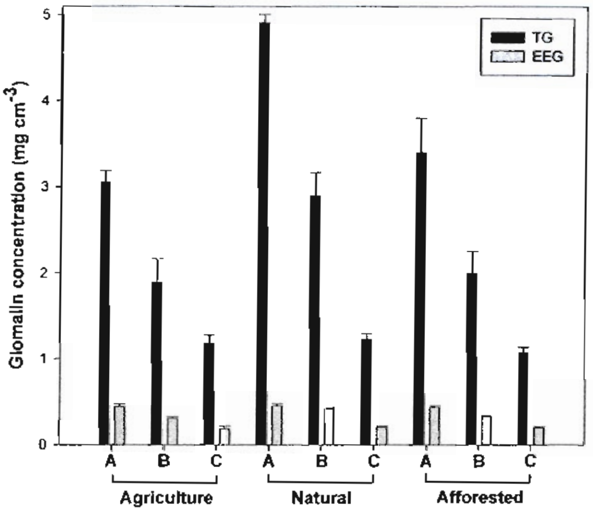
↓

Significance: Assessing abundance and activity of AMF (spore counts, % colonization, hyphal lengths) is difficult and time consuming

↓

GLOMALIN

Fungus specific glycoprotein as a potential direct measure of AMF activity



Glomalin: land use change Delaware County, Ohio: deciduous forest

(Rillig et al. 2003 Plant&Soil)

New nomenclature

Glomalin-related soil protein (GRSP) refers to pools extracted from soil

Bradford reactive soil protein

Immunoreactive (MAb32B11) soil protein

Glomalin is reserved for the putative gene product

Other examples: GRSP responds to factors of global environmental change

- Elevated atmospheric carbon dioxide
  - Rillig et al. (1999) Nature
  - Rillig et al. (2000) Ecology Letters
  - Rillig et al. (2001) Global Change Biology
- Warming
  - Rillig et al. (2002) Oikos
- Invasive plant species
  - Lutgen and Rillig (2004) Weed Science

Methodology RSP extraction

- Easily extractable fraction:
  - Soil (1g) is autoclaved for 30 min in 20mM citric acid pH 7.0
- Regular extraction ("total" fraction):
  - Autoclaving in rounds of 1 hour in 50mM citric acid pH 8.0
  - Repeat autoclaving, centrifuging, decanting, resuspending in new buffer until supernatant becomes clear (or light yellow)

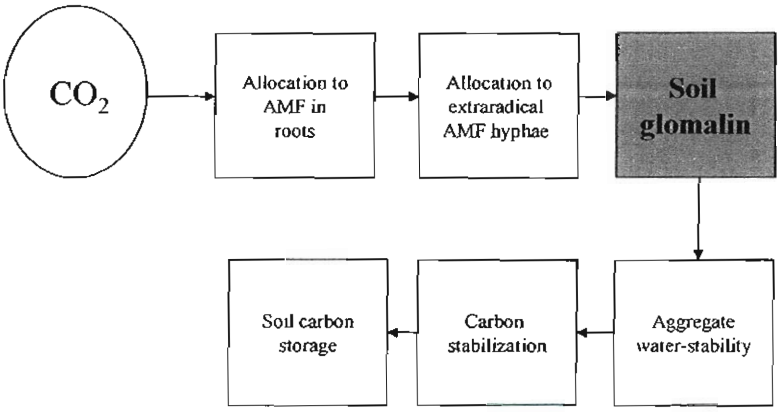
GRSP fractions: measurement

Bradford reactive soil protein (BRSP)

- Use a microplate reader
- Standard curve with BSA (bovine serum albumin)
- Dilute samples appropriately to fit within range of standard curve
- Use Bradford Dye Reagent, measure absorption
- Extrapolate to 1 g of soil

- Immunoreactive fractions
  - Same as before, except:
  - Perform an indirect ELISA (enzyme-linked immunosorbent assay) using the monoclonal antibody MAb32B11
  - This is generally a two-day process

GRSP in the plant-soil system



7. Soil agreggates análisis BGBD BRazil

Maria da Glória B. F. Mesquita UFLA, Maurício Rizzato Coelho EMBRAPA, Fernanda Peruchi UFLA, Maria Tereza Carvalho UFLA

In order to verify fauna influence on soil aggregation, analysis were carried out to select, classify and describe soil aggregates according TSBF sampling method and Ponge method presented by Patrick Lavelle in the Soil Ecology course (Belém, July 2004). Eighty nine soil samples were collected in the different sampling points at the benchmark area. Undisturbed soil samples measured 5 X 5 X5 cm (125 cm^3 soil volume). Samples were classified according size and type at Soil Physics laboratory of DCS/UFLA. Dispersed clay and aggregates stability were also determined.

Preliminary results were analyzed by Principal component analysis (PC's). Assuming total variability of 70% is already enough, so, 5 PC´s are needed (accumulated explanation of 74,2%). Each is given by: PC1 = - 0.29*ADA - 0.29*DMG - 0.53*agom + 0.33*amom + 0.35*apom + 0.35*leaves + 0.39*stems + 0.10*roots + 0.56*peel; PC2 = 0.22*ADA + 0.35*DMG - 0.34*agom + 0.55*amom - 0.20*apom + 0.02*leaves + 0.01*stems + 0.14*roots + 0.58*peel; PC3 = - 0.18*ADA - 0.12*DMG + 0.10*agom + 0.28*amom + 0.22*apom - 0.51*leaves + 0.13*stems - 0.71*roots - 0.17*peel; PC4 = 0.38ADA - 0.32*DMG + 0.16*agom - 0.06*amom - 0.38*apom + 0.49*leaves + 0.37*stems - 0.40*roots - 0.18*peel; PC5 = 0.65*ADA - 0.19*DMG - 0.18*agom + 0.17*amom + 0.35*apom + 0.06*leaves - 0.52*stems - 0.18*roots+ 0.22*peel. These coefficients show how the variables (ADA, DMG, etc) combine to explain variability among observations. In case of PC1, variables ADA, DMG, and agom, form a contrast with the others, showing that PC1 is an index that means a measure of such characteristics. Statistical analysis is still being carried out.

8. Evaluation of soil fertility in different Land Use Systems in upland soils of The upper Solimões River, Benjamin Constant Municipality, Am, Brazil

Sonia Alfaia, Fernanda Villani, Katell Uguen, Acácia Neves, José Edvaldo Chaves, INPA-AM

The study aimed to evaluate the soil fertility in upland soils in the upper Solimões River, near Benjamin Constant, Amazonas State, Brazil. The following land use systems were evaluated: forest, old secondary forest, young secondary forest, crops, agroforestry and pasture.

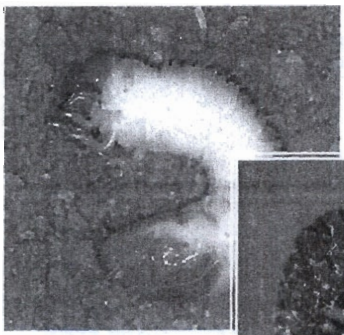
At each of the 101 points of six large grids, soil samples, composed by 4 sub-samples, were collected in the 0-10, 10-20 and 20-30 cm layers. The main chemical parameters of soil fertility were determined: pH, macronutrients (P, K, Ca e Mg), micronutrients (Fe, Mn e Zn) and aluminum.

The results shown in all the studied sites, pH values were low according to levels for soil fertility in the South American tropics, varying from 3,98 to 5,22, 4,01 to 5,05 and 4,04 to 4,84 $cmol_c.kg^{-1}$ in the 0-10cm, 10-20 and 20-30cm layers respectively. Available aluminum contents, in most sampled points, were high, varying from 0,91 to 7,57, 3,40 to 11,60 and 5,35 to 13,67 $cmol_c.kg^{-1}$ in the 0-10cm, 10-20 and 20-30cm layers respectively. Highest concentrations were found in forest and lowest in crops. Contents of exchangeable Ca varied from 0,94 to 10,88, 0,48 to 8,51 and 0,37 a 7,41 $cmol_c.kg^{-1}$ in the 0-10cm, 10-20 and 20-30cm layers respectively. Mg varied from 0,40 to 2,45, 0,23 to 1,96, 0,21 to 1,85 $cmol_c.kg^{-1}$ in the 0-10cm, 10-20 and 20-30cm layers respectively. Despite high variations, Ca and Mg contents were higher than in most Amazonian soils and were higher, in general, in crops, agroforestry, secondary forests and forests. Contents of exchangeable K in most cases were relatively high, varying from 0,16 to 0,75, 0,13 to 0,69 and 0,09 to 0,52 in the 0-10cm, 10-20 and 20-30cm layers respectively. P contents didn't varied much between the studied land use systems and were low in all systems, as it's the case in 90% of the Amazonian soils. P contents varied between 3,15 to 13,37, 1,28 to 4,62 and 0,98 to 4,27 mg kg^{-1} in the 0-10cm, 10-20 and 20-30cm layers respectively.

Studied soils have very high aluminum concentrations. Slash and burn highly changed soil chemical parameters, especially reducing soil acidity. In order to understand the effect of land use systems on soil fertility, land use historic will help in the interpretation.

9. Integrated soil and Pest Management for an Environmentally Sound Tropical Agriculture

Andreas Gaigl



Structure of presentation

- Whitegrubs — a global problem
  - Highlights of the project's first phase (2002 – 2005)
  - Future Perspectives
    - Goal, purpose
    - Outputs

Whitegrubs are globally Present (Genera)

Asia	New Zealand/ Australia	Europe	Africa	South and Central America
Holotrichia	*Lepidiota*	*Melolontha*	*Hoplochelus*	More than 600 species of 107 genera described
Anomala	*Antitrogus*	*Amphimallon*	*Eulepida*	
Leucopholis	*Costelytra*	*Anisopliae*	*Hypopholis*	*Phyllophaga*
Heteronychus	*Aphodicus*	*Phyllopertha*	*Heteronychus*	*Anomala* *Clavipalpus*
Maladera	*Heteronychus*	*Aphodius*	*Cochliotus*	*Plectris*
Lepidiota	*Leucopholis*		*Schizonycha*	*Podischnus*
Ligyrus	*Dermolepida*		*Phytalus*	

Bellotti & Peck 2000, modified

Whitegrubs are Cosmopolitan Pests

Reported Yield Losses and Plant Damage Due to Whitegrub Feeding (I) Central America

Crop	Country	Loss	Species	Reference
Beans	Guatemala	13%	*Phyllophaga* spp.	Velásquez 1999
Potatoes	Nicaragua	45%	*Phyllophaga* spp.	Mendez 1994
Maize	Costa Rica	8-70%	*Phyllophaga* spp.	King 1986
	Guatemala	47%	*Phyllophaga* spp.	Velasquez 1999
	Panama	30-50%	*Anomala* spp.	Guerra et al. 1994
	Honduras	23-39%	*Anomala* spp.	Lastres de Rueda 1994
Basic grains	El Salvador	50-90%	*Phyllophaga* spp.	Mendoza 1994

Bellotti & Peck 2000

Reported Yield Loss Due to Whitegrub Feeding(II) Asia and Australia

Crop	Country	Loss	Species	Reference
Sorghum	India	52%	*Holotrichia serrata*	Hasabe et al. 1984
Potato	India	58%	*Holotrichia* sp.	Mishra & Sharma 1988
Peanut	China	56-89%	*Leucopholis lepidophora*	Adsule & Patil 1990
Eucalyptus	Philippines	50-80%	*Leucopholis irrorata*	Bruza 1987
Groundnut	India	88%	*H. consanguinea*	Srivastava et al. 1986
Groundnut	India	32%	*H. consanguinea*	Siva Rao et al. 1984
Soybean	India	70-78%	*Anomala dimidiata*	Mishra & Singh 1994
Maize	Australia	25.8%	*Lepidiota* ssp.	Gough & Brown 1998
Sugarcane	India	44%	*Lepidiota mansuata*	Singh & Dayal 1986

Bellotti & Peck 2000

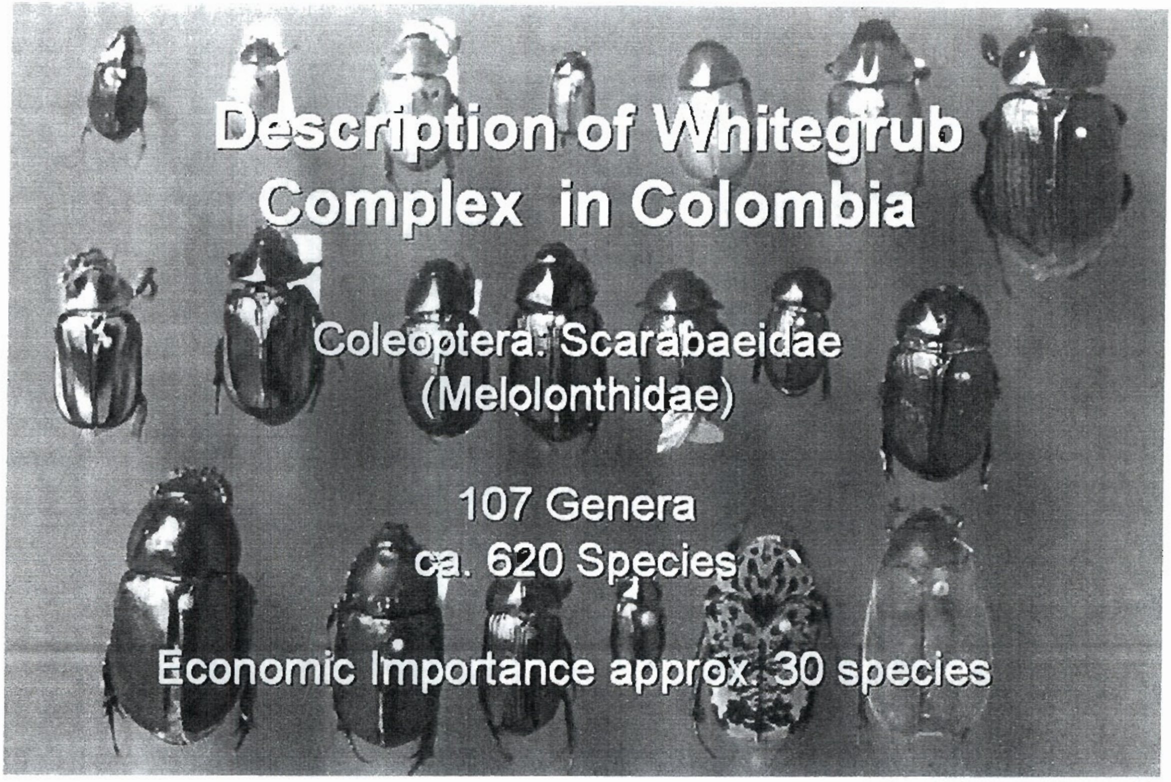
Reported Yield Loss Due to White Grub Feeding(III) Africa

Crop	Country	Loss	Species	Reference
Sugarcane	Uganda	n.s.	Not specified	Conlong & Mugalula 2003
Groundnut	Sub-Sahara	n.s.	Not specified	Umeh et al. 2001
Sugarcane	Tanzania	n.s.	*Cochliotus melolonthoides*	Evans et al. 1999
Beans	Malawi	n.s.	Not specified	Ross 1998
Sugarcane	Swaziland/ South Africa	n.s.	*Heteronychus, Hypopholis, Schizonycha, Asthenopholis, Adoretus*	Carnegie 1988
Eucalyptus/Acacia	South Africa	n.s.	Not specified	Govender et al. 1996
Pineapple	South Africa	n.s.	*Astenopholis, Trochalus, Macrophylla, Congella, Adoretus*	Smith et al. 1995

Highlights 2002-2004 Summary of Research & Achievements

Reported Whitegrub Damage Colombia

Crop	Region	Damage	Reference
Cassava	Cauca, Quindío, Risaralda, Valle del Cauca	30- 100%	CIAT (2003)
Coffee (seedlings)	Quindío	Up to 100%	CIAT (2003)
Maize	Caldas, Cauca, Quindío	30- 100%	CIAT (2003)
Arracacha	Cajamarca (Tolima)	15,000 t/year	Corpoica Tolima (2000)
Potato	Nariño, Antioquia, C/marca	30-100%	Peña (Corpoica Pasto, 2004)
Wheat	Nariño	30- 100%	Peña (Corpoica Pasto, 2004)
Ornamental flowers	Cundinamarca	30-100%	F. Valcárcel (Jardines de los Andes, pers. com. 2004); A. Gaigl (pers. observation 2004)



Farmer Interviews

- More than 80% of 201 interviewed farmers did not associate whitegrubs or burrower bugs with observed plant damage
- 86% use insecticides
- 14% apply biological control tactics
- 15% apply traditional treatments

Out of sight, out of mind

- Only since about 20 years, these soil insects are considered pests.
- So far research has been anecdotal and rarely published.
- Little data on economic importance available.

Pest and Non-Pest Species of Whitegrubs in Different Climatic Zones

- Cold Zones (2400–3000 m)
  - Key pest: 1 (Clavipalpus ursinus)
  - Pest species: ca. 17
  - Saprophytic species: 8
- Medium Altitude Zones (1800–2200 m)
  - Key pest: 1 (Phyllophaga obsoleta)
  - Pest species: 33
  - Saprophytic species: 8
- Hillsides (1000 – 1500 m)
  - Key pest: 1 (Phyllophaga menetriesi)
  - Pest species: ca. 12
  - Saprophytic species: 14
- Lowlands (< 1000 m)

- Key pest: not identified
- Pest species: ca. 20
- Saprophytic species: 11

Biology of Three Species described

Class	Insects		
Order	Coleoptera		
Superfamily	Scarabaeoidae		
Family	Melolonthidae		
Subfamily	Melolonthinae	Melolonthinae	Rutelinae
Genus	*Phyllophaga*	*Phyllophaga*	*Anomala*
Species	*menetriesi*	pos. *bicolor*	*inconstans*

Biology of Three Key Pest Species Duration of each stage (days)

Species	**Egg**	**L1**	**L2**	**L3**	**Pupa**	**Adult**	**Total**
Phyllophaga menetriesi	13	19	27	175	64	29	327
P. pos. *bicolor*	15	24	29	171	65	25	329
Anomala inconstans	12	27	30	163	44	34	310

Whitegrubs: Pests or Recycler of Soil Organic Matter?

Species	Sand	Sand+ Wood	Sand+ potato	Soil	Soil+ Wood	Soil+ Potato
Ancognatha scarabaeoides	-	+	+	+++	+++++	+++
Clavipalpus ursinus	-	+	++++	+++++	+	++++
Heterogomphus dilaticollis	-	+++++	++	+	+++++	++

Variables: Increase of weight and body diameter

Natural Enemies Identified Isolated from Insects or Soil

CIAT strains collection:

- 411 entomopathogenic fungal strains (EPF) (Fusarium, Metarhizium, Paecilomyces etc.)
- 89 bacterial strains (mainly from Bacillus spp.)
- 15 entomopathogenic nematode (EPN) strains (Steinernema feltiae, S. kraussei and Heterorhabditis bacteriophora)

Natural Enemies Identified Promising EPF Strains against Whitegrubs

Strains	**Control level (in the lab)**
CIAT 515 (*Metarhizium anisopliae*)	100%
CIAT 418 (*M. anisopliae*)	100%
CIAT 338 (*Gliocladium*)	100%
CIAT 405 (*Beauveria bassiana*)	100%

Natural Enemies Identified Bacteria against Whitegrubs

- Six strains of *Bacillus popilliae* (milky disease) tested vs. second instar of *P. menetriesi*
- Bacteria applied to soil: CIAT-LF24 obtained a mortality of 90% (concentration of 1x108 spores) or 78% (1x105); CIAT-Bp4 killed 60% (1x108)
- Natural Enemies Identified Nematodes against Whitegrubs

- *Phyllophaga menetriesi has highly efficient defense mechanisms against nematodes (phenoloxidase isoenzymes)*
- *Steinernema feltiae and Heterorhabditis sp. obtained a control of 70% and 98% respectively vs. third instar of Anomala inconstans in the greenhouse*

Phase II: Integrated Soil Fertility and Pest Management

Goal

Enhance food security and reduce environmental degradation due to excessive use of pesticides

Purpose

Improve integrated management of soil pests and diseases through a balanced soil biota and sustainable control strategies

Outputs (I)

Output 1	**Output 2**	**Output 3**
Pest and disease problem in key zones of problem described and defined	Dynamic of soil biota and soil fertility better understood	Control strategies of soil-borne pests and diseases developed

Output 4	**Output 5**	**Output 6**
Enhance farmers' and extensionists' capacity of integrated pest, disease and soil management	IPM network of soil biota, fertility and plant health improved	Project outputs monitored

Session 10 Land use intensity mapping and analyses of BGBD at landscape level.

Content

1. Parameterisation of the LUI Index; possibilities and challenges in Mexico

Simoneta Negrete Yankelevich, Tajín Fuentes Pangtay

Content

- Why a land use intensity index?
- The LUI index proposed in Lampung
    - Characteristics
    - Assumptions
- The problems with the assumptions in Mexico
- How well did we manage to parameterise the index in Mexico?
- Sources of errors and inprecisions

The LUI index proposed in Lampung

LUI = Crop1 + Fallow1 + Crop2 + Fallow2...

Crop1 = time + yield + irrigation + energy + pesticides + fertilisers

The index is dimentionless: everything is in terms of proportions

time = time in crop /total time

irrigation = H2O irrigated/H2O use by crop

pesticides = pesticide amount/pesticide impact

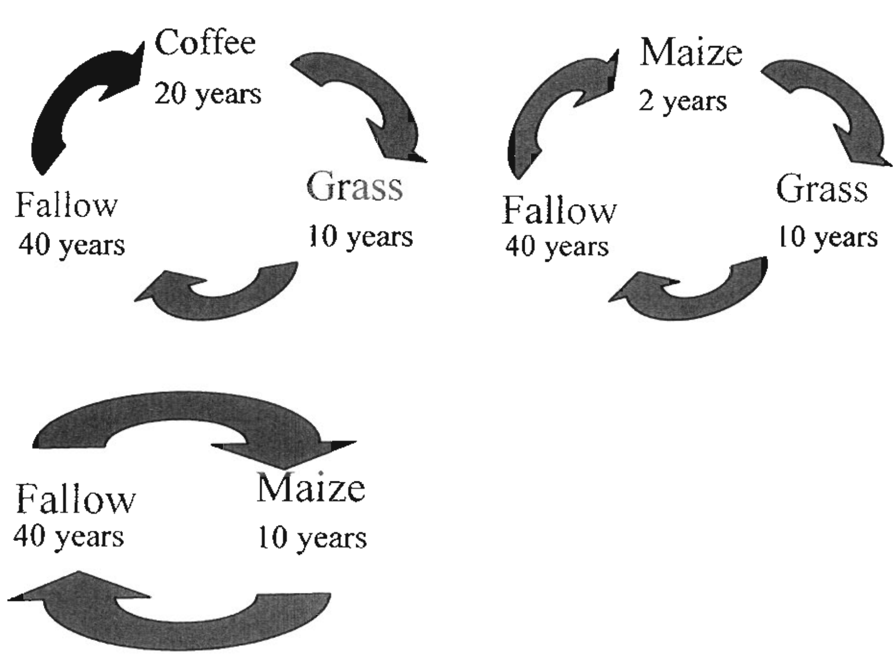
yield = harvest biomass/total biomass

energy = energy used by humans/energy in crop tissue/

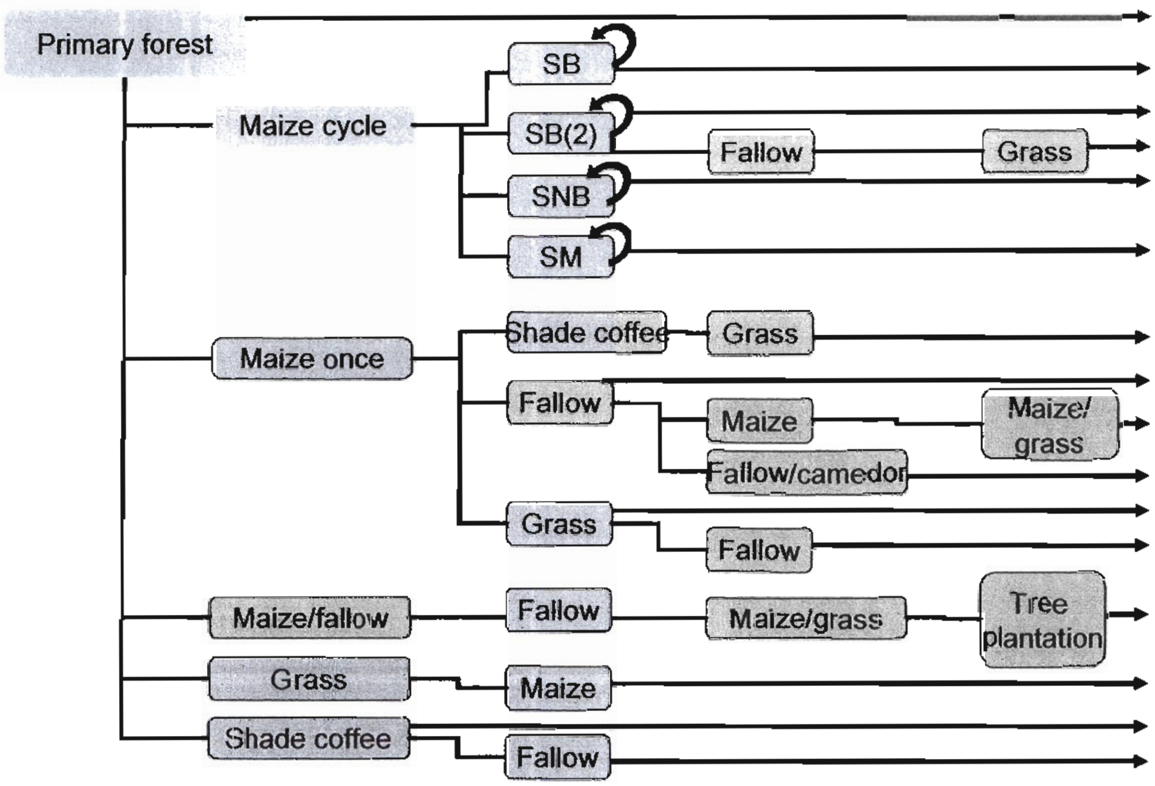
fertilisers = N + P + K input/N + P + K content in crop

Assumptions:

Typical land use cycles



In Mexico there are no cycles, but historical trends



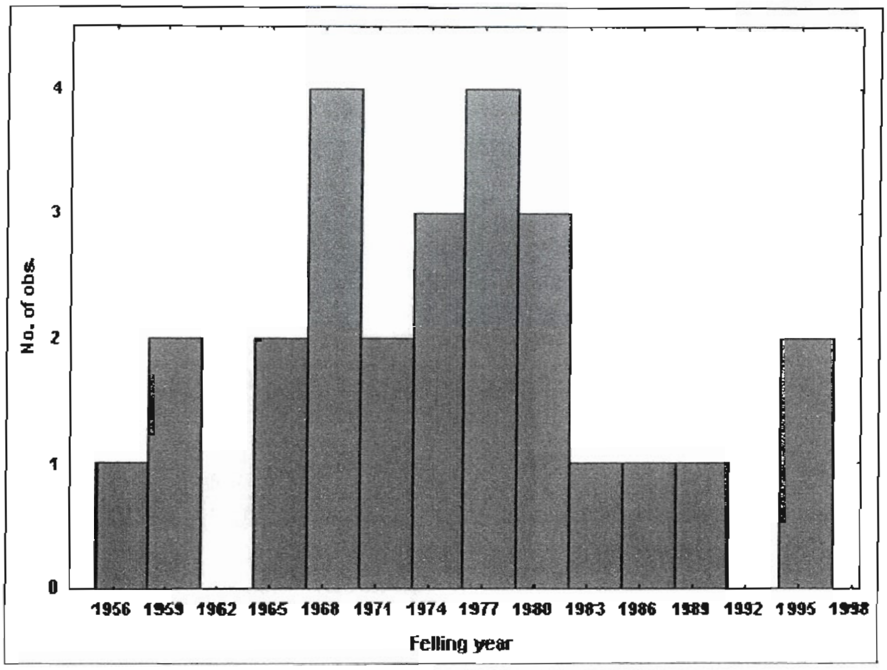
b) Similar starting conditions

- Distance to original vegetation
- Soil characteristics: organic matter, nutrient content, depth
- Geographic: altitude, slope aspect

In Mexico sampling windows differ in several aspects

	López Mateos	**San Fernando**	**V. Carranza**
Location	18° 24' 56'' to 18° 26' 33'' North Latitude and 94° 56' 53'' to 94° 58' 18'' West Longitude	18° 15′ 08''to 18° 19′ 55'' North Latitude and 94° 52′ 00'' to 94° 54′ 06'' West Longitude	18° 19' 09'' to 18° 21′ 50'' North Latitude and 94° 44′ 41'' to 94° 46′ 44'' West Longitude
Altitude	238.39 – 37.45 m	994.86 - 144.37 m	225.7 - 44.89 m
Rainfall	2000 y 2500 mm	1182.7 mm	2900 mm
Soil type	Humic Andisol	Cromic Acrisol and Mollic Acrisol	Cromic Luvisol and Ocric Luvisol
C:N	9	15	7
pH (water)	5-6	5-6	4-5
Main land use	Rain forest conservation	Shaded Coffee plantations	Grassland for cattle raising
Forest cover	76.85%	49.55%	27.23%
Window Size	571.99 Ha	2192.32Ha	970.73Ha

c) Similar management time



- The index does not consider the cumulative impact of human activity as part of the intensity of land use

How well did we manage to parameterise the index?

	Total biomass	Removed biomass	Nutrients in plant	Fertilisers	Pesticides
Coffee	ML	SI	WL	PI	PI
Maize	LL	LL	WL	PI	PI
Grass	?	PI	WL	PI	PI
Fallow	LL	LL	NA	NA	NA

■	World literature	■	Parcel information
■	Mexico literature	■	Site information
□	Local literature	□	Not aplicable

Sources of errors and inprecisions

- Assuming that literature information is true for the particular case.
- Extrapolation from one plot to another: yield, quantities of pesticides, etc.
- Historical changes in management practices: we know that the use of fertilisers was common in the 1980's.
- Mixed scales in the information: point and plot.

Acknowledgments

Data extraction and management

- José Antonio García
- Martín de los Santos

Illustrations

- Rafael Ruíz

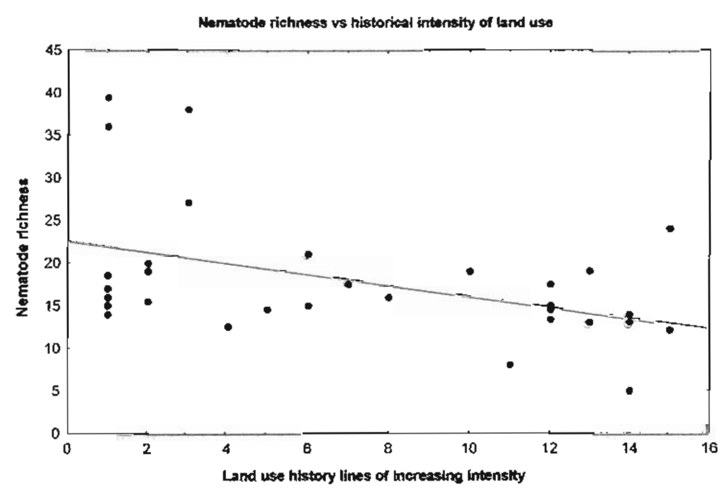
2. Possible modifications to the LUI index using the Mexican case as an example

Simoneta Negrete Yankelevich, Tajín Fuentes Pangtay

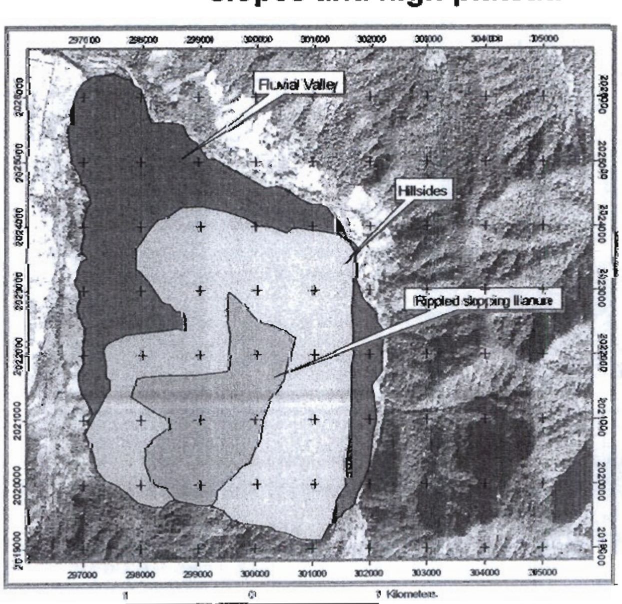
Content

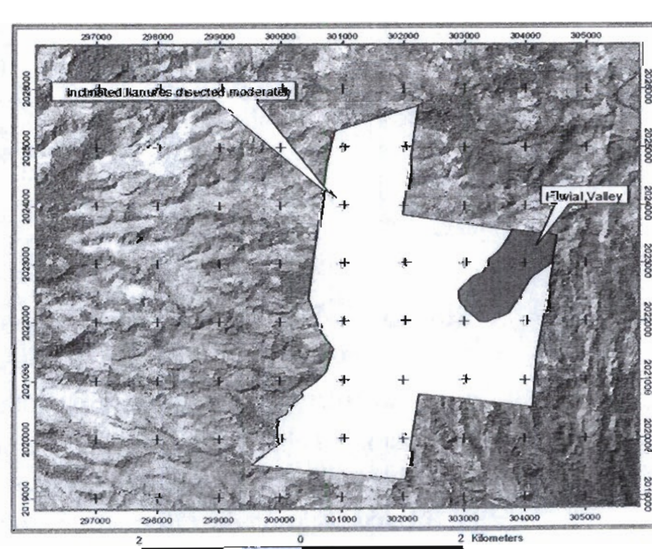
- Suggested Modifications to the assumptions
  - Typical land use cycles
  - Similar starting conditions
  - Similar management time

a) In Mexico there are no cycles, but historical trends



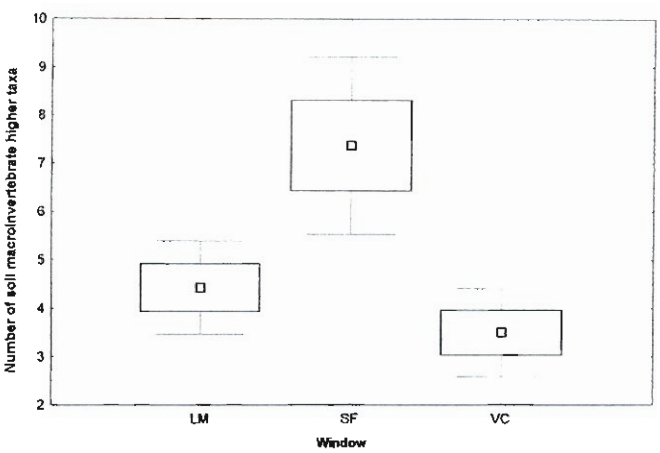
b) Not similar starting conditions. Within windows: fluvial valleys, slopes and high plateau



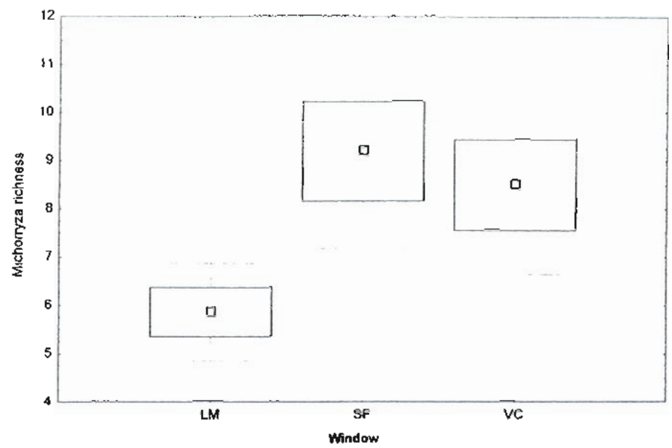


Consequences for BGBD: Richness per group

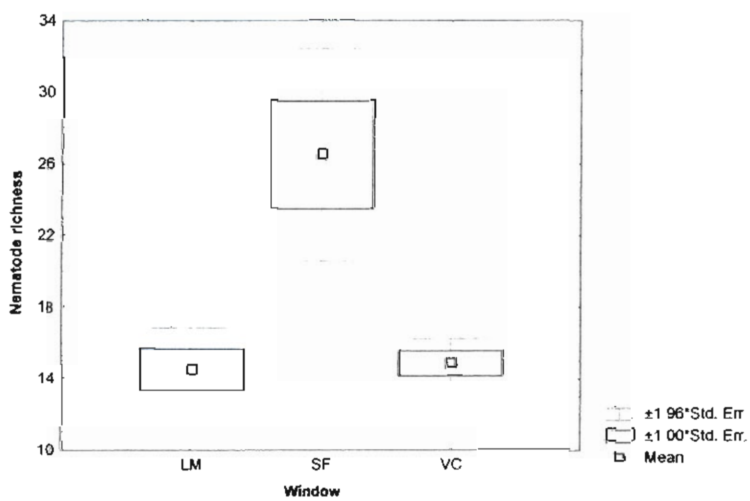
Macroinvertebrates



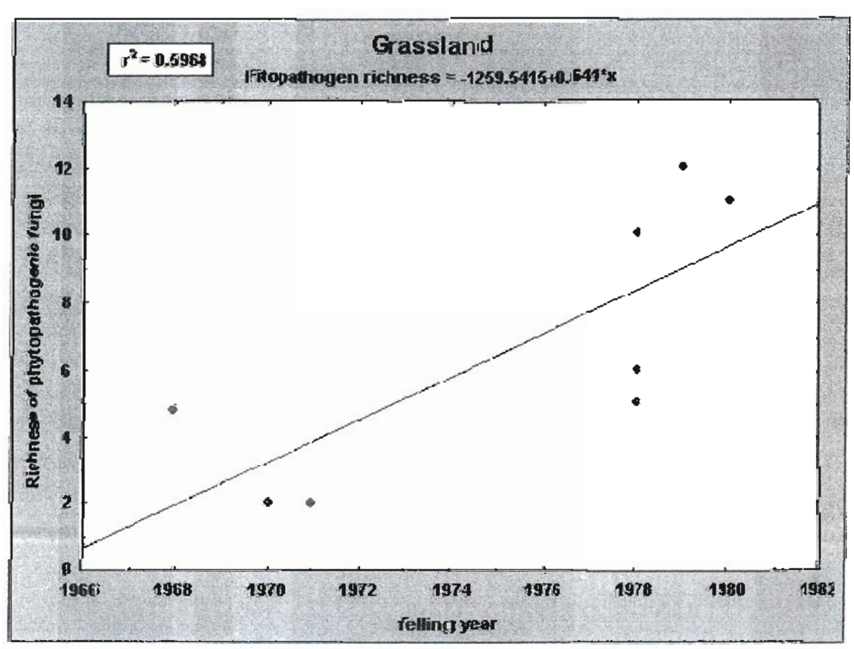
Mycorrhiza



Nematodes



Similar management time



Possible modifications

HLUI = (Crop1 + Fallow1 + Crop2 + Fallow2...n) time in use* sensitivity modifiers

Sensitivity modifiers: those characteristics that make a particular soil more sensitive AND have shown relevance to BGBD

Acknowledgments

Data extraction and management:

- José Antonio García
- Martín de los Santos

Maps:

- Enrique Meza

Illustrations:

- Rafael Ruíz

3. Land Use History, Intensity, and Socio-economic Background Of CSM-BGBD Sumberjaya Window, Lampung Benchmark, Indonesia

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Abstract

A farmers' household and on-farm survey was conducted in Sumberjaya Window of Lampung Benchmark in 2004 to study land use history, land use intensity, and socio-economic background using graded stratification sampling method. The forest opening of the field areas were started in 1952 by West Java migrants, but now it owned by the second generation or migration who opened secondary forest, shrub, or old coffee fields in 1970-ies. It was found some land use history (land uses followed by its age) such as F(?)Hc(4)Tc(14)S(3)Tc(5) where F = forest, Hc = horticulture-crops, Tc = tree-coffee, S = shrub, showing a continue coffee farming or S(9)Tc(16)Hc(4) showing coffee-crops farming system. The land use change is a dynamic among shrub, coffee, and crops performing a continue cultivation system. Land use intensity (LUI) could be quantified by calculating the mean of intensification level, production level, and system intensity scale using primary forest as standard. For land use type in Sumberjaya Window, the results showed that land use intensity (LUI) of undisturbed forest (FLI) lay between 0 – 9.9%, disturbed forest between 5.3 – 27.2%, shrub between 6.1 – 34.4%, monoculture coffee (TBI) lay between 35.1 – 64.5%, LUI of shade coffee (TBLI) between 30.9 – 66.2%, LUI of food crop (CBLI) between 55.3-63.5%, LUI vegetable (CBI) between 66.4 – 84.7%. Farmers' income of vegetables farming (CBI) was the highest than other farming, but only practiced in small scale. Income from monoculture or shaded coffee farming provided low food security. Coffee farming mixed with high compatible commodities will increase farmers' income.

Key words: history, land use intensity, household income

4. Operationalisation of the Land Use Intensity Index: the Mexican case

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Extended summary

One of the central questions of the BGBD project is whether there is a relationship between land use intensification and below-ground biodiversity, which equally applies in different regions of the tropical belt. To be able to tackle this question, the project requires a measurement of land use intensity that may be calculated for any productive plot, independently of local specificities such as the identity of the crop or the type of fertilizer. For this purpose a dimensionless land use intensity index (LUI index) was proposed by M. van Noordwijk and others in the BGBD project meetings in Wageningen and Lampung. In this paper, we first examine the applicability of this index to the data set of the Mexican benchmark site. Then, we consider possible adaptations to render the index operational in the Mexican context and to improve its ability to capture the trends of land use intensification in this particular benchmark site.

The applicability of the LUI index to the Mexican data

We present the results of a variable-by-variable examination of the applicability of the LUI index to the Mexican data. To do so we have analysed circa 50% of the sampling plots in this benchmark site, which consists of three communities within the buffer zone of the Los Tuxtlas biosphere reserve. As far as possible we have extracted the data required by the index from the project inventories and socio-economic interviews. When the parameters were not available from the projects data base, we resorted to figures in the literature that were obtained within the Los Tuxtlas region or in similar environments elsewhere in Mexico.

We found that there are three assumptions made by the LUI index that are incompatible with the management history in the communities of Los Tuxtlas:

1.- The index assumes that sampling plots can be subscribed to one of a limited set of crop cycles that are typical for the region. It further assumes that these cycles have been constant historically in terms of the management practices involved and that each plot has been subscribed to the same cycle in its whole management history. In Los Tuxtlas the changes in land use do not follow clear cycles but seem to have followed different trends in history. The general historical paths can be represented in a branching tree, but the specificities of management for the same crop have changed with time.

2.- The LUI Index assumes that every plot has similar starting conditions (soil type, slope, soil depth, etc.) therefore a given practice can be considered to be equally intensive wherever it is applied. In the Mexican benchmark site the soils are not uniform. Some of the differences are attributable to the topography (aspect and slope), but others to geological constitution. Because the BGBD project is centered on the effect of land use intensity on below ground biological diversity a given management practice should be considered to be more intense for less resilient soils.

3.- The index assumes that all of the sites have been managed for the same length of time or in other words it does not consider the impact of cumulative human activity as part of the variation in intensity of land use. In Los Tuxtlas region plots of pristine forests have been cleared yearly from the 1960's up to date. Within the sampling windows the project has covered a range of plot ages that need to be considered.

Proposed adaptations to the Land Use Intensity index

For the Mexican benchmark we can only be certain of how intensively the plot or parts of it have been managed so far (considering historical records and present conditions) but it is difficult to establish a rule that describes a fixed set of rotational systems for the region. For this reason we suggest calculating an index per plot, not per rotational system. This

implies that land-use intensity becomes a characteristic that each individual plot acquires through its history of usage. This approach accounts for all the variability in land use history present in the Mexican data and does not make assumptions about future management.

We present in this paper a list of variables (not considered by the original index) that appear to be important determinants of the intensity with which land is being managed in the Mexican benchmark site. Of particular interest are two groups of variables, those that concern intensity of use in terms of temporal cumulative impact (for example how continuously the plot has been used since it was cleared) and those related to differences in the initial susceptibility of the soil to impact (such as initial organic matter content, slope and distance to the nearest forest). In order to keep the index as simple as possible, we suggest considering for the index's equation only those variables from this list that show a significant correlation with BGBD.

5. Determination of stand quality of the natural forest study sites in Windows established in BGBD project

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Natural forest is one the landuse categories to be sampled in each country for the BGBD project. My experience and understanding indicate that natural forest/s selected for the sampling may differ in different countries in terms of overall ecological qualities. In some benchmark sites, forest may be relatively undisturbed and with climax vegetation. On the other hand, in some other benchmark sites natural forest site/s may be secondary forest/s or even highly degraded forest patches. Thus one can expect that the comparison of points laid in the natural forests and those in other landuse system for any given parameter (soil characteristics, belowground biodiversity of flora and fauna etc.), without giving clear indication or information on the quality of natural forest, may be misleading. In this context, I propose that at each benchmark site we should determine the quality of the natural forest. I am explaining below a method to estimate the stand quality index for a forest in the tropical region (Chandrashekara and Sankar, 1998; Chandrashekara, 1998).

Based on life history pattern, tropical forest species can be categorized into primary species, late secondary species, early secondary species and deciduous species. In the case of primary species, seedlings establish in closed canopy area but need small canopy gaps for grow up. The late secondary species are those seedlings establish in small canopy gaps but need small to medium size gaps for grow up. The early secondary species are the light demanding (heliophytic) evergreen species whose seedlings need larger canopy gaps for both establishment and growth. On the other hand, deciduous species are light demanding species which shed their leaves completely in one season of the year. We can assign the pioneer index for these four categories of species as follows

Species categories	Pioneer index
Primary species	1
Late secondary species	2
Early secondary species	3
Deciduous species	4

Based on phytosociological studies following standard methods (Kershaw and Looney, 1985) relative frequency, relative density and relative dominance may be calculated for each species. The sum of these three values obtained for a species would give the Importance Value Index (IVI) of that species (Shannon and Weiner, 1963).

Subsequently the following formula may be used for to quantify the forest stand quality.

$$\textbf{RISQ} = \Sigma\ (n_i \times \text{pioneer index}) / N$$

Where,

RISQ = Ramakrishnan index of stand quality.

n_i = Importance value index of species i.

N = Importance value index of all species

RISQ value of a given site can be vary from 1.0 (all stumps, group I species) to 4.0 (all stumps deciduous species, group IV).

I have calculated the RISQ value for the natural forest located in the Window established in a benchmark site of BGBD at the Nilgiri Biosphere Reserve of India. Detailed Table is given below.

Table: *Relative density, relative dominance, relative frequency and, species importance value index (IVI), and the RISQ value calculated for the natural forest located in the BGBD site in the Nilgiri Biosphere Reserve, India.*

Species	Relative density	Relative dominance	Relative frequency	IVI	(IVI X pioneer index)/300
Primary species (pioneer index = 1)					
Aglaia sp1	1.38	1.16	4.68	7.22	0.024
Drypetes oblongifolia	0.46	0.50	0.78	1.73	0.006
Nothopegia sp.	0.46	0.25	0.78	1.48	0.005
Polyalthia fragrans	2.14	4.11	3.12	9.37	0.031
Myristica malabarica	14.55	3.25	11.43	29.23	0.097
Knema attenuata	24.20	11.42	12.21	47.83	0.159
Aglaia lawii	0.46	1.12	0.52	2.09	0.007
Palaquium ellipticum	0.61	0.19	1.04	1.84	0.006
Cullenia exarillata	0.31	0.33	0.52	1.16	0.004
Kingiodendron pinnatum	3.52	2.22	3.90	9.64	0.032
Vateria indica	4.90	3.59	4.94	13.42	0.045
Hopea racophlea	13.32	9.78	9.61	32.71	0.109
Fahrenheitia zeylanica	5.82	5.75	5.45	17.03	0.057
Syzigium gardneri	1.53	6.60	1.82	9.95	0.033

Species	Relative density	Relative dominance	Relative frequency	IVI	(IVI X pioneer index)/300
Primary species (pioneer index = 1)					
Diospyros bourdillonii	0.77	0.05	1.30	2.11	0.007
Baccaurea courtallensis	3.37	0.59	4.42	8.37	0.028
Meiogyne pannosa	0.15	0.09	0.26	0.50	0.002
Otonepelium stipulaceum	0.15	0.20	0.26	0.62	0.002

Cinnamomum malabatrum	3.37	3.73	3.90	10.99	0.037
Orophea erythrocarpa	0.61	0.02	1.04	1.67	0.006
Polyalthia coffeoides	1.23	2.28	1.82	5.32	0.018
Xanthophyllum arnottianum	0.15	0.02	0.26	0.43	0.001
Unidentified 162	0.15	0.43	0.26	0.84	0.003
Garcinia morella	0.46	0.17	0.78	1.41	0.005
unidentified 174	0.15	0.51	0.26	0.92	0.003
Syzigium densiflorum	0.31	0.29	0.52	1.12	0.004
Litsea glabrata	0.15	0.07	0.26	0.48	0.002
Diospyros oocarpa	0.31	0.48	0.52	1.31	0.004
Calophyllum polyanthum	1.53	5.91	1.30	8.75	0.029
Drypetes elata	0.15	0.03	0.26	0.44	0.001
Litsea mysorensis	0.31	0.82	0.52	1.64	0.005
Nothopegia racemosa	0.61	0.12	1.04	1.77	0.006
Unidentified 410	0.15	1.05	0.26	1.46	0.005
Unidentified 455	0.15	0.27	0.26	0.68	0.002
Syzigium mundagam	0.31	6.88	0.52	7.70	0.026
Unidentified 490	0.15	0.41	0.26	0.82	0.003
Cyathocalyx zeylanica	0.15	0.00	0.26	0.42	0.001
Diospyros sp.3	0.61	0.25	1.04	1.91	0.006
Holigarna grahamii	0.15	0.58	0.26	0.99	0.003
Unidentified 591	0.15	0.19	0.26	0.60	0.002
Diospyros assimilis	0.15	0.03	0.26	0.44	0.001
Diospyros paniculata	0.15	0.08	0.26	0.50	0.002
Unidentified 649	0.15	0.32	0.26	0.73	0.002
Late secondary species (pioneer index = 2.0)					
Hydnocarpus pentandra	1.23	1.24	1.82	4.28	0.029
Toona ciliata	0.15	1.49	0.26	1.90	0.013
Bischofia javanica	0.46	4.16	0.78	5.40	0.036
Ficus drupacea	0.15	0.47	0.52	1.14	0.008

Species	Relative density	Relative dominance	Relative frequency	IVI	(IVI X pioneer index)/300
Late secondary species (pioneer index = 2.0)					
Artocarpus hirsutus	1.07	3.51	1.82	6.40	0.043
Holigarna arnottiana	0.92	3.89	1.56	6.36	0.042
Mangifera indica	0.92	1.55	1.04	3.50	0.023
Mallotus beddomei	1.53	0.39	2.34	4.26	0.028
Alstonia scholaris	0.15	0.04	0.26	0.46	0.003
Croton malabaricus	0.46	0.70	0.78	1.94	0.013
Actinodaphne boudillonii	0.61	1.08	1.04	2.73	0.018
Spondias pinnata	0.15	1.21	0.26	1.62	0.011

Vitex altissima	0.15	0.29	0.26	0.70	0.005
Actinodaphne angustifolia	0.61	0.66	1.04	2.31	0.015
Trewia polycarpa	0.15	0.11	0.26	0.53	0.004
Canthium angustifolium	0.15	0.04	0.26	0.45	0.003
Ficus beddomei	0.15	1.28	0.26	1.69	0.011
Mallotus stenanthus	0.15	0.00	0.26	0.42	0.003
Flacourtia montana	0.15	0.01	0.26	0.42	0.003
Early secondary species (pioneer index = 3.0)					
Macaranga peltata	0.15	0.14	0.26	0.55	0.006
Deciduous species (pioneer index =4.0)					
Cassia fistula	0.15	0.22	0.26	0.64	0.008
Gmelina arborea	0.15	0.00	0.26	0.42	0.006
Artocarpus gomezianus	0.15	0.10	0.26	0.51	0.007
Lagerstroemia microcarpa	0.15	1.31	0.26	1.72	0.023
			RISQ value		**1.192**

Thus the RISQ value obtained to the natural forest in the BGBD Benchmark site at Nilgiri Biosphere Reserve is **1.192**. The expected value for a relatively undisturbed and climax wet evergreen forest is 1.0. The slight high value is due to the natural disturbances such as tree fall and crown fall resulting in the opening of canopy in certain points in the forest plot which lead to growth of some secondary and deciduous species.

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6. Benchmark selection and site description in centre-west Cote d'Ivoire

Typology of agro-ecological units

	Surface (ha)	Percentage (%)
Primary forest	41.8	10.4
Secondary forest	111.2	27.8
MSTP	84.4	21.1
20 year-old teak	22.7	5.7
10 year-old teak	27.9	7.0
4 year-old teak	36.1	9.0
Old fallow	64.5	6.4
Cocoa plantation	16.5	4.1
Coffee plantation	0.85	0.2
Mixed crop field	20.5	5.1

Estimating land-use index (lui)

- Agricultural Intensification (AI) index (Decaëns & Jiménez 2002), modified from Giller et *al.* (1997)
- Based on the monography of each points from the grid
- LUI is a set of land management pattern and the duration of it's utilization

LUI=(D+F+I+P)/N

D = duration of land utilization
F = fire option
I = inorganic fertilizer input
P = pesticide option
N = number of factors or sub-index

Except D, each sub-index has a binary value: 0 when the option was not used, 1 when it was an input

The respective maximum value are brought back to 1 by divising each value by the correspondant high value. As a result, LUI is ranged from 0 to 1.

	Surface (ha)	LUI
Primary forest	41.8	0
Secondary forest	111.2	0.13
MSTP	84.4	0.26
20 year-old teak	22.7	0.26
10 year-old teak	27.9	0.28
4 year-old teak	36.1	0.31
Old fallow	64.5	0.26
Cocoa plantation	16.5	0.26
Recurrent fallow	0.85	0.31
Mixed crop field	25.7	0.38

Land-use index of agro-ecological units

Floristic diversity

- Regular sampling of the flora through a sampling unit of 200 m^2 at each 107 points
- 471 species (312 genus and 78 families) were identified accross the landscape

Table Significant variation of diversity accross the agro-ecological units

	S. number	Shannon I.	Eveness
Primary forest	163	7.10	0.97
Secondary forest	108	7.28	0.97
Mul. planted trees	94	6.28	0.95
10 year-old teak	70	5.91	0.96
4 year-old teak	85	6.13	0.95
Cocoa plantations	84	6.31	0.96
Recurrent fallows	125	6.66	0.96
Mixed crop fields	117	6.64	0.96

Table Frequency of main species

Chromolaena odorata	96
Motandra guineensis	70
Parquetina nigrescens	70
Griffonia simplicifolia	54
Centrosema pubescens	48
Antiaris toxicaria	46
Secamone afzelii	46

Dendrogram of the different agro-ecological units

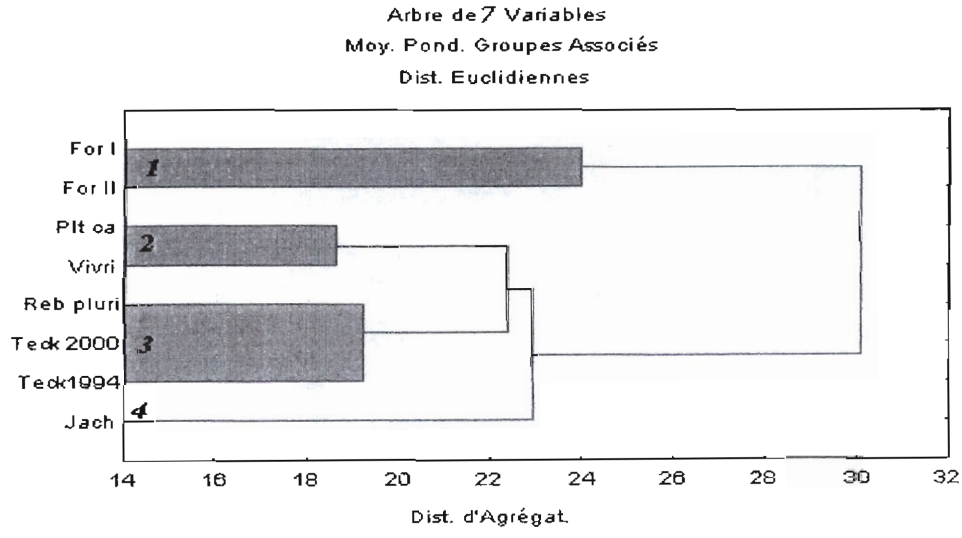


Figure. Water infiltration as function of land-use types

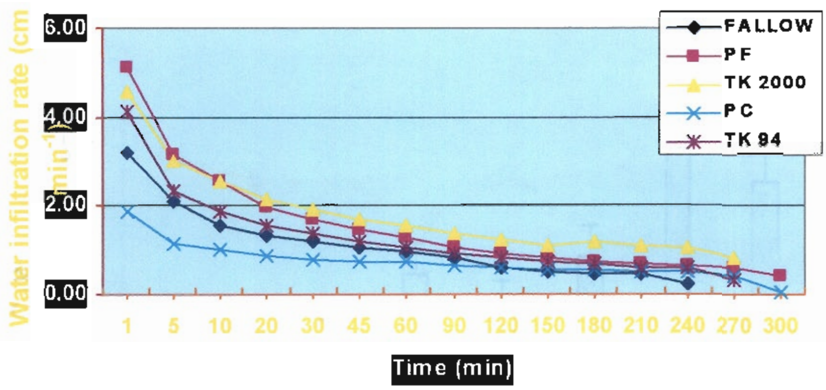


Figure *Soil resistance to penetration (KPa) as a function depth and land use types*

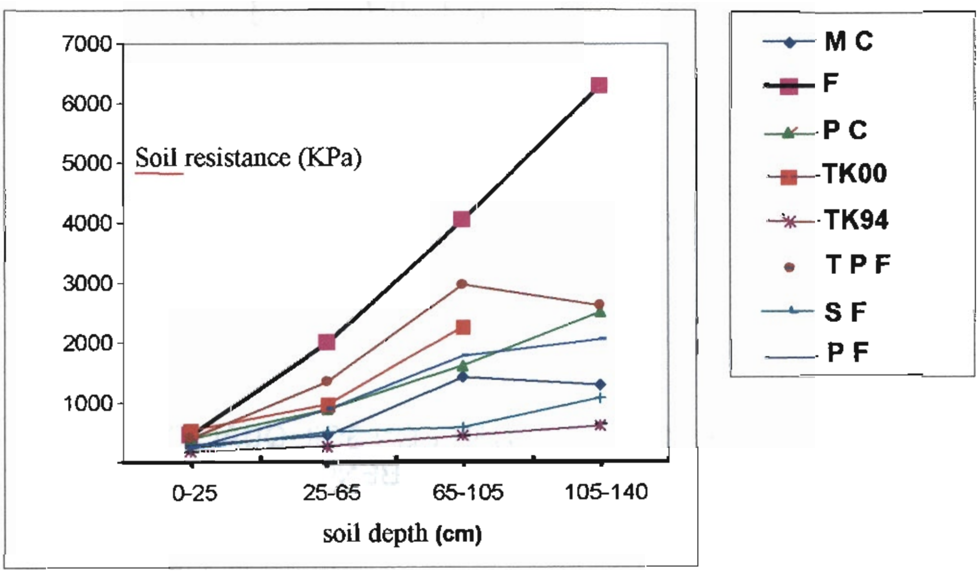
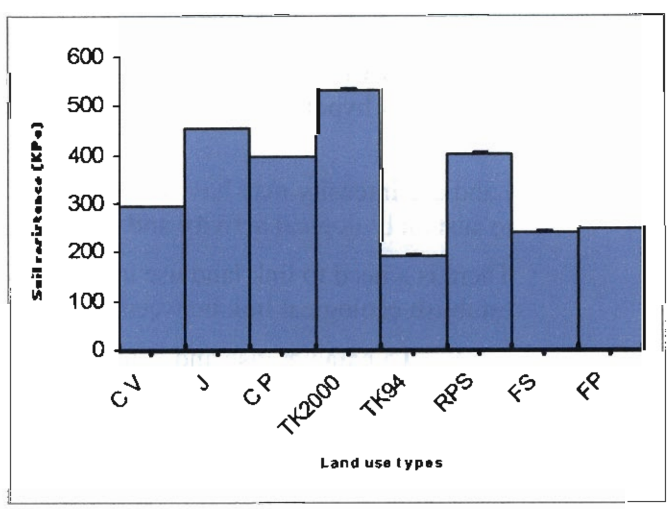
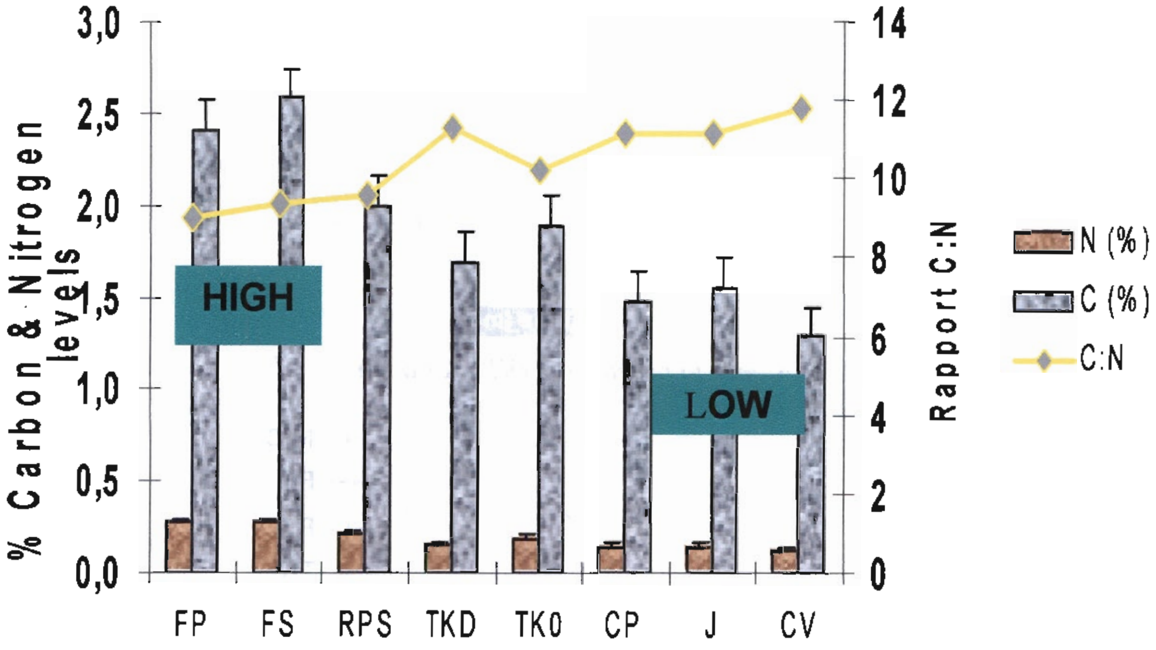


***Figure**. Penetrometer values 0 – 20 cm*



Significant variation of soil organic matter



7. EFFECTS OF LAND USE INTENSITY ON SOIL QUALITY UNDER DIFFEENT LAND USE SYSTEMS IN EMBU BENCHMARK SITE, KENYA

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Introduction

The project hypothesis is that land use intensification is the significant cause of BGBD loss

Land use intensity may have an influence on soil quality which is the capacity of the soil to sustain biological activity and environmental quality

There is a need to link land use intensity with ecosystem services in an attempt to establish ecological link between land use and BGBD

1. To parameterise and quantify land use intensity
2. To correlate land use intensity index with soil quality

Determination of land use intensity

The components of LUI considered are:

1. The total quantity of the inputs applied per ha
2. The frequency of input application
3. Crop density (no of crops/ha)
4. Cultivation intensity

Table 1: Components of land use intensity and their indicators

Forms of land use intensity	Indicators/Criteria	Assigned values
Increased use of inputs	Quantity of inorganic inputs Quantity of organic inputs	0.25
Increased frequency of using agricultural inputs	Frequency of application of inputs	0.25
Increased cropping	Number of crops per unit area	0.25
Increased frequency of cultivation	Frequency of cultivation	0.25

Assigning values to the inputs

The value 0.25 was assigned to the highest level of inputs (Kg/ha) observed in the identified land use systems surveyed, namely:

- coffee, tea, maize-beans, Napier, fallow, planted forest and indigenous forest.

The highest level of inputs is applied in coffee at 5000 kg/ha. Therefore, the value assigned to this is 0.25. Other land use systems are assigned a fraction of 0.25, in proportion to the level of the highest input application in each (Table 2).

Determination of land use intensity index

The input intensity index at any given sampling point is given by the following equation:

Yi=(Xi/Maxi)*Vi

Where:

Yi = Input intensity index at a given sampling point
Xi = The total quantity of inputs applied (kg/ha)
Maxi = The highest level of input observed in kg/ha
Vi = Maximum value assigned to the system (Table 2)

Land use	Highest level of Inputs	Total quantity in Kg/ha	Remarks	Assigned values (Vi)
Coffee	CAN>20 bags each 50 Kgs DAP>20 bags each 50 kgs Copper spray>20 Kgs	5000	Coffee has the highest level of inputs in the area. The quantity of inputs given here is obtained from a farmer who is known to be applying the highest level of inputs in the area.	0.250
Tea	Sulphur>50 Kgs per 500 tea stems for 2500 stems	2500	Tea is second in terms of the quantity of inputs applied, and the values given are the maximum applied in tea.	0.125
Maize	2 grams of compound fertilizer per planting hole	180	Maize is third in terms of the quantity of inputs applied .	0.009
Napier	1Kg of manure per hole	1000	Only organic input is applied to the Napier grass.	0.05
Fallow	0.00	Zero	No inputs at all	0.00
Planted forest	0.00	Zero	No inputs at all	0.00
Indigenous forest	0.00	Zero	0	0.00

Assigning values to the frequency of input application, cropping density and cultivation intensity

The highest frequency of input application observed in the area is 3 times per season. This is assigned the value of 0.25.

Frequency of input application index at a given point:

Yfi=(Xfi/3)*0.25

Where:

Yfi	=	Frequency of application index
Xfi	=	The frequency of application of input per season

The maximum number of crops in the area is taken as 10 per ha, and this is assigned a value of 0.25. The cropping intensity index is given as follows:

Yci=(Xci/10)*0.25

Where:

Yci	=	Cropping intensity index in a given point
Xci	=	The number of crop per ha per point

The highest frequency of cultivation in the benchmark site is:

- ploughing or digging the fields,
- harrowing,
- Planting,
- and weeding per season.

The value assigned to this is 0.25, and most annual crops in the area have this value. For perennial crop, arbitrary value is given as 10% of 0.25. The cultivation frequency is given by the symbol CI, and it is determined by whether the land use is annual or perennial at a given point.

Calculation of land use intensity index (LUI)

Land use intensity index of a given land use system is the summation of the indices of input application, frequency of input application, cultivation intensity and cropping intensity. This is given by the following equation:

LUI=∑((Xi/Maxi)*Vi)) + (Xfi/3)*0.25) + (Xci/10)*0.25 + CI).

The calculated land use intensity index was plotted against each of the main land use systems and cOrrelated with soil quality attributes

Figure 1: Land use intensity, based on inputs only

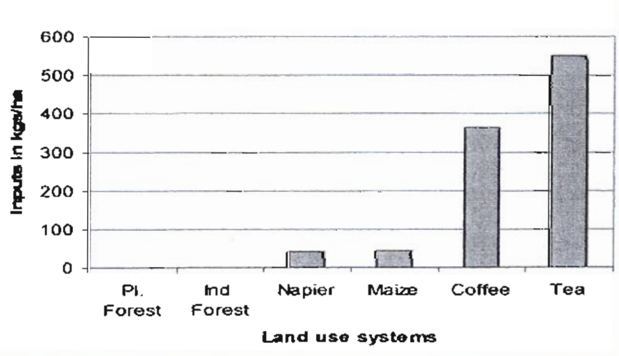
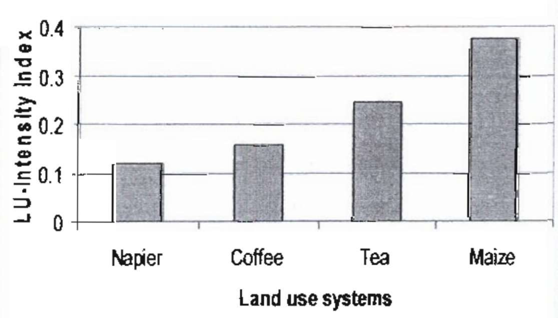
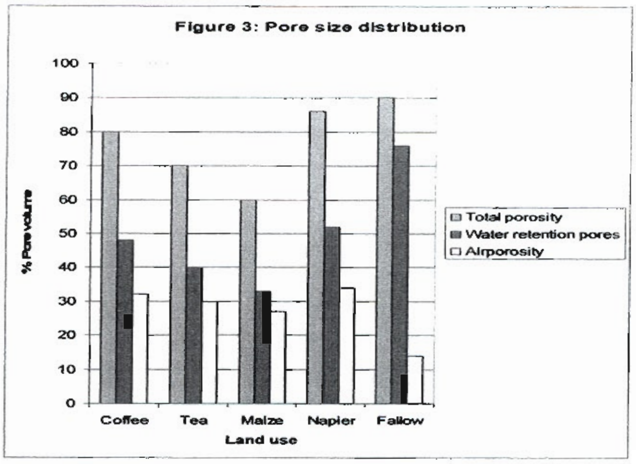
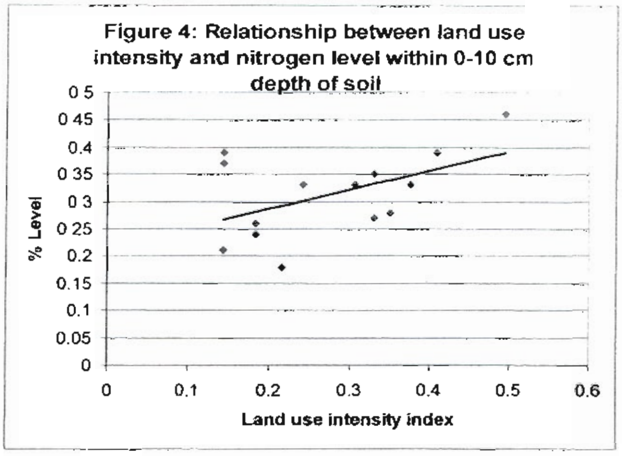
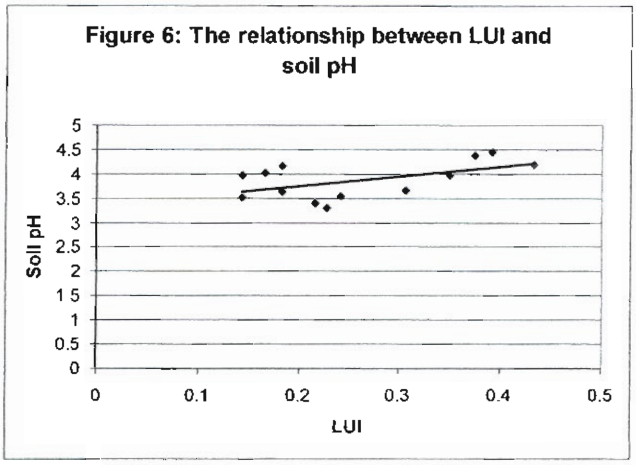


Figure 2: Land use intensity, based on inputs plus other parameters









CONCLUSIONS

1. Land use intensity gradients exist across different land uses and ecosystems
2. There is some correlation between land use intensity gradients and nitrogen level, organic carbon and soil pH

8. Methods for spatial and multiscale analysis

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See section on planning sessions of the working groups

Session 11. EEVAL Task Force; Economic valuation case study report.

Content

1. Economic Valuation of Below Ground Biodiversity: Report of Progress to Date and Recommendations for Path Forward

Dr. Diane Osgood

On Behalf of the EEVAL Task Force.

This paper covers:

- Team Leaders and other participants
- Summary of main issues
- Case Study 1 progress
- Case Study 2 progress
- Plans for Phase 2

I. Team Leaders and participants in project work:

Each of the seven countries has a lead economist for the project:

- B.V. Chinnapa Reddy -India
- Bustanul Arifin -Indonesia
- Anabel Martinez -Mexico
- Mody Bakar -Cote d'Ivoire
- Alexandre Rivas- Brazil
- Benea Mutsotso - Kenya
- Elizabeth Balirwa -Uganda

B.V. Chinnapa Reddy (India), Mody Bakar (Cote d'Ivoire), and Elizabeth Balirwa (Uganda) participated in the first planning workshop for the economists (France, 2003). The others have subsequently joined the project, and we look forward to working with them as a global project. In addition to the above economists, the global team is joined by:

- Mike Swift - convener
- Diane Osgood - TAG
- Seth Danso - case study one expert (Ghana)
- Jonah Chianu –TSBF

At the first global workshop (see below), we were also joined by: Anne Marie Izac (CIRAD) Josh Bishop (IUCN), Jo Anderson (TAG), Joshua Ramish (TSBF), Edmundo Barrios (TAB) and Jeroen Huising

II. Summarizing main issues:

Outcomes of our First Planning Workshop, France 2003.

This workshop launched the economic component of the overall BGBD project. It was our first and only meeting to date of economists, and six of the seven countries were able to send economists[1].

The workshop focused on the links between BGBD, ecosystem services and economic value. More questions were raised than answered, yet the team made excellent progress in defining frameworks for handling the complex issues. We also decided that two case studies be undertaken by each team (details below):

1. Rhizobium Inoculation Technology (RIT).

1 Bustanul Arifin from Indonesia was unable to join us due to visa problems.

2. Water Balance

The team agreed that it is of the utmost importance that ***evaluation work across seven countries must be comparable.*** Therefore, we need to coordinate the development of hypotheses and methodologies for the country studies. If we do not, we greatly risk having results that cannot be compared, thus weakening the overall outcome of the five year project. This has proven difficult to do, but recent email exchanges between the economists has helped.

It was also very clear from the workshop that ***training in environmental/ecological economic valuation skills is required*** by most of the teams. This is because the case studies go beyond traditional agricultural economics.

Framing the Valuation Exercises:

There are many layers of complexity in attempting to value BGBD in economic terms eg: whose value, which type of value and over what timeframe, which aspect of diversity, and at what scale. These are simple sounding questions, but each one demands serious consideration and there are no clear-cut right approaches. In addition – and indeed at the heart of the project – is that fact that we are still discovering the links between BGBD and ecosystem functions.

At the workshop we spent most of our time in rich debate about the above questions. The resulting frameworks synthesize the complexity of issues, and propose discrete categories. We know, however, much of value is blurred between scales, timeframes, types of diversity, etc. Yet, the team agreed to employ the frameworks in our case studies, and we all look forward to more debate as our work progresses.

Scale	**Regulating Features**	**Diversity Components**	**Valuation**
Landscape/ Watershed	LU diversity and pattern in space and time, including anthropogenic structures	Beta diversity	Ecosystem Services
Farm/cropping System	Choice of plant spp., and pattern in space and time at plot level	Beta for farm Alpha for plot	Resiliences Risk aversion
Plot	Soil management practices and other interventions	BGBD FG disparity Alpha diversity within FGs	Related Ecosystem Services
Niche	Specific soil organisms and their functions/processes	Alpha diversity of specific groups	Specific functions/services

Following standard valuation methods, we agreed to frame the valuation of BGBD and related ecosystem values in terms of direct, indirect, option and existence values. Existence value is important in terms of protection of rare or endangered species. For this project, the India team suggested we try to identify which species of BGBD is in danger of extinction or species whose habitats are under threat. However, to do this, we needed first to consider the issue of scale, and identified the four key scales as: landscape/watershed; farm/cropping system; plot; and niche. For each we identified the regulating ecological features and what would be evaluated at each level:

Next, we developed a framework for values within each level of scale, breaking the questions down into: who values BGBD, how they value it, and in what timeframe:

Who values?	HOW they value	WHEN they value
Farmer/household	Direct Š thru the market Indirect Š ecosystem functions	t=0 →∞ t=0 →∞
Region/country/Government Or landscape	Indirect Š ecosystem functions a) non-renewable b) food security c) soil as capital	t=0 →∞
International R&D (public and private sector)	Option values Š thru market	future
ŒGlobal communityÕwhich includes public sector, civil society, scientists, etc	a) existence b) tourism (indirect value because BGBD supports above ground biodiversity)	t=0 →∞

This framework incorporates the notion of indirect, direct, option and existence values. We know that theoretically there is not a direct correlation to 'who values the BGBD' and scale. In other words, farmers value BGBD at all scales: niche, plot, farming systems and landscape. However, for the practical purpose of the case studies, the teams may elect to estimate only the value at either the plot or farming system level.

Conservation and Management of BGBD: A Framework for Valuation

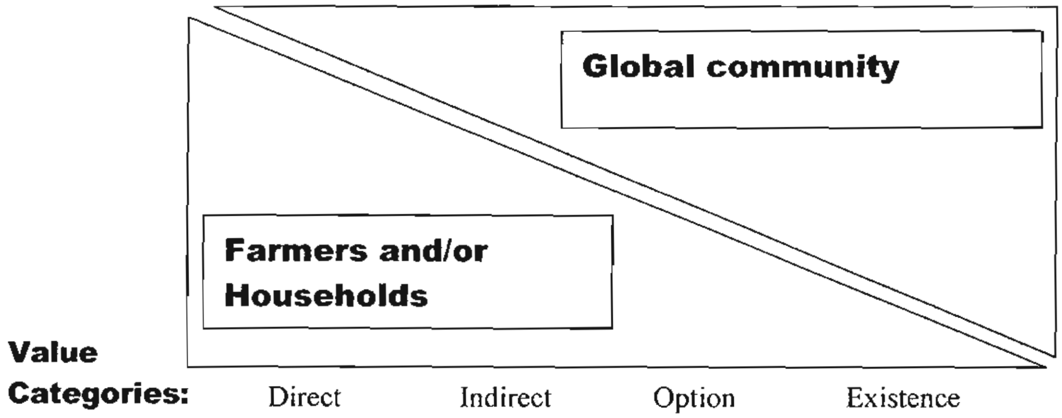
Conservation of BGBD, including the protection of its functions	Values of BGBD and Related Ecosystem Services			
	Direct Use Values	Indirect Use Values	Optional Values	Existence Values
	Production (goods) Pest and disease control Nutrient availability Carbon Sequestration Decomposition Hydrolic Functions Soil Formation etc		Potential discoveries (e.g bio-prospecting)	The concept of 'living soil' Values of global conservation projects, such as this project or other CBD activities

Finally, the team combined the above concepts into one table to summarize the value of BGBD.

In this table we combined direct and in-direct values because we found it too difficult to consistently determine the difference between direct and indirect relationships for benefits such as pest and diseases control, nutrient availability, and other ecosystem functions.

We agreed that country teams should choose which stakeholders ('who values') in the case studies. Thus country teams will select widely or narrowly from the table – some might focus on households, and others on benefits accrued to the region. If the valuation methodologies are comparable, we will be able to compare the seven country studies regardless of different stakeholder focus.

We also discussed if the case studies should incorporate hypotheses related to poverty and location. Do poor households place higher values on BGBD than wealthier ones? Do farmers place a higher value on BGBD for its direct/indirect use values (soil fertility, disease resistance, etc), while a global citizen place values on the existence and perhaps scientific option value of BGBD? We captured the later hypothesis in the following graph and expect the case studies to provide data related to it:



Case Study One: Rhizobium Inoculation Technology (RIT).

We selected this focus because RIT is practiced in all countries. Subsequent to the workshop, we learned that it is no longer practiced in the Mexican field site. For the most part, we expect data to be available, so the studies will be desk rather than field based. The studies are to focus on:

- Direct value to RIT through estimating the saving in N-fertilizer costs due to N-fixation.
- Indirect value through disease resistance, reduction of soil, water pollution.

The country teams will to decide scale and crops. To date, there was a preparatory meeting held in Ghana in November 2004. Professor Danso launched a first study, the results are summarized in the box below.

India has initiated a case study on rhizobium evaluation, and they are currently revising it. Results are pending. The team found one study (1985) on rhizobium inoculated groundnut crop that showed yield increased by 20 per cent over normal crop. The study also showed cost of production of groundnut declined by 11 percent and profits increased by 27 per cent because of increase in yields and decline in cost of cultivation due to savings in N fertilizer.

Indonesia has started some studies on LNB (legume-nodulating bacteria) which will include economic valuation of the LNB, using available data on the sites (landscape scale) and to provide lessons learned and some ways to conduct the Case Study 2 on Mycorrhizae. The team is currently finalizing the estimates based on reasonable assumptions and local specific conditions.

Kenya, Uganda, Cote d'Ivoire and Brasil are establishing case study one, and Mexico has identified an economist and will work on case study two. The Kenyan team has been slowed down by a change in lead economists. Uganda will report progress at the AA.

Danso Case Study One:

Goal: assign monetary value to the nitrogen and yield enhancement induced by the symbiotic contribution by rhizobia principally through the N that they fix in leguminous crops.

Crop: promiscuous soybean lines.

Basis: nitrogen fixed by rhizobia can be regarded as nitrogen from savings in fertilizer (or soil N). Any enhancement in N fixation through agronomic practices, such as from Rhizobium inoculation or P fertilizer application can be regarded as diminishing the amount of N fertilizer needed

Method: Cost the agronomic practice subtracted from any monetary gain.

Benefits of increased N balance in soil being considered:

- measurable grain yield, with a price for whatever is left in the soil (e.g. from rotation)
- N spared (e.g. in mixed cropping)
- any stubble left in field will contribute at least some N

NB: There has been some difficulty in costing with much certainty the physical benefits from such stubble. The stubble could also be fed to animals, and where data on yield gain is available, this could be priced.

Data: Requires both fixed and variable costs for all inputs and farm operations, and income or price for each output, directly or indirectly measured.

Finding data gaps. Thus, will make certain assumptions in many cases, and others will be ignored.

Time Table: Not definite, but hopefully, some form of draft should be available before the April meeting.

Case Study Two: Water Balance

As defined at the first workshop, the purpose of this case study is to look into both ***biodiversity aspects and ecosystem services*** - thus more encompassing of BGBD than case study one. At the Annual Meeting 2003 in Indonesia it was decided that the focus should be on Soil Structure Modification by soil biota rather than confined to water balance. This shift in emphasis was felt to be more practicable and also to reflect the multiple benefits gained from ecosystems engineers rather than just those connected with water regimes.

This study will be more experimental in nature and requires valuation at a variety of scales.

We know that BGBD affects infiltration and flow of water in soil, and the effects manifest through their impact on soil structure. Soil structure modification methods have been extensively discussed in the ESERV-TF and Edmundo Barrios will report on this so we can cross-refer. At the AM05 in Brazil a joint meeting will be held between the EVAL and ESERV Task Forces to develop plans for conducting Case Study Two in Phase 2.

Based on feedback from the economist email exchange and the slow start on Case Study One, ***it is clear that for case study two, the country team economists require***:

- A group meeting to ensure we are all on the same trajectory, and using the same methods.. As we have seen from Case Study One, there was a wide interpretation of the initial goals of the study, and we need to ensure closer collaboration for establishing Case Study Two. If not, we risk having results which can not be compared or that do not really address the broader aspects of valuation of BGBD that derive from the use of economic methods beyond conventional agricultural economics. It is critical that we focus on pragmatic valuation methods that get to the heart of BGBD that the teams can all employ.

- In relation to above, it is very clear that some training in environmental evaluation techniques is desirable. Case Study Two needs to go well beyond classic agricultural economic models, and to use other valuation models. Feedback from the economists is that they ***require training before starting Case Study Two.***
- Case Study Two will require close collaboration with ecologists/PAC/TAC members to ensure good understanding of ecosystem services linked to BGBD and water balance.
- The literature review has fallen by the wayside and needs to be reconsidered as both a method of publishing results from the projects and helping the teams.

We therefore propose a ***planning workshop for all economists with a few ecologists from countries and/or TAG in next 3-4 months*** to prepare and launch case study two. The up-take to date of case study one has been slow and the results still forthcoming. At the workshop, we will review Case Study One, with particular focus on the Danso study. If the project is to contribute to the better understanding of the value of BGBD, it is imperative that the economists meet and develop and joint strategy, including aspects of methodology, to undertake a field-based case study. We need to ensure that the results of the studies are comparable, and do so this, we need to work on evaluation methods and training.

We understand that the teams will have to fund their own participation in the workshop and we aim to have it at one of the field sites to ensure we devise workable, reality based plans for Case Study Two.

2. Economic evaluation of production systems in the OUME Region (North-West Côte d'Ivoire)

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Key words: ***Biodiversity; economic evaluation; production systems; land use practices***

Abstract

In a sustainable development context, when it comes to setting up strategies for poverty alleviation it becomes crucial to make a sound economical assessment of the different agricultural production systems. This work aims at identifying and analysing the main production systems in the Oumé Region (Centre-West Côte d'Ivoire). The survey was conducted on a sample of 30 households, having the most representative production systems in the village of Golikahou and vicinity. Three major land use types were identified: 1) forest resources exploitation (timber, coal, medicinal plants, hunting, fishing, etc.); 2) restocking with plant species of high commercial value (teak); 3) mixed cropping systems consisting of plantain, yam, cassava, vegetables, cocoa and/or coffee. The latter system, characterized by slash and burn with low inputs (i.e. absence of conservation practices) was found to be the most representative in the region. In this system, soil regeneration was based solely on the length of the fallow periods. However, despite the presence of small livestock (lamp, goats), there was no land set aside for pasture. As a result, animal husbandry and agricultural production systems are usually dissociated. Such type of land use will, in the long run, result in important losses of soil fertility and biodiversity. Finally, the study showed that restocking with teak trees generated the highest income per hectare (US$ 1490 year^{-1}). The second highest income

was observed for the cocoa-based production system, with an average of US $ 360 $year^{-1}$) and the third income was obtained with coffee-based systems (US$ 168 $year^{-1}$).

3. ECONOMIC VALUATION OF BGBD: Lessons from the Case I of LNB and Some Notes for Case II of Mycorrhizae

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How do Economists See Biodiversity?

- Impressed, ignored, confused, challenged, else?
- Biodiversity, despite its widely used, the concept is still problematic, and poorly understood.
- Valuing environmental benefits (and costs) using Contingent Valuation (CV) take times and costly.
- Recently, economists have developed an alternative approach, termed "benefit transfer". Valuation in a benchmark sites could be "transferred" to other sites having similar agro-ecosystem characteristics.

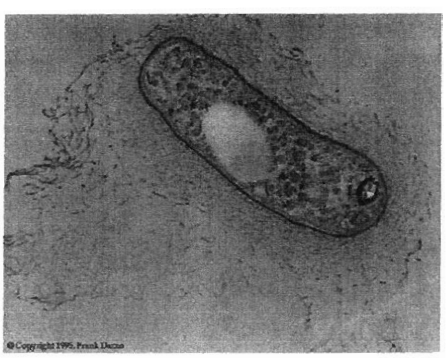
Belowground (Agro) Biodiversity?

- "The variety of living organisms and the ecological complexes in which they occur, in the agriculture"
- Economists comment: "it is quantitative without necessarily being quantifiable".
- Conventional economic analysis: to explain how economic value of biodiversity components can be conserved, managed, or maximized.
- However, it fails to recognize that such values is accrued, perceived differently by different people.

Management and Policy Issues

- Biodiversity in tropical rainforest may have high existence value for people living in Europe and North America, but high direct consumptive use for people living within or in close proximity to it.
- This leads to different policy prescriptions and the possibility of trade-offs or conflicts between different uses, values, and sectors of society.
- The impacts (benefits and costs) of biodiversity loss will be socially differentiated by socio-economic groups, by scales whether at local, national, or global.

Lessons from the Case I of LNB



- Two main frameworks for economic valuation: production systems and ecosystem services
- Speculation was made to establish functional relationship in production system and ecosystem services (based on previous studies)

Valuation for Production System

Direct Valuation

- Nutrient availability:
  - How much Nitrogen is fixated?
  - How much Nitrogen is already available?

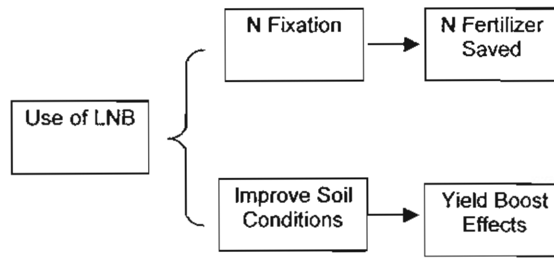
Indirect Valuation

- Other nutrient availabilities, how much other nutrients (primarily P and K) are available?

(Notes: the number of nodules are usually more abundant in soybean, than in groundnuts and leguminous crops)

- Nitrogen from LNB and other bio-fertilizers do not necessarily have to substitutable 100% for the nitrogen from chemical fertilizers.

Some Components of LNB Valuation



Multipurpose Microbe Fertilizer for Soybean (MMF)

Based on Saraswati (1999, 2004) & Syaukat (2004)

- Urea saved 100%, Phosphate saved 50%
- Soybean production increases by 12.5%

(Rough) Estimated Economic Value of MMF =

N saved + P saved + Yield Boost ➔Rp 595,800/ha

Estimated Economic Value of MMF

Varieties	N saved (kg)	P saved (kg)	Yield Boost (kg)	Econ-Value (Rp/ha)
Willis	100	50	208	599,400
Mancuria	100	50	232	642,600
Putri Mulyo	100	50	178	545,400

Notes:

- Assumption: price of urea, phosphate and potassium is Rp 1,800/kg.
- Under proper policy, the fertilizer price should be lower and affordable.

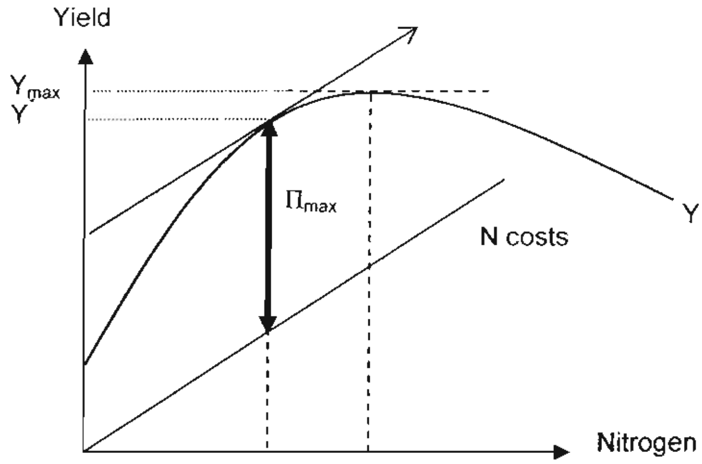
Rhizobium Inoculant Technology (RIT)

- Based on Sutarwi (1977), Sunarlim (1986), Sunarlim *et al.* (1993), Saraswati (2004) and Syaukat (2004).
- In PMK soils (2 ton N, 69 kg P and 50 kg K per ha), amount of N fixated is 63.2 kg/ha or 45.4% of total;
- Soybean production increases at 12-15%

(Rough) Estimated Economic Value of RIT =

N saved + Yield Boost ➔ Rp 431,760 per ha

Profit Maximization in Production Function



Important variables not yet considered

(We need data and functional relationship!)

- Soil quality: water-holding, cation-exchange-capacity.
- Crop management (crop rotation) which may reduce pesticide application.
- Land management: no-till, mulching, organic matter
- Greenhouse gas/carbon sequestration. (It depends on crop management and land management, which also affect the functional relationship);
- Water-retention capacity (hydrologic function), soil aggregation (porosity of the soils), etc.

Some Notes for Case II of Michorrizae

- Economic valuation would be focused mostly on ecosystem services, where land-use changes affect the functional relationship and their roles on:
  - nutrient cycling through microbial regulation,
  - reduced greenhouse gas emissions,
  - increased soil carbon sequestration due to improved regulation of decomposition process.
  - increased effectiveness of biological control of soil-borne pests and others.

Economic Valuation Strategies

- **Determining the value of the total flow of benefits from ecosystems**. How much are ecosystems contributing to economic activity? It is most often asked at the national level, but can also be asked at the global, regional, or local level.
- **Determining the net benefits of interventions that alter ecosystem conditions**. Would the benefits of a given conservation investment, regulation, or incentive justify its costs? It differs fundamentally from the previous question in that it asks about *changes* in flows of costs and benefits, rather than the sum total value of flows.
- **Examining how the costs and benefits of ecosystems are distributed.** Different stake-holder groups often perceive very different costs and benefits from ecosystems. Understanding which groups are motivated to conserve or destroy an ecosystem, and why, can help to design more effective conservation approaches.

- **Identifying potential financing sources for conservation.** Valuation can help identify the beneficiaries of conservation and the magnitude of the benefits they receive, and thus help design mechanisms to capture some of these benefits and make them available for conservation.

Approaches to Economic Valuation of Ecosystem Services

Approach	Why do we do it?	How do we do it?
Determining the total value of the current flow of benefits from an ecosystem	To understand the contribution that ecosystems make to society	Identify all mutually-compatible services provided; measure the quantity of each service provided; multiply by the value of each service
Determining the net benefits of an intervention that alters ecosystem conditions	To assess whether the intervention is economically worthwhile	Measure how the quantity of each service would change as a result of the intervention, as compared to their quantity without the intervention; multiply by the marginal value of each service
Examining how the costs and benefits of an ecosystem (or an intervention) are distributed	To identify winners and losers, for equity and practical reasons	Identify relevant stakeholder groups; determine which specific services they use and the value of those services to that group (or changes in values resulting from intervention)
Identifying potential financing sources for conservation	To help make conservation financially sustainable	Identify groups that receive large benefit flows, from which funds could be extracted using various mechanisms

4. Some preliminary results from the case study on economic benefits derived from the promiscuous soybean – Bradyrhizobium symbiosis; a case study conducted by Prof. Seth Danso.

Below you find some preliminary results from the case study on economic evaluation of the promiscuous soybean – Bradyrhizobium symbiosis. The figures are presented without further explanatory text. However, the figures may give an indication of how the valuation of this symbiotic relationship is approached, which is mainly through valuating nitrogen fixed and valuing of increased nitrogen stock in the soil. The case study is being worked on by Professor Seth Danso. Given the very preliminary character, these results may not be copied or referred to in any way.

Fig. 1: Economic gains from narural biodiversity of Bradyrhizobia as influenced by plant genotype (Cultivars)

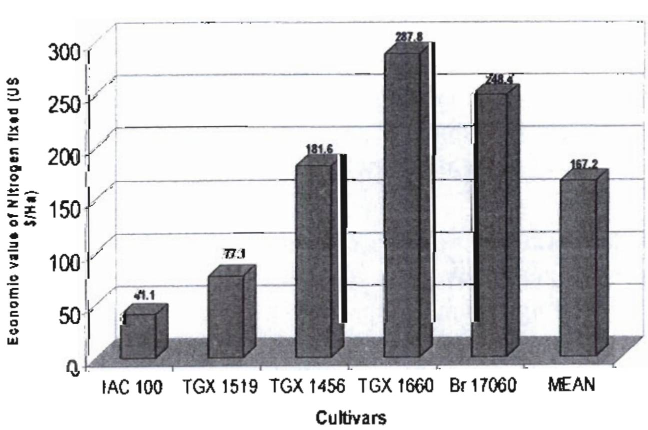


Fig. 2: Economic value of inoculated versus uninoculated soybean in Zimbabwe

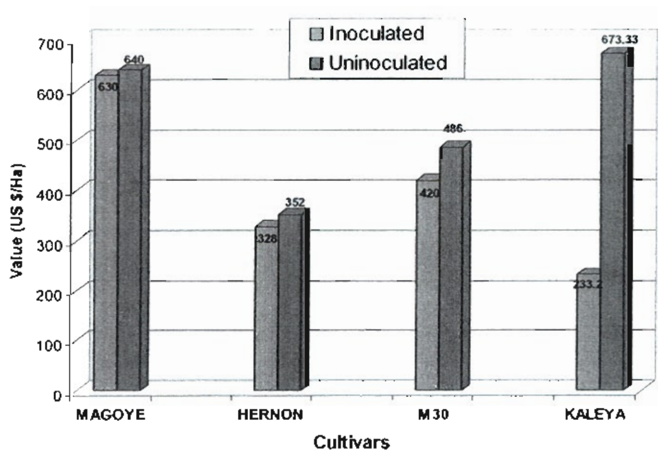


Fig. 3: Economic Gains of Nitrogen Fixed in Five Inoclated (Biodiversity enhanced) Versus Uninoculated (Natural Biodiversity)

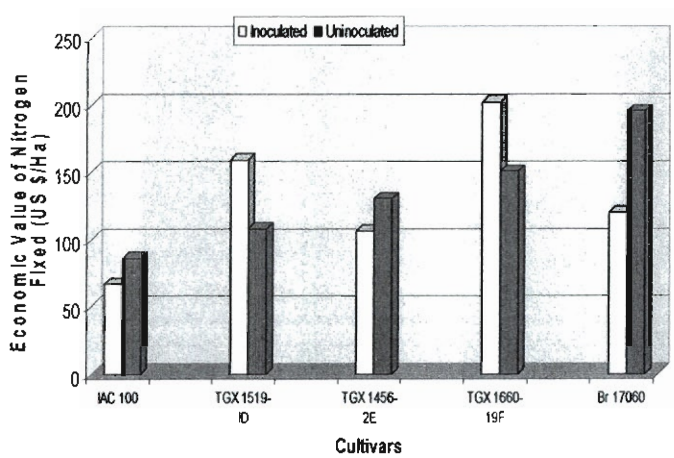
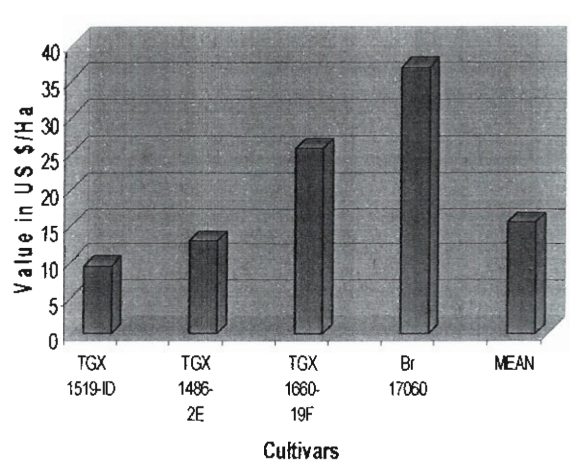


Fig. 5: The Economic Value of the Contribution of N (Net N Balance) to the Soil Following the Cultivation of Five Soybean Cultivars)



Report of the Technical Advisory Committee on results of the inventory, on standard methods, ecosystem services, land use intensity index & spatial analyses and economic valuation of BGBD as presented during the Annual Meeting 2005.

CONTENTS

CSM-BGBD PHASE 1: TECHNICAL ADVISORY REPORT

Professor Mike Swift (Ed., coordinator of the technical review)

SUMMARY

This report was written by members of the Technical Advisory Group (TAG) and Project Advisory Committee (PAC) and edited by Mike Swift. It contains comments and advice in response to presentations made during the 2005 Annual Meeting on results obtained to date in the CSM-BGBD Project. The report is largely a collation of the comments as written by the named reviewers with only a limited amount of editing for clarification, transfers of some material from one section to another or removal of some unnecessary duplications. The major part of the comments are with respect to work on methods (Output 1) and the Inventory (Output 2) including benchmark site characterization together but with also some more limited comment on the work and plans reported from Working Groups 2, 3 and 4 on landscape issues, ecosystem services, economic evaluation, policy and other components contributing to Outputs 3 and 4.

The overall conclusion of the reviewers was that the project has succeeded in agreeing on appropriate standard methods for most of the functional groups mandated for Output 1 and has used them to assemble a unique and comprehensive dataset during the period since the last Annual Meeting. There remains however one sector of the project where these objectives have not been achieved – that of Soil-borne Pests and Pathogens. ***Urgent action is required to fill this gap.***

This now provides a major challenge which is also a very exciting opportunity – that of analysis and synthesis. The task ahead can be divided into three sets of activities:

1. **Actions to ensure that there is a consistent quality and quantity of inventory data across the sites.**
   The extent of completion of the agreed inventory is different between sites – in some cases due to lack of expertise. The project needs to provide the appropriate advice and capacity building to ensure consistency in methods and data quality and quantity across the sites.

2. **Application of consistent analyses and hypothesis testing to the inventory data in all countries.**
   To date most analysis of results has been confined to testing the relationship between diversity and land use type or intensity. The scope of analysis and synthesis needs to be widened and the statistical rigour improved. Many suggestions in these respects are given below.

3. **Establishment of a meta-database and across-site synthesis of the data.**
   Once data are synthesized at a national scale then the exciting opportunity emerges to conduct cross-site analyses and syntheses to achieve the 'global' products contracted by UNEP and GEF. The project needs to put in place the mechanisms for doing this which will take into account the intellectual property rights of all participants.

Whilst the major content of the report is concerned with review of work in progress or already carried out there is also some reference to plans for new work in Phase 2 (particularly under Outputs 3 and 4). It should also be noted that this document covers only Sessions 2 to 11 ie up to lunchtime Wednesay April 13th and was out of date by the time it was edited. A number of the recommendations were followed up in subsequent workshops. Detailed workplans, by countries and Working Groups, resulting from these later sessions will be reported separately.

GENERAL COMMENTS ON THE PRESENTATIONS

(Avilio Franco and Mike Swift)

1. In general the presentations were well and attractively prepared and delivered clearly
2. A few introductions contained too much basic information; presenters should always take account of the expertise of their audience; and when time is short prioritise the content – in the case of inventory specific results are more important than generalities on the group in question.
3. For the Material and Methods most presentations did not make it clear what was part of the protocol and what was different from the protocol. Any discrepancy from protocol should have been justified;
4. As presented it was not possible to see links and consequences from the studies;

SESSION 2: BENCHMARK AREA CHARACTERIZATION AND SOCIOECONOMIC BASELINE

(Diane Osgood, Krishnan Ramakrishnan, Tom Tomich)

SUMMARY:

- Tremendous amount of valuable and impressive work and data gathering completed by each country team. The challenge now is how to realize full potential for science and for action.
- Great detailed work for many subjects covered, and wide variety of subjects covered.
- Our biggest question: to what extent are the seven country studies comparable? Including LU, grid, variation in measurements of bio-physical indicators, etc.
- For most part, good justification for decisions taken, although differences in sampling, indexing, and foci will make it difficult to analyze results across the countries.
- Not all countries used the grid system for biophysical data as given in the guidelines Some improved the system to make it fit objectives better. – can we adjust or how do we deal with this in the cross-country analysis?
- The direction connection between the people and biophysical data points needs to made through understanding the LU at the data point . It will be at separate scale: bio-physical is at plot/point level. LU is farm, landscape, field etc level. There must be a direct link, otherwise the studies are 'cutting and pasting' socio economic analyses onto the bio-physical studies which would be sub optimal.
- Some of the study areas of high cultural diversity (Brasil and Cote d'Ivoire) and others more homogenized cultures. This allows us to test for the importance of cultural diversity in the value and management practices of BGBD.

Opportunity to increase integration for synthesis and out-scaling to other sites:

- The number of windows, how they were selected, and the number of data points in each window vary greatly across the seven studies. What can we do to harmonize this?
- How to address different land use indices being used in the next phase – not all countries followed the recommended/agreed process, some improved them to be more relevant to their study site. Are specific land use concepts/definitions consistent across benchmark sites (thereby enabling cross-site comparison and

analysis)? Do these concepts/definitions include social and economic aspects as well as agronomic aspects? Problematic areas may be: Agroforestry/tree based systems; cropping systems; fallows – in each case, is there too much lumping going on

- Are inventory methods and functional group concepts consistent across sites?
- What about seasonality, timing of observations, and cross site comparisons?
- Can land use gradients be compared across benchmark sites?
- How will the land use intensity index be used? Is it being applied consistently? If not, what does that mean for synthesis? Is the index useful (or would it be better to develop specific indicators that are relevant to farmers and policymakers concerns)? How much are patterns in BGBD explained by specific practices (fire, pesticide use, etc) rather than 'intensification' per se?
- There are other indices, which if used across the seven countries would greatly facilitate cross-country comparisons: soil quality, forest quality (India) and fallow/time index (Brasil)
- Where agreed LU categories used, one country developed sub-land use categories to increase relevance to study area.
- A long list of external driving factors were mentioned by various studies: how can these be synthesized / compared across sites? Who will organize and lead that synthesis in Phase II? Can the synthesis effectively make the social-biophysical connection?

GAPS TO BE PLUGGED

- Gender characterizations should be done for all studies. Only two countries reported exploring gender *viz* local knowledge about soil and crop management and thus indicators and perceptions about BGBD.
- Similarly, how farmers perceive role of BGBD would be great to have from all countries. Uganda's results very interesting.
- No variability or errors in statistics, only averages presented.
- Soil organic matter is considered, but organic residues on the soil are also important from the point of soil organisms and their distribution; this has been excluded from the country reports thus far.
- Representation of pastures in data points appears low compared to extent of pastures in landscape in many of the study sites.
- Land Use history is not being done at plot level, being done at landscape. This is good background information. However it needs to be done specifically for the data points. What has happened at this exact plot over time? Usually farmers will know.
- We need to be clear about the scale used for above ground biodiversity sampling. Needs to be correlated to LU which then correlates to data point for bio-physical.
- Standardization of socio-economic data is required to all comparability across studies. We can do covariant analysis to test corresponding data and identify the parameters from one set of data that most influence parameters of the other set, for example education levels of farmers.
- Vegetation cover and structure needs to be defined because it impacts the invertebrates and quality of resources (e.g. litter) inputs.

- What are the baseline conditions regarding knowledge systems / knowledge, attitudes and practices of key groups (farmers, policymakers, scientists)?

TECHNICAL NOTES:

- The spatial relationships of sample points need to be defined.
- Beta diversity depends on the proximity of the location to the habitat refugia for recolonization of disturbed areas.
- The site characterization data set lacks a description of the surface horizon O and A1 that would allow us to know if we have litter and organic horizon and how they function (humus types?)
- The type of social macro aggregation needs to be described, as it is highly dependent on soil engineer activities. See Lavel for more details in ESERV session.
- Soil porosity and infiltration rates should be reported because they are important for assessing soil structure as an ecosystem service.
- The measurements of root density and distribution should be reported because it is a key determinant on plant influences on soil properties.
- Data on carbon and nutrient concentrations are not generally referred.
- Some groups did not present data on bulk density hence compression of concentration between horizon and sites can not be made.
- Carbon must be calculated as mass/unit area for comparison of systems since depth distribution vary with vegetation /LU types (preferably to 1m depth minimum and 2m optimal.)

SUGGESTED TOPICS FOR PHASE 2

- To what extent is above ground biodiversity an indicator for below ground biodiversity?
- Can a socio-ecological system approach make comparability more possible?
- To what extent can the dynamism (in both space and time) of traditional ecological knowledge be used as a connecting link between social and ecological systems?
- To what extent are the 'windows' representative of socio-ecological systems available in the study area?
- To what extent have the windows been selected on the basis of external factors, such as market forces and land tenure policies?
- Need to be sure any technologies we recommend are practical from cost and socio-cultural point of view.
- The idea is to arrive at answers to determine the appropriate mixture of traditional with the formal knowledge based sustainable social fertilizer management through health social biodiversity.
- What epistemologies are we using for the studies and why?
- What are the exogenous biophysical "controls" across benchmark sites? How much of variation in BGBD is due to biophysical differences?
- What are the underlying forces driving land cover change (e.g., macro and trade policies, infrastructure investments, agricultural research priorities) at benchmark

sites? What do these suggest regarding possibility/opportunities for policy intervention?

- How are endogenous / proximate drivers of land use change (e.g., land tenure/farm size, land use and management practices (including input use), food security and other household objectives and constraints, individual characteristics (gender, education, ecological knowledge), population density/migration) related to BGBD? How much of the variation in BGBD is driven by resource management by humans? Note: many of these would be major research tasks on their own – are necessary resources (human and financial) available to tackle them all? If not, what are the top priorities?

NULL HYPOTHESES TO TEST:

H01: Land use and BGBD.

Deforestation / land use change has no impact on BGBD—this probably should be tested for specific functional groups. (Alternatively, compared to natural forests, which land uses differ significantly in terms of BGBD for specific functional groups?).

- How important is: land use history, length of cycle (eg age of stand, 4 years vs 10 years for teak; what stage in the cycle is appropriate for measurements?) and landscape context in determining BGBD at plot level? I.e., are temporal and spatial factors confounding comparisons?

If data analysis from Phase 1 is not sufficient to reject H01 convincingly, this has important implications for Phase 2 priorities, design, and resource allocation.

If H01 is rejected,

H02: BGBD and ecosystem functions.
Changes in BGBD (within specific functional groups) has no effect on specific ecosystem functions.

- How do specific land use practices affect BGBD?

H03: AGBD and BGBD.

Changes in AGBD (or perhaps just vegetation) and BGBD (within specific functional groups) are unrelated/independent.

SESSIONS 3 & 4: INVENTORY OF SOIL FAUNA

(David Bignell, Patrick Lavelle, Diana Wall, Andreas Gaigl, George Brown, Mary Okwakol, Elizabeth Franklin).

SUMMARY

- Sampling and inventory of soil animals have largely been completed on schedule, and to plan. Limited additional sampling of some groups is recommended.
- Termites, ants, earthworms and nematodes must be identified at least to genus level and allocated to functional group.
- Some details of sampling and back-calculation remain under discussion, and will be decided shortly.
- A Manual of Standard Methods for the sampling of soil biota will be co-edited by Fatima Moreira and David Bignell, with a completion deadline of 31 May 2005.
- A minimum datatset for each country inventory has been specified.
- Improvements in descriptive statistics are needed at all levels of data reporting.

- Preliminary analyses of faunal data have shown many responses to land use change and/or intensification.
- Hypothesis-testing needs to be added to the data analysis and synthesis now.
- The Project has already led to the discovery of many organisms new to scientific description.

RESULTS

- The inventory of macrofauna and nematodes is proceeding well, due both to the extensive lead-time for the preparation of methods and to special workshops held in 2003 and 2005. In general, all countries have sampled, extracted, characterized and enumerated these highly diverse and numerous invertebrates, according to prescribed or workshop-specified methods. Some sampling of mesofauna has also taken place. While progress is good and methodology almost completely uniform, a further training course is needed on collembolans and mites. Additional or remedial sampling, particularly for earthworms, mesofauna and nematodes is recommended in four countries.
- The minimum standard of country performance is that:
- termites, ants, earthworms and nematodes should be identified to genus + morphospecies or genus + species level. Beetles should be identified to family and other macrofauna to at least ordinal level.
- termites, ants, earthworms and nematodes should be allocated within agreed schemes of functional groups.
- In total, the progress made in learning and identifying genera and species is exciting and is applauded. There may be a case to extend the use of digital reference imaging (already available for ants) to nematodes, and for extending the use of electronic networks for specimen identification in general.
- A number of issues in sampling methodology, including the basis of calculation of some population parameters, remain to be resolved, although these are mainly concerned with details rather than principles:
- the optimum number and length of transects per sampling point, and the use made of transect data (they should estimate relative, but not absolute abundances either of specified taxa or functional groups).
- the validity of using Winkler bag data in estimating ant and beetle abundances.
- the uses made of data from casual sampling and pitfall traps.
- the value and practicability of extending the sampling of earthworms by digging additional monoliths.
- options in the protocols for mesofaunal sampling, including the use of lamps in Berlese/Tullgren extractions and the choice of preservatives.
- Actions should be taken to compile the methods on soil faunal sampling for the Manual of Sampling Methods, which is required as an early output of the Project.
- The use of agreed single keys for identification purposes, and where necessary the creation of such keys on a regional basis is strongly recommended.
- We recommend that a minimum datatset for faunal assemblages be required across all sampling points, as specified in the report of the Nairobi Workshop on Ant and Termite Ecology and Taxonomy (14 – 19 February, 2005), be mandatory for inventory reporting. Some additional sampling of earthworms, mesofauna and nematodes is approved in selected cases.

- We advise that descriptive statistics for soil animal abundance and (where available) biomass must include estimations of variance and, where appropriate, transformations of data so that variance can be easily represented in graphical form. Concerning diversity, there is an over-reliance on theoretical estimates of actual species richness, which should not be substituted for, or confused with, real field data.
- We note with approval that data already obtained have been subjected to preliminary analysis assessing diversity, abundance and functional group representation across land uses. We recommend that theses analyses are re-visited in line with the Project decision that a universal quantitative index of LUS intensity is not required, but that local or regional quantitative indices may be derived with reference to country traditions in land management and the particular characteristics of the windows selected for sampling.
- We suggest that future data analysis and synthesis should be designed in the context of clearly stated hypotheses concerning the relationships of faunal diversity, abundance and functional group composition to ecosystem services and vulnerabilities. For example (and see also below),
- indicating soil quality/health, especially SOM sequestration and porosity,
- mediating the biocontrol of pathogenic nematodes, fungi and bacteria,
- control of aboveground and belowground insect herbivores,
- determining rates of decomposition and other primary nutrient transformations
- estimating of potential crop and forest damage by pest species
- Unique genera or taxa new to science are particularly valuable and should be noted:
- to determine if invasive genera /species are being introduced that will impact forest and agricultural tree and crop productivity
- to determine endemicity across the soil fauna
- to show trends towards extinctions of predators and other fauna with key roles.

Mesofauna

- Distribution of the sampling points adopted by different countries seems to follow the established protocol. However, the actual collecting of the samples (size of the sample units, compounding the samples, etc.) in the sampling points should be made comparable between all the countries.
- Berlese funnels are the classical method for extracting the mesofauna from soil and litter samples. However, there are many different models and procedures being used by soil ecologists. Three different funnel types are being used by the participating countries. It is strongly recommended that all teams agree on the use of the same model of equipment. We suggest the simplest model, as that used by Mexico, should be adopted.
- The use of lamps (specifically tungsten light bulbs) above the soil or litter sample is very important, because it is the warmth produced by the bulb that forces the organisms down the funnel. It is necessary that all countries agree on a common protocol concerning the strength of the bulbs used (should not be too strong; we suggest around 40 W). The layer of soil or litter on the sieve of the Berlese funnel should not be more than circa 4 cm thick.
- The killing fluid where the animals are collected in the funnels should be agreed upon by all the teams. We suggest 5% formalin solution with some drops of

detergent. Afterwards, 70% alcohol with some glycerin must be used to preserve the collected animals.

- The material sampled is composed of several groups and most of these groups are being classified and analyzed in high taxonomic levels (Class, Order or Family). These categories are composed by a lot of species with different habits. We suggest that target/key groups should be selected among the sampled material. Groups where the taxonomy is resolved and that have resources in the web should de chosen. Because of the lack of specialist on the taxonomy of many groups, the project must spend some time in training programs. In a project about biodiversity it makes all the sense to put a fraction of the budget (10% ??) to train new taxonomists and para-taxonomists. The morpho-characterization must be used with some caution, taking as a basis the taxonomic aspects and the keys already available in the literature.

HYPOTHESIS-TESTING

Example I. Site History and Successions

The dynamics of soil organism communities cannot always be understood merely by inspection of the existing inventory in any given LUS and comparison with the nearest pristine system. The shaping of a community may not be a continuous process and therefore cannot necessarily be predicted by measurement of the apparent distance between the LUS and the pristine system along a factorised disturbance gradient, however detailed the calculation. Special events may accelerate changes and /or result in sudden shifts from one type to another as thresholds are passed. A great challenge of the BGBD programme is to describe laws that link physical environment, history of LUS, the socio-economic environment and the diversity observed at any time.

Four different stages may be distinguished in the course of a succession (see fig 1).

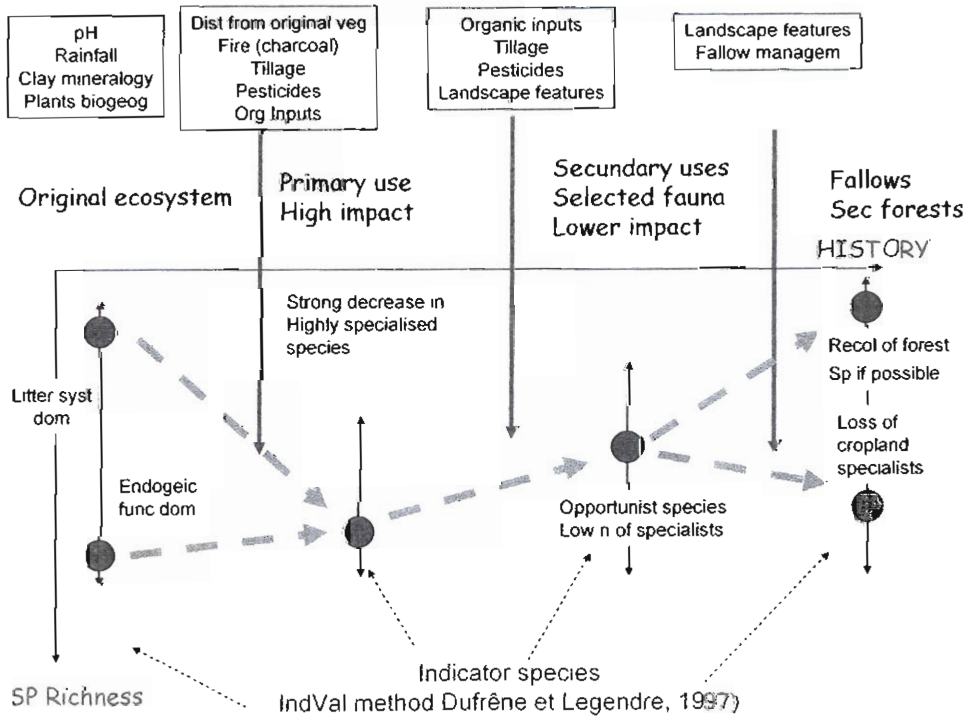


Figure 1: Hypothetical changes in species richness and composition (exotics vs. natives) along a secondary succession of managed changes in LUS at the ecosystem (sampling point) scale. Circles: number of species collected; vertical arrows: range of possible species richness in a single taxonomic group; upper boxes: main

determinants of species richness at each stage; dashed arrows: trajectory of species richness.

The first clearing and burning of a pristine forest generally has a very strong impact on species richness. Since communities often comprise a large proportion of highly specialised (and often rare) species, many of them do not adapt to the radically different conditions of the deforested environment. At that stage, the distance (difference) of the transformed land from the original system will generally determine the amount of species loss. Different types of LUS systems may be ranked in the following order according to their distance to the original forest: forest, 0; forest disturbed by wood exploitation, 1;

forest plantation, 2 (if broad leaf evergreen forest); higher distance if eucalyptus or coniferous; agroforestry system, 3 or more depending on the density of trees and the quality of litter produced; pastures, 4 (may be less if associated with legumes and limited grazing (more if low quality grass and/or overgrazing); crops, 5 to 8 depending on practices (aggravating practices are lack or organic residue inputs, tillage and pesticide application).

Some changes in soil associated with burning may have positive effects on elements of the fauna. This is particularly the case for the incorporation of ashes and charcoal. Ashes have an immediate effect in neutralising pH and charcoal once incorporated, micro-fractioned and thoroughly mixed into the soil, may enhance soil CEC and have durable mitigation of Al toxicity and acidity that prevailed in the pristine forest. In this case, some rare species only found in special micro-sites in the forest may become more abundant. Also, exotics may start to enter in a soil that is suitable for their maintenance. Therefore, communities that had species richness in the lowest range because of unsuitable soil conditions may have increased species richness after deforestation and burning.

After the first use of soil, LUS often changes, for example to pastures, or to natural or improved fallows of different durations. At that stage, a rather large number of generalist species adapted to disturbed conditions may comprise the communities. Biodiversity is likely to increase by the addition of exotic species. Species richness will largely depend from the possible occurrence of detrimental practices in the land use system (tillage, pesticides, and insufficient organic matter inputs). Species from the original ecosystem may also re-colonise the soil if conditions are suitable for them and colonisation is made possible by the structure of the landscape (high density of refugees for species and proximity to the original ecosystem). Comparison of data sets containing species richness in different types of LUS and landscape metrics at compatible scales may allow evaluation of the importance of the effect of landscape structure on species richness.

In these derived communities, the number of generalist species able to adapt to a wide range of conditions and with great resistance and/or resilience to disturbances is expected to be relatively large. Such communities will then be much less sensitive to disturbances, unless some threshold effect in degradation (or improvement) of soil quality allows a shift towards either a restored or highly degraded community.

When land that was previously used intensively for cattle raising or crop production is left to fallow, species richness may either increase or decrease depending principally on the type of management of the fallow and the structure of the landscape. Fallow management, when practiced, and/or maintenance of forest elements throughout the landscape may, by contrast, greatly enhance the recovery of the original diversity. In some cases, the generalist/exotic species that invaded the crops and intensively used soils, may persist and prevent native species from recolonising.

Example II: Interactions among soil biota: the value of analysing co-variations among soil organisms

Changes in LUS and the associated disturbances or rehabilitation phases not only result in different species richnesses and changes in the proportion of specialist to generalist species. They may also greatly affect the interactions among soil biota and result in the loss of some essential biological controls. The following three examples show how such mechanisms may operate:

- mycorrhizae, rhizobium and pathogens spreading by different groups of soil fauna: Soil invertebrates may transport spores and propagules at their body surface or incorporate them into their castings and constructions, after they have (or not) experienced transit through the gut. The consequences of this interaction between useful and harmful micro-organisms on their population dynamics and ability to infect plants are very poorly known. These effects can be searched for by comparing datasets on communities of micro-organisms with soil fauna communities. Co-inertia analyses should allow identifying possible positive and negative relationships between selected pairs or groups of both types of organisms. Further experiments may then verify the link and describe the mechanisms.

- nutrient redistribution by soil fauna:
  Soil ecosystem engineers (mainly termites, ants and earthworms) have significant effects in enhancing nutrient mineralization at specific scales of time and space. Termites may have dramatic effects by transporting clay minerals with high CEC to the surface horizons. Like earthworms, they may create microsites where nutrient availability is greatly enhanced. Comparison of datasets on fauna and soil nutrient distributions will indicate if such relationships are visible at the scale of samples and types of LUS.

- nematode control by earthworms and the overall soil biodiversity:
  In this hypothesis (H1), mitigation of the negative effects of plant parasitic nematodes by earthworms has been suspected from field datasets and demonstrated in laboratory experiments. Mechanisms may be a direct negative effect on nematodes or systemic effect on plants that enhance their tolerance for nematodes. In both cases, the activation by earthworms of microbial communities that produce phytohormones and/or growth precursors is hypothesised.

As an alternative hypothesis (H2), mitigation of nematode effects can also be favoured by the proper diversity of their communities. It has been shown that the diverse community of plant parasitic nematodes in a fallow from Senegal had considerably less harmful impact (and even a positive impact under certain conditions) than the much less diverse community of a soil that had been cropped for millet for several years.. This effect can be observed by comparing community structures and abundances of earthworms (and other invertebrates) with plant parasitic nematodes (H1) and relating the diversity of PP nematodes to the evaluation of damages they cause to crops (H2).

SESSION 5: INVENTORY OF PLANT SYMBIONTS (LNB AND AMF)

(Avílio A.Franco and Sidney Luiz Sturmer)

METHODS AND RESULTS

- The presentations contained a large amount of information on Legume Nodulating Bacteria (LNB) and Arbuscular Mycorrhizal Fungi (AMF) under different Land Use Intensive (LUI) cropping systems that may be relevant to enhance the contribution of nodulated and mycorrhizal legumes to food production and sustainability.

- Without following the same protocol the value of data integration will have less significance;

- For field sampling it was not clear that all groups disinfected utensils between sampling. In one case it was indicated that disinfestations was carried out by flaming the utensils what is not ease to be done properly under field conditions. This is a very important point that need attention;

- For the experiments to study LNB efficiency it is suggested to include a control inoculated with a highly efficient strain to be sure that the experimental conditions were favourable for nodulation and BNF;
- There was variation on how to grow nodulated trap hosts to obtain isolates. The procedure described by Dr. Esperanza Martinez from Mexico seems the most adequate and should be used as the protocol;
- The use of forest soils as control for below ground biodiversity sustainability is adequate for phase one of the project. However, to have impact on ecological systems since on real life people, at maximum, would manage systems for sustainable production at high levels of productivity. Under those conditions forest soils would be inadequate for comparison;
- Parameters determined for the project should be the most relevant and common to all groups. Presentations should be limited to those parameters agreed upon;
- Apart from the above observations, the methodology used for isolation and characterization of LNB and AMF is adequate
- Contrary to the AMF, the study on the population of legume nodulating bacteria does have limited contribution as indicator because of the strong dependence on the history of the presence of the host on the site.
- The collection of AMF and LNB strains obtained in phase one is useful as a stock of strains to be incorporated into culture collections, to obtain legume inoculants and for further studies of the group of below ground organisms with greatest contribution to food production and sustainability of cropping systems;
- A more in depth evaluation of the progress report would be possible if a written version of the report together with the project would have been handed out prior to presentations.
- There is no question about the great value of the data already obtained in phase one of the project. However, considering the great difficulty to have consequences at farmers level, that represents the next steps of the project, any further planning should be carried out within the farmers environment at least from their perspective with the eye on the market.
- Large amount of work done and a huge dataset on species diversity (if properly identified to the species level) that can be used to test ecological hypothesis on species biogeography and relationship of AMF diversity and plant diversity.
- Results presented at the genus levels for AMF (most countries) are not enough if differentiation of LUS are to be identified and germplasm banks are to be established. Some data are meaningless (from Cote d'Ivoire where species are separated on colour only)
- Taxonomic identification at the species level must be done if we want data to be meaningful. This is the main gap in the Mycorrhiza Team from most countries. An additional training workshop on mycorrhiza must be organized again (this is one of the outcomes from the India workshop) so researchers can have better conditions to identify their materials. Identification at the colour level and genus level reflects lack of training.
- Once the proper identification has been done, then characterization of any inoculants can be done and used in the Phase II. Plans for Phase II should include demonstration on farm of how to produce mycorrhizal inoculants, how AMF and

LNB increase plant growth and seedling survival in the field and assessment of glomalin production.

- Data on AMF diversity need to be better analyzed to integrate ecological concepts (cluster analysis, species rank-log abundance graphic).
- Mycorrhizal researchers are willing to collaborate with each other.
- At this point, there is no way to synthesize the complex results and to cross data from different countries.

SESSION 6: INVENTORY OF SOIL-BORNE PESTS & PATHOGENS.

(Andreas Gaigle and Mike Swift)

Soil-borne pests and pathogens are one of the components of soil biodiversity that has been identified as having major significance for the livelihoods of land-users. The project plans have included investigation of both the inventory and ecosystem service aspects of these organisms from the outset but it was noted by the reviewers at the meeting that there has been very little relevant inventory work carried out. This urgently needs to be rectified.

SOIL PESTS:

It was noted that there was only one presentation on soil pests (by Brazil on fruit flies) although this has remained a mandatory target for the inventory, with White Grubs identified as a major target group. This omission is probably due to lack of adequate discussion on standard methods. The following general comments were made by Dr Andreas Gaigle from the IPM Research Programme at CIAT who was invited to the Annual Meeting to address this subject. Dr Gaigle made a presentation in the Ecosystem Services Task Force workshop in Session 9 and provided a framework for work in this topic which is attached to this report as Annex 1.

RECOMMENDATIONS:

- Soil pest research should be conducted in a standardisized manner. In many parts, especially in Africa, the documentation of the economic importance is fragmental; however, these data are crucial for the development of winner proposals.
- An intensification of working relation between Africa, Asia and Latin America (LA) is desirable according to the global character of soil pests, especially whitegrubs. The methodologies developed in LA facilitate the implementation of soil pest rearch in Africa. This alliance will increase prospectives of future proposals.
- A holistic approach of entomology, pathology, and soil science for a sustainable crop management is needed. It is suggested that IPM will be included in the BGBD project.

PATHOGENS:

- All countries reported work on Soil Fungi and this included some excellent and interesting results on specific genera with important pathogenic (Pythium, Phytophthora, Fusarium and Rizoctonia) or antagonistic (Trichoerma) species.
- There was no standardization of methods however or, apparently of which groups to be studied. At present therefore the project lacks a coherent global programme in this sector.
- Some of the methods reprted were inappropriate and yielded inaccurate results (eg. the use of tannic acid plates is not a good indicator of ligninolytic activity; the cellulose plates also gave some questionable results eg that Rhizopus is cellulolytic).

- Careful consideration should also be given to the use of general soil plating techniques for micro-fungi as useful indicators of diversity. The genera and species that dominate results are so ubiquitous and the significance of their presence in terms of function so difficult to interpret that strong justification of such studies is required.
- It is thus strongly recommended that revert to the Standard Methods approved at Embu: ie selective isolation of a restricted number of genera containing important plant pathogens (eg. Pythium. Phytophthora, Fusarium, Rhizoctonia) and/or antagonists (eg. Trichoderma).
- This can provide the link with ecosystem service investigations including field studies of disease incidence, infectivity baiting with trap plants, suppressive soils etc.
- The above programme should be mandatory; other studies, such as soil saprohytes, can be added as optional if there is adequate justification.

SAMPLING AND STATISTICAL ANALYSIS IN PHASE 1

(Ric Coe)

Note that these comments do NOT refer to the measurement methods (the 'Standard Methods') used at each sample point. Any limitation in those will of course give rise to limitations in analysis and interpretation.

INVENTORY

- If 'inventory' means recording what is found in each window, then the **analysis** is a matter of documenting and cataloguing. It appears to be going well, subject to slow progress on extraction and identification of some organisms.
- The grid **sampling** is probably effective for this, except that:
- It misses rare landscape elements, particularly linear features (eg hedges, stream banks etc). Such elements may be important refugia or corridors
- Taxa cummulation curves shown by some groups suggested that the sample size may have been larger than necessary in some cases, too small in others. This could not have been predicted. It may mean there is a case for further sampling for inventory in a few cases.

EFFECT OF LAND USE (LU) AND LAND USE INTENSITY (LUI)

- This is at the heart of the project so needs most attention
- Some limitations of the **sampling** were discussed and recorded last year and do not need repeating now, though certainly have an impact on (a) how easy the analysis is and (b) how clearly the effects we are looking for can be seen. There is an opportunity for further measurement in Phase 2 which can fill the gaps – discussed below.
- **Analysis** so far has been effective in that it has produced information about the key question of the effect of LU and LUI. These results are non-trivial, contain new information and generated discussion. They show that very simple statistical analysis tools have a role.
- The presentation of results even from these simplest of methods has to meet some basic standards. For example:
- Can we standardise the unit used across countries, so that results are comparable?
- Are those error bars se's, sd's, sed's, ci's or what?

- And should all reported quantities have standard errors attached?
- What spatial unit (window, site etc) do results represent?
- However even these simple methods (based on comparison of means through analysis of variance) need using correctly, and that was not always done. There were examples in which they were used inappropriately, for example when the variance was clearly different in different LU classes, or when the response variable was a small integer. Structure in the data, in the form of window and site effects, has sometimes been ignored. And results of statistical tests have not always been correctly interpreted.
- When presenting and discussing results, we need to be more honest about here limitation. In some windows there was a single example of a land use class (e.g. forest). Results then apply to *that* forest, and may not generalise to forests in the site. This is the question of 'What is a replicate?'. The Mexican team noted that their windows sometimes did not capture sufficient replicates of land use types, and supplemented the sample plan accordingly. Another limitation comes from LU class differences being confounded in some cases (eg Embu) with window differences.
- The usual limitation of survey data, showing correlations not causes also need keeping in mind with all interpretations. It is the scientist's responsibility to think of all the possible confounding factors and explanations other then the relationship sought, and explore ways in which they can be written off.
- I would also expect scientists to notice mistakes in results before presenting them.
- However, despite showing some new and important results these analyses are only a superficial beginning, and need considerably more sophistication to get at much of the information in the data.

Adding Insights

- Very generally we are looking for relationships of the form Y = f (X), where Y is the measure of BGBD of interest (so far mainly measures of abundance and diversity of functional groups) and X are the factors that effect it (so far land use class or LUI).
- The analysis will be more insightful if we are a bit cleverer in selecting both X and Y.

Dealing with X

- Even though little pointwise data (rather than just averages) were presented, it is clear that there is huge variation within LU categories. Various reasons have been suggested:
- The LU classes group too many different land use practices together
- LU classes ignore history
- Land use intensity is not a uni-dimensional concept, so we need to separate effects of, for example, biomass removal and cultivation frequency.
- There are environmental factors not captured in land use (such as soil variables)
- Landscape effects – factors determined not by observations made at the sampling point but in the neighbouring landscape. This is discussed in a later session.
- Including these has the effect of making X multivariate, and the basic methods multiple regression, $Y = f(X_1, X_2, X_3, \ldots)$. Note that various generalisations of 'ordinary' regression will be needed.

DEALING WITH Y

- There are some ways in which Y can be made more insightful, both by combining data across functional groups (for example to look correlations or co-occurrence of different groups), and breaking a group down into lower level taxa. I noted that the nematode group looked at indices based on function (eg ratio of plant pathogenic to other nematodes) and would expect other groups to have similar insightful measures.
- In both cases, the key requirement is for scientifically meaningful hypotheses to be proposed. If these are sufficiently clear and well stated, and the data contains the information needed to investigate them, we can always find methods - the statistician's challenge!
- I would expect these insightful hypotheses to be founded on good science, building on what is known, challenging it when there is good cause to. I would expect them to contain '*...because...*' clauses,
- An alternative is a data mining approach. The idea is to look for any aptterns in the data without starting out with specific hypotheses. The sample sizes are inadequate for this to work.

MEASUREMENT IN PHASE 2

- I predict that these more insightful analyses will suggest many important results but confirm few. It will be necessary to do some more measurements in designs carefully planned to investigate specific hypotheses. This might involve, for example,
- Sampling along planned gradients, controlling for other factors
- Chronosequences
- It may be feasible to do these in conjunction with management experiments.

GETTING IT DONE

- The statistical methods needed depend on:
- the specific, detailed objectives
- the data
- This means that there can be no standard methods that can automatically be applied to each data set from each country. Of course there are some common methods that will be useful. These can (and have been) described. But their successful application will never be automatic, and all aspects can not be described and documented. Hence high quality analysis will be done when two (groups of) people work together:
- the scientists who collected the data and understand the ecology, can interpret results, spot surprising out comes, explain outliers etc
- those who understand the analysis methods, their specific requirements and assumptions, and ways in which they can be modified to new problems
- The latter may not be a biometrician: some ecologists are rather good at it (most are not).
- I suggest:
- A suitable quantitatively inclined individual be identified by each country team
- If necessary they should be hired by the project

- Their role is to work with all the scientists to ensure high quality statistical analysis
- They are networked across the 7 countries, perhaps with additional expertise, to exchange methods and experience, produce documents and training materials, swap software, etc.

SESSION 9: ECOSYSTEM SERVICES

(Edmundo Barrios)

On the basis of presentations and discussions at Session 9 the following recommendations were made for work on Ecosystem Services in Phase 2. These included the proposal that it is essential that the work on Ecosystem Services, Spatial Analysis & LUI and Economic Evaluation is integrated during Phase 2.

Many of the recommendations were subsequently followed up in workshops later in the meeting, resulting in more detailed workplans which will be reported separately.

RECOMMENDATIONS:

- It is important to determine the contribution of functional groups of soil biota to key soil processes; however, ecosystem services provision needs to be closely linked to different stakeholder needs.
- Focus Ecosystem Services planned to be studied in the BGBD project include soil structure modification, control of pest and diseases, C sequestration and maintenance/restoration of soil fertility.
- Soil structure modification a key ecosystem service because of its impact on soil water and nutrient dynamics, and C sequestration
- Roots have a key role in determining soil properties and contribute with earthworms and AMF in soil aggregate formation/stabilization and thus ecosystem service provision.
- New methodologies like soil morphology, NIRS and GRSP (glomalin) have shown great potential to provide integrated measures that allow linking soil biodiversity and function to the ecosystem service of soil structure modification and relationship to soil hydrology (bulk density, porosity, infiltration, hydraulic conductivity, etc.).
- It is critical that the BGBD mediated ecosystem service is linked to farmer understanding and practices through participatory research

SESSION 10: LANDSCAPE LEVEL BGBD, LUI & DATABASE.

(George Brown)

Note: These comments relate to initial presentations and discussion in Session 10. Some of the following issues were discussed in later workshop sessions. These discussions and consequent workplans will be reported separately.

LAND USE INTENSIFICATION INDEX.

- The land use intensification (LUI) index appeared to still be causing major constraints of adaptation (dealt with below). Each country appeared to have come up with their own adaptation! Uganda and Indonesia seem to have a LUI gradient that is similar, and these similarities should be explored.
- It is essential to have a generalized (for all countries) land use system list, with categories which encompass all the diversity of the categories proposed by the

different countries. Some were similar, but called by different names... Standardization means producing a list of all the land uses presently in the benchmark sites of all countries. This should be done immediately and discussed by the country convenors and then incorporated into the database and the presentations, so that for each land use type, people know what is being talked about...

- Complexity of the original index (Meine) was stated as a limitation (rather than a positive factor), but it is really not that difficult (some countries were scared away and did not even try).... an attempt should be made at least by all countries to identify the major limitations to the adoption and the modifications necessary to adopt the index as is.
- Some countries created/adapted their own index to suit their own needs (Kenya, Ivory Coast, Indonesia). These have limitations as well and none seem to be adequate for a global index.
- The Kenyan team presented an index which depends on what is done locally (based on maximum local values for intensity factors), which will not be comparable across locations.
- The Indonesian Team stated that they did try to parameterize the index with Meine's help, but they did not inform us of this in their presentation, rather they just presented their new index, which is also complex and not applicable to all the countries/benchmark sites...
- India proposed Forest stand quality index, however this index will require adaptation to different countries and their floristic primary forest. Furthermore, this index depends on arbitrary scores to grade the different forest qualities and any index should rather use Ratios to generate a score. The same applies to the Ivory Coast and Kenyan index... Both were based on arbitrary scoring of the factors of the index...
- The components of the index should not include arbitrary scores, but rather proportions and scores that can be calculated using some measurement with real data (from research or from literature, when lacking).
- If a Global Index is to be used, we need an x-axis common for ALL countries... therefore, need global terms of reference for factors of the equation, and agreement on the factors by all participants...
- Main problems raised concerning the calculations and calibrations of the index:
- Must meet all the assumptions of the Index (e.g., land use is in cycles & not progression, similar starting condition & management times)
- Multidimensional processes are placed into a single dimensional (x axis) line
- LUI Index is a response by farmers to environmental conditions of the area (local specificity...).
- Therefore, this begs the question... DO WE STILL WANT A GLOBAL INDEX? There was agreement that at least we should try to reach a globally applicable index... And if so, an agreement must be reached and the index applied globally (i.e., in all countries)...
- An excellent presentation was made by the Mexican team on how to move forward with the index and deal with the various problematic issues of missing data to apply in the index parameters... Simoneta agreed that she would send an e-mail to all the country conveners with the guidelines as to how they advanced in the use of the index and in finding solutions to the various missing components.

This guide would help the countries through the task of applying the index to their benchmark sites.

- Suggestion made during the evening discussion.... Country participants would look at their local conditions to decide which parameters/components would be necessary to include in the index and try to apply the index to their situations...

DATABASE:

- The presentation showed a very complete database structure that would be very useful and interesting to apply to a variety of tests, but it must be useful, and not just become another database on the shelf of large UN organizations and country institutions.
- Other problems I foresee... The construction was not made to facilitate the interface with the local country's databases. If data must be entered individually for all the points, this database becomes unfeasible! Who is going to have the time and pay for someone to enter individually all of the information of the sample points, particularly when this has already been done to a great extent by the countries in their own databases? This is duplication of efforts and unwise spending of public funds.
- The database must have an interface for instance with excel, so that the data can be put into excel and imported easily into the database.
- Finally, if the database does not have a sense of ownership with the countries, not only is it not going to be adopted, but rather rejected and not going to be used for further testing of hypotheses, relationships, etc...
- The most important question is to consider what the database will be used for. Is it more powerful than the statistical tests that will be explored globally? Will it be useful to build the datasheets to be used in these statistical tests?
- Finally issues of data-sharing must be resolved before any global database can be implemented.

SESSION 11: ECONOMIC EVALUATION OF BGBD

(Tom Tomich and Jeff McNeely)

Some of the following issues were discussed in later workshop sessions. These discussions and consequent workplans will be reported separately.

- Need for **integration** of work on ecosystem functions, scaling and valuation. Economic valuation is largely an empty activity without firm links to ecosystem functions and scaling of those functions.
- The approach to economic valuation so far has emphasized **tangible benefits and pragmatic approaches**. This is essential.
- **Functions for whom?** Users' needs should be the starting point for development of concepts for functions and indicators. Don't forget that food production is an ecosystem services that matters to farmers and policymakers. What are the BGBD functions that matter at the farm/forest plot level? What are meaningful indicators (eg for productivity, profitability, food security, risk, resilience; spiritual aspects?) from the local perspective? Similarly for policymakers. How can local knowledge and policy makers' perceptions be used to develop appropriate indicators? This also is essential for **effective communication**: are the indicators measured, expressed and communicated in ways that will be effective for information users? Can users understand easily what indicators mean (e.g., ecosystem engineers)? Do they reflect users' bottom line concerns: say profitability? Food security? Risk? Aliens versus natives?

- **Tradeoffs**. Who is affected by changes in BGBD? Who wins? Who loses? At what scale? Are there tradeoffs within or across scales; across groups?
- **Thresholds.** Are the processes of ecosystem degradation/restoration continuous, smooth processes? Or are they marked by discontinuities / thresholds? If there likely are thresholds, can they be identified / quantified? This is a HUGE challenge, but if successful, would be a MAJOR contribution. here would one expect to observe these thresholds? Probably in "degraded" environments rather than "natural forest"—if so, what does that imply for additional sampling and priority strata/land uses?
- Interventions. If there are farm level and/or policy level problems, what can be done to address them? Are there interventions that are proven to be effective, efficient, and equitable? What are appropriate indicators for the adoptability of these interventions?
- **Communication strategy and partnerships.** How do farmers and policymakers get information for their decision-making? What form is most useful? Who is most credible? Should BGBD do this communication directly or through partners? Who will take time/effort to translate results for specific audiences? Does it have the partners it needs to reach out to producers and policymakers?
- **Capacity building and resource allocation.** Do the BGBD national and international teams have the disciplinary mix they need to address these issues? What are the capacity building needs in this area? What specific capacity needs are felt by the national teams?
- Log Frame (1.3) says: 'no data exist on the economic value of the services provided by BGBD' this clearly is not true. Hundreds, perhaps, thousand of papers on topics such as economic of carbon fixation, pharmaceuticals from the soil (bioprospecting) and the nitrogen cycle. The project should, as a first priority, do a detailed literature review (perhaps on a country basis) as a basis for moving ahead. This would also provide a valuable training tool.
- The log frame also includes 'guidelines for economic valuation of BGBD and its functions agreed and accepted' as a key performance indicator. It appears that little progress has been made on this product, and the literature review would be a useful building block for such guidelines, which GEF needs.
- Guidelines on evaluation would be potentially of great interest to ministries of agriculture, but they are more likely to adopt them if they are involved in preparing the guidelines. FAO might also have useful contributions to make. Have they been asked to contribute?
- Markets, with real money, are now established for carbon. In at least some biomes, BGBD sequesters more carbon than AGBD; this would offer important economic opportunities for farmers
- The ' market' is also keenly interested in the nitrogen cycle. N fertilizer was first manufactured in 1913, but more than half of all manufactured N has been applied in the past 20 years. According to the recently-released Millennium Ecosystem Assessment, Human activities now produce more biologically usable N than is produced by all natural processes. This is greatly accelerating the cycle of N through soils, water courses, and the atmosphere, potentially upsetting the functioning of agro-ecosystems. Implication: N – fixation through natural processes may become significantly more economically important. BGBD should explore this possibility

- BGBD should seek to link its work with others working on similar issues. and encourage other economists (agricultural, environmental, and ecological). To work on valuation of BGBD. Examples: organize workshops at relevant society meetings, encourage involve graduate students, convince FAO to hold an e-conference on the topic
- Water is likely to become increasingly limited in supply, hence more valuable, so the research on the impact of BGBD on water balance is highly relevant. The water cycle is an ecosystem service of the highest importance, so better knowledge about the role of BGBD is well worth a significant investment.

ANNEX 1: REVIEW OF INSECT PESTS

Andreas Gaigl, CIAT IPM

Results	Praise/Critics	Gaps	Advice
Insect pest problems defined and described (diagnosis): (1) identification of the species complex involved, (2) techniques for the rapid taxonomic identification of scarab larvae involved, (3) distribution and occurrence of principal species, (4) participatory methods for problem diagnosis, (5) yield loss and damage estimates for whitegrubs.	+ Farmers' perception of insect pests documented + Key pests in 5 Colombian agroecological zones described + Survey methods available for other countries and continents + Taxonomic keys for identificationn of beetles and larvae (Col.: Melolonthidae) developed Insufficxient preparation of farmer interviews	Economic thresholds not established Many farmers were reluctant in releasing data about their farm	Extend surveys to other regions/countries/continent s Systematic documentation of economic losses, especially in Africa Identify relation between soil health and appearance of soil pests Prepare farmer interviews by announcing research activities in press, TV, radio, etc. Include social scientists
Basic knowledge of the bioecology and behaviour of principal subterranean insect pest species: (1) rearing methodologies (2) recognition of life stages, (3) life cycle, (4) population dynamics and phenology.	+ Feeding behaviour of pest and suspicious species described + Colonies of Colombian key insect pest species established + Biology of key pests in Colombia described (feeding behaviour documented/ rearing methods established/life cycle described)	Lack of information on feeding behaviour of whitegrubs that are presumed reyclers of SOM	Colonies of whitegrubs in other zones should be established Study whitegrub species of further agroecological zones Establish close linkage with plant patholoists and soil scientists
Basic knowledge of potential biological control agents: (1) identity and incidence of naturally occurring natural enemies, (2) methodologies for laboratory propagation and evaluation, (3) methodologies for laboratory and glasshouse evaluation, (4) known potential of natural enemies for field deployment	+ Ca. 400 entomopathogenic fungi, 15 nematodes, and 90 bacterial strains isolated from insects and soils in Colombia and stored in ceparium + Rearing and evaluation methods for entomopathogenic organisms improved	Promising strains still have to be evaluated under field conditions	Extend search for entomopathogenic organisms in other regions/countries/ continents Evaluate more entomopathogenic organisms, also in combination with eaqch other

Network of soil arthropod researchers in Latin America: (1) electronic compilation of data and bibliographic references related to the management of subterranean pests, (2) internet-based communication network of soil arthropod researchers and extensionists (3) website for information dissemination and systematization of names	+ Data base of soil pest researchers, data and literature online available + Website for information dissemination established	- Participation in online network very poor	More logistic input from website designer and better maintenance of database necessary Installation of joint research on soil insect pests

SUMMARY

1. Soil pest research should be conducted in a standardisized manner. In many parts, especially in Africa, the documentation of the economic importance is fragmental; however, these data are crucial for the development of winner proposals.
2. An intensification of working relation between Africa, Asia and Latin America (LA) is desirable according to the global character of soil pests, especially whitegrubs. The methodologies developed in LA facilitate the implementation of soil pest rearch in Africa. This alliance will increase prospectives of future proposals.
3. A holistic approach of entomology, pathology, and soil science for a sustainable crop management is needed. It is suggested that IPM will be included in the BGBD project.

Report of the planning sessions of the working groups 1, 2 and 3 & 4 (Sessions 13, 14 and 15)

CONTENT

1. Proposal of a spatial analysis of BGBD project data: up scaling from point to global scale in three steps

Simoneta Negrete-Yankelevich

Departamento de Biología de Suelos, Instituto de Ecología A.C.

EXTENDED SUMMARY

Traditionally the impact of human activities on soil biology and functioning has been studied at a fine scale and very rarely in a spatial context. However, the expansion and complexity of human impact on ecosystems demands studies aimed to understand spatial heterogeneity and make broad scale predictions by extrapolating from fine scale measurements. One of the primary objectives of the BGBD project is to understand the impact of land use intensity on below-ground biodiversity and function. In its first phase the project has explored this relationship using point data at 100m intervals. In this paper I propose how, for the second phase, the project's point data could be spatially analysed to address the BGBD-land use intensity question considering spatial patterns at three different scales: the sampling window, the regional landscape and the global comparison. This proposal has been developed considering the body of data collected for the Mexican benchmark sites and the spatial configuration of the land use mosaic in those areas.

Scale1: The sampling window. The analysis at this scale considers the within window correlation between spatial features of the land use mosaic and the distribution of BGBD. The use of geostatistical techniques like variography and interpolation through kriging may be used to generate continuous contour maps for both below-ground diversity and possible management and physical explanatory variables (nutrient concentration, organic matter, slope, management intensity, time since clearance, vegetation cover, etc.) within each window. These maps will highlight the management and physical conditions prevailing where BGBD concentrates. Once the spatial behaviour of all variables has been modelled and mapped, GIS technology can be used to overlap them and statistical tests of spatial correlation (such as Mantel) used to test for their association. Additionally, these maps can be used to explore the influence of spatial objects (such as live fences, households and preserved forests) on the spatial distribution of BGBD.

Scale 2: The regional landscape. The windows studied in the BGBD project were selected as representative of the typical management practices in the broader regional landscape. In the case of Mexico, the three study communities cover 3.72% of the 125,401 ha included in the buffer zone in the Los Tuxtlas biosphere reserve. Preliminary data analysis has shown that there are substantial differences between windows in the intensity of land use as well as in their below-ground diversity. These results indicate that there may be substantial heterogeneity in BGBD and the factors that determine it at the regional scale. In this paper I present how remotely sensed information combined with satellite imagery may be used to explore this heterogeneity. An important body of literature is available that relates remotely sensed electromagnetic energy with land use intensity indicators (such as land cover and vegetation attributes proportions) and geophysical factors (such as topography, soil forms, aspect, and slope). These remote indicators could be correlated with BGBD within sampling windows by combining background knowledge with on site data. Then, by extrapolation, regional maps of potential distribution of BGBD at the landscape level could be constructed. Finally sampling outside current study windows could be performed to corroborate the veracity of these BGBD distribution maps.

Scale 3: The global comparison. Once up scaling from point to windows and windows to landscape has been performed for different regions of the tropics, a considerably detailed model of the factors that correlate with BGBD spatial distribution at different

scales and for each benchmark site would have been developed. This information may be then used to explore whether the same limiting factors of BGBD operate in different tropical regions and weather land use intensification has the same impact on BGBD in different regions of the tropical belt.

This paper also discusses various foreseen constrains to each step of the study. For example in the initial stage it will be necessary to explore weather the 100 m interval scale at which the current sampling has been performed presents sufficient degree of autocorrelation to permit interpolation and mapping. If this is not the case, then the project needs to consider re-sampling at smaller intervals and targeting influential spatial structures (such as edges and live fences).

2. Methods for spatial and multiscale analysis

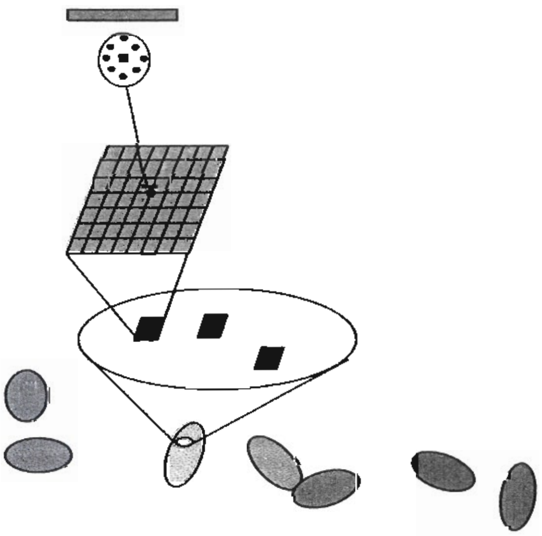
Ric Coe: r.coe@cgiar.org

CONTENT

1. Approaches
2. Problems
3. Requirements

THE DATA

NB: Limitations of the sampling scheme discussed last year, not repeated!

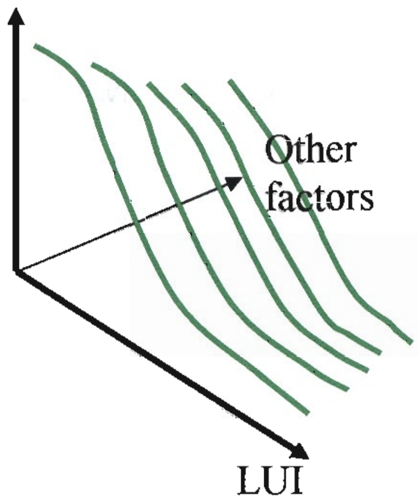


Level	Data
40 - 100 'Points'	Density and diversity of functional groups Local environment
≥1 window	?
≥1 site	Basic environment GIS layers
7 countries	?

(IT ALL DEPENDS ON) OBJECTIVES

- .1. In documents
  - Inventory (what is there)
  - Relation with LU intensity
  - Impact of specific LU practices
  - 'Hot spots'
  - Heterogeneity and scale effects – spatial distribution
  - All for
    - Benchmark sites
    - Comparison across sites
    - All BGBD / specific functional groups / specific taxa

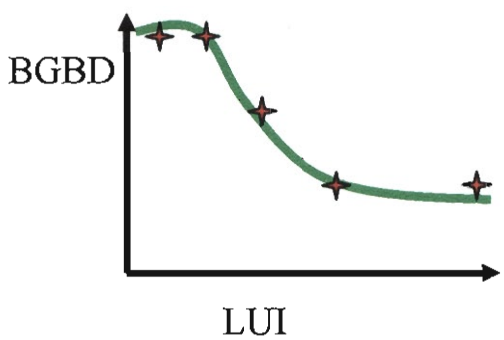
- 2. BGBD - land use intensity relationship considering spatial patterns at three different scales:
  - the sampling window
  - the regional landscape
  - the global comparison



Relation with land use intensity

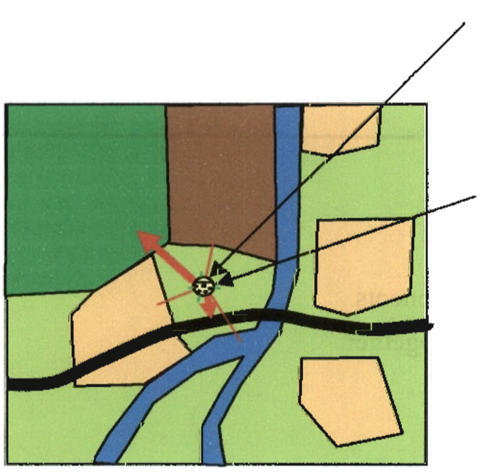
Needs (whether LU/LUI qual or quan)

- Points to define the curve
- Unconfounded with other effects
- With precise comparisons



Needs...

- Indicators of BGBD
  - presence/abundance of taxa/groups
  - measures of diversity
  - measures of function
- Indicators of LUI
  - qualitative/quantitative
  - multivariate – multiple dimensions
- Hypotheses connecting the above
- 'Regression-type' methods
- Comparison between windows/sites/countries
  - consistency
- All point-based



Adding landscape elements

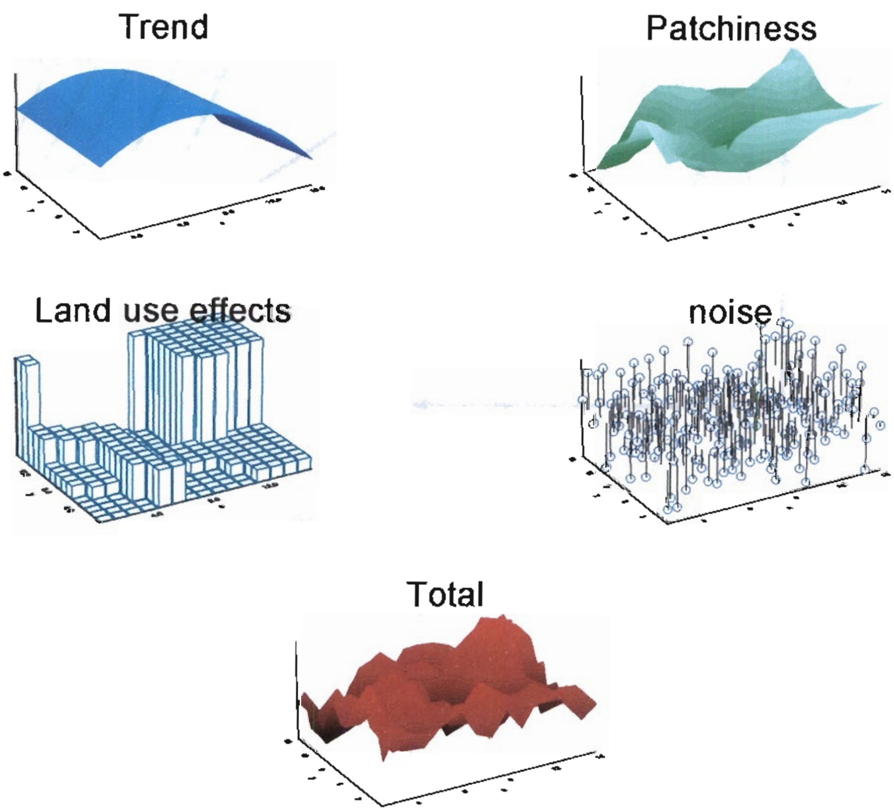
BGBD=f(landuse, soil, history,...)

- BGBD=g(landuse, soil, history,...
 + neighbour LU, distance to forest, barriers, corriodors,...)

NEEDS...

- Clear definition of the landscape elements
- Hypotheses to suggest effects
  - proximal-distant effects
  - too few observations for data mining approach
- Still point-based

MAPPING WITHIN A WINDOW



COMPONENTS

	cause / interpretation	tools
Trend	topography, parent material,...	regression
Land use	proximal and distal land use	as above
Patchiness	population patterns, other env. effects	variograms, interpolation
Noise	Local variation, measurement error	residual

CHALLENGES

METHODS:

- no unique decomposition into 4 components
- all components have to be estimated together

DATA:

- keystone landscape elements may be missing
- no close sampling
- Hypotheses and indicators (what is it useful to map?)

STILL ON POINT-BASED

DIVERSITY IN THE LANDSCAPE

TWO RELATED IDEAS

- Scaling from points to area

$$Diversity_{area} \neq \sum_{area} Diversity_{points}$$

- Turnover function
  - rate at which species replaced with increasing distance

NEED

- clear objectives
  - e.g. Why compare on equal area basis?
- hypotheses
- Give us the questions, we can find methods!

MOVING UP A SCALE

- Requires
  - common 'x-variables' across sites
  - common 'y-variables' across sites
  - comparison methods to identify common relationships
- Challenges: ecological scale principles
  - different factors important at different scales
  - 'x-variables' that can be mapped (eg from remote sensing)

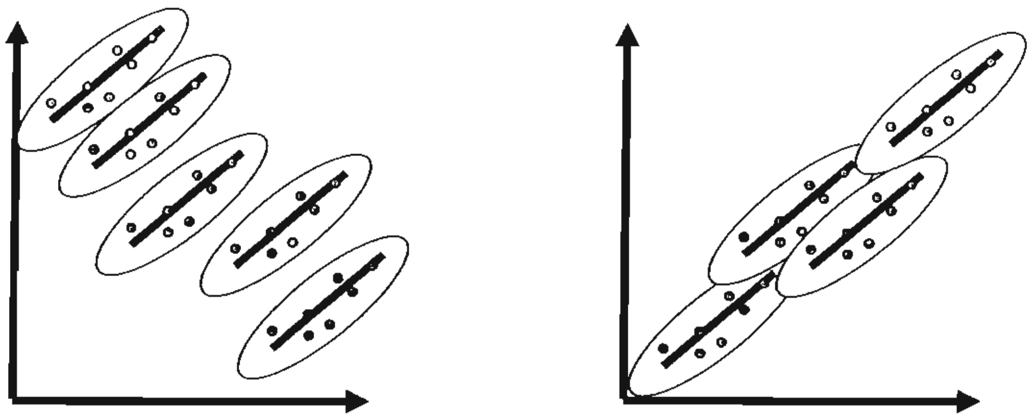
EXAMPLES

Scale	Possible factors	number of data points
10-2 m	competition	?
10 m	organic matter	100?
103 m	soil types	?
105 m	climate	7+

REMEMBER STRUCTURE

- Analysis at one level has to allow for effects at higher levels

GETTING THE STATISTICS DONE



- Appropriate methods depend on
  - exact objectives
  - the data
- Require joint work of statistically and ecological competent

3. BGBD Project Database Implementation Strategy

PETER OKOTH

CSM- BGBD Project Information Manager

PRESENTATION OUTLINE

- Project Information Management
- Purpose of Information in the Project
- Database Content
- Website Content
- Suggested Way Forward

PROJECT INFORMATION MANAGEMENT

INFORMATION MANAGEMENT

- Individual data sheets and record sets
- Project database
- Project documents
- Published papers
- List of publication
- Brochures
- Newsletter
- Websites
- Links to relevant websites
- Intellectual Property Rights
  - Knowledge
  - Genetic Material

PURPOSE

- Data sharing
- Information hub
- To keep track of products emanating from the project
- To have a reference hub
- To share knowledge gained
- To publish output
- Monitor and regulate compliance

DEFINITIONS

- Record sets
  - Tables having raw data in any format
- Database a collection of all record sets and material presented in the scope.
  - Reports, published papers, newsletters, brochures, etc.

PUBLICATIONS

- All data emanating through project funding belongs to the project
- Intellectual property must be protected by all during publishing. i.e. publish with consent and jointly

- Proper acknowledgement of GEF, UNEP, TSBF, CIAT, other participating institutions must appear in project documents

Country Databases

- Could be made information and reference hubs (i.e. through querying, etc)
- A generally shared information system

Content

- Benchmark Site Data
- Window Data
- Points Data

Benchmark Site data

- Country
- Benchmark Name
- Bounding Co-ordinates
- Global Ecoregion
- Sub Ecological Region
- Actual Ecoregion
- Broad Geology
- Climatic Classification
- Land Cover
- Geomorphology
- Altitude

Window Data

- Window Name
- Window Code
- Agro-ecological zone covered by the window
- Bounding coordinates
- Soil Types
    - Soil Profiles
    - Morphological characteristics
    - Chemical data
- Broad Land Use Categories
- Stakeholders
- Temperature
- Rainfall
- Evaporation

Point Data

- Country
- Benchmark
- Point Number
- Centre Coordinates
- Socio-economic Data
- Farmers' plot management + History
- Land Use Intensity Data
- Land Use Conversions
- Distance to hedges, terraces, forests
- Soils Data
- Species Data
- Geographic Data

Website Data

- Home Page
- Country Links
- Species Links
- Mailing Lists
- Announcements
- Events
- Newsletter
- Global Database

Way Forward

- Establish IT capacity in each country
- Conduct a global training workshop on the project database and website
- Implement Database in each Country
- Synthesize species data for project website
- Have each country develop own website
- Implement global internet base species database from project results

Global Database

- General information including
- Participating members
- Shared documents
- Synthesized information from the country databases (i.e. BGBD species info in agriculture, ecosystem services, pharmaceutical services, collection, transfer, benefits, etc)
- Benchmark site descriptions

4. An option for on-line training in the use of R statistics on the WEB

Francisco Luiz Vilas Boas, Luci Aparecida Nicolau, Denismar Alves Nogueira, Marcelo Silva De Oliveira, F_atima M.S. Moreira,

ABSTRACT

Courses through internet are a promising option for training and learning. The experience f a on line Statistics course given by professionals of to the federal University of Lavras to a group of researchers and students working in a international project is reported. By the systematic observation and data collected through questionnaires the participant's impression is described. A good acceptance of the course was noticed even by those who never used this learning tool.

5. Report on the discussions of the WG2 planning session (session 14)

Jeroen Huising

INTRODUCTION

The sessions started with a presentation by Simoneta still on the land use intensity index that she had not been able to present during session 10, dedicated to that issue. Also her presentation on the proposal for investigation of spatial or scale aspects in the distribution of BGBD was deferred to this session. Apart from these a presentation was given by Richard Coe and furthermore presentations on the BGBD database (or information management strategy) and on the BioSBrasil Web site were given. Discussions where conducted on each of theabove themes, the LUI, spatial analyses, database and statistical analyses.

DISCUSSIONS

Q1. Do we want to develop a uniform Land Use Intensity Index that can be applied by the country programems equally?

A. The answer seems to be "no". Simoneta indicates that there is a difference in 'baseline' between benchmark areas and even between windows within the benchmark areas. She proposes to use 'modifiers' to the parameters used in the index to account for these differences (in soil for example). The question is then raised whether these should not be treated as other variable in the equation. Another point is the scale. Scale can also be applied to the time dimension; distances may also be measured in time. What comes out of the discussion is the need for a clear hypothesis based on ecological principals and insights that should underline the definition of a LUI index and the observation is that such a clear hypothesis is lacking.

Conclusion may therefore be that working towards a uniform LUI is not useful at this point in time and that first we need to develop a clear hypothesis that will underlie the definition of a relevant LUI index. A LUI index or indices is considered very relevant still and work on LUI should be done (continue) in a few countries at least.

Q2. Do we as a project want to investigate scale aspects of BGBD distribution? The question in fact comprises to separate questions. 1) Do we want to consider/observe the various scale levels in looking at BGBD, 2) do we want to investigate specific spatial aspects in the BGBD.

A1. Answer to the first question is that we want to consider certainly the landscape level. It is mentioned as one of the important topics in the project document. That is also where we want to establish the link to global level, which is indicated as an important gap in the project document. It is also that ecosystem services express themselves at various scale levels. The landscape level is also important as a 'marketing tool' since it is at that level that the project wants to generate impact. **The conclusion is therefore that all country programmes should address the landscape level in their analyses.**

A2. As for the second question, again the need for a clear hypothesis about proximal and distance effects on the distribution of BGBD is needed. The spatial distribution has different components that make up the total: trend, patchiness, land use effects, noise. And so far in the project we aim to address only the land use effect and the noise effect. There is no unique decomposition of the 'total' distribution into these four components. The inventory will not provide the necessary data, being it point based. It is understood that the total variance (or diversity) of an area is not the sum of diversity at point level. There is a need for a clear objective to engage in this type of study. **The conclusion is this case is that it is left to the country programmes to decide whether they wan to take this up as a relevant topic for their investigation.**

It is also suggested that this should be the joint work of the statisticians, but this may relate more the landscape level analyses. A stepwise approach will be followed: 1) looking a the point level variation using landscape elements, 2) Map patterns of diversity within the windows, 3) Go to benchmark area where we expect the best results. The last step is to be further discussed on Friday in a special session.

Q3. Should the project (i.e. the country programmes) adopt one uniform database and how can sustainability be guaranteed.

A. Peter developed a prototype database, intended for storing data generated from the inventory of BGBD. So far the database is not being used by any of the country programmes (the database is empty as yet). **It is not the idea that the GCO will keep a database that will store all the data generated by the various country programmes. It will rather be a responsibility of the country programmes to develop and maintain a database themselves to keep the data generated by the inventory. A uniform database is not feasible given the differences between the country programmes** (since they have not employed exactly the same methods and since we do not have uniform way of describing the benchmark area characteristics like for example the land use intensity index). Country programmes need to take their own responsibility in establishing their database (to specify the list of data items to be included in the database). **Aspect if precision and accuracy of the data therein should be addressed.**

Questions are also raised as to how the spatial analyses would benefit from the database. This is only very partially the case at the moment.

With respect to the sustainability national biodiversity databases are being mentioned like the one held in CATIE/ Costa Rica and CONABIO in Mexico. Hot links to existing taxonomic database is mentioned (like for example the "antbase")

Q4. Would the online learning on R statistics as provided by the BiosBrasil be an option for the other country programmes to boost the statistical analysis of the data?

A. "R" is a difficult programme to learn by oneself online. It will require additional training and instruction. In this context the book on using "R" by Richard Coe and Roeland Kindt is announced. So the conclusion is yes, if we are able to accompany this by assistance and support (training) by a biometrician it would be a useful tool. Possibilities should be further explored. A data analyses workshop is suggested and should be included in the project's workplan. This could be combined with the workshop to be organised to work on the synthesis.

6. Report on Working Group 3: End Phase 1 and Start Phase 2

1. Progress (to the end of the 2005 Annual Meeting in Manaus):

The activities so far under WG3 have been mainly concentrated within Outcome 2, addressing site characterisation. This has meant a primary emphasis on putting together capacity within the country teams to complete the socio-economic baseline survey, providing baseline information on land management and assessing awareness of stakeholders. In the 2004 Annual Meeting in Embu, the country teams agreed to collect a minimum set of socio-economic questions at the grid points in the sample windows, complemented with broader socio-economic characterisation of the surrounding communities using appropriate survey techniques (see Annex 1). The checklist of minimum data also includes questions about awareness of and attitudes towards BGBD. A similar set of attitude and awareness questions was designed for research and policy stakeholders in the project, to serve as a baseline for changes in knowledge promoted by the project.

***Table 1**. Achievement of WG3 workplan objectives (April 2005)*

<table>
<tr><th>Component</th><th>Key performance indicator</th><th>Status of the activities and achievements</th></tr>
<tr><td>3.1. Information on management option made available from which to select management options</td><td>Information on management options compiled and made available to each of the countries for selection

Selected management practices documented</td><td>Socio-economic surveys completed as follows:
<table>
<tr><th></th><th>BR</th><th>CI</th><th>IN</th><th>ID</th><th>KE</th><th>MX</th><th>UG</th></tr>
<tr><td>Data at grid sample points</td><td>Y</td><td>Y</td><td>Y</td><td>½*</td><td>½*</td><td>Y</td><td>Y</td></tr>
<tr><td>Survey beyond grid (n=)</td><td>Y**
?</td><td>Y
?</td><td>No</td><td>Y
84</td><td>No
32</td><td>Y
?</td><td>Y
306</td></tr>
<tr><td>Attitudes and awareness</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
</table>
Mexico: Extensive land-use history data.
India: Local survey complemented by secondary data.
*Kenya and Indonesia: Survey in second benchmark pending. In Côte d'Ivoire only the Oumé site will be used.
**Brazil: Because the communities do not extend beyond the study windows they have been exhaustively studied.

The results of these surveys have to varying degrees been incorporated in all the country reports. Separate papers / extended abstracts on the baseline / characterisation work were produced for the Manaus meeting by Kenya, Uganda, and Mexico.

Specific publications are also being planned in countries with appropriate data (e.g. Mexico, Uganda, Kenya?). Brazil team is already publishing their results.</td></tr>
<tr><td>3.2. Demonstration of successful management and conservation of BGBD</td><td>Demonstration plots of practices for BGBD management and conservation established in benchmark sites in all participating countries

Increase in BGBD in</td><td>All country teams have held planning meetings to decide on potential technologies and alternative land uses to demonstrate. Community-based facilitators / contact staff are in place in the benchmark sites.

No large-scale demonstration plots or experiments have yet been initiated by the project, but the following activities have already taken place:
India (NDBR): Trials on the nodulation of 10 different</td></tr>
</table>

	demonstration plots	pulses, grown on soils with varying soil fertility classes. **Mexico**: Vermi-composting training course; organised a "living museum" as awareness raising programme. Partners to the project in Indonesia, Kenya, India, and Mexico are also already active with experiments with which we plan to integrate BGBD components.
5.1. Capacity enhanced in disciplines identified as lacking in cooperating countries	BGBD research and management capacity institutionalized in scientific institutions in participating countries. Capacity of farmers, extensionists and NGOs to interpret and apply information on BGBD improved.	Country teams have identified lack of capacity as a constraint for WG3, particularly where the team does not have strong representation of social scientists (e.g. India). Capacity building in farmer participatory research methods and community development does not appear to rate highly as a priority, though, when compared to lack of capacity in biological skills needed to complete the inventory.
5.2. Enhanced awareness and knowledge of BGBD and its functions among stakeholders from farmers to national planners	Knowledge of soil biota and its management disseminated to farmers, extensionists, NGOs and lower governments Decision makers utilise soil biodiversity information in national and regional plans	The project brochure and newsletter has been published and widely distributed. Mexico, Brazil, Indonesia, and Kenya produced their own brochures and leaflets for targeting national audiences. Stakeholder meetings have been held in all countries. Those in Brazil, Côte d'Ivoire, Mexico and Indonesia were quite formal, high profile events. India, Kenya, and Uganda have had more direct contacts with local officials and community-based organisations.

2. Issues Related to Phase Two

In Phase Two, WG3 will become more prominent as its members take on responsibilities related to Outcome 3, the conservation and sustainable management of BGBD. The annual meeting in Manaus has therefore provided an opportunity to address whether the current membership and resources of each country's WG3 are able to move from delivering the Phase One (characterisation) goals to tackling the Phase Two (demonstration & experimentation) goals.

This has been particularly important since WG3 members have had the lowest involvement in project management in all the countries. High turnover in WG3 membership has also undermined understanding and "ownership" of the project objectives in this team. One of the most prominent members (i.e. Dan Bennack, Mexico) left the project in 2005, and several countries (Uganda, Kenya) did not have clearly designated WG3 leaders until late in 2004. Brazil has reported that integration of WG3 activities (which are largely part of ongoing other projects) with the rest of the BGBD has been difficult. Other countries WG3 members (e.g. Côte d'Ivoire, Uganda) report that it is difficult to get their participation in the BGBD project to be recognised as a necessary component of their already busy workplans, creating conflicts with their home institutions.

Table 2 shows the current staffing profile in the countries. N.b.: even the most recent project directory (April 2005) does not in some cases accurately reflect the membership (e.g. Uganda).

Table 2. WG3 membership and competencies (April 2005)

	Brazil	CDI	IND	Indo	KEN	MEX	UGA
WG3 Leader	N Marques / S Alfaia	Angui P.	BK Senapati	Rusdi E.	Mutsotso	T. Fuentes	E Balirwa
Discipline	Entomology	Soils	Earthworm	Agronomy	Economics	Anthropology	Economics
Leader in Manaus?	(S Alfaia)	(Barry M, Konate S)	BK Senapati, UM Chandra-shekara	Rusdi E.	Mutsotso	(I. Barois)	E Balirwa
Disciplines represented in WG3 + WG4							
Economics	S. Noda, Elizabeth?	Barry M.	C. Reddy	Bustanul A Suyanto	B Mutsotso, J Chirchir	(AP Portillo)	E Balirwa, G Mugonola
Anthropology / Sociology	-	Agnissan A.	-	Pitojo B.	-	T. Fuentes C. Robles	-
Ecology / Biology	N Marques H. Noda	-	UM Chandra-shekara	M. Utomo	D Odee N Karanja?	I. Barois	-
Soils / Agronomy	S Alfaia	Angui P.	-	Rusdi E Suprayogo, F. Agus Lumbanraja	-	-	-
Policy / Community development	HS Pereira	Egnankou Konate S	-	-	-	AG Azuara R Vega, AG Morales	-

It is obvious from this table that size of WG3 varies greatly from large teams (Mexico, Brazil, Côte d'Ivoire, Indonesia) to much smaller ones (Uganda, Kenya, India). It is also clear that some countries (e.g. Uganda) have primarily viewed WG3 as an "economics" group, while others (e.g. Indonesia, India) had put more emphasis on the ecology or technology development aspect. The remainder take a hybrid approach, but with the exception of Mexico it is not clear to what extent the socio-/economists in WG3 have so far worked with their soil / ecologist / agronomist colleagues (e.g. in Kenya, where the role of N. Karanja has not been clear). The lack of institutional support (and the perceived low priority of WG3 within Phase One – voiced as "service provision" during the baseline rather than strategic research of its own) has meant that most of the teams (except Mexico and Brazil) have not been able to really start making substantial analysis of results on their own. This constraint will become acute particularly for the implementation of any economic valuation activities related to the EEVAL task-force Case Study on Soil Structure Modification or the valuation of alternative land management options.

A final concern is about the role of partnership in the project. To implement Phase Two effectively, we must be willing to reshape the research activities (and perhaps the staffing profile of the country teams – e.g. to better address pests and diseases, a priority area from all the countries' surveys but not found in any depth in the research teams) to address BGBD-related concerns of the communities and nations we serve. This will mean responding to the demands of a variety of stakeholders who are also not well incorporated in most countries' activities, namely local officials, government- or NGO-based makers or shapers of biodiversity policy, as well as community-based groups and farmers. WG3 members already in some cases represent the addition of "new" institutions (CBOs, socio-economic departments of universities) to the perceived "core group" of biology research institutions and researchers. The global office and advisors of the project must be ready to assist the country convenors to further expand the scope of their teams to include these additional types of partnership.

SUGGESTED ACTIONS:

i) Integrate support and implementation between WG3 and 4 with local mergers.

In the countries with smaller WG3 teams, it is already effectively the case that WG3 and 4 have merged (Kenya, Uganda, Côte d'Ivoire, India). Increasing integration of the task forces on the Economic Evaluation of Ecosystem Services will also mean that members of the previously distinct WGs will be working together much more regularly.

Greater integration would require finances dedicated within the country teams to support the achievement of workplan objectives. It is also requested that money be available from the global office to support additional follow-up studies and strategic research on WG3 objectives (such as on attitudes and values placed on ecosystem services and BGBD, or the analysis of farmer-led experiments on alternative land-use strategies).

ii) Increase interaction between country teams (joint publications?)

Communication in Phase One was patchy. Various explanations have been given, but most relate to the absence of activities that demanded central coordination. The baselines were implemented within each country according to the demands of country teams, and once the concern about using a "standard" set of questions was met, members were more than busy enough and did not see a reason to be sharing results of baseline surveys amongst themselves outside of the country documents. Even the synthesis of results across countries is not a topic that appears of high relevance to the teams outside of its potential contribution to the GEF reporting documents.

However, a **synthesis paper on attitudes and awareness of BGBD** does appear to be of interest to enough of the teams to warrant including it in the immediate workplan as a new activity. This could foster greater cooperation and interest in each others' work, and stimulate further interaction. There is also interest within countries (voiced so far by Mexico, Uganda, India) in producing multidisciplinary characterisation papers for their sites. In several cases (Uganda, Côte d'Ivoire) there is an immediate need to publish some of these outputs because WG3 members have had to sacrifice their participation in other projects to take part in the CSM-BGBD project.

iii) Increase interaction with the global convenor by establishing a Task Force on Conservation and Sustainable Management.

Phase Two will likely continue with a pattern of autonomy. However, in order to improve our focus on achieving the outcomes related to technology demonstration and changes in practice, we propose establishing a Task Force on "Conservation and Sustainable Management (CSM?)". Such a task force will take advantage of the complementarities of skills between the countries without obliging all countries to undertake the same demonstrations or approaches. It will also give the WG3 members a greater interaction with their ecological colleagues within the teams. Finally, the task force could take the lead on capacity building within the teams; for example, community-based and participatory practice needs strengthening in India, Kenya, and Uganda. Country team members have suggested that capacity can be built during the demonstration / experimentation activities with more opportunities for:

a. South-South exchange of knowledge and expertise,

b. Direct face-to-face interaction with the global WG3 convenor in the field settings,

c. Training on farmer participatory research methods (at one of the field sites) in 2005-06 similar to what is being proposed for the EEVAL task force

Without more "hands-on" assistance from the global office, teams facing significant skills gaps will have difficulty achieving their promised outputs in Phase Two. Uganda, India, Kenya, Brazil, and Mexico have specifically asked for more hands-on help and "pressure" to keep them going. Cote d'Ivoire cites time as major constraint. We therefore recommend that the global convenor continue to spend at least 30% of his time, with travel budget, on this project, visiting the countries and providing direct training between team meetings. Priority sites in 2005-06 would be India and Mexico, which have not yet had direct support from the global convenor.

3. PROPOSED WORK-PLAN 2005-06

Activity	What	Who	Start-end dates
Annual report (2005)	Summaries of baseline, stakeholder, and other characterisation included in the annual report	All WG3 teams	Now – 1 May '05
GEF evaluation	Specific responses to GEF evaluators on socio-economic questions	WG3 teams as needed	mid-end May '05
Socio-economic baseline	Complete baseline in second benchmarks, include in country site characterisation	Indonesia, Kenya WG3	Now – end May '05
Socio-economic point data	Confirm that data are available to be entered and analysed for the country / global database	All WG3 teams, JJR, PO	Now – June '05
Journal publications prepared	Individual country papers finished Awareness and attitude paper finished Interactions BGBD with practices in demonstrations (planned)	(Uganda, Côte d'Ivoire) JJR + all WG3 teams	Now – June '05 Now – July '05 To be begun before 2006 AM
Increased communication	Circulation of relevant journal articles Stimulate email discussions on BGBD – society interface	JJR JJR + all WG3 teams	Now – May '05 May '05 – Apr '06
Identify training needs	WG3 team members consult with those who were not in Manaus to prioritise FPR, economic valuation, and/or other training needs	All WG3 teams, JJR, JH	Now – July '05
Training workshop	As needed on topics identified in previous item	All WG3 teams, selected members, external trainers	Sept-Dec '05
Inter-site capacity building	In lieu of workshop or as needed on topics identified in training workshop	Relevant WG3 teams, selected members	Sept-Mar '06 (best if coincident with host's growing season)
Direct support from global office	JJR (or JC, JH) visits countries to help them with methods training, demonstration establishment / analysis, EEVAL case study two…	JJR, JC, JH, All WG3 teams that request assistance (Uganda, Kenya, India, Mexico so far)	On-going from Sept '05
Demonstration / experimentation	1. Sites and partners confirmed 2. First technologies / management options established with farmers		Apr - June '05 June '05 + (end dates will depend on local growing seasons)
Data collection and analysis	Establish protocols for data collection with farmers; Establish indicators of BGBD in demo sites; Conduct trials / demonstrations;	All WG3 teams, JJR, PO	June '05 + (end dates will depend on local growing seasons)

	Make use of FFS or other learning & feedback mechanisms; collect additional BGBD data related to trial performance; Analyse data and make plans for second round of trials / demonstrations		
Monitoring and evaluation	Establish reporting mechanisms to monitor trials and stakeholder learning	All WG3 teams, JJR	June '05 + (end dates will depend on local growing seasons)
Identify and communicate benefits of alternative management options	Identify and undertake best analysis to assist country teams identify and communicate sustainable management and conservation strategies for BGBD - Printing & disseminating communication materials	All WG3 teams, JJR, JC, JH All WG3 teams, JJR, global office	Oct '05 +

JJR = Joshua Ramisch; JC = Jonas Chianu; JH = Jeroen Huising

N.b. This workplan does not currently include the activities related to the EEVAL or ESERV task forces, which should be reported elsewhere.

Resources:

- JJR's time for project – 30% of his time + travel, to support teams and visit them throughout the year with initial focus on unvisited sites in Mexico and India. Ongoing support to Kenya and Uganda will also be increased. Wherever possible, travel will be combined with existing TSBF commitments or travel by other WG convenors / project coordinator.
- Travel and logistics costs for Training Workshop in Mexico or Kenya (15 people maximum: 1+ / country team + 2-3 external trainers, JJR, JC, Ritu Verma, Jo Anderson or other advisor, JH).
- Travel and logistics costs for inter-site collaboration between country teams, facilitated by JJR or other project leaders. Pairings need to consider disciplinary strengths and complementarities of ecosystems, not simply geography (although there will be advantages to getting Kenya and Uganda working more closely together even if this is not a strength-to-strength pairing).
- Additional global resources to facilitate the a) follow up data analyses by WG3 as needed if not covered by country budgets, b) editorial, translation and printing of dissemination and communication materials

ANNEX 1. AGREED CHECKLIST OF "MINIMUM STANDARDS" FOR THE CSM-BGBD PROJECT BASELINE QUESTIONNAIRE (SOCIO-ECONOMICS, LAND-USE HISTORY, CURRENT PRACTICES AND AWARENESS)

A) Background information

Farmer's name (+ unique identifier code)
Household head gender, age, marital status, education level
Household size (# adult family on-farm labour, # hired labour, # dependents)
Farm production is: subsistence only / subsistence + market / mainly market
Months the household considers itself food secure, # months that food needs to be purchased
Primary household income source (i.e.: farm, employment / pension, etc.?)
Off-farm labour (# working off-farm: casual / seasonal / full-time?)

B) Land holdings and land use history

Total area cultivated / used (area owned, area rented / borrowed)

Area	Previous use, when?	Time since previous fallow	Length of previous fallow	Time since conversion (from primary forest...)
Land use 1 (or crop 1?)				
Land use / Crop 2				
...				

C) Land management practices (this year)

Area	Burning (y / n)	Tillage (plough, hoe)	Weeding (plough, hoe)	Chemical inputs used (NPK, pesticide, herbicides)	Biological inputs used (manure / composts, green manures, mulch, inoculants)
Land use 1 (or crop 1?)					
Land use / Crop 2					
...					

Other land-uses that might impact BGBD (e.g.: brick-making, charcoal burning, mushroom harvesting, etc.)

D) Current awareness

What living things can you name that **live in** or **come from** the soil? (This list will probably be skewed towards larger creatures, including moles, snakes, etc.) (Use the list to prompt further ideas – if a harmful organism is identified (e.g. a termite), see if there are similar organisms known which are thought to be positive or neutral... and vice versa)

Organism	Any known role?	Consider these mostly harmful?	Consider these mostly helpful?	No opinion / neutral impacts?
Organism 1				
...				

If not already mentioned... Can you name any pests or diseases that come from the soil? Otherwise, use this table for the diseases / pests already listed, and use the discussion to see if others are known.

Pest / disease	Crop(s) affected	Known effects	Perceived severity (areas affected, how often, how badly)	Where found?
Organism 1				
...				

Are there any ways that you know of that you can:

- Increase the effects of the beneficial organisms? Which ones? How?
- Reduce the effects of the harmful organisms? Which ones? How?

7. Report on Working Group 4 Discussions, Session 15 (Joint with WG3)

NB: only WG4 issues discussed here except in final section.

PRESENTATION:

Mike Swift as convener of the group made a short presentation clarifying the TOR which were amended at the Annual Meeting in February 2004. The group now has three Task Forces: for Economic Evaluation (EEVAL-TF), Ecosystem Services (ESERV-TF, joint with WG3) and Policy and Public Awareness (POL-TF).

He reminded the participants that the work on ecosystem services and economic evaluation was discussed in other sessions (Sessions 9 and 11) and that discussions will continue on these topics over Thursday and Friday, and so proposed that the current discussion should be confined to the work of the third Task Force (POL) which will commence in Phase 2. This Task Force will be largely targeting Outcome 4 of the project ie: '*Recommendations of alternative land use systems and an advisory support system for policies that will enhance the conservation of BGBD*'. He proposed that the POL-TF should be established as soon as possible as a discussion group to exchange experiences on interactions with stakeholders and decision makers of all kinds both within each country and internationally. All countries had already established many of the necessary contacts during the preparatory and Phase 1 activities and now, with results of the inventory to talk about, is the time to involve these people more closely in the project.

He pointed out that the issue of conservation and management of BGBD is not an easy one to present to non-expert audiences and suggested a principle that could help to explain it: Given that the soil organism(s) (the diversity) are essential for the maintenance of function(s) which are essential for the agro-ecosystem - then the major principle for CSM is 'Conserve the organisms (the diversity) by conserving the function(s) by conserving and managing the system'.

DISCUSSION:

Tom Tomich said that the first priority for policy work was to identify what the major policy problems are in each country.

Ramakrishnan emphasized that traditional societies and therefore their practices are protected by legislation in some countries and a principle should be to utilize this knowledge and integrate ITK with the technological insights developed in the project.

Isabelle Barois stated that as we were taking much away from the farmers it was essential to take as much back. This stimulated a long discussion on the topic of communication from country team members with contributions from Barry Mody, Juvenil Cares, Elizabeth Balirwa and Agus Fahmudin all reporting that there are already feed-backs from farmers including requests for help; it was agreed that an essential issue is to ensure that the dialogue is continuous and to avoid 'disappearing from sight' after having made contacts and conducted work. This was reinforced by Jo Anderson emphasizing that we should take care against over-raising expectations.

Tom Tomich suggested that key contacts for this work are the 'policy shapers' of various kinds who come from all sectors of society, including NGOs, University staff etc, and get them involved as champions of the project. We should be careful to distinguish between 'selling our product' and finding matches with need.

He went on to say that a key issue was that the project needed to define carefully what the balance in the project is between BGBD in itself (ie. the scientific results of the project) and BGBD as a resource in terms of services and benefits for farmers and other stake holders. This balance will need to change during Phase 2 and new people will be be conducting the work .This will need careful management in each country.

WORKPLAN:

On the basis of the suggestions by Mike Swift and the following discussion the outline workplan for the POL-TF is as follows:

1. WG4 convenor to establish the POL Task Force as a discussion group on Outcome 4 by contacting WG4 members in all countries.
2. The initial tasks of the TF will be to establish TOR and finalize a workplan and a set of targets for the TF.

3. Country teams to establish or resume contacts with the project 'clients' – decision makers at all scales - and involve them in the further development of the project.
4. Country teams to review relevant legislation and identify policy problems in their countries.
5. Mechanisms be put in place to do the same on a global scale.
6. All teams to develop plans, and set targets, for raising public awareness of BGBD and providing information and recommendations to stakeholders and decision makers at all scales.

FUTURE, AND BUDGETS, OF WORKING GROUPS 3 AND 4:

At the end of the session there was discussion round the question of whether these two working groups should merge. In favor of this is that there are many overlaps of both topics and people. The general feeling seemed to be that for the time being they should remain separate but change in structure should be kept as an option.

It was agreed however that the work in the areas covered by the two Working Groups (ie. 3 and 4) would be much enhanced if the funds for their work were clearly identified in the budgets. These could be allocated at country level but should also be identifiable through the working groups.

8. Workplan for EEVAL Task Force: End Phase 1 and Phase 2

Diane Osgood (report to convener WG4 Mike Swift)

PROGRESS:

The following points concerning the economic valuation component of the project are clear from the AM Manaus meeting:

- The skills are very uneven between the countries: India and Indonesia have outstanding economist on their team and are making swift progress in Case Study One. Kenya, Uganda and Cote d'Ivoire have economists who have been unable to start any analysis. Brazil and Mexico do not yet have economists on the team.
- Without more 'hands-on' assistance from the global office, the teams who have not yet produced any analysis will most likely not be able to produce much in Phase 2, as they face significant skills gap. Uganda, Kenya and Mexico have specifically asked for more hands-on help and 'pressure' to keep them going. Cote d'Ivoire cites time as major constraint.
- I therefore strongly recommend that JC is able to spend at least 25% of his time, with travel budget, on this project, visiting the countries and providing direct training between team meetings.
- The economists would like bi-annual meetings so that we can exchange learning and work on methods face-to-face. Given the level of difficulty of Case Study 2, this seems reasonable. One could be organized around the AM to reduce costs.
- Our first joint session of EEVAL, ESERV and SPANAL was very successful and clearly demonstrated the need and benefit of working together for case study two. We all agreed that a joint workshop is very much needed. End of August/early September is the best window. There is 100% agreement that we need to hold this at a field site to test valuation methods. India and Mexico have been suggested, and both teams are considering our request.
- The economists will have work beyond Case Study 2 in assisting the identification and communication of best sustainable management practises and conservation of BGBD to different stakeholders. Thus, we need to continue as a separate group that integrates with ESERV and SPANAL for specific activities, such as Case Study 2.

- Teams with results might be best served to combine papers or package them together cross countries – global office needs to help coordinate this for countries like Uganda who has base line data need guidance in getting publication. JC could take lead?
- The environmental economic literature review was resuscitated and broken into a two-step process. First the teams have committed to searching national sources for any literature on the economic value of RIT. This will include MSc and Ph.D. work. The results of their search will be compiled and synthesized by JC with help from DO. Second, revised guidelines for a general global literature review will be an output from the Workshop. Timeframe and responsibilities will be defined at the workshop.

Activity	Outcome	Who	Start – End dates
Completion of Case Study One	India, Indonesia, and Danso baseline studies submitted and disseminated via email to all teams	India, Indo, & Danso	Completed end of June 05
Identify and confirm participation of economists with right skills base for Brazil and Mexico.	Economists join Mexico and Brazil teams	DO with team leaders & JC	April 05 DO to visit candidate in Mexico. On going for Brazil
Countries gather literature on econ value of RIT with focus on MSc/Ph.D.s, etc and send to Jonas for compilation and synthesis.	Literature review on economic valuation of RIT. Possible publication.	All teams	Immediate, completed 4 weeks before joint E-S EVAL Workshop (Sept 05)
Gather top ten-twenty articles on environmental economics for background to Workshop	Primer on environmental economics shared with all teams	JC with support DO	Completed at least 6 weeks before Workshop
Discussion of RIT literature review and Case Studies by email	Group learning from Case Study One, cataloguing of types of data gaps and understanding of functional relationships.	All teams, facilitated by JC or DO	July
Revise guidelines for global literature review for econ value of BGBD based on findings RIT study and workshop deliberations.	Re-launch of economic literature review for global project.	DO	At/after workshop
Identify what we need to know to prepare for Workshop	Realistic preparation of Workshop	DO, JJR, EB, SN w/ RC	Manaus AM mtg
Cross discipline framing of nitty-gritty issues involved in assessing econ value of soil structure, eg integration ecosystem services & economics	Integrating Frameworks to launch Workshop. Decision on possible scales to use in case studies, and/or implications of choosing different scales, probing possible economic valuation methods. Identification of gaps in knowledge & expected data. Assignments for Workshop. Settle exact time and venue and invite list for workshop.	DO, JJR, EB, SN, MJS, JA, RC, JC, and possible KG, AMI, JB	Brain storming session, early July 05

Workshop to integrate ecosystem services, econ value and scale to prepare for Case Study Two	Guidelines for Case Study 2. Understanding of gaps, potential, etc. Agreement upon standardized methods for economists and ecologists.	All teams + above list	Early Sept 05 in field study site of one country
Write up results of workshop, outline methodology manual, circulate, revise and present AM 06.	Draft methodologies manual presented at AM 2006.	JC and DO draft	Draft circulated by end Oct. Revised by end of 05
Economic Case Study 2	Launch and complete case study two	All teams	October 05-Feb 06
Identify and undertake best analysis to assist country teams identify and communicate sustainable management and conservation strategies for BGBD. Could be straight CBA. Could integrate case study 2 findings, etc	Input into identification of sustainable management and conservation strategies for BGBD	All teams	October 05-end of Phase 2
JC / JJR visits countries to help them with methods training, case study two and management analysis, etc. Possible visits from E.B. or other ecologists may be requested.	Direct support from global office for teams that request it.	JC / JJR with support from DO	On going after Sept 05
Bi-annual meetings for economists and ecologists to advance understanding for case study two and other studies.			March 06

KG: Ken Giller, AMI: Anne-Marie Izac, JB: Josh Bishop

RESOURCES:

- JC's time for project – 25% of his time + travel, to support teams and visit them throughout the year with initial focus on Uganda, Kenya, Cote d'Ivoire. Needs for Mexico and Brazil will depend on economist. Travel/assistance to India and Indonesia to be determined.
- Time for DO, beyond current contract (4 days remain on contract after AM). In next nine months require time to:
  - Email follow up from AM with teams, Mexico econ — 1 day
  - organize brain-storming, if in France — 2 days
  - attend brain storming, — 3 days
  - write up session with JC — 2 days
  - input on RIT econ lit review — 1 day
  - prepare workshop (with JC and global office), — 3 days
  - revise guidelines for literature review (with JC) — 1 day
  - assist in developing primer, — 1 day
  - workshop — 5 days
  - draft with JC methods manual. — 5 days
- Travel and logistics costs (and time?) for brain storming meeting (8-10 people max). Travel costs minimized by meeting in France? (2 from Nairobi, 2 from LA,

2 from France, JO from UK, possible Ken and Josh from Netherlands/CH, JR from US or Nairobi.

- Workshop in India/Mexico in September for 14 country members + MJS, E.B., S.N., DO, RC, JA, JC + possible KG, JB or other economists.
- Circulation costs of journal articles used in Primer. Might have to purchase or subscribe to key journals.
- Bi-annual economists team meeting (April 06, Sept 06). Could plan around next AM.

Session 17; project ideas and plans for the second phase

A framework for developing plans for the second phase of the BGBD project

Jeroen Huising

OBJECTIVE FOR 2ND PHASE

The objectie for the second phase is to demonstrate that by appropriate **management** of (above- and) below-ground biota, optimal conservation of biodiversity for **national and global benefits** can be achieved in mosaics of land-uses at differing intensities of management and furthermore result in simultaneous gains in **sustainable agricultural production**

The further plans for the second phase regarding the **alternative land use and management practices** that we want to demonstrate or experiment with will have to fulfil the following criteria :

- The plans need to be relevant from farmer's perspective
- Feasible
- Provide prospect of benefits (in economic terms or to improve livelihood)

The plans should be based on a sound **diagnostic and problem identification** rather than on scientific interest. This requires: for this purpose we need to

- Establish environmental profile/ assess status of ecosystem services
- Translation of results from phase 1

The second would feed into the first task. The inventory of the first phase should help us to select the relevant land uses, the relevant management practices to consider maybe, the farmer groups to be targeted, etc.

THE QUESTIONS

We need to answer the following questions in developing further plans (and these question should be answered in the proposals put forward):

- **What** is it that we want to do. This does not only relate to the activity (e.g. use of inoculants) but also to the purpose. Other way of putting it is 'what' do we have (referring to the inventory), 'so what' (is it a problem) and 'now what' (what are we going to do about it)
- **Where** do we want to do it (referring to the management unit [farm, protected area, other], scale aspects)
- **How** are we going to do it (which methods and techniques are we proposing and how does this relate to existing management practices)
- **Who** is going to do it and for **whom** (farmers, other stakeholders, scientific interest – stakeholder inventory)

THE WHAT QUESTION

Let's go a it further into the "what" question. What we should do at least is things that we have not addressed during phase 1. Topics not properly addressed so far:

- Indicators of soil biodiversity loss
- Soil Biological Quality Indicators

We aim to experiment with alternative management practices. But what will be the purpose of this intervention? The direct aims may be to improve soil structure but the question will remain for what purpose or larger objective. So what is the impact we hope to generate. The objective or purpose may refer to (and these should be clearly stated in the proposal). The purpose should have a clear link to the perceived major problems in the area.

- Rehabilitation of **degraded lands**
- Improving **crop production**
- Improving **food security**
- Protecting **water resources**

Once the objectives are determined we want to consider our **approach** to achieving these objectives. It is clear that the approach has top deal with **conservation and sustainable management of BGBD.**

So What we want to do? To cconserve and enhance both above- and below-ground (components of) biological diversity for improving **ecosystem services** (environmental benefits); agro-ecosystem management

Biological control of Pest and Diseases

- Improvement of **soil structure and associated water regimes** through the activity of soil fauna and microbial regulation
- Reduction of green house gas emissions and increased soil **carbon sequestration** due to improved regulation of decomposition processes
- Restoring and maintaining **soil fertility and associated crop production** (increased efficiency of nutrient cycling through microbial regulation)

THE 'WHERE' QUESTION

SCALE LEVELS AND GRADIENTS; HIERARCHICAL MANAGEMENT OF SOIL BIOTA

Where? At which scale levels do gradients in BGBD and land use intensity occur and where (at what level) to intervene. Things to consider:

- Preservation of key land uses (e.g. forest patches, **landscape elements** like hedges); Land use mosaics (conservation biology)
- **Farm gradients &** diversity at farm level. Allocation of resource at the farm (maintaining and improving productivity at farm level; rehabilitating degraded lands?)
- **Plot level diversity** (Integrated pest management)

We have to realize that the entities on the one level provide the context for the observation on the next lower level. E.g. when we want to establish BGBD at plot level we have to realize that these fields are managed within the context of the farm and that we are dealing with farm gradients as such. The same applies to the farm level. We have to account for that in the evaluation of the results but also in the planning of experiments and demonstration.

***Figure 1**. Hierarchical management of soil biota (Swift, 1998)*

1. CROPPING SYSTEM LEVEL
Choice of plants
Genetic manipulation
Design in space and time
Micro-symbionts & Rhizosphere
2. SOIL MANAGEMENT LEVEL
Organic matter inputs (RQ)
Mineral Fertilisers & Amendments
Tillage, Irrigation
3. KEYSTONE BIOTA LEVEL
Macrofauna
Biological control agents
Chemical manipulation

THE HOW QUESTION; METHODS AND TECHNIQUES

How to improve diversity and enhance ecosystem services?

- ***Direct*** manipulation, e.g. re-inoculation with desirable indigenous organisms, (such as N2-fixing bacteria or agents for biological control of plant disease which have been lost as a result of intensification methods.

- *Indirect* manipulation of the cropping system (e.g. by choice of plants, the cropping pattern in time and space, or management of organic inputs)

FUNCTIONAL PROPERTIES OF BGBD

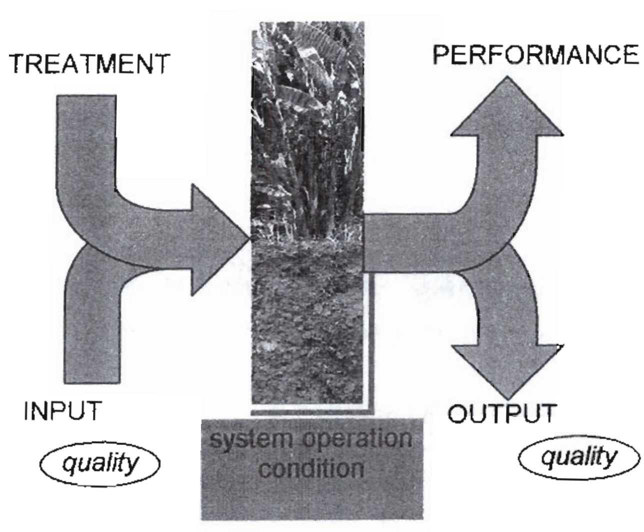
Changes in the below-ground biodiversity are often thought to track those of plants, although there is evidence that the soil community may be more functionally resilient than the above-ground biota (Giller *et al.*, 1997). As land conversion and agricultural intensification occur, the planned biodiversity above-ground is reduced (up to the extreme of monocultures) with the intention of increasing the economic efficiency of the system. This impacts the *associated* biodiversity of the ecosystem eg., micro-organisms and invertebrate animals both above- and below-ground thus lowering the biological capacity of the ecosystem for self-regulation and hence leading to further need for substitution of biological functions with agrochemical and petro-energy inputs. Equivalent effects have been observed in intensive cattle pastures (Lavelle *et al.*, 1999). The sustainability of these systems thus comes to depend on external and market-related factors rather than internal biological resources.

We may want to consider looking t relevant threshold in evaluating the loss of BGBD (or for that matter the improvement of BGBD to enhance services). For that we have to consider the objective function. From the text above were can distill that this may be restoring the self regulating capacity, which is different from improving ecosystems services (like improved production). Since all these may be difficult to establish we could restrict ourselves to the 'functional performance' (e.g. looking at effect on soil structure and establishing which organisms contribute to this). This also has implications for the where and how questions.

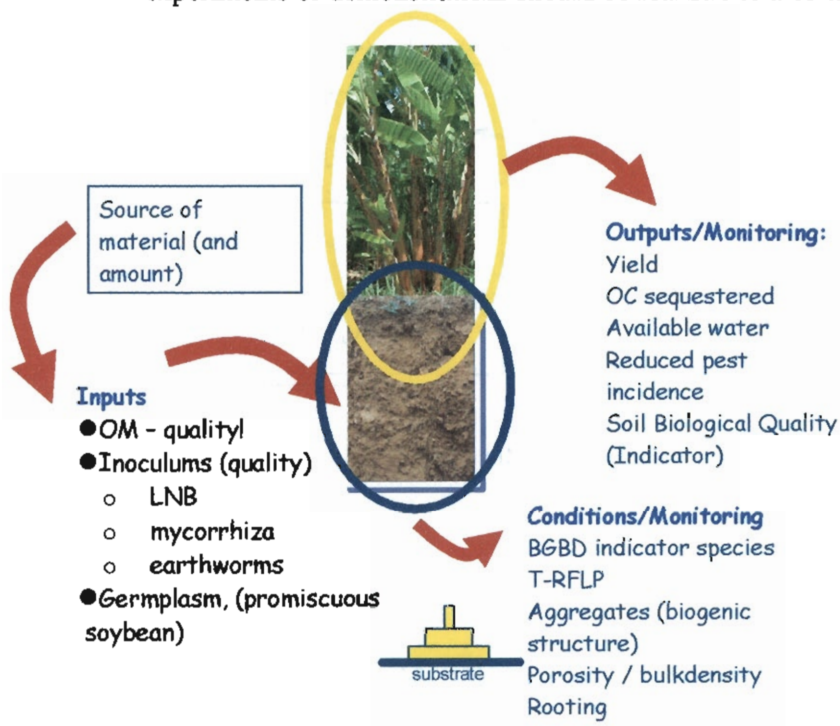
- Self regulating capacity
- Ecosystem services
- Functional performance

THE SET-UP OF EXPERIMENTS OR DEMONSTRATIONS

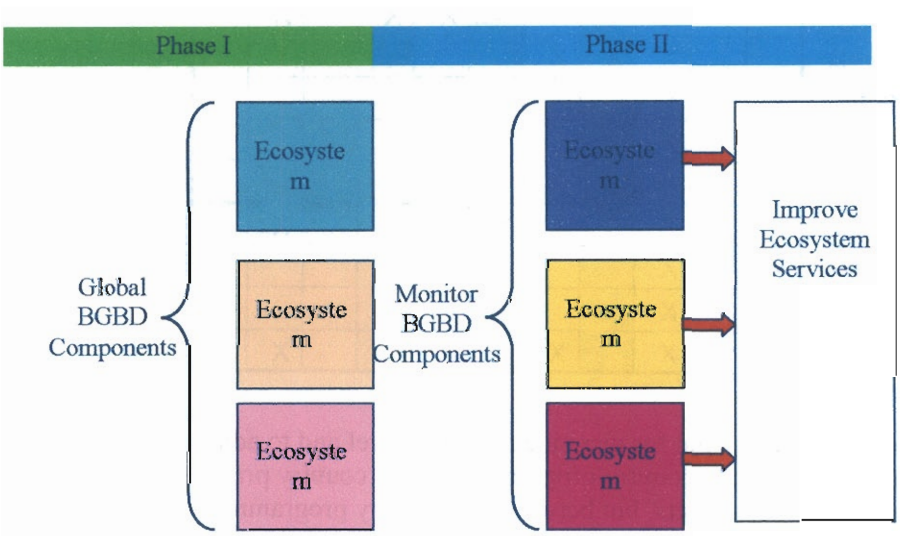
The experiments or demonstrations have different components or aspects, as indicated in the figure below, that need to be addressed. It operates like a system. Outputs will be generated but we also want to monitor the performance referring to the objective and purpose mentioned before (how does the output contribute to the achieving the objectives. Also indicated are aspects of quality, not implying that we should experiment with different qualities of inputs, but that we should be aware of the quality of the inputs and of the outputs. For example when experimenting with organic matter management we should be aware of the quality of the organic matter inputted to the system (that is e.g. the quality of the organic resource available in the area). The terms condition an quality are used very much as they are applied in soil science with quality always referring to the performance or aptitude of the certain resource for a certain function or use.



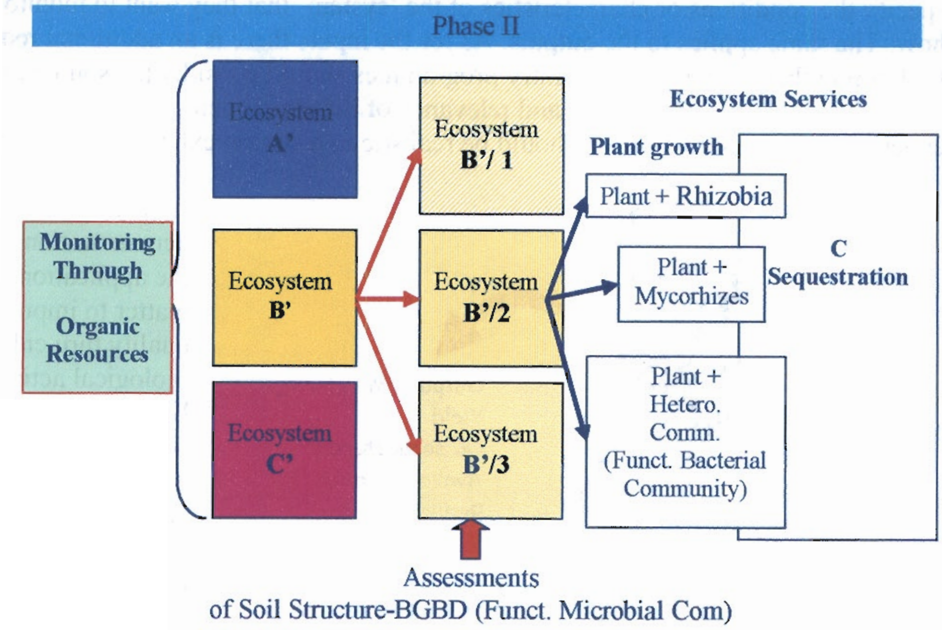
At the same time we want to monitor the condition of the system (e.g. soil). Options are given in the figure below. This may for example include looking at food web structure. In many case we will have to resort to the use of indicators for the monitoring and this still fits nicely with the defined project objectives (to defines and test indicators). Country Programmes have to specify the conditions or characteristics of the 'system' that they want to monitor and how. The same applies to the outputs. As for the inputs there is an additional requirement. In defining their experiments country programmes should consider the source of material input, in view of the availability and relevance of the experiment. As indicated before the experiments or demonstrations should be realistic to a certain extent and provide prospect possible benefits for the farmer. If for example the demonstration concerns the application of organic matter to improve soil quality thru enhanced biological activity it may be wise to investigate to what extent these organic resource are available within the area in relation to the quality and quantities needed if these techniques would be adopted by larger groups of farmers. An **ex-ante economic assessment should therefore be part of the proposal** to provide justification for the selected techniques or interventions (indication of relevance)



So the general concept is that in phase 1 we have assessed the BGBD components of the various ecosystems and that in the second phase we are going to intervene in these various ecosystem to improve the ecosystem services and that we will monitor the BGBD component while doing so.



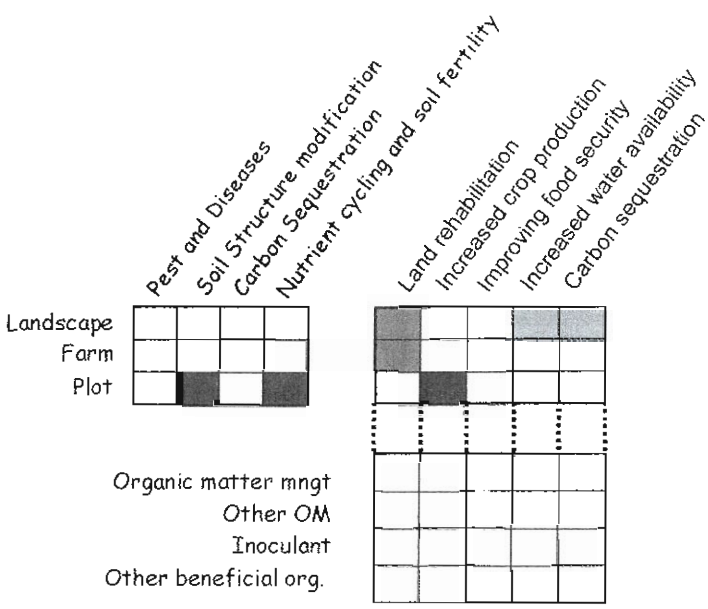
A more specific elaboration of the above scheme would be one as presented below, which is a proposition that was developed in discussion with IRD-CIRAD. In this case we target enhance carbon sequestration through providing organic resources as amendments to the soil. The functional bacterial community will be assessed and monitored together with other parameters like plant growth or functional characteristics like decomposition of organic matter. The point to stress here is that we will have to consider capacity available in the country programmes and that the country teams should establish partnerships with organizations that have the comparative advantage in investigating particular aspect of the experiment.



Of course the farmer should not be forgotten.

	Landscape analyses	Scale aspects of BGBD	Indicators of BGBD loss	SBQI	Socio-ecology	Near Infrared Spectrometry	Economic valuation	Land rehabilitation	Increased crop production	Improving food security	Increased water availability	Carbon sequestration
Brazil	X		X	X			X		X		X	
Cote d'Ivoire - Oume	X	X	X			X	X		X			X
Cote d'Ivoire - Tai												
India NDBR	X		X		X		X	X		X		X
India NBR Kerala			X	X	X							X
India NBR Karnataka	X		X		X		X					
Indonesia Sumberjaya	X		X				X					
Indonesia Jambi	X		X									X
Kenya - Embu	X		X			X	X		X	X		
Kenya - Taita	X		X			X	X	X				
Mexico	X	X	X			X	X				X	
Uganda	X	X	X		X		X			X		

Above a matrix is given as an aid for planning at global level and to address complementarities between the country programmes. Each country programme is not expected to address all the subjects, but between the country programmes all topics should be addressed in such a way that we have at least a few 'replications'. Each topic should a t least be addressed by two or three country programmes.



The matrices to the left may further assist in this task. Country programmes are requested to fill n these matrices to give a clear idea of what the programmes intend to undertake and to allow to evaluate whether we a re addressing all relevant topics between the CPs as a project.

Phase II - Brazil

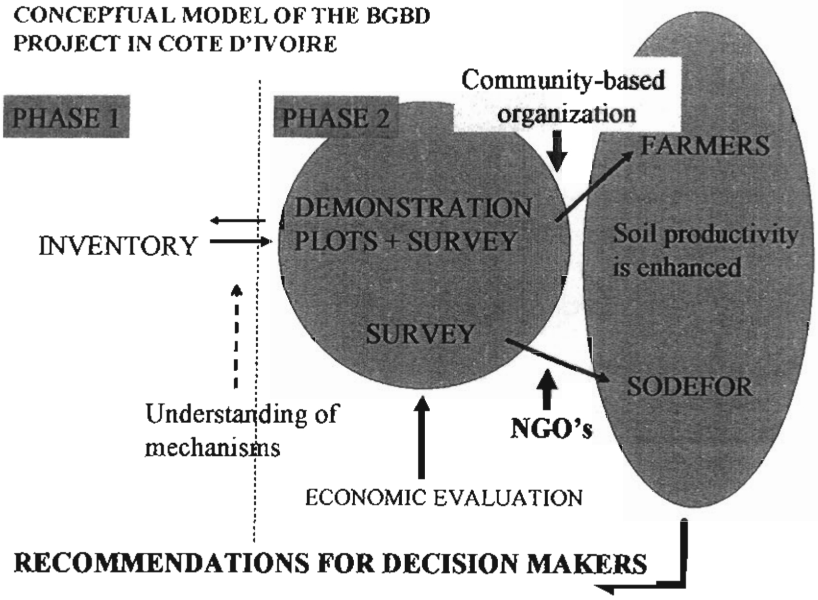
- Soil Limitations
- P defficiency (recycling agriculture and other residues)
- High Al contents (Al availability?)
- Soil physical characteristics (parent material? If not – rehabilitation by managment of soil macrofauna)
- Soil aggregation (polissacarids, glomalin)
- BNF, AMF inoculation
- Gas Emission (CO2, CH4 and N2O)
- Seed bank
- Litter Decomposition
- T-RFLP overall assessment of Prokaryotes diversiy (also Eukaryotes?)
- Biological Control of Pest and Diseases

Project ideas for Phase 2; Ivory Coast

- **Biogenic structures to be studied** (preliminary observations have been made for earthworms)
- **Interaction between soil functional groups to be point out** (some trends appear with the preliminary results: e.g. earthworms and Nematodes, termites (humuvorous) as bioindicators
- **Ecosystem services to be measured** (clear idea will be identified after this AM05 and a national short workshop team back home)
- **Monograph of species from different functional group which are relevant to sustainable management of soil**

BGBD MANAGEMENT PRACTICES

Land use systems that preserve BGBD seem to be in our case Multispecific Tree and Cocoa plantations. Regarding these preliminary results, discussion with farmers and National forest Agency (SODEFOR) will be conducted during next weeks, and demonstration plots set-up. Survey of BGBD and sensibilisation of farmers will be undertaking



- Economic evaluation of ecosystem services (soil structure and water service)
- BGBD management practices (demonstration sites/systems selected regarding the results of the phase 1): cocoa+fast growing legume trees, legume cover crops+ mixed crop fields, survey of ecosystem services in reafforestation plots.
- National workshop to be held to finalized our plan

India- way forward

OUTCOME 1. INTERNATIONALLY ACCEPTED STANDARD METHODS FOR CHARACTERIZATION AND EVALUATION OF BGBD INCLUDING A SET OF INDICATORS FOR BGBD LOSS

OUTCOME 2. INVENTORY AND EVALUATION OF BGBD IN BENCHMARK SITES REPRESENTING A RANGE OF GLOBALLY SIGNIFICANT ECOSYSTEMS AND LAND USES

More detailed studies on population dynamics and taxonomic/functional diversity of soil biota in' belowground biodiversity hotspots' (viz. homegardens, trench systems, compost pits and irrigated terraced slopes close to the dwellings) in the selected biosphere reserves (Two Benchmark sites) following a purposive sampling design- food web approach.

Finding out the relationship between the organisms valued by local people (e.g., oak trees in forests, a variety of agroforestry tree/shrubs/herbaceous species (16 species in the study area), pulses (10 pulses grown in the region with a large number of local cultivars), earthworms, grubs with the organisms/their functions not known to them (e.g., mycorrhizae, rhizobia, micromorphology and overall soil fertility).

- Are all pulses equally effective across the altitudinal and soil fertility gradients?
- Does intermixing of leguminous crops/trees with major crops lead to positive interactions or does it lead to competition?
- Do some agroforestry tree species support higher abundance and diversity of mycorrhizae and other beneficial organisms?

- Do traditional management practices such as maintenance of naturally regenerating grasses on terrace margin/risers and cutting during rainy season but not winter season favour beneficial soil biota over harmful ones? Identification of threshold and critical level may help for management options.
- Do traditional methods of incorporation of foliage favour beneficial soil biota and soil fertility? Can we improve this traditional practice?
- Whether improved soil and water management practices in oak and teak, which are showing poor productivity would favour beneficial soil biodiversity?
- Does traditional fallowing (during winter season every alternate year) favours beneficial soil biota over harmful ones (white grubs)?
- To strengthen country capacity in respect of molecular level characterization of belowground diversity and its applications for developing sustainable landscape management practices.

OUTCOME 3. SUSTAINABLE AND REPLICABLE MANAGEMENT PRACTICES FOR BGBD CONSERVATION IDENTIFIED AND IMPLEMENTED IN PILOT DEMONSTRATION SITES

- Operationalization of a network of participatory landscape scale research and management – presently participatory research principles, by and large applied to forest management.
- *Test the hypothesis that use of oak forest based manure enables higher crop yields together with conservation of forests/meadow and enhancement of belowground diversity and its functions compared to the use of pine forest based manure – insights based on the chemical analysis of litter quality, traditional manure preparation technology and other farmers practice.*
- *Test the hypothesis that retention of some branches of agroforestry in winter season will improve conservation of belowground biodiversity and its functions to the benefit of both local farmers and global communities-insights based on experiments carried out on varied lopping regimes on crop yields.*
- *Test the hypothesis that manipulation of native earthworm community composition and abundance will be a more efficient way of managing soil fertility than the prevailing techniques of vermicomposting and traditional manure applications – mulching, trenching etc – insights based on the past experiments and inventory results.*
- *Establish long-term participatory integrated nutrient management/integrated pest management experiments including a pure organic farming treatment – site characterization results show very high crop yields in a few traditional organic farms.*

OUTCOME 4. RECOMMENDATIONS OF ALTERNATIVE LAND USE PRACTICES AND AN ADVISORY SUPPORT SYSTEM FOR POLICIES THAT WILL ENHANCE CONSERVATION OF BGBD

OUTCOME 5. IMPROVED CAPACITY OF ALL RELEVANT INSTITUTIONS AND STAKEHOLDERS TO IMPLEMENT CONSERVATION AND MANAGEMENT OF BGBD IN A SUSTAINABLE AND EFFICIENT MANNER

- **On-site training workshops involving policy makers and managers**
- **Scientific back up for organic farming policies**

Workplan for Conservation and Sustainable Management of Below-ground Biodiversity (CSM-BGBD) Project Indonesia Phase II

ACTIVITY	RESPONSIBLE[1]	Ref. #
0. MANAGEMENT		
- MOA agreed and signed	M. UTOMO	1
- National workshop (start-up)	S. MURWANI	2
- National workshop (evaluation)	S. MURWANI	3
- Visit of national advisers	S. MURWANI	4
- Working group coordinator meeting (monthly)	FX SUSILO	5
- Progress Report to UNEP/GEF via CIAT-TSBF	FX SUSILO	6
- Financial Report to UNEP via CIAT-TSBF	I G SWIBAWA	7
1. OUTCOME 1		
2. OUTCOME 2		
2.1 Site selection and characterization.	-	
2.2 Inventory (BGBD monitoring & bioindicators)		
b. Carry out inventory 3rd round	A. KARYANTO	8
c. Specimen identification	A. KARYANTO	9
c. Report inventory	A. KARYANTO	10
2.3 Database		
e. Incorporate of national database to global database	AFANDI	11
f. Maintain and update national database	AFANDI	12
2.4 Management	FX SUSILO	13
3. OUTCOME 3		
3.1 Baseline survey (socio-economic & management practice) (Economic valuation Case II: AMF)	BUSTANUL	14
3.2 Baseline impact assessment		
3.3 BGBD Management Practices		
a. Represent BGBD project in watershed forum and farmer groups (Sumberjaya)	PITOJO	15
h. Conduct farmer's experimentation and demonstration	RUSDI	16
i. Report results of the experiments (BGBD conservation/ecosystem services, farmer's acceptability)	RUSDI	17
c. Management	FX SUSILO	18
4. OUTCOME 4		
c. Keep constant dialogue with decision makers and stakeholders about the project through out the five years	PITOJO	19
-- with Environmental Commission in the House of Representative -- with Local (provincial and district) Planners Agency (BAPEDALDA) -- with Local (provincial and district) Forestry Division -- with Local (provincial and district) Agriculture Division -- with universities -- with research institutes -- with NGOs / farmer groups	PITOJO	
d. Keep diary of all contacts with decision makers through out five years of	PITOJO	20

[1] Abbreviations: C = National Convenor; DC = Deputy Convenor; SFO = Secretary/Financial Officer; L = Logistics; A. KARYANTO = National WG1 Coordinator; AFANDI = National WG2 Coordinator; RUSDI = National WG3 Coordinator; PITOJO = National WG4 Coordinator

project		
e. Develop webpage, color brochures, video, and articles aimed at different stakeholder groups (including materials)	PITOJO	21
f. Document evidence of adoption of practices by landholders at project sites	PITOJO	22
g. Develop guidelines and make recommendations on conservation of BGBD and well as scientific synthesis of project findings	PITOJO	23
h. Management	FX SUSILO	24
5. OUTCOME 5		
5.1 Academic Capacity Building (MS, PhD, Technical etc)		
b. Finish Ph.D training in nematology	I G SWIBAWA	25
c. Finish Ph.D training in soil macrofauna	W.S. Dewi	26
d. Finish MS training in termite	F.K. Aeny	27
e. Finish MS training in soil macrofauna	Sri Rahayu	28
f. Finish Ph.D training in BGBD bio-indicator / modelling	Luth	29
5.2 Other Capacity Building		
a. AMF mass-production training at farmer level	PITOJO	30
5.3 Management	FX SUSILO	31

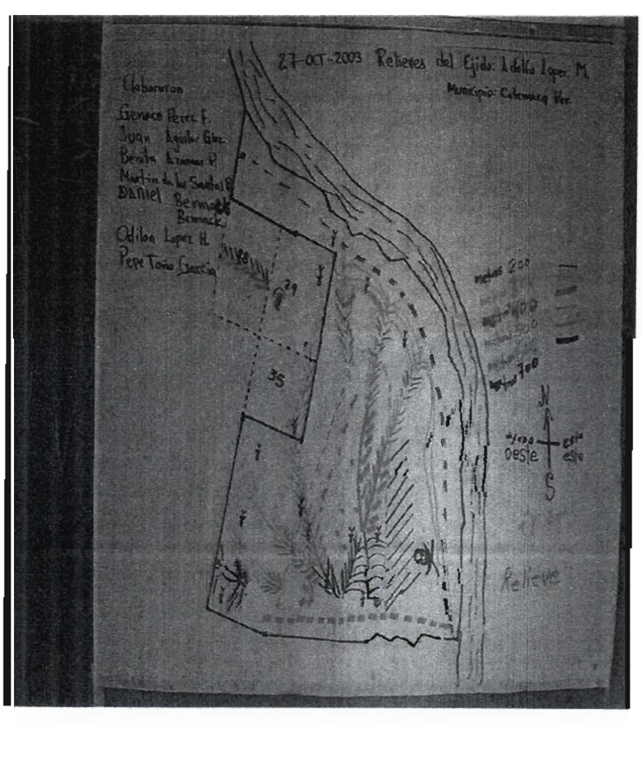
PARTICIPATIVE STRATEGY TO PROMOTE BGDB MANAGEMENT IN MEXICO

Tajín Fuentes and Isabelle Barois

November 2003 Participative Rural Appraisal (PRA) were conducted in the three communities

- Information about stakeholders, socio-environmental and productive systems to allow the inventories, was generated in a participative way, with farmers and community authorities

PRA lead to identify some problems and issues relevant to farmers, related to soil



- López Mateos community requested the information about BGDB to be return in form of a didactic museum, so they can deliver a better information on Los Tuxtlas environment to their ecotouristic visitors.
- Venustiano Carranza community asked BGDB project to find out about problems of lily production, due possibly to soil poverty or pests.
- San Fernando has Camedor palm nurseries requested training on vermicompost production.

April 2004 PRA continued…

- Semi structured interviews with owners of plots where BGDB samples were taken.
- Information on points and plots land use history was gathered.

- As well as today productive practices.

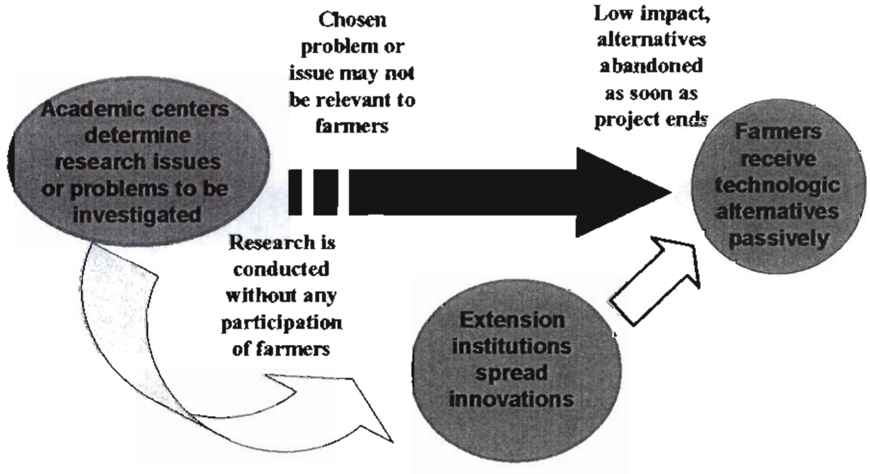
Since early 1990'several programs and projects promoted diverse alternative technologies to soil management and conservation (i.e vermicompost, cover crops and green manure)

Low impact achieved in the long term, despite training, and financial support

September 2003 BGDB in Mexico and Red a.c elaborated a joint initiative to promote local actors participation in the project

- Red de Estudios para el Desarrollo Rural (RED a.c.) is a mexican NGO specialized in participative methodologies to work with farmers, on investigation and extension topics related to technologic development in agriculture.
- General objective of the strategy is to promote an alternative scheme to generate and spread knowledge on BGDB in order to solve some of the limitations of conventional research and extension process

Conventional research - technology generation – and extension of innovations for agriculture process



PHASE II

Promoting BGBD sustainable management, through farmers research

- Farmers research is a process and a mechanism to contribute to materialize a new distribution of responsibilities between actors.
- Does not exclude formal research protocol and methodologies, it looks for building bridges between local and scientific knowledge to generate new alternatives
- This approach implies to share the control and agenda about alternatives to work on and information spread process

Participative strategy in this phase will engage stakeholders at several levels:

- Farmers and communities were samples were taken.
- Farmers from productive organizations.
- NGO's
- Academic centers
- Government institutions and instances responsive of public policy toward soil in the region.

STAKEHOLDERS DIRECTLY ENGAGED WITH BGDB PROJECT AT THE THREEE COMMUNITIES

Stakeholder	Cooperation with BGDB
Collaboration at the three communities	
Los Tuxtlas Biosphere Reserve, trough Integral Ecosystem Management (MIE) project	MIE is a GEF-PNUD project , collaboration specifically trough Environmental education project.
Red de Estudios para el Desarrollo Rural	Training on participative approaches.
CECITEV–Pajapan Technological education institution of the region, with soil fertility career	interested in a collaboration agreement to train students in participative methodologies and agronomic issues.
Collaborators at López Mateos	
RECT (Red de Ecosturismo Comunitario).	Communitarian Ecotouristic net work of Los Tuxtlas region, interested in BGDB to enhance information to be delivered to visitors.
Comité de Ecoturismo de López Mateos, "Cielo, Mar y Selva".	Interested in BGDB to enhance information to be delivered to visitors.
López Mateos municipal and ejidal authorities	Through Municipal Sustainable development council.

STAKEHOLDERS DIRETLY ENGAGED WITH BGDB PROJECT AT THE THREEE COMMUNITIES

Stake holder	Cooperation whit BGDB
Collaborators in San Fernando and Venustiano Carranza	
San Fernando municipal and ejidal authorities	Through Municipal Sustainable development council.
Sierra de Santa Marta Project A.C. NGO working in these communities since early 90's, promoter of PRA exercises	Through our respective projects
SSS Productores de Palm Camedor de San Fernando (only in S. F).	Vermicomposting training

PROCESS TO LAUNCH FARMERS RESEARCH

Present our results to the communities in a simple way

2.- Work with stakeholders on:

1. Lessons of previous experiences related to soil conservation and management (successes and limitations).
2. Analysis of initial project findings: relation between land use intensity and BGDB.

3.- Select and conduct BGDB management experiments and demonstrations in sampled sites and other places suitable to achieve broader impacts; i.e. nearby communities, at request of farmers organizations and NGO's .

4.- Implement and monitor experiments that will be carried out by Farmers organizations, NGO's, and BGDB researchers.

SOME BGBD EXPERIMENTAL MANAGEMENT PRACTICES TO BE IMPLEMENTED MIGHT BE:

- Mycorrhiza
- Antagonistics microorganisms
- Earthworm
- Vermicompost
- Green manure

One or the combinations of these practices could be experimented in different crops, such as lily and maize. Compost or vermicompost and micorrhiza could be used in seedlings of Camedor palm, coffee and trees.

- End the Inventories
- Analyze the data : find out bioindicators groups
- Write papers
- Do study case 2 for economic valuation of BGBD (SSM/Water)
- Reinforce our links with policy makers

Kenya: Management of BGBD for sustainable ecosystem structure and services for enhanced agricultural productivity

James H.P. Kahindi, Nancy Karanja, Edward Muya, Sheila Okoth, John Kimenju, Beneah Mutsotso, Joyce Jefwa, David Odee and Joshua Ramisch

INTRODUCTION

Problems at the benchmark sites leading to food insecurity and poverty :

1. low soil fertility hence low crop yields
2. High incidences of pests, diseases and weeds
3. land fragmentation
4. Poor policy implementation and coordination.

PROBLEM STATEMENT

The critical problems in Embu and Taita Taveta are :

- low soil fertility, low pH and high exchangeable acidity and Al
- low water-holding capacity of some soils with very compact B-horizon
- High land fragmentation making it increasingly difficult to break even with the application of the current technologies.
- High rates food insecurity and poverty,

BROAD OBJECTIVE

Sustainable management and utilization of BGBD for improved livelihoods i.e. to promote the application and adoption of suitable land-use and management practices that facilitate conservation and restoration of BGBD.

SPECIFIC OBJECTIVES

- To identify and demonstrate integrated best-bet soil fertility management practices for improved soil structure, nutrient availability and water use efficiency.
- To identify and demonstrate appropriate IPM approaches.

- To increase agro-biodiversity in order to restore and conserve BGBD.
- To empower farmers, local groups (children, youth, self-help groups etc) and other stakeholders foe effective participation in BGBD management through public awareness and capacity building.
- To strengthen institutional linkages/partnership for conservation of BGBD.

METHODOLOGY/APPROACHES

SPECIFIC OBJECTIVE 1:

- Characterize soil fertility gradient at farm level and identify lime requirement rates
- Investigate the role of soil aggregate turnover in controlling the amount and dynamics of organic matter in the soil and quantify the reciprocal effects on organic matter decomposition
- Development appropriate outreach systems to farmer groups for improved fertility management and soil biodiversity conservation through active demonstrations, extension, training and technical meetings

SPECIFIC OBJECTIVE 2

- Review existing technologies that would add value in improving below ground biodiversity and agricultural productivity.
- On farm demonstrations plots will be established to compare the selected technologies with farmers' practices.
- Indicator organisms will be monitored to verify the usefulness of best-bet technologies in conservation of below-ground biodiversity.
- Stakeholder workshops will be organized with the aim of sharing experiences and strengthening of institutional partnerships.

SPECIFIC OBJECTIVE 3

- Investigate resistant crop cultivars for use in development of suitable integrated pest management practices.
- Evaluation and demonstration of such cultural practices as crop rotation, multiple cropping, push-pull strategies and safety belts for natural enemies in pest and disease management.
- Use of bio-control agents such as *Trichoderma*, and *Bacillus thuringiensis* to facilitate establishment of natural enemies of pests and diseases.

SPECIFIC OBJECTIVE 4

- Involvement of farmers in selection of farmers to best-bet technologies
- Dissemination of appropriate technologies to stakeholders.
- Training of selected stakeholders

SPECIFIC OBJECTIVE 5

- Organise joint workshops, demonstrations and field days with all stakeholders days
- Production of manuals, newsletters and brochures, farmer exchange visits, farmer field schools and training of trainers.

EXPECTED OUTPUTS

- Dissemination materials on BGBD principles and management.

- Socially acceptable, economically viable and, ecologically sound technologies for BGBD management.
- Empowered farmers, trainers and policy makers.
- Existing partnership and policies strengthened for sustainable management of BGBD.

Data sharing and intellectual property rights

Project Data Sharing and Intellectual Property Rights: The Conservation and Sustainable Management of Below-Ground Biodiversity Project[1]

Peter Okoth

Tropical Soils and Biology and Fertility (TSBF) Institute of the International Centre for Tropical Agriculture (CIAT)

ABSTRACT

The Conservation and Sustainable Management of Below-Ground Biodiversity (CSM-BGBD) Project is a global project being implemented in seven tropical countries by over fifty institutions and one hundred and eighty scientists. It employs the service of scientists spread all over the world including the United States of America, Europe, Asia and Africa. As such it represents quite a wide range of varied interests, backgrounds, knowledge bases and aspirations.

Due this varied diversity; individual scientists, technical advisors, students and other stakeholders in many instances are confronted with challenges and conflicts of interest. One such challenge is the issue concerning data acquisition and use within the project and with other interest groups. Another issue of major of concern touches on intellectual property rights during project execution, data collection and publication of scientific findings. The last issue also touches on soil biota ownership, benefits sharing and intellectual property for scientific findings of hitherto undiscovered soil biota.

This paper tackles issues that create conflict among different project members including: intellectual property, publishing, data acquisition, data custody, and data ownership; the other part deals with biodiversity or genetic material acquisition, collection, transfer, ownership, and finally the position of land owners and rural communities in the project.

The objectives of the paper is to have in place a comprehensive internal policy framework that guides members of the project in issues that deal with intellectual property rights, data ownership, data sharing and scientific publishing. The other objective is to have in the project a reference policy on new scientific discoveries, including rights to the soil biota that is the main theme of the project. The last objective is to ensure that the project produces what is expected of it such as project outputs, reports and other material with less friction and conflict of interest than is currently prevailing.

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[1] Paper presented at the annual meeting of the Conservation and Sustainable Management of Below-ground Biodiversity project in Manaus Brazil (April 11-17th 2005)

The output is a policy guideline that will enable all project participants' position themselves and their interests within the project requirements and their own scientific interests.

1. INTRODUCTION

As a precursor to developing a policy guideline for the project, there are general terminologies and concepts that must initially be sated and agreed upon to guide the process. In doing this, and in order not to reinvent the wheel, this paper borrows extensively from the Alternatives to Slash and Burn (ASB) project policy and other existing guidelines on intellectual property rights. The ASB project is a global project with diverse interest groups like the CSM-BGBD project. According to the ASB guideline, there are 4 key principles that underlie a data sharing policy.

1. Data created with use of public funds should be recognized as a public resource and remain publicly accessible.
2. Quality assurance of scientific data is required for sound decision making.
3. Use of information and communication technologies (ICT) should ensure open access and transparency essential for the effective use of data by researchers and decision makers.
4. Scientific methods need to be documented in order to be replicable.

1.1 DEFINITIONS

1.1.1 Intellectual Property Rights (IPR)

What is Intellectual Property and what does it aim at achieving?

Conceptually, intellectual property dwells around information or knowledge considered to bear a level of 'novelty' or 'distinctiveness'. It is centred on new inventions and the knowledge that goes with it. In order to have rights to such information, the applicant must prove that the information or material being granted intellectual property rights is new and has economic benefits that are attached to it and that can be lost through the disclosure of or sharing of such information. The information so claimed should be in a form that it can be replicated by third parties to produce what the applicant wants to protect. The protection of such information is then provided for through legal patenting or protection depending on its classification and content. Intellectual property right rights are normally granted to reward the originator of the knowledge for the time spent, mental indulgence and resources used to generate the new knowledge and are normally for a fixed period of time.

Copyrights... Copyright rules give the holder some exclusive rights to control some reproduction of works of authorship, such as books, and music, for a certain period of time.

Patents... Give the holder an exclusive right to prevent third parties from commercially exploiting an invention for a certain period, typically 20 years from the filing date of a patent application.

Trademarks... These are distinctive names, phrases, designs, or marks used to identify products o consumers.

Trade secrets... This is where a company keeps information secret, perhaps by enforcing a contract under which those given access to information are not permitted to disclose it to others.

These rights normally conferred by law, can be given, sold, rented (called 'licensing') and in some countries, even mortgaged, in as much the same way as physical property (especially real property). However, the rights typically have limitations, sometimes including term limits and other expectations (such as fair use for copyright works). These limitations are sometimes analogous to public easements, they grant the public certain rights which are considered essential.

It is important to understand that it is the rights that are the property, and not the intellectual work they apply to. A patent can be bought and sold, but the invention that it covers is not owned at all. For this and other reasons, some people think that the term intellectual property is misleading, some use intellectual monopoly because such so called 'intellectual property' is actual government granted monopoly.

In recent times intellectual property rights (IPR) is being extended to living organisms such as plants and animals unique to specific regions, countries or communities (Mugabe et al, 1996; Mugabe, 1999; and Mbote and Cullet, 1999). In the CSM-BGBD project IPR could emanate more form the discovery of new organisms with trade or commercial value and such making the individuals or communities responsible for its discovery demand intellectual property rights for the discovery. In such an event, there are several parties that are directly entitled to a claim the rights. The rights first goes to the project itself and the coordinator of the project must be joined in the IPR application. The other parties include the Donor organizations and the other sponsoring institutions. The individual scientists who participated in the discovery also have a direct claim to the IPR. This creates a win-win situation with no aggrieved parties. A memorandum must be signed detailing the rights and royalties that accrue to each party applying for the IPR. Proper legislation must be invoked and the application tabled to relevant institutions (national or internal that confer such rights).

1.1.2 COLLABORATIVE RESEARCH

The collaborative model of doing research involves a lot of different national and international partners. To be effective, this mode of research requires close sharing of data in various forms including raw data, processed data, analyzed data, meta data and published information. A project such as the 'Conservation and Sustainable Management of Below-Ground Biodiversity (CSM-BGBD), is considered to be a collaborative research involving many interest groups and donor communities.

1.1.3 GENERAL PROJECT CONCEPT

A project such as the CS-BGBD is compounded into three parts. The parts include (i) the project character, (ii) the project interest groups, and (iii) the project handlers.

The Project Character

The project character is considered to be the discernable components with which the project can be identified and evaluated. The components of the project character include:

Image... This is how a project presents itself to external or internal view, whether to members of the public, customers, service providers, reviewers or to any other parties including participating members in the project.

Substance... The project substance includes, the project proposal, the data generated, articulated methods, the results, and the message the project produces for its beneficiaries. Participating members of the project are also considered to form the project substance both in terms of intellectual quality and capacity to carry out the project successfully to its final conclusion.

Project Output... The project output includes, reports, articles (published and unpublished), brochures, fliers, books, databases, websites, synthesis papers, reviews, etc.

Project Impact... The project impact is considered to be the intangible and tangible consequences caused by it outputs and activities. The impact of the project is normally felt by third parties who the project considers to be their direct beneficiaries and general members of the public.

Project Interest Groups

A project such as the CSM-BGBD project has a long list of interest groups. The groups and their areas of interest are described in the following subsections:

Individual Researchers... These are the individuals with the technical know-how and play lead positions and are as such the executioners of most parts of the project. These individuals are normally rewarded either through direct payments for their efforts or through intellectual fulfilment they derive by participating or publishing when participating in the project.

Field and laboratory technicians... These are individuals who provide data collection services to the project in paid capacity or as students who are able to publish academic degrees or diplomas from the project.

Biometricians... These are normally participants who support the project to produce information that can be converted to knowledge through accepted statistical analysis, organisation of the data or otherwise by participating in project design and data collection strategies.

Involved communities (farmers and others)... These are normally the people who are to be affected directly by the activities of the project. They include rural communities, and farmers who directly derive benefits or promised benefits from the project. They own the piece of land where the project carries out its activities and could be considered to be co-financiers of the project by contributing their land and allowing free access for project purposes.

Funding agencies and donors... These are individual governments, non governmental organizations, United Nations agencies and bodies and other parties that have agreed to invest public or private money to enable the project realise its objectives. The funding bodies are normally interested in the promised outputs and outcomes of the project. They use the outcomes to justify their investment of their time and financial resources in the project. They sometimes demand that their investments are paid back by royalties or intellectual property rights emanating from the project.

Participating institutions... These are institutions that are either interested in the outcomes of the project because they have invested their personnel, resources or intellect into the project. They gain through enhanced capacity for their staff, royalties, or any other tangible or intangible benefits that could accrue from the project.

General public... Members of the public are the tax payers who are responsible for indirect investments into the project. They can sometimes question the rational or beneficial gain arising from financing certain projects using their tax money. They influence the politics of many governments and funding agencies. Sometimes members of the public participate in project as private companies by directly contributing project funds or even participating in some project activities.

The project itself... The project has its own calendar and plan of work and expected outputs that it must meet in order to be judged as being a successful project. It therefore has an interest in itself by setting milestones; ensuring that activities go on uninterrupted, conducting internal and external reviews and producing expected outputs. The project's survival and continuation is therefore based on these cardinal concerns that put it in its forward motion.

The Project Handlers

The project handlers are individuals or groups of individuals that assist the project to meet its goals and achieve its objectives. They may include a project director, a project manager, a project coordinator, etc. These individuals normally work with committees that assist them set or reset goals or boards that oversee their work. All in all, the project handlers oversee all aspects of the project and ensure that all interests are taken care of.

The give a project its character and are considered to provide the direction for successful accomplishment of the project. They normally protect the interests of all the interest groups and participants in the project including those who collaborate with the project.

2. DATA AND INFORMATION SHARING

The following definitions from Bellinger, et al, 2004, highlights the definitions of data, information, knowledge and wisdom which are important entry points to the policies suggested in this paper. According to Ackoff, 1989, the content of the human mind can be classified into five categories:

1. **Data**: symbols
2. **Information**: data that are processed to be useful; provides answers to "who", "what", "where", and "when" questions
3. **Knowledge**: application of data and information; answers "how" questions
4. **Understanding**: appreciation of "why"
5. **Wisdom**: evaluated understanding.

Ackoff indicates that the first four categories relate to the past; they deal with what has been or what is known. Only the fifth category, wisdom, deals with the future because it incorporates vision and design. With wisdom, people can create the future rather than just grasp the present and past. But achieving wisdom isn't easy; people must move successively through the other categories. A further elaboration of Ackoff's definitions is as follows:

Data... data is raw. It simply exists and has no significance beyond its existence (in and of itself). It can exist in any form, usable or not. It does not have meaning of itself. In computer parlance, a spreadsheet generally starts out by holding data.

Information... information is data that has been given meaning by way of relational connection. This "meaning" can be useful, but does not have to be. In computer parlance, a relational database makes information from the data stored within it.

Knowledge... knowledge is the appropriate collection of information, such that its intent is to be useful. Knowledge is a deterministic process. When someone "memorizes" information (as less-aspiring test-bound students often do), then they have amassed knowledge. This knowledge has useful meaning to them, but it does not provide for, in and of itself, integration such as would infer further knowledge. For example, elementary school children memorize, or amass knowledge of, the "times table". They can tell you that "2 x 2 = 4" because they have amassed that knowledge (it being included in the times table). But when asked what is "1267 x 300", they can not respond correctly because that entry is not in their times table. To correctly answer such a question requires a true cognitive and analytical ability that is only encompassed in the next level... understanding. In computer parlance, most of the applications we use (modeling, simulation, etc.) exercise some type of stored knowledge.

Understanding... understanding is an interpolative and probabilistic process. It is cognitive and analytical. It is the process by which previously held knowledge can be synthesized and added to new knowledge to create further knowledge. The difference between understanding and knowledge is the difference between "learning" and "memorizing". People who have understanding can undertake useful actions because they can synthesize new knowledge, or in some cases, at least new information, from what is previously known (and understood). That is, understanding can build upon currently held information, knowledge and understanding itself. In computer parlance, Artificial Information systems possess understanding in the sense that they are able to synthesize new knowledge from previously stored information and knowledge.

Wisdom... wisdom is an extrapolative and non-deterministic, non-probabilistic process. It calls upon all the previous levels of consciousness, and specifically upon special types of human programming (moral, ethical codes, etc.). It beckons to give us understanding about which there has previously been no understanding, and in doing so, goes far beyond understanding itself. It is the essence of philosophical probing. Unlike the previous four levels, it asks questions to which there is no (easily-achievable) answer, and in some cases, to which there can be no humanly-known answers period. Wisdom is therefore, the process by which we also discern, or judge, between right and wrong, good and bad.

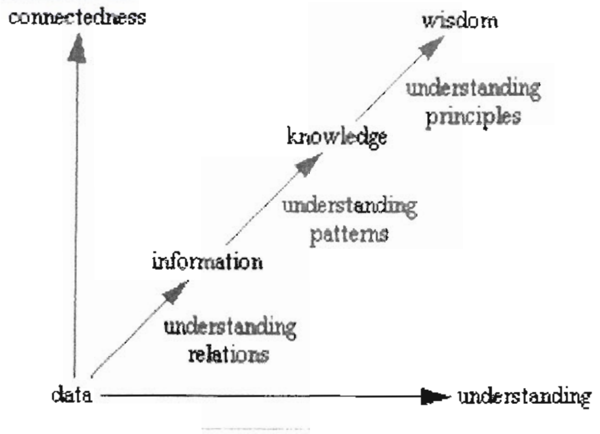

***Figure 1**: Relational presentation of data, information, knowledge and wisdom according to Bellinger, et al, 2004.*

From the preceding discussion questions arise such as at what stage can any derived data or information be shared and for which category of the interested audience can the data be shared? It is important that we determine the parts of the curve we want to refer to when discussing or dealing with the issue of data or information sharing. Do we mean the whole length of the three curves or are there specific locations of the curves we are most sensitive to? Another question is that of time-frame. When do we or do we not share the data in question? In an attempt to respond to these questions, most individual scientists are normally most worried about data occurring at the point of intersection of the three curves. They believe that raw data is the most sensitive part of the knowledge or wisdom continuum. Why is this so? Basically I believe that this notion has to do with issues revolving around collecting the data that is many times time and resource consuming. Data collection entails and requires special experimental designs or special field data collection designs that the scientist has undertaken in order to produce the data. They believe that raw data is the starting point of creating the understanding that one finally gets.

2.1 Data Sharing

2.1.1 What is data sharing?

According to the ASB project, data sharing means free public access. This is the placement of well documented data into a central database accessible to project researchers, partners and the general public with varying degrees of accessibility depending on the state of the data set.

Sharing data will help attain the goal of free public access. There are 2 broad models for sharing data: centralized and decentralized. Centralized access refers to the allocation of all data sharing resources to one particular office or partner that provides the data archiving and sharing service to all the others. The main characteristics of a centralized model include control, efficiency and economy. The decentralized model gives individual partners autonomy over their own data sharing resources (FTP sites, websites, databases, etc.) with flexibility, empowerment of the partners and service orientation.

In this particular case and for the BGBD project, the decentralized model fits well with how the BGBD project operates and is likely to be the preferred model for the project, but its lack of controlled access makes it unsuitable to share data that are not published. This in itself is not a disadvantage, since we believe that unpublished data can only be shared on specific prior agreed upon terms. In doing this, it should be clear that data could be centralized in the lead institutions in each of the participating countries as the central data hub or for global data, in the global coordinating office of the project. From the previous discussion on the progression of data from raw data to information, etc., it is quite evident that raw data that has not been processed has no real value and therefore does not warrant any intellectual protection. It is more the question of how the data would be used that could be an issue of concern. For the individual scientists, it is more the issue of authorship of knowledge derived from the data that needs to be clarified and agreed upon. Intellectual rights could be invoked when the data has been processed and new innovative knowledge derived from it. The matter of intellectual property rights discussed in the first section of this paper has elaborated in detail who qualifies for an IPR. The last section of this paper will deal with the issue of publication and how the authorship is normally arrived at.

In the BGBD project, we are faced with a range of different categories of interest groups involved in the data collection, analysis, interpretation and final publishing of the results. The question therefore arises as to who has control or rights over the project data.

Using the centralized model, one could think of a database archive hosted at the Global Coordination Office where the level of data accessibility could be controlled depending on the intended audience. Data that are placed in the database and that are very much a work-in-progress could be made accessible through password protection. Once the information appears in a journal article, website, donor report, etc. it would be considered published and opened up for access to the wider public.

2.1.2 When can data be shared and by whom?

Introduction

We discuss this and present the consideration in view of the CSM-BGB project and borrow from what happens in other projects as well. We view the concept of possibilities for data sharing as elaborated in Table 1.

***Table 1**: Data categories and the interest groups*

Data Type	*Data Form*	*Interested Parties*	*Intellectual Rights*
Raw data			
	Raw data collected in the field	Researcher Field Assistant Farmer Project Coordinator	None
	Raw data collected in the labs	Researcher Lab Assistant Project coordinator	None
Processed data			
	Protocols	Researcher Lab Assistant Project Coordinator	Possible

Data Type	*Data Form*	*Interested Parties*	*Intellectual Rights*
	Field methods	Researcher Field Assistant Project Coordinator	Possible
	Analytical tables	Researcher Data Assistant Project Coordinator	None
	Statistically analysed	Researcher Biometrician Research Teams Project Coordinator	None
Interpreted data	Discussion of results	Researcher	Possible
	Discussion of methods	Researcher Research Teams	Possible
	Discussion of findings	Researcher Research Teams	Possible
Published data	Project reports	Project Coordinator Researcher Research Teams Donor	None
	Synthesized outputs	Project Coordinator Researcher Research Teams Donor	None
	Peer reviewed journal articles	Project Coordinator Researcher Research Teams Donor Journal	None
	Web published	Project Coordinator Researcher Research Teams Donor Wider Reading Audience	None

The actual data (raw data)

Archiving the raw data

It will be at the discretion of the researcher whether to archive raw data electronically or not. Should the researchers(s) decide to archive the raw data, then he/she/they will be required to provide, detailed descriptions of the data files and the variables contained in them. For the CSM-BGBD project, such data will be made available to all researchers in the project and country teams for purposes of integrating with their own data to produce expected output of the project. During such an event the concerned parties will agree on how to share the data and for what purpose the data will be used or shared. Authorship of any paper arising from such collaboration will mutually be agreed upon by the concerned parties. The data will also be made available by the researcher for synthesizing to produce a country, benchmark or window synthesis that provides a complete picture of biodiversity of an area. The data will likewise be made available through a central control mechanism for landscape, regional or global level analysis and synthesis. A database placed in a centralized country office will be used to archive complete datasets for referencing and linking with other biodiversity databases via the internet or otherwise as agreed upon by the country teams and the global coordinating office from time to time. Similar data will likewise be maintained in a centralized global database, all raw data, maps, figures, tables, photographs, etc, will be availed to the global coordinating office for archiving and placement into a global database and the Internet. Access will thus be made available to a wider and distributed public. In the event that protection of the data is requested or desired, only then that the access will be controlled through the award of passwords to only a small population as mutually agreed upon for a period of time before the data is published and made public. Processing of all project data will be subject to agreements within the countries, with the countries and in some cases such as the synthesis of country data, will involve a wider team in consultation and participation of the global coordinating office.

Archiving Processed data

The other level of detail of a data set comprises processed data. Archiving of the processed data is desirable. However, it could involve more or less work than archiving raw datasets. The question therefore is; should we archive processed data? The answer is that for continuity and for future reference, it is important to archive processed data also in a centralized location for future or for any intended purpose or reference. Some authors may feel that the summary tables, graphs or maps presented in the data analyses are sufficient and that the raw data from which they are derived are not useful anymore. Others may feel that the raw data may have much more information than what has appeared in publications so far. Such data could be useful candidates for publishing in refereed journals, etc. Processed data has its strength in that it provides more insight than raw data. The data could be in the form of digital data – spatial or non-spatial that is already manipulated and can be queried for desired output. Such processed data should ideally be archived in folders within the centralized country offices. The data becomes handy when the individual who was working on the data or in the project leaves the project for any reason. Since the present construction of the project membership is distributed in different and varied institutions, and countries, even within a country it is important that a special computer is bought and dedicated to this activity. Otherwise the global office might require that all processed data is forwarded to it for archiving on a regular basis by the project information manager or his/her assignee for reference and for consultation by all interested parties in the project. The question that remains is whether such data should be used for publishing or when should the data be made available for public sharing or when could it be handed over to a centralized repository for common access. We could all agree that such data should be made available only after the outcome has been published in order to protect the intellectual rights associated with the data processing. The processed data should however be comparable and accessible across the countries by making the data have standardized catalogues. Creating standard archiving catalogues require that we enter for each data set, in the file property details that describe the title of the data, author of the data, date created, category of the data, key words that describe the data, a broad classification of the data, where archived and if possible a hyperlink that links with the data wherever it is stored or maintained in a website. Such data can also be protected by passwords if they are only intended for access by only a restricted audience for a period of time. It should be emphasized that keeping the data to oneself represents the least level of openness and stifles other innovative possibilities of applying the data and bringing it to the public domain.

For processed data sets that are works in-progress, the researchers will still archive them. A grace period of 2 years after the end of a project will be given to data originators for publishing based on their data unless otherwise specified in the contract. Project researchers may negotiate with the Global Coordination Office for extension of this period on a case by case basis

How can I share my data without losing the advantage of being the first one to publish from them?

A commonly cited fear among researchers, which hinders data access to the public, is the likely loss of publishing opportunities when data are provided fully and openly sooner than later. Hard work needs to be recognized, and that justifies holding back data for a limited time to pre-empt loss of recognition and promotion. How long can such reclusive rights be enjoyed? Kurtzman et al (2002) argue that data that will be reported in publications are ideally shared immediately upon the report's acceptance. However, for some types of data, it is reasonable to delay the sharing for a period following publication. These include longitudinal studies that produce rich data sets that may reasonably be reported in separate publications. The length of the delay depends on the study, and different institutions have reported times ranging from 6 months to 3 years after the end of the study. Very few agree on time limitless custody of data, because it is a real threat to data flow to the public.

Published Data

The other level of data is data that has been processed and discussed in a public forum such as the global annual meeting or country meetings. Such data could in the form of presentations or project documents. How do we deal with such data? Such data in my opinion is preliminary knowledge that bears a level of intellectual rights though sometimes the article carrying such data has not been written to a level for publishing in refereed journals. The way I see it is that we need to publish such data before making it available for public access and utility. During publishing, as what is currently happening for many journals, they want the data obtaining to such publication be appended to the paper as an appendix so that any other person using the data quotes the source of the data as meta-data. In this way the authors don't loose recognition for their work in data collection and originality of the data. For the CSM-BGBD project, we need that all published papers using the project fund bear reference to the project in the acknowledgement section of the paper. The acknowledgement must also bear citations and logos of the project including the standard text acknowledging UNEP and GEF for their roles in the project. Before publishing, the lead author must ensure that the material that is to be published is sent to the global office and UNEP-GEF Division for approval. The Global office and UNEP are normally only interested to know that the proper citation is made before the paper or report is published for access by a wide reading public. Quality control will remain the responsibility of the author but the global office could make recommendations for improving the manuscript should there be need. The global office could also seek peer review to ensure that the prepared manuscripts meet minimum scientific standards before presenting the papers for publication in a priori agreed journals. In doing this, the global office could appoint editors to go through the manuscripts before finally approving them for publication. The standard language for publication should be 'English'. If the paper is written in any other language than English, then an English translation of the paper should be made to ensure a wider readership and outreach.

As a matter of policy in the project, all published material should have some copies sent to the global office, to UNEP-GEF Division supporting the project, and to CIAT.

2.1.4. Conflict resolution

What do I do if contentious issues of data sharing arise?

Specific contracts, Memoranda of Understanding and other types of agreements with the partners and or contractors, should describe procedures for handling contentious issues on data sharing. So far we don't have such memoranda and if need be then we can design forms to be signed by each participant of the project.

Key issues in conflict resolution relate to respecting privacy and confidentiality of subjects, respecting the needs of those generating data while avoiding barriers to the flow of data to reach consumers who may need it for further agricultural research, policy formulations and informed public debates.

Who pays for the cost of sharing data?

Each Country Team will pay for the cost of publishing data for archiving. The project and the individual researchers must therefore budget for data publishing during the initial planning of research. The archiving will be a continuous process, carried out during the execution of a project, rather than at the end of the project.

2.1.3. Who is an author?

The International Committee of Medical Editors journal states that an "author" is generally considered to be someone who has made substantive intellectual contributions to a published study. In the past, readers were rarely provided with information about contributions to studies from those listed as authors and in acknowledgments. Some journals now request and publish information about the contributions of each person named as having participated in a submitted study, at least for original research. Editors are strongly encouraged to develop and implement a contributing policy, as well as a policy identifying who is responsible for the integrity of the work as a whole.

The International Committee of Medical Journal Editors has recommended the following criteria for authorship; these criteria are still appropriate for those journals that distinguish authors from other contributors.

- Authorship credit should be based on 1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published. Authors should meet conditions 1, 2, and 3.
- When a large, multi-center group has conducted the work, the group should identify the individuals who accept direct responsibility for the manuscript (3). These individuals should fully meet the criteria for authorship defined above and editors will ask these individuals to complete journal-specific author and conflict of interest disclosure forms. When submitting a group author manuscript, the corresponding author should clearly indicate the preferred citation and should clearly identify all individual authors as well as the group name. Journals will generally list other members of the group in the acknowledgements.
- Acquisition of funding, collection of data, or general supervision of the research group, alone, does not justify authorship.
- All persons designated as authors should qualify for authorship, and all those who qualify should be listed.
- Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content.

Who is an Editor?

The Role of the Editor

The editor of a journal is the person responsible for its entire content. Owners and editors of journals should have a common endeavor—the publication of a reliable and readable journal, produced with due respect for the stated aims of the journal and for costs. The functions of owners and editors, however, are different. Owners have the right to appoint and dismiss editors and to make important business decisions in which editors should be involved to the fullest extent possible. Editors must have full authority for determining the editorial content of the journal. This concept of editorial freedom should be resolutely defended by editors even to the extent of their placing their positions at stake. To secure this freedom in practice, the editor should have direct access to the highest level of ownership, not only to a delegated manager.

References:

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Kurtzman, H. S., Church, R. M., Chrystal, J. D. Data archiving for Animal Cognition Research: Report of an NIMH workshop. Animal learning & Behaviour, 2002, 30(4), 405-412. http://www.nimh.nih.gov/research/dataarchivingpublication.pdf

Report on agreements reached on data sharing during the session

POSITION OF THE GCO:

1. Data will be available to all researchers, country teams and the GCO for archiving
2. Scientists are responsible for publishing of the data and the choice of journal but they must acknowledge the donor, other relevant parties.

AGREED THAT:

1. Data shall be held on to by the scientist for more then two years during which time it will be published
2. Country teams shall share data in-country but cross-border sharing o data shall be governed by an MoU drawn up and agreed to by the countries involved
3. Published information shall be immediately shared
4. Sharing of data/ intellectual property (IP) on genetic material is subject to country laws and regulations
5. Farmers and communities are recognised and will be included in any royalties accruing from IP but the proportion of royalties paid to them will be agreed upon later.
6. Countries are responsible for the management (input, synthesis, storage) of their data; the GCO will be responsible for only synthesised data.

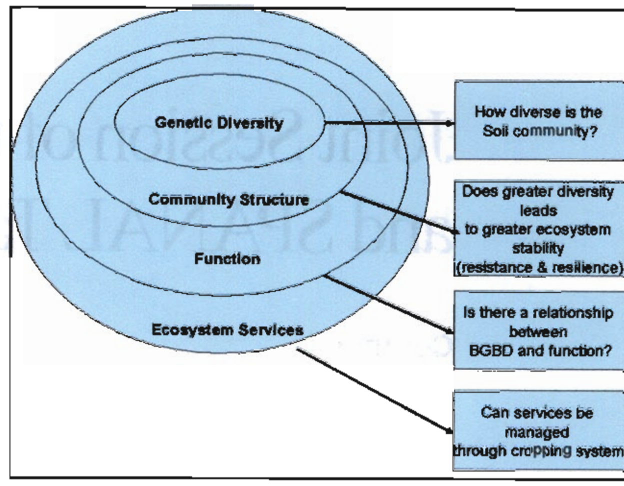
Joint Session of the ESERV, EVAL and SPANAL Task Forces

CONTENT

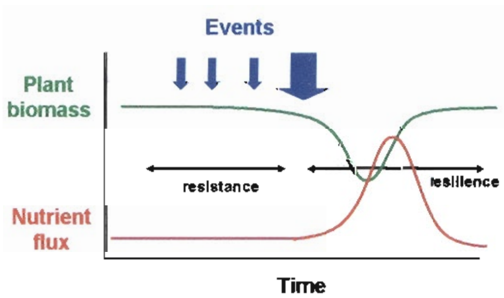
The Ecosystem Services (ESERV) Task Force

Edmundo Barrios
Jo Anderson
Patrick Lavelle

Conservation and Sustainable Management of Below Ground Biodiversity



ECOSYSTEM STABILITY: RESISTANCE AND RESILIENCE



Ecosystem function and services

Functions are the physical, chemical and biological processes that contribute to what the ecosystem does (e.g. carbon and nutrient cycling, BD habitat).

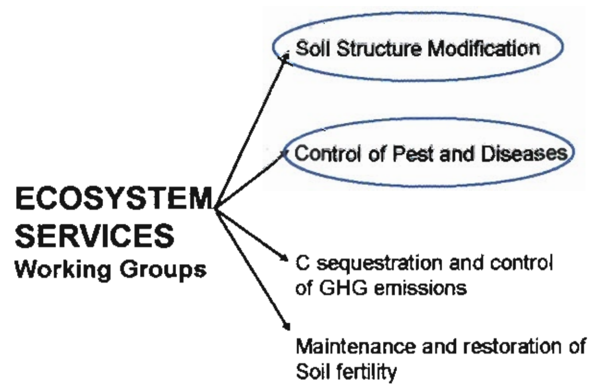
Ecosystem functions are value-neutral.

Ecosystem services are the transformation of ecosystem properties and functions into assets valued by society.

Farmers generally have a concept of 'healthy soil' how to improve soil properties - but rarely the mechanisms involved

Issues of cause and effect

- Management practices (fallows, crop rotations, tillage, organic manures, fertilisers, mulches) can be valued in direct returns as improved crop performance.
- Indirect returns from processes carried out by BGBD may not be valued because of the scales, variability or cumulative time over which they manifest effects.

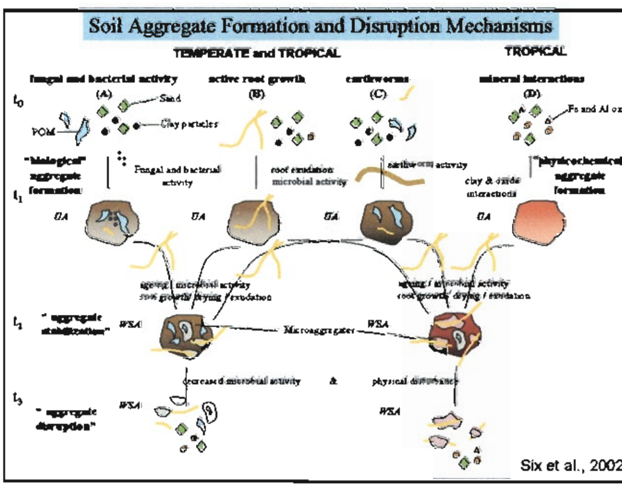


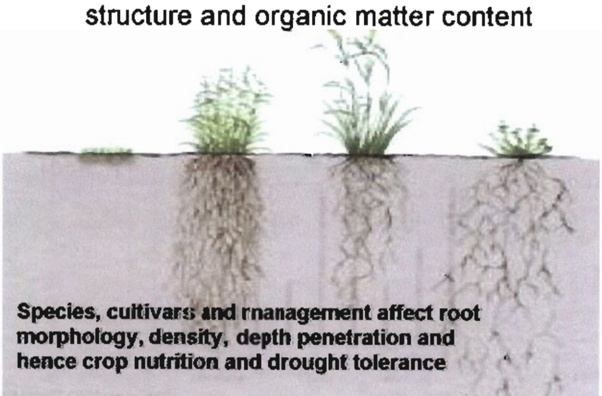
SSMWG of ESERV.

- **Potential parameters to assess the influence of soil biodiversity on Soil Structure Modification**

Parameter	Scale	Method	Ref	Propo
Tillage history	Per plot	Farmer surveys	LISQ guide	EB
Texture	Per point	Boyoucos	Methods of Soil Analysis - ASA	MS
Porosity	Per point	Methylene blue Dye Infiltration Method	?	JA, MS
	Per point	Bulk density/volume of compacted soil	?	JA
	Per point?	Pore distribution	?	EA
Water Infiltration Rate	Per point	?	?	IB
Water retention capacity	Per point (per m² in the whole profile)	?	?	IB
Aggregate distribution	Per point	Particle size distribution	Methods of Soil Analysis - ASA	EA
Percent of water stable aggregates	Per point	Yoder Method	Beare et al., 1993	EB, EA
*** Biogenic structures Microfauna	Selected points and soil depths	Thin sections analysis	Fitzpatrick et al.??	JA
*** Biogenic structures Macrofauna	Per point	Undisturbed soil monolith 5 cm per side	Velasquez, et al. PhD thesis	PL, BS, JH
*** Biogenic structures AMF fungi	Per point	Glomalin content in soil aggregates	Wright&Jawson, 2001	EB, IB
*** Biogenic structures "biological signature"	Selected biogenic structures	NIRS	Lavelle et al.	PL, EB

JA= Jo Anderson, IB= Isabel Barois, BS= B.K.Senapati, EA= Edgar Amézquita, PL= Patrick Lavelle, MS= Mike Swift, JH = Jeroen Huising, EB = Edmundo Barrios





Crotolaria or *Tithonia* green manures and fertilisers affect maize root length (& thickness)

Treatments	Root length (mm)		
	Primary	Nodal	Total
Soil	**2742**	622	5449
Soil + Fertiliser	2482	**815**	6951
Crotolaria	**3102**	542	6059
Crotolaria + Fert	2792	**835**	7348
Tithonia	**3035**	756	6684
Tithonia + Fert	2757	**995**	7676

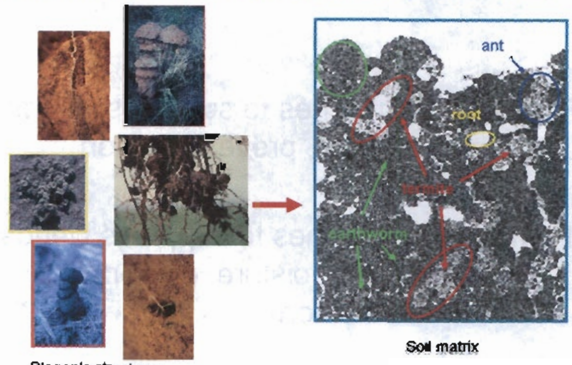
Sangakkara et al. (2004) J Agron& Crop Sci 190:339-346

Root density

Species	Soil Depth (cm)	Root density ($cm\ cm^{-3}$)
Eucalyptus marginata	0-15	9
	50-60	0.2
Fodder grasses	0-15	50
	25-30	15
Cereals	0-15	5-25
	25-50	4

Bowen 1985

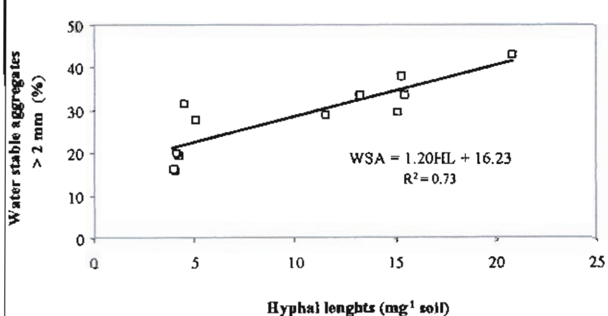
Invertebrates and roots build soil architecture



...and hence influence all soil services, depending on their abundance and diversity

Soil aggregation by AMF

Correlation hyphal lengths and %WSA > 2 mm



Reyes et al., 2003

AMF-glomalin and soil aggregation

Background:

Wright and Uphadyhaya (1996) Extraction of an abundant and unusual protein from soil and comparison with hyphal protein of AMF. Soil Science 16(9): 575-586

↓

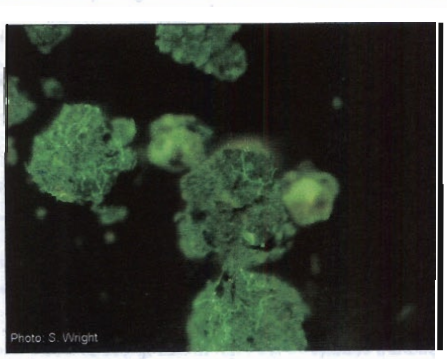
Significance: Assessing abundance and activity of AMF (spore counts, % colonization, hyphal lengths) is difficult and time consuming

↓

GLOMALIN

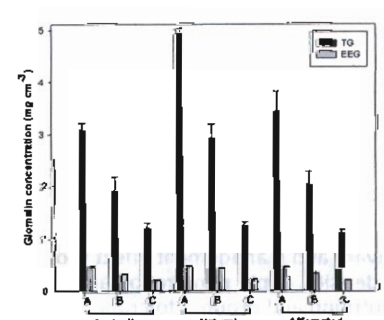
Fungus specific glycoprotein as a potential direct measure of AMF activity

Glomalin visualized with FITC-coupled MAb32B11 (on 1-2 mm aggregates)



Glomalin: land use change

Delaware County, Ohio: deciduous forest



$P_{Land}=0.001$
$P_{Horiz}<0.0001$
$P_{LxH}=0.24$

Rillig et al. 2003 Plant&Soil

SOIL MORPHOLOGY

Materials

Materials needed for field sampling

Soil cutting

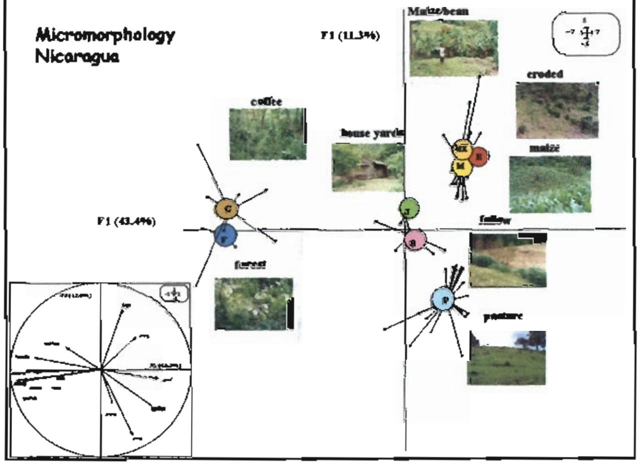
Block extraction 5x5 cm

Methodology

3

Soil-Used System	Biological or organic aggregate			Mineral aggregates			roots	stones	seeds	woods	stems
grassland											
fallow											

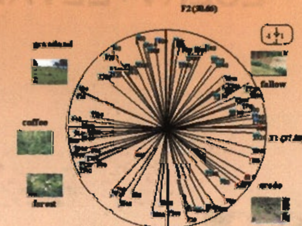
Micromorphology Nicaragua



Co-inercia between Macrofauna and morphology

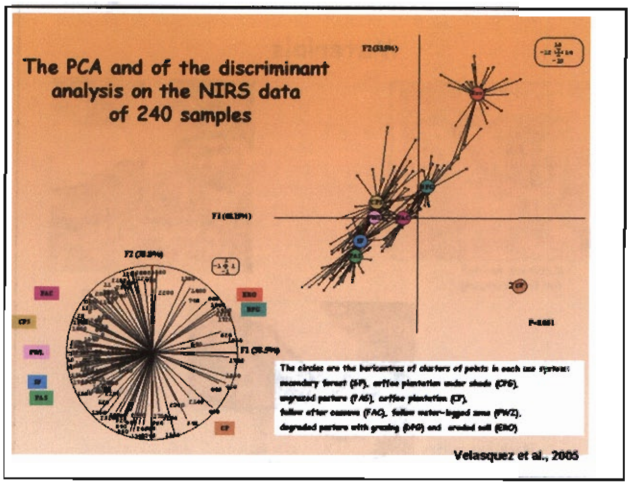
Pays	morphology discriminates land uses F1(%)	F2(%)	P<	Co-Inercia with Macrofauna F1(%)	F2(%)	P<
Nicaragua	42,2	12	0,001	73,8	8,5	0,001
Guyane	20,4	18,7	0,007	35,3	26,7	0,035
Colombie	39,7	18,7	0,22	68,2	26,4	0,05
Brésil	25,4	14,4	0,001	41,4	15,8	0,56

Using Near Infrared Reflectance Spectroscopy (NIRS) for determine quality and quantity of organic matter soils



Patrick LAVELLE
Elena VELASQUEZ

Manaus, april 2005



SOME FUTURE STEPS
for discussion

Proposed approach

BIOGENIC STRUCTURES
(Soil Morphology Method)

NIRS — Organismal signature to Soil Biogenic Structures — Glomalin

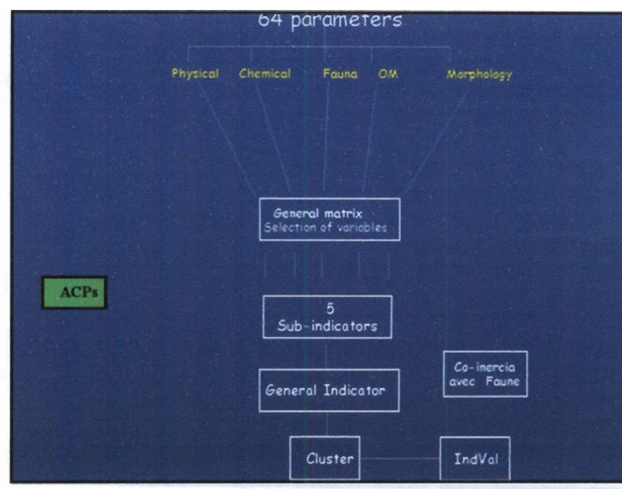
↓

Key hydrological measures (i.e. Infiltration, porosity, hydraulic conductivity, etc) - Sampling Implications

↓

Link changes in soil water dynamics and quality to the ESERV provision and improved Livelihoods

Economic Valuation (EEVAL) — Spatial Analysis (SPANAL)



The Integrated Task Force for Phase 2 (INTEG) ESERV+EEVAL+SPANAL

TSBF — Conservation and Sustainable Management of Below Ground Biodiversity — CIAT

Economic valuation of BGBD

How we think about value and for whom?

Case Study One

Plans for Phase 2:

- Case Study Two
- Economic valuations as input to management and conservation recommendations (for farmers and policy makers)

***WHAT do we need to know to prepare for our workshops: who are key people, characteristics of sites, key organisms.

Values of BGBD

	Values of BGBD and Related Ecosystem services		
Conservation of BGBD including the protection of its functions	Direct and indirect use values	Optional values	Existence Values
	Production (goods) Pest and disease control Nutrient availability Carbon Sequestration Decomposition Hydrological Functions Soil Formation Etc	Potential discoveries, bio-prospecting	The concept of living soil Value of global conservation projects such as this project or other CBD activities

Who, how, when:

WHO VALUES	HOW they value	WHEN they value
Farmer-household	Direct – thru the market Indirect –ecosystem functions	T = 0 into infinity
Landscape -Regional-Country	Indirect ecosystem a) non-renewables b) food security c) soil as capital	T = 0 into infinity
International R&D	Option value thru markets	Future
Global Community which included public sector, civil society and scientists	a) existence values b) tourism (direct + indirect value b-c supports AGBD)	T = 0 into infinity

Case study one

- RIT. Indonesia, India, SSA based study. Final results due in June
- Agreed scale to be determined by each country. Desktop study only.

- Direct values: nutrient availability, how much N fixated, much N already available?
- Indirect values. other nutrient availabilities, how much other nutrients (P,K) –depends on crops. More nodules in soybean than groundnuts and leguminous crops

NB: Nitrogen from LNB and other bio-fertilizers do not necessarily have to substitute 100% for the nitrogen from chemical fertilizers.

- Preliminary results from Indonesia: at farm level from existing data sets
  - N saved + P saved + yield boost = Rp 595,800/ha
  - important variables not yet considered b-c need data and functional relationships
  - Soil quality, water holding
  - Crop management/rotation which may reduce pesticide application
  - Land management: no-till, mulching, organic matter
  - Greenhouse gas sequestration
  - Water Retention capacity, soil aggregation (porosity of soils)

  Danso study available end of day in secretariat.

Case Study 2

- Hypothesis: BGBD impacts ecosystem services. Agreed to look at soil structure and water balance. Important all study sites. Requires interaction with scientists. More experimental in nature! Design of study to be decided at workshop.

- WHAT DO WE NEED TO KNOW TO PREPARE OUR WORKSHOP?

Required: methods manual. Outline as output of workshop?

Input into management strategies and conservation recommendations

- Could be straight forward CBA based on direct use values (RIT study)
- Could integrate findings from ecological services (Case Study 2)
- Could be opportunity to draw conclusions across countries
- Scale important depending on audience

- TIMING? Management studies influenced by seasons, phase 2 funding…but nonetheless this year!

Spatial Analysis and Environmental Services for BGBD project

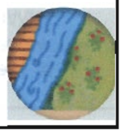
Simoneta Negrete Yankelevich

Richard Coe

Why spatial analysis for environmental services?

- Most of what we measured directly of soil biology concerns a scale no larger than $1 m^2$. But...

1. Processes depend on landscape level variables, not just point measurements (eg distance to refugia)
2. Environmental services need describing for areas not points (eg infiltration and catchment hydrology)
3. Landscape arrangement not just elements may be crucial (eg closely integrated or separated land use units)
4. We need to extrapolate beyond windows



1. Using landscape elements

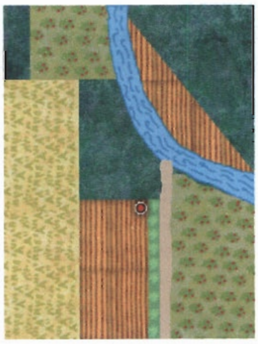
Surrounding spatial heterogeneity

Techniques: heterogeneity indices:

a) Constructed specifically

b) Fragmentation indices: Monica G. Turner (Turner, 1989)

Ready made software: Fragstat



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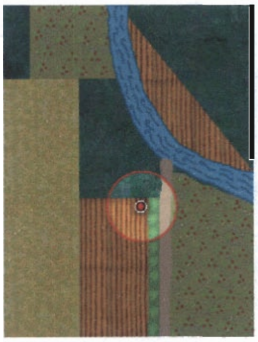

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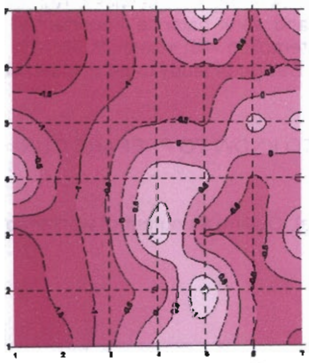
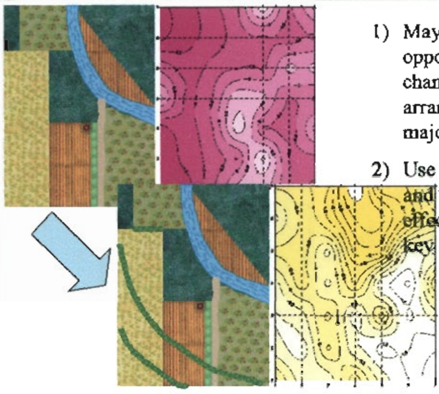
2. Mapping windows



Contour maps of BGBD and environmental variables

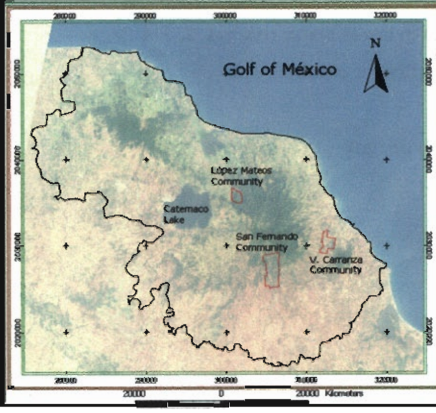
Techniques: geostatistics (variography, spatial regression and interpolation-kriging)

3. Changing landscape



1) May be more opportunity to change landscape arrangement without major LU change
2) Use models from 1 and 2 to predict effect of changing key elements

4. Extrapolate to Benchmark sites



The Los Tuxtlas Biosphere Reserve
Windows

4. Extrapolate to Benchmark sites

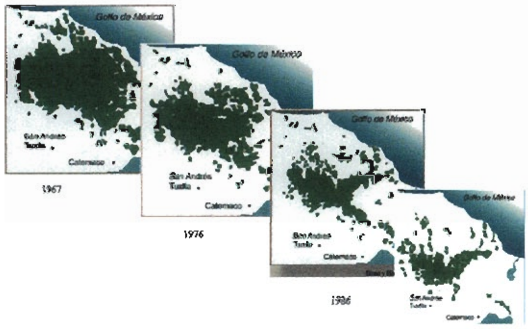
BGBD potential distribution maps considering two elements:

a) extrapolation of determinant factors at the window level.

b) differences between windows within the same region (candidate explanatory variables: temperature, altitude, vegetation, etc.)

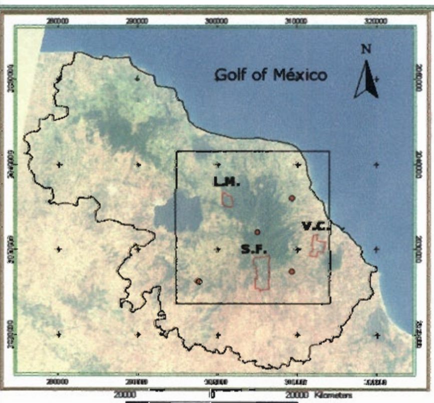
Remote sensed and other mapped data provide the means to extrapolate

SIG-Los Tuxtlas: Deforestación 1967-1992 (70%)



Deforestation in the San Martín volcano region (Guevara, S., J. Laborde y G. Sánchez-Ríos. 2004)

4. Extrapolate to Benchmark sites



Field confirmation of predicted BGBD distribution

Risks and Challenges

1. Predictive variables may not be found
2. Ecological scale principles - different factors important at different scales, but most information at window scale
3. Key controlling variables may be ones that can not easily be mapped from RS data (eg soil depth)

Scale	Possible factors	number of data points
10^{-2} m	competition	?
10 m	organic matter	100?
10^3 m	soil types	?
10^5 m	climate	7+

Proposal

1. Proceed from low to higher risk = 1, 2, 3, 4
2. Implement first for countries with
   - data
   - suitable designs
   - interest

Proposal to BGBD Project Coordinator resulting from joint meeting of Task Forces ESERV, EVAL and SPANAL in Manaus, 2005

RATIONALE

Objective: Understanding the link between ecosystem function of BGBD, provision of ecosystem services in space and time, and their economic value. Preparation for Phase 2 and Case Study 2.

Context: Why is this work important? Simply put, if no value is attached to environmental services, involuntarily the value of zero is most often assigned. If this occurs, the role and impact of the ecosystem services derived from biodiversity would not be considered in economic and policy decision. However, we can change that. Science is producing abundant evidence that the natural environment provides a wide range of economic benefits beyond the obvious 'direct use'values (such as timber, fodder and food). We know much more about how ecosystems work above ground and which habitats deliver which services. For all such efforts, the difficult part is the precise description of links between structures and function of species in the environment so that proper values can be calculated. There has been significant advancement towards developing techniques in economics to value environmental benefits and costs. Now, our challenge and our attention goes to BGBD and the same challenges face us: 1) how to describe the links between BGBD (or elements thereof) and ecosystem functions which provide services and 2) valuation methods for these 'invisible' parts of our biodiversity. By tackling these difficult questions, we will be contributing to not only understanding what happens in the farmers'fields, but also have a tool to influence policy and economic decisions.

Why have an integrated approach?

- The joint session of ESERV, EEVAL and SPANAL highlighted the highly complementary nature of research questions across task forces as well as the multiple challenges of phase 2 activities regarding approaches to address complexity.
- We are not only interested in measuring those functions in which BGBD is involved but we also want these functions to be clearly linked to ecosystem services that farmers/citizens/politicians would perceive and value, and therefore would be willing to pay for them at their respective scales of operation.
- We are aware that the scales at which the ecosystem function is performed, the ecosystem service perceived by farmers, and at which the ecosystem service has the highest economic/political value are different. We need to understand the relationships among different scales (i.e. nested hierarchy of scales) in order to be able to provide information that is meaningful and useful for scientists, farmers and politicians.
- We think that a meaningful way in which we can present the ecosystem service/economic valuation results could be through maps that show critical areas that constitute "hot spots" of biological function/service provision that are then overlaid by socio-economic information regarding environmental values and willingness to pay for particular ecosystem services.
- We need to assess the risk of BGBD loss and function loss through scenario analysis at different spatial and temporal scales.

OUTSTANDING QUESTIONS:

During our discussions in Manaus, it become clear that there are some fundamental questions we need to work on as an interdisciplinary group. The following questions were raised, and we summarize the ensuing debate below:

1) **To what extent can the various groups of BG organisms be managed or manipulated independently of other aspects of the land use system?** If not, is it ever possible to attached value to BG organisms (or BGBD) which is separate from the value of roots or soil carbon, or perennial cover or…? Maybe we can only value alternative management practices which modify the combined soil biological x chemical x physical complex which in turn modifies es services. If this is the case then it has a profound impact on methods. Discussion: This point is a critical one. However, having the BGBD project experimental design along agricultural intensification gradients rests on the recognition of the inseparable relationship of cropping system and BGBD under field conditions (i.e. the ecological/hierarchical management of soil biota). Organisms do not function or exist independently of the rest of the system and thus tearing apart their contribution to the function and/or manipulating their populations without changing the organic matter resources or physical characteristics of the soil may prove rather difficult (particularly under field conditions). Two consequences could be expected. One is that if we do not find a way to quantify (with observation or experimental manipulation) the sole contribution of organisms to the function and service (because they may co-vary tightly with other factors), we will not be able to assign an economic value to the organisms alone and our main mission may be compromised. The second is that we may end-up having to conclude that the soil needs to be generally 'healthy' (in terms of organic matter, nutrients, physical structure and organisms all together) in order to have the function operating. And therefore recommend well known soil conservation practices as the way forward.

2) **What are the specific measurable variables that BGBD performs and that we can specifically measure at the plot or farm level regarding soil structure modification?** At what scale are the organisms operating to perform the selected function?. At what scale are the ecosystem services perceived and can be considered/valued?. Discussion: The ESERV Task Force organized a working group discussion on methods to assess the provision of the ecosystem service of soil structure modification. This working group was composed of experts (including Jo Anderson, Patrick Lavelle and Edgar Amézquita) also Mike, Jeroen, Edmundo and one soil physics/structure representative (sometimes two) from each country, and sometimes also the country convener if interested (i.e. Isabel Barois). After two one month discussion sessions considering all the methods known and our objectives we reached a consensus that the soil morphology methodology would be the best option to separate biogenic structure (aggregates) produced by different organisms and the use of NIRS and the Glomalin assay to provide the organismal signatures to such biogenic structures and thus link the production of such soil structures to particular groups or organisms. For example, this could be a unique way to link increased crop yield due to an extra-month of adequate soil moisture in sub-humid environments to the relative contribution of let's say key soil organisms as defined by NIRS/glomalin signatures. Nevertheless, we may not be able to avoid looking at trade-off because of different scales of analyses as farmers may want increased water holding capacity at the farm scale but cities want increased water availability downstream. To understand the trade-offs we face in selecting exactly which study we will do, we need to clarify our hypothesis about the impact of the BGBD on particular functions/services as % of total impact on agronomic indicators (yields, crop stability, soil fertility, pest resistance, etc). How does this compare to farmer priorities to limiting factors at study sites?.

3) **How well tested have the proposed method for soil morphology been?. We do not know how well the patterns can be extrapolated to the whole farm or even the whole plot?** Discussion: Probably the best person to answer this would be Patrick himself. Soil morphology and micromorphology studies have been made for many years. The proposed method is a modified version of a method by Ponge et al. that has been used with success across cropping systems in Colombia, Nicaragua, Brasil, French Guiana and China (maybe India and Ivory Coast also). The strengths of this method include its capacity to clearly discriminate among land use systems, simple to do, inexpensive, and biogenic structures separated have shown different NIRS signatures. One drawback is that results may vary according to the experience of the operator. However, this is the limitations of many methods. We just need very good hands-on training. Nevertheless, we need to get a feeling of spatial variability of results using this method as I understand this aspect has not been thoroughly tested.

4) **Once we have demonstrated that certain organisms are correlated with a well formed soil structure, we need to translate that into a service that the farmers or politicians value which is clearly associated with the contribution that specific organisms are making to the soil structure (and not the soil structure in general). How do we do that?** Discussion: This is not a simple question. For example, how are we going to demonstrate that the biogenic structures created by earthworms are actually making a significant contribution to the water retention that the farmer values? We would only be able to do this if we could measure water retention in soil structures with organism's contributions and in soil structures with out (or less organism's) contributions, all else being equal (see point below). Nevertheless, there are different soil standard methods that can be used to answer the question of the impact of biogenic structures produced by earthworms or arbuscular mycorrhizal fungi (AMF) on soil water retention. Water retention is not so complicated to measure. One important measurable attribute of soil aggregates is their resistance to disruption when in contact with water (i.e. water stable aggregation) that is linked not only with water holding capacity but also to soil erosion (i.e. less susceptibility to disruption = less material to be eroded) and soil carbon sequestration (i.e. less disruption = more potential for C sequestration). Focusing on water, with the methods proposed in Manaus it would ideal to be able to say that such % of the aggregates contributing to increased water holding capacity are due to earthworm activity or AMF activity. One potential approach may be to say that such % of the total water holding capacity increase was a result of earthworm or AMF activity and then put a value to it independently of other contributing factors to that increase. The linkage between increased soil water holding capacity, the partial attribution to activity of a particular soil organism and the possibility for economic evaluation is a quick example of potential approaches that could be taken. We need to be able to have enough time for focused discusions and that is why we are all finding necessary to meet for three intense days.

WORK PLAN

We fully agree about the need for a small brain storming session in order to progress on these issues. This is required before we hold the planned larger workshop for economists from the seven country teams.

For the small brain storming session, attendees are: EB, SNY, RC, JR, PL, MJS, JC, JA, Do and, budget allowing, two economists (Mexico and Indonesia are most likely candidates).

We have found dates that suit everyone (August 30 to September 3rd, no small task!), and based on rough budget calculations, found France to be the easiest and cheapest place for us to meet for a three day session.

PRE-FRANCE WORKSHOP 'HOMEWORK'

Literature review and expert 'down load' from team on the specific function (in terms of measurable variables) that BGBD perform and status of measurements tools in lab, field experiment, and farmer's field. To do this:

1. ask experts for best general papers on relationship between BGBD and ecosystem functions. To be read by everyone.
2. Ask experts for best papers specifically on: scale (SN), methods to measure function and services (EB) and methods to value services (DO and JC).

Beyond the lit review, we might have to 'interview' experts…in case there is knowledge not yet captured in literature (and ask JA, MJS, PL, RC)

JR to summarize farmer needs, priorities and limiting factors in all seven countries.

TENTATIVE WORKSHOP PLAN:

Start meeting with report on status of knowledge, farmer/policy maker priorities. Agree on priorities, strategy for integrated approach, discuss and identify answers to "outstanding questions", set priorities and define tentative strategy for Phase 2.

Annex 1. Hypothesis on land use on BGBD and soil ecosystem services and indicators of soil ecosystem services

CONTENT

(draft)

Effect of land use dynamics on soil below-ground biodiversity and soil ecosystem services at the BGBD sites: Some hypotheses regarding soil fauna

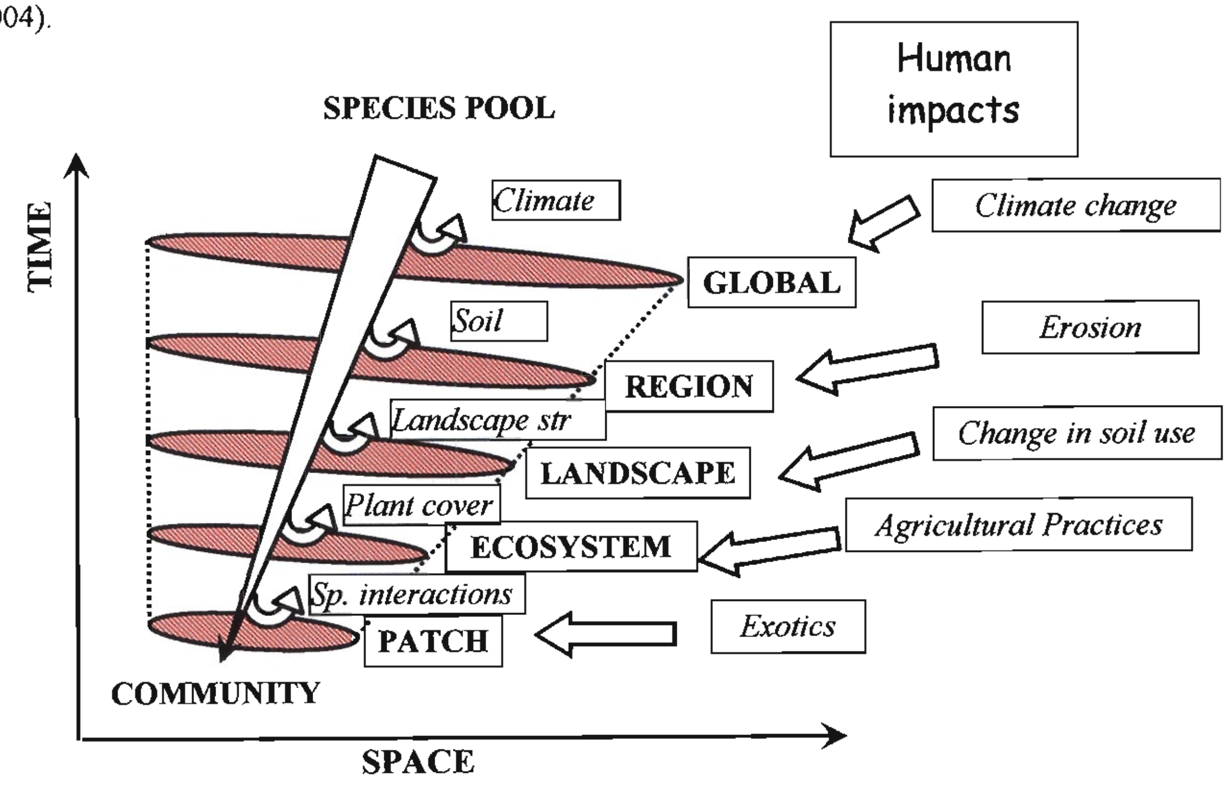
by Patrick LAVELLE, David BIGNELL, Diana WALL, Herbert SHUBART, F.X. SUSILO, George BROWN.. others???

1. How LUI and SOCEC drivers affect communities : the search for laws and threshold effects

The environment filter paradigm (Allard, 2000, others?)

Species present and their assemblages in a given place are determined by a nested suite of hierarquically organised determinants (fig. 1):

Figure 1: Species pools and environmental filters (Huston, 1996; Allard, 2000; Decaëns, 2004).



GLOBAL: Every group of organisms has a more or less known number of species worldwide; some have high numbers (ex. Coleoptera, Spiders), others less so (termites, earthworms).

REGIONAL: Of this total pool, a certain fraction is found at a regional scale. Cliate variations Biogeographical parameters may have effects on the type of species and functional groups. A striking example is the lack of fungus growing termites in America and Australia, whereas fungus growing ants are restricted to tropical America.

LANDSCAPE: the landscape structure affects diversity by providing a set of diverse habitats that will allow a certain number of species from the regional pool to find their preferred habitat.

ECOSYSTEM: vegetation cover by affecting the amount and quality of organic inputs and micrclimatic factors selects a subset of species from the landscape pool.

PATCH: finally, species interactions shape communities at the very local scale through positive (mutualism or positive non trophic effects of ecosystem engineering) neutral or negative (competitive exclusion; negative non trophic interactions).

Human activities interfere at all scales through effects like climate change, management of plant cover, agricultural practices or facilitation of introduction of exotics and/or invasive species.

In the end, specific characteristics of each

Dynamics of soil organism communities

Shaping of a community in response to the different filters may not be a continuous process. Special events may accelerate changes and /or result in sudden shifts from one type to another as thresholds are passed. A great challenge of the BGBD programme is to describe laws that link physical environment , history of landuse, the socio-economic environment and the diversity observed at any time.

Four different stages may be distinguished in the course of a succession (figure 2).

1. The original ecosystem

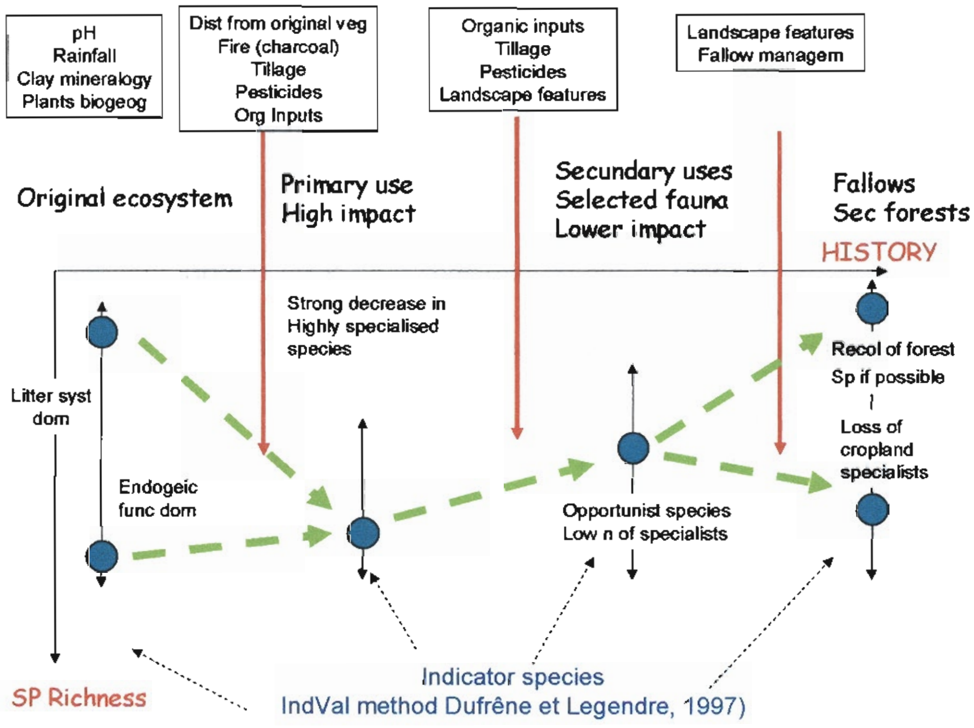


Figure 2: Hypothetical changes in species richness and composition (exotics vs. natives) along a secondary succession of managed changes in land use at the ecosystem (sampling point) scale.

Circles : number of species collected.

Vertical arrows : range of possible species richness in a single taxonomic group;

Upper boxes: main determinants of species richness at each stage
Dashed arrows : trajectory of species richness

In natural ecosystems, species richness within a single taxonomic group may greatly vary. Termite species richness may vary from 16 to 90 depending on the location and forest type, wheras earthworm richness generally vary between 6 to 18 (Lavelle and Spain, 2001).

Climate and soil characteristics and to a lesser extent, the type of vegetation, have been shown to influence these numbers. For example, Fragoso and Lavelle (1993) showed that earthworm species richness was maximum at average rainfalls of ca. 1800 to 2500mm and tended to decrease outside these limits. Soil acidity also has a strong effect, often in combination with high rainfall. In acid soils (< pH 4 to 5 in the humid tropics), soil dwelling earthworms (endogeics and anecics) tend to disappear and only epigeics that live in the thick litter cover do persist. On the contrary, soils with neutral pH may host a large number of soil dwelling species. An example is the earthworm community studied by Fragoso in the Lacandon forest of Mexico that had 18 different species, one of the highest local diversities recorded so far.

Observation of the humus layers and soil morphology in the upper 5 to 10 cm may provide a general assessment of the overall function of the litter-soil system function: accumulation of litter in several Ol, Of and Oh layers will generally go along with a large diversity of litter dwelling arthropods, the presence of epigeic earthworm species and low numbers of soil dwelling earthworms What about termites???

2. First conversion of a pristine forest

The first clearing and burning of a pristine forest generally has a very strong impact on species richness. In Eastern Amazonia for example, Mathieu et al. (2005) found a decrease from 80 to 30 morphospecies in macrofauna communities after conversion of a pristine forest by slash and burn to rainfed rice cropping.

Since communities often comprise a large proportion of highly specialised (and often rare) species, many of them do not adapt the radically different conditions of the deforested environment.

At that stage, the distance (difference) of the transformed land from the original system will generally determine the amount of species loss. Different types of landuse systems may be ranked in the following order according to their distance to the original forest:

Forest: 0;
Forest disturbed by wood exploitation: 1;
Forest plantation: 2 (if broad leaf evergreen forest); higher distance if eucalyptus or coniferous;
Agroforestry system: 3 or more depending on the density of trees and the quality of litter produced;
Pastures: 4 (may be less if associated with legumes and limited grazing ; more if low quality grass and/or overgrazing);
Crops: 5 to 8 depending on practices; aggravating practices are lack or organic residue inputs, tillage and pesticide application.

Some changes in soil associated with burning may have positive effects on some elements of the fauna. This is particularly the case for the incorporation of ashes and charcoal to the soil. Ashes have an immediate effect in neutralising pH and charcoal one incorporated, microfractionned and thoroughly mixed to the soil, may enhance soil CEC and have durable effects on the mitigation of Al toxicity and acidity that prevailed in the pristine forest. In this case, some rare species only found in rare microsites in the forest may become more abundant and exotics may start to enter in a soil that is suitable for their maintenance. Therefore, communities that had species richness in the lowest range because of unsuitable soil conditions may have increased species richness after deforestation and burning.

3. Secondary uses

After the first use of soil, generally for one or two successive rainfed rice or maize, landuse changes to a different type. In Amazonia it may often be pastures; in other places, natural or improved fallows of different durations may be the preferred option.

At that stage, a rather large number of generalist species adapted to disturbed conditions may comprise the communities. Biodiveristy is likely to increase by the addition of exotic species.

Species richness will largely depend from the possible occurrence of detrimental practices in the land use system (tillage, pesticides, unsufficient organic matter inputs).

In Eastern Amazonia, Mathieu et al (2005) observed an increase in species richness of macro invertebrate communities from 30 in a rice field the first year after deforestation to 45 in pastures after 6 years of continuous use as pasture. In this case, the increase in species numbers may come from colonisation by accidentally introduced exotic species (e.g., with soil coming with tree seedlings produced in nurseries); species from the original ecosystem may also recolonise the soil if conditions are suitable for them and colonisation is made possible by the structure of the landscape (high density of refugees for species and proximity to the original ecosystem). Comparison of data sets containing species richness in different types of land use and landscape metrics measured at compatible scales may allow to evaluate the importance of the effect of landscape structure on species richness at this stage.

In these communities, the number of generalist species able to adapt a wide range of conditions and with great resistance and/or resilience to disturbances is expected to be large. These communities will be much less sensitive to disturbances, unless some threshold effect in degradation (or improvement) of soil quality allows a shift towards a restored or highly degraded community.

4. Fallows and secondary forests

When land that was previously used intensively for cattle raising or crop production is left to fallow, species richness may alternatively increase or decrease depending principally on the type of management of the fallow and the structure of the landscape.

Mathieu et al (2005) found rather high species richness of macroinvertebrates in ricefields that had only been cropped once after a primary deforestation. In that case, species had recolonised from refugia that had been preserved inside the cropped area (e.g., below unburned trunks; unburned microsites), or from the nearby forest. In the Manaus region, Barros (1999) reported very low species richness of macroinvertebrates in secondary forests when they had not recovered the lost native forest species and part of the exotic species that had once colonised the open land, had been eliminated after reconstitution of the litter and forest environment.

Fallow management, when practiced, and/or maintenance of forest elements throughout the landscape may, on the opposite, greatly enhance the recovery of the original diversity.

In some cases, the generalist/exotic species that invaded the crops and intensively used soils, spromay persist and prevent native species to recolonise. This case seems to be frequent in earthworm communities, at least in Tropical rainforest areas where native species characterised by a highest rate of endemism are irremediably eliminated by a few exotics originated from Africa, Asia and Central America (Lavelle and Lapied, 2004).

2. *Interactions among soil biota: the value of analysing covariations among soil organisms*

Changes in landuse and the associated disturbances or aggradation phases not only result in different species richnesses and changes in the proportion of specialist to generalist species. They may also greatly affect the interactions among soil biota and result in the loss of some essential biological controls. The following three examples show how such mechanisms may operate:

- <u>mycorrhizae, rhizobium and pathogens spreading by different groups of soil fauna</u>:

  Soil invertebrates may transport spores and propagules at their body surface or incorporate them into their castings and constructions, after they have -or not - experienced transit through the gut. The consequences of this interaction between useful and harmful microorganisms on their population dynamics and ability to infect plants is very poorly known (see for ex. Doube, 1994; Stephens and Davoren, 1994; Stephens et al., 1994 complete).

  These effects can be searched for by comparing datasets on communities of microorganisms with soil fauna communities. Coinercia analyses should allow to identify possible positive and negative relationships between selected pairs or groups of both types of organisms. Further experiments may verify the link and describe the mechanisms.

- <u>nutrient redistribution by soil fauna</u>:

  Soil ecosystem engineers (mainly termites, ants and earthworms) have significant effects in enhancing nutrient mineralization at specific scales of time and space (see e.g., Lavelle et al., 2004 others for termites etc...). Termites may have dramatic effects by transporting clay minerals with high CEC to the surface horizons. Like earthworms, they may create microsites where nutrient availability is greatly enhanced.

  Comparision of datasets on fauna and soil nutrient distributions will indicate if such relationships are visible at the scale of samples and types of landuse.

- <u>nematode control by earthworms and the overall soil biodiversity</u>:

  H1: Mitigation of the negative effects of plant parasitic nematodes by earthworms has been suspected from field datasets (Clermont-Dauphin, 2004) and demonstrated in laboratory experiments (Senapati, 1992; Blouin et al, 2005; Boyer, 1998). Mechanisms may be a direct negative effect on nematodes or systemic effect on plants that enhance their tolerance for nematodes. In both cases, the activation by earthworms of microbial communities that produce phyto hormones and/or growth precursors is hypothesised.

H2: Mitigation of nematode effects can also be favored by the proper diversity of their communities (Cadet, *in press*; Lavelle et al., 2004). Cadet (in press) showed that the diverse community of plant parasitic nematodes in a fallow from Senegal had considerably less harmful impact (and even a positive impact under certain conditions) than the much less diverse community of a soil that had been cropped for millet for several years (Lavelle et al., 2004).

This effect can be observed by comparing community structures and abundances of earthworms (and other invertebrates) with plant parasitic nematodes (H1) and relating the diversity of PP nematodes to the evaluation of damages they cause to crops (H2).

- More hypotheses??

3. Community structure and soil ecosystem services

Soil invertebrate communities affect several soil ecosystem services though in different ways according to their structure and abundance.

There effects are three fold:

1. By building and maintaining macroaggregate structures made of aggregates with diverse sizes and compositions, they participate in climate regulation (C-sequestration) and water supply (infiltration and storage in soil; detoxification and transport to water tables and surface effluents) (refs).

2. Through their diverse interactions, as already mentioned in previous§, they participate in pest and disease control.

3. Their regulation of nutrient cycling and direct or indirect enhancement of plant growth is a significant contribution to the provisioning services (production of food, fibers and other plant products)(De Ruiter et al., 1993; Lavelle et al., 2004, others).

4. Interactions among above ground and below ground communities may result in effects on plant diversity (Hooper et al., 2000; De Deyn et al., 2003, others).

The challenge for research is to relate datasets of community structure and abundance to indicators of the performance of ecosystem services. In case 1, indicators may be soil aggregation measured by image analysis on thin sections, physical separation of aggregates by classical techniques or manual separation of different classes of soil aggregates as proposed by Topoliantz and Ponge (2000) and Velasquez (2004).

(add more???)

References *(to be completed)*

Doube, B. M., P. M. Stephens, C. W. Davoren, and M. H. Ryder. 1994. Interactions between earthworms, beneficial soil microorganisms and root pathogens. APPLIED SOIL ECOLOGY 1:3-10.

Lavelle, P., F. Charpentier, C. Gilot, J. P. Rossi, B. Pashanasi, L. Derouard, J. André, J. F. Ponge, and N. Bernier. 2004. Effects of earthworms on soil organic matter and nutrient dynamics at a landscape scale over decades. Pages 145-160 *in* C. E. Edwards, editor. Earthworm Ecology (2nd. Edition). CRC Press.

Rouelle J. 1983. Introduction of amoebæ and *Rhizobium japonicum* into the gut of *Eisenia foetida* (Sav.) and *Lumbricus terrestris* L. Pages 375-381 *in* J. E. Satchell, editor. Earthworm Ecology. Chapman and Hall, London.

Stephens, P. M., and C. W. Davoren. 1994. Increased growth of subterranean clover and increased nodulating comptetitiveness by a strain of rhizobium leguminosarum BV. trifolii, associated with the presence of the earthworm aporrectodea trapezoides. Published in conference proceedings of an OECD sponsored workshop on sustainable Agric. **6**:1-3.

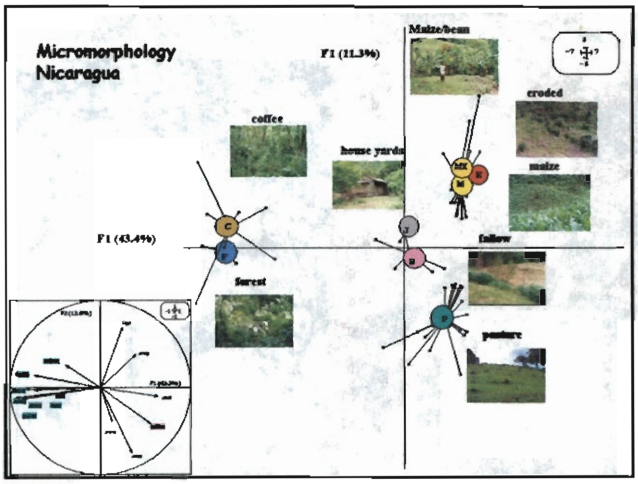
Stephens, P. M., C. W. Davoren, M. H. Ryder, and B. M. Doube. 1994. Influence of the earthworm aporrectodea trapezoides (Lumbricidae) on the colonization of alfalfa (medicago sativa L.) roots by rhizobium meliloti L5-30R and the survival of R.Meliloti L5-30R in soil. Biol. Fertil Soils:1-25; 63-70.

1. ➔ Identification of laws and threshold effects

   - Resistance of native species to changes
   - Resistance of community to exotic species
   - Secondary successions: the historical dimension

(➔ explore covariation with LUI and SOCEC data)

Results



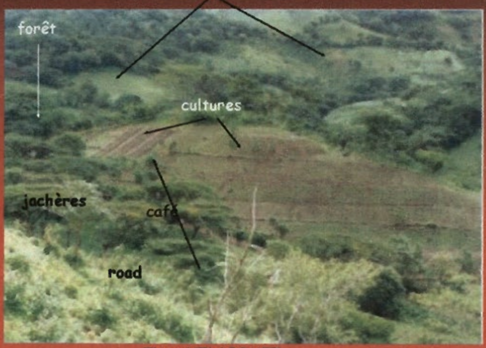
Co-inercia between Macrofauna and Micromorphology

Pays	Micromorphology discriminates land uses F1(%)	F2(%)	P<	Co-Inercia with Macrofauna F1(%)	F2(%)	P<
Nicaragua	42,2	12	0,001	73,8	8,5	0,001
Guyane	20,4	18,7	0,007	35,3	25,7	0,035
Colombie	39,7	18,7	0,22	68,2	28,4	0,05
Brésil	25,4	14,4	0,001	41,4	15,8	0,56

General Index of Soil Quality

The General Index of Soil Quality

Nicaragua-Colombia



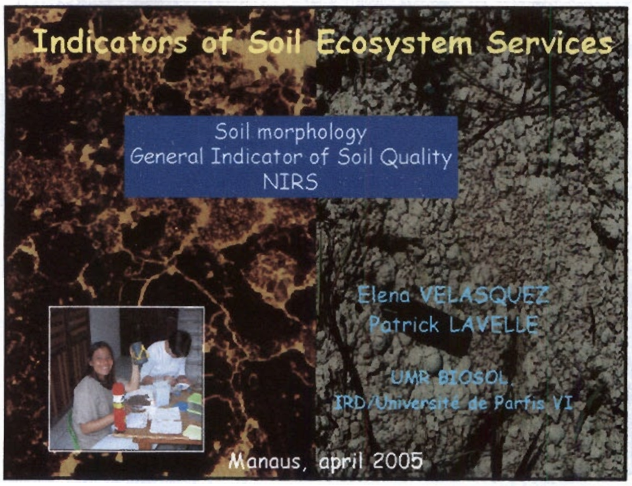
Elena VELASQUEZ IRD/CIAT cooperation

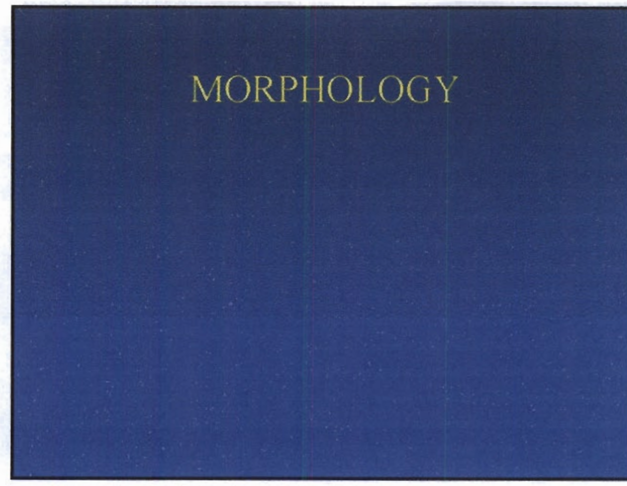
Dans un Bassin versant, 64 paramètres mesurés en 60 points distribués sur une grille régulière

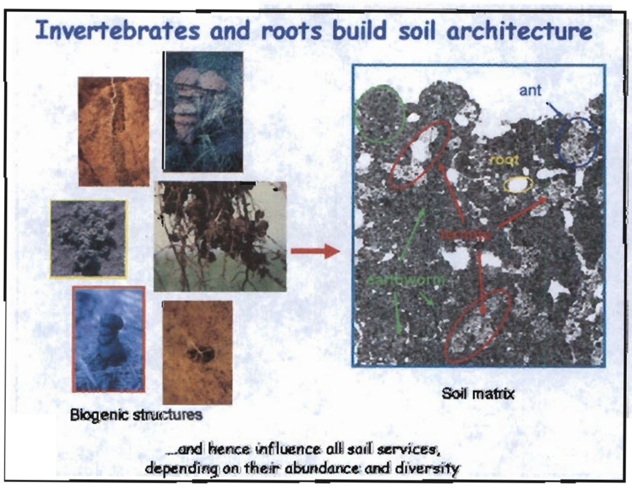
- Matière organique :, C, Fract. densimétrique, Respirométrie, NIRS
- Chimique : CEC, N, Ca, P, K, Mg, Al, pH
- Physiques: Pénétrométrie, RTC, densité apparente, humidité, pente

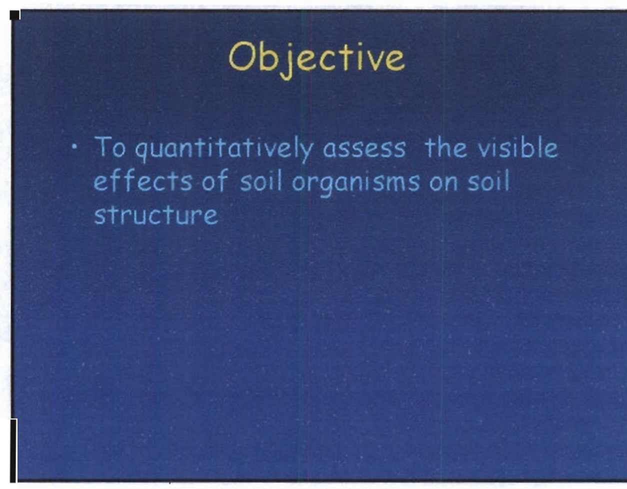
Morphologie: 6 classes d' agrégats + 6 autres critères

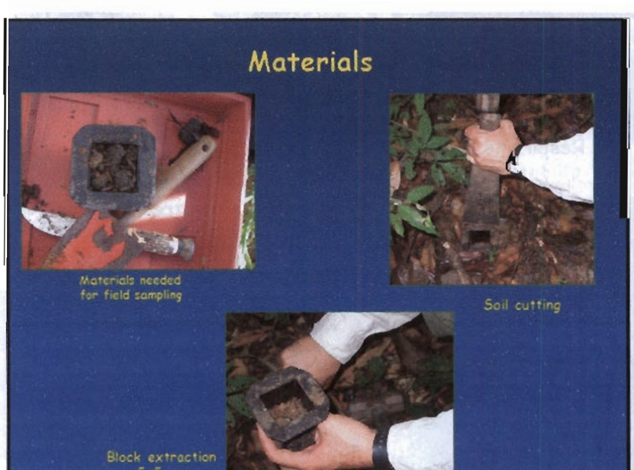
Biodiversité: les 18 taxons TSBF

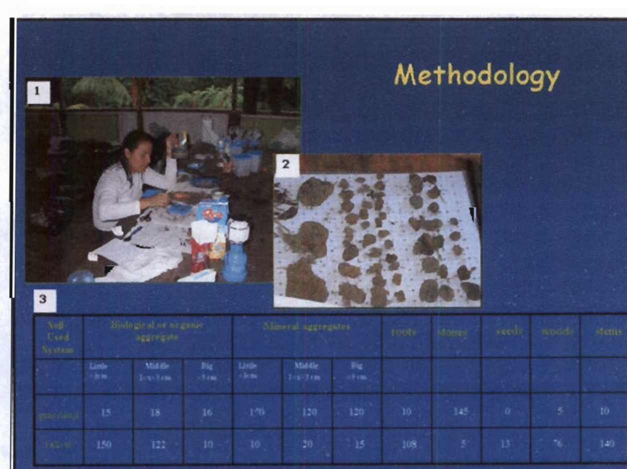

Indicators of Soil Ecosystem Services
Soil morphology
General Indicator of Soil Quality
NIRS
Elena VELASQUEZ
Patrick LAVELLE
UMR BIOSOL
IRD/Université de Paris VI
Manaus, april 2005

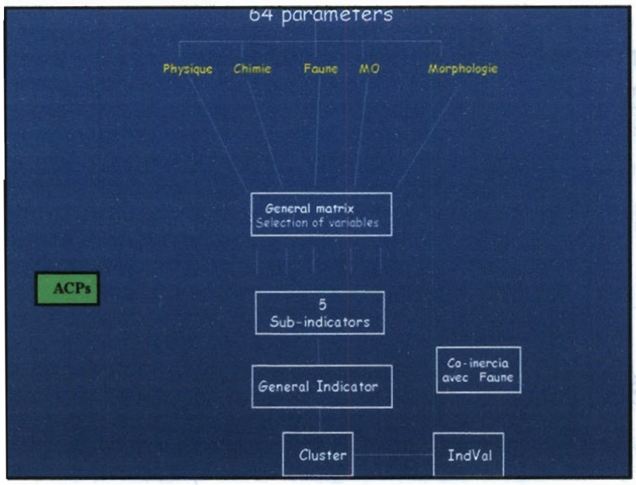

MORPHOLOGY

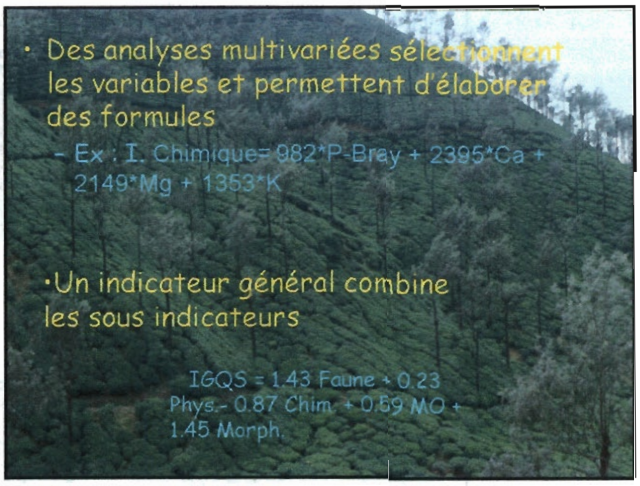

Invertebrates and roots build soil architecture
ant
root
earthworm
Biogenic structures
Soil matrix
...and hence influence all soil services,
depending on their abundance and diversity


Objective
• To quantitatively assess the visible effects of soil organisms on soil structure


Materials
Materials needed
for field sampling
Soil cutting
Block extraction
5x5 cm

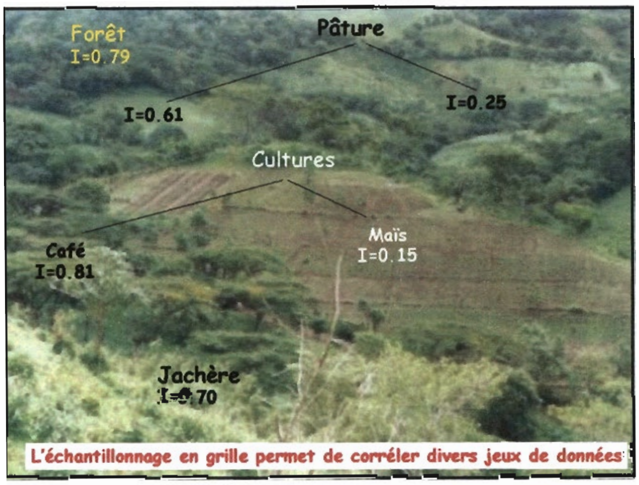

Methodology
1
2
3
Soil Used System
Biological or organic aggregate
Mineral aggregates
roots
stones
seeds
woods
stems
Little
Middle
Big
grassland 15 18 16 170 120 120 10 145 0 5 10
fallow 150 122 10 10 20 15 108 5 13 76 140

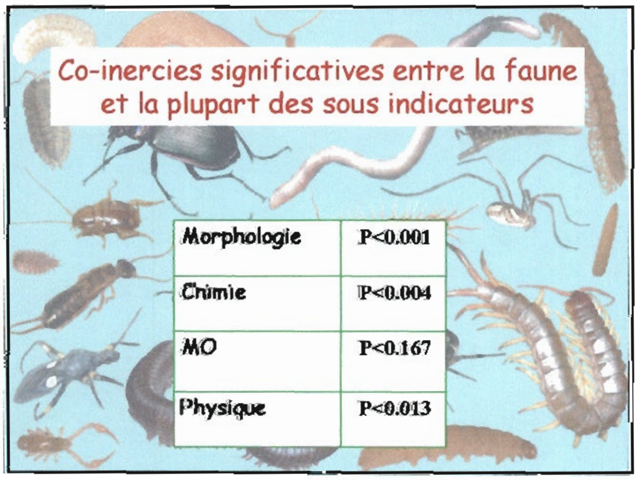


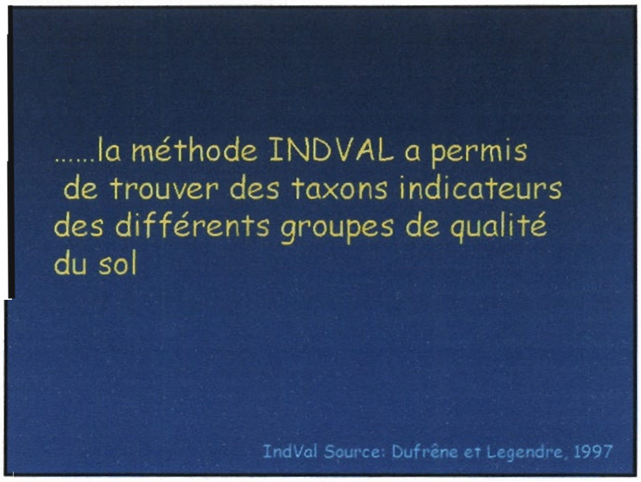


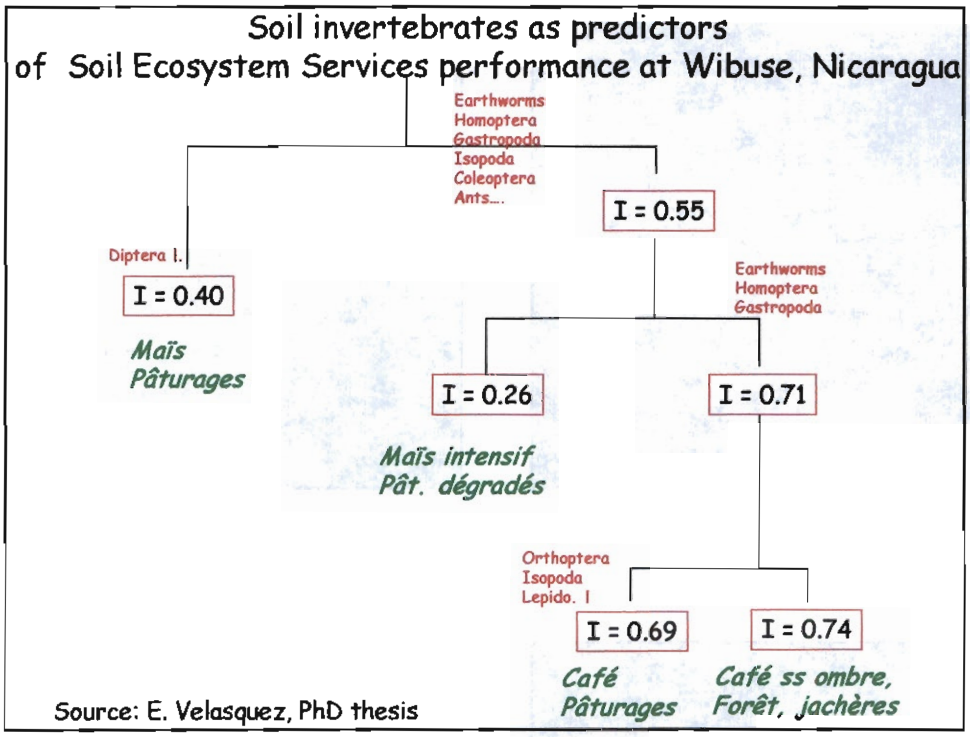
Valeurs des sous indicateurs en quelques points

Système	Faune	Micro	Chimie	Physiq	MO	General
Maïs	0.23	0.28	0.83	0.77	0.39	0.15
Café	0.97	1.00	0.55	0.67	0.80	1.00
Erodé	0.18	0.20	0.23	0.10	0.10	0.21
Pâturage	0.27	0.36	0.53	0.35	0.39	0.25
Pâturage	0.50	0.61	0.51	0.63	0.85	0.61
Jardin	0.10	0.32	0.21	0.25	0.72	0.35
Forêt	0.79	0.75	0.63	0.59	0.82	0.79
Jachère	1.00	0.41	0.68	0.39	0.81	0.70

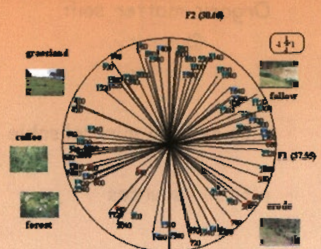







Soil invertebrates as predictors
of Soil Ecosystem Services performance at Wibuse, Nicaragua
Earthworms
Homoptera
Gastropoda
Isopoda
Coleoptera
Ants...
Diptera l.
I = 0.40
Maïs
Pâturages
I = 0.55
Earthworms
Homoptera
Gastropoda
I = 0.26
Maïs intensif
Pât. dégradés
I = 0.71
Orthoptera
Isopoda
Lepido. l
I = 0.69
Café
Pâturages
I = 0.74
Café ss ombre,
Forêt, jachères
Source: E. Velasquez, PhD thesis

Using Near Infrared Reflectance Spectroscopy (NIRS) for determine quality and quantity of organic matter soils



Patrick LAVELLE
Elena VELASQUEZ

Manaos, april 2005

Introduction

- The success of Near Infra Red Spectroscopy
  - Instrumentations, statistics, computer software and philosophy of technology.
- Process monitoring
  - Analysis rapid, relevant and reliable way.
- NIRS can be successfully used to determine:
  - Some parameters of organic matter soil (particularly total C and N)

The Chemistry of NIRS

- All organic matter consists of atoms, C, O, H,N, P, S and other elements.
- The Molecules vibrate at frequencies corresponding to wavelengths:
  - The near infra-red: 450 - 2600 nm
    -CH- -OH- -NH- etc...

The Chemistry of NIRS

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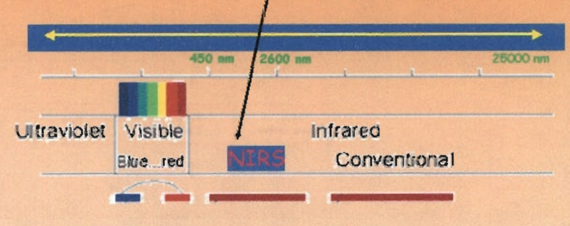
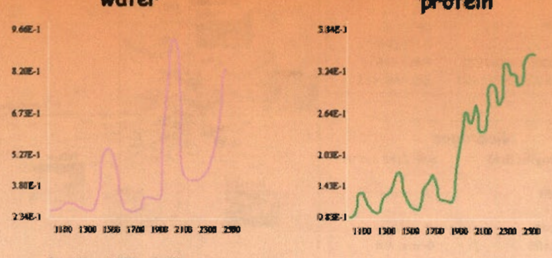
The near infra-red: 450 - 2600 nm
-CH- -OH- -NH- etc...



Near infra-red reflectance (log/R) spectra of

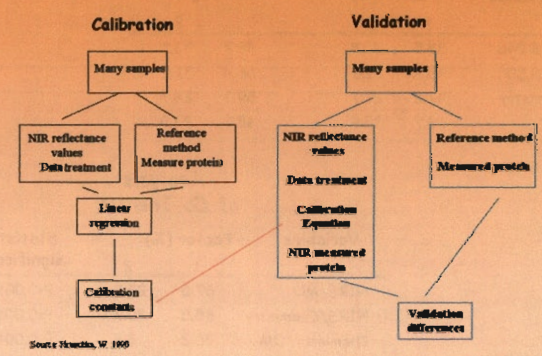
water

protein



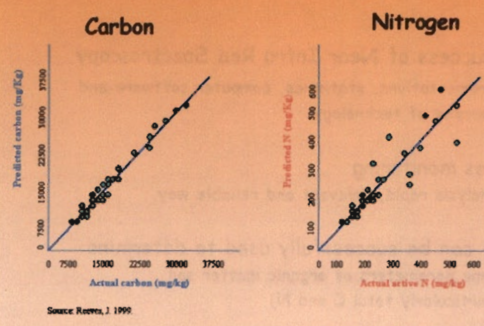
Source Murry, I.; Williams, P. 1999

Flow diagram of calibration and validation process



Source Hruschka, W. 1990

Calibration results

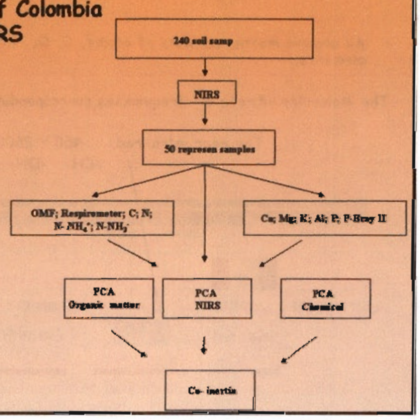


Source: Reeves, J. 1999.

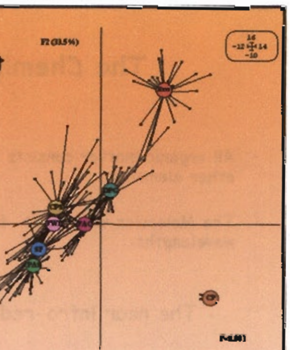
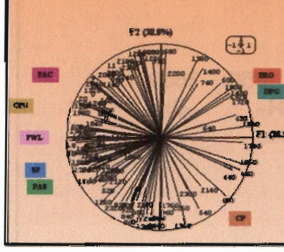
Use of NIRS for the analysis of agricultural soil

- Organic matter soil:
  - Quantity
  - Quality
- Biomass and mineralisable N
- pH, soil sources

Evaluating soil quality in tropical agroecosystems of Colombia using NIRS



The PCA and of the discriminant analysis on the NIRS data of 240 samples

The circles are the barycentres of clusters of points in each use system: secondary forest (SF), coffee plantation under shade (CPS), ungrazed pasture (PAS), coffee plantation (CP), fallow after cassava (FAC), fallow water-logged zone (FWL), degraded pasture with grazing (DPG) and eroded soil (ERO)

Variables	PCA† Factor (%) 1	2	Discriminant Analysis 1	2
NIRS 240	38.5	30.8	48.2	33.5
NIRS 50	45.8	31.6	56.4	31.0
Chemistry	47.2	27.7	59.3	24.7
OM*	38.7	23.9	48.1	23.9

Analysis of Co-Inertia

Variables	Factor (%) 1	2	Statistical significance
NIRS/MO	67.5	23.7	P<0.001
NIRS/Chemistry	65.5	30.7	P<0.001
Chemistry/OM	86.2	8.1	P<0.001

*OM= Organic Matter
†PCA=Principal Component Analysis

NIRS wavelength values (nm) characteristc of the soil-use system*

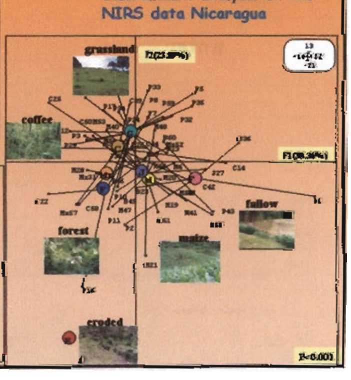
Colombia

Wavelengths (nm)	Soil-Used System*
400-560	CP
580-740; 1220-1420	ERO; DPG
760-1200; 1900-2220	FWL; CPS
1440-1880; 2240-2400	SF; PAS; CPS

Nicaragua

Wavelengths (nm)	Soil-Used System*
400-680	M; Grass; Fw
700-800	Ero
820-1240	C; M; Grass
1260-1460	Grass; Mx
1480-1560	Ero
1580-1920	Fw; Mx
1940-2440	F; C; Grass

Discriminant analysis on the NIRS data Nicaragua



Conclusions

- NIRS has high potential for evaluating and characterizing large areas of soil, quickly,reliably and economically
- NIRS has the potential to generate the extensive data bases on soil properties.
- NIRS has high potential because it is simple, highly efficient, and is safe for the operator.

Annex 2. Facilitating access to improved statistical analysis

Notes from a meeting 9.00 -10.30, 16 April

Ric Coe

Representatives from Kenya, Uganda, India, Indonesia and Mexico plus Ric Coe

1. To varying degrees in different countries, the following were noted:

- Examples of the benefits of more insightful analyses were not clear – all the presentations on this were conceptual without worked through examples.
- Scientists are not clear on the detailed ecological hypotheses that they should be investigating
- Help is needed with analysis of both ecological and socio-economic data
- Country team scientists need both specific statistical tools for BGBD data as well as more general updating of statistics
- Access to and knowledge of suitable software is also a problem

2. A new working group is proposed, though this may not be the right organisational structure. 'WG5' would coordinate, compile and disseminate information on statistical methods. The group would work by:

- Each country identifying someone as the 'quantitative methods expert' (QME). This may be a statistician or may be another scientist who is interested in learning new methods and helping others use them.
- QME's are responsible for helping all the country team with analysis.
- The QME's work together, with help from outside experts. They:
  - Exchange ideas on methods
  - Swap tricks fro overcoming problems
  - Exchange training and other materials
  - If necessary, meet to themselves be trained and solve analysis problems.

3. Country team members need:

- Illustrative examples of analyses worked through with project data
- Technical guides, specifically on choice of appropriate methods, interpretation of software output, presentation of complex data.

QME should jointly produce these, with guidance from outside facilitators.

4. Country teams can be responsible for organising their own basic statistical training to suite their needs

Annex 3
Annual meeting 2005 – Brazil
Particpants list

PSC

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Annex 4. Programme Annual Meeting 2005

April 11 -18, 2005, Tropical Manaus Business, Manaus, Brazil

	Event/Activities
Monday, April 11	
8:30 – 10:00	**Session 1. Opening of the 4th Annual Meeting and Introduction** **Chair: Prof. Fatima Moreira** Word of welcome *Fatima Moreira (convener of the BGBD Brazil programme and chair of the local organising committee for the AM05)* Opening remarks Deputy director of INPA Director IBAMA-Amazonas (Brazilian Institute of Environment) Dr. Henrique Pereira Significance of the fourth annual meeting Marieta Sakalian (task manager UNEP/GEF) Objectives and programme of the fourth annual meeting, *Jeroen Huising (project coordinator)* Introduction and organisation of the technical review *Mike Swift* Programme of the external evaluation during the AM05 *Dr. Eric Smaling* Progress and achievements of the BGBD project in 2004 *Jeroen Huising* (project coordinator)
10:00 – 10:20	**Tea and coffee break**
10:20 – 12:15	**Session 2. Benchmark area descriptions and socio-economic characterization** **Chair: Prof. Ramakrishnan** 1. Characterization of Benchmark sites in India *Balakrishna Gowda, U.M. Chandrashekara, M.P. Sujatha and R.K. Maikhuri* 2. Benchmark description: Lampung, Indonesia *Afandi, M. Utomo and d. Mizwar* Land use & Socio-economic Characteristics of the Sumberjaya BA *Rusdi Evizal, S. Bududarsono and H. Ismono* 3. Los Tuxtlas Benchmark area description and sampling approach *José Antonio Garcia, Simoneta Negrete-Yankelevitch* Socio-economic characterization of three communities of the Los Tuxtlas area *Isabelle Barois* 4. Characterization of land use types in the Mabira Forest ecosystem, Uganda *G. Lamtoo and M. J. N. Okwakol* Socio-economic characteristics and indicators of below-ground biodiversity in Mabira Forest ecosystem, Uganda *E. Balirwa, B. Mugonola and G. Byandala* 5. Land use land cover mapping using high resolution images of The Upper Solimões River, Benjamin Constant Municipality, Am, Brazil

	Elaine Cristina Cardoso Fidalgo (1), Mauricio Rizzato Coelho (1), <u>Fátima M. S. Moreira</u> (2), Fabiano de Oliveira Araújo (1), Humberto Gonçalves dos Santos (1), Maria de Lourdes Mendonça S. Brefin (1). The Physical Environment With Emphasis in Upland Soils of The Upper Solimões River, Benjamin Constant Municipality, Am, Brazil. *Maurício Rizzato Coelho, Elaine Cristina Fidalgo, Fabiano of Oliveira Araújo, Humberto Gonçalves dos Santos, Maria of Lourdes Mendonça Santos Brefin EMBRAPA Solos, RJ.* Flora survey in Upland Soils Of The Upper Solimões River, Benjamin Constant Municipality, Am, Brazil *Hiroshi Noda[(1)], Ieda Amaral[(1)], Ayrton Urizzi[(2)], Danilo Fernades da Silva Filho[(1)], Francisco Manoares Machado[(1)], Jucélia Oliveira Vidal. [(1)]*
12:15 – 13:30	**Lunch**
13:30 – 14:30	**Session 2 (cont.)** 6. Land-use mapping and typology in Oumé benchmark site (Centre-West Côte d'Ivoire) *N'DoumE C[1], GnessougoU N[1], Tondoh J E[2], TANO Y[3].* Demographic and socio-economical characterisation of the Oumé benchmark area (Centre-West Côte-d'Ivoire) *Ogni K. B[1], Ibo J[2], Agnissan A A[1]* Morphological and physical characteristics of soils along a gradient of land use intensity in Center-West Côte-d'Ivoire *Angui P.K.T.1[1] Tie B.T[2]., Tamia J.A[1]., Assie K. H[1]., Danho D. M[1]* Impact of human activities on floral diversity in the Oumé Region (Centre-West Côte d'Ivoire) *N'Guessan K. E; Ake-assi L; Kouassi K. E; Assi Y. J; Sagne C.* 7. Land use and biophysical characterization of below-ground biodiversity (bgbd) benchmark site in kenya *E.M. Muya, N. Karanja, H.Roimen, and B. Mutosotso*
14:30 – 15:30	**Session 3. Result of the inventory on macro fauna** **Chair: Prof David Bignell** 1. Termite Diversity in a Range of Land Use Types in Sumberjaya *<u>F.X. Susilo</u> and F.K. Aeny* Ant Diversity in a Range of Land Use Types in Sumberjaya *<u>F.X. Susilo</u> and Hazairin* Beetle Diversity in a Range of Land Use Types in Sumberjaya *F.X. Susilo, A.M. Hariri, Indriyati, and L. Wibowo* Earthworm Diversity in a Range of Land Use Types in Sumberjaya *W.S. Dewi and Sri Murwani* 2. Biodiversity of the Macrofauna in Santa Marta los Tuxtlas , Veracruz México. *Isabelle Barois, Martín de los Santos, Simoneta Negrete-Yankelevich and Jose Antonio Garcia* Inventory of Earthworms in the Los Tuxtlas benchmark area *José Antonio Garcia* Ants and termites abundance and diversityin three location within lox Tuxtlas BA Simoneta Negrete-Yankelevitch Coleoptera in Santa Marta Los Tuxtlas, Veracruz, Mexico *Miguel A. Morón & Roberto Arce (<u>Isabelle Barois</u>)* 3. Effects of land use change on the diversity and abundance of earthworms in a tropical high forest ecosystem in Uganda *Nkwiine C, Okwakol M J N, Rwakaikara M S and Akol A* Effects of land use change on the diversity and abundance of soil macrofauna (termites, ants and beetles) in a tropical high forest ecosystem in Uganda *Alemu S O, Akol A and Okwakol M J N*
15:30 – 15:50	**Tea and Coffee break**
15:50 – 17:50	**Session 3 (continued)**

	4. The abundance and diversity of earthworms and termites in the BGBD benchmark sites. *G.H.N.Nyamasyo; M. Kibberenge and Fred Ayuke.* 5. Diversity of earthworm along a gradient of agricultural landscape in Centre-West Region of Côte d'Ivoire *Tondoh E. J[1], Monin L [1], Tiho S[2], CSUZDI C[3]* Diversity of termites and ants along a gradient of land-use in a tropical forest margins (Oumé, Côte d'Ivoire) *Konate S.[1]; Tra-bi S.C.[2]; Adja A.N[2]; Katia S.C.[1]; Kolo Y.[1] & Tano Y.[2]* 6. Composition Of Soil Macro-Invertebrates Communities In Different Land Use Systems In Alto Solimões, Brazil *Sandra Celia Tapia-Coral & José Wellington Morais* Community structure of ants in different land use systems in the upper Solimões River – AM *Ronald Zanetti[1], Nívia Dias[1], Mônica Silva Santos[1], Márcia Lídia Gomide[1], Jacques Delabie[2]* Scarabaeidae (Insecta: Coleoptera) community structure in different soil use systems in the the upper Solimões River – AM *Silva, P.H.; Louzada, J.N.C.; Shiffler, G* Diversity of Termites in diverse Land Use Systems in Benjamin Constant Municipality, AM, Brazil. *Agno Accioly[(1)] and Reginaldo Constantino[(2)].* 7. Inventory of macrofauna in different land use systems in the Nilgiri and Nanda Devi Biosphere Reserve in India *Radha D. Kale, N.G. Kumar, B.K. Senapati, R.V. Varma and R.K. Maikhuri*
Tuesday, April 12	
8:30 – 10:30	**Session 4 Result of the inventory for nematodes and meso-fauna** **Chair: Diana Wall** 1. Collembola Diversity in a Range of Land Use Types in Sumberjaya *Cahyo Rahmadi and I Gede Swibawa* Nematode Diversity in a Range of Land Use Types in Sumberjaya *I Gede Swibawa* **(F.X. Susilo)** 2. Nematodes in Los Tuxtlas *Pilar Rodrigeuz Gusmán* Sampling of the mesofauna of Sierra de Santa Marta in Los Tuxtlas Veracruz, México *Isabelle Barois, Martín de los Santos, Antonio Angeles, José Antonio García and Patricia Rojas.* 3. Effects of land use change on the diversity and abundance of soil nematodes in Mabira forest ecosystem, Uganda *Namganda J, Bafakuzara D and Nabulya G* Effects of land use change on the diversity and abundance of soil Mesofauna in Mabira forest ecosystem, Uganda *Akol A, Alemu S O and Lamtoo G* 4. Inventory of mesofauna in different land use systems in the Nilgiri and Nanda Devi Biosphere Reserve in India *R.V. Varma, B.K. Senapati, N.G. Kumar and R.K. Maikhuri* 5. Response of the nematode communities to different land-use systems in the upper Solimões, Benjamin Constant (Amazonas, Brazil) *Cares[2], J. E, Huang S. P. Andrade[2], E. P.* Density and diversity of soil meso-invertebrates in different land use systems, in Alto Solimões, Amazonas, Brazil.

	José Wellington de Morais & Sandra Celia Tapia-Coral 6. Effects of various land uses on nematode communities in Côte d'Ivoire Gnonhouri G. P[1], Nandjui J[2], Adiko A[1] 7. Presentation by Kenyan team (to be confirmed)
10:30 – 11:00	**Tea and coffee break**
11:00 – 12:30	**Session 5. Results of the inventory on leguminosae nodulating bacteria, arbuscular mycorrhizal fungi (and ectomycorrhiza).** **Chair: Avilio France** 1. Leguminosae nodulating bacteria in four land uses from Santa Marta Los Tuxtlas. *Esperanza Martinez, Lourdes Lloret , Pablo Vinuesa (Dora Trejo)* Land Use and Diversity of Arbuscular Mycorrhizal Fungi in Mexican tropical ecosystems *Varela, L.[1], D. Trejo[2], F.J. Álvarez[3], I, Barois [4], E. Amora-Lazcano[5], P. Guadarrama[3], L. Lara[2], D. Olivera[3], I. Sánchez-Gallén[3], W. Sangabriel[3], R. Zulueta[2].* 2. LNB Diversity in a Range of Land Use Types in Sumberjaya *R.D.M. Simanungkalit and Agus Karyanto* AMF Diversity in a Range of Land Use Types in Sumberjaya *Yadi Setiadi, Noor Faiqoh, and Agus Karyanto* 3. Charaterization of Phaseolus vulgaris, Glycine max and Macroticlum atrapurpereum nodule bacteria under different land use types in Mabira forest ecosystem, Uganda *Rwakaikara M S, Zawedde J and Kizza C L* Impact of land use change on the diversity and abundance of Mycorrhiza in Mabira forest ecosystem, Uganda *Mutumba G, Serani S and Lamtoo G* 4. Morphological diversity of AM fungi isolated from the TENE area in Center-West Côte d'Ivoire *ZEZE Adolphe, Ouattara Brahima and Zabouo Armand* Investigation of rhizobia ressources in the TENE region in Center-West Côte d'Ivoire *Koné Kinanpara, ZEZE Adolphe, Kimou Akomian.*
12:30 – 13:30	**Lunch**
13:30 – 15:00	5. Assessment of diversity of legume nodulating bacteria (LNB) in Nilgiri and Nandadevi Biospheres of India *A. N. Balakrishna, M. Balasundaran2, R. K. Singh3, R.K. Maikhuri4, S. Shanker1, Devyani Sen3, S. Binisha2 & A. Chandra4* Diversity of AM fungi across a gradient of land uses in Western Ghats and Nanda Devi biosphere *A.N. Balakrishna, R.K. Maikhuri and K.V. Sankaran* 6. Density and diversity of associative diazotrophic bacteria in soils under diverse land use systems in Amazonia *Fátima M. S. Moreira,: Rafaela Nóbrega, Adriana Lima, Alexandre Barberi, Krisle da Silva, Ligiane Florentino* Diversity of leguminosae nodulating bacteria from three different land use systems in Brazilian Western Amazon *Ederson da Conceição Jesus[(1)], Ligiane Aparecida Florentino[(1)], Maria Isabel Dantas Rodrigues[(1)], Marcelo Silva de Oliveira[(2)] e Fátima Maria de Souza Moreira[(1)]* Diversity of Leguminosae nodulating bactéria in diverse Land use systems in the upper Solimões River Basin, Benjamin Constant Municipality, AM- Brazil by using three trap species. *Fátima M. S.Moreira[(1)], Adriana S.Lima[(2)], Alexandre Barberi[(2] Ligiane Florentino[(3)], Paulo Avelar Ferreira[(3)], Michele Aparecida da Silva[(3)], Marlene A de Souza[(4)], Marcelo de Oliveira[(5)]* Diversity and community structure of arbuscular mycorrhizal fungi in several land use systems in the Amazon. *Sidney L. Stürmer[(1)], José O. Siqueira [(2)], Carlos R. Grippa [(1)], Patricia Alves[(1)], Glaucia*

	Alves Silva[(1)]. 7. Abundance and growth characteristics of legume nodulating bacteria in Embu and Taita benchmark sites of Kenya *David W. Odee*[1*], *E. Makatiani1, Nancy Karanja*[2] *and James Kahindi*[3] AMF spore abundance and species composition along land use gradient in Embu and Taita *Joyce Jefwa*
15:00 – 15:30	**Tea and Coffee break**
15:30 – 17:30	**Session 6. Results of the inventory on pathogenic and antagonistic fungi and insect pests.** **Chair:** Prof. Mike Swift 1. Inventory and diversity of soil-borne plant pathogenic fungi in the biosphere reserve of los Tuxtlas, Veracruz, Mexico. *María del Pilar Rodríguez-Guzmán and Grisel Negrete-Fernández.* 2. EPF and PPF Diversity in a Range of Land Use Types in Sumberjaya *Darmono Taniwiryono and Titik Nur Aeny* SDF Diversity in a Range of Land Use Types in Sumberjaya *Iswandi Anas, Titik Nur Aeny, and Joko Prasetyo* **(F.X. Susilo)** 3. Relative abundance of pathogens in different land use types in the Mabira forest ecosystem, Uganda *Akol A and Alemu S O* The diversity and abundance of entomopathogenic fungi in relation to land use in Mabira forest ecosystem, Uganda *Serani S and Akol A* 4. Monitoring diversity of microfungi in soils under different conditions of land-use *Ludwig H. Pfenning*, Lucas M. de Abreu**, Mirian Salgado***, Larissa Gomes da Silva*, Janine Mendes de Oliveira, Anderson R. Almeida*, Ricardo T.G. Pereira** Inventory of entomopathogenic nematodes and fungi on soil samples. *Alcides Moino Junior, Ricardo Souza Cavalcanti, MSc, Vanessa Andaló* Diversity of fruit flies (Diptera: Tephritidae) and potencial impacts on traditional agroforestry systems in the upper Solimões River- AM.: *Dr. Neliton Marques, Frederico Vasconcelos, Alexandra Priscila Tregue* 5 Characterization of soil fungi in different agro-ecological units in Center-West Côte-d'Ivoire *Abo K., Diallo A.H.., Koffi N. B. C., Ganiyu K., Babacauh, K.D., and Agneroh A.* T. 6. Indian presentation (to be confirmed) 7. Land use systems and distribution of *Trichoderma* species in Embu *Sheila Okoth*
17:30 – 18:00	**Tea and coffee break**
18:00 – 19:30	**Session 7. Review of standard methods** 1. Standard methods for the inventory of earthworms *Jérôme Tondoh* (to be confirmed) 2. Standard method for the inventory of ants and termites *Souleymane Konate (to be confirmed)* 3. Methods of Below-ground Mesofauna Inventory ***Agus Karyanto*** *and F.X. Susilo* 4. Methodology for soil nematode diversity evaluation *Huang, S. P. (in memoriam) and Cares, J. E.* 5. Standard methods for the inventory of LNB

	Fatima Moreira 6. Standard methods for endo- and ecto-mycorrhizal fungi *A.N. Balakrishna (to be confirmed)* 7. Standardization of methods for inventory of phyto-pathogenic and antagonistic fungi *Sheila Okoth* (to be confirmed) 8. Standardization of methods for inventory of fruit flies *Neliton Marques* (to be confirmed)
Wednesday, April 13	
8:30 – 10:00	**Session 8. Review and synthesis of the results of the inventory** **Chair: Mike Swift** (Forum discussion with short presentations of maximum 10 minutes as indicated below) Remarks on the benchmark area characterisation (to be confirmed) *K. Ramakrishnan* Socio-economic baseline survey: cross cutting issues (to be confirmed) *Tom Tomich and Diane Osgood* Comments on results on the inventory of earthworms and method for inventory (to be confirmed), *Patrick Lavelle* Observation concerning the inventory results for termites and ants and methods for inventory (to be confirmed), *David Bignell* Observation concerning nematode inventory (to be confirmed) *Diane Wall* Observation concerning the inventory of mesofauna (to be confirmed) *Beth Franklin* Observation concerning the inventory of LNB (to be confirmed) *Avilio Franco* Observations concerning the inventory of AMF and ectomycorrhiza *Sidney Sturmer* Observation concerning the inventory of soil fungi (pathogenic and other) (to be confirmed), *Mike Swift* Observations with respect to land use inventory, sampling strategy and statistical analyses (to be confirmed), *Ric Coe*
10:00 – 10:20	**Tea and Coffee break**
Parallel session 10:20 – 11:30	**Session 9. Ecosystem services and soil quality indicators** **Chair:** Edmundo Barrios 1. Introduction to the session Tasks of the ESERV task force and summary of the discussions on methods for ecosystem service, *Edmundo Barrios.* 2. BGBD and farmer appreciation of Ecosystem Services *Jo Anderson* 3. Carbon stocks under different land uses in Oumé Region (Center-West Côte d'Ivoire) *Yao K.M[1], Abbadie L[2], Konate S[1], Benest D[2].* 4. Assessing soil morphology: a simple and robust method to evaluate the role of soil ecosystem engineers and other soil structuring processes *Elena Velasquez and Patrick Lavelle* 5. Soil engineering by Arbuscular Mycorrhizal Fungi *E. Barrios and M. Rillig*

	6. Qualitative distribution of soil agregates *Maria da Glória B. F.Mesquista, Mauricio Coelho, Fernanda Perechi, Maria Tereza Carvalho (Fatima Moreira)* 7. Evaluation of soil fertility in different Land Use Systems in upland soils of The upper Solimões River, Benjamin Constant Municipality, Am, Brazil *Sonia Alfaia, Fernanda Villani, Katell Uguen, Acácia Neves, José Edvaldo Chaves,* 8. Integrated control of subterranean pest in South America *Andreas Gaigl*
Parallel session 10:20 – 11:30	**Session 10. Analyses of BGBD at landscape level and land use intensity**. **Chair:** Simoneta Negrete 1. Land Use Intensity of CSM-BGBD Sumberjaya Window, Lampung Benchmark, Indonesia *Rusdi Evizal1, Suseno Budidarsono2, F. Erry Prasmatiwi3* 2. Operationalisation of the Land Use Intensity Index: the Mexican case *Simoneta Negrete-Yankelevich and Tajin Fuentes-Pangtay* 3. Proposal of a spatial analysis of BGBD project data: up scaling from point to global scale in three steps, *Simoneta Negrete-Yankelevich* 4. Spatial analyses and scale aspect to inventory of BGBD (title to be confirmed) *Ric Coe*
Parallel session 10:20 – 11:30	**Session 11 (parallel). Economic valuation case study**. **Chair**: Diane Osgood 1. Economic Valuation task force: progress to date and path forward *Diane Osgood and Mike Swift* 2. Economic evaluation of production systems in the OUME Region (North-West Côte d'Ivoire) *Barry M.B. and Kouadio E.* 3. Conservation and breeding in situ: contributing to the preservation of traditional knowledge/ Social economic aspects of The Upper Solimões River, Benjamin Constant Municipality, Am, Brazil *H.Noda and S.Noda* 3. Discussions
11:45 – 12:30	**Session 12. Report back of working groups of session 9, 10 and 11.** **Chair: Jeroen Huising** (report and observations from technical advisers as introduction to discussions) 1. Observation on ecosystem services and management of BGBD (to be confirmed) *Jo Anderson and K. Ramakrishnan* 2. Observations with respect to landscape analyses and indexing land use intensity *George Brown and Michael Stocking* 3. Observation on case studies for economic valuation of BGBD *Tom Tomich and Jeff McNeely*
12:30 – 14:00	**Lunch**
Parallel session 14:00 – 16:30	**Session 13. WG1 - planning of remaining activities and of reporting concerning the inventory and standard methods.** **Chair: Fatima Moreira**. 1. Remaining activities inventory of BGBD in the benchmark areas 2. Final reporting on results of the inventory. 3. Synthesis of the results of the inventory. 4. Manual for inventory of BGBD (standard methods)

Parallel session 14:00 – 16:30	**Session 14. WG2 planning session** (remaining activities, plan of work, reporting). **Chair: Jeroen Huising** 1. The BGBD project's data base; implementation by the GCO and Country Programmes *P. Okoth* 2. Portal BiosBrasil, and online training course software R. *Fatima Moreira* 3. Discussion: WEB sites to be developed by the Country Programmes and integration with the BGBD project WEB site. 4. Discussion: Site characterisation: inventory of remaining tasks and activities; Procedures and guidelines for synthesis of benchmark description and results of the site characterisation	
Parallel session 14:00 – 16:30	**Session 15. WG3&4 planning session** **Chair: Joshua Ramish** 1. Presentation on plans of WG3 for phase 2 followed by discussion. 2. Presentation of WG4 plans for phase 2 followed by discussion 3. General discussion on plans for integrating the work of WG3 and 4 into the BGBD project.	
16:30 – 17:30	**Session 16. Reporting back from working groups of session 13, 14 and 15** **Chair: Mary Okwakol** 1. Report from WG1 planning session *Fatima Moreira* 2. Report from WG2 planning session *Jeroen Huising* 3. Report from WG3/4 planning session *Joshua Ramish*	
Thursday, April 14		
8:30 – 10:15	**Session 15. Project ideas and plans for the second phase** **Chair: Nteranya Sanginga** 1. Framework for development of proposals for the second phase of the project *Jeroen Huising* 2. Plans for the second phase of the Mexican BGBD programme *Isabelle Barois* 3. Project ideas for the second phase by the other BGBD country programmes (to be confirmed)	
10:15 – 10:30	**Tea and coffee break**	
10:30 – 12:00	**Session 16. Closing session of the annual meeting (of the official programme)**	
12:00 – 13:30	**Lunch**	
13:30 – 17:00	**Visit to INPA (Science Forest, Herbarium, Entomology collection)**	
Friday, April 15		
Whole day	**Joint PSC and PAC meeting** **Chair: Michael Stocking** Members of the project steering committee and project advisory committee will hold joint meeting.	**Programme to be finalized during annual meeting** **- Joint ESERV-EVAL-SPANAL meeting** Paralle sessions on

	Major topics to be addressed are the review of progress and achievements of the project so far; suggestions for the second phase and strategic links with other major initiatives.	- **LUI** - **Soil morphology and NIRS** - **Transect (Bignell)** Lunch - **Data sharing and intellectual property rights** Proposal for BGBD data sharing protocol, to be tabled at the PSC meeting
Saturday, April 16		
Morning session and afternoon sessions	**PSC meeting** **Chair: Prof Okwakol** Discussion on conclusions and recommendations by PAC Planning of further activities towards end of phase one. Project implementation and management structure	- **Facilitating statistical analysis** (Opportunities for work and planning meetings on procedures, guidelines and formats of final reporting phase 1; Opportunities for demonstration, and other).
Sunday, April 17	Travel	