CONSERVATION AND SUSTAINABLE MANAGEMENT OF BELOW GROUND BIODIVERSITY

By

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Introduction

Soil organisms provide a wide range of essential services for the sustainable functioning of all ecosystems and are an important resource for the sustainable management of agricultural ecosystems. Apart from the importance in agriculture, and ecosystem services, there is a good prospect of finding new genetic resources among the soil organisms that can be potential source for pharmaceutical or chemical industries. For example, the immuno-suppressant drug, cyclosporin, was first isolated from the soil microfungus, *Tolypocladium inflatum*, in a mountain soil sample from Norway.

"Soil organisms" is a collective term for micro-organisms and invertebrates that live in the soil, and includes such small organisms as bacteria, fungi, protozoa, insects, worms, and other invertebrates. Their numbers, types, and population numbers are staggering. For example, just 1 m^2 of soil in a temperate forest may contain more than 1000 species of invertebrates, and the number and diversity of microbes in just 1 gm of soil may be even greater. Soil organisms constitute what is now referred to as "below-ground biological diversity" (BGBD) or, sometimes, "soil biodiversity".

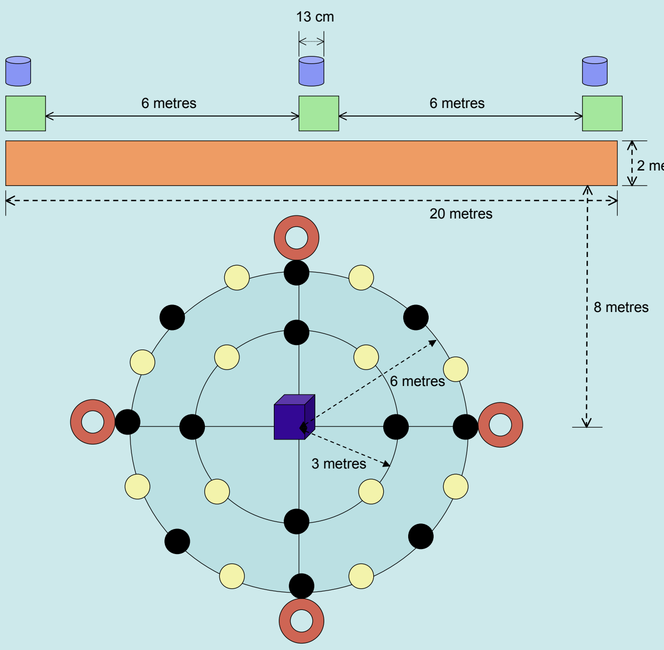
Below-ground biodiversity is dramatically reduced when forests are converted to agricultural land, and when agricultural land use is intensified. Reduced BGBD may decrease agricultural productivity and reduce the "resilience" of agricultural systems, which then become more vulnerable to adverse climatic events, erosion, pests, diseases, and other threats.

For this reason, a global project linking seven tropical countries is currently developing knowledge on soil organisms and their potential role in environmental system services and agricultural productivity enhancement. The project is coordinated by the Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT), with co-financing from the Global Environment Facility (GEF), and implementation support from the United Nations Environment Programme (UNEP). The GEF is contributing more than US dollars 9 million of the total US dollars 16.5 million budget.

Methodology

Field BGBD Inventory Methods

The figure and table below shows the methods being used in the BGBD inventory and the soil organisms to be quantified using the methods.



Symbol	Diversity Component	Description
Pitfall traps	Ants Beetles Mesofauna	Baited pitfall trap or pitfall trap (13 cm diam.)- 3 traps per sampling point
Transect	Termites Earthworms	Semi-quantitative transect (2x20 metres) 1 per sampling point (Bignell and Swift, 2001)
Winkler extractors	Ants Beetles Mesofauna	Winkler extractor for litter sample (1x1 metre) along side of the transect, 3 winklers per sampling point, distance about 6 metres (Bignell and Swift, 2001)
Soil cores	Mesofauna	Soil cores with litter (3.5x3.5x5 cm) 12 sub-samples per sampling point (depth 0-5 cm) for mesofauna 1 composite sample (first option) or 3 composite samples composed of the 4 sub-samples of each quadrant of the circle (second option)
Soil cores	Nematodes Microbes	Soil cores for microbes 12 at 0-20 cm depth without litter. Circles radius 3 and 6 metres
Soil monolith	Ants Termites Beetles Earthworms	Monolith (25x25x30 cm) including litter 1 per sampling point-TSBF method
Soil profiles	Soil characteristics	Soil sample-at least 4 sub-samples for chemical and physical analysis and soil classification (Coring), depths: 0-10; 10-20; 20-30 cm, inside the 6 m radius of the circle

Laboratory Methods

Both molecular biochemical techniques and morphological count methods are used to quantify the BGBD in the collected soil samples.

Expected Outcomes from the Project

1. Internationally accepted standard methods for characterizing and evaluating BGBD including indicators for BGBD loss.
2. An Inventory of BGBD at benchmark sites representing a broad range of globally significant ecosystems and land use types in seven tropical countries.
3. A global network for information exchange on BGBD among the seven participating countries and from invited scientists from global internationally recognized institutions.
4. Sustainable and replicable land management practices that enhance BGBD conservation and to implement pilot practices at demonstration sites in the seven participating countries.
5. Policy advice support systems developed and capacity built for sustainable conservation of BGBD

Participating Countries and Below-Ground Biodiversity

The Table below shows the mandatory functional groups to be studied in the individual participating countries.

Functional Group \ Country	Brazil	Cote d'Ivoire	India	Indonesia	Kenya	Mexico	Uganda
Legume Nodulating Bacteria (LNB) (Previously named rhizobia)	Y	Y	Y	Y	Y	Y	Y
Phytopathogenic Bacteria* (Pseudomonas, Ralstonia, Erwinia, Xanthomonas)	N	Y	N	Y	Y	N	?
Arbuscular Mycorrhizal Fungi (AMF)	Y	Y	Y	Y	Y	Y	Y
Ectomycorrhizae*	N	N	Y	Y	Y	N	?
Soil Borne Fungi: Phyto-pathogenic (Phythium, Fusarium, Rhizoctonia)	Y	Y	Y	Y	Y	Y	Y
Entomopathogenic Nematodes*	Y	N	N	N	N	N	N
Nematodes (Soil, i.e., plant pathogens and free living)	Y	Y	Y	Y	Y	Y	Y
Mesofauna (Collembola and Acari)	Y	Y	Y	Y	Y	N	Y
Macrofauna • Ants • Beetles • Termites • Earthworms	Y	Y	Y	Y	Y	Y	Y
Plant pests (white grubs-fruit flies)	Y	N	Y	Y	Y	N	Y

*Y= to be studied; N=not to be studied; ?=unsure; * = optional*

Impacts

1. Knowledge generated will create understanding of BGBD and their role in ecosystem services across a range of diverse ecosystems.
2. An understanding of BGBD will contribute to the use of soil organisms in the conservation of the environment, improving ecosystem health and enhancing agricultural productivity.
3. The global information exchange platform developed and maintained by the project will enhance knowledge exchange and create awareness on the importance of BGBD.
4. Identifying and recommending alternative land-use practices will assist in the management of BGBD, and thereby support soil processes that sustain crop production and thereby contribute to improving livelihoods of tropical farmers through the sustainability of their farming systems.
5. BGBD based technologies will enhance both rural and urban economic growth and thereby contribute to poverty reduction.

Functions of BGBD in the Soil System

Soil organisms provide a range of essential ecological services to terrestrial ecosystems. They help:
1. Control mineral nutrient cycling.
2. Sequestrate carbon in soils and reduce greenhouse gas emissions.
3. Maintain the soil's physical structure and its water retention capacity.
4. Assist plants acquire nutrients, especially through mycorrhizal fungi and nitrogen-fixing bacteria.
5. Maintain plant health through natural predation and parasitism of plant pathogens and pests.


Collecting soil samples from the Benjamin Benchmark-Site in Brazil


Field excursion in the Embu Benchmark site, Kenya

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