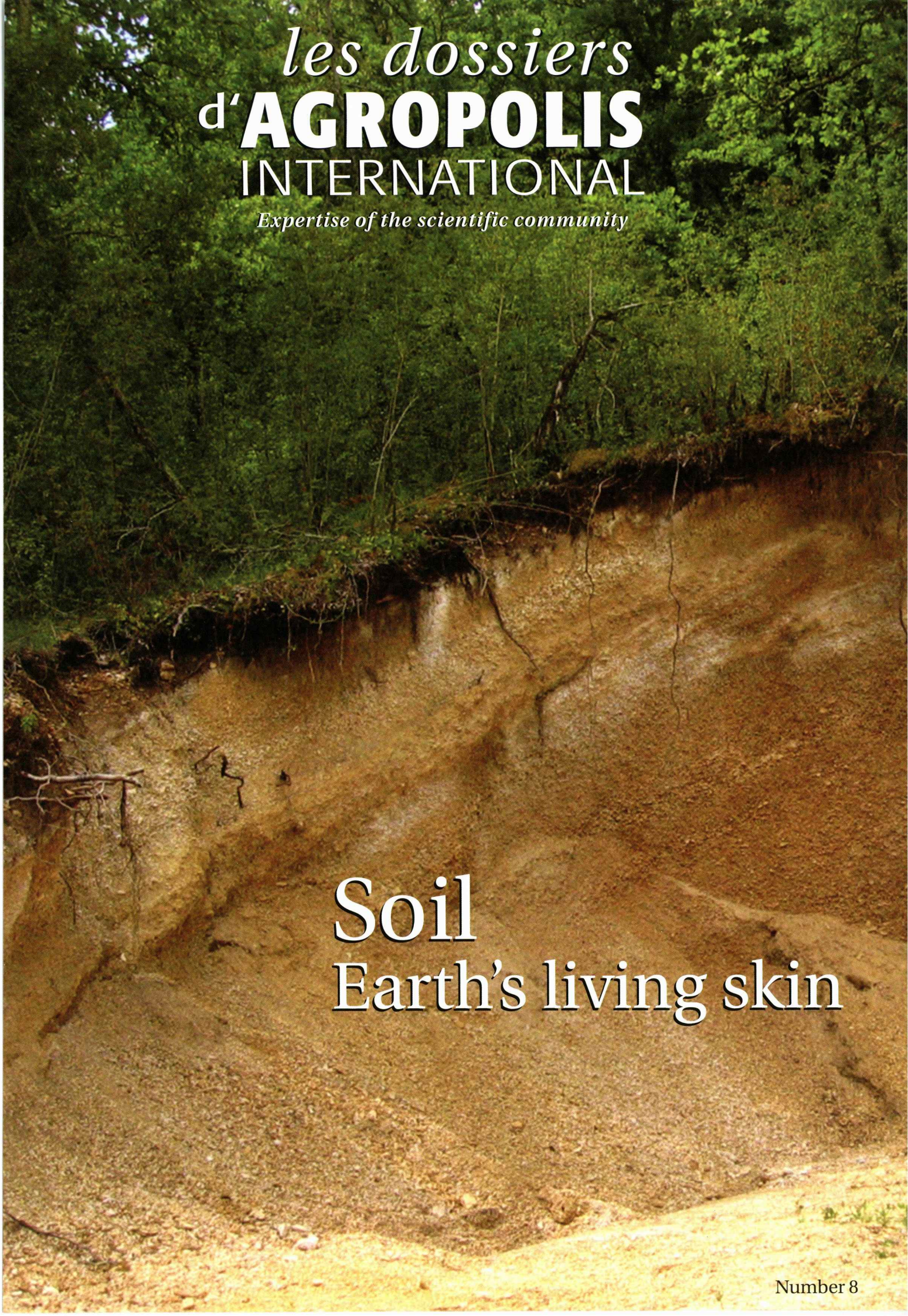

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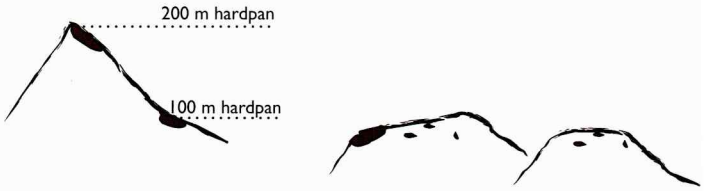
Soil
Earth's living skin

Number 8

Study of relationships between tropical forest soils, diversity and production

Soils, in addition to the climate, determine the species composition and production of natural or planted tropical forests. For instance, tree diameters and heights are reduced when the soil layer under a tropical rainforest is shallow and the stand is very dense. Similarly, the viability of plantations of species that are fast growing (e.g. eucalyptus and acacia) and/or have a high added value (teak) is determined largely by the soil properties. Based on examples from natural forests (French Guiana) and tropical plantations (Congo Basin, West Africa), studies carried out by CIRAD (UPR Dynamics of Natural Forests and UPR Functioning and Management of Tree-Based Planted Ecosystems) are aimed at determining the role of the soil in the structure of tropical rainforests and in the sustainability of planted forests. For tropical rainforests, permanent tree vegetation research projects have been set up (northern French Guiana) with different geological substrates, soil types and under annual rainfall conditions ranging from 2 000 to 4 000 mm. The findings have revealed that the floristic composition is influenced at different scales (local or regional) by the soil type in interaction with the climate (hydromorphic gradient), and by the forest's Holocene history (climatic variations and human activities).



Hardpan distribution according to the model and elevation in French Guiana.

For plantations, the research involves studies of biogeochemical cycles carried out on instrumented sites (e.g. in Congo) and/or studies on regional soil characteristics. The findings have shown that the soil physical and chemical characteristics, the biological cycle (recycling via the litter layer), and stand management strategies that are geared towards preserving soil carbon and nitrogen reserves and limiting mineral export, are key factors that determine the production and sustainability of tropical plantations.

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Through increased applied fertilizer efficiency, the process leads to increased above- and below-ground biomass production, which in turn sequesters atmospheric nitrogen within a few years. Overall, this restoration of plant and animal biodiversity in the cultivated ecosystem–an ecological intensification effect–enables the system to benefit from the restored soil functions. Efficient crop associations in systems in which chemical treatments are reduced by half have been developed through the research.

This intensification in the use of ecological processes also hampers parasite attacks in some cases. Consequently, plant breeding can be specifically targeted towards improving the nutritional quality of products. For instance, cropping new rice varieties under DMC in rainfed conditions has been shown to control rice blast 'naturally' while ensuring a rice production potential of 10 t/ha–so rice is now considered as the 'wheat of the tropics'.

Research is currently focused on solving two major problems:
- controlling weeds and plant pests for which treatments with glyphosate and other environmentally damaging herbicide molecules are no longer tolerable
- managing crop pests–phytophagous nematodes, pathogenic fungi and bacteria, and pest insects–by yet to be developed control methods. Baseline studies are required to take advantage of the allelopathic properties of plants and to develop industrial-scale production of elicitors and other natural organic molecules that could stimulate the immune functions of plants.

Close synergy between research and industry (to manufacture organic inputs of the future), associated with a vigorous researcher and farmer training policy, is required to ensure that these innovations will be adopted by farmers, especially in developing countries. It should be possible to recover millions of hectares of land that is currently abandoned due to the lack of suitable agricultural treatments.

The researchers are working on three continents. The unit has been collaborating with the University of Ponta Grossa State in Brazil (over 20 million ha cropped under DMC) for 30 years. Several researchers are working in Laos, in partnership with the Laotian Institute of Agriculture and Forestry, in Cambodia with the Cambodian Rubber Research Institute and in Thailand with the University of Kasetsart. A large-scale research initiative has been launched in Madagascar in collaboration with the *Centre de recherche agronomique pour le développement.*