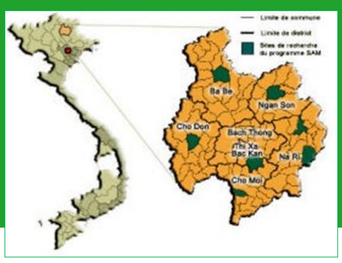
Impact of agroecological no-tillage techniques on soil biological activity in Northern Vietnam

Husson O.; Tuan H.D.; Boyer J.; Chabanne A.; Caesar-Thon That T.C.

Experimental sites in Northern Vietnam



Soil macro-fauna

and its activity can accurately reflect the efficiency of some soil ecological functions: recent studies showed a direct and proportional relationship between earthworms activity and vegetal growth.

To prevent soil degradation due to cultivation, cropping practices creating an environment favorable to micro- and macro-fauna have been developed in Vietnam based on agroecological no-tillage (ANT) principles. Such systems have been developed for acid, ferrallitic soils of Northern Vietnam mountains, proposing a range of alternatives to the traditional slash-and-burn systems, based on permanent soil cover with plants such as *Brachiaria* species and *Arachis pintoï*. Specific studies on soil biological activities under these systems have been conducted.

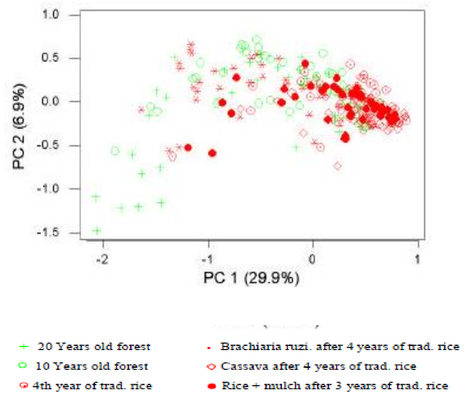
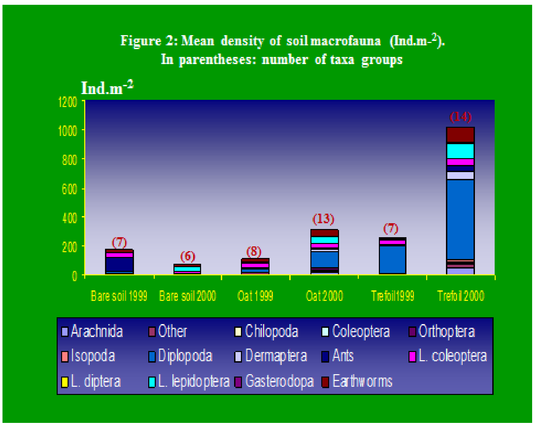


Figure 1: Principal Components Analysis of FAME profiles (3 replications per system). Only fatty acids 20 carbons and less in length considered (only microbial activity) in the analysis. Number in parenthesis on each axis indicate the percent variance explained by this axis



Diversity and structure of soil macro-fauna populations (mean of 10 replications per system) showed:

-A significant decrease in the diversity (number of taxa groups) and the density of the soil macrofauna with traditional systems of monocropping with bare soil (Figure 2).
-A rapid raise of the diversity and density of the soil macrofauna from degraded soil when cultivated with a permanent soil cover associated to the main crop (*Avena sativa*: oat; *Lotus uliginosus*:Treefoil), (Figure 2).

Brachiaria brizantha roots and oxidized rhizosphere

Field diagnosis of biological activity

based on observations in diferent soil layers of structure characteristics, texture, pH, organic matter, soil aeration, root systems and fauna, evaluation of soil lixiviation and analysis of biological activity, showed:

- A rapid soil degradation (biologically but also chemically and physically) upon cultivation with traditional systems.
- The fast recovery of soil biological activity with all the systems based on ANT systems.
- The extremely powerful root system of *Brachiaria sp*. which allows fast oxygenation of hydromorphous pastures, recycling of nutrients and increase in organic matter content, also in the deeper horizons.

Study of soil microbiological activity

for various horizons, by FAME (Fatty Acid Methyl Ester) method. The Eukary method of the Microbial Identification System (MIS) by Microbial ID, Inc. (MIDI, Newark, DE) was used to develop fatty acid profiles which were compared through principal components analysis (Figure 1). It showed:

- Different microbial populations between pasture, and all other systems or forests.
- Discrimination along PC1 indicating an evolution of microbial population with degraded systems on the right side (the most degraded being "Cassava") and favourable ones on the left side (20 years old forest).
- Microbiological populations identical for "Brachiaria" (after less than two years of *Brachiaria ruziziensis*) or after 10 years of natural forest regeneration.

Conclusions

These changes in micro and macro-fauna populations, abundance, and diversity and in the soil biological activity all follow the same trends: a rapid decrease upon cultivation with traditional systems, and a fast improvement when a vegetal cover is permanently kept on the soil and plants with strong root systems improve its structure. These evolutions are similar to trends in yield evolution under various cropping practices. ANT systems proved to be highly efficient in restoring biological activity and fauna diversity in degraded soils.

Further Reading:

Lienhard P., Tivet F., Chabanne A., Dequiedt S., Lelièvre M., Sayphoummie S., Leudphanane B., Prévost-Bouré N.C., Séguy L., Maron P.A., Ranjard L. 2013. No-till and cover crops shift soil microbial abundance and diversity in Laos tropical grasslands. Agronomy for sustainable development, 33 (2) : 375-384. http://dx.doi.org/10.1007/s13593-012-0099-4

De Moraes Sa J.C., Tivet F., Lal R., Briedis C., Hartman D.C., Zuffo dos Santos J., Bürkner dos Santos J. 2014. Long-term tillage systems impacts on soil C dynamics, soil resilience and agronomic productivity of a Brazilian Oxisol. Soil and tillage research, 136 : 38-50.http://dx.doi.org/10.1016/j.still.2013.09.010

Boulakia S., Séguy L., Tantachasatid P., Leng V., Thanisawanyankura S., Pheav S., Boyer J. 2015. Diversity and structure of soil macrofauna communities under plant cover in a no-till system in Cambodia. Journal of Environmental Biology, 36

Boyer J., Reversat G. , Lavelle P., Chabanne A. 2013. Interactions between earthworms and plant-parasitic nematodes. European Journal of Soil Biology 59 (2013) 43-47

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